Loss Aversion and Anchoring in Commercial Real Estate Pricing: Empirical Evidence and Price Index Implications

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Abstract

We consider two famous phenomena from behavioral economics: loss aversion (based on prospect theory), and anchoring, for the role they played in the pricing of commercial property in the U.S. during the 2000s decade. We find that loss aversion played a major role, approximately as big as was found by Genesove & Mayer in their 2001 study of the 1990s Boston housing market. We also find that more experienced investors, and larger more sophisticated investment institutions, exhibit *at least* as much loss aversion behavior as less experienced or smaller firms. We extend earlier research by examining how behavior changes in different market environments during the dramatic cycle of 2001-09, and discover that loss aversion operated most strongly during the cycle peak and turning point in 2007, and then became virtually ineffective during the extremely severe drop in the demand side of the market during the 2008-09 crash.

We extend previous work by developing longitudinal price indices of the U.S. commercial property market that control for, and explicitly incorporate, the behavioral phenomena we have modeled. From an econometric methodology perspective, these price indices suggest that controlling for behavioral phenomena can be quite important for developing successful hedonic price indices. The indices also suggest that, while the behavioral phenomena are important at the individual property level, the impact of the psychological loss aversion behavior reflective of prospect theory was sufficiently attenuated at the aggregate market level such that the pricing and volume cycle in the U.S. commercial property market during 2001-09 was little affected by it. However, we document substantial strategic pricing differences between sellers facing a gain compared to sellers facing a loss, consistent with a strategy to sell winners and hold onto losers, with the extent of the pricing difference varying longitudinally across the market cycle.

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1. Introduction

This is an empirical paper examining the role of two psychological theories in the marketplace. The first is prospect theory, often suggested as an alternative paradigm to supersede the utility theory of neoclassical economics. It is based on the concept of *loss aversion*, i.e. for equal sized gains and losses around a reference point, individuals give up more utility for the loss than they receive from the gain. Such a reference dependent preference function was not recognized in classical economic theory. Today, despite considerable laboratory evidence in favor of prospect theory, some economists still believe that loss aversion is merely the result of a mistake made by inexperienced individuals and through time they will learn, and their behavior will more closely match predictions from neoclassical models. In the context of the current literature, the present paper confirms, extends, and enhances the previous evidence regarding loss aversion, including a very influential 2001 paper by Genesove & Mayer which found loss aversion and anchoring behavior in the Boston housing market of the 1990s.

In this paper, we use market data based on all U.S. sales of commercial property greater than $5,000,000 from January 2001 through December 2009. We find that loss aversion plays a significant role in the behavior of investors in commercial real estate. We thus extend the Genesove-Mayer findings to the commercial property market where the participants are “professionals” operating in a more purely business environment (compared to homeowners). Furthermore, contrary to common belief and some prior evidence, we find the degree of loss aversion to be actually higher the more sophisticated or experienced the investor is.[1]

The second piece of theory tested in this paper is known as the anchoring-and-adjustment heuristic. Specifically, an asking price could serve as an anchor or heuristic used by a buyer to judge the value of a property, and they may not be able to adjust sufficiently away from the anchor to arrive at what would otherwise be a fair market price. As a result, real estate could be mis-priced if sellers play to this behavior by buyers. We find that there is considerable evidence for the predictions of this theory in the marketplace.

A feature of the present paper is that we develop longitudinal price indices of U.S. commercial property that control for and reflect both the anchoring and the prospect theory phenomena. We show that explicitly including these behavioral factors can greatly improve the construction of a traditional hedonic price index. We also combine our behavioral pricing model with price indices to demonstrate the magnitude and nature of the effect of the behavioral pricing phenomena during the dramatic commercial property market cycle of the 2000s.

While we study both loss aversion and anchoring, the focus of the present paper is primarily on loss aversion. One hypothesis has been that loss aversion may play a significant role in real estate's famously dramatic pro-cyclical variation in asset trading volume, causing property markets to be excessively illiquid during down markets. The hypothesis is that loss aversion could cause transaction prices of completed deals (those

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[1] Although the motivation or cause of this behavior is beyond the scope of the present paper, discussions we have had with participants in the commercial property market suggest to us that behavioral phenomena among professional investors in that market may be due to the reluctance on the part of agents to realize losses to the stakeholders in their companies. Further research is needed to document the decision-making process for the various investor types.

that are reflected in the market-wide average prices on which price indices are based) to be "sticky" or fail to register much of a drop during the early phase of a sharp downturn in the market, as compared to movements on the demand side of the market ("constant-liquidity" prices). Sticky pricing and related illiquidity certainly seemed to be present in the 2007-09 drop in the U.S. commercial property market. For example, in the early phase of that downturn from 2Q2007 through 1Q2008, the "TBI" index published by the MIT Center for Real Estate dropped 15% on the demand side while actually rising 2% on the supply side leading to only a 7% drop in consummated transaction prices, while trading volume of major commercial property assets fell during that same period from $136 billion to $48 billion.[2] However, there is a question how much of this "sticky pricing" behavior is due to prospect theory based "psychological" loss aversion, as distinct from more classical and rational explanations. With this in mind, we examine the impact of prospect theory at the aggregate market level, and find that while our models attest to the economic importance of loss aversion at the individual property level, they suggest that psychological loss aversion had a relatively small impact on overall average transaction prices (and therefore on trading volume) during the recent market peak and downturn. Most of the "sticky pricing" behavior was either explainable by classical explanations, or may be due to other behavioral phenomena besides psychological loss aversion not examined in the current paper.

[2] These volume numbers are based on sales of assets greater than $5,000,000 as reported by Real Capital Analytics Inc (RCA), the datasource used for this study. The TBI demand and supply indices employ the Fisher *et al* (2003) methodology based on NCREIF property sales to measure movements in reservations prices on the two sides of the market. Hence, the implication is that property owners (the supply side) actually raised their willing-to-receive prices by 2% while potential property buyers dropped their willing-to-pay prices by 15%, resulting in the huge drop in transaction volume.

The rest of the paper is organized as follows. We begin with an overview of prospect theory and the anchoring-and-adjustment heuristic. We then develop an empirical model to test these theories. We then describe the data source and highlight some of the features of the data used in this study. The empirical results are then presented in Section 5. Finally our analysis of the implications for commercial property price indices and the aggregate market-wide effects of loss aversion are presented in Section 6. A final section then concludes the paper with some finishing remarks.

2. Prospect Theory and the Anchoring-and-Adjustment Heuristic

2a) Prospect Theory

Prospect theory, which helped gain a Nobel Prize in economics for Daniel Kahneman in 2002, is characterized by three essential features [Kahneman and Tverksy (1979); Tversky and Kahneman (1991)]. First, gains and losses are examined relative to a reference point. Second, the value function is steeper for losses than for equivalently sized gains. Third, the marginal value of gains or losses diminishes with the size of the gain or loss. Thus, under prospect theory, people behave as if maximizing an S-shaped value function as shown in figure 1.

Insert Figure 1 here

A difficulty in applying prospect theory to empirical studies is that the reference point is seldom observed in the data. An influential exception has been Genesove and Mayer's 2001 study (hereafter "G-M"), examining seller behavior in the Boston housing market using the home purchase price as the reference point. They find evidence that loss aversion explained the behavior of condominium sellers in their choices of asking prices and in their decisions as to whether to accept an offer or not. They find that property owners, faced with a prospective loss, set a higher asking price and in fact do sell at a higher price than other sellers, suffering as a result less sale frequency or, in effect, a longer time on the market. The first contribution of the current study is our attempt to replicate G-M using data on U.S. commercial real estate instead of housing. Thus, a key aspect of the present paper is that it examines the evidence on loss aversion among sellers that are primarily investors (as opposed to being owner-occupiers who are arguably primarily consumers). A commonly held view is that property owners have a sentimental attachment to their homes, as well as being not full-time "in the business" of real estate investment, and as a result could be overly optimistic or overly influenced by emotions in their listing and sales behavior. Therefore, owner-occupants may understandably behave in a loss-averse manner while it remains unclear if commercial property investors, who typically should not have sentimental motivations, would behave in a similar way.

Under prospect theory, a seller with a potential loss compared to his purchase price would be expected to set a higher reservation price than a seller with a prospective gain. The former can avoid or mitigate loss by setting a sufficiently high reservation price and sticking with it until trade goes through. To formalize this intuition, consider the following simple model.

Assume that the utility from sale, $U(P)$ is increasing in price ($U(P)' > 0$) and greater than the utility from no sale ($U(P) > U_0$), for all relevant prices. Also assume that the probability of a sale is decreasing in price (*prob(P)′ < 0*). The seller would then maximize their expected utility from a sale by choosing a reservation price *P*:

$$\max_{p} prob(P)U(P) + (1 - prob(P)U_0$$
$$\Rightarrow$$
$$U(P)' prob(P) = prob(P)'U(P) - U_0$$

The above first order condition states that the seller would set a price so as to equate (in expectations) the marginal gain from an increase in price to its marginal cost. Next, we examine the behavior of a loss-averse seller compared to that of a risk-neutral seller. This can be illustrated with a simple reference-dependent utility function where the reference point is the price that the seller first paid for the property, P_f

$$U(P) = \begin{cases} (P - P_f) \text{ if } P \geq P_f \\ \lambda(P - P_f) \text{ if } P < P_f \end{cases}$$

where $\lambda > 1$ is the loss aversion parameter. The first-order conditions can then be written as:

$$prob(P) = -prob(P)'((P - P_f) + U_0) \text{ if } P \geq P_f$$
$$\lambda prob(P) = -prob(P)'(\lambda(P - P_f) + U_0) \text{ if P < P}_\text{f}$$

Figure 2 below shows the difference between the loss-averse seller and risk-neutral seller ($\lambda = 0$), where the prior price (reference point) P_f is at a hypothetical value of 50. We make the following points about the behavior of these two types of sellers. (1) When the market value is greater than the purchase price ($P \geq P_f$), there is no effect of loss aversion. (2) There is bunching at $P = P_f$, and (3) when $P \leq P_f$, the marginal benefit and marginal cost from an increase in price disproportionately increase for the loss-averse agent compared to the risk-neutral seller. Thus, when faced with a loss, a loss-averse seller (as compared to the risk-neutral seller) would find it optimal to set a higher price since for that seller the difference between the marginal benefit and the marginal cost of an increase in price is greater at every price level.

Insert Figure 2 here

The simple prospect theory based value function formalized above and illustrated in Figure 2 allows us to propose a finer and more rigorous distinction in the definition of loss aversion behavior. In particular, it is only the behavior of agents who are to the left of the prospect theory value function "kink-point" in Figure 1, or to the left of the reference price of 50 in Figure 2, who are in a position to exhibit the sort of psychological loss aversion behavior that is distinguished by prospect theory. This "behavioral loss aversion" will be the major focus of the current paper, and we will identify it by looking for empirical evidence of asymmetric pricing behavior between sellers facing a loss (those to the left of the reference point) versus those facing a gain. More broadly, however, agents may display other types of strategic pricing behavior based on a reference point such as the prior purchase price of the property. Some such behavior could be "rational" (or consistent with classical utility theory, not reflective of prospect theory). But it is nevertheless of interest in understanding the behavior of market participants and how the commercial property market functions, and we will not ignore this broader aspect of reference point based pricing behavior. Such behavior can be quantified by considering both the symmetric as well as asymmetric component of the reference point's impact on sellers' pricing strategy.

These considerations highlight another behavioral phenomenon that is closely related to loss aversion and predicted by Prospect Theory, known as the *Disposition Effect* - the tendency to sell winners quickly and hold on to losers. This phenomenon has been documented extensively in the finance literature (see, for example, Odean (1998), Feng et al (2005), Locke et al (2000) and Shapira et al (2001)). In the real estate literature, Crane and Hartzell (2009) find evidence for the disposition effect in REITs. They find that managers of REITs are more likely to sell properties that have performed well and accept lower prices when selling profitable investments. In a relevant paper not focused on behavioral factors, Fisher et al (2004) find that there is a greater likelihood of a sale following increases in the national index of commercial real estate returns and for properties that have outperformed that index. But to date, and unlike the case with housing and the G-M study, there has been no empirical documentation of loss aversion behavior *per se* among commercial property market participants in general.

2a.i) Loss Aversion and Experience

If loss aversion was a fundamental and stable component of preferences as advocated by prospect theory, then it must be the case that the market experience of an individual and loss aversion would be uncorrelated. For instance, if an investor with little experience behaved in a loss-averse manner (during a down market), then that same investor once he has gained experience would behave in the same fashion in a similar situation.

G-M's study of the Boston housing market in the 1990s found that investors in condominiums were less loss-averse than their owner-occupant counterparts. Presumably, condominium sellers are more experienced in the market than homeowners.[3] List (2003) is an example of a recent experimental field study that also supports the notion that loss aversion can be attenuated with market experience. Examining trading rates of sport memorabilia in an actual marketplace, List observed an inefficiently low number of trades by naive traders, consistent with prospect theory.

On the other hand, there is some evidence that even sophisticated traders are sometimes subject to behavioral biases. Haigh and List (2005) provide experimental evidence that CBOT traders are more likely to suffer from myopic loss aversion[4] than student participants. The 2009 Crane-Hartzell study suggests that even experienced REIT managers can exhibit loss aversion behavior.

In this paper, we shed new light on this question by studying the degree of loss aversion across different types of investors as well as among groups of investors that have significant differences in trading experience.

2b) Anchoring-and-Adjustment

Besides prospect theory, psychological anchors could also affect the valuation of real estate. Specifically, an asking price could serve as an anchor or heuristic used by a buyer to judge the value of a property, and they may not be able to adjust sufficiently away from the anchor to arrive at a rational market value[5]. In the context of housing, Northcraft

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[3] This would be because condominiums are better suited to investment trading than houses, and the G-M study incorporated a period of a condominium boom in Boston, attracting considerable speculative investment in the market.

[4] Myopic loss aversion is a term first coined by Benartzi and Thaler (1995) that combines the concepts of loss aversion and mental accounting (see Thaler (1985)) to provide an explanation for the equity-premium puzzle in the stock market. A myopically loss-averse agent would tend to make shorter-term choices and evaluate losses and gains more frequently.

[5] The anchoring heuristic was first demonstrated by Tversky and Kahnemann (1974) in an experiment where they asked participants to estimate a number such as the percentage of African countries that are

and Neale (1987) took local real estate agents to a house and asked them to appraise it. Each group of agents was given the same information packet about the house that they could use to appraise the property. However, a key difference was that different groups had been given different asking prices. The appraised values turned out to be positively related to the provided anchor, the asking price. Interestingly, most participants reported that the asking price should be irrelevant to the appraised value, yet they were nonetheless influenced by it. It should be noted that in that study, group differences in the appraisals could not be explained by individual differences in appraisals methods alone.

In the present study, a hypothesis generated by the Northcraft and Neale study is that any over- or under-pricing (i.e. the extent to which the asking price is above or below the expected sale price) by a seller could influence a buyer's valuation and thus have an effect on the subsequent transaction price. Black and Diaz (1995) tested this hypothesis in a laboratory experimental setting and found that manipulated asking prices influenced both the buyer's opening offer and the eventual transaction price, indicating a strong anchoring effect of the asking price.

However, it is important to note that another theory common in the urban economics literature makes a similar prediction based on neoclassical ("rational" rather than "behavioral") economics. Yavas and Yang (1995) propose a game theoretic model in which they argue that a seller strategically lists an asking price that reflects his bargaining power in an attempt to signal to certain types of buyers. For instance, a seller who can wait for a high-paying buyer may post a high asking price to attract only those buyers that would value his property higher than the going market value. This is clearly a

members of the United Nations. The experiment began with the subjects being given a number (between 1 and a 100) generated by the spin of a wheel. It turned out that the subjects showed a bias in their final estimates toward the number they were originally given.

different behavior than anchoring, which would say that *any* asking price influences the valuation of *all* buyers (although only buyers whose influenced valuations are sufficiently high would come forth to negotiate with the seller).

Another type of signaling behavior in the seller's asking price that would be rational and not inconsistent with classical economic theory would be for the seller to use his asking price to signal private information that he has about the (true market) value of the property. Properties are unique, and no one knows the property as well as its current owner.

Due to the nature of the market data used in this study, which reflects the results from the interactions between a buyer and a seller and our inability to observe their respective bargaining powers, we cannot distinguish between "irrational" psychologically based anchoring behavior versus "rational" signaling behavior such as that described above. However, we are able to test their joint predictions.

3. Empirical Model

In this section we develop an empirically testable model that reflects the prospect theory and anchoring phenomena described above. The model developed here is similar to that employed by G-M, but extends and enhances their model by explicitly incorporating the prospect theory reference point in the value function.[6]

To test for prospect theory, the structural model specifies that the log asking price, L is a linear function of the expected log selling price in the quarter of entry (when the property is put up for sale), labeled μ, and a variable defining the reference point, RF^*:

[6] One advantage of the model presented here compared to the G-M model is that we are able to estimate a single unbiased coefficient measuring loss aversion, whereas G-M were only able to produce upward and lower biased estimates which they used to provide a range.

(1) $L_{ife} = \alpha_0 + \alpha_1\mu_{ie} + mRF^*_{ife} + \varepsilon_{ie}$

Here i indicates the unit, f the quarter of previous or first sale and e the quarter of entry into the market. If there were no behavioral effects: m=0. Furthermore, the expected log selling price is a linear function of a vector of observable attributes of the property ($X_i\beta$), the quarter of entry Q_e and unobservable quality, ν. The unobserved quality is observable to a buyer or a seller but not to the analyst:

(2) $\mu_{ie} = X_i\beta + Q_e + \nu_i$

We define the reference-point variable, RF^* as the difference between the previous log selling price and the expected log selling price:

$$RF^*_{ife} = (P_{if} - \mu_{ie})$$

RF^*_{ife} is therefore positive if there is an expected loss. Assuming that equation (2) holds for all periods, the previous log selling price can be written as:

$$P_{if} = \mu_{if} + w_{if} = X_i\beta + Q_f + \nu_i + w_{if}$$

where w_{if} is the over- or under- payment by the current seller to the previous seller at the time of the current seller's purchase.

Thus the true reference-point term is

(3) $RF^*_{ife} = (\mu_{if} + w_{if} - \mu_{ie}) = (Q_f - Q_e) + w_{ie}$

The interpretation of the first term is the change in the market price index between the quarter of original purchase and the quarter of listing.[7] If $RF^* \leq 0$, then the seller faces a prospective gain but if $RF^* > 0$, then they face a prospective loss.

[7] It is interesting to note that Pryke and Du Gay (2002) find, in their cultural study of the commercial real estate market in the UK after the crash in the late 1980s, that there was a conscious effort by investors to evaluate the performance of their property relative to a market index. Such a phenomenon has also clearly been present in the U.S. since the mid-1990s (e.g., Geltner 2000).

Combining equations (1), (2) and (3):

(4) $$L_{ife} = \alpha_0 + \alpha_1(X_i\beta + Q_e + \nu_i) + m(Q_f - Q_e + w_{if}) + \varepsilon_{ie}$$

The specification above cannot be estimated since w_{if} and ν_i are unobserved. However, we proceed by substituting a noisy measure of the reference-point variable in place of the true term:

(5) $$L_{ife} = \alpha_0 + \alpha_1(X_i\beta + Q_e) + mRF_{ife} + \eta_{ie}$$

where

(6) $$RF_{ife} = (P_{if} - X_i\beta - Q_e) = (Q_f - Q_e + \nu_i + w_{if})$$

i.e. *RF* is estimated as the difference between the purchase price and the predicted selling price from a hedonic regression at the quarter of listing. Substituting (6) into (5), we get:

$$L_{ife} = \alpha_0 + \alpha_1(X_i\beta + Q_e) + m(Q_f - Q_e + \nu_i + w_{if}) + \eta_{ie}$$

where

$$\begin{aligned}\eta_{ie} &= \alpha_1\nu_i + m(Q_f - Q_e + w_{if}) - (Q_f - Q_e + \nu_i + w_{if}) + \varepsilon_{ie} \\ &= (\alpha_1 - m)\nu_i + \varepsilon_{ie}\end{aligned}$$

Thus, ν_i is an omitted variable, correlated with the reference-point term, *RF*. Thus *m* is expected to be biased since *RF* is correlated with ν_i.

To address this omitted variable bias, we can add to our model the residual of the previous selling price, $\nu + w$, as a noisy proxy for unobserved quality, ν:

(7) $$\begin{aligned}L_{ife} &= \alpha_0 + \alpha_1(X_i\beta + Q_e) + \alpha_1(P_{if} - X_i\beta - Q_e) + m(Q_f - Q_e + \nu_i + w_{if}) + u_{ie} \\ &= \alpha_0 + \alpha_1 X_i\beta + \alpha_1 Q_e + \alpha_1(\nu_i + w_{if}) + m(Q_f - Q_e + \nu_i + w_{if}) + u_{ie}\end{aligned}$$

The residual u_{ie} now contains the following terms:

(8) $$\begin{aligned}u_{ie} &= \alpha_1\nu_i + m((Q_f - Q_e + w_{if}) - (Q_f - Q_e + \nu_i + w_{if})) - (\alpha_1 - m)(\nu_i + w_{if}) + \varepsilon_{ie} \\ &= (m - \alpha_1)w_{if} + \varepsilon_{ie}\end{aligned}$$

Expanding and rewriting equation (7) as:

$$(9)\quad \begin{aligned} L_{ife} &= \alpha_0 + \alpha_1 X_i\beta + \alpha_1 Q_e + \alpha_1(\nu_i + w_{if}) + m(Q_f - Q_e + \nu_i + w_{if}) + (m - \alpha_1)w_{if} + \varepsilon_{ie} \\ &= \alpha_0 + \alpha_1(X_i\beta + Q_e + \nu_i) + m(Q_f - Q_e + w_{if}) + \varepsilon_{ie} \end{aligned}$$

We can see that equation (9) is equivalent to equation (4) and thus our specification is fully identified and estimable. In section 5 where we estimate this model, the reference point variable is broken into two components representing prospective gain or loss. We would expect that the coefficient *m* on the loss component would be positive (significantly different from 0) and higher in magnitude as well as significantly different from the coefficient on the gain component. Such a result would confirm the presence of loss aversion in the market.[8]

In order to test for anchoring/signaling effects, we have to switch focus from the listing price to the transaction price. Equation (9) above is a listing price regression and its residuals represent the extent to which the asking price is above or below the average or typical asking price, after taking into account any possible effects of loss aversion. Thus, in order to test for the effect of the asking price on the eventual sale of the property, the residuals from equation (9) are used as a right-hand side variable in a hedonic regression on the acheived sale price of a property. In section 5 where we estimate this model, these residuals are referred to as the Anchoring/Degree of Over-Pricing. The coefficient on this variable would have to be significantly different from 0 in order to make any conclusive statement about the presence of psychological anchoring and/or signaling in the marketplace.

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[8] Note that by comparing the magnitude of the estimate of *m* on the sales with a loss with that of the estimate of *m* on sales with a gain, and considering only the ***difference*** between those two, we are focusing on a narrow and pure definition of loss aversion as an explicitly "behavioral" phenomenon of prospect theory, as sales that face a gain instead of a loss are "beyond the kinkpoint" of Figure 1, that is, beyond the reference point of the prospect theory value function.

4. Data

The sales data used in this study comes from Real Capital Analytics (RCA), a New York based firm that is widely used to provide commercial property transactions data among institutional investment firms in the U.S. RCA attempts to collect price and other information about all commercial property sales in the U.S. of greater than $5,000,000 in price. RCA estimates that they achieve at least 90 percent coverage of that sales population. The sample period is from January 2001 until December 2009. This time period includes the largest and most dramatic rise and fall in the U.S. commercial property market at least since the Great Depression, and therefore provides an ideal sample for the present study.

The dataset covers all four "core" investment property sectors (usage types: office, retail, industrial and apartments) and has information on location and physical attributes. The raw data obtained from RCA consisted of about 100,000 commercial properties. For the purpose of this study, we discard properties that have incomplete information on property location, sales dates, listing dates as well as those with missing information on prices. To filter observations with a greater likelihood of error, we dropped properties that had a first sale before 1988. All properties that were not part of an arms length transaction are not included. Furthermore, to avoid any overstatement in the calculation of the market price appreciation, we exclude properties that were held for less than 1.5 years ("flipped" properties).[9] Finally, properties that sold as part of a portfolio

[9] Other filters were also imposed to ensure the integrity and appropriateness of the data. Details are available from the authors upon request.

(multiple property) transaction are filtered out, as it is not possible to determine each property's contribution to the portfolio's transaction price.

Table I provides a summary of the remaining data. There are 6,767 total listings of which 4,782 properties actually sold in the market. The other 1,985 properties were delisted or pulled from the market without a sale. Of the 4782 completed transactions, 3723 were sold at a gain, and 1059 at a loss.[10] All the properties have complete information on the first sale price and the asking price, the two key variables required to compute our empirical model. As Table 1 shows, about one-fourth of the total listings over the sample period faced a loss at the time of entering the market. Moreover, properties that sold spent less time on the market (37 weeks) than delisted, unsold properties.

Insert Table I here

To construct a variable for experience, we exploit the fact that the RCA data contains the names of buyers and sellers. The same investor is often both a buyer and a seller in the market. Thus we calculate trading experience by counting the number of times an investor's name has appeared in either the buyer or seller name lists. The mean number of trades per seller is 101 for sold listings and slightly less at 88 for all listings, which include unsold, delisted properties.

[10] This included 1186 properties sold during the 2007 peak of the market cycle, including (perhaps surprisingly) 234 properties sold at a loss (compared to their prior purchase price) during that peak year (suggesting the extent of heterogeneity or idiosyncratic risk at the asset level in commercial property). A further 1068 properties were sold during 2008-09 including 309 at a loss.

The RCA data also contains information on the type of investor the seller is. There are primarily four groups of investors: “Institutional” (consisting of banks, insurance companies, pension and hedge funds; national and international entities who tend to purchase larger properties); “Private” (consisting of generally smaller and more local companies geared towards operating, developing or investing in commercial real estate); “Public” (consisting of companies that are listed on public markets like REITS and REOCs}; and “Users” (consisting of owner-occupiers such as government, educational, and religious institutions or business that own commercial property for their own use). Of these four groups, the institutional investors and the publicly traded companies are the most experienced in the market which is reflected in our dataset as they make up the majority of the 100-plus trades investors over the given time period.

5. Empirical Analysis

5a) Effects of Loss Aversion on Asking Prices

Table II presents our main empirical results of the test of loss aversion behavior. It shows the equation (9) regression of asking prices onto prospective gains and losses, as well as onto the estimated value of the property ($X_i\beta$), the residual from a first sale price regression so as to control for unobserved quality, and dummy variables for the quarter of entry into the market for sale (results for the latter omitted, available from the authors). All price variables are measured in logs. The results confirm that losses play a greater role than gains: the coefficient on Loss is higher and different with statistical significance compared to that on Gain. The estimated coefficient of 0.38 on Loss suggests that a 10 percent increase in a prospective loss (referenced on the seller’s purchase price), leads the seller to set an asking price approximately 3.8 percent higher than she otherwise would.[11] In other words, commercial property sellers faced with a loss relative to their purchase price tend to post asking prices higher than otherwise-similar sellers not facing a loss, by a magnitude of about 38% of their loss exposure. The comparable finding in the G-M housing study was 25% to 35%.

Insert Table II here

It is important to note that it is the ***difference*** between the coefficient on "Loss" and that on "Gain" that suggests a type of psychological loss aversion based on prospect theory that is inconsistent with classical utility-based economic models. Referring back to Figure 2, sellers facing a gain are beyond the kink-point in the prospect theory value function, and hence their pricing behavior presumably does not reflect prospect theory based loss aversion. However, the fact that sellers facing a gain also price differentially is still interesting from an economic perspective. It suggests a type of pricing strategy influenced by a reference point (in this case the property's prior purchase price). In particular, the positive coefficient on the "Gain" variable suggests that sellers facing a gain set a *lower* price than they otherwise would, while sellers facing a loss set a *higher* price, in the latter case, asymmetrically so. The asymmetry in this behavior likely reflects the "behavioral" loss aversion phenomenon of prospect theory. But even the symmetrical reference point based pricing behavior may involve "behavioral" components. For example, the pricing behavior discovered here would be consistent with the "sell

[11] More precisely, this is a point elasticity based on log-differences, so the arc elasticity based on a 10% loss might be slightly different. The mean value of the Loss variable among sold properties with a loss was 0.32 which implies a price loss of 27% of the prior purchase price.

winners/hold losers" behavior referred to as the "disposition effect", and found by Crane & Hartzell (2009) in their study of REIT behavior. We will discuss these issues further in the next section about participants' experience and in Section 6 where we quantify the historical magnitude of these pricing strategies during the 2000s commercial property market cycle.[12]

Finally, Table II also shows the coefficient on the residual from the first sale regression, which is a proxy for unobserved quality. This coefficient (0.346) is positive and statistically significant, implying that controlling for unobserved property heterogeneity is important.

5b) Loss Aversion and Experience

We next divide the data into two groups; investors that engaged in more than a hundred trades were labeled the "more experienced investors" group, and those with less than a hundred trades, the "less experienced investors" group. In Table III, we find that there is no significant difference between the two groups when they are faced with a gain. However, contrary to previous findings in the literature, we find that the more experienced investor group exhibits a *higher* degree of loss aversion than their less experienced counterparts. A test of the equality of coefficients on "Loss - more experienced investors" (0.46) and "Loss – less experienced investors" (0.35), significantly rejects the null hypothesis that the two groups behave the same.

[12] We should note that loss aversion, and the disposition effect, may have "rational" components. However, Crane & Hartzell (2009) argue that the disposition effect they find in REITs cannot be explained by rational motivations such as mean reversion in asset prices. Asymmetric loss aversion such as we find here also can be rational if the seller has a mortgage whose balance exceeds the likely current value of the property. Unlike Genesove & Mayer who are able to control for this consideration, we do not have data on sellers' loan balances. However, we note that certain types of institutions typically rely less on property-level debt, including REITs, pension funds, and foreign investors, and as we will note in the next section, we find that such institutions exhibit even greater than average loss aversion pricing.

Insert Table III here

It is interesting to note that over 40 percent of the more experienced investors trading group consists of institutional investors. In Table IV, we compare the degree of loss aversion across different investor types and find that consistent with the findings in Table III, the coefficient on Loss for institutional investors (0.485) is among the highest. It is not significantly different from equity fund investors (0.515), who also make large investments in commercial real estate. The next most experienced group is publicly traded companies, which, with a coefficient of 0.346 is more loss-averse than private investors (0.26), although the difference is not statistically significant.

The difference in the loss coefficient of private investors and that of institutional as well as equity fund investors is statistically significant, and we find this difference intriguing. Perhaps local knowledge that's available to private investors has a role in explaining this difference, cutting through the psychological behavioral tendency to indulge in loss aversion (possibly by giving such investors a greater self-confidence to sell at a loss recognizing that it does reflect the current true state of the local market). Or perhaps private investors tend to employ more property-level debt, and their creditors enforce a more ruthless business logic on their sales in the face of loss. Finally, another explanation for greater loss aversion among large institutions could be that such investors tend more to be “agents” managing the capital of other investors (“principals”), and the agents, fearing judgment by their stakeholders, may be more reluctant to realize losses.

Insert Table IV here

5c) Evidence of Behavioral Effects on Transaction Prices

In this section, we turn our analysis to the final transaction price. It could be argued that since the results in the previous sections were not based on the selling price (they were based only on asking price), the anomalies exhibited by the sellers would disappear once they enter into a bargaining environment with the buyer. We test if loss aversion still plays a role in the final transaction price. We also test if the asking price has any influence on the sale price when the asking price is set above, or below, the market value (as predicted by the hedonic model). This analysis is achieved by taking the residual from the asking price equation (9) and including it in the final sale price regression. This residual will be positive and larger in cases where the asking price is higher than normal *relative to* the average asking price (controlling for other characteristics of the sale and effect of loss aversion), and vice versa. This residual from eqn.(9) is termed the "degree-of-overpricing" (DOP). It captures both the signaling aspect of the bargaining process as well as the psychological anchoring-and-adjustment process.

Insert Table V here

We present the results in Table V in two different ways. In column (1) of Table V, we include the Loss variable in the same way as in earlier regressions. However, in column (2), we divide the Loss variable into three regimes; LossPre07 (Loss before 2007), Loss07 (the Loss variable for the market transition year of 2007), and LossPost07 (for the post 2007 regime of 2008-09).

The rationale for this breakdown is that the commercial real estate property market arguably passed through three distinct regimes during the past decade. The period through 2006 was characterized by first a stable and strong market then rising to a full-scale boom (or perhaps a bubble) of historic proportions in the latter few years of that period. The year 2007 was a transition year when the market suddenly and dramatically turned, but with such rapidity that market participants were faced with great uncertainty. Finally, by 2008 it had become clear that commercial real estate property prices were in a serious tailspin the likes of which had not been seen even in the previous "crash" of the early 1990s (which had been the worst fall since the Great Depression of the 1930s).

Consider first the transaction price model presented in column (1), which applies to the overall average during the entire 2001-09 sample, and which is therefore directly comparable to the previous results on the asking price. We note that in the transaction price the effect of loss aversion is smaller in magnitude (0.25) than we found it to be in the asking price in Table II (0.38).[13] Nevertheless, it is still both statistically and economically significant. This suggests that, while the loss aversion effect carries through to actual transactions, there is some degree of learning in the market through the deal negotiation process. Sellers are not able to achieve in actual sale prices as much loss aversion as they attempt to achieve (or signal) in their asking prices.

[13] The difference would probably be not so big if we restricted the sample in the asking price regression to only the properties that eventually sold.

Interestingly, the anchoring effect, or degree of over-pricing, turns out to be not only statistically significant but larger than the effect of loss aversion. The coefficient of 0.77 implies that a 10 percent increase in the asking price over the market value results in the seller obtaining a higher transaction price by approximately 7.7 percent. This result implies that signaling and/or psychological anchoring is a potentially very powerful influence on the transaction price (within the range of the DOP observed in the data[14]). However, it is important to recall that the data do not allow us to know how much of the DOP effect we are quantifying here is actually anchoring versus signaling true (superior) quality attributes of a property which buyers subsequently discover and agree with the seller about. It seems possible that the signaling effect could quite large, particularly in cases where the asking price deviates widely from the expected market value.

Next consider the results in column (2) of Table V where we show the transaction price model with the three different regimes of loss aversion. The coefficient on the Loss variable is statistically significant in all three regimes, but of greater interest is the fact that it is *different* between and across each of the three regimes, and the nature of these differences is quite interesting. First, during the stable and growing market regime of 2001-06 we find that the coefficient of 0.28 on LossPre07 is similar to the overall average result from column (1) discussed above (0.25). This might be viewed as reflecting the "normal" or typical effect of loss aversion in the commercial property market transaction prices. (Note that this coefficient is statistically significantly different from the coefficient of 0.155 on the Gain variable, again confirming the power of the prospect theory based behavioral loss aversion phenomenon even in transaction prices.) But of particular

[14] It should be noted that the average magnitude of DOP in the data is relatively small, suggesting that the influence of the anchor on the buyer, while powerful up to a point, may not extend to large deviations of the asking price from the otherwise-expected market value.

interest is what then happens to the loss aversion phenomenon in the following two exceptional market regimes.

First came the transition period of 2007 at the peak of the market cycle when the turnaround first hit and the market was dealing with great uncertainty. During this period loss aversion in the achieved transaction prices grew greatly in magnitude, to 0.38, significantly different from its prior and more "normal" level of 0.28. This reflected an extreme aversion of sellers (property owners) to facing the possibility of the dramatic change in fortunes that was occurring in 2007. They reacted by simply avoiding agreeing to any sales that did not reflect substantially greater than normal loss aversion. And they apparently succeeded in finding buyers who exhibited a larger-than-normal tendency to reach up toward the sellers' higher loss-averse asking prices (relative to the otherwise-expected market value). The result, of course, was a dramatic drop off in consummated sales volume in the latter part of 2007.

Finally this transition period was followed by an even more curious behavior. During the drastic downfall in the market of 2008-09 loss-aversion actually *weakened* to less-than-normal levels, falling statistically significantly below the "normal" level (the 0.16 coefficient on LossPost07 is less than the 0.28 coefficient on LossPre07 with statistical significance). Furthermore, the coefficient on LossPost07 is *not* significantly different from the coefficient on Gain, suggesting that in some sense there was perhaps very little loss aversion (of the prospect theory based behavioral form) during the most dramatic downturn in the market. We hypothesize that this suggests an ability for what one might term "extreme reality" to "break through" psychological behavior and enforce a more rational or "cold-eyed" business behavior. After all, loss aversion is based on a sort of psychological “wishful thinking” or illusion, an illusion that can indeed be realized to some extent in normal times (but only at the cost of lost liquidity and greater time on the market). It may be more difficult cognitively to keep up this type of thinking in the face of the magnitude of downturn that the market faced in 2008-09. It is also possible, of course, that the *demand side* of the market collapsed to such an extent in 2008-09 that loss-aversion behavior on the part of sellers could no longer be effective in consummated transaction prices. Indeed, this could be the actual market mechanism by which the sellers are forced to face reality; they simply can no longer find any buyers at all who will deal at prices that reflect loss aversion.

In summary, the results reported in column (2) of Table V suggest a wide temporal variation in loss aversion over the market cycle (at least when the cycle is as strong as it was during the 2000s decade). During “normal” times, loss aversion results in average transaction prices slightly higher than they would otherwise be (with concomitantly lower volume). During transition periods of a major market turning point (from up to down), we see that sellers facing a prospective loss during the year 2007 were able to obtain higher prices more so than they normally could (on a reduced volume of closed deals). We conjecture that the uncertainty in the market during that year made it difficult for the demand side to determine the true market value. Then, during 2008-09, the demand side revised downwards drastically its reservation prices, making it unrealistic for potential loss-averse sellers to continue holding out. The coefficient on LossPost07 is similar in magnitude to the coefficient on Gain, implying that loss-averse sellers could not do any different than other sellers in the market. This finding gives a unique perspective on how the market can correct behavioral anomalies. To our knowledge, this type of behavior has not been discovered previously in the literature.

5d) Effects of Loss Aversion on Time on the Market

Consistent with the transaction price evidence of the preceding section, we would expect that if sellers facing a prospective loss have a higher reservation price, then they must also experience a longer time on the market, or equivalently, a lower hazard rate of sale. The hazard rate is defined as the probability that a property sells in any given week, given that the seller has listed the property for sale but it hasn't sold as yet. In this section, we estimate the effect of loss aversion on the hazard rate of sale. The hazard rate is specified as $h(t) = h_0(t)\exp(\alpha X)$, where X is a vector of covariates (in particular, "determinants" of sale propensity), with α being the vector of coefficients. The variable measuring the time spent on the market is the listing duration in weeks. For sold listings, duration is defined by the weeks elapsed between the date of entry into the market and the date of eventual sale. For properties that were delisted without sale (or "pulled" properties), their time on the market is measured by the weeks that elapsed between the dates of entry and exit from the market. In other words, they are treated as being censored at exit.

Insert Table VI here

In Table VI, we estimate a Cox proportional hazard model (the classical methodology for calibrating this type of model). As expected, the coefficient on Loss is negative (-0.32) and statistically significant. This indicates for example that investors facing a 10 percent loss (when entering the market and therefore tending to post a higher asking price due to loss aversion behavior), experience approximately a 3% [= exp(-0.32*0.1) – 1] reduction in the weekly sale hazard (with a resulting concomitant increase in the expected time to sale). The comparative result in the G-M housing study was 3% to 6% (in other words, a slightly greater TOM effect in the 1990s Boston housing market). We also note that the positive and significant coefficient on Estimated Value (0.275) indicates that higher quality or larger properties have a higher hazard of sale (or shorter time on the market).

6. Implications for Price Indices and Aggregate Market Pricing

This section presents two extensions to the previous literature on loss aversion. First, we consider the effect of incorporating the behavioral phenomena, described in Sections 2 & 3 and quantified in Section 5, on the construction of hedonic price indices. We will see that hedonic index construction can be greatly improved by incorporating the behavioral variables[15] Second, we consider the magnitude of the impact of prospect theory based loss aversion on the aggregate market in terms of the effect on the market-wide average realized transaction price. This effect will also be pictured relative to an historical price index so as to enable a better visualization of the relevant context. Finally, we will demonstrate the magnitude and nature of the entirety of the reference point based pricing

[15] It should be noted that the price indices developed here are not directly comparable to Moody's/REAL Commercial Property Price Indices (CPPI) that are based on RCA data and published by Moody's Investors Service. The indices developed here are based on hedonic models (with an implied "representative property"), rather than the same-property repeat-sales model employed in the CPPI. The estimation dataset is also somewhat different, including here less than 5,000 sold properties greater than $5,000,000 containing the necessary hedonic and behavioral variables, versus the CPPI which is based on approximately 17,000 repeat-sales of generally over $2,500,000 in price and some different data filters than what is employed here. Finally, for practical reasons the CPPI is a "frozen" index that is not revised with new data, whereas the present analysis of course includes all of the historical effects in the current dataset. The indices presented here have been developed solely for academic research purposes.

that we have quantified in our transaction price model, including symmetric as well as asymmetric effects, and including the three-regime model of the 2000s market cycle.

6a) Hedonic Index Construction

Consider first the role of the behavioral variables in the construction of a hedonic price incex. Figure 3 presents a direct comparison of two hedonic indices based on the same database, the 4782 repeat-sales observations with sufficient hedonic data to employ the behavioral variables, the same database used in the empirical analysis presented in Section 5. The hedonic indices presented here are pooled models of the Court-Griliches form in which the hedonic variables are treated as constant across time and the price index is thus constructed purely from the coefficients on the time-dummy variables. The smoother index indicated by the blue squares includes the behavioral variables in the hedonic price model, while the more choppy index indicated by the green triangles is based on an otherwise identical hedonic model only without the behavioral variables. The model underlying the blue index is that of column 1 of Table V and therefore does not reflect the differential effect of loss aversion over time. The comparison with the green index shows that including the behavioral variables greatly improves the index, as the blue index clearly is less noisy than the green.[16] The index without the behavioral variables also does not capture as much of the downturn in prices, as it falls only 26% from 3Q07 to 2Q09 compared to 33% for the blue index.

[16] This comparison can be quantified more rigorously by comparing the standard errors on the index log levels across the two models. As seen in Table VII, the average standard error in the index without the behavioral controls is almost seven times that of the index with the behavioral controls.

Insert Figure 3 here

Next, consider Figure 4 (below). We note that we had to eliminate a large number of otherwise potentially usable sales observations from the RCA database in order to construct the behavioral index, because we needed information on the reference point (prior sale price) and the asking price, data which was not available for most RCA transaction observations. The result is that the behavioral index must be estimated with barely more than one-tenth the sample size that could otherwise be used for a hedonic index. Figure 4 compares the behavioral index (the same blue index indicated by squares as in Figure 3) with a straight hedonic index based on a much larger dataset. The index in Figure 4 indicated by the red squares is estimated without behavioral variables, like the green index of Figure 3, only now based on the full dataset of 45,870 single-sale observations. The much greater sample size tames the noise that we saw in the non-behavioral index of Figure 3, but the red-squares hedonic index in Figure 4 is still arguably not as good as the behavioral index even though the latter is based on a much smaller dataset. Without the behavioral variables the hedonic index fails to adequately capture the 2007-09 market downturn, dropping only 19% instead of the 33% of the blue index.

Insert Figure 4 here

6b) Aggregate Market Impact of Behavioral Loss Aversion

As we noted at the outset, an interesting question is the extent to which behavioral loss aversion is responsible for a salient feature of commercial property markets, namely, their tendency to lose liquidity during down markets. Clearly, the drastic drop in trading volume that occurs at the beginning of a price downturn results from a pulling apart of the demand and supply sides of the market. In principle, loss aversion could explain at least part of the tendency of property owners (the supply side) to hold up their reservation prices rather than following the demand down to pricing at which the market would maintain its normal liquidity.

Figure 5 presents a graphical image of the light our study can shed on this question, using the Moody's/REAL CPPI as a sort of "benchmark" to frame the history of the U.S. commercial property market.[17] Four price indices are presented in the chart. The solid black line is the CPPI, indicating the history of the average realized prices in the market, prices which therefore reflect whatever effect loss aversion behavior has at the aggregate level in the actual marketplace.[18] The red-squares and blue-diamonds indices track the movements of, respectively, the demand and supply sides' reservation prices, as measured by the TBI, presented here ***relative to*** the realized market transaction prices tracked by the CPPI.[19] Note that the potential buyers' reservation prices on the

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[17] The Moody's/REAL CPPI is a useful benchmark because it is widely followed by industry participants and is viewed as presenting a good picture of actual transaction price movements in the market. Like the rest of this study, the CPPI is based on repeat-sales data from RCA. However, as noted previously there are some database differences that should be kept in mind.

[18] The CPPI depicted in Figure 5 has been reset to have a starting value of 1.0 as of 1Q2001, as that is the first date in our analysis.

[19] See MIT Center for Real Estate: http://web.mit.edu/cre/research/credl/tbi.html. The indices depicted in Figure 5 are based on the "Liquidity Metric" published by the MIT/CRE. This metric is constructed as the percentage difference, each period, between the demand (supply) index and the TBI price index, normalized to starting values set so that the average value level of all the indices is equal over the entire 1984-2009 history of the TBI. The result is a reasonably good measure of the percentage gap between

demand side began dropping after 2Q2007 but a gap between demand and supply did not open up until 1Q2008, increasing dramatically further by 1Q2009 to over 25% of the then-prevailing average transaction price. This was accompanied by a drop in RCA major-asset trading volume from $136B in 2Q07 to $48B in 1Q08 to a nadir of $10B in 1Q09. In the early part of this drop the increase in the demand-supply gap was due in part to actual *increases* in the property owners' supply side reservation prices. The question is to what extent this behavior in the marketplace can be attributed to the type of prospect theory based psychological loss aversion behavior we have focused on in the present paper.

One way to answer this question is presented by the green line (indicated by "x" hash marks) in Figure 5. This index presents a picture of how different the prevailing average market transaction prices would have been had there been no behavioral loss aversion of the type modeled in Table V of Section 5. This "adjusted" market index is constructed using a three-regimes model of loss aversion similar to what was discussed in Section 5.

Insert Figure 5 here

The index is constructed as follows. First, a behavioral transaction price model similar to that in Table V is estimated, including three regimes for both the "Gain" and "Loss" variables. The regimes are defined as before: Pre-2007, 2007, and Post-2007

demand and supply prices as a fraction of current transaction prices, such that when the gap is zero there is approximately normal (long-term average) liquidity (trading volume) in the market. In Figure 5 we simply take that same gap (each period) and apply it to the CPPI in the same way that the MIT/CRE applies it to the TBI.

(ending with 4Q2009); and as before we see that the Loss coefficient is significantly larger than the Gain coefficient in the first two regimes but not in the third. Next, we take the difference, within each regime, of the Loss coefficient minus the Gain coefficient. As noted in Section 5, this difference reflects the purely "behavioral" loss aversion phenomenon associated with the kink-point in the prospect theory value function.[20] We then multiply this difference by the average magnitude of the Loss variable within each regime to arrive at the magnitude of impact on the average transaction price within each regime conditional on the sold property facing a loss. Finally, we multiply that conditional loss impact times the proportion of transactions actually facing a loss (within our 4782-observation dataset), within each regime. We then subtract these regime-specific market-weighted impact factors from the CPPI, to produce a "loss-aversion adjusted" price index that presumably reflects something like what the overall market-wide average prices would have been had there been no prospect theory based loss aversion behavior.[21]

If behavioral loss aversion played a substantial role in "sticky pricing", keeping sellers' reservation prices high and thereby successfully influencing transaction prices to not fall far enough to maintain normal liquidity, then we would see the loss-aversion adjusted price index in Figure 5 drop rapidly and substantially below the actual CPPI,

[20] In other words, there may be some influence of prior purchase price on sellers' asking prices that is "rational" (consistent with classical economic theory), included in the magnitude of the coefficient on the properties that have no loss (the "Gain" coefficient). For example, sellers booking a gain might rationally decide to ask a lower price than they otherwise would in order to apply some portion of their potential profits to selling more quickly, or selling a larger number of properties, rather than taking it all in price appreciation. Similarly, sellers facing a loss may rationally (and symmetrically) decide to do the opposite, asking a higher price in order to trade off some otherwise-expected book loss against taking a longer time to sell or selling fewer properties. This rational component of pricing behavior is not the loss aversion behavior rooted in prospect theory and that we are primarily focusing on in the current paper, though it also is an interesting phenomenon which we will consider further shortly.

[21] Technically, we first take the log of the CPPI level, then subtract the described loss-aversion adjustment factors, then exponentiate to convert back to straight levels.

with the loss-aversion-adjusted index tracing a path similar to that of the demand-side reservation price index (the red-squares index in Figure 5) during the 2007-09 period. But we don't see this. In fact, the impact of behavioral loss aversion is relatively minor. As thusly computed, loss aversion increased aggregate market-wide average prices by only 0.7% during the 2001-06 regime, by 1.2% in 2007, and by 0.4% during 2008-09.

Thus, prospect theory based "behavioral" loss aversion did not apparently have a large impact on the broad macro-behavior (average transaction prices and volumes) within the U.S. commercial property market during the great cycle of the 2000s decade. However, as noted in Section 5, behavioral phenomena are evidently important at the disaggregate, individual property level, and they may represent much of the strategic pricing behavior in the marketplace. Figure 6 presents one way to picture this, in a framework similar to what we have just used to evoke the macro-level impact.

6c) Magnitude & Nature of Reference Point Based Pricing Behavior

The chart in Figure 6 is again keyed on the Moody's/REAL CPPI. The index indicated by purple circles above the CPPI is the total effect of loss aversion pricing on properties facing a loss. Unlike the previous loss-aversion-adjusted market index in Figure 5, the loss-properties price effect index in Figure 6 reflects *total* loss aversion. It shows how much higher are the prices achieved by sellers facing a loss due to the pricing strategy of such sellers, including both the "rational" and "behavioral" components of that strategy. Because they are facing a loss, such sellers set prices higher than they otherwise would. (This is what is implied by the coefficient on the "Loss" variable in the price model in Table V discussed in the previous section.) The difference above the market-average

CPPI price level indicated in the loss-properties price effect index is computed as the entire coefficient on the "Loss" variable times the mean magnitude of loss among sold properties that were facing an expected loss when they entered the market. It thus includes the component of loss-properties pricing that is symmetric with that of properties facing a gain (as well as the asymmetric "extra" component reflected in Figure 5). The indicated difference between the loss-properties price effect index and the CPPI reflects the three regimes described previously, and is approximately 9%, 13%, and 7.5% above the average price indicated by the CPPI in each of the three regimes respectively: 2001-06, 2007, and 2008-09. This is therefore how much higher were the prices achieved (on average) by sellers facing a loss, compared to what they would have obtained if they were facing neither a loss nor a gain, over the 2000s market cycle.

Correspondingly, the orange-diamonds index showing the gain-properties price effect indicates how much lower was the average price obtained by properties sold conditional on the fact that they were facing an expected gain when they entered the market. As noted, such sellers take a lower price than they otherwise would (i.e., if they were facing neither a gain nor a loss). Such sellers are beyond the "kink-point" in the prospect theory value function, and their pricing strategy could reflect "rational" motivations consistent with classical economic utility theory, for example, to sell properties faster or to sell a larger volume of such properties. However, as noted in Section 5, there could also be "behavioral" components in this pricing strategy, such as the "disposition effect" found by Crane and Hartzell (2009) in their study of REITs property sales. The gain-properties price effect index is computed similarly to the loss-properties price effect index, as the CPPI price level ***minus*** the hedonic transaction price model coefficient on the “Gain” variable times the mean magnitude of the “Gain” variable (among sold properties facing a gain), within each temporal regime.[22] This price reduction effect is estimated to be approximately 8%, 10%, and 8% below the average transaction price in the market as a whole indicated by the CPPI in each of the three regimes respectively: 2001-06, 2007, and 2008-09. The gain-properties price effect is thus only slightly less in magnitude than the loss-properties price effect. This is because, even though the coefficient on “Gain” is generally smaller than the coefficient on “Loss” (as reported in Table V), the average magnitude of “Gain” is much greater than the average magnitude of “Loss” (at least during the 2001-09 cycle). Thus, the pricing impact is nearly symmetrical between the two cases (gainers vs losers).

The gap in pricing achieved by sold properties facing a loss versus those facing a gain, relative to what they would otherwise fetch (as a percentage of that average market price), is thus seen to be approximately 18%, 23%, and 15.5% within the three temporal regimes of the 2000s commercial property cycle (summing the magnitude of the two gaps noted above). These are clearly very substantially different pricing strategies employed by sellers facing a loss versus those facing a gain. Note also that the gap widened during the peak and turnaround year of 2007, and closed during the severe downturn of 2008-09, reflecting the previously-noted greater-than-normal strength of loss-aversion during the 2007 turning point and the weaker-than-normal loss-aversion of the severe downturn. As noted, not all of the difference between gainers and losers pricing is due to prospect theory based psychological loss aversion behavior, and the effect on overall average

[22] For the gain-properties index the difference is subtracted (versus added for the loss-properties index), because the “Gain” coefficient is positive and the “Gain” variable is defined to have a negative sign (prior purchase price minus expected current sale price: same definition as that for “Loss” in the case of loss-properties, giving the “Loss” variable a positive sign).

market prices is partly attenuated by the offsetting nature of the two effects, although the greater proportion of gainers compared to losers in combination with the nearly symmetrical price gap suggests that the gain properties price effect exceeds that of the loss properties in the overall market average price.[23]

The magnitude of the gap between the loss-properties and gain-properties pricing portrayed in Figure 6 suggests the importance of differential pricing strategy among sellers facing a loss versus those facing a gain. While some of this strategy may reflect purely rational profit-maximizing concerns, the findings of the present paper combined with those of Crane & Hartzell (2009) on the disposition effect in REITs suggests that at least an important part of the revealed pricing gap may be reflect psychological behavior.

Insert Figure 6 here

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7. Conclusion

Using data on U.S commercial property sales of greater than $5,000,000 during the January 2001 - December 2009 period, this paper has explored the effect of loss aversion and anchoring on both asking prices and realized transaction prices, and we have developed historical price indices that are controlled for loss aversion behavior. This study has replicated and extended and enhanced the seminal study of Genesove & Mayer

[23] Note that the loss properties and gain properties price effect indices in Figure 6 do not reflect the market weights of the two types of sales (gainers and losers). The indices simply represent the pricing differential of each type of sale relative to the market average. A combined and weighted market index adjusted to remove the effect of all reference point based pricing (both symmetric and asymmetric) would lie above the CPPI by 6.1%, 7.4%, and 4.2%, respectively during 2001-06, 2007, and 2008-09. Such an index would have fallen about 2% farther peak-to-trough in the 2007-09 downturn than the CPPI (as a percent of peak value).

that discovered loss aversion behavior in housing markets, and has also added importantly to the Crane & Hartzell findings about the disposition effect in REITs. We confirm not only that such behavior exists also in the commercial property market, but indeed that loss aversion is of similar magnitude and impact as in the housing market that G-M studied. We furthermore find, contrary to some prior literature, that loss aversion behavior in asking prices is actually greater among more experienced investors and among larger more "professional" institutions such as funds and REITs than among smaller private investors. The loss aversion behavior carries through to higher transaction prices (on average), and longer time on the market.

During the particularly dramatic commercial market cycle of the 2000s decade we find the effect of loss aversion behavior varied interestingly, first increasing in the early stage of the market peak and turning point, then collapsing in the face of the overwhelming reality of lack of buyers on the demand side. We explore the role of behavioral variables in the construction of hedonic price indices, finding that they can greatly improve such indices. We use our three-regime model to analyze the nature and magnitude of prospect theory based behavioral loss aversion on market-wide average prices at the aggregate level. We find that this impact is small and appears not to be the major source of the pulling apart of buyer (demand) and seller (supply) reservation prices that caused the severe illiquidity of the 2008-09 market collapse. However, we also use the same three-regime behavioral pricing model to develop indices of the pricing strategy of sellers facing a loss juxtaposed with that of sellers facing a gain. This illustrates the magnitude and cyclical nature of the differential pricing strategy of "losers" and "gainers" during the historic property market cycle of 2001-09, and may be at least partly reflective of a “disposition effect”. We see both the substantial relative magnitude of this pricing strategy difference, as well as the way that it changed during the cycle, increasing during the peak and turning point year of 2007, and then attenuating during the subsequent severe downturn. The magnitude of the pricing strategy difference between gainers vs losers is substantial, as much as 23% during the peak and turning point year of 2007 and falling to 15.5% in the crash of 2008-09.

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Figure 1: Value Function of Prospect Theory

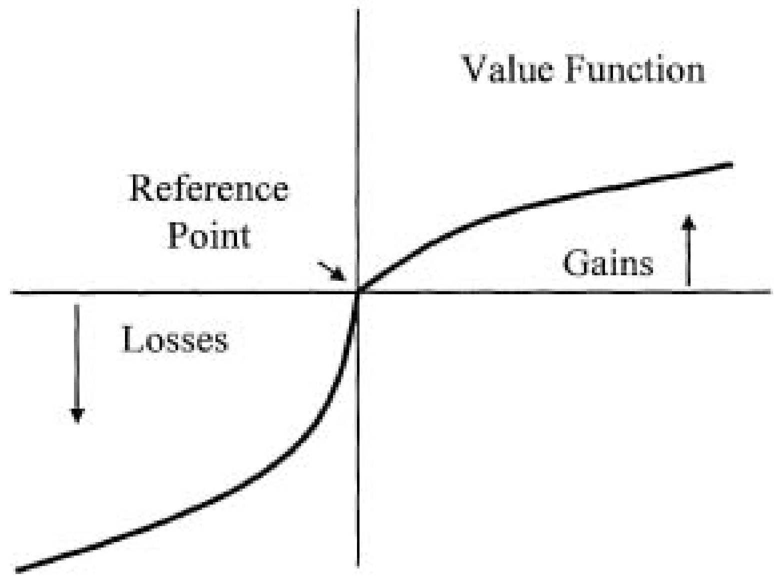

Figure 2: Marginal Benefit and Marginal Cost of an increase in Price – Comparison between Risk-Neutral and Loss-Averse Sellers

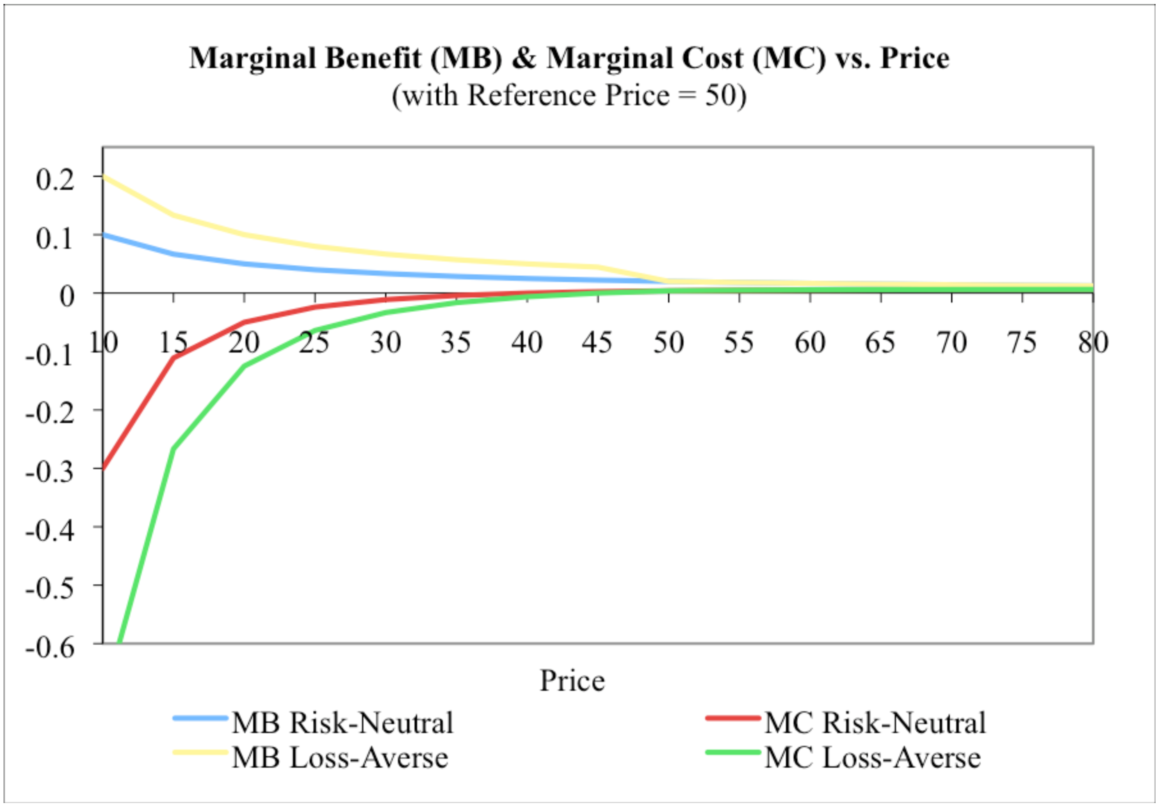

Table I
Data Summary (Means with standard deviation in parenthesis)

VARIABLES	All Listings	Sold Listings
Number of Observations	6767	4782
Second Sale Price	-	$31,775,301 (77510785)
First Sale Price	$20,537,628 (50984144)	$22,084,851 (5359336)
Asking Price	$29,863,672 (71117741)	$32,857,296 (78344285)
Square Footage	176551 (218790)	186250 (217986)
Percent with First Sale Price > Expected Selling Price	25%	22%
Months Since Last Sale	48 (42)	57 (44)
Time on the Market (weeks)	50 (38)	37 (31)
Trading Experience*	88 (174)	101 (185)

*Number of trades the agent has participated in within the database.

Table II
Loss Aversion and Asking Prices
Dependent Variable is Log Asking Price

VARIABLES	(1) LogAskingPrice
Gain	0.223
	(0.0309)
Loss	0.380
	(0.0565)
Estimated Value	0.943
	(0.00592)
Residuals from first sale	0.346
	(0.0309)
Months since first sale	0.000588
	(0.000190)
Constant	8.028
	(0.116)
Observations	6767
R-squared	0.869

Robust standard errors are shown in parentheses. Dummies for the quarter of entry are included in the regression but results are not shown here. Loss (in logs) is defined as the difference between the first sale price and the expected selling price at the quarter of entry truncated below at 0. Gain (in logs) is the same difference truncated above at 0. Estimated Value is for the quarter that the property enters the market and comes from a hedonic regression using all sold properties. Regression results are available from the authors.

Table III
Loss Aversion and Trading Experience
Dependent Variable is Log Asking Price

VARIABLES	(1) LogAskingPrice
Gain - Less experienced traders	0.219
	(0.0309)
Gain - More experienced traders	0.233
	(0.0362)
Loss - Less experienced traders	0.350
	(0.0647)
Loss - More experienced traders	0.463
	(0.0554)
Estimated Value	0.942
	(0.00597)
Residuals from first sale	0.347
	(0.0309)
Months since first sale	0.000583
	(0.000191)
Constant	8.061
	(0.117)
Observations	6767
R-squared	0.869

Robust standard errors are shown in parentheses. Dummies for the quarter of entry are included in the regression but results are not shown here. The experience of traders is defined as the number of trades the seller has participated in. The more experienced traders are those engaged in over a 100 trades.

Table IV
Loss Aversion and Investor Types
Dependent Variable is Log Asking Price

VARIABLES	(1) LogAskingPrice
Gain	0.193
	(0.0292)
Loss - Institutional Investors	0.485
	(0.0657)
Loss - Private Investors	0.260
	(0.0709)
Loss - Equity Fund	0.515
	(0.0823)
Loss - Public Investors	0.346
	(0.106)
Loss - User/Other Investors	0.335
	(0.213)
Estimated Value	0.935
	(0.00614)
Residuals from first sale	0.381
	(0.0286)
Months since first sale	0.000410
	(0.000181)
Constant	8.072
	(0.0958)
Observations	6767
R-squared	0.869

Robust standard errors are shown in parentheses. Dummies for the quarter of entry are included in the regression but results are not shown here. Institutional Investors include banks, insurance companies, retirement-, hedge-, or mutual-fund making large investments. Public Investors are companies or funds traded on open public markets - includes REITs REOCs and publicly-listed funds.

Table V
Loss Aversion and Anchoring/Signaling
Dependent Variable is Log Transaction Price

	(1)	(2)
VARIABLES	LogSecondSalePrice	LogSecondSalePrice
Gain	0.155	0.154
	(0.0126)	(0.0125)
Loss	0.245	
	(0.0296)	
LossPre07		0.280
		(0.0488)
Loss07		0.383
		(0.0448)
LossPost07		0.160
		(0.0376)
Anchoring/Degree of over-pricing	0.774	0.771
	(0.0187)	(0.0186)
Estimated Value	0.961	0.961
	(0.00389)	(0.00395)
Residuals from first sale	0.467	0.465
	(0.0138)	(0.0137)
Constant	7.788	7.791
	(0.0544)	(0.0537)
Observations	4782	4782
R-squared	0.955	0.955

Robust standard errors are shown in parentheses. Dummies for the quarter of sale are included in the regression but results are not shown here.

Table VI
Hazard Rate of Sale
Duration variable is the no. of weeks spent on the market

VARIABLES	(1) TOM in weeks
Gain	0.0238
	(0.0917)
Loss	-0.321
	(0.127)
Estimated Value	0.275
	(0.0174)
Residuals from first sale	0.254
	(0.0948)
Months since first sale	0.00670
	(0.000512)
Observations	6737

Standard errors are shown in parentheses. Dummies for the quarter of entry are included in the regression but results are not shown here.

Table VII

Cumulative Log-Level Hedonic Indexes - Regression coefficients, standard errors and t-statistics

	Hedonic Index with Average Loss Aversion			Hedonic Index based on Repeat Sales Data			Hedonic Index based on Single Transactions Data		
	4782 Repeat Sales Observations			4782 Repeat Sales Observations			45870 Single Sales Observations		
Quarters	Cum. Log Levels	Std. Errors	T-Statistic	Cum. Log Levels	Std. Errors	T-Statistic	Cum. Log Levels	Std. Errors	T-Statistic
1Q 2001	-0.111	0.050	-2.21	0.094	0.292	0.32	0.020	0.059	0.33
2Q 2001	-0.122	0.040	-3.02	0.240	0.287	0.84	0.065	0.059	1.10
3Q 2001	-0.100	0.041	-2.48	0.056	0.279	0.20	0.022	0.059	0.38
4Q 2001	-0.147	0.042	-3.48	0.180	0.275	0.66	0.080	0.058	1.37
1Q 2002	-0.145	0.048	-3.03	0.260	0.286	0.91	0.075	0.059	1.28
2Q 2002	-0.103	0.045	-2.30	0.324	0.281	1.15	0.042	0.058	0.72
3Q 2002	-0.103	0.040	-2.59	0.258	0.277	0.93	0.078	0.058	1.34
4Q 2002	-0.064	0.044	-1.47	0.236	0.278	0.85	0.083	0.058	1.44
1Q 2003	-0.090	0.041	-2.17	0.203	0.273	0.74	0.045	0.058	0.78
2Q 2003	-0.056	0.043	-1.32	0.295	0.278	1.06	0.075	0.058	1.29
3Q 2003	-0.004	0.044	-0.09	0.344	0.278	1.24	0.107	0.058	1.84
4Q 2003	0.008	0.037	0.21	0.358	0.271	1.32	0.127	0.057	2.23
1Q 2004	-0.013	0.041	-0.31	0.225	0.272	0.83	0.134	0.057	2.35
2Q 2004	0.046	0.038	1.21	0.379	0.272	1.40	0.153	0.057	2.69
3Q 2004	0.085	0.037	2.27	0.433	0.270	1.60	0.167	0.057	2.94
4Q 2004	0.067	0.037	1.83	0.429	0.270	1.59	0.215	0.057	3.79
1Q 2005	0.127	0.038	3.36	0.389	0.270	1.44	0.203	0.057	3.59
2Q 2005	0.162	0.039	4.13	0.503	0.270	1.86	0.285	0.057	5.03
3Q 2005	0.234	0.038	6.23	0.533	0.269	1.98	0.318	0.056	5.64
4Q 2005	0.238	0.037	6.51	0.636	0.270	2.36	0.342	0.056	6.07
1Q 2006	0.232	0.036	6.40	0.546	0.270	2.03	0.331	0.056	5.87
2Q 2006	0.232	0.036	6.47	0.541	0.270	2.00	0.318	0.056	5.63
3Q 2006	0.242	0.036	6.69	0.598	0.269	2.22	0.334	0.056	5.91

4Q 2006	0.259	0.036	7.23	0.604	0.269	2.24	0.368	0.056	6.52
1Q 2007	0.271	0.036	7.43	0.580	0.269	2.15	0.367	0.056	6.50
2Q 2007	0.269	0.035	7.70	0.564	0.270	2.09	0.377	0.056	6.68
3Q 2007	0.292	0.037	7.97	0.638	0.270	2.36	0.426	0.057	7.53
4Q 2007	0.268	0.036	7.42	0.558	0.270	2.07	0.399	0.057	7.03
1Q 2008	0.260	0.037	7.01	0.565	0.270	2.09	0.366	0.057	6.40
2Q 2008	0.220	0.036	6.09	0.511	0.270	1.89	0.396	0.057	6.91
3Q 2008	0.183	0.038	4.77	0.529	0.271	1.95	0.361	0.058	6.24
4Q 2008	0.128	0.039	3.29	0.507	0.271	1.87	0.301	0.058	5.16
1Q 2009	-0.014	0.047	-0.29	0.431	0.275	1.57	0.266	0.060	4.42
2Q 2009	0.043	0.041	1.04	0.489	0.274	1.78	0.226	0.060	3.78
3Q 2009	-0.100	0.047	-2.11	0.339	0.274	1.23	0.240	0.061	3.93
4Q 2009	-0.082	0.040	-2.05	0.372	0.272	1.37	0.216	0.059	3.65

Figure 3: Comparison of Hedonic Indexes with and without Behavioral Controls

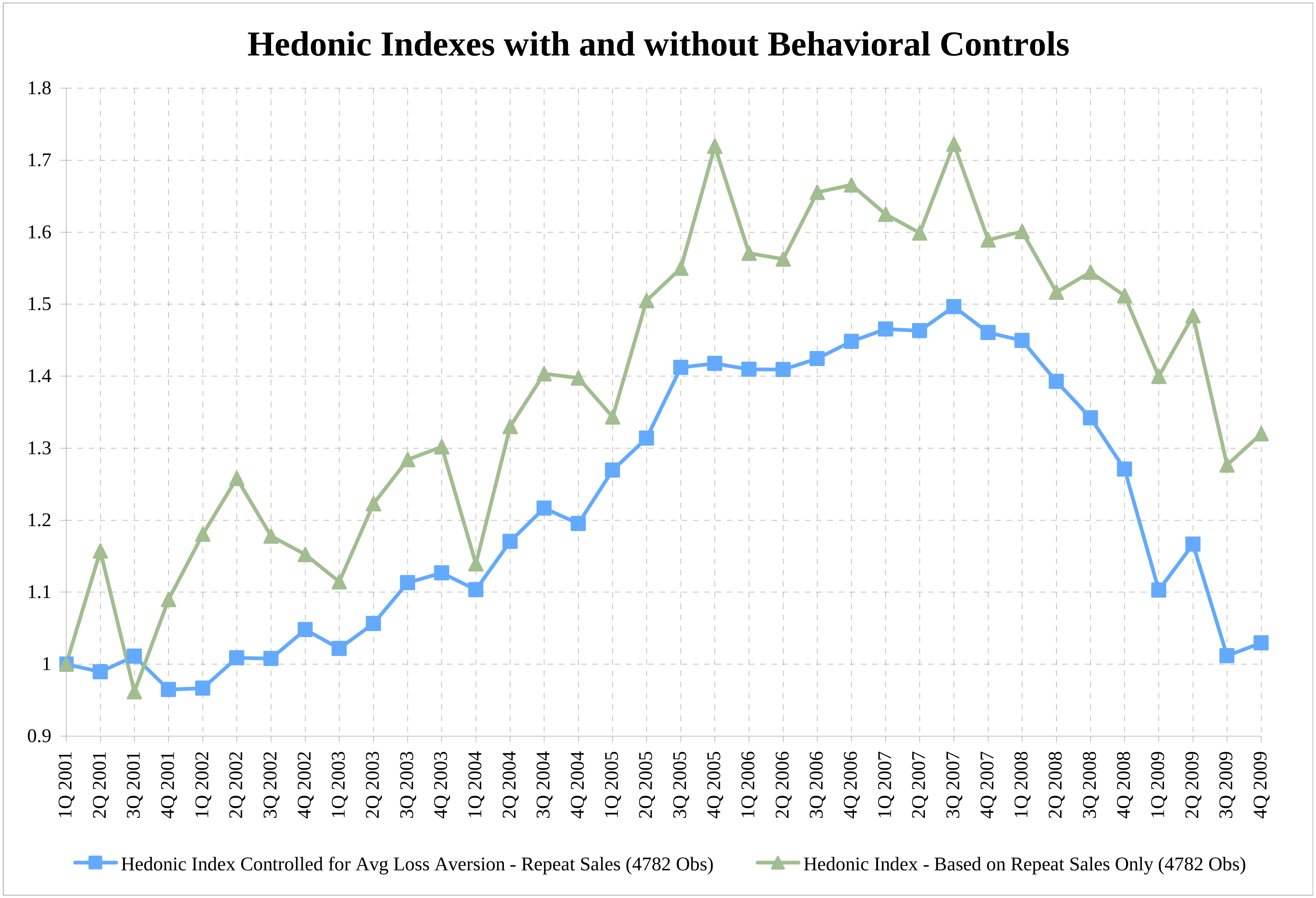

Figure 4: Hedonic Indexes: Behavioral Controls vs Larger Sample

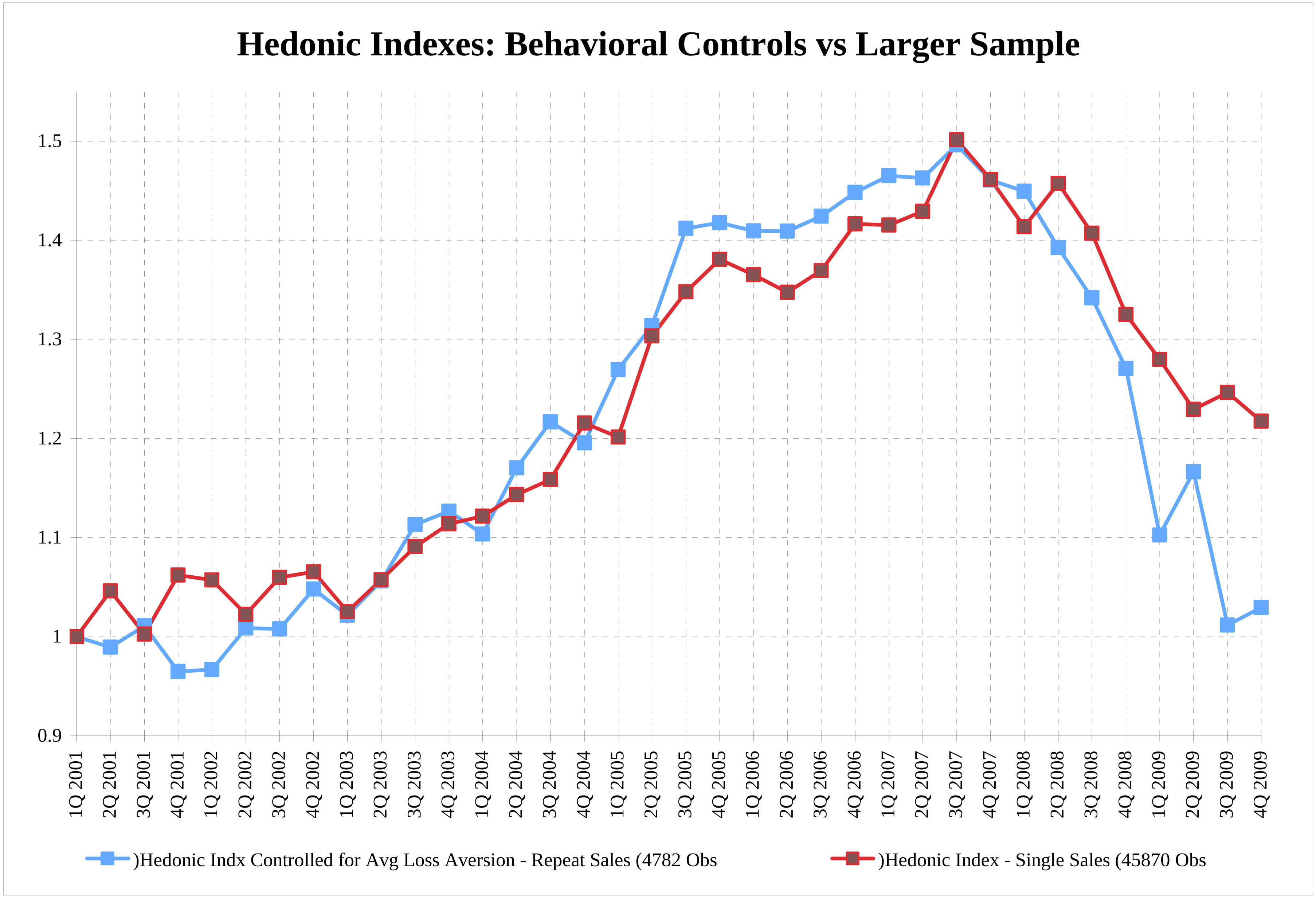

Figure 5: U.S. Commerical Property Prices:
Effects of Supply & Demand, and Behavioral Loss Aversion

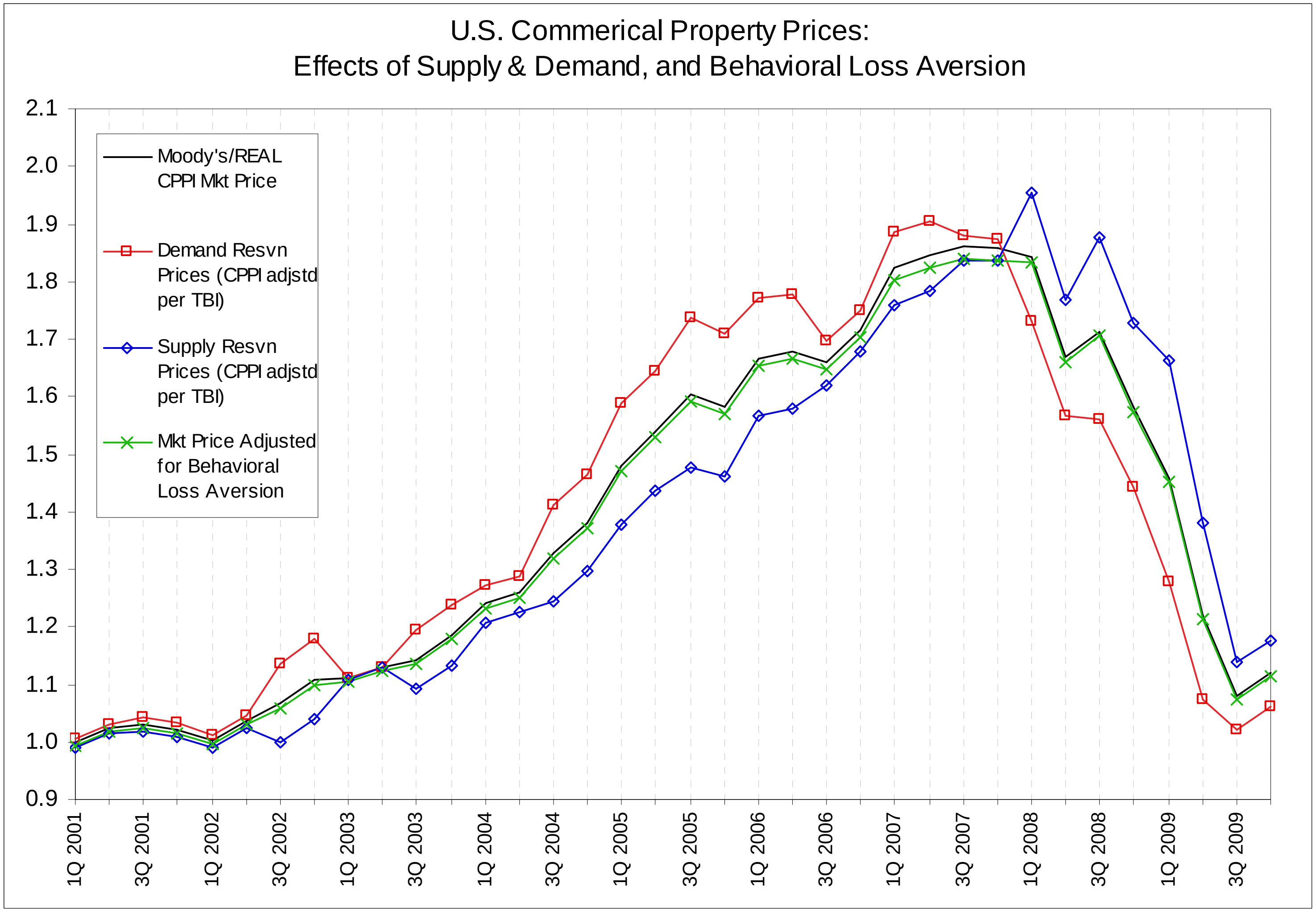

Figure 6: U.S. Commerical Property Prices:
Relative Magnitude of Loss/Gain Pricing Effect on Price Levels (3-regime model)