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Title: Could Loss Aversion Retain on the Market? Evidence from the Hong Kong Property Market

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Could Loss Aversion Retain on the Market? Evidence from the Hong Kong Property Market

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Abstract Loss aversion not only affects the list price of properties but can retain on actual transactions. Utilizing the data of over a million commercial and residential property transactions in Hong Kong from 1991 to 2015, we find that sellers facing nominal losses relative to their prior purchase prices attained higher selling prices than their counterparts. We suggest two market factors to account for the extent of the loss aversion effect on the market transaction prices. First, the loss aversion effect is only prominent when comparable transaction information is not readily accessible, such as in the less-transacted commercial property market. Second, our results suggest the relevance of loss aversion to the boom-bust property cycle in both the residential and commercial markets. The effect of loss aversion on transaction prices is relatively weak in the bust period between 1998 and 2003 when the Hong Kong property market lost almost two-thirds of its value, and it enlarges with the market recovering. The power of loss aversion is not attenuated at the aggregate market level but is associated with strong reductions in price declines in the bust period and in the commercial market. These results have implications for understanding the market adjustment of loss aversion in different property sectors and its association with the aggregate market dynamics in a boom-bust property cycle.

Key Words: Loss aversion, Behavioural bias, Market information, Property cycle, Commercial property, Residential property

1. Introduction

This paper revisits the importance of loss aversion in the property market. The loss aversion explanation was first demonstrated by Tversky and Kahneman (1979) suggesting that a loss is more painful than a gain, which makes people reluctant to realize a loss. It has quickly grown in popularity in the real estate literature with its potential to account for the positive correlation of prices and trading volume, a key feature of the property market cycle (e.g., Genesove and Mayer, 2001; Engelhardt, 2003; Einiö et al., 2008; Bokhari and Geltner, 2011; Anderson et al., 2019). Sellers are averse to selling their houses for less than they initially paid, and they tend to set a high list price due to an expected loss, which results in a low likelihood of sales. The loss aversion effect becomes pronounced in a market downturn when a lot of homeowners witness value depreciation of their homes.

The economic importance of loss aversion may not be limited to trading volume. Since sellers facing an expected loss were found with a high list price, it is intriguing to figure out whether and how the loss aversion effect could carry through negotiations and retain on transaction

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prices. In an efficient market, the loss aversion effect as a psychological bias should be limited to the decision of list prices and disappear with exposure to market conditions (Anenberg, 2011). However, the market correction for loss aversion can be insufficient. Without perfect information, home sellers subject to expected losses are likely to fish a buyer who will pay more than the market value, though at the cost of staying longer on the market (Anenberg, 2016; Clapp et al., 2018). For example, early experimental evidence from Northcraft and Neale (1987) and Black and Diaz (1996) suggested that the list price serves as an anchor for the buyer to judge the value of the property, and the buyer is not able to fully adjust the transaction price to the rational market value. Market movements may also play a role in adjusting loss aversion. Through directing buyer search and bargain, list prices influence transaction prices differently in the boom and bust periods, with loss aversion retained on the market price to different extents (Carrillo 2013; Han and Strange, 2016).

The main contribution of this paper is a focus on analysing the market adjustment of loss aversion by examining variations of the loss aversion effects on the transaction prices. Several studies reported strong evidence of loss aversion on transaction prices, such as Bokhari and Geltner (2011)—henceforth, BG—and Zhou et al (2020a), but none of it disentangled the mechanisms behind. Anenberg (2011) is an exception, and he attributed the higher price obtained by a seller facing expected losses to the lack of competition. Otherwise, with the threat of substitute houses available to the buyer, it is difficult for sellers to negotiate a high price. We extend Anenberg's (2011) study by considering the role of two market factors in adjusting loss aversion: market information and market movements. If the loss aversion effect on transaction prices is due to limited information of the buyer, then we expect a mitigating effect of better market information. If it is because of the bargaining power of the buyer that is sensitive to the movement of the market, then we expect the loss aversion effect on transaction prices to vary with the boom-bust property cycle.

In line with Genesove and Mayer (henceforth, GM), we regard the prior nominal purchase price as the reference point around which sellers are sensitive to gains and losses. In estimating the loss aversion effect on transaction prices, we follow GM's approach to address the entangling of unobserved property characteristics. This concern can be further alleviated by the interaction between loss aversion and the market condition that does not vary the valuation of unobserved quality. We utilize a rich dataset from the Hong Kong property market which consists of over 1 million sales from four major sectors—residential, industrial, office, and retail, with approximately half a million pairs of repeat sales identified. To our knowledge, this is the first study on loss aversion that encompasses both homeowners of residential properties and professional investors of commercial properties. The sample period spans over two decades, including a large boom-bust market cycle.

Overall, our results from reduced-form regressions add to the literature with new evidence on the loss aversion effect in different sectors of the property market. First of all, our findings suggest a mitigating effect of comparable market information on loss aversion retained on transaction prices by cross-sector and within-sector comparisons of the loss aversion effects. Close to GM's findings, the residential sector presents a positive loss aversion effect on transaction prices in the upper bound, while it turns insignificant in the lower bound with unobserved quality controlled. In comparison, the three commercial sectors report significantly positive loss aversion effects in the lower bound, consistent with the U.S. evidence provided by BG. The results remain robust while we limit the confounding effect of equity constraints by focusing on less constrained sellers, that is, with expected losses not exceeding the minimum equity amount. Considering that only 10% of the total property transaction volumes are from the three commercial sectors, we ascribe the strong loss aversion effect on transaction prices of commercial properties to the lack of comparable transaction information. The argument is

further supported by a negative crossing effect between loss aversion and a variable of comparable transaction information within each property sector.

Secondly, we find that the effect of loss aversion on individual transaction prices decreases with buyers' bargaining power, that is, stronger during market booms than during market downturns. This relationship holds across the four property sectors. In the bust period between 1998 and 2003 when the Hong Kong property market lost two thirds of its value, we observe the weakest loss aversion effect, along with the largest presence of sellers subject to potential losses. The loss aversion effect on transaction prices increased when the market recovered and started to boom after 2009, with a small pool of loss-facing sellers. It is also noticeable that the association between loss aversion and the market cycle is relatively weak in the retail and office sectors of relatively a small market size.

Lastly, we establish the relevance of loss aversion to the market cycle at the aggregate market levels. We follow the approach of BG and Zhou et al. (2020b) to investigate the loss aversion effect on the aggregate property price indices and several distinct findings were presented. The aggregate loss aversion effect is revealed to be stronger in the retail and office sectors than in the residential sector, and larger in the bust period than in the boom period. That is, the presence of loss aversion is associated with reduced price declines in the market trough, particularly in the commercial property market. While existing studies, such as Glaeser and Nathanson (2016), suggested that anchoring to past transaction prices is associated with excess volatility in the property market, our evidence supports the opposite.

Given no asking price information, we rely on the variations in the loss aversion effects on transaction prices to disentangle under what conditions could the loss aversion effect carry through the negotiation process. In addition, the findings on the loss aversion effect on the aggregate property market suggest an alternative to understand the price volatility of the boom-bust cycle. The rest of the paper proceeds as follows. The next section reviews the related literature. Section 3 develops the estimation strategy, and Section 4 describes the unique dataset with summary statistics. Baseline results following GM are presented in Section 5. Section 6 reports the loss aversion effect across sectors and its interaction with comparable transaction information. Sections 7 and 8 establish the relevance of loss aversion to the market cycle at the micro and aggregate levels. The last section concludes.

2. Loss Aversion in the Literature

The theoretical motivation of loss aversion roots in the prospect theory proposed by Tversky and Kahneman (1979, 1992) to model decision-making under risk. Three highlights are usually made in the prospect theory in accordance with the s-shaped value function (see Appendix Figure A1): decision-makers classify outcomes into gains and losses relative to a reference point, individuals are loss-averse (the slope is steeper over losses than over gains), and the marginal value of gains and losses diminishes with their magnitude (the slope becomes flatter for each additional gain or loss). The prospect theory, as summarized in Barberis (2013), provides useful insights to unravel empirical phenomena left unexplained by expected utility theory such as the disposition effect (Shefrin and Statman, 1985; Odean, 1998), the status-quo bias and endowment effect (Samuelson and Zeckhauser, 1988; Kahneman et al., 1990), and the equity premium puzzle (Benartzi and Thaler, 1995).

Early empirical studies discerned loss aversion behaviour in the financial markets. In general, investors were found with reluctance to realize losses by selling stocks that have fallen in value relative to the previous purchasing price (Shefrin and Statman, 1985; Odean, 1998; Grinblatt and Keloharju, 2001; Dhar and Zhu, 2006; Chang et al, 2016). More recent literature focused

on debating which component of the prospect theory plays a major role in determining the reluctance to sell financial assets at a loss, or the so-called disposition effect (Barberis, 2013). While some studies, such as Shefrin and Statman (1985) and Li and Yang (2013), attributed the disposition effect to the convexity of the value function, other researchers argued that reference dependence alone can account for the disposition effect if the discount rate is sufficiently positive (Barberis and Xiong, 2009, 2012; Bodnaruk and Simonov, 2016).

The real estate market is recognized as an important counterpart to identify the behaviour of loss aversion. GM is the first to examine loss aversion and seller behaviour in the housing market and two important findings were documented. First, as a test of the loss aversion effect, they found that a home seller facing expected losses sets a higher asking price and exhibits a lower likelihood of sales. Second, in line with the diminishing sensitivity, the marginal mark-up in list prices decreases with the size of a seller's expected losses. Similar evidence has been reported by follow-up studies (Engelhardtt, 2003; Lee and Ong, 2005; Einiö et al., 2008; Bokhari and Geltner, 2011; Anenberg, 2011; Bao and Meng, 2017; Bracke and Tenreyro, 2019).

Loss aversion has grown in popularity in the real estate literature because of its potential to account for the stylized positive price-volume relationship. Previous studies attributed sellers' reluctance to sell at the trough of the market to equity constraints which are binding when the resale price is lower than the buying price (Stein, 1995; Genesove and Mayer, 1997; Ortalo-Magné and Rady, 1998). However, GM found that equity constraints alone failed to fully explain the trading volume declines in the bust market, and Anenberg (2011) and Bracke and Tenreyro (2019) identified substantial effects of loss aversion while controlling the effect of equity constraints. Anderson et al. (2019) also identified interaction effects between loss aversion and equity constraints, that is, households' responses of list prices to equity constraints are modified by their interaction with nominal losses.

Home sellers subject to psychological loss aversion set higher list prices than their counterparts, but evidence on how much of this pricing behaviour would retain on the market is inconclusive. With unobservable features controlled, GM documented no significant effect of loss aversion on transaction prices, while BG, Anenberg (2011) and Zhou et al. (2020a) found it to be positive though weaker than that on list prices. This implies that the market can adjust the loss aversion effect, as reflected in the differences between list prices and selling prices. Yet, it is not explored what determines the adjustment for loss aversion. BG and Zhou et al. (2020b) provided some insights by considering the relevance of loss aversion and the property cycle in addition to the price-volume relationship, and they documented different loss aversion effects on transaction prices in the boom and bust periods.

This study aims to add to the literature with further evidence on the market adjustment for loss aversion. We refer to the literature that addresses the relationship between list prices and selling prices (e.g., Northcraft and Neale, 1987; Carrillo, 2013; Haurin et al., 2013; Han and Strange, 2016). Selling prices can stick to list prices for the sake of psychologically-based anchoring behaviour (Northcraft and Neale, 1987) or signalling for private information (Yavas and Yang, 1995), and depart from list prices for rational search and bargain (Han and Strange, 2016). In addition, unlike the literature that addressed loss aversion in the western property markets, we focus on the Hong Kong market that has experienced more frequent and sharp fluctuations. Leung and Tsang (2013a, 2013b) are two exceptions to investigate the average relation between loss aversion and Hong Kong property prices. We extend their analyses by examining variations in the loss aversion effects across different property sectors and over a large boom-bust cycle between 1991 and 2015 as shown in Figure 1.

[Insert Figure 1 here]

3. Empirical Models

We estimate the effect of loss aversion on transaction prices following the models proposed by GM and BG, with several specific modifications made to suit the characteristics of our dataset. The estimation can be summarized in two stages. In the first stage, we estimate the expected market selling price of the property using a hedonic pricing model and calculate potential losses that the seller may incur. In the second stage, we estimate the effect of potential losses on the final transaction price, with potential biases from unobserved housing features controlled.

Using the full sample of transaction records in each property sector, the expected selling price of property *i* in district *j* at time *t* is derived from the following hedonic regression model:

$$\log(P_{ijt}) = X'_{ij}\beta + \varphi_{jt} + \varepsilon_{ijt}, \quad (1)$$

where the dependent variable uses the log form of the transaction price (P_{ijt}). X_{ij} denotes a set of controls for physical housing features, such as building age, unit area, floor, and distances to the closest seacoast, hospital, bus stops, MTR stations, and parks.[1] We include both the first order and the second order terms for these controls to capture the nonlinear relationships. Hong Kong is divided into 57 districts by the Land Registry of Hong Kong. We use φ_{jt} to denote the year times district fixed effects to control spatially and time-varying characteristics that are not easy to observe. Using the coefficients estimated from Equation (1), we are able to derive a predicted market value of this property specifically at time *t*, that is, the expected selling price. We denote this expected selling price in log form as μ_{ijt}. Considering the previous purchase price ($P_{ij,t-1}$) of the property as the reference point to the seller, the expected loss of the seller is therefore defined as the difference between the previous purchase price and expected selling price, truncated below at zero:

$$Loss_{ijt} = \begin{cases} \log(P_{ij,t-1}) - \mu_{ijt}, & \log(P_{ij,t-1}) - \mu_{ijt} > 0 \\ 0, & \log(P_{ij,t-1}) - \mu_{ijt} \leq 0 \end{cases}. \quad (2)$$

To estimate the effect of expected losses on the transaction price, we then regress the transaction price in the log form on the expected losses using the following specification:

$$\log(P_{ijt}) = \gamma Loss_{ijt} + \delta\mu_{ijt} + C'_{ijt}\theta + \epsilon_{ijt}. \quad (3)$$

Specifically, we add the expected selling price μ_{ijt} at the right-hand side and include a vector of additional controls (C_{ijt}), such as the months since the last transaction and the district times year fixed effects. The coefficient estimate of γ thus represents the price difference between the expected selling price and transaction price that is driven by expected losses.

As discussed by GM, two major issues threaten the validity of the estimate of the loss aversion effect on property price. We illustrate how these two issues biased our estimate in Equation (3). The first issue is the unobserved housing features that we failed to include in Equation (1). We assume these unobservables to be fixed over time and denoted as v_{ij}. Ignoring these factors may bias the estimation of the expected selling price in the hedonic model. Specifically, the real expected selling prices ($\tilde{\mu}_{ijt}$) should be given by:

$$\tilde{\mu}_{ijt} = X'_{ij}\beta + \varphi_{jt} + v_{ij}. \quad (4)$$

The second potential bias is from the under- or over-payment relative to the expected price

[1] For the model of residential properties, we include additional controls such as the housing estate type (i.e. single building or multiple buildings) and the number of total housing units within the estate.

when the seller originally purchases the unit, and we denote it as $w_{ij,t-1}$. Since the hedonic model of Equation (1) also holds for the previous transaction, we have:

$$\log(P_{ij,t-1}) = X'_{ij}\beta + \varphi_{j,t-1} + v_{ij} + w_{ij,t-1}. \quad (5)$$

Combining Equations (3) – (5), the real expected loss of the seller ($\widetilde{Loss}_{ijt}$) at time *t* is thus expressed as:

$$\widetilde{Loss}_{ijt} = \log(P_{ij,t-1}) - \tilde{\mu}_{ijt} = \varphi_{j,t-1} - \varphi_{jt} + w_{ij,t-1}. \quad (6)$$

Substituting Equation (4) and (6) into Equation (3), the unbiased model to estimate the loss aversion effect on property prices is given as:

$$\log(P_{ijt}) = \gamma(\varphi_{j,t-1} - \varphi_{jt} + w_{ij,t-1}) + \delta(X'_{ij}\beta + \varphi_{jt} + v_{ij}) + C'_{ijt}\theta + \epsilon_{ijt}. \quad (7)$$

Since both $w_{ij,t-1}$ and v_{ij} are unobservable, this reflects that our estimate of γ in Equation (3) is biased. To address these issues, we follow the adjustment method proposed by GM and BG. Firstly, we still use the noisy measure of the expected loss as in Equation (2). Secondly, we include the residuals from Equation (1) as an additional control in Equation (3). Expanding and rewriting the adjusted Equation (3) will end up with an equivalent model to Equation (7).[2] This means that the corresponding coefficient of γ in the adjusted model is unbiased. If buyers with expected losses are selling at higher prices, then a positive estimate of γ is expected.

4. Data

Our data comes from EPRC Limited, which covers all transactions of residential properties in Hong Kong from 1993 to 2015, as well as of retail, industrial and office properties from 1991 to 2014. This dataset provides detailed information on transactions, including the transaction prices, dates, and the names of buyers and sellers. It also includes comprehensive information on physical characteristics, including address, unit size, floor, and property type. Using the public geographic data of amenities from ESRI China (Hong Kong) Limited and the tool of ArcGIS, we geocoded the property addresses and calculated the distances between the property and the closest MTR station, bus stop, seacoast, school, university, hospital, and park. The initial dataset contains over 1 million property transactions. To address the potential entry errors in the sample, we filtered the transactions with prices lower than 0.1 million HKD and discarded transactions with incomplete information on the transaction details and physical features. For the commercial properties, the unit sizes are truncated at the top 1% to remove the outliers. The filtered transaction sample is utilized in the hedonic pricing regression of the first stage, i.e, Equation (1), to generate estimates of predicted selling price and the results are reported in Appendix Table B1. In general, the hedonic models provide a good interpretation of the log of the property sales price. The attributes included can explain 67% of the variations of retail transaction prices, while that number exceeds 80% in the other three sectors.

Since we are interested in the effect of expected nominal losses from the previous purchase price on the subsequent selling price, we further restricted our sample to transactions paired with a previous sale with the same buyer name as the seller name of the target sale. The residential market has the most repeat sales, with 49.6% of the total transactions paired with a previous sale in the secondary market.[3] The percentage equals at 48.4% in the industrial and

[2] The details of derivation can be referred to GM and BG.

[3] Considering the different pricing mechanisms in the primary and secondary property market, we exclude repeat sales paired with a previous purchase from property developers.

office property sectors. The retail properties are the least frequently transacted in terms of repeat sales, with the percentage to be 39%. In the sample of repeat sales, the holding period of the seller is defined as the number of months between consecutive transactions of the same property. To address the impact of property flippers, we excluded transactions with a holding period of less than a year. After filter, the repeat sales sample includes 413,263 residential transactions, 31,374 industrial transactions, 14,566 office transactions, and 6,572 retail transactions.

Table 1 provides summary statistics of the repeat sales sample by property sectors. As shown in Panel A, the average residential property is transacted at 3.46 million HKD (equivalent to approximately 0.44 million USD), and it is about 18 years old with a size of 521 square feet. In Hong Kong with extreme density, the average residential property is located at the 15th floor and comes from an estate consisting of over 2,000 housing units that are more or less homogeneous. Panels B to D summarize the repeat sales in the industrial, office, and retail property sectors. The average transaction prices are 2.37 million HKD, 4.63 million HKD, and 4.83 million HKD, respectively, and the average sizes are 16,744 square feet, 999 square feet, and 409 square feet. Compared across sectors, the average holding period of a residential property is 66 months, more than a year shorter than holding a commercial property.

[Insert Table 1 here]

As stated in the empirical strategy, we apply a noisy proxy for the expected nominal loss of the seller, i.e., *Loss*, using the difference between the log of the predicted transaction price and the log of the previous transaction price. Table 1 also distinguishes the seller by the variable of *Loss Dummy*, which is equal to 1 if the predicted transaction price is smaller than the previous transaction price and 0 otherwise. We compare the housing features and transaction details between sellers facing expected losses (*Loss Dummy*=1) and expected gains (*Loss Dummy*=0). In the residential sector, approximately one third of the sellers are facing expected losses in the study period, which is much less than the level (50 – 55%) in the Boston housing market documented by GM. In general, the distributions of physical housing features are balanced between transactions predicted with losses and with gains apart from age. The average holding period of loss-facing sellers is over 11 months longer than that of gain-facing sellers, suggesting that loss-facing sellers have a longer time on the market. In the commercial sectors, the percentage of sellers subject to expected losses are 38.4% for industrial properties, 43.7% for office properties, and 42.7% for retail properties. This is much higher than the 22 – 25% level identified by BG in the commercial property market of the U.S.

5. Effects of Loss Aversion on Transaction Prices

Table 2 presents the baseline results of discerning the loss aversion behaviour in the residential sector following GM. As shown in column (1), the log transaction price is the dependent variable, with the estimated value of the property and holding months since the last sale as the regressors. According to GM, column (1) registers the upper bound of the loss aversion effect with the assumption of no unobservable characteristics. That is, a one-percent increase in nominal loss is associated with 0.22% increase in the transaction price. When the variable of residuals from the last sale was included in column (2) to control for unobserved quality, the coefficient estimate on *Loss* documents the lower bound on the true loss aversion effect. Consistent with the findings of GM, the lower bound loss aversion effect is small and insignificant. Column (3) adds a quadratic loss term and the result gives evidence that the effects of loss are diminishing as the value function predicts.

[Insert Table 2 here]

According to Anenberg (2011), GM's estimation strategy introduces a bias in the measurement of unobservable housing quality because of omitting the loss aversion behaviour in the first stage hedonic regression. We follow Anenberg's (2011) approach to produce a variable of adjusted residuals as the proxy for unobserved quality. Specifically, we restricted the sample used in the first stage to housing transactions that occurred in boom periods, that is, between 1993 and 1997 and between 2009 and 2015. Given the large price increases during these periods as shown in Figure 1, it is reasonable to assume that sellers are less likely to face nominal losses. Because the loss aversion behaviour is rare during these hot markets, it is safe to assume that the unobserved quality of a house only affects prices linearly. By utilizing the restricted sample, we generated adjusted residuals by repeating the hedonic pricing regression in the first stage. The period restriction in the first stage further limits the sample in the second stage to housing transactions of which the previous sale occurred between 1993 and 1997 or between 2009 and 2015. Given this requirement on the previous sale, approximately 60% of the repeat sales sample remain in the second stage. In column (4) of Table 2, we repeat Equation (7) with the variable of *Adjusted Residuals*, and the coefficient estimate on the *Loss* variable is positive and significant, falling in the range of the lower and upper bounds following GM's approach. Considering that Anenberg's (2011) approach requires a restrictive repeat sales sample, it may not be applicable to the commercial sectors with relatively limited transactions. Since the revised loss aversion effect is above the GM's lower bound, we can argue that the true loss aversion effect is larger than what was identified by using GM's lower-bound approach.

In addition, we consider loss aversion and trading experience. In prospect theory, the loss aversion behaviour is suggested as a stable component of preferences and should be uncorrelated to the market experience of an individual. However, past empirical studies give mixed evidence. List (2003) conducted an experimental field study that came out with support for the attenuating impact of market experience on loss aversion. GM documented that investors in the Boston housing market are less loss aversive than owner-occupants, while BG revealed that more experienced investors are as loss averse as their counterparts. In our test, we label sellers as "Experienced" if they engaged in more than one sale in the previous five years in the same property sector. As shown in the last column of Table 1, the interaction term between *Loss* and *Experienced Seller* registers a negative and significant sign, while the coefficient estimate on *Loss* becomes significantly positive.[4] It is therefore suggested that experienced sellers exhibit a lower degree of loss aversion than their less experienced counterparts.

6. Loss Aversion and Market Information

The property market is characterized by imperfect information due to its uniqueness and high transaction costs associated. Property buyers rely heavily on transaction details of comparable properties to evaluate the pricing of the target property (Anenberg, 2016). More transactions of comparable properties enable ordinary buyers to reduce the mispricing of target properties. That is, sellers facing nominal losses would be less likely to fish a buyer with an irrational high price. In this section, we try to quantify the importance of comparable transaction information in reducing the loss aversion effect.

Market Information and Loss Aversion: Across-sector Evidence

[4] The results remain if we increase the threshold (i.e., the number of sales conducted in the previous five years) defining experienced sellers.

We rely on the number of comparable transactions to measure how informative a market is. To begin with, we compare the loss aversion effect across property sectors of different sizes. In Hong Kong, the residential market is the most frequently traded sector. It occupied 90% of the entire property transaction volume with an average of over 80,000 transactions per year between 1995 and 2014 (see Appendix Table B2). The three commercial sectors—Retail, industrial, and office—as a whole only constitute 10% of the total transaction volume over the same period, making it difficult to find comparable transactions for deciding the price of the target commercial property. Therefore, we expect that the loss aversion effect on list prices should be more likely to carry through to transaction prices in the three commercial sectors than in the residential market. We further divide the residential market into the mass market (housing units with a saleable floor area of below or equal 1,000 square feet) and the luxury market (housing units with a saleable floor area of above 1,000 square feet). The mass units are the dominant housing type in Hong Kong, accounting for 95% of residential transactions that occurred between 1995 and 2014. Likewise, fewer comparable transactions should be available for purchasing a luxury unit, thus enabling the loss aversion behaviour to be realized on transaction prices.

Table 3 reports the results of Equation (7) by utilizing samples across the five property sectors. To our knowledge, BG is the only exception to examine loss aversion in the commercial property market. Without differentiating the sectors, they documented an overall increase of 2.45% in transaction prices per 10% increase in nominal loss. As shown in the first column of Panel A, we obtain a similar effect of loss aversion in the retail sector. It suggests that a seller facing a nominal loss of 10% receives a 2.57% higher price on average, and the effect is statistically significant at the 1% significance level. The loss aversion effect decreases by around half in the office and industrial sectors where a larger pool of sales is available to search for comparable transactions. In line with the prediction, the effect of loss aversion dissipates considerably in the residential sector. In the luxury housing market, the loss aversion effect registers to be positive and significant—10% nominal losses are associated with 0.18% higher transaction prices, whereas it turns statistically insignificant for mass housing units.

[Insert Table 3 here]

The loss aversion effect may be confounded with the effect of equity constraints. In Hong Kong, homeowners are not allowed to sell the property with negative equity, that is, when debt is higher than the market value. That means equity constrained owners incline to delay sales in particular in a market downturn and try to fish for better prices, which obviously confounds with the loss aversion effect. Given the lack of loan-to-value information of each seller, we alleviate the concern by limiting the expected losses to a threshold value. The maximum mortgage amount obtained in Hong Kong is 80% of the property value, and it can go further up to 90% for first-time buyers. Therefore, we assume that sellers facing a loss within 20% are less likely to be constrained by negative equity. In Panel B of Table 3, we report the results by excluding sales with a ratio of predicted loss to previous transaction price smaller than 20% and 10%, respectively. Consistently, we find statistically significant and stronger loss aversion effects on transaction prices of commercial properties than of residential properties.

Market Information and Loss Aversion: Within-sector Evidence

We carry out a second step to further explore whether comparable transactions play a role in reducing the loss aversion effect. For each transaction, we calculate the number of comparable transactions (i.e., *Comparables*) in a quarter before the target transaction. A quarter window is allowed for two reasons. First, the pre-determined measurement of *Comparables* mitigates the endogeneity concern. Second, considering the fast changes in the property market, more recent the transactions, more informative they could be. In the residential sector, we select comparable

transactions based on two criteria: coming from the same estate with the target transaction and of the same size category (i.e., mass or luxury housing unit). Housing units within the same estate share the same location and neighborhood facilities[5], and they provide the closest substitutes for each other (Wong et al., 2020). Because the format of estates only exists in the residential market, we revise the comparable criteria for commercial properties to transactions in the same building that occurred in the previous quarter. We interact the *Loss* variable with *Comparables* to test the counteraction effect of comparable transaction information. As shown in Panel C of Table 3, we obtain a negative and statistically significant interaction estimate between the *Loss* variable and the *Comparables* variable except for the office sector. That is to say, comparable transaction information is useful in mitigating the loss aversion effect in the retail, industrial, and residential sectors.

The consideration of comparable transaction information further alleviates the concern of negative equity constraints. While negative equity represents an institutional constraint on seller's behaviour, loss aversion as a psychological bias should be more likely to be overcome in transactions if the seller is bargaining with well-informed buyers. Our findings of negative crossing effects between loss aversion and comparable transaction information provide the evidence.

7. Loss Aversion and the Market Cycle

We hypothesize that whether sellers facing nominal losses could fetch a higher price than their counterparts should also depend on the market conditions. In hot markets, home sellers have greater bargaining power in the negotiation than buyers and transaction prices tend to follow the list prices closely (Carrillo, 2013). That suggests a great possibility for the loss aversion effect to carry through to actual transactions. When the property market experiences continuous declines, buyers gain the bargaining power to set the price (Han and Strange, 2016). Though sellers are more likely to face nominal losses in downward periods, they are limited by their bargaining power to achieve any loss aversion in actual sale prices.

Five Distinct Periods of the Market Cycle

To test the relevance of loss aversion to the market conditions, we break down the cycle of the Hong Kong property market between 1991 and 2015. As shown in Figure 1, the period through 1997 depicted the first stable and increasing property market across the four sectors. The year 1997 is a transition year coincided with the Asian financial crisis and the sovereignty return of Hong Kong to China, followed by a sudden crash of the whole market. The industrial and office sectors seemed to foresee the negative impact of the transition and started the crash three years before 1997. With the epidemic of SARS in 2003, all sectors reached the bottom with about one third of the price at the last peak. Afterwards, the property market recovered gradually from the bottom and most sectors (except for residential) went back to its pre-crisis level before the global financial crisis (GFC) hit in 2008. Unlike the U.S. and U.K. property markets that lost 20% of the value in the GFC, the Hong Kong market experienced an approximately 10% price decline which is limited to the industrial and office sectors. Soon the whole market regained the momentum of increase and has begun to shoot new records with rapid increases year by year. At the end of 2015, the residential sector increased by almost 4 times compared with the price at the trough of 2003, while the office and retail sectors witnessed an increase of 6 times and the industrial sector skyrocketed to 10 times of its price at 2003. Therefore, the Hong Kong property market can be divided into five distinct periods: two boom periods (i.e.,

[5] However, there are exceptions. Some residential estates in Hong Kong are developed in different phases, which are not located in the exact same location. For such estates, we calculate the comparable transactions by estate phases.

before 1997[6] and after 2009), two bust periods (between 1998 and 2003 and the year of 2008) and a recovery period (i.e., between 2004 and 2007).

Descriptive Statistics

We start with descriptive statistics on sales by the market cycle as reported in Table 4. In general, sales subject to expected nominal losses or *Loss* sales are closely related to the boom and bust cycle. First, the share of *Loss* sales and the magnitude of losses exhibit a negative relationship with the heat of the market. In the residential sector, 90% of repeat sales face expected losses in the bust period between 1998 and 2003. This figure is 56% in the recovery period and 25% in the year of GFC. Given that the residential sector suffered little price decline in the GFC as shown in Figure 1, it is not surprising to obtain a relatively small share of *Loss* sales in 2008. The *Loss* share further declines to 18% and 10% in the two boom periods before 1997 and after 2009, respectively. Likewise, the magnitude of nominal losses (on average) is considerably higher in the bust and recovery periods than in the boom periods. Similar patterns present in the three commercial sectors but in different degrees. The interaction of *Loss* sales and the property cycle in the retail sector is not as strong as in the other sectors. Specifically, the difference in the share of *Loss* sales between the bust period (1998-2003) and the boom period (after 2009) is approximately 40% in the retail sector in comparison with around 80% in the residential and industrial sectors and 74% in the office sector. Through the cycle, the retail sector also presents much flatter variations in the magnitude of expected nominal losses. In addition, because the industrial and retail sectors started the first market crash from 1994 rather than from 1997, they contain an exceptionally large *Loss* share in the boom period before 1997.

[Insert Table 4 here]

Second, we divide the sample conditional on expected losses and gains and find that the holding periods of *Loss* sales are more sensitive to the cycle than those with expected gains or *Gain* sales. When comparing holding periods, we focus on the periods after 1997 that are less biased.[7] Moving from the bust to the boom periods, the average holding period of *Gain* sales increases steadily by around 10 months per period across sectors, while that of *Loss* sales see more radical increases as well as declines. For example, in the industrial sector, the average holding period of *Loss* sales is 79 months in the bust period between 1998 and 2003, and it shot to 125 months in the recovery period and peaked at the GFC period with 139 months, before dropping by over 40 months in the boom period after 2009. Likewise, we find a much weaker sensitivity of the average holding period of *Loss* sales to the cycle in the retail sector. As a result of different sensitivities of the average holding period between *Loss* sales and *Gain* sales, we observe the holding back behaviour of Loss sales to vary with the cycle. Consistent with Zhou et al. (2020b), we find the *Loss* sales to be sold relatively quickly in the boom period compared to the bust and recovery periods in all four property sectors.[8]

[6] For the purpose of comparison, we define the bust period as between 1997 and 2003 for all sectors. This makes the period before 1997 not entirely a boom period for the industrial and office sectors.

[7] The lack of early transaction data prevents us from fully identifying repeat sales occurred before 1997. For example, the average holding period of residential sales before 1997 is approximately two years, while that is six years in the next boom period. The concern is not fully alleviated in the following bust period between 1998 and 2003 considering that there remains a discrepancy of one to two years in the average holding periods with the rest periods. In addition, the implementation of Special Stamp Duty in 2012 that prevents short sales would possibly cause the sample in the boom period after 2009 to be different. Because we have removed repeat sales with a holding period less than a year, the average holding period in the boom period after 2009 is not substantially affected.

[8] In the residential sector, the difference between *Loss* sales and *Gain* sales is only 9 months. We attribute it to the exclusion of long-holding *Loss* sales. As comparison, we limit repeat sales within a holding period of 10 years, and the difference between *Loss* sales and *Gain* sales reduces to 16 months in the GFC period and turns negative in the boom period after 2009.

Regression Results

We run Equation (7) separately by using subsamples of different periods and Table 5 presents the results across the four property sectors. In general, we find that the effect of loss aversion on transaction prices is larger in the period of market booms than in the period of market downturns. As shown in Panel A of Table 5, in the residential sector, the coefficient estimates on *Loss* are statistically significant and, interestingly, different across the periods. The first boom period between 1993 and 1997 registers the largest loss aversion impact—a seller facing a nominal loss of 10% receives a 2.25% higher price on average (Column (1)), double that in the second boom period after 2009 (Column (5)). When the market started to recover from the bust, 10% of nominal losses are only associated with a higher price of 0.098% (Column (3)). The loss aversion impact in the GFC period (Column (4)) is about one third of that after 2009. However, in the bust period between 1998 and 2003, sellers subject to nominal losses accepted a price lower than the average. Specifically, a one-percent increase in the nominal losses is associated with a higher transaction price of 0.243%.

[Insert Table 5 here]

Similar findings of the loss aversion effects across the periods, according to the results from Panel B and Panel D, are observed in the three commercial sectors.[9] Nevertheless, it is worthy to note that the pattern of loss aversion increasing with the market heat is less clear in the retail sector as shown in Panel D of Table 5. This is consistent with the finding from the descriptive statistics suggesting a weak interaction of loss aversion and the property cycle in the retail sector.

We consider two robustness tests. First, we repeat the tests in Table 5 by limiting the holding period within 10 years and results are reported in Appendix Table B4. Because there are more long-holding sellers in the latter periods, it is concerned that different loss aversion effects over the cycle may be ascribed to different holding periods of the repeat sales. According to Appendix Table B4, we find that, with the repeat sales sample to be more comparable across the cycle, variations in the effects of loss aversion strengthen in the residential and industrial sectors with relatively frequent transactions.

Second, we set thresholds for the ratio of predicted loss to the previous transaction price to deal with the confounding effect of equity constraints. Appendix Tables B5 and B6 present the results when the ratio of predicted loss to previous transaction price is limited to be less than 0.2 and 0.1, respectively. In general, with losses being restricted, we find the coefficient estimates of the *Loss* variable to be large and significant, and the patterns over the cycle remain more stable in the residential and industrial sectors than in the office and retail sectors. The weaker significance of the *Loss* estimation in the latter two sectors is possibly due to the limited number of observations in each period with the loss restriction.

In summary, our empirical results reveal that, while the magnitude of expected nominal losses decreases with the market heat, the loss aversion effect moves in the opposite direction at the individual transaction level. During booming periods when the pool of potential buyers with high willingness to pay is large, loss-facing sellers with high reservation prices may still find a buyer. However, in the market downturns characterised by low demand, it is difficult for the loss-facing sellers to find buyers that are willing to accept "abnormally" high transaction prices. Consequently, sellers are forced to accept more "rational" prices justifiable by property features and market conditions. It thus implies that the strengths of buyers' bargaining power

[9] We repeat the tests for the industrial and office sectors by adjusting the cut-off year of market cycle and the results remain. Results are provided in the Appendix Table B3.

under different market conditions plausibly exert a channel that influences the extent to which the loss aversion bias retains on the market transaction prices.

8. Aggregate Loss Aversion Effect on Property Price Indices

Construction of the Loss-aversion Adjusted Property Price Indices

While loss-averse sellers are active in the property market, evidence about the aggregate impact of loss aversion is mixed. BG took the difference of the impact from losses and gains as the measure of loss aversion behaviour, and they found the aggregate impact negligible: the maximum effect is in the bust period, but it has only increased the market price by approximately 1.2%. Zhou et al. (2020b) adjusted for anchoring to the previous purchase price, including but not limited to loss aversion, and they found that the anchoring effect significantly decreases the market volatility across the property cycle. Still, there are no conclusive evidences explaining the relevance of the aggregate impact of loss aversion to the market cycle.

Our empirical evidence on the individual-level effect of loss aversion across the cycle sheds new insights on the puzzle of the aggregate impact: we find that the individual loss aversion impact on transaction prices in the boom period is stronger than in the bust period, but the total number of sellers facing losses and the average loss per seller are also smaller in the boom period. The aggregate impact is thus influenced by the interaction of both changes in the magnitude of individual impact and the number of loss-averse sellers. We attempt to reveal this by investigating the aggregate impact of loss aversion on the price index in the four property sectors in Hong Kong.

We use the repeat sales index derived from the paired repeat transactions in our sample period as the benchmark, which is computed using the widely applied methodology proposed by Case and Shiller (1989).[10] We employ a similar empirical strategy developed by BG and Zhou et al. (2020b) to calculate the loss aversion adjusted property price index. The difference is that, unlike BG and Zhou et al. (2020b) that consider both the effects of gains and losses, our focus is on loss aversion and only the coefficients of losses are included in the price index adjustment. Specifically, we decompose the aggregate impact into three components: weight, magnitude, and coefficient. In each year, we first calculate the percentage of sellers that are facing an expected loss (i.e. the weight), based on Equation (2). Then we calculate the expectation of the loss amount (i.e. the magnitude) given that the seller faces an expected loss. Next, we calculate the impact of a unit amount of expected loss on the transaction price (i.e. the coefficient), following the specification in Equation (3). Due to insufficient data on a yearly basis, we use the coefficient in each period instead, which are reported in Table 5. Finally, the aggregate adjustment factor to the property price index is calculated as the product of the weight, the magnitude and the coefficient, and the repeat sales index in each year is adjusted accordingly.[11]

Unlike the individual-level loss aversion effect of which the magnitude is larger in the boom period, we find the aggregate impact of loss aversion is more prominent during the bust period. Figure 2 plots the original repeat sales index and the loss-aversion adjusted repeat sales index for the four property sectors in Hong Kong. In the year of 2003 during the bust period, the loss aversion behaviour increases the transaction prices (i.e., reduced the price declines) by approximately 1.60% in the residential sector, 11.55% in the industrial sector, 29.07% in the

[10] The Rating and Valuation Department (RVD) of Hong Kong also publishes a transaction-based index for all the four major property sectors, which uses the official land registry records and virtually covers all property transactions (Chau et al., 2005). Our derived repeat sales index closely follows the trend of this RVD index, which is plotted in Appendix Figure A2.

[11] Technically, we follow BG and take the log of the repeat sales index first. Then we subtract the loss-aversion adjustment factor, and exponentiate the adjusted index back to the straight levels.

office sector, and 23.01% in the retail sector. However, in 2014 when the market is booming, the loss aversion behaviour only raises the transaction prices by 0.02% in the residential sector, 0.52% in the industrial sector, 0.46% in the office sector, and 2.98% in the retail sector. This implies that the considerable increase in the number of loss-facing sellers mainly drives the effect of loss aversion on the aggregate market during the bust period. Appendix Figure A3 plots changes in the percentage of *Loss* sales and the magnitude of the *Loss* sales across the four property sectors. Taking the residential sector for an example, the percentage of loss-facing sellers (i.e. the weight) in the bust period from 1998 to 2003 is 89.51%, which is over 9 times of the percentage in the boom period after 2009 (see Table 4). Also, the expected loss of these loss-facing sellers in the bust period is significantly larger than that in the boom period. Although the impact of a unit expected loss on transaction price (i.e. the coefficient) is only 0.0243 in the bust period, which is around 1/3 of the coefficient in the boom period, the overall aggregate impact of loss aversion is still stronger in the bust period.

The adjusted repeat sales index also reveals that, at the aggregate market level, the effect of loss aversion is much stronger in the three commercial sectors. On the one hand, this can be explained by our findings at the individual level that comparable transaction information impacts the market's adjustment of loss aversion on the real transaction prices. On the other hand, it is also attributable to the larger market volatility of the commercial property markets in Hong Kong. In 2003, the percentages of the loss-facing commercial property sellers range from 72.2 percent to 94.7 percent, and the expected loss amounts of them are also higher than sellers in the residential market.

Our estimated aggregate impact of loss aversion in Hong Kong's residential market is comparable to that was estimated in the U.S. by Zhou et al. (2020b).[12] Table 6 reports the estimated loss aversion effect on the residential markets in the U.S. and Hong Kong during the bust period, when the aggregate market impacts are found to be larger. Because Zhou et al. (2020b) focused on the overall anchoring effect of purchase prices on the subsequent transaction prices, which include the impact of both nominal losses and gains. It may be concerned that solely extract their estimate of the impact from nominal losses may not be comparable to our estimate of loss aversion without considering the gain impact. Therefore, we also calculate the individual loss aversion effect with the gain impact controlled by the inclusion of the variable of *Gain*, defined as the expected loss of the seller being truncated above at zero. In Table 6, the first row reports the coefficient estimates of the *Loss* variable from Table 5, while the second row gives the estimates with the impact of gains controlled. We find the individual impact, reflected by the coefficient estimate of loss aversion, on Hong Kong's residential transactions (Column (2) of Table 6) is smaller than that in the U.S. (Column (1) of Table 6) with or without the gain impact controlled. Considering that more comparable market information from neighborhood residential units exists in the very dense urban context in Hong Kong, it may be difficult for Hong Kong property sellers to earn a higher price. However, the aggregate impact of loss aversion on Hong Kong's residential market, driven by a substantial share of loss-facing sellers, is not larger than that in the U.S. In Hong Kong where the property market is more volatile than that in the U.S., sellers are more likely to face a loss. For example, 87.8% of the Hong Kong residential property sellers face nominal losses in 2003, while the figure is only 68.6 percent in the U.S. when the burst period ends in 2012. We also document the aggregate loss aversion effects with the impact of gains being controlled in the

[12] For the commercial sectors, BG estimate that in the U.S., the individual-level impact of loss aversion on all commercial properties is 0.380, which lies in the range of our estimates using sub-sectors of commercial properties in Hong Kong. Unfortunately, we cannot compare the aggregate impact of loss aversion on the commercial property market in Hong Kong with that in the U.S, because BG does not report the aggregate impact solely from loss aversion (i.e. excluding the impact from nominal gains) on commercial property market in the U.S.

three commercial sectors and they remain rather stable as shown in the last three columns of Table 6.

[Insert Table 6 here]

Limitations

One limitation with our loss-aversion adjusted index is that only the paired repeat transactions are used to calculate the percentage of loss-facing sellers and their expected losses, but a large proportion of transactions in the early years of the sample period do not have information on the prior purchase prices (i.e. these units were initially purchased before the start of our sample period). Specifically, for repeat sales in the bust period from 1997 to 2003, we can only identify the expected losses for the sellers who purchased the units after 1992. Since Hong Kong's property markets had been continuously increasing from 1980 to 1992 (see Figure 1), excluding the sellers who purchased in earlier years with lower prices is likely to cause overestimation of loss-facing sellers and the expected losses in the bust periods.

To partially alleviate this concern, we conduct a robustness check by only including the paired repeat transactions with the holding period of less than 10 years (denoted as the truncated sample). Since our sampling period starts from 1992, this allows a more balanced sampling for comparing the by-year impact of loss aversion, especially from 2003 onward. The repeat sales index and the adjustment factors for loss aversion are modified accordingly. Appendix Figure A4 plots the corresponding repeat sales index and the loss-aversion adjusted index using the truncated sample. We compare the by-year adjustment factors derived from the full paired samples and from the truncated samples, which are reported in Appendix Table B7. We find that, for the truncated sample, the aggregate impact of loss aversion remains stronger during the bust period, which indicates that our main finding is robust.

In addition, the estimates of a unit expected loss on transaction price in the office and retail sectors where fewer transactions occurred may also be a concern. In accordance with the tests in Section 7, the coefficient estimates on loss aversion over the property cycle are less stable in the office and retail sectors than in the residential and industrial sectors. This may pose a threat to the accuracy of loss aversion estimates, thus causing bias in aggregating the loss aversion effect on the overall market.

9. Conclusions and Discussions

Built upon the insights of GM, this paper provides new evidence on the importance of loss aversion on the property market. Our results by using a comprehensive dataset of Hong Kong property transactions suggest that the loss aversion effect carries through from list prices to transaction prices across the residential, industrial, office, and retail sectors. We also find the effect of loss aversion to be stronger in the commercial market than in the residential market where there is abundant comparable transaction information to help reduce the mispricing of the target property. Combined with the study of BG, we shed light on the importance of loss aversion in the commercial property market where professional investors occupy.

We also examine variations in the effects of loss aversion in a large boom-bust cycle across different property sectors. We find the loss aversion effect on the individual transaction prices to be more prominent in the boom period than in the bust period. But when combining the percentage of sellers facing an expected loss, the expectation of the loss amount, and the impact of a unit amount of expected loss on the transaction price in the aggregate market analysis, the loss aversion effect turns stronger in the bust period than in the boom period. That is, loss aversion reduces aggregate price declines in market downturns, the effect of which is

particularly strong in the commercial property sectors. These results suggest a role of loss aversion in accounting for aggregate property market dynamics.

Our effort of examining the interaction between loss aversion and different market conditions also provides clues understanding why loss aversion can retain on market prices. Based on the reduced-form regression results, we are able to relate it to limited market information and the role of list prices in directing bargain and search. Admittedly, the results of this paper should be taken with caution for two reasons. First, we don't have the assessed property value like Zhou et al. (2020a,b) to deal with unobserved features but mostly relying on GM's approach combined with Anerberg's (2011) improvement. Second, we address the confounding effect of equity constraints by a subsample of less equity-constrained sellers in the individual-transaction analysis, which cannot be applied to the aggregate market analysis. That is, reductions in aggregate price declines in the bust period should not be fully ascribed to loss aversion.

Reference

Anenberg, E. (2011). Loss aversion, equity constraints and seller behavior in the real estate market. *Regional Science and Urban Economics*, *41*(1), 67-76.

Anenberg, E. (2016). Information frictions and housing market dynamics. *International Economic Review*, *57*(4), 1449-1479.

Bao, H. X., & Meng, C. C. (2017). Loss Aversion and Housing Studies. *Journal of Real Estate Literature*, *25*(1), 49-75.

Barberis, N. C. (2013). Thirty years of prospect theory in economics: A review and assessment. *Journal of Economic Perspectives*, *27*(1), 173-96.

Barberis, N., & Xiong, W. (2009). What drives the disposition effect? An analysis of a long-standing preference-based explanation. *The Journal of Finance*, *64*(2), 751-784.

Barberis, N., & Xiong, W. (2012). Realization utility. *Journal of Financial Economics*, *104*(2), 251-271.

Benartzi, S., & Thaler, R. H. (1995). Myopic loss aversion and the equity premium puzzle. *The Quarterly Journal of Economics*, *110*(1), 73-92.

Black, R. T., & Diaz III, J. (1996). The use of information versus asking price in the real property negotiation process. *Journal of Property Research*, *13*(4), 287-297.

Bodnaruk, A., & Simonov, A. (2016). Loss-averse preferences, performance, and career success of institutional investors. *The Review of Financial Studies*, *29*(11), 3140-3176.

Bokhari, S., & Geltner, D. (2011). Loss aversion and anchoring in commercial real estate pricing: Empirical evidence and price index implications. *Real Estate Economics*, *39*(4), 635-670.

Bracke, P., & Tenreyro, S. (2019). History dependence in the housing market. *Working paper*.

Buisson, F. (2016). Prospect theory and loss aversion in the housing market. *Journal of Real Estate Research*, *38*(2), 229-249.

Carrillo, P. E. (2013). To sell or not to sell: Measuring the heat of the housing market. *Real Estate Economics*, *41*(2), 310-346.

Case, K., & Shiller, R. (1989). The Efficiency of the Market for Single-Family Homes. *American Economic Review*, 79(1), 125-37.

Chang, T. Y., Solomon, D. H., & Westerfield, M. M. (2016). Looking for someone to blame: Delegation, cognitive dissonance, and the disposition effect. *The Journal of Finance*, *71*(1), 267-302.

Chau, K., Wong, S., Yiu, C., & Leung, H. (2005). Real estate price indices in Hong Kong. *Journal of Real Estate Literature*, *13*(3), 337-356.

Clapp, J. M., Lu-Andrews, R., & Zhou, T. (2018). Anchoring to Purchase Price and Fundamentals: Application of Salience Theory to Housing Cycle Diagnosis. *Real Estate Economics*.

Dhar, R., & Zhu, N. (2006). Up close and personal: Investor sophistication and the disposition effect. *Management Science*, *52*(5), 726-740.

Einiö, M., Kaustia, M. & Puttonen, V. (2008) Price setting and the reluctance to realize losses in apartment markets. *Journal of Economic Psychology*. 2 (1), 19-34.

Engelhardt, G. (2003) Nominal loss aversion, housing equity constraints, and household mobility: evidence from the United States. *Journal of Urban Economics*. 53 (1), 171-195.

Genesove, D., & Mayer, C. (1997). Equity and Time to Sale in the Real Estate Market. *American Economic Review*, 87(3), 255-69.

Genesove, D., & Mayer, C. (2001). Loss aversion and seller behavior: Evidence from the housing market. *The Quarterly Journal of Economics*, *116*(4), 1233-1260.

Glaeser, E. L., & Nathanson, C. G. (2017). An extrapolative model of house price dynamics. *Journal of Financial Economics*, *126*(1), 147-170.

Grinblatt, M., & Keloharju, M. (2001). What makes investors trade?. *The Journal of Finance*, *56*(2), 589-616.

Haigh, M. & List, J. (2005) Do Professional Traders Exhibit Myopic Loss Aversion? An Experimental Analysis. *The Journal of Finance*. 60 (1), 523-534.

Han, L., & Strange, W. C. (2016). What is the role of the asking price for a house?. *Journal of Urban Economics*, *93*, 115-130.

Haurin, D., McGreal, S., Adair, A., Brown, L. & Webb, J. (2013). List price and sales prices of residential properties during booms and busts. *Journal of Housing Economics*, 22 (1), 1- 10.

Kahneman, D., Knetsch, J. & Thaler, R. (1990) Experimental Tests of the Endowment Effect and the Coase Theorem. *Journal of Political Economy*. 98 (6), 1325-1348.

Lee, N. & Ong, S. (2005) Upward mobility, house price volatility, and housing equity. *Journal of Housing Economics*. 14 (2), 127-146.

Leung, T. & Tsang, K. (2013a) Anchoring and loss aversion in the housing market: Implications on price dynamics. *China Economic Review*. 24, 42-54.

Leung, T. & Tsang, K. (2013b) Can Anchoring and Loss Aversion Explain the Predictability of Housing Prices? *Pacific Economic Review*. 18 (1), 41-59.

Li, Y., & Yang, L. (2013). Prospect theory, the disposition effect, and asset prices. *Journal of Financial Economics*, *107*(3), 715-739.

List, J. (2003) Does Market Experience Eliminate Market Anomalies?. *The Quarterly Journal of Economics*. 118 (1), 41-71.

Northcraft, G. B., & Neale, M. A. (1987). Experts, amateurs, and real estate: An anchoring-and-adjustment perspective on property pricing decisions. *Organizational behavior and human decision processes*, *39*(1), 84-97.

Odean, T. (1998). Are investors reluctant to realize their losses?. *The Journal of Finance*, *53*(5), 1775-1798.

Ortalo-Magne, F., & Rady, S. (1998). Housing market fluctuations in a life-cycle economy with credit constraints. *Working paper available at SSRN 102933*.

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, *1*(1), 7-59.

Shefrin, H., & Statman, M. (1985). The disposition to sell winners too early and ride losers too long: Theory and evidence. *The Journal of Finance*, *40*(3), 777-790.

Simmons-Mosley, T. & Malpezzi, S. (2006) Household mobility in New York City's regulated rental housing market. *Journal of Housing Economics*. 15 (1), 38-62.

Stein, J. C. (1995). Prices and trading volume in the housing market: A model with down-payment effects. *The Quarterly Journal of Economics*, *110*(2), 379-406.

Tversky, A., & Kahneman, D. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 263-291.

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297-323.

Wong, S. K., Li, L., & Monkkonen, P. (2020). Developers' Market Power: How do Developers Price New Housing in a Highly Oligopolistic City?. *Working paper*.

Yavas, A., & Yang, S. (1995). The strategic role of listing price in marketing real estate: theory and evidence. *Real Estate Economics*, *23*(3), 347-368.

Zhou, T., Clapp, J. M., & Lu-Andrews, R. (2020a). Do Sellers with Expected Losses Obtain a Premium Price? Really? *Working paper available at SSRN 3534732*.

Zhou, T., Clapp, J. M., & Lu-Andrews, R. (2020b). Is the Behavior of Sellers with Expected Gains and Losses Relevant to Cycles in House Prices? *Working paper available at SSRN 3379083*.

Tables

Table 1. Summary Statistics

Panel A: Residential Sector

	Total (Obs 413,263)				Loss Dummy = 1 (Obs 143,377)		Loss Dummy = 0 (Obs 269,886)	
	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	Mean (1)	Std. Dev. (2)	Mean (1)	Std. Dev. (2)
Transaction Price (million HKD)	3.455	3.813	0.120	128	2.571	3.073	3.929	4.083
Previous Transaction Price (million HKD)	2.863	2.912	0.110	106.8	3.347	3.368	2.611	2.608
Building Age	18.340	9.501	0	49.99	16.510	8.039	19.35	10.034
Unit Size (100 sq.ft.)	5.210	2.547	1.005	3.290	5.24	2.516	520	256.77
Floor	15.420	10.839	0	89	14.54	9.665	15.89	11.379
Estate units (thousand)	2.560	3.344	0.002	13.149	2.600	3.415	2.542	3.313
Distance to Seacoast (km)	1.180	1.409	0.017	8.060	1.213	1.441	1.163	1.392
Distance to Hospital (km)	1.581	1.427	0.038	8.575	1.627	1.460	1.557	1.41
Distance to Bus Stop (km)	0.368	0.351	0.010	7.636	0.371	0.368	0.366	0.341
Distance to Park (km)	0.960	0.937	0.057	9.536	0.954	0.949	0.964	0.931
Distance to MTR (km)	0.959	1.251	0.003	16.011	1.000	1.333	0.937	1.204
Distance to School (km)	0.146	0.203	0.001	2.992	0.149	0.216	0.145	0.195
Distance to University (km)	3.220	2.743	0.024	21.255	3.269	2.660	3.193	2.787
Holding Period (in months)	65.980	47.041	12.030	269.400	73.452	43.777	62.112	48.279
Sale Year	2007	5.121	1994	2015	2004	3.926	2009	4.879
Purchase Year	2002	5.469	1993	2014	1998	3.472	2004	5.28
Loss Dummy	0.347	0.476	0	1				
Loss	0.129	0.243	0	2.140	0.371	0.284		
Ratio of Predicted Loss to Previous Transaction Price	0.098	0.173	0	0.882	0.284	0.183		

Panel B: Industrial Sector

	Total (Obs 31,374)				Loss Dummy = 1 (Obs 12,036)		Loss Dummy = 0 (Obs 19,338)	
	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	Mean (1)	Std. Dev. (2)	Mean (1)	Std. Dev. (2)
Transaction Price (million HKD)	2.372	3.693	0.100	99.800	1.750	2.645	2.760	4.169
Previous Transaction Price (million HKD)	1.732	2.365	0.100	75.936	2.278	2.660	1.393	2.090
Building Age	18.334	8.194	0	50.000	14.242	6.929	20.881	7.882
Unit Size (100 sq.ft.)	16.744	19.571	1.250	503.160	17.109	15.748	16.516	21.609
Floor	10.473	6.263	0	39.000	10.766	6.506	10.291	6.101
Distance to Seacoast (km)	1.211	1.128	0.024	7.797	1.247	1.104	1.190	1.143
Distance to Hospital (km)	1.349	0.588	0.124	5.114	1.324	0.574	1.365	0.596
Distance to Bus Stop (km)	0.322	0.137	0.018	1.728	0.318	0.136	0.325	0.138
Distance to Park (km)	0.888	0.442	0.171	2.969	0.879	0.437	0.894	0.446
Distance to MTR (km)	0.595	0.585	0.030	4.637	0.579	0.543	0.605	0.610
Holding Period (in months)	84.669	63.119	12	278	90.853	53.314	80.820	68.235
Sale Year	2006	5.638	1992	2014	2003	4.500	2008	5.315
Purchase Year	1999	6.468	1991	2013	1995	4.607	2001	6.358
Loss Dummy	0.384	0.486	0	1				
Loss	0.221	0.383	0	4.025	0.575	0.422		
Ratio of Predicted Loss to Previous Transaction Price	0.150	0.235	0	0.982	0.390	0.225		

Panel C: Office Sector

	Total (Obs 14,566)				Loss Dummy = 1 (Obs 6,360)		Loss Dummy = 0 (Obs 8,206)	
	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	Mean (1)	Std. Dev. (2)	Mean (1)	Std. Dev. (2)
Transaction Price (million HKD)	4.625	8.047	0.100	315.000	4.207	5.793	4.948	9.418
Previous Transaction Price (million HKD)	4.120	6.696	0.120	98.763	5.572	6.781	2.994	6.406
Building Age	17.070	8.826	0	50	15.096	7.791	18.600	9.266
Unit Size (100 sq.ft.)	9.994	11.527	1.050	287.250	10.973	9.544	9.235	12.803
Floor	12.656	7.248	0	47	12.645	7.218	12.665	7.272
Distance to Seacoast (km)	0.596	0.456	0.023	7.918	0.577	0.433	0.612	0.473
Distance to Hospital (km)	0.823	0.562	0.064	2.905	0.841	0.547	0.809	0.573
Distance to Bus Stop (km)	0.318	0.183	0.003	0.828	0.312	0.186	0.323	0.181
Distance to Park (km)	0.745	0.364	0.100	2.237	0.744	0.366	0.745	0.363
Distance to MTR (km)	0.356	0.515	0.004	3.751	0.351	0.497	0.360	0.528
Holding Period (in months)	80.412	62.218	12	280	88.255	54.934	74.332	66.695
Sale Year	2005	5.932	1992	2014	2003	4.605	2007	6.486
Purchase Year	1998	6.266	1991	2013	1996	4.824	2000	6.645
Loss Dummy	0.437	0.496	0	1				
Loss	0.264	0.434	0	6.171	0.604	0.474		
Ratio of Predicted Loss to Previous Transaction Price	0.174	0.252	0	0.998	0.398	0.236		

Panel D: Retail Sector

	Total (Obs 6,572)				Loss Dummy = 1 (Obs 2,806)		Loss Dummy = 0 (Obs 3,766)	
	Mean (1)	Std. Dev. (2)	Min (3)	Max (4)	Mean (1)	Std. Dev. (2)	Mean (1)	Std. Dev. (2)
Transaction Price (million HKD)	4.691	8.143	0.100	98.000	5.581	9.126	4.028	7.256
Previous Transaction Price (million HKD)	3.386	5.602	0.100	92.800	4.975	7.137	2.202	3.679
Building Age	21.473	9.808	0	63.000	19.194	9.568	23.170	9.640
Unit Size (100 sq.ft.)	4.094	4.708	0.270	46.820	3.987	4.531	4.173	4.834
Floor	0.762	1.067	0	19.000	0.739	1.211	0.779	0.945
Distance to Seacoast (km)	0.885	0.834	0.000	8.060	0.875	0.785	0.893	0.869
Distance to Hospital (km)	1.077	0.756	0.088	6.941	1.114	0.792	1.050	0.726
Distance to Bus Stop (km)	0.348	0.298	0.003	7.103	0.358	0.290	0.340	0.304
Distance to Park (km)	0.854	0.495	0.092	7.546	0.872	0.494	0.841	0.496
Distance to MTR (km)	0.514	0.796	0.009	12.290	0.518	0.804	0.511	0.791
Holding Period (in months)	79.278	64.376	12	273	78.807	61.023	79.628	66.771
Sale Year	2007	5.218	1992	2014	2005	4.824	2008	5.269
Purchase Year	2000	6.246	1991	2013	1999	5.913	2001	6.302
Loss Dummy	0.427	0.495	0	1				
Loss	0.254	0.426	0	4.192	0.595	0.471		
Ratio of Predicted Loss to Previous Transaction Price	0.168	0.247	0	0.985	0.394	0.232		

Table 2. Baseline Results of Loss Aversion

	Residential				
	(1) log(price)	(2) log(price)	(3) log(price)	(4) log(price)	(5) log(price)
Loss	0.2238***	0.0029	0.0424***	0.0912***	0.0061***
	(0.0022)	(0.0022)	(0.0053)	(0.0024)	(0.0023)
Loss Squared			-0.0463***		
			(0.0059)		
Loss * Experienced Seller					-0.0153***
					(0.0028)
Estimated Value	0.9809***	0.9657***	0.9659***	0.9561***	0.9658***
	(0.0009)	(0.0008)	(0.0008)	(0.0011)	(0.0008)
Residuals from Last Sale		0.4518***	0.4504***		0.4159***
		(0.0029)	(0.0029)		(0.0029)
Adjusted Residuals				0.3710***	
				(0.0037)	
Holding Period	-0.0004***	-0.0010***	-0.0010***	-0.0002***	-0.0010***
	(8.2E-06)	(8.7E-06)	(8.8E-06)	(9.2E-06)	(8.8E-06)
Year * District Fixed Effect	Y	Y	Y	Y	Y
Observations	413,263	413,263	413,263	252,474	413,263
R-squared	0.918	0.932	0.932	0.928	0.932

Loss is defined as the difference between the log of the predicted transaction price and the log of the previous transaction price, truncated below at zero. Experienced Seller is a dummy variable, equal to 1 if the seller engaged in more than one sale in the previous five years in the same property sector and 0 otherwise. Adjusted Residuals are the residuals of the previous transaction price from the first-stage hedonic pricing regression by utilizing a subsample with transactions occurred in the boom periods between 1993 and 1997 and between 2009 and 2015. Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table 3. Loss Aversion Across Four Property Sectors in Hong Kong

	Retail	Office	Industrial	Residential: Luxury	Residential: Mass
	log(price)	log(price)	log(price)	log(price)	log(price)
Panel A	(1)	(2)	(3)	(4)	(5)
Loss	0.2568***	0.1451***	0.1098***	0.0177***	-0.0002
	(0.0639)	(0.0380)	(0.0221)	(0.0128)	(0.0029)
Estimated Value	1.0683***	1.0174***	1.0233***	0.9155***	0.9498***
	(0.0222)	(0.0137)	(0.0125)	(0.0061)	(0.0009)
Residuals from Last Sale	0.6994***	0.7444***	0.6770***	0.5241***	0.4459***
	(0.0224)	(0.0117)	(0.0209)	(0.0153)	(0.0029)
Holding Period	-0.0016***	-0.0004***	-0.0003***	-0.0007***	-0.0010***
	(0.0003)	(0.0001)	(0.0001)	(4.5E-05)	(8.8E-06)
Year * District Fixed Effect	Y	Y	Y	Y	Y
Observations	6,572	14,566	31,374	18,711	395,979
R-squared	0.849	0.933	0.915	0.891	0.918
Panel B:	(1)	(2)	(3)	(4)	(5)
Ratio of Predicted Loss to Previous Transaction Price<0.2					
Loss	0.8358***	0.4589***	0.2350***	0.2067***	0.1769***
	(0.2243)	(0.0717)	(0.0398)	(0.0488)	(0.0091)
Observations	4,483	9,854	22,425	14,805	310,336
R-squared	0.850	0.940	0.914	0.869	0.912
Ratio of Predicted Loss to Previous Transaction Price<0.1					
Loss	1.0843**	0.6736***	0.5741***	0.5133***	0.4526***
	(0.4331)	(0.2031)	(0.1051)	(0.1134)	(0.0221)
Observations	4,120	9,016	20,885	13,469	285,604
R-squared	0.851	0.940	0.913	0.867	0.910
Panel C	(1)	(2)	(3)	(4)	(5)
Loss	0.3952***	0.0670**	0.1525***	0.6279***	0.5030***
	(0.0538)	(0.0282)	(0.0231)	(0.1371)	(0.0274)
Loss * Comparables	-0.0435***	0.0228	-0.0082***	-0.0167***	-0.0007***
	(0.0092)	(0.0136)	(0.0020)	(0.0081)	(0.0002)
Observations	6,572	14,566	31,374	18,711	395,979
R-squared	0.855	0.934	0.915	0.867	0.911

Residential: Luxury refers to transactions of housing units with saleable floor area of above 1,000 square feet; *Residential: Mass* refers to transactions of housing units with saleable floor area of below 1,000 square feet. *Comparables* measures the number of comparable transactions in the same building (estate for residential properties) as the target property in a quarter before the target transaction. Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table 4. Key Statistics by the Hong Kong Market Cycle

	Before 1997 Boom	1998-2003 Bust	2004-2007 Recovery	2008 GFC	After 2009 Boom
	Mean	Mean	Mean	Mean	Mean
Residential	(1)	(2)	(3)	(4)	(5)
Share of Loss Sales (Loss>0)	18.28%	89.51%	55.53%	24.90%	9.92%
Loss conditional on Loss>0	0.131	0.466	0.346	0.237	0.125
Holding Period	26.30	48.27	72.77	72.33	73.76
Holding Period of Loss Sales (a)	24.04	49.19	90.46	111.90	101.79
Holding Period of Gain Sales (b)	26.81	40.43	50.68	59.21	70.67
(a)-(b)	-2.77	8.76	39.78	52.69	31.12
Industrial	(1)	(2)	(3)	(4)	(5)
Share of Loss Sales (Loss>0)	47.33%	93.80%	49.40%	20.72%	11.05%
Loss conditional on Loss>0	0.151	0.790	0.260	0.055	0.027
Holding Period	31.97	79.32	94.23	96.00	95.30
Holding Period of Loss Sales (a)	35.21	78.84	124.92	139.35	92.66
Holding Period of Gain Sales (b)	29.06	38.31	64.28	84.67	95.63
(a)-(b)	6.15	40.53	60.64	54.68	-2.97
Office	(1)	(2)	(3)	(4)	(5)
Share of Loss Sales (Loss>0)	31.77%	92.97%	56.62%	29.68%	19.00%
Loss conditional on Loss>0	0.090	0.856	0.321	0.105	0.051
Holding Period	30.26	72.37	91.29	94.63	97.2
Holding Period of Loss Sales (a)	29.89	73.94	114.55	128.39	100.03
Holding Period of Gain Sales (b)	30.44	51.56	60.93	80.39	96.54
(a)-(b)	-0.55	22.38	53.62	48	3.49
Retail	(1)	(2)	(3)	(4)	(5)
Share of Loss Sales (Loss>0)	40.63%	72.57%	51.91%	41.46%	29.08%
Loss conditional on Loss>0	0.195	0.584	0.333	0.246	0.152
Holding Period	32.58	63.48	80.38	73.87	94.08
Holding Period of Loss Sales (a)	31.55	64.68	88.19	79.92	88.65
Holding Period of Gain Sales (b)	33.29	60.31	71.96	69.59	96.30
(a)-(b)	-1.74	4.37	16.23	10.33	-7.65

Table 5. Loss Aversion Across the Hong Kong Market Cycle

	Before 1997 Boom log(price)	1998-2003 Bust log(price)	2004-2007 Recovery log(price)	2008 GFC log(price)	After 2009 Boom log(price)
Panel A: Residential	(1)	(2)	(3)	(4)	(5)
Loss	0.2009***	0.0243***	0.0428***	0.0396***	0.0729***
	(0.0245)	(0.0043)	(0.0037)	(0.0122)	(0.0100)
Estimated Value	1.0131***	0.9941***	1.0697***	0.9938***	0.8940***
	(0.0027)	(0.0021)	(0.0016)	(0.0034)	(0.0011)
Residuals from Last Sale	0.4727***	0.3447***	0.4368***	0.5012***	0.4757***
	(0.0111)	(0.0080)	(0.0059)	(0.0123)	(0.0039)
Holding Period	-0.0015***	-0.0015***	-0.0148***	-0.0012***	-0.0117***
	(0.0001)	(4.5E-05)	(2.1E-05)	(3.8E-05)	(1.1E-05)
Year * District Fixed Effect	Y	Y	Y	Y	Y
Benchmark log(price)	1.080	0.544	0.651	0.810	1.204
Observations	28,883	66,142	95,599	24,795	197,844
R-squared	0.932	0.915	0.934	0.918	0.918
Panel B: Industrial	(1)	(2)	(3)	(4)	(5)
Loss	0.2162**	0.1346***	0.1202***	0.1680	0.3233***
	(0.0801)	(0.0421)	(0.0290)	(0.1098)	(0.0528)
Estimated Value	1.0601***	1.0126***	1.0491***	1.0542***	0.9930***
	(0.0224)	(0.0168)	(0.0192)	(0.0194)	(0.0146)
Residuals from Last Sale	0.6988***	0.6483***	0.7169***	0.6226***	0.6254***
	(0.0512)	(0.0516)	(0.0266)	(0.0453)	(0.0252)
Holding Period	-0.0009	-0.0020***	-0.0010***	-0.0004**	-0.0001
	(0.0006)	(0.0003)	(0.0001)	(0.0002)	(0.0001)
Year * District Fixed Effect	Y	Y	Y	Y	Y
Benchmark log(price)	0.407	-0.408	0.001	0.421	0.880
Observations	3,693	4,856	7,987	1,530	13,308
R-squared	0.906	0.859	0.878	0.878	0.892

Table 5. Loss Aversion Across the Hong Kong Market Cycle (Cont')

	Before 1997 Boom log(price)	1998-2003 Bust log(price)	2004-2007 Recovery log(price)	2008 GFC log(price)	After 2009 Boom log(price)
Panel C: Office	(1)	(2)	(3)	(4)	(5)
Loss	0.0521*	0.2643*	0.1306***	0.1494***	0.2548***
	(0.0299)	(0.1518)	(0.0284)	(0.0498)	(0.0443)
Estimated Value	1.0541***	0.9482***	1.0489***	1.0558***	0.9946***
	(0.0140)	(0.0185)	(0.0232)	(0.0461)	(0.0139)
Residuals from Last Sale	0.8895***	0.5833***	0.7987***	0.7438***	0.6812***
	(0.0252)	(0.1130)	(0.0349)	(0.0329)	(0.0132)
Holding Period	-0.0023**	-0.0024**	-0.0009***	-0.0003***	-0.0001
	(0.0009)	(0.0010)	(0.0002)	(0.0001)	(0.0001)
Year * District Fixed Effect	Y	Y	Y	Y	Y
Benchmark log(price)	1.004	0.303	0.651	0.867	1.241
Observations	2,395	2,418	3,778	721	5,254
R-squared	0.952	0.909	0.919	0.917	0.939
Panel D: Retail	(1)	(2)	(3)	(4)	(5)
Loss	0.1974	0.3534***	0.2505***	0.3905***	0.2953**
	(0.1473)	(0.1247)	(0.0890)	(0.0912)	(0.1190)
Estimated Value	1.0185***	0.9906***	1.0544***	1.0608***	1.1114***
	(0.0258)	(0.0525)	(0.0593)	(0.0438)	(0.0238)
Residuals from Last Sale	0.8098***	0.5451***	0.7046***	0.6666***	0.6845***
	(0.0947)	(0.0963)	(0.0504)	(0.0517)	(0.0198)
Holding Period	-0.0015	-0.0041***	-0.0023***	-0.0015**	-0.0013**
	(0.0017)	(0.0012)	(0.0003)	(0.0006)	(0.0005)
Year * District Fixed Effect	Y	Y	Y	Y	Y
Benchmark log(price)	0.718	0.432	0.597	0.561	0.934
Observations	636	920	1,615	369	3,032
R-squared	0.922	0.835	0.822	0.865	0.847

The benchmark log(price) is the mean of the log(price) for transactions with expected nominal gains. Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

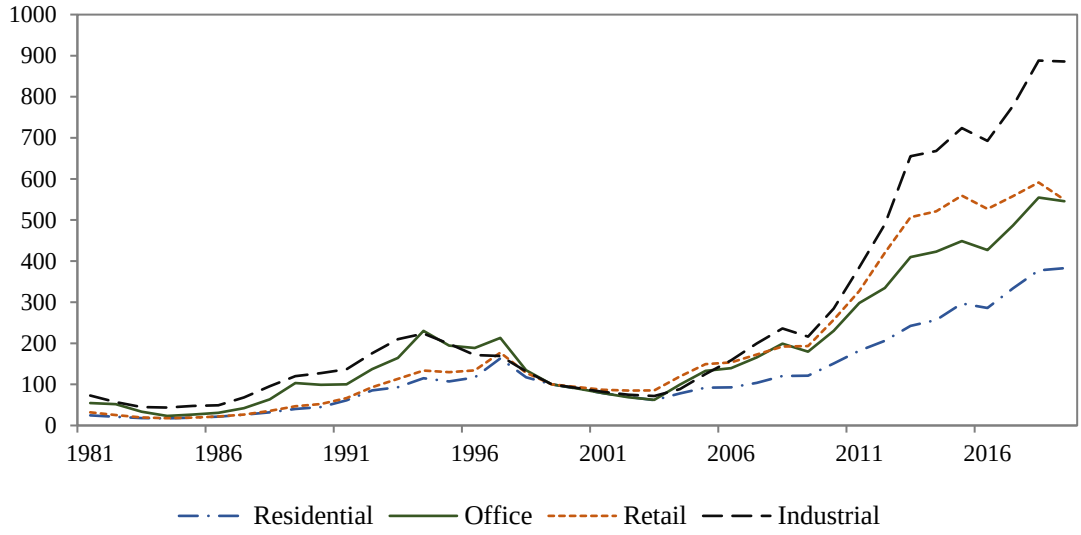
Table 6. Comparison between the Aggregate Impact of Loss Aversion in the U.S. and Hong Kong during the Bust Period

	(1) U.S. Residential 2012	(2) H.K. Residential 2003	(3) H.K. Retail 2003	(4) H.K. Industrial 2003	(5) H.K. Office 2003
Coefficient Estimate of Loss Aversion	/	0.024	0.353	0.135	0.264
Coefficient Estimate of Loss Aversion—with the variable of Gain included	0.046	0.013	0.384	0.139	0.269
Loss-Facing Sellers (%)	0.686	0.959	0.789	0.898	0.947
log (Expected Loss)	0.290	0.683	0.743	0.905	1.019
Original Price Index	1.079	0.490	0.800	0.602	0.420
Adjusted Price Index	/	0.482	0.651	0.539	0.326
Adjusted Price Index—with the variable of Gain	1.069	0.485	0.639	0.537	0.324
Change	/	*1.60%*	*23.01%*	*11.55%*	*29.07%*
Change—with the variable of Gain	*0.90%*	*0.85%*	*25.22%*	*11.92%*	*29.70%*

Statistics in Column (1) are extracted from Table 5 & 7 in Zhou et al. (2020b), which are estimated using the residential transactions in Connecticut. Column (1) include transactions in 2012, which is the last year of the bust period defined by Zhou et al. (2020b). Columns (2) — (5) include transactions in Hong Kong in 2003, which is also the last year of the bust period from 1998 to 2003. *log (Expected Loss)* denotes average loss amount in log form that the sellers face given expected losses occur. *Loss Adjustment Factor* is the product of *Coefficient of Loss Aversion*, *Loss-Facing Sellers (%)* and *log (Expected Loss)*. Following BG, the *Adjusted Price Index* is calculated by first taking logarithm of the *Price Index*, subtracting the *Loss Adjustment Factor*, and finally being converted back to the straight levels.

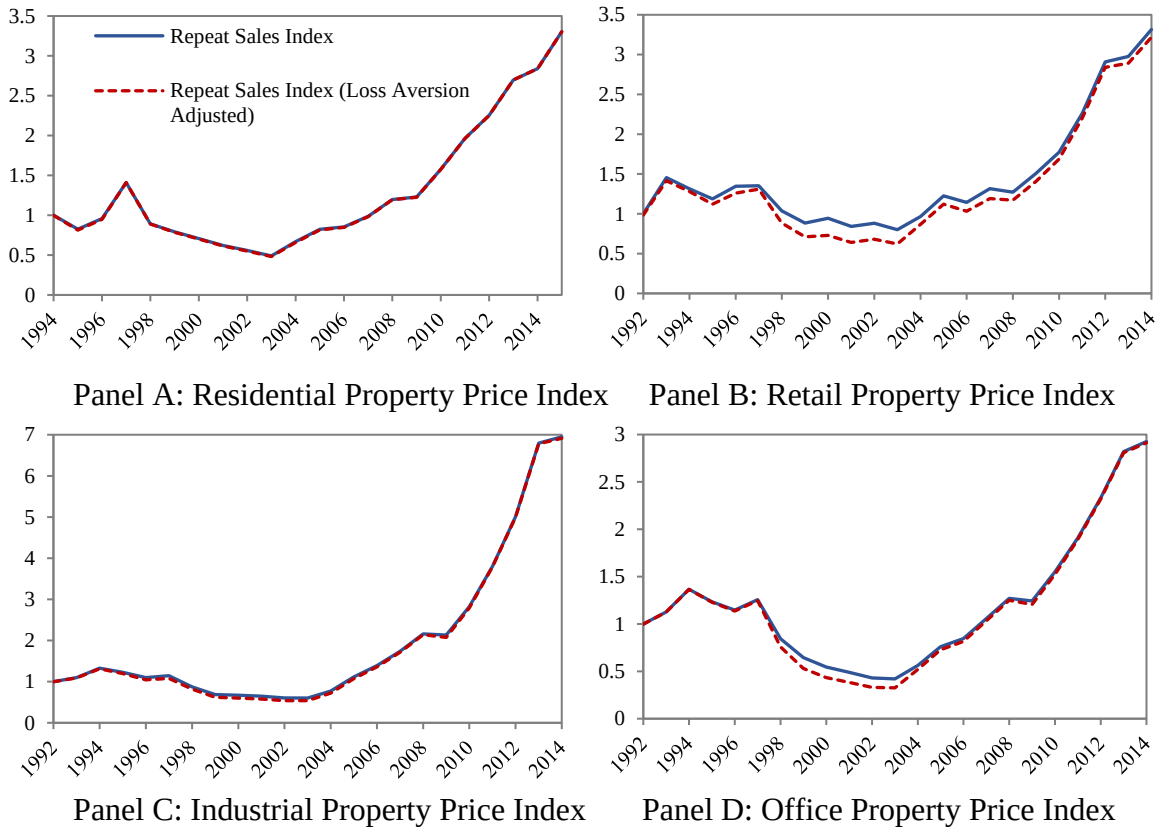
Figures

Figure 1. Hong Kong Property Price Indices by Sectors: 1981-2019



Note: Raw data from Rating and Valuation Department of Hong Kong.

Figure 2. Aggregate Impact of Loss Aversion on Hong Kong Market Prices Across Four Property Sectors



Panel A: Residential Property Price Index

Panel B: Retail Property Price Index

Panel C: Industrial Property Price Index

Panel D: Office Property Price Index

Could Loss Aversion Retain on the Market? Evidence from the Hong Kong Property Market

Online Appendix

Appendix A. Supplementary Figures

Appendix B. Supplementary Tables

Appendix A. Supplementary Figures

Figure A1. Value Function in Prospect Theory

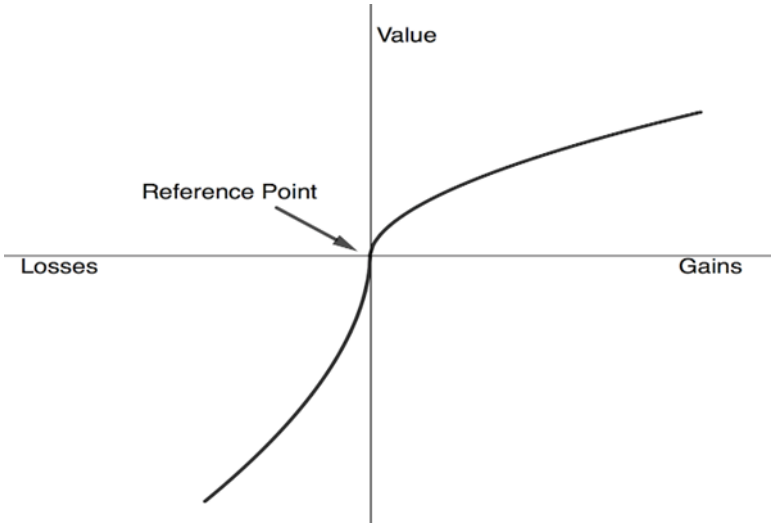


Figure A2. Comparison between Repeat Sales Index and RVD Index Across Four Property Sectors in Hong Kong

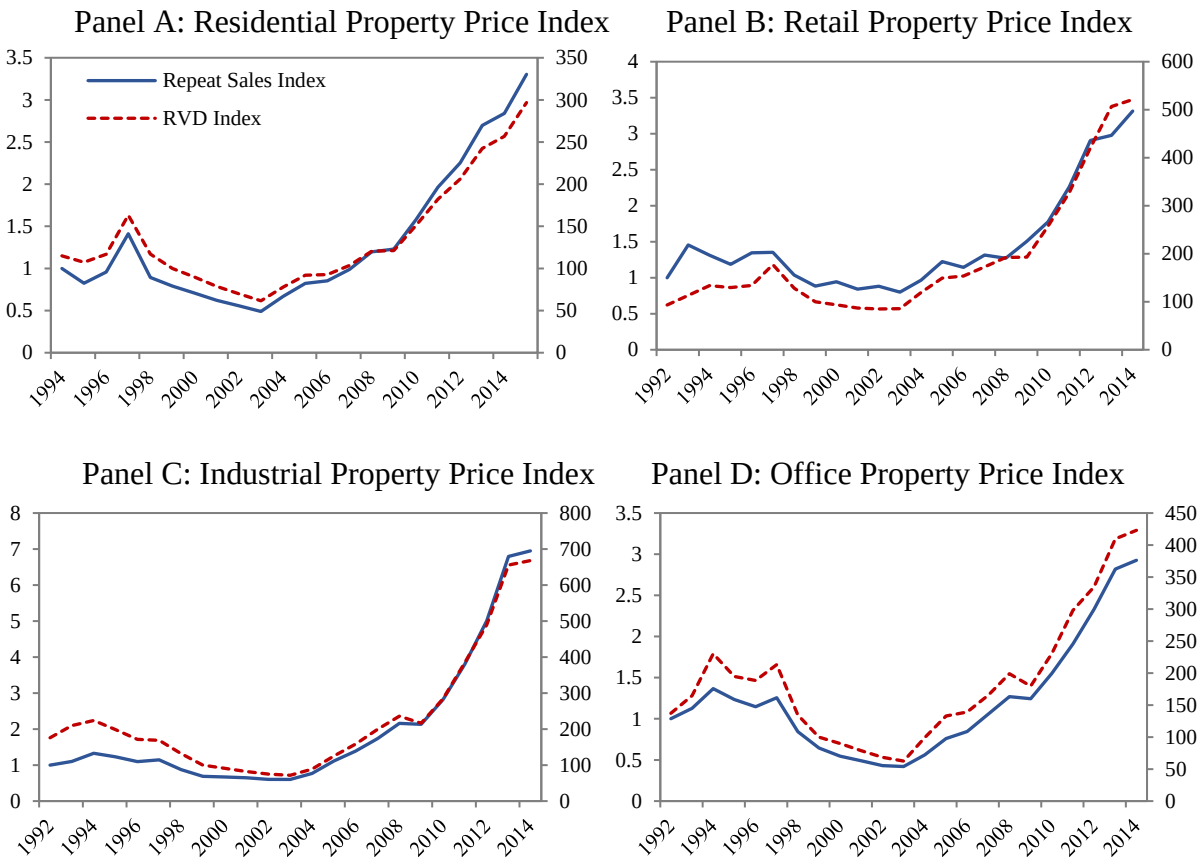


Figure A3. Percentage and Magnitude of Loss Sales Across Four Property Sectors in Hong Kong

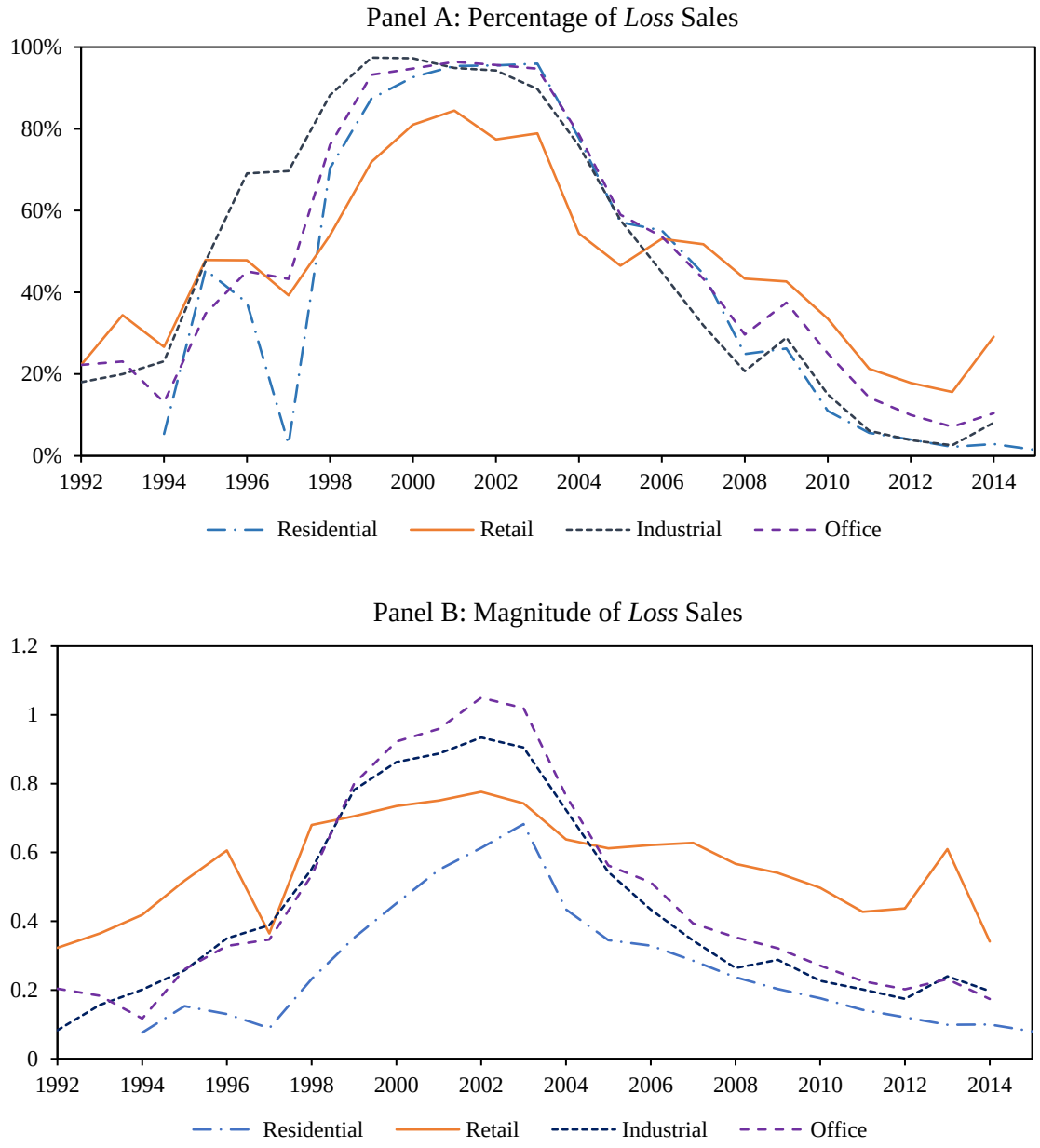
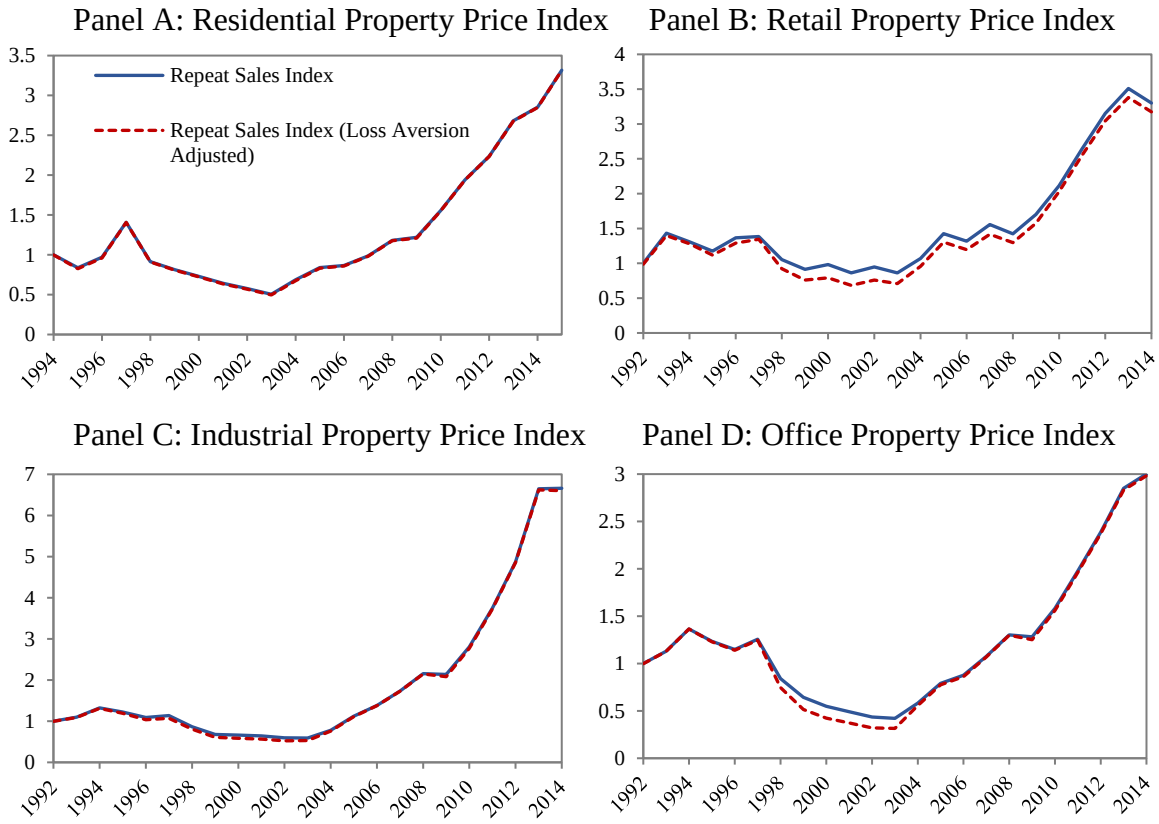


Figure A4. Aggregate Impact of Loss Aversion on Prices of Repeat Sales Held for Less Than 10 Years Across Four Property Sectors in Hong Kong



Appendix B. Supplementary Tables

Table B1. First Stage Hedonic Estimation

	Residential log(price)	Industrial log(price)	Office log(price)	Retail log(price)
	(1)	(2)	(4)	(3)
Building Age	-0.0272***	-0.0639***	-0.0255***	-0.0408***
	(0.0001)	(0.0036)	(0.0043)	(0.0064)
Building Age-squared	0.0002***	0.0009***	0.0004***	0.0009***
	(2.2E-06)	(0.0001)	(0.0001)	(0.0001)
Unit Size	-0.8560***	0.0366***	0.0799***	0.2361***
	(0.0132)	(0.0017)	(0.0050)	(0.0082)
Unit Size-squared	0.1542***	-0.0001***	-0.0003***	-0.0044***
	(0.0010)	(0.0000)	(0.0000)	(0.0003)
Floor	0.0067***	-0.0127**	0.0014	-0.4986***
	(0.0001)	(0.0050)	(0.0037)	(0.0562)
Floor-squared	-7.1E-05***	0.0003**	0.0002*	0.0255***
	(1.2E-06)	(0.0001)	(0.0001)	(0.0034)
Single building	-0.1298***			
	(0.0008)			
Estate units	-6.2E-06***			
	(3.6E-07)			
Estate units-squared	1.6E-09***			
	(3.1E-11)			
Distance to Seacoast	-0.0313***	-0.0140	-0.5276	-0.3085*
	(0.0007)	(0.0635)	(0.3339)	(0.1699)
Distance to Seacoast-squared	0.0568***	0.0064	0.1636	0.0335
	(1.1E-07)	(0.0129)	(0.1129)	(0.0299)
Distance to Hospital	0.0314***	0.0904	0.7885***	-0.1611
	(0.0005)	(0.1087)	(0.2677)	(0.1653)
Distance to Hospital-squared	-2.5E-06***	0.0049	-0.2249**	0.0871**
	(1.4E-07)	(0.0312)	(0.0823)	(0.0406)
Distance to Bus Stop	-0.0133***	-0.1347	-1.6824***	-0.3735
	(0.0015)	(0.2850)	(0.3088)	(0.2894)
Distance to Bus Stop-squared	1.3E-05***	0.3572	1.5472***	0.1583**
	(5.3E-07)	(0.2271)	(0.4396)	(0.0763)
Distance to Park	-0.0162***	0.1959	0.1188	0.0365
	(0.0010)	(0.2052)	(0.3065)	(0.1345)
Distance to Park-squared	2.4E-08	-0.1265	-0.0027	-0.0450
	(2.6E-07)	(0.0925)	(0.1653)	(0.0353)
Distance to MTR	-0.060***	-0.5594**	-0.4063	-0.6061***
	(0.0004)	(0.2353)	(0.2519)	(0.1764)
Distance to MTR-squared	3.8E-06***	0.0805*	-0.0199	0.0293***
	(1.1E-07)	(0.0420)	(0.2004)	(0.0100)
Distance to University	0.0314***			

	(0.0005)			
Distance to University-squared	-2.4E-06***			
	(4.8E-08)			
Distance to School	0.0568***			
	(1.1E-07)			
Distance to School-squared	-6.5E-05***			
	(2.2E-06)			
Year * District Fixed Effect	Y	Y	Y	Y
Observations	1,021,729	95,982	43,146	23,963
R-squared	0.899	0.823	0.836	0.670

Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table B2. Transaction Volumes of Hong Kong Property Market by Sectors

Year	Retail	Industrial	Office	Residential
1995	1,270 (1.6%)	3,030 (3.7%)	1,505 (1.9%)	75,437 (92.9%)
1996	2,464 (1.7%)	3,437 (2.4%)	2,625 (1.9%)	133,342 (94.0%)
1997	4,525 (2.8%)	3,881 (2.4%)	2,937 (1.8%)	149,137 (92.9%)
1998	1,730 (2.0%)	2,177 (2.5%)	1,123 (1.3%)	82,443 (94.2%)
1999	1,772 (2.4%)	2,148 (2.9%)	1,496 (2.0%)	69,193 (92.7%)
2000	1,698 (2.6%)	2,575 (4.0%)	1,489 (2.3%)	59,253 (91.1%)
2001	1,922 (2.6%)	2,529 (3.5%)	1,369 (1.9%)	67,136 (92.0%)
2002	1,919 (2.7%)	2,708 (3.8%)	1,213 (1.7%)	65,557 (91.8%)
2003	2,860 (3.8%)	2,856 (3.8%)	1,392 (1.8%)	68,639 (90.6%)
2004	5,533 (5.2%)	4,677 (4.4%)	2,473 (2.3%)	94,191 (88.1%)
2005	5,167 (4.9%)	5,627 (5.3%)	2,854 (2.7%)	92,552 (87.1%)
2006	3,219 (3.6%)	6,487 (7.3%)	2,504 (2.8%)	76,219 (86.2%)
2007	3,902 (2.9%)	7,686 (5.7%)	3,555 (2.6%)	119,433 (88.7%)
2008	2,598 (2.9%)	4,124 (4.6%)	2,045 (2.3%)	81,435 (90.3%)
2009	3,997 (3.3%)	4,997 (4.1%)	2,366 (1.9%)	111,516 (90.8%)
2010	5,368 (3.9%)	7,171 (5.2%)	3,341 (2.4%)	123,259 (88.6%)
2011	3,910 (4.3%)	6,693 (7.4%)	2,877 (3.2%)	76,930 (85.1%)
2012	3,700 (4.0%)	9,354 (10.1%)	3,075 (3.3%)	76,889 (82.7%)
2013	2,865 (5.2%)	3,989 (7.2%)	2,025 (3.7%)	46,538 (84.0%)
2014	1,428 (2.2%)	2,803 (4.2%)	1,301 (2.0%)	60,675 (91.6%)

Percentages in brackets.

Table B3. Adjust the Cut-off Year of Market Cycles for Industrial and Office Sectors of Hong Kong

	Before 1994 Boom log(price)	1995-2003 Bust log(price)
Panel A: Industrial	(1)	(2)
Loss	0.0771	0.1409***
	(0.1771)	(0.0442)
Estimated Value	1.0852***	1.0247***
	(0.0335)	(0.0153)
Residuals from Last Sale	0.7753***	0.6704***
	(0.0641)	(0.0446)
Months since Last Sale	0.0115	-0.0239***
	(0.0406)	(0.0046)
Year * District Fixed Effect	Y	Y
Benchmark log(price)	0.557	-0.178
Observations	1,424	7,125
R-squared	0.918	0.892
Panel B: Office	(1)	(2)
Loss	-0.0058	0.1914
	(0.0903)	(0.1157)
Estimated Value	1.0908***	0.9796***
	(0.0156)	(0.0145)
Residuals from Last Sale	0.9647***	0.7060***
	(0.0410)	(0.0676)
Months since Last Sale	0.0326	-0.0250***
	(0.0225)	(0.0082)
Year * District Fixed Effect	Y	Y
Benchmark log(price)	0.947	0.870
Observations	997	3,816
R-squared	0.956	0.929

Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table B4. Loss Aversion Across the Hong Kong Market Cycle: Transactions with A Holding Period<10 Years

	Before 1997 Boom log(price)	1998-2003 Bust log(price)	2004-2007 Recovery log(price)	2008 GFC log(price)	After 2009 Boom log(price)
Panel A: Residential	(1)	(2)	(3)	(4)	(5)
Loss	0.2009***	0.0245***	0.0457***	0.2544***	0.4540***
	(0.0245)	(0.0043)	(0.0043)	(0.0752)	(0.0580)
Benchmark log(price)	1.080	0.544	0.650	0.840	1.223
Observations	28,883	65,967	82,697	18,975	154,096
R-squared	0.932	0.915	0.935	0.923	0.926
Panel B: Industrial	(1)	(2)	(3)	(4)	(5)
Loss	0.2162**	0.1454***	0.0635	0.1555	0.4384***
	(0.0814)	(0.0437)	(0.0470)	(0.2285)	(0.0520)
Benchmark log(price)	0.407	-0.387	0.049	0.473	0.887
Observations	3,693	4,480	4,780	906	8,854
R-squared	0.906	0.859	0.882	0.879	0.900
Panel C: Office	(1)	(2)	(3)	(4)	(5)
Loss	0.0521*	0.2972*	0.0902*	0.0679	0.2847***
	(0.0299)	(0.1632)	(0.0469)	(0.1355)	(0.0673)
Benchmark log(price)	1.004	0.340	0.781	0.953	1.295
Observations	2,395	2,249	2,326	427	3,419
R-squared	0.952	0.911	0.924	0.923	0.952
Panel D: Retail	(1)	(2)	(3)	(4)	(5)
Loss	0.1974	0.3662***	0.3727***	0.4566***	0.3465***
	(0.1473)	(0.1084)	(0.0751)	(0.0849)	(0.0450)
Benchmark log(price)	0.718	0.468	0.776	0.678	1.101
Observations	636	856	1,134	269	2,025
R-squared	0.922	0.852	0.873	0.893	0.904

Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table B5. Loss Aversion Across the Hong Kong Market Cycle: Transactions with A Ratio of Predicted Loss to Previous Transaction Price<0.2

	Before 1997 Boom log(price)	1998-2003 Bust log(price)	2004-2007 Recovery log(price)	2008 GFC log(price)	After 2009 Boom log(price)
Panel A: Residential	(1)	(2)	(3)	(4)	(5)
Loss	0.2886***	0.2147***	0.2495***	0.26336***	0.4237***
	(0.0301)	(0.0277)	(0.0150)	(0.0375)	(0.0159)
Benchmark log(price)	1.098	0.637	0.743	0.837	1.224
Observations	27,932	19,309	53,082	22,203	192,109
R-squared	0.933	0.898	0.938	0.920	0.918
Panel B: Industrial	(1)	(2)	(3)	(4)	(5)
Loss	0.3058**	0.4716	0.1760**	0.3556*	0.4546***
	(0.1208)	(0.3686)	(0.0664)	(0.1881)	(0.0672)
Benchmark log(price)	0.317	-0.482	0.020	0.371	0.862
Observations	2,739	622	4,980	1,382	12,702
R-squared	0.923	0.893	0.891	0.880	0.892
Panel C: Office	(1)	(2)	(3)	(4)	(5)
Loss	0.5690***	0.6419**	0.5009***	0.5114*	0.4276***
	(0.1673)	(0.2644)	(0.1711)	(0.2490)	(0.0541)
Benchmark log(price)	0.884	-0.084	0.607	0.788	1.186
Observations	2,019	338	2,130	584	4,783
R-squared	0.954	0.951	0.927	0.922	0.938
Panel D: Retail	(1)	(2)	(3)	(4)	(5)
Loss	1.1135	0.8337*	0.6572*	0.7948	0.9402**
	(0.6692)	(0.4400)	(0.3463)	(0.5954)	(0.3949)
Benchmark log(price)	0.541	0.221	0.445	0.392	0.807
Observations	469	329	970	251	2,464
R-squared	0.922	0.857	0.817	0.865	0.842

Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table B6. Loss Aversion Across the Hong Kong Market Cycle: Transactions with A Ratio of Predicted Loss to Previous Transaction Price<0.1

	Before 1997 Boom log(price)	1998-2003 Bust log(price)	2004-2007 Recovery log(price)	2008 GFC log(price)	After 2009 Boom log(price)
Panel A: Residential	(1)	(2)	(3)	(4)	(5)
Loss	0.5324***	0.3719***	0.5240***	0.6892***	0.8146***
	(0.0657)	(0.0716)	(0.0363)	(0.0818)	(0.0353)
Benchmark log(price)	1.080	0.544	0.651	0.810	1.204
Observations	26,327	11,946	53,082	20,789	186,931
R-squared	0.933	0.894	0.939	0.921	0.917
Panel B: Industrial	(1)	(2)	(3)	(4)	(5)
Loss	0.6943**	0.8108	0.5860*	0.7529*	0.8059***
	(0.3099)	(0.4766)	(0.2980)	(0.4260)	(0.1711)
Benchmark log(price)	0.286	-0.442	0.026	0.356	0.858
Observations	2,334	432	4,466	1,313	12,340
R-squared	0.927	0.907	0.891	0.882	0.891
Panel C: Office	(1)	(2)	(3)	(4)	(5)
Loss	1.2061***	1.3051	0.8028***	-0.0977	0.5620
	(0.4108)	(0.7626)	(0.2627)	(0.8887)	(0.3376)
Benchmark log(price)	0.824	-0.064	0.590	0.780	1.165
Observations	1,830	249	1,858	545	4,534
R-squared	0.954	0.957	0.928	0.921	0.937
Panel D: Retail	(1)	(2)	(3)	(4)	(5)
Loss	1.7319**	-0.1890	0.6133	1.4696	1.7406**
	(0.7995)	(1.6440)	(0.7787)	(3.2278)	(0.8185)
Benchmark log(price)	0.509	0.193	0.410	0.372	0.790
Observations	427	261	876	231	2,325
R-squared	0.925	0.873	0.816	0.862	0.842

Robust standard errors are clustered at town level. ***, **, * denote for 1%, 5% and 10% significance, respectively.

Table B7. Comparison between the Aggregate Impact of Loss Aversion with All Repeat Sales and with Repeat Sales Held for Less Than 10 Years

	Increase in Housing Price Index Due to Loss Aversion (Adjustment Factor)							
	Repeat Sales Index				Repeat Sales Index (Hold < 10 Years)			
Year	Residential	Retail	Industrial	Office	Residential	Retail	Industrial	Office
1992		1.43%	0.32%	0.24%		1.43%	0.32%	0.24%
1993		2.51%	0.68%	0.22%		2.51%	0.68%	0.22%
1994	0.08%	2.23%	1.01%	0.08%	0.08%	2.23%	1.01%	0.08%
1995	1.41%	5.02%	2.68%	0.47%	1.41%	5.02%	2.68%	0.47%
1996	0.98%	5.88%	5.37%	0.78%	0.98%	5.88%	5.37%	0.78%
1997	0.05%	2.86%	6.02%	0.79%	0.05%	2.86%	6.02%	0.79%
1998	0.40%	13.85%	6.77%	11.32%	0.40%	14.39%	7.33%	12.82%
1999	0.75%	19.64%	10.80%	21.79%	0.76%	20.42%	11.71%	24.81%
2000	1.02%	23.42%	11.96%	25.99%	1.03%	24.37%	12.98%	29.67%
2001	1.28%	25.13%	12.00%	27.68%	1.29%	26.33%	13.07%	31.70%
2002	1.43%	23.64%	12.59%	30.38%	1.45%	24.82%	13.66%	35.87%
2003	1.60%	23.01%	11.55%	29.07%	1.63%	21.72%	11.44%	33.61%
2004	1.46%	9.08%	6.82%	8.17%	1.55%	11.66%	2.50%	4.41%
2005	0.85%	7.39%	3.83%	4.42%	0.89%	9.39%	0.86%	1.98%
2006	0.78%	8.62%	2.37%	3.66%	0.81%	10.15%	0.40%	1.60%
2007	0.55%	8.48%	1.33%	2.25%	0.36%	9.90%	0.20%	0.65%
2008	0.23%	10.07%	0.92%	1.58%	0.32%	9.78%	0.35%	0.23%
2009	0.39%	7.04%	2.73%	3.12%	0.79%	8.08%	2.62%	2.42%
2010	0.14%	5.05%	1.11%	1.75%	0.20%	4.25%	1.21%	1.43%
2011	0.06%	2.72%	0.40%	0.82%	0.10%	3.60%	0.50%	0.81%
2012	0.04%	2.33%	0.22%	0.51%	0.11%	3.61%	0.37%	0.64%
2013	0.02%	2.85%	0.20%	0.42%	0.09%	3.84%	0.41%	0.64%
2014	0.02%	2.98%	0.52%	0.46%	0.15%	3.97%	0.91%	0.65%
2015	0.01%				0.06%			