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Anchoring and Loss Aversion in the Housing Market: Implications on Price Dynamics

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Abstract

In this paper we develop a simple model with anchoring and loss aversion to explain house price dynamics. We have two testable implications: 1) when both cognitive biases are present, price dispersion and trade volume are pro-cyclical; 2) if anchoring decreases with time, then price dispersion and trade volume are higher for transactions whose previous purchase is more recent. Using a dataset that contains most real estate transactions in Hong Kong from 1992 to 2006, we find strong and significant anchoring and loss aversion which are robust to type of housing and sample period. The finding is consistent with the strong correlation between house price, price dispersion, and volume in the data. Moreover, anchoring decreases with time since previous transaction, and both price dispersion and volume show the same pattern. Our results suggest that anchoring and loss aversion can induce cyclicity in house prices.

Keywords: Price Dispersion, Anchoring, Loss Aversion, Housing Market

JEL Classification: R31, D03

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1. Introduction

Contrary to what Lucas (1978) suggests, there is well-documented evidence that trading volume and price are positively correlated in the property market. Economists attribute this correlation to different sources, such as information diffusion, down-payment requirement (see Stein, 1995), loss-aversion consideration (see Genesove and Mayer, 2001) and informational friction (see Berkovec and Goodman, 1996).

A less-documented fact in the property market is that the level of price dispersion is also positively correlated with the trading volume and price.¹ The explanations mentioned above do not have such implication on price dispersion. In this paper, we present a simple model in which buyers anchor the value of a housing unit with its previous purchase price and sellers are averse to loss. The model has implications for i) the correlation between prices and trading volume as in Genesove and Mayer (2001) and ii) the correlation between price dispersion and price. We test the implications of the model with housing transaction data in Hong Kong.

Anchoring is present when a buyer's decision is affected by the initial purchase price (the previous price at transaction). When a rational buyer makes such a decision, the buyer inquires about the characteristics of the housing unit, and then compares the price with that of other housing units. In other words, the buyer equates the marginal utility of the housing service with the marginal cost. The initial purchase price should not matter here, unless the initial price contains information on the unobserved characteristics of the housing unit, and the buyer is learning them. We make use of a sample of repeated sales to separate the unobserved characteristics and anchoring, and we find a strong anchoring effect in the Hong Kong housing market.

A related, though not identical, concept is loss aversion. The effect is related to the timing of the seller putting the housing unit on the market: homeowners tends to sell housing units when there is a gain in nominal value instead of a loss. With loss aversion, homeowners have asymmetric attitudes towards gains and losses. Homeowners use the initial purchase price as a reference point to make their selling decision. If the seller is rational, the initial purchase is only relevant for calculating the sunk cost, and the seller's behavior should not be affected by it. Using the same sample of repeated sales in the Hong Kong housing market, we find that homeowners are strongly loss averse.

Should homeowners avoid or delay selling their property at a loss, and should buyers care about the price at which the property was first bought? If market participants are rational, the answer to both questions is "no". Studies in behavioral finance provide ample evidence suggesting the opposite. Using non-experimental data, Odean (1998), Grinblatt and Keloharju (2001) and Shapira and Venezia (2001) show

¹ We define price dispersion as the standard deviation of the residual from a hedonic regression.

that stock market investors in various countries are reluctant to sell losers relative to winners. McAlvanah and Moul (2010) find that horseracing bookmakers anchor to previous odds when horses are withdrawn. In the art market, Beggs and Graddy (2009) find that buyers anchor to previous selling price, while MeiMoses, Shapira and White (2010) argue that sellers are not loss averse. Tests for both effects require a sample with repeated sales of the same product, buyers and sellers knowing the previous purchase price, and that the unobserved characteristics are constant between sales. Due to the stringent requirements on the data, there are relatively few non-experimental empirical studies on either phenomenon.

We look at the Hong Kong second-hand housing market, a market that is highly competitive and informational efficient. After showing the existence of anchoring effects and loss-aversion in the Hong Kong property market, we build a model with anchoring buyer and loss-averse seller to explain the correlation among price, trading volume and price dispersion. The existence of loss-averse sellers would lead to the price-trading volume correlation as explained in Genesove and Mayer (2001). The novelty of our model is that we include anchoring buyers. In the model, buyers are matched with housing units with a different previous purchase price. Price dispersion arises due to anchoring. And since housing units with a high previous purchase price would opt out of the market when prices are falling, price dispersion will drop with prices.

To put our model to a more stringent test, we make use of its other implication that a smaller anchoring effect reduces both price dispersion and volume. First, we allow anchoring to vary with time since a previous transaction in the anchoring regression. We find that anchoring decreases with time since a previous transaction, suggesting that if a previous price is older the buyer puts less weight on it. We then calculate the price dispersion and volume by the time since a previous transaction, and find that both match with the downward trend in the anchoring effect.

By combining anchoring and loss aversion we are able to explain several features of our housing data, and our results suggest that the two phenomena contribute to the cyclicity of house prices. While the reader may draw different policy implications from the results, our non-structural model does not allow us to conduct counterfactual experiments.

2. The Hong Kong Second-Hand Housing Market

More than 90% of the transactions in the Hong Kong second-hand housing market involve real estate agents.² The complete process of a transaction usually goes as follows. A seller first contacts one or

² The source of information in this section is Estate Agents Authority, a government statutory body that regulates the real estate agents. The reader may refer to their *Practice Guide for Hong Kong Estate Agency Practitioners* (<http://www.eaa.org.hk/practice/documents/pguide.pdf>) and *Guide to Purchasing Properties* (<http://www.eaa.org.hk/consumers/doc/property.pdf>) for more details on the Hong Kong second-hand housing market.

several agents to put his house up for sale. Since it is costly to contact too many agents, different agents would hold different sets of houses. A buyer then contacts one or several agents to look for the available housing units. Thus, different buyers can face different sets of housing units. If a buyer is interested, the buyer and seller will negotiate the price through the agent. Once the price is agreed the transaction is completed, and the agent gets 2% of the sale price (1% from the buyer and 1% from the seller) as the commission fee.

One attractive feature of using data from Hong Kong is that its second-hand housing market is very competitive. There is close-to-free entry in the industry (the license fee for an agent is about HK\$2000 which is roughly US\$250 per year). There were about 30,000 real estate agents (almost 0.5% of total population in Hong Kong) as of 31 October 2010.³ As there are few second-hand housing markets in the world that are as active and competitive as that of Hong Kong, it makes the Hong Kong housing market ideal for identifying the two cognitive biases.

We are going to test whether buyers anchor their purchase price with the previous purchase price of the housing unit. As a prerequisite for identifying the anchoring effect, a buyer must know the previous purchase price. Another attraction of using Hong Kong data is that such information is easily accessible in Hong Kong. The Land Registry, a government department responsible for land registration and owners corporation registration, is required by law to provide this information. A buyer can get access to this information through its website at a very low cost.⁴

3. Data Description

We use housing transaction data provided by the Economic Property Research Center (EPRC) as our main source of data. The dataset covers most of the housing transactions from 1992 to 2006. It contains many aspects of each transaction, including prices, gross and net area, address, floor, age, number of bedrooms and living rooms, and so forth.

Initially, there were about 2.1 million observations in the EPRC data. We drop problematic observations. First, we drop observations with missing characteristics like prices, floor, and area. Second, we drop observations with outlier prices (ie, top and bottom 0.1% of the data). Third, we exclude transactions of new housing units since the first hand property market is not entirely competitive. Lastly, it is a common practice in Hong Kong to sign a provisional agreement for the transaction before signing the official agreement. The time lag between the provisional and formal agreement can be two to three months. We only keep the former transactions since the price recorded in the former transactions reflects the market

³ Please again refer to the Estate Agents Authority at <http://www.eaa.org.hk/>.

⁴ The website is: www.iris.gov.hk/eservices/byaddress/search.jsp

conditions at that time.⁵ We drop the latter observations. This leaves us with 746,574 observations, and 371,590 housing units, in the second hand housing market. Of those 746,574 observations, 266,720 are repeated sales (which involve 175,556 housing units).⁶ Table 1 reports the summary statistics of the housing units transacted in the sample period. As suggested by the table, housing units that were sold multiple times are not significantly different from those that were sold only once during the sample period.

We now present the first two features of the data that we want to explain. First, a hedonic regression is fitted to the data and we use the residual to obtain a measure of price dispersion. Since no hedonic regression is perfect, we expect our measure of price dispersion to be contaminated with unobserved heterogeneity. With that said, we try to minimize the problem by fitting the hedonic regression every quarter. That is, hedonic prices and district fixed effects are allowed to be time-varying. The standard deviation of the residuals is the measure of price dispersion. Price is the deflated price per square foot, and the explanatory variables are floor and its square, age and its square, gross area and its square, net-gross ratio and its square, bay window size and its square, club dummy, district dummies, and monthly dummies.

Figure 1 plots the quarterly price dispersion for the full sample with the average price per square foot. Price dispersion tracks the housing cycle closely (the correlation is 0.71). Trading volume shows a similar pattern in Figure 2, and the correlation of the two variables is 0.31. Figure 5 shows that, given the large cross-sectional data, the hedonic regression has a reasonably good fit for most of the sample. On average the hedonic regression can explain over 75% of the movements in price.

We can also observe some important turning points in the Hong Kong housing market. From the beginning of the sample till the last quarter of 1997, there was a housing boom in which the average price increased more than three times. With the Asian crisis and the “85,000 policy” of the Hong Kong SAR government house prices decreased to the 1992 level.⁷ From the end of 2003 to the end of the sample, we observe another housing boom.

The simple correlations among the three variables may be misleading when the variables are non-stationary. As a further check, we calculate the two-sided moving average of the quarterly growth rate of average house price, dispersion and transaction volume. As in Lucas (1978), the correlations of the moving averages can tell us whether there is a long-run relationship among the variables. We use a window of 12 quarters on each side to calculate the moving average, but using a different window size or other more sophisticated filtering methods does not change the results substantially. As shown in Figure 3

⁵ For the same transaction, there are two different transaction dates. The first is called the instrument date which is the date at which the transaction occurred. The second is called the delivery date which is the date at which the transaction documents are delivered to the Land Registry. We use the instrument date as our definition of the transaction date.

⁶ For a housing unit that was sold in 1994, 1997 and 2000, we only count the sales in 1997 and 2000 as repeated sales.

⁷ The reader can refer to the 1997 Policy Address for details: <http://www.policyaddress.gov.hk/pa97/english/polpgm.htm>

and Figure 4, the transformed variables are positively correlated, especially for average price and price dispersion. The results confirm that there is a strong positive correlation among the three variables.

4. Test for Anchoring Effect

Anchoring is a well-established bias in laboratory experiments. A famous example is in Tversky and Kahneman (1982). In the experiment, subjects are first given a random number between 1 and 100 and are then asked to estimate a number which is not related to the original random number (in their example it is the percentage of African countries in the UN). The subjects show a bias in their estimates toward the original random number. This anchoring heuristic has been documented in many other laboratory experiments.⁸ Empirical work that tests the presence of the anchoring effect is rare. In a recent work Beggs and Graddy (2009) find support for the anchoring effect in the art market.

In this paper, we follow Beggs and Graddy (2009) and first estimate a hedonic regression for log house price per square foot P_{it} of housing unit i in quarter t :⁹

$$P_{it} = X_i \beta_t + \varepsilon_{it}$$

The vector X_i include characteristics of the house that may affect house price. As in the hedonic regression in Section 3, we include floor and its square, age and its square, gross area and its square, net-gross ratio and its square, bay window size and its square, club dummy, district dummies, and monthly dummies. The difference between the hedonic regression here and that in Section 3 is that we are using log price here (which is required in the next regression). The fit of the two hedonic regressions is very similar (with R^2 above 0.75 on average). We call the fitted price from the hedonic regression $\hat{P}_{it} = X_i \hat{\beta}_t$.

Using the results of the hedonic regression, we consider the following regression, all in logs:

$$P = \mu \hat{P} + \lambda (P_p - \hat{P}) + \xi (P_p - \hat{P}_p)$$

The log price is denoted by P , and the subscript p denotes value at the previous sale. The term $P_p - \hat{P}_p$ captures any constant but unobserved characteristics of the housing unit. The characteristics

⁸ See Chapman and Johnson (2002) for a survey of the topic.

⁹ As in Beggs and Graddy (2009), we use nominal prices for our analysis.

may be time-varying, but we assume that their movements are negligible between previous and current sale. The second term on the right $P_p - \hat{P}$ captures the influence of the last period's price on the dependent variable. The presence of the anchoring means λ is positive and significantly different from zero. For the extreme case when a) there is no anchoring and b) there is no unobserved characteristics omitted in the hedonic regression, the coefficient should be exactly 1 and the second and third terms on the right drop out.

In the regression, we exclude repeated sales whose previous sale was made within 2 months or more than 2 years before the current sale. There is usually a lag of 4 to 5 weeks between the time of the transaction and the time that the documents arrive at the Land Registry. As a result, buyers cannot anchor on the previous purchase price if the previous transaction took place too recently. We set the first restriction in order to avoid such identification problem. The second restriction is to avoid significant changes in the unobserved qualities of the housing unit. This leaves us with 73,860 observations in the benchmark sample.

Table 2 reports the regression results. In column 1, we use the whole sample with 80,589 observations. In column 2, we restrict the sample to transactions after the Asian financial crisis and "85,000 policy" in 1997. The Hong Kong housing market is considered to be "overheated" in and prior to 1997, so we drop transactions in this period to see whether the anchoring effect is still present when the large rise and drop of housing prices in that period is omitted. In column 3, we restrict the sample to transactions in big housing complexes.¹⁰ Since there are usually more transactions within a big housing complex, buyers can obtain more market information about other housing units similar to the ones they are interested in. This may reduce the "need" for buyers to anchor on the previous purchase price. In column 4, we restrict the sample to transactions to bank-owned housing units. One concern in our analysis is that, unlike in the art market described in Beggs and Graddy (2009) in which sellers have a passive role in setting only the reservation price, the transaction price in the housing market is the outcome of negotiation between buyers and sellers, and thus anchoring effects may be attributable to both buyers and sellers. To estimate the anchoring effects solely from buyers, we look at transactions in which sellers have a more passive role in deciding on the transaction price. In Hong Kong, when a homeowner defaults on his mortgage, the bank will take and sell the housing unit by auction. These housing units are called bank-owned housing units. In the auction, the highest bidder wins the auction and the seller (the bank) does not play an active role in deciding the final transaction price.

The results indicate that buyers do anchor on the previous purchase price. The anchoring coefficient with the whole sample is statistically significant at about 0.07. This means that a 10 percent positive difference between the previous sale price and the hedonic prediction would lead the final price to be adjusted

¹⁰ We define big housing complexes as those housing complexes with more than 1000 housing units.

upward toward the previous price by about 0.7 percent of this difference. For example, if a housing unit is worth HK\$ 1 million according to the hedonic regression, then if the previous transaction price is HK\$ 1.1 million, now the buyer is willing to pay HK\$ 1.007 million for the housing unit. The anchoring effect is a little bit stronger, at around 0.08, for transactions that occurred after the financial crisis in 1997. The anchoring effect is only around 0.01, for transactions in big housing complexes. The weaker anchoring effect in big housing complexes is expected since buyers have more market information with more similar housing units. However, the anchoring effect, though smaller, is still statistically significant. The anchoring effect is at around 0.08 for bank-owned housing units, which implies that most of the anchoring effect found earlier can be attributed to buyers.

5. Test for Loss Aversion

According to Tversky and Kahneman (1991), there are three attributes that characterize the value function from prospect theory. First, gains and losses are defined relative to a reference point. Second, the value function is steeper in the loss domain than in the gain domain (loss aversion). Third, the marginal value of both gains and losses decreases with their size. While most of the evidence of loss aversion is documented from survey questions and experiments, there are some papers that document sellers in housing markets and stock markets that exhibit loss aversion. Genesove and Mayer (2001) show that home sellers in downtown Boston subject to nominal losses set a higher asking price, attain a higher selling price, and exhibit a lower sale hazard than other sellers. Similarly, Odean (1998), Grinblatt and Keloharju (2001) and Shapira and Venezia (2001) empirically show that stock market investors in various countries are reluctant to sell losers relative to winners. However, Mei, Moses, Shapira and White (2010) argue that sellers in the art market are not loss averse.

We adopt the approach in Mei, Moses, Shapira and White (2010) to test for the presence of loss aversion. According to them, as the lag of the original purchase and sale increases, there are three possibilities. First, some loss-averse purchasers may finally decide to sell. This would skew the observed prices for longer lags toward showing losses. They call it “delayed loss realization.” Second, loss-aversion may lead to permanent disappearance of the housing unit from the market. This would skew the observed prices for longer lags toward showing gains. They call it “permanent loss avoidance.” Third, if sellers are loss-neutral, the length of the lag would not have any impact on the observed prices.

Following their approach, we create two dependent variables: 1) gain dummy $D_{g,i}$ that has a value of 1 if the transaction i leads to a gain, and 2) sale-purchase ratio $R_{g,i}$, which is defined as the ratio of the sale price to the initial purchase price of a housing unit, for a particular transaction i . We take the log of the ratio.¹¹

¹¹ As in Genesove and Mayer (2001), we use nominal prices for our analysis.

Explanatory variables are as follows: months held Y_i which is the number of months between the original purchase and the sale; $P_{p,i}$ is the initial purchase price for the transaction i ; X_i is the hedonic characteristics of the housing unit; $\Delta\bar{P}_i$ is the change in the general house price level; and T_i is a dummy for the year of the sale. We can estimate a logit model for the gain dummy:

$$z_i^* = \begin{cases} \alpha + \beta_Y Y_i + \beta_P P_{p,i} + X_i \beta + \beta_{\bar{P}} \Delta\bar{P}_i + \beta_T T_i + \varepsilon_i > 0 & \text{if } D_{g,i} = 1 \\ \alpha + \beta_Y Y_i + \beta_P P_{p,i} + X_i \beta + \beta_{\bar{P}} \Delta\bar{P}_i + \beta_T T_i + \varepsilon_i \leq 0 & \text{if } D_{g,i} = 0 \end{cases}$$

For the sale-purchase ratio, we run an OLS. The coefficient we are interested in is β_Y . If $\beta_Y < 0$, sellers are loss averse and exhibit “delayed loss realization.” If $\beta_Y > 0$, sellers are loss averse and exhibit “permanent loss avoidance.” If sellers are loss neutral, we should find $\beta_Y = 0$.

Here we do not restrict the lag between original purchase and sale to be within 2 years, as when we are testing for anchoring.¹² This leaves us with a larger sample with 265,638 observations.

Tables 3 and 5 provide the estimation results from the logit model and the OLS. Again, we display the results for three groups of observations (whole sample, post-1997 sample, and big-housing-complex sample). The coefficient on months held, Y_i , is significantly negative for both the logit model and the OLS. This means that sellers in the Hong Kong housing market exhibit “delayed loss realization.” The effect of loss aversion decreases with the time since last purchase. This result is robust using the post-1997 sample and the big-housing-complex sample. The signs of the other coefficients are as expected.

In Hong Kong, homeowners cannot sell a housing unit with negative equity (i.e. when debt is higher than the market value of the unit). Thus, given the same willingness to sell the unit, a homeowner with negative equity may delay the sale until part of the debt is paid while a homeowner with positive equity may not. This non-behavioral reason can also lead to the negative estimates on the coefficients on months held, Y_i .¹³ To see if this non-behavioral factor is driving our results, we run the logit regression on two separate samples. The first sample consists of repeated transactions whose initial sale occurred between September and December in 1997, right after the Asian financial crisis. According to the Hong Kong Monetary Authority, about 70% of housing units with negative equity in 2006 were bought in 1997.¹⁴ Thus the first sample represents those home units that are more likely to be affected by the negative equity

¹² We have also tried dropping those with a lag between 0 to 2 months, or limiting the sample to below 1 year, and results are very similar.

¹³ We thank Charles Leung for pointing this out.

¹⁴ See www.info.gov.hk/hkma/eng/viewpt/20060112e.htm.

constraint. The second sample consists of repeated transactions whose initial sale occurred in 1999, of which the portion of housing units with negative equity is much lower.¹⁵ In Table 4, the estimates of coefficients on months held, Y_i , are negative using both samples. While it is true that the estimates using the 1997 sample are more negative because of the negative equity effect, the homeowners who bought in 1999 still exhibit statistically significant “delayed loss realization.”

6. A Simple Model of the Housing with Anchoring and Loss Aversion

For simplicity, we take a snapshot of the housing market and look at the buying and selling decisions of individuals in a single period. In other words, buyers and sellers are myopic.¹⁶

There are N potential buyers and N potential sellers in the market. A seller s originally bought the house at price P_p , which for simplicity is drawn from a uniform distribution $U(0,1)$. The reservation value of a buyer on a housing unit with the previous purchase price P_p is:

$$R_b = \gamma_b + \lambda P_p$$

where $\lambda > 0$ measures the anchoring effect. That is, the higher the initial price, the higher is the reservation value. The constant γ_b can be interpreted as a demand shock.

The seller's reservation value, or asking price, is not a function of P_p :

$$R_s = \gamma_s$$

The constant γ_s can be interpreted as a supply shock. We assume $\gamma_b > \gamma_s$ so that there is a gain from trade for both parties. When a buyer meets a seller with previous purchase price P_p , the price is determined by symmetric Nash bargaining:

$$P(\gamma_b, \gamma_s, P_p) = \frac{\gamma_b + \gamma_s + \lambda P_p}{2}$$

¹⁵ Only 1% of housing units with negative equity in 2006 were bought in 1999, according to the citation in the previous footnote.

¹⁶ We understand that the static model may not be sufficient to test the dynamic behavior of the housing market. But we think this simple model can offer intuition on why we observe the cyclicity of price dispersion and transaction volume.

We then consider four possible cases.

6.1 “Rational” Benchmark: No Anchoring and No Loss Aversion

When the buyer does not anchor ($\lambda = 0$) and the seller is not loss averse, the price for each match is the same:

$$P(\gamma_b, \gamma_s, P_p) = \frac{\gamma_b + \gamma_s}{2}$$

Since both parties gain from each match ($\gamma_b > \gamma_s$), every match will result in a transaction. Thus, price dispersion in the market is zero, and transaction volume is N .

6.2 Anchoring Buyer, Loss Neutral Seller

When buyers anchor their price on the previous purchase price P_p , i.e. $\lambda > 0$, the price from each match will depend on P_p :

$$P(\gamma_b, \gamma_s, P_p) = \frac{\gamma_b + \gamma_s + \lambda P_p}{2}$$

Again, both parties gain from each match, and every match will result in a transaction. The transaction volume is N , and the variance of price can be calculated as:

$$V(P) = V\left(\frac{\gamma_b + \gamma_s + \lambda P_p}{2}\right) = \frac{\lambda^2}{4} V(P_p) = \frac{\lambda^2}{48}$$

Price dispersion depends on the dispersion of P_p , which follows a uniform distribution. Also, price dispersion depends on anchoring effect λ . A bigger anchoring effect increases price dispersion.

6.3 Loss Averse Seller, Non-Anchoring Buyer

When anchoring effect is absent ($\lambda = 0$), the price is the same in every match:

$$P(\gamma_b, \gamma_s, P_p) = \frac{\gamma_b + \gamma_s}{2}$$

We consider an extreme case of loss aversion: the seller compares the bargained price with P_p , and the seller will not sell if and only if $P < P_p$, i.e. the seller suffers a loss. In other words, a transaction occurs only when:

$$\frac{\gamma_b + \gamma_s}{2} \geq P_p$$

We normalize the parameters so that $\frac{\gamma_b + \gamma_s}{2} < 1$, and only a proportion $\frac{\gamma_b + \gamma_s}{2}$ of the N matches will result in a transaction. Since there is no anchoring, price dispersion is zero.

6.4 Anchoring Buyer and Loss Averse Seller

Combining the two previous cases, the price in a match with previous purchase price P_p is written as:

$$P(\gamma_b, \gamma_s, P_p) = \frac{\gamma_b + \gamma_s + \lambda P_p}{2}$$

Transaction occurs when:

$$\frac{\gamma_b + \gamma_s}{2 - \lambda} \geq P_p$$

The variance of price, or price dispersion, is calculated as:

$$V(P) = \frac{\lambda^2}{48} \left(\frac{\gamma_b + \gamma_s}{2 - \lambda} \right)^2$$

When we have a boom in the housing market, $\gamma_b + \gamma_s$ is bigger. Price dispersion and volume are both positively correlated with the housing market cycle.

The intuition is straightforward. During a downturn, $\gamma_b + \gamma_s$ is low, and so is the price of every match. A large proportion of sellers expect a loss and will opt out of the market. The market only sees transactions from sellers with a low P_p . During a housing boom, $\gamma_b + \gamma_s$ is high and so is the transaction price.

Sellers with higher P_p are attracted into the market and sell at a higher price than sellers with lower P_p , due to the anchoring effect. Price dispersion increases.

Suppose anchoring goes down with time, and let λ_1 be anchoring for transactions with recent previous sales and λ_2 be anchoring for transactions with old previous sales. We know $\lambda_1 > \lambda_2$.

$$\frac{V_1(P)}{V_2(P)} = \frac{\frac{\lambda_1^2}{48} \left(\frac{\gamma_b + \gamma_s}{2 - \lambda_1} \right)^2}{\frac{\lambda_2^2}{48} \left(\frac{\gamma_b + \gamma_s}{2 - \lambda_2} \right)^2} = \left(\frac{\lambda_1}{\lambda_2} \right)^2 \left(\frac{2 - \lambda_2}{2 - \lambda_1} \right)^2 > 1$$

That is, regardless of the business cycle, there will be more price dispersion when the anchoring effect is stronger. Also, as transactions occur when $\frac{\gamma_b + \gamma_s}{2 - \lambda} \geq P_p$, transactions volume also increases with λ .

6.5 Testable Implications

We summarize the predictions of our model in Table 6. If both effects are present the model has the following testable implications:

Implication 1: *Price dispersion and volume are pro-cyclical.*

We define pro-cyclical as positively correlated with the average house price. According to our model, when the housing market is in a boom, we will observe a larger number of transactions and more disperse prices. That is, for two housing units with similar characteristics, we find them to have more diverse prices during the boom time.

Implication 2: *If anchoring decreases over time, then for transactions with earlier previous transaction dates, both price dispersion and volume are smaller.*

Suppose anchoring disappears with time, i.e. buyers put less weight on the previous price if the previous transaction happened a longer period ago. Our model then predicts that dispersion and volume will be smaller if we look at a sample of transactions with a longer time since the previous transaction.

As shown in Section 3, the first implication is consistent with the data. In the next section we will show that the second implication is also supported by the data.

7. A Further Test: Decreasing the Anchoring Effect

As mentioned in the introduction, there are several papers explaining the positive correlation between price and volume. Stein (1995) shows that in a housing demand model with a down-payment requirement, an exogenous negative shock to house prices can have a large and broad-based negative impact on household liquidity and lead to lower transaction volume. By simulating a search model in which sellers differ by their time on the market, Berkovec and Goodman (1996) generate the time series correlation among demand, turnover and prices. Leung, Lau and Leong (2002) empirically test the two models above, and argue that the findings, based on Hong Kong housing transaction data, are more consistent with the predictions of the search theoretical model. Genesove and Mayer (2001) use housing data in Boston in the 1990s to empirically show that house sellers are loss averse, which they argue can explain the correlation between price and volume. But these papers do not have implications on price dispersion.

Regarding price dispersion, Leung, Leong and Wong (2006) use Hong Kong housing data to attribute the level of price dispersion to macroeconomic factors like interest rates, and they also find that the level of price dispersion is positively correlated with trading volume.

We have documented the positive correlation among price, trading volume and price dispersion in the housing market in Section 3. In Section 6, we use a simple model with anchoring buyers and loss-averse sellers to explain the correlation among them. In this section, we further test another implication of our simple model.

According to our model, given loss aversion, when anchoring is weaker both trade volume and price dispersion will go down (Implication 2). If anchoring decreases with the time since previous transaction, then our data allow us to conduct a further test of our model. A decreasing anchoring effect means that, for the same previous transaction price of \$1 million, a buyer will put less weight on it when deciding the offer price if the housing unit was sold 10 years instead of 5 years ago.

To test for a decreasing anchoring effect we run the anchoring regression again but with λ varying by the number of months since the last transaction. The coefficients are plotted in figure 6 (plus and minus two standard errors). Anchoring effects at all time lags are positive and significantly different from zero, but it changes from roughly 0.20 for lags below 1 year, to roughly 0.10 for lags above 1 year. That is, if the previous purchase price is HK\$ 1.1 million and the current hedonic price is HK\$ 1 million, a buyer is willing to pay HK\$ 1.01 if the previous purchase happened more than 1 year ago, and a buyer is willing to pay HK\$ 1.02 if the purchase was made less than 1 year ago.

According to our model, a smaller anchoring effect implies smaller price dispersion and volume. Based on the declining anchoring effect in Figure 6, we should find price dispersion and volume decreasing with the

time since the previous transaction. We calculate price dispersion and volume by time since previous transaction, from 3 months to 2 years. In Figure 7 and Figure 8 we plot them against the anchoring effect in Figure 6. Consistent with our model's prediction, both price dispersion and volume are positively correlated with the time-varying anchoring effect (with a correlation of 0.465 and 0.561 respectively).¹⁷

8. Conclusion

Using a sample of repeated sales, we show that both anchoring and loss aversion are present in the Hong Kong housing market. Knowing that both buyers and sellers are not rational, we propose a simple model to show the impact of the two cognitive biases on house price dynamics. When both effects are present, both price dispersion and trade volume are positively correlated with the average house price. In addition, given loss aversion, a smaller anchoring effect reduces price dispersion and volume. We find that a declining anchoring effect does relate to declining price dispersion and volume. We view these findings as supportive of an important role played by anchoring and loss aversion on the cyclicity of house prices.

¹⁷ Changing the starting date of the sample changes the results very little.

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Table 1. Summary Statistics of Housing Units in Hong Kong

We use housing transaction data provided by the Economic Property Research Center (EPRC) as our main source of data. The dataset covers most of the housing transaction from 1992 to 2006. The standard deviations are in parenthesis.

	Whole Sample	Non-Repeated-Sales	Repeated-Sale
Age	9.1101 (8.6835)	7.6248 (8.7085)	11.7775 (7.9715)
Gross Area	699.5105 (266.1649)	712.3189 (269.0761)	676.4684 (259.2581)
Net Gross Ratio	0.7934 (0.0598)	0.7925 (0.0586)	0.7948 (0.0619)
Floor	15.9126 (10.7564)	16.4840 (11.1536)	14.8845 (9.9198)
Baywindow	9.9732 (15.268)	9.2658 (15.1699)	11.2460 (15.3611)
Housing Units	371,590	371,590	175,556
N	746,547	479,827	266,720

Table 2. Anchoring Regression

We first fit a hedonic regression on the data and we call the fitted price from the hedonic regression $\hat{P}_t = X_t \hat{\beta}$. We then run the regression $P_t = \mu \hat{P}_t + \lambda (P_p - \hat{P}_t) + \xi (P_p - \hat{P}_p)$. The term $P_p - \hat{P}_t$ captures any constant but unobserved characteristics of the housing unit. The characteristics may be time-varying, but we assume that their movements are negligible within the period p (the date of previous sale) and t . The second term on the right $P_p - \hat{P}_p$ captures the influence of last period's price on the dependent variable. The presence of the anchoring means λ is positive and significantly different from zero. The standard errors are in the parenthesis.

	Whole Sample	Post-1997 Sample	Big-Estate Sample	Bank-Owned Houses Sample
Current Hedonic Price (\hat{P}_t)	0.9577 (0.0014)	0.9250 (0.0023)	0.9429 (0.0021)	0.9928 (0.0149)
Anchoring Effect ($P_p - \hat{P}_t$)	0.0670 (0.0028)	0.0771 (0.0042)	0.0100 (0.0036)	0.0816 (0.0240)
Unobserved Heterogeneity ($P_p - \hat{P}_p$)	0.3855 (0.0039)	0.3288 (0.0055)	0.4162 (0.0055)	0.3184 (0.0403)
Constant	0.3861 (0.0114)	0.6380 (0.0183)	0.4999 (0.0172)	0.0048 (0.1199)
Adjusted R^2	0.8682	0.7798	0.8683	0.9082
N	80,589	48,572	36,560	458

Table 3. Loss Aversion Regression (Gain Dummy Logit)

We run a logit regression for the dummy variable $D_{g,i}$ that has a value of 1 if the roundtrip transaction i leads to a gain. The model says that $\alpha + \beta_Y Y_i + \beta_P P_{p,i} + X_i \beta + \beta_{\bar{P}} \Delta \bar{P}_i + \beta_T T_i + \varepsilon_i$ is larger than 0 if $D_{g,i} = 1$, and it is less than or equal to zero if $D_{g,i} = 0$. If $\beta_Y < 0$, sellers are loss averse and exhibit "delayed loss realization." If $\beta_Y > 0$, sellers are loss averse and exhibit "permanent loss avoidance." See section 5 for details. The standard errors are in the parenthesis.

Independent Variable	Whole Sample	Post-1997 Sample	Big-Housing-Complex Sample
Months Held (Y_i)	-0.0244 (0.0002)	-0.0262 (0.0003)	-0.0228 (0.0004)
Initial Purchase Price ($P_{p,i}$)	-1.6047 (0.0197)	-1.566 (0.0218)	-2.5758 (0.0388)
Change in house price level ($\Delta \bar{P}_i$)	4.9227 (0.0408)	4.2026 (0.0436)	6.1725 (0.0720)
Year Dummies	Yes	Yes	Yes
Hedonic Controls	Yes	Yes	Yes
Constant	7.7679 (0.2533)	4.6559 (0.1910)	12.6291 (0.4102)
Pseudo R^2	0.5603	0.4776	0.6166
N	265,638	167,589	120,287

Table 4. Loss Aversion Regression (Gain Dummy Logit)

We run the same logit regression as in Table 3. The first column consists of repeated sales whose initial purchase occurred between September and December of 1997, right after the Asian Financial Crisis. The second column consists of repeated sales whose initial purchase occurred in 1999. The standard errors are in the parenthesis.

Independent Variable	Initial Purchase in 1997	Initial Purchase in 1999
Months Held (Y_i)	-0.3364 (0.0832)	-0.1284 (0.0091)
Initial Purchase Price ($P_{p,i}$)	-3.7085 (0.3264)	-0.6832 (0.0781)
Change in house price level ($\Delta \bar{P}_i$)	2.0989 (0.6129)	1.2784 (0.2637)
Year Dummies	Yes	Yes
Hedonic Controls	Yes	Yes
Constant	57.8923 (10.3125)	2.2411 (1.0546)
Pseudo R^2	0.6466	0.2590
N	5,253	10,033

Table 5. Loss Aversion Regression (Sale-Purchase Ratio OLS)

We run the OLS regression $R_{g,i} = \alpha + \beta_Y Y_i + \beta_P P_{p,i} + X_i \beta + \beta_{\bar{P}} \Delta \bar{P}_i + \beta_T T_i + \varepsilon_i$. The coefficient we are interested in is β_Y . If $\beta_Y < 0$, sellers are loss averse and exhibit "delayed loss realization." If $\beta_Y > 0$, sellers are loss averse and exhibit "permanent loss avoidance." See section 5 for details. The standard errors are in the parenthesis.

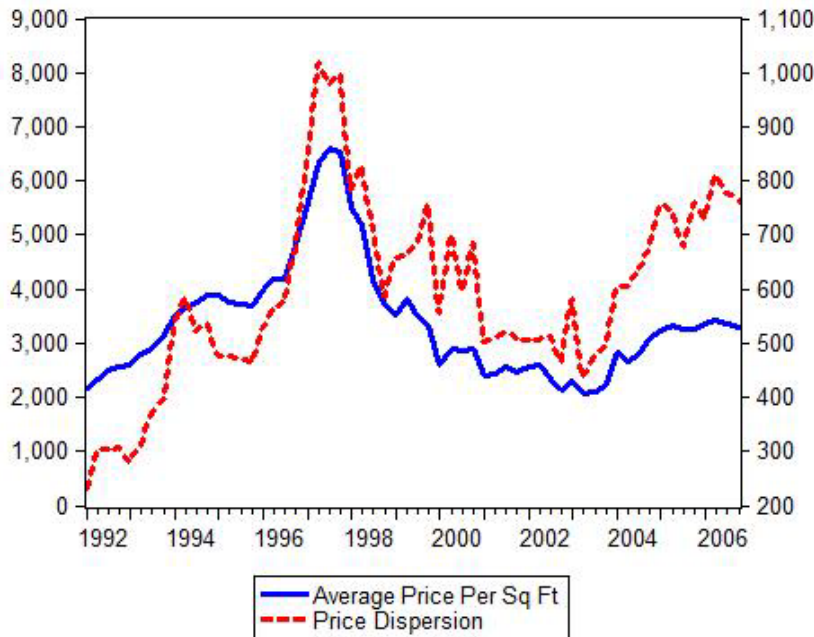
Independent Variable	Whole Sample	Post-1997 Sample	Big-Estate Sample
Months Held (Y_i)	-0.0016 (0.0000)	-0.0017 (0.0000)	-0.0013 (0.0000)
Initial Purchase Price ($P_{p,i}$)	-0.2653 (0.0014)	-0.2994 (0.0020)	-0.3148 (0.0022)
Change in house price level ($\Delta \bar{P}_i$)	0.6279 (0.0024)	0.5793 (0.0034)	0.6511 (0.0035)
Year Dummies	Yes	Yes	Yes
Hedonic Controls	Yes	Yes	Yes
Constant	0.9562 (0.0155)	1.2937 (0.0203)	1.2802 (0.0224)
Adjusted R^2	0.6728	0.5832	0.7245
N	265,638	167,589	120,287

Table 6. Summary of the Simple Model

There are N potential buyers and N potential sellers in the market. A seller s originally bought the house at price P_p , which is drawn from a uniform distribution $U(0,1)$. The table summarizes the implications when either anchoring or loss aversion or both are present. The standard errors are in the parenthesis.

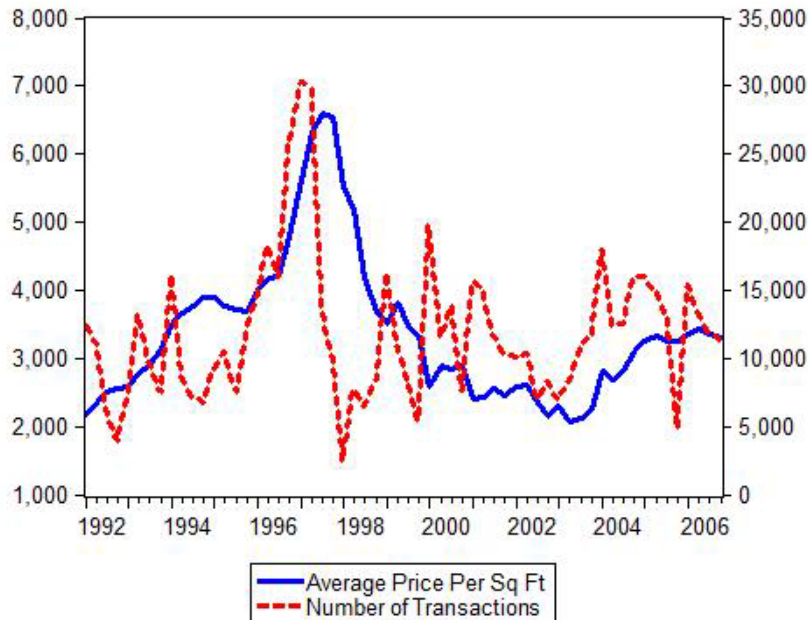
	Anchoring	No Anchoring
Loss Aversion	Pro-cyclical Price Dispersion	No Price Dispersion
	Pro-cyclical Volume	Pro-cyclical Volume
Loss Neutral	Non-cyclical Price Dispersion	No Price Dispersion
	Constant Volume	Constant Volume

Figure 1. Price Dispersion (Right axis) and Average Price Per Sq. Feet (Left axis)



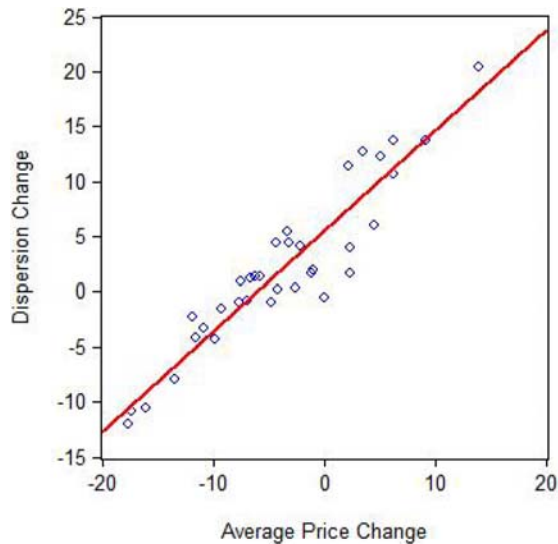
For each month we plot price dispersion and the average price per sq. feet. Please refer to Section 3 on how the sample is selected, and for the hedonic regression that generates our measure of price dispersion.

Figure 2. Number of Transactions (Right axis) and Average Price Per Sq. Feet (Left axis)



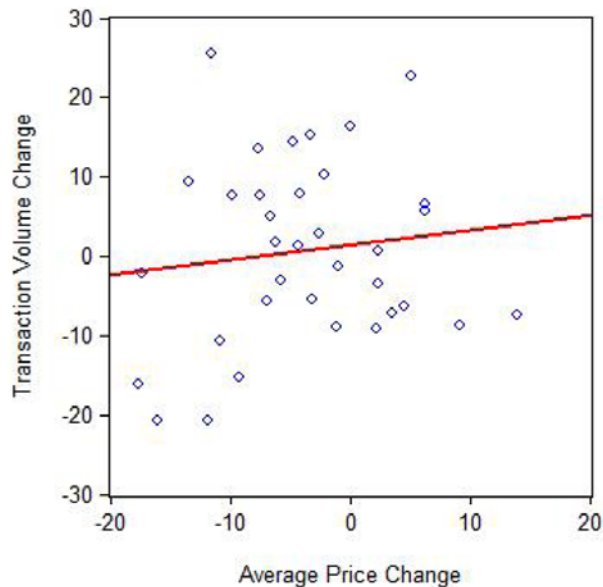
For each month we plot the number of transactions and the average price per sq. feet. Please refer to Section 3 on how the sample is selected.

Figure 3. Moving Average of Change in Price Dispersion and Change in Average Price Per Sq. Feet

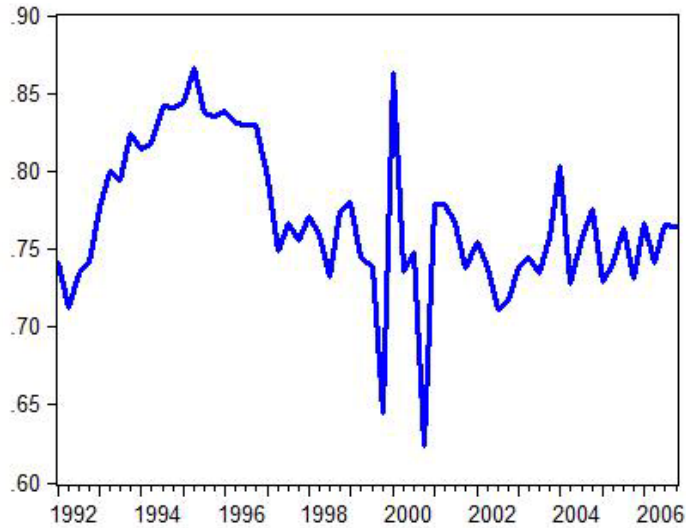


We calculate two-sided moving average of the quarterly change of price dispersion and average price, using a window of 12 quarters on each side. The correlation between the two transformed variables tells us whether there is a long-run relationship between the two variables, as in Lucas (1980). The straight line is fitted by ordinary least squares.

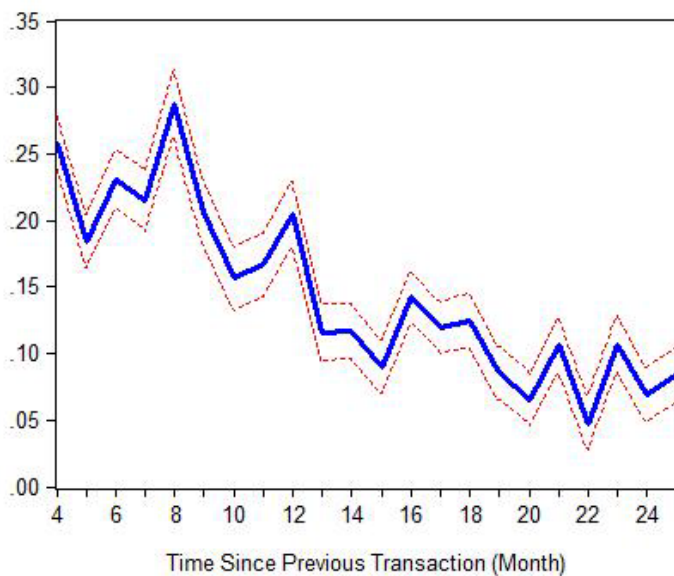
Figure 4. Moving Average of Change in Number of Transactions and Change in Average Price Per Sq. Feet



We calculate two-sided moving average of the quarterly change of the number of transactions and average price, using a window of 12 quarters on each side. The correlation between the two transformed variables tells us whether there is a long-run relationship between the two variables, as in Lucas (1980). The straight line is fitted by ordinary least squares.

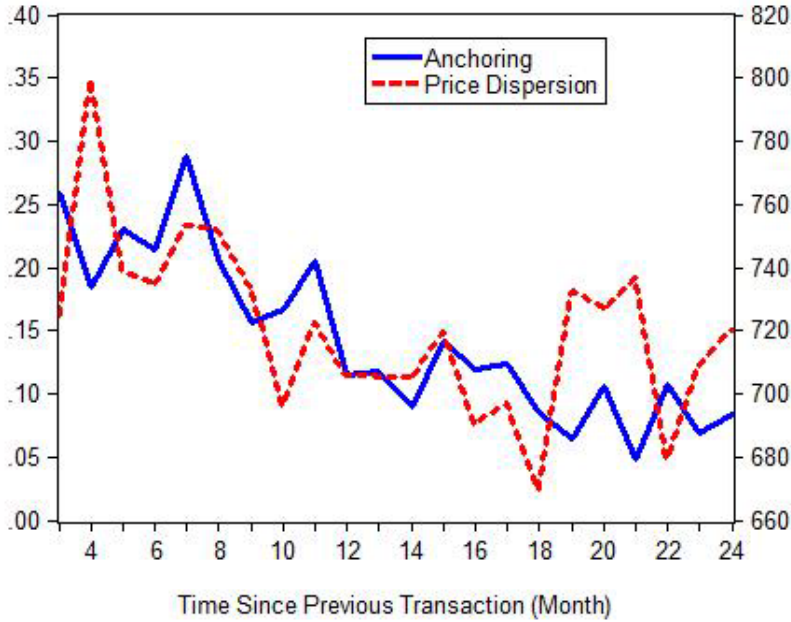
Figure 5. Adjusted R^2 for the Hedonic Regressions

To calculate price dispersion, we first fit a hedonic regression on the real price per squared feet. We try to minimize the problem by fitting the hedonic regression every quarter. That is, hedonic prices and district fixed effects are allowed to be time-varying. The explanatory variables are floor and its square, age and its square, gross area and its square, net-gross ratio and its square, bay window size and its square, club dummy, and district dummies. The standard deviation of the residuals is the measure of price dispersion.

Figure 6. Anchoring Coefficients by Time Since Previous Transaction

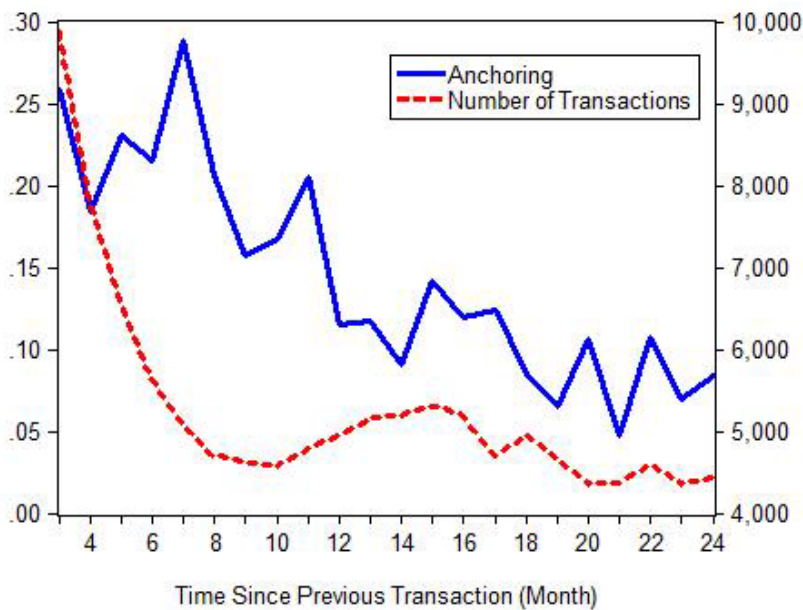
We run the hedonic regression $P_t = \mu\hat{P}_t + \lambda(P_p - \hat{P}_t) + \xi(P_p - \hat{P}_p)$ allowing the anchoring coefficient λ to vary with time since previous transaction, from 3 to 24 months.

Figure 7. Anchoring Coefficients and Price Dispersion by Time Since Previous Transaction (Correlation = 0.465)



We calculate price dispersion by the number of months since previous transaction, from 3 to 24 months. We then plot it with the anchoring coefficients reported in Figure 6.

Figure 8. Anchoring Coefficients and Number of Transactions by Time Since Previous Transaction (Correlation = 0.561)



We calculate the average number of transactions by the number of months since previous transaction, from 3 to 24 months. We then plot it with the anchoring coefficients reported in Figure 6.