



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. The model has 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 with a previous purchase that is more recent. Using a data set that contains most real estate transactions in Hong Kong from 1992 to 2006, we find anchoring and loss aversion to be important, and the results are robust to type of housing and sample period. The finding is consistent with the strong correlations among house price, price dispersion, and volume found in the data. Moreover, anchoring, price dispersion and volume decrease with time since previous transaction. Our results suggest that anchoring and loss aversion contribute to the cyclical of the housing market.

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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 asset markets.¹ To explain the correlation in the housing market, Stein (1995) shows that in a housing demand model with down-payment requirement, an exogenous negative shock to house price can have a large and broad-based negative impact on household liquidity and lead to a lower transaction volume. By simulating a search model in which sellers differ by their time on the market, Berkovec and Goodman (1996) generate the correlation among demand, turnover and prices over time. 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, and loss aversion can explain the correlation between price and volume.

A less-documented fact in the property market, which the studies above do not consider, is that the level of price dispersion is also positively correlated with the trading volume and price.² Regarding price dispersion, Leung, Leong, and Wong (2006) use

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¹ The literature is too large to be mentioned here. See Lee and Swaminathan (2000) for a recent example in the stock market. See the citations in Genesove and Mayer (2001) for examples from the housing market.

² We define price dispersion as the standard deviation of the residual from a hedonic regression.

Hong Kong housing data to attribute the level of price dispersion to macroeconomic factors like interest rates. They also find that the level of price dispersion is positively correlated with trading volume.

In this paper, we present a simple model in which buyers anchor the value of a housing unit with its previous purchase price (the price of the previous transaction) and sellers are averse to loss. The model implies both 1) positive correlation between prices and trading volume and 2) positive correlation between price dispersion and price. Using data from the Hong Kong second-hand housing market, we show that the presence of both anchoring and loss aversion can explain the observed cycles in the housing market.

We ask whether buyers anchor the value of a housing unit with its previous purchase price. When a rational buyer decides whether to buy a housing unit, the buyer inquires on the characteristics of the housing unit and then compares the price with that of other housing units. Unless the initial price contains information on the unobserved characteristics of a housing unit (which the buyer may want to learn), the initial purchase price should not matter here. We make use of a sample of repeated sales to control for the unobserved characteristics, and find that buyers' decision still depends on the initial purchase price. We argue that there is 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 of putting the housing unit to the market: homeowners tend to sell housing units when there is a gain in nominal value instead of a loss. Homeowners with loss aversion have asymmetric attitudes toward gains and losses and use the previous purchase price as a reference point to make their selling decision. If the seller is rational, the previous purchase price is only relevant for calculating the sunk cost and it should not affect the seller's behavior. Using the same sample of repeated sales in the Hong Kong housing market, we find that homeowners are strongly loss averse.

After showing the existence of anchoring and loss aversion in the Hong Kong property market, we build a model with anchoring buyers and loss-averse sellers to explain the correlations among price, trading volume and price dispersion. In our model, the existence of loss averse sellers 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. Buyers are matched with housing units with different previous purchase prices. Price dispersion arises due to anchoring. Since housing units with a high previous purchase price will be taken out of the market when prices fall, 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 the time since previous transaction in the anchoring regression. We find that anchoring decreases with time since previous transaction, suggesting that buyers put less weight on an "older" previous price. We then allow price dispersion and volume to also vary with the time since previous transaction, and find that they 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. Our results suggest that the two phenomena contribute to the cyclicity of the housing market.

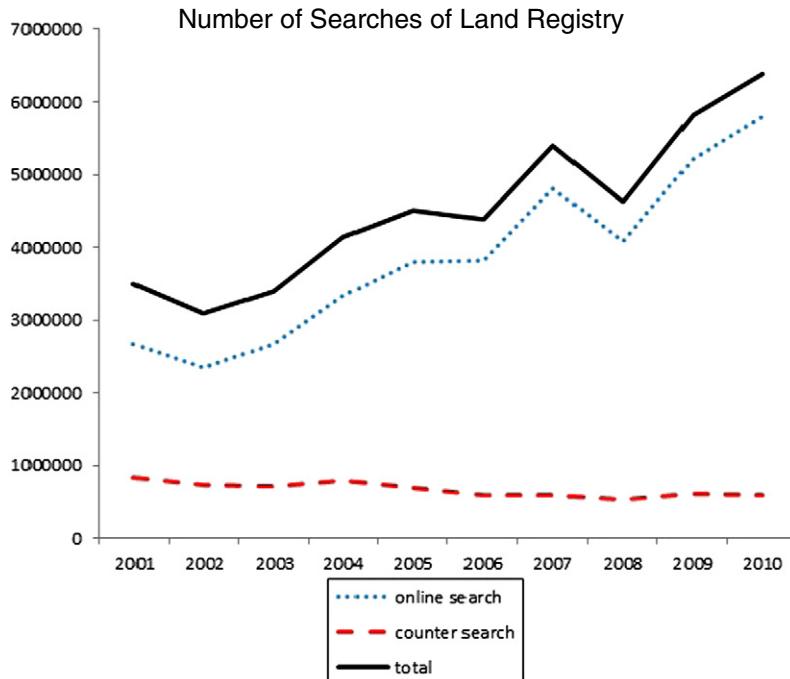


Fig. 1. Number of searches of land registry.
Source: Hong Kong Land Registry.

2. The Hong Kong second-hand housing market

An attractive feature of the second-hand housing market in Hong Kong is that it is highly competitive.³ There are huge number of buyers and sellers in the market.⁴ While more than 90% of the transactions involve real estate agents as the middleman, the level of competition in the real estate agents' market is very high: There are about 30,000 real estate agents (almost 0.5% of the total population in Hong Kong) as of 31 October 2010.⁵ The standard commission fee for a real estate agent is only 2% (1% each from the buyer and seller) of the transaction price. The competitive nature of the market makes strategic behaviors of buyers, sellers or agents very unlikely and provides an ideal condition for testing the two cognitive biases.

Our hypothesis is that buyers anchor the value of a housing unit with its previous purchase price. 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, and usually does, get access to this information through the internet at very low cost (usually less than HK\$ 30).⁶ Indeed, the demand for this information is huge. The annual number of searches of land registers is on average at 4.5 million between 2001 and 2010 (the population of Hong Kong is about 7 million as of 2011), while the number of second-hand transactions in each year is less than 200,000. This suggests that buyers do take this information into account when they make any purchasing decision. The internet has made accessing such information even less costly. As Fig. 1 shows, there is an increasing trend in the total number of searches of land registers. The number of online searches has more than doubled from 2001 to 2010 while the number of counter searches has steadily declined over the same time period. A direct implication of this trend, which we find support in Section 4, is that anchoring effect has become more important over the years.

3. Data description

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

There are about 2.1 million observations in the EPRC data. We drop some problematic observations. First, we drop observations with missing characteristics like prices, floor, and area. Second, we drop observations with extreme prices (i.e., top and bottom 0.1% of the data). Third, we exclude transactions in the first-hand property market because this market is highly oligopolistic. Lastly, it is a common practice in Hong Kong to sign a provisional agreement for the transaction before the signing of the official agreement. The time lag between the provisional and formal agreement can be as long as three months. We only keep the former transactions to avoid duplication and because the price recorded reflects the market conditions at the time when the former transaction took place.⁷ 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).⁸ Table 1 reports the summary statistics of the housing units transacted in the sample period. We can see that housing units that are sold multiple times are not significantly different from those that are sold only once during the sample period (except, of course, that housing units that are sold multiple times are older on average).

We construct price dispersion time series in the following way. 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 quarter by quarter. That is, hedonic prices and district fixed effects are allowed to be time-varying. The standard deviation of the residuals is our measure of price dispersion. Price is the deflated price per square feet, 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.⁹ Fig. 6 shows that, given the large cross-sectional data, the hedonic regression has reasonably good fit for most of the sample. On average the hedonic regression can explain over 75% of the movements in price.

Fig. 2 plots the quarterly price dispersion for the full sample with the average price per square feet. Price dispersion tracks the housing cycle closely (the correlation is 0.71). Trading volume shows a similar pattern in Fig. 3 and the correlation of the two variables is 0.31.

³ The source of information in this section is the 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.

⁴ The annual number of transaction has been above 100,000 in the past 15 years according to the Land Registry.

⁵ Please refer to the Estate Agents Authority at <http://www.eaa.org.hk>.

⁶ The website is: www.iris.gov.hk/eservices/byaddress/search.jsp.

⁷ For the same transaction, there are two different transaction dates. The first is called instrument date which is the date at which the transaction occurred. The second is called 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 transaction date.

⁸ For a housing unit that was sold in 1994, 1997 and 2000, we only count the sales in 1997 and 2000 as repeated sales.

⁹ Mok, Chan, and Cho (1995) and Bao and Wan (2004) use similar explanatory variables in their hedonic regressions for their studies of the Hong Kong housing market.

Table 1

Summary statistics of housing units in Hong Kong: We use the housing transaction data provided by the Economic Property Research Center (EPRC) as our main source of data. The data set covers most of the housing transaction from 1992 to 2006. 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)
Bay window	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

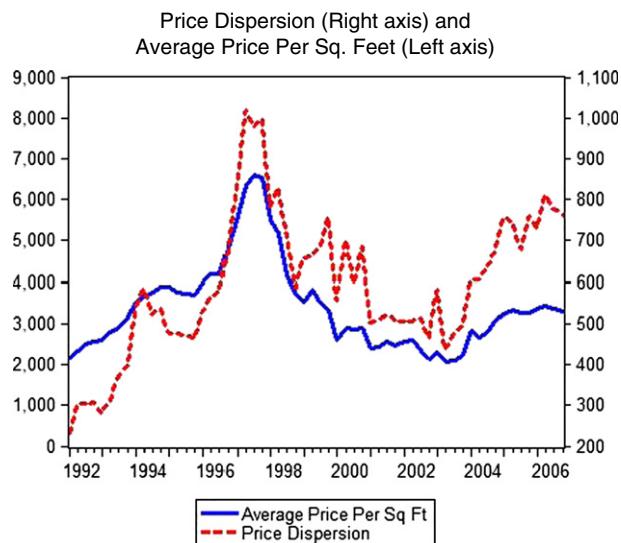


Fig. 2. Price dispersion (right axis) and average price per sq. feet (left axis). For each month we plot price dispersion and the average price per sq. feet. Please refer to Section 3 on how the sample is selected, and for the hedonic regression that generates our measure of price dispersion.

We 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 is a housing boom that has average price increased more than three times. With the Asian crisis and the “85,000” policy of the Hong Kong SAR government house price has decreased to the 1992 level.¹⁰ 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 (1980), 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 of the first difference of each variable.¹¹ As shown in Figs. 4 and 5, the transformed variables are still positively correlated, especially between average price and price dispersion.

4. Test for anchoring

Anchoring is a well-established bias in laboratory experiments. A famous experiment 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). The subjects show a bias in

¹⁰ The “85,000” policy aims at providing 85,000 new private and public housing units every year. The reader can refer to the 1997 Policy Address for details: <http://www.policyaddress.gov.hk/pa97/english/polpgm.htm>.

¹¹ Using a different window size or other more sophisticated filtering methods does not change the results substantially.

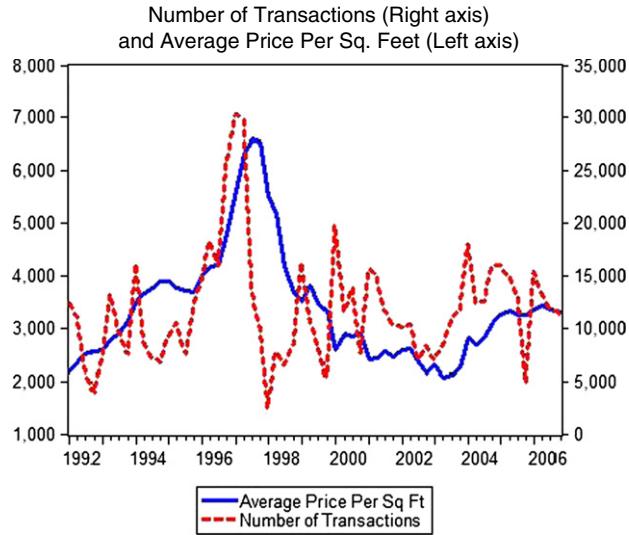


Fig. 3. Number of transactions (right axis) and average price per sq. feet (left axis). For each month we plot the number of transactions and the average price per sq. feet. Please refer to Section 3 on how the sample is selected.

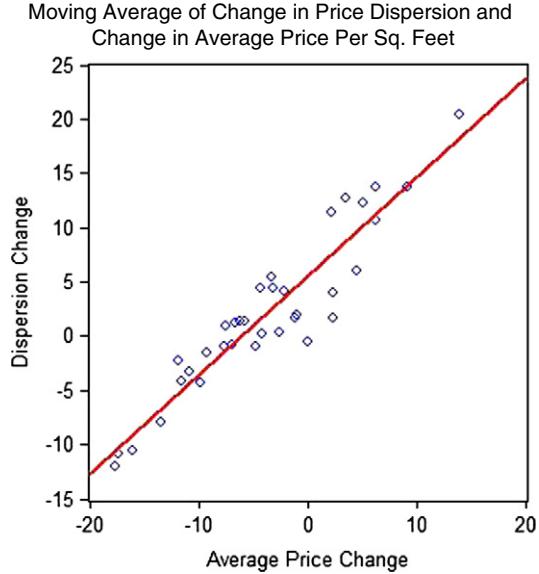


Fig. 4. Moving average of change in price dispersion and change in average price per sq. feet. We calculate the two-sided moving average of the quarterly change of price dispersion and average price, using a window of 12 quarters on each side. The correlation between the two transformed variables tells 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.

their estimates toward the original random number. Such anchoring heuristic has been documented in many other laboratory experiments.¹² Non-experimental studies that test the presence of anchoring effect are rare. McAlvanah and Moul (2010) find that horseracing bookmakers anchor to previous odds when horses are withdrawn. In another recent work, Beggs and Graddy (2009) find support for anchoring effect in the art market.

When testing for anchoring, one faces the problem of distinguishing between anchoring and learning. If past prices contain information about the unobserved characteristics of the housing unit, buyers will refer to past prices to learn about those characteristics. To avoid this problem, we adopt the method proposed by Beggs and Graddy (2009). With a hedonic regression, we can control for such unobserved characteristics as long as they do not change over time.

We would like to point out that the Hong Kong housing market has two major differences from the art market considered by Beggs and Graddy (2009). First, unlike a piece of art, the characteristics for a housing unit are mostly observable and quantifiable.

¹² See Chapman and Johnson (2002) for a survey of the topic.

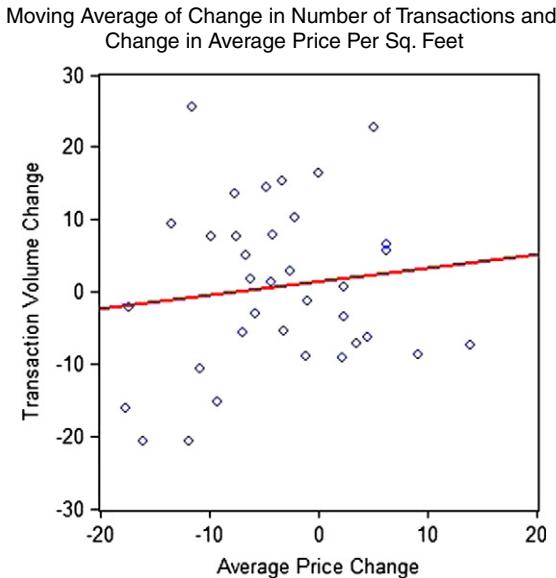


Fig. 5. Moving average of change in number of transactions and change in average price per sq. feet. We calculate the two-sided moving average of the quarterly change of the number of transactions and average price, using a window of 12 quarters on each side. The correlation between the two transformed 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.

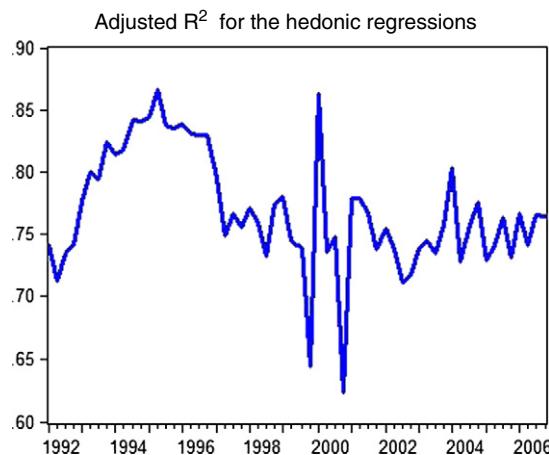


Fig. 6. Adjusted R^2 for the hedonic regressions. To calculate price dispersion, we first fit a hedonic regression on the real price per square feet. We try to minimize the problem by fitting the hedonic regression every quarter. That is, hedonic prices and district fixed effects are allowed to be time-varying. The standard deviation of the residuals is the measure of price dispersion.

In addition, there is an active market for each of those characteristics. Thus, the hedonic regression can explain most of the variations of house prices, leaving anchoring a less important role than that in the art market. The impact of anchoring is expected to be smaller than what is found in the art market. Second, comparing to the art market, the Hong Kong housing market is a “thick” one that has a much larger number of buyers and sellers. The competitiveness of the market makes the hedonic regression (which assumes a competitive market) a more suitable framework.

We first estimate a hedonic regression for the log house price per squared feet P_{it} of housing unit i in quarter t ¹³:

$$P_{it} = X_i \beta_t + \epsilon_{it}.$$

The vector X_i includes characteristics of the house that may affect house price.¹⁴ 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 regression below). The fits of the

¹³ As in Beggs and Graddy (2009), we use nominal prices for our analysis.

¹⁴ The regressors are the same ones used in the hedonic regression in Section 3.

Table 2

Anchoring regression: We first fit a hedonic regression on the data and we call the fitted price from the hedonic regression $\hat{P}_t = X_t \beta$. 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 second term on the right $P_p - \hat{P}_p$ captures the influence of the last period's price on the dependent variable. Standard errors are in parenthesis.

	Whole sample	Post-1997 sample	Pre-internet era (on or before 2001)	Post-internet era (after 2001)	Bank-owned houses
Current hedonic price (\hat{P}_t)	0.9576 (0.0014)	0.9248 (0.0023)	0.9913 (0.0018)	0.9255 (0.0030)	0.9928 (0.0149)
Anchoring effect ($P_p - \hat{P}_t$)	0.0661 (0.0028)	0.0761 (0.0043)	0.0677 (0.0026)	0.1510 (0.0082)	0.0816 (0.0240)
Unobserved heterogeneity ($P_p - \hat{P}_p$)	0.3864 (0.0039)	0.3298 (0.0055)	0.5249 (0.0046)	0.2247 (0.0089)	0.3184 (0.0403)
Constant	0.3870 (0.0115)	0.6399 (0.0183)	0.1026 (0.0147)	0.6524 (0.0236)	0.0048 (0.1199)
Adjusted R^2	0.8677	0.7789	0.8983	0.7605	0.9082
N	80,579	48,563	48,111	32,468	458

two hedonic regressions are very similar (with R^2 above 0.75 on average). We define the fitted price from the hedonic regression $\hat{P}_{it} = X_i \beta_t$.

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. There may be some characteristics that are time-varying, but we assume that their movements are negligible between previous and current sales. Or, we assume that such changes are rare (e.g. there is a suicide in the housing unit). 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-hand side are dropped out.

In the regression, we exclude repeated sales whose previous sale is made 1) within 2 months or 2) 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. The first restriction avoids such identification problem. The second restriction prevents significant changes in the unobserved qualities of the housing unit. This leaves us with 80,589 observations in the benchmark sample.

Table 2 reports the regression results. Column 1 reports the results using the whole sample. 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” up until 1997, and we drop transactions in this period to see whether the anchoring effect is still present when the large rise and drop of the housing price in that period are omitted. In column 3 and column 4, we restrict the sample to the pre-internet era (on or before 2001) and the post-internet era (after 2001).¹⁵ As Fig. 1 shows, the emergence of internet has made searching of the previous purchase price of a housing unit easier. It makes anchoring less costly, and we expect a bigger anchoring effect in the post-internet era. In column 5, we restrict the sample to transactions to bank-owned housing units. It addresses the concern 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, 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. 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 previous purchase price. The anchoring coefficient with the whole sample is statistically significant at about 0.07. This means that a 10% positive difference between the previous sale price and the hedonic prediction would lead the final price to be adjusted upward toward the previous price by about 0.7% of this difference. For example, if a housing unit is worth HK\$ 1 million according to the hedonic regression, and if the previous transaction price is HK \$ 1.1 million, the buyer would be 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 around 0.15 for transactions that occurred in the post-internet era, more than double to that in the pre-internet era. The bigger anchoring effect in the

¹⁵ Of course, it does not mean that few people had access to the internet on or before 2001. We just need the number of households with access to the internet to be different between the two periods. Furthermore, many internet service providers entered the market in Hong Kong from 1999 to 2001, and the use of broadband networks also saw a huge growth since 2001. See the statistics from the Office of the Telecommunication Authority at <http://www.ofta.gov.hk/en/tele-lic-operator-licensees opr-isp/s2.html> for more information.

post-internet era is consistent with the fact that information on the previous purchase price of a housing unit, the information that buyers anchor on, is more accessible in the post-internet era. The anchoring effect is 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 the 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 sellers in downtown Boston subject to nominal losses set higher asking price, attain 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 et al. (2010) to test for the presence of loss aversion. As the lag of the original purchase and sale increases, there are three possibilities. First, some loss averse purchasers finally decide to sell. This will skew the observed prices for longer lags toward showing losses. They call it “delayed loss realization.” Second, loss-aversion leads to permanent disappearance of the housing unit from the market and skews 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 will 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) log of the sale–purchase ratio $R_{g,i}$, which is defined as the ratio of sale price to the previous purchase price of a housing unit, for a particular transaction i .¹⁶

We include the following explanatory variables: the months held Y_i , which is the number of months between the original purchase and the sale; the previous purchase price for the transaction i , $P_{p,i}$; the hedonic characteristics of the housing unit X_i (the variables included are the same as those in Section 3); the change in the general house price level $\Delta\bar{P}_i$ and a dummy for the year of the sale T_i . We estimate a logit model for the gain dummy $D_{g,i}$:

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

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 the original purchase and sale to be within 2 years, as when we are testing for anchoring.¹⁷ For testing loss aversion, our sample has 265,638 observations.

Tables 3 and 4 provide the estimation results from the logit model and the OLS. Columns 1 and 2 of Tables 3 and 4 report the results from the whole sample and the post-1997 sample. The coefficient on months held, Y_i , is significantly negative for both the logit model and the OLS.¹⁸ This means that sellers in the Hong Kong housing market exhibit “delayed loss realization.” The effect of loss aversion decreases with the time since the last purchase. This result is robust using the post-1997 sample. The signs of the other coefficients are as expected.

In Hong Kong, homeowners cannot sell the 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 sales until part of the debt is paid. This non-behavioral reason can also lead to the negative estimates on the coefficients on months held, Y_i .¹⁹ 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 1997.²⁰ Thus the first sample represents those home units that are more likely to be affected by the negative equity 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.²¹ In columns 3 and 4 of Table 3, the estimates of coefficients on months held, Y_i , are negative using both

¹⁶ As in Genesove and Mayer (2001), we use nominal prices for our analysis.

¹⁷ We have also tried dropping those with lag between 0 and 2 months, or limiting the sample to below 1 year, and results are very similar.

¹⁸ According to List (2003, 2004), anomalies such as loss aversion decrease with market experience. In a housing market, there is a mix of experienced sellers (such as speculators) and inexperienced sellers (such as first-time sellers). But our data do not allow us to distinguish the two types. Hence, the coefficient on Y_i is roughly the average of that of the experienced sellers and the inexperienced sellers.

¹⁹ We thank Charles Leung for pointing this out.

²⁰ See www.info.gov.hk/hkma/eng/viewpt/20060112e.htm.

²¹ Only 1% of housing units with negative equity in 2006 were bought in 1999, according to the citation in the previous footnote.

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. 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." Standard errors are in parenthesis.

Independent variable	Whole sample	Post-1997 sample	Initial purchase in 1997	Initial purchase in 1999
Months held (Y_i)	−0.0244 (0.0002)	−0.0262 (0.0003)	−0.3364 (0.0832)	−0.1284 (0.0091)
Previous purchase price ($P_{p,i}$)	−1.6047 (0.0197)	−1.566 (0.0218)	−3.7085 (0.3264)	−0.6832 (0.0781)
Change in house price level ($\Delta\bar{P}_t$)	4.9227 (0.0408)	4.2026 (0.0436)	2.0989 (0.6129)	1.2784 (0.2637)
Year dummies	Yes	Yes	Yes	Yes
Hedonic controls	Yes	Yes	Yes	Yes
Constant	7.7679 (0.2533)	4.6559 (0.1910)	57.8923 (10.3125)	2.2411 (1.0546)
Pseudo R^2	0.5603	0.4776	0.6466	0.2590
N	265,638	167,589	5253	10,033

Table 4

Loss aversion regression (sale–purchase ratio OLS): We run the OLS regression $R_{g,i} = \alpha + \beta_Y Y_i + \beta_p P_{p,i} + X_i \beta + \beta_{\bar{P}} \Delta\bar{P}_i + \beta_T T_i + \epsilon_i$. 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." Standard errors are in parenthesis.

Independent variable	Whole sample	Post-1997 sample
Months held (Y_i)	−0.0016 (0.0000)	−0.0017 (0.0000)
Previous purchase price ($P_{p,i}$)	−0.2653 (0.0014)	−0.2994 (0.0020)
Change in house price level ($\Delta\bar{P}_t$)	0.6279 (0.0024)	0.5793 (0.0034)
Year dummies	Yes	Yes
Hedonic controls	Yes	Yes
Constant	0.9562 (0.0155)	1.2937 (0.0203)
Adjusted R^2	0.6728	0.5832
N	265,638	167,589

samples. While it is true that the estimates using the 1997 sample is 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

In this simple model, we take a snapshot of the housing market and look at the buying and selling decisions of individuals in a single period.²²

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 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.

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 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:

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

²² We use the model only to offer some intuition on why we observe the cyclicity of price dispersion and transaction volume. Since we look at house price level and not house price change here, we do not need to make the model dynamic. For a dynamic model that has implications on the change in house price, please see Leung and Tsang (in press).

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 have 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 have gained 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:

$$V(P) = \frac{\lambda^2}{4} V(P_p) = \frac{\lambda^2}{48}.$$

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

6.3. Loss averse seller, non-anchoring buyer

When the 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, 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. Because 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.

Table 5

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. Standard errors are in parenthesis.

	Anchoring	No anchoring
Loss aversion	Pro-cyclical price dispersion Pro-cyclical volume	No price dispersion Pro-cyclical volume
Loss neutral	Non-cyclical price dispersion Constant volume	No price dispersion Constant volume

The intuition is straightforward. During a downturn, $\gamma_b + \gamma_s$ is low, 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, 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 the anchoring for transactions with recent previous sales and λ_2 be the anchoring for transactions with old previous sales. We know $\lambda_1 > \lambda_2$.

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

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

6.5. Testable implications

We summarize the predictions of our model in [Table 5](#). If both biases are present, the model has the following testable implications:

Implication 1. *Price dispersion and volume are positively correlated with the average house price.*

According to our model, when the housing market is in boom, we will observe a larger number of transactions and more disperse prices. For example, for two housing units with similar characteristics, we find them to have more diverse prices during the boom time. As shown in [Section 3](#), this implication is consistent with the data.

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

Suppose anchoring decreases with time, i.e. buyer puts 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 longer time since the previous transaction. In the next section we will show that this second implication is also supported by the data.

7. A further test: decreasing anchoring effect

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 we can 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 (using dummy variables). The coefficients are plotted in [Fig. 7](#) (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 [Fig. 7](#), we should find price dispersion and volume decreasing with the time since the previous transaction. We group transactions by the months since the previous transaction, and then calculate the price dispersion and volume for the different groups. In [Figs. 8 and 9](#) we plot them against the anchoring effect in [Fig. 7](#). 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).²³

²³ Changing the starting date of the sample changes the results very little.

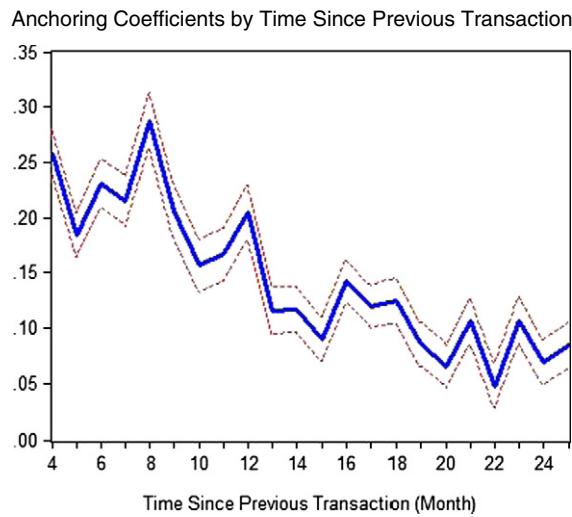


Fig. 7. Anchoring coefficients by time since previous transaction. We run the hedonic regression $P_t = \mu\hat{P}_t + \lambda(P_p - \hat{P}_t) + \xi(P_p - \hat{P}_p)$ allowing the anchoring coefficient λ to vary with time since previous transaction, from 3 to 24 months.

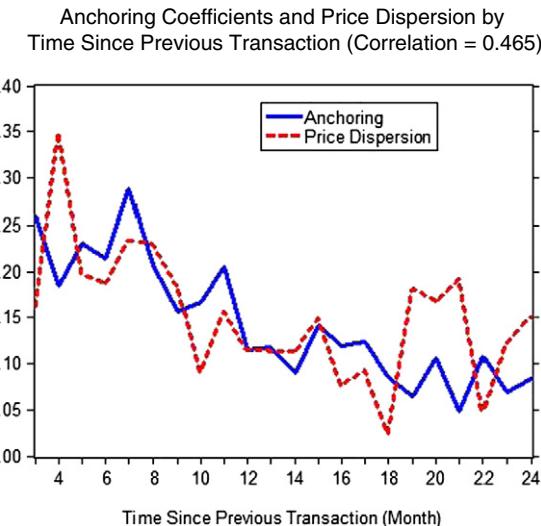


Fig. 8. Anchoring coefficients and price dispersion by time since previous transaction (correlation=0.465). We calculate price dispersion by the number of months since previous transaction, from 3 to 24 months. We then plot it with the anchoring coefficients reported in Fig. 7.

8. Conclusion

Using a sample of repeated sales, we show that both anchoring and loss aversion are present in the Hong Kong second-hand housing market. We then propose a simple model to show the impact of these two cognitive biases on house price dynamics. In the model, with the presence of these cognitive biases, 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 observed cycles of house price.²⁴

Our results shed light on the Special Stamp Duty (SSD) introduced by the Hong Kong SAR government in 2010.²⁵ The SSD imposes extra cost on transactions for housing units that are resold within two years. According to the results in Section 7, the anchoring effect is weakened by this policy. Hence, in addition to the reduction in the trading volume, the introduction of the SSD will also reduce the amount of price dispersion in the housing market.

²⁴ In a companion paper (Leung and Tsang, *in press*), we have also shown that anchoring and loss aversion can predict house price change.

²⁵ Please refer to the website of the Inland Revenue Department at <http://www.ird.gov.hk/eng/faq> for more details.

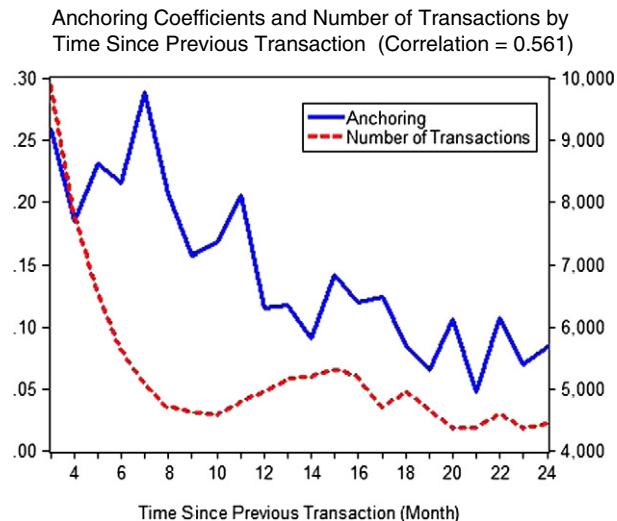


Fig. 9. Anchoring coefficients and number of transactions by time since previous transaction (correlation = 0.561). We calculate the average number of transactions by the number of months since previous transaction, from 3 to 24 months. We then plot it with the anchoring coefficients reported in Fig. 7.

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