Loss Aversion through Centuries and across Generations

Piet Eichholtz
Maastricht University
Netherlands
p.eichholtz@
maastrichtuniversity.nl

Thies Lindenthal
Visiting Scholar
Massachusetts Institute of Technology
thilin@mit.edu

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Abstract

This paper is the first to provide empirical insights into the long-term nature of the loss aversion bias. Using a database of Amsterdam housing transactions spanning 324 years, the paper studies the question whether loss aversion was present in centuries past, whether its effects were stable across these centuries, and whether the psychological effect of the purchase price on selling behavior eroded with time and through the occurrence of important events.

The purchase price of the house is found to have been a psychological anchor, below which home owners were reluctant to sell their home. This result holds for 17th and 18th century Dutch home owners as well as for those who followed in their wake, but loss aversion appears to get stronger over the centuries. The anchoring power of the purchase price was strong: it survived the death of the original owner when the house passed on to the heirs. It was however diminished by loss realizations in housing transactions in the direct vicinity, and even more so by the occurrence of wars involving foreign occupation. The aversion to a loss relative to the purchase price was also gradually reduced by the time passed since the purchase.

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Eichholtz is corresponding author: Maastricht University, PO Box 616, 6200 MD, Maastricht, The Netherlands, p.eichholtz@maastrichtuniversity.nl, +31433883838. We are grateful for the research assistance of Sven van Hoof and Maarten Rijnburg.

Introduction

Loss aversion and anchoring are implications of prospect theory (Daniel Kahneman and Amos Tversky, 1979, and Amos Tversky and Daniel Kahneman, 1991), under which people examine losses and gains relative to a reference point, and maximize a value function that is steeper for losses than for gains.

The last three decades have produced strong evidence for the importance of loss aversion in economic behavior (see, for example, Michael Haigh and John A. List, 2005). However, some scholars argue that these biases are likely to vanish under competitive pressures as decision makers gain experience (John A. List, 2003), while Steven D. Levitt and John A. List (2008) note that much of the evidence for behavioral biases is based on laboratory experiments, and express doubts whether they apply to decision makers in real markets.

Outside of the laboratory, loss aversion has now been shown in the stock markets (Hersh Shefrin and Meir Statman, 1985, Terence Odean, 1998), in the art market (Alan Beggs and Kathryn Graddy, 2009), in sports (Devin Pope and Maurice Schweitzer, 2011), in the housing market (David Genesove and Christopher Mayer, 2001), and in the commercial real estate markets (Alan Crane and Jay C. Hartzell, 2008, Sheharyar Bokhari and David Geltner, 2011).

Most of this empirical evidence is based on short-term data. In order to investigate whether the critique concerning the pervasiveness of behavioral biases holds sway, the researcher needs to look at data spanning a longer time, during which decision makers have had a chance to build up experience, and market forces have done their work. The presence of evidence for behavioral biases in data spanning decades or even centuries would counter the notion that time eliminates behavioral biases.

We put the loss aversion bias to the test of time by analyzing 324 years of housing transactions on the *Herengracht*, a canal in Amsterdam. These transactions took place between 1650 and 1973. We investigate whether house owners on that canal were more reluctant to realize their losses than their gains, and whether that reluctance changed over the centuries.

The key issue when testing the empirical implications of prospect theory is the reference point. Odean (1998), Genesove and Mayer (2001), and Bokhari and Geltner (2011) all use the purchase price of the asset under consideration as the reference point, or anchor. Our study does so too, as

we explicitly investigate the anchoring power of the purchase price. Odean (1998) notes that the reference point may be different than the purchase price. On the housing market, other potential mental anchors could be the price estimate from an external property appraisal, or the value of a not-accepted offer to buy the house, or the more recent sales prices of houses nearby. Especially if a lot of time has gone by since the house was bought, the latter factors influencing the reference point are likely to become more important, possibly reducing the salience of the purchase price. One of the aims of our study is to see whether the purchase price was indeed a strong psychological anchor with which prospective sellers compared the sales price of their home, and to investigate whether its effect on behavior was affected by the passage of time and the incidence of major societal and personal events.

The results of this study show that loss aversion appears to be of all times. Although it did seem to get stronger during our sample period, it was already present in the 17th and 18th century. Between 1650 and 1799, homeowners on the Herengracht were 15 percent less likely to sell their home when it was valued at a loss than when it was valued at a gain. For the 20th century, that difference was 38 percent.

The purchase price appears to have been a powerful anchor. Indeed, even the passing away of the original owner and the transfer of the house to his heirs did not significantly diminish the aversion to sell the house at a loss relative to the original purchase price. However, the passage of time slowly reduced the psychological influence of the purchase price. The occurrence of wars also weakened the power of that reference point, but only when these wars involved occupation by a foreign power. Loss realizations on houses in the immediately surrounding area had a much stronger diminishing effect on the salience of the purchase price, suggesting the presence of a social side to loss aversion. Our results show that house sellers measure losses and gains in nominal, not real terms, confirming previous findings by Genesove and Mayer (2001). These results provide strong evidence for loss aversion and anchoring in real estate markets, involving large amounts of money.

The remainder of this paper starts with a data section. Sections II and III describe the estimation methods we use to establish the nature of loss aversion in historical housing transactions and provide the empirical results for each, Section IV provides a discussion regarding the interpretation of the main results, and Section V summarizes and concludes the paper.

I. The Data

The database used for this paper consists of housing transactions spanning the period between 1650 and 1973. It consists of all the transactions of houses on the *Herengracht*, one of the canals in Amsterdam. The source for these data is a book (Isabella van Eeghen, G. Roosegaarde Bisschop and H.F. Wijnman, 1976) that was commissioned on the occasion of Amsterdam's 750th anniversary as a city in 1975. The book contains a history of the construction and development of the *Herengracht*, as well as a history of each of the 615 buildings located on the canal. These individual histories contain the names and sometimes the occupation of the owners, as well as information on the transfer of ownership either through purchase or inheritance.

This database has been used previously by Piet Eichholtz (1998), who has used the transactions prices in it to estimate a biennial constant quality house price index, and by Brent Ambrose, Piet Eichholtz and Thies Lindenthal (2012), who have used it to estimate an annual index, and who have subsequently analyzed the price behavior of that index in relation to housing market fundamentals, i.e. housing rents and interest rates.

However, these two studies have only used the transactions for which prices are available. We look at all transfers of home ownership, either through inheritance or through purchase, and we also include the transactions for which we do not have a price. Table 1, Panel A, provides key information about the dataset of houses on the canal, and about the housing transactions that took place on it between 1650 and 1973. The table shows that all 614 individual houses have traded in our sample period. The vast majority of homes traded at least once in each of the three subperiods 1650-1799, 1800-1899, and 1900-1973. The level of detail of the transaction records increases throughout the centuries, as the share of sales without price information falls from 36 percent in 1650-1799, to 24 percent in the 19th century and 16 percent thereafter. In the first sub period, sales accounted for only 56 percent of all changes of ownership, leaving about 44 percent to bequests. The sales rates increased to 70 percent of all transactions in the 19th and 83 percent in the 20th century.

---- Table 1 ----

The owners of the dwellings on the *Herengracht* do not make up a representative sample of the Dutch population throughout the centuries. The *Herengracht* has been among the best addresses

in Amsterdam since it was dug, especially its middle section called de *Gouden Bocht* (Golden Curve), so the buildings on the canal were relatively expensive, and their occupants well off. The typical inhabitants of these houses were initially merchants, but that subsequently broadened to lawyers, doctors and other educated citizens (Van Eeghen, Roosegaarde Bisschop and Wijnman, 1976). These people were the professionals of their time, which suggests that the occupants of the *Herengracht* homes tended to be economically proficient, with a relatively strong understanding of concepts like risk and return.

We use a modified version of the repeat sales house price index that Ambrose, Eichholtz and Lindenthal (2012) created on the basis of the *Herengracht* data.[1] We reduce excess variation in annual returns by using Bokhari and Geltner's (2012) frequency conversion technique, which was developed specifically to construct indices from low-frequency data. Using exactly the same data as in Ambrose et al. (2012) we create 10 repeat sales indices, all at 10-year frequencies but each starting in a different base year. Subsequently, a generalized inverse estimator converts the 10 base indices to one index at 1-year-frequency. The resulting index features less noise. Its variance in annual returns is only 8 percent of the variance of the traditional repeat sales index' annual returns. The index is visualized in Figure 1, with 1900 as base year. The graph shows a rather stationary development of house prices until the mid-20th century, with long-lasting periods of growing and falling prices. The second half of the 20th century clearly stands out, with unprecedented growth in nominal house prices.

---- Figure 1 ----

Panel B of Table 1 provides statistical information about this index: the average annual index return and the percentage of years with a positive return. The average annual growth rates of the canal-wide house price index over the 324 years covered by the sample period was 0.91 percent, with most of the price increase concentrated in the 20th century. Annual price growth averaged 0.38 percent in the first 150 years, increasing to 0.53 percent in the 19th century and 2.60 percent in the 20th century. These growth rates are all in nominal terms. The percentage of years with a positive nominal return is 61.6, which is rather stable across sub-periods, varying between 60.1 percent and 62.9 percent.

[1] For detailed information regarding this index we refer to Ambrose, Eichholtz and Lindenthal (2012).

In order to do the analysis in real terms, we need an index for inflation. We use a long-run consumer price index, based on different sources. Nusteling (1985) is the source for the development of the general consumer price level until 1850. This index is based on a basket of consumer goods, including rye bread, beer, butter, meat, potatoes, peas, different types of fish, and various textiles. The basket changes with broad use of the products. For the period between 1850 and 1913 we employ Van Riel (2006), who uses a similar basket of goods, and adds housing rental expenses. From 1914 onwards, we use the CPI calculated by the Dutch Central Bureau of Statistics. The resulting long-term consumer price index was also used in Ambrose, Eichholtz and Lindenthal (2012), and we refer to that publication for statistical information regarding the inflation index.

Figure 1 and Table 1 provide more information about the index in real terms. The graph shows that most of the index appreciation in the second half of the 20th century was due to inflation. The real index stays much closer to its long term average. The last two columns of Panel B in Table 1 show that the mean annual return of the real index is 0.45 percent, and that average real house prices at the Herengracht went up in just over half of the years in the sample period (51.3 percent). In real terms, the 20th century turns out to be the worst sub-period, with an average annual return of -0.07 percent, and just 41.4 percent of years with a positive return.

II. Paper Gains, Losses, and House Sales

We first employ a method to measure loss aversion that is similar in spirit to the one employed by Terence Odean (1998), but we have adapted it for the specific characteristics of the housing markets and of our sample. Odean (1998) uses 10,000 trading records of private traders at a discount brokerage to investigate whether they are less likely to realize their losses than their gains, which would be a sign of loss aversion. Odean first calculates paper gains or losses for stock investments by comparing the current market price for a particular share to the price at which an investor has initially purchased it. He then tests whether these paper gains or losses influence the likelihood of a divestment.

With real estate data, however, we are missing two crucial pieces of information to calculate paper gains and losses. First, home owners cannot sell their investment at any time they wish but

have to find a counterparty who is willing to trade. That holds for stocks as well, but given the institutions of the stock market, finding a counterparty there is likely to be easier than in the housing market. We cannot track the bids home owners in our sample have evaluated as only transactions were recorded. We therefore assume that bids for a house arrive at a year-specific intensity λ_t, which is the same for all homes.

Second, no central market place provides price quotes for individual houses. Potential buyers make offers based on individual valuations unknown to us. We assume that their offers $O_{i,t}$ are distributed around a fair market value which is the last transaction price $A_{i,t}$ adjusted for the changes in the canal-wide price index. Obviously, buyers' offers can and do deviate from these prices.

Loss aversion among home owners exists if the probability P of a purchase offer being accepted by an owner is higher if the highest offered price $O_{max,i,t}$ for house i in year t exceeds the price anchor $A_{i,t}$: $P(sale_{t,i} \mid O_{max,i,t} > A_{i,t}) > P(sale_{t,i} \mid O_{max,i,t} < A_{i,t})$. $O_{max,i,t}$ depends on both λ_t and the distribution of the individual offers.

Empirically, we first calculate paper gains or losses for each house on the canal and each year from 1650 through 1973. If the canal-wide index has a positive (negative) cumulative return since the last sale of a certain house, then we note a paper gain (loss) for that house. Using an index implies that we estimate the paper gains and losses for each individual house with error, and this also holds for the proportions of gains and losses realized.

We can quantify this error for 2,393 transactions where we know the purchase and subsequent sales prices. For this subset, the median realized return is 2.5 percent higher than the estimated return while the difference in means is 14 percent higher. In 74.5 percent of the cases, the estimated indicator for paper losses or gains is pointing in the same direction of realized returns. For 14.5 percent, a paper loss is estimated while sellers were actually able to realize a gain. For 11 percent, a paper gain is estimated while sellers suffered a loss.

Overall, the noise in the estimate and the tendency to detect somewhat more paper losses than warranted by our sales data makes it less likely that the difference between the two proportions are statistically significant, making it more difficult to detect loss aversion, even if it is present.

Table 2 shows the average of the annual proportion of gains realized, and of the annual proportion of losses realized. It also provides the difference between the two, and the t-statistic of that difference. The first row of the table gives these numbers for the complete sample period from 1650 until 1973, followed by the three sub periods.

---- Table 2 ----

The table shows a positive and statistically significant difference between the proportion of gains realized (3.8 percent) and the proportion of losses realized (3.0 percent), suggesting that home owners are indeed loss averse. Economically, the difference is substantial: The sales rate for houses estimated to have accumulated paper gains is 26 percent higher than the sales rate for houses at paper losses. This loss aversion is statistically very significant as well, as indicated by a t-value of 8.64.

Interestingly, we find evidence of loss aversion for each of the three sub-periods, so loss aversion is not a phenomenon that only appeared in modern economies. It affected human decision making in recent times, but also in that of our ancestors in the 17th,18th, and 19th century. However, we do find evidence that the loss aversion bias got stronger over time, since the difference in the annual sales rate widened as time progressed. In the first 150 years of the sample, the average sales rate for houses valued at a paper gain was almost 15 percent higher than for houses valued at a loss, while that difference had grown to 38 percent in the 20th century.

III. Logit Regressions

The adjusted Odean (1998) approach provides a first look at the loss aversion bias, and it allows the researcher to study the bias in time. But to study the salience of the reference point in-depth, we estimate a logistic panel model equation with fixed time effects[2]:

$$(1)\ P_{i,t} = \beta_1 ln(\text{Years since last transaction}) + \beta_2 D_{\text{Paper Loss}} + \beta_3 ln(\text{Years since last sale}) + \beta_4 ln(\text{Years since last sale}) \cdot D_{\text{Paper Loss}} + \varepsilon_{i,t}.$$

[2] Cox Proportional Hazard Rate models do not offer any advantages over plain logit regressions in this case, as both the base hazard rate of sales and the covariate are time-variant. See Ralph B. D'Agostino et al. (1990).

In this equation, the β's represent regression coefficients, while the error term is denoted by $\varepsilon_{i,t}$. In the base setup of this model, the chance P of a sale of house i in year t is explained by a linear combination of the following variables:

- The natural logarithm of the years since the last transaction, which could be either a sale, a bequest or a division of property.
- A dummy variable $D_{Paper\ Loss}$ which is set to 1 in case a house i is valued at an estimated paper loss in year t, and 0 otherwise.
- The natural logarithm of the years since the last sale, which captures the 'age' of any existing price anchor. The interaction term with $D_{Paper\ Loss}$ studies the effect of the passing of time on the psychological anchoring power of the purchase price.

In subsequent estimations of (1) we also explicitly estimate the effect of inflation and the occurrence of important events on the anchoring power of the purchase price, distinguishing between events of a personal nature and events that affected society as a whole. First, we look at the question whether inflation erodes the salience of the purchase price. Then, we investigate the effect on loss-taking in houses nearby and the passing away of the original owner. Last, we look at broader events like the occurrence of a financial crisis, the outbreak of a war, and the occupation by a foreign power. These events could possibly weaken the emotional relevance of the purchase price, which may reduce its anchoring power. We investigate this by including additional variables in (1) as follows:

- The natural logarithm of the change in CPI since the last sale. Interacting this variable with $D_{Paper\ Loss}$ estimates whether the power of anchor prices decreases when overall price levels change.
- The variable *Realized losses nearby* is a variable indicating whether relatively many houses close by are estimated to have sold at a paper loss in the year before. We consider houses to be 'close' if they are located on the same canal bank, subdivided into segments by crossing bridges. *Realized losses nearby* is defined as the number of sales at estimated paper losses divided by the total number of sales for this canal segment in the preceding year.

- The dummy variable $D_{Inheritance\ since\ purchase}$ is set to 1 for all years after a house has been passed on to the next generation in a bequest. It is reset to 0 after a subsequent sale.
- In a similar fashion, we define $D_{Financial\ crisis}$, $D_{War\ since\ purchase}$ and $D_{Occupation\ since\ purchase}$ as 1 for the years after the outbreak of a war or during the occupation of the city by foreign troops, respectively. Again, these variables are reset to 0 after a subsequent sale. Interacting these variables with $D_{Paper\ loss}$ gives insights whether the psychological power of anchors is affected by strong city-wide shocks.

We do not aspire to explicitly model differences in housing market liquidity caused by a changing political and economic climate, interest rate movements or any other general factors. Instead, year-to-year differences in the overall liquidity of the real estate market are controlled for by annual fixed time effects. The coefficients for the covariates therefore estimate in how far differences in these variables lead to deviations from the overall likelihood of a sale in a given year.

The comparison of homes within the same year but with either paper gains or losses requires that we observe variation in $D_{Paper\ Loss}$, which is not the case for years where the index reaches a new local maximum (minimum) because all $D_{Paper\ Loss}$ are then set to 0 (1). We therefore exclude years in which more than 90 percent or less than 10 percent of observations are flagged having accumulated paper losses. Without these extreme peak or trough years, 186 years remain in the sample.

Table 3 provides information regarding the key regression variables: the dummy for paper losses and the variables we use to investigate the salience of the purchase price as the reference point. These include the years since the purchase, the dummy for realized losses in the direct proximity of the dwelling, the dummy for an inherited house, and dummies for societal shocks since the purchase of the house. The table shows that the average holding period for houses at the *Herengracht* was 18.5 years, and that wars and foreign occupations were relevant to many home owners over time, with dummy variables of 0.35 and 0.14, respectively.

---- Table 3 ----

Table 4 gives the estimation results of the model. The first column of the table presents the results for the base model. The estimated regression coefficients confirm the earlier findings in

Table 2, and again show that loss aversion is present and pervasive in housing transactions. The likelihood of sale is negatively associated with the house being estimated to be at a paper loss. Keeping all other factors equal, the chance of observing a sale is 1.1 percent ($1-e^{-0.012}$) lower for houses flagged as being at paper losses. This evidence for loss aversion is not only economically but also statistically significant with a p-value below 0.01[3].

The longer a house has not been transacted, the lower the odds of observing a transaction in a particular year, as indicated by a negative -0.003 coefficient for *ln(Years since last transaction)*. This result is in line with Genesove and Mayer (2001), who find a negative relation between the time since last sale and the hazard rate of a sale.

The regression coefficient for *ln(Years since last sale)* is statistically insignificant while the interaction term *ln(Years since last sale)* $\cdot D_{Paper\ loss}$ is positive and significant. This positive estimate indicating that the passage of time indeed reduces the psychological power of the purchase price. However, the small magnitude of 0.004 suggest that anchors fade slowly.

---- Table 4 ----

The next step in the analysis is to include additional explanatory variables in the model, with the aim to see how the aversion to selling at a loss relative to the purchase price is affected by important events. First, we study the effects of inflation. Calculating paper losses and gains in real terms instead of nominal terms leads to insignificant coefficients for $D_{Paper\ loss}$ and *Share losses in proximity.* Still, we test whether the power of anchors depends on changes in consumer prices indirectly. A rapid change in prices observed by home owners could erode the perceived relevance of old price points as historical price levels lose comparability. Our estimates tell a different story, however. When overall consumer prices move up (*CPI change since sale*), the influence of pricing anchors is reinforced. Households are less willing to accept a loss for their home if prices for other goods have increased.

Misery appears to love company. Losses previously realized by neighbors reduce a home owner's reluctance to accept a loss himself. The coefficients for *Realized losses nearby* do not show any significant effect for houses at paper gains but have a positive coefficient (0.007) when interacted

[3] Many of the houses in our sample were owned by women, and female home ownership was common in the Netherlands as early as in the late medieval period. We investigated whether women and men differed in their reluctance to loss realization. They did not.

with $D_{Paper\ loss}$. This suggests the presence of a social dimension to loss aversion: It is easier to justify a loss to oneself and others if one can refer to others who have experienced similar adversities. As far as we can tell, this is the first evidence of the social aspect of loss aversion.

These findings hold up under alternative definitions for *Share losses in proximity*. It does not matter whether "proximity" between house is conditional on houses being located in the same bridge segment or whether more generic n-nearest-neighbor distances are used. In robustness tests we measure the share of realized losses within ranges of 10 and 20 houses to the left and right of each house and find coefficients of comparable magnitude and direction.

Our data enables us to investigate whether the salience of the purchase passed on to the next generation after a bequest. It turns out that heirs were suffering as much from loss aversion as their predecessors: the coefficients for $D_{Inheritance\ since\ sale}$ interacted with $D_{Paper\ loss}$ are not significant at any level of confidence, and since bequests were common, covering about one third of all ownership transfers, this lack of significance is not likely to be caused by a lack of observations. So a bequest does not break the link between the prices paid by the parents' generation and the children's reluctance to accept a price below anchors they have not negotiated in the first place.

We now turn to the influence of societal turmoil. For example, the Second World War, with its five years of foreign occupation and hardship, may well have reduced the psychological importance of events preceding it. Indeed, the purchase price of a house may have seemed trivial compared to the traumatic experiences of the war.

It turns out that some societal shocks did annihilate price anchors. Economic shocks like the stock market crashes of 1763 or 1773 or other catastrophes like famines or plagues did not 'reset' price anchors. Shocks like the outbreak of wars that did not lead to occupations did not 'reset' price anchors either. That makes sense, since many of these wars were fought elsewhere, both on land and at sea. So for the average home-owner, they were unlikely to affect daily life very significantly. That was different for the wars that involved foreign occupation. These events could be perceived as the beginnings of a new era. For the Herengracht canal, the most severe shocks were the three foreign invasions of the city in 1795, 1810, and 1940. In the aftermaths of these devastating experiences, prices from the 'old era' (before the occupation) did not seem

matter in the new epoch (after the occupation): The coefficient for $D_{Occupation\ since\ purchase}$ interacted with $D_{Paper\ loss}$ is big enough to offset the estimated effect of loss aversion and is statistically significant.

IV. Discussion

Capuchin monkeys, with whom humans shared common ancestors as much as 40 million years ago, display loss aversion behavior (Keith Chen, Venkat Lakshminarayanan, and Laurie Santos, 2011). This suggests that loss aversion is a hardwired trait of human behavior. That finding makes it perhaps not very surprising that our ancestors in the 17th century were affected by the loss aversion bias.

On the other hand, Joseph Henrich's (2000) seminal work shows that the degree to which human beings diverge from the model version of homo economicus is culture-dependent, and it is likely that Dutch culture has changed during the last three centuries. Perhaps the fact that we find increasing loss aversion is a sign of cultural change, but if that is the case, the presence of loss aversion in all three sub-periods suggests that this change was limited.

The question is how our results should be interpreted: Is the loss aversion we find a sign of irrational behavior, or could it be explained by rational motivations? Genesove and Mayer (2001) find that the home mortgage's loan-to-value ratio significantly increases the reluctance to sell at a loss, so credit considerations play a role in selling behavior. It is likely that they play a role in our data as well, but we do not have comprehensive statistical information regarding housing finance in Amsterdam. But even if we cannot do any formal tests, we do have relevant information about housing finance in Dutch history.

There was already a functioning mortgage market in the Netherlands in the late medieval period, despite the absence of a banking system. Jan Luiten van Zanden, Jaco Zuijderduijn and Tine de Moor (2012) provide a detailed analysis of the local credit market in Edam, a medium sized city just north of Amsterdam. They show that property rights were well protected, and that real properties were commonly used as collateral as early as in the 15th century, with interest rates around 6 percent. The loans, named *kustingen*, were made between households, and credit was

available to rich and poor households alike, no matter whether the household was led by a woman or a man. There was also a lively secondary market in loans. The typical loans had a maturity of 2 to 12 years, and were gradually amortized over that period. A Dutch mathematics handbook by Jacob van der Schuere (1643) shows that *kustingen* were amortized in equal annual portions over their life time.

So we cannot explain the increase in loss aversion over the centuries by the development of the mortgage market: that market already existed before our sample period. Moreover, the characteristics of the typical loans suggest that the salience of the loan to value ratio is limited: the life of the typical loan was quite a bit shorter than the average holding period for the houses on the Herengracht, which was 18.5 years.

V. Concluding Remarks

This paper provides the first long-run historic evidence of loss aversion in a key asset market. By employing a database of housing transactions spanning the period between 1650 and 1973, this paper shows that loss aversion appears to have been important throughout the ages: 20th century home owners on Amsterdam's *Herengracht* were reluctant to sell their houses at a loss relative to the purchase price, just as their forebears in the 19th, 18th, and 17th century had been.

The force of the purchase price as a mental anchor seemed to remain strong even after the house had been in possession of the same person for a long time: the years that passed since the purchase of the house only slowly affected the likelihood of a sale. In fact, the psychological value of the purchase price was so big that it transcended the death of the first owner, and was passed on to his heirs: we see the same association between price since last sale and the likelihood of a sale even if we control for the fact that the house has been inherited.

An important finding of this paper is that the reluctance to sell at a loss seems to be diminished by loss-taking in houses nearby. This could be interpreted as a social dimension of loss aversion: to come to peace with ones losses, it probably helps if the neighbors have gone through the same painful experience before.

The psychological power of the purchase price is confirmed by our subsequent analysis, in which we include important societal events in the regression: crises, epidemics, and wars. But for one exception, these events did not noticeably affect the relation between price since last sale and the likelihood of a sale. The exceptions were wars that involved the occupation by a foreign power. These seem to have put an end to the spell of the purchase price, and caused a clean mental slate.

These results provide compelling evidence for the existence of loss aversion. Even long-run economic forces do not seem to nullify its effect on human behavior. The purchase price of a house has been a very important determinant of the decision to sell it or keep it throughout the centuries. Only enemy occupation could change that.

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Figure 1: House Price Index for *Herengracht*, 1650-1976

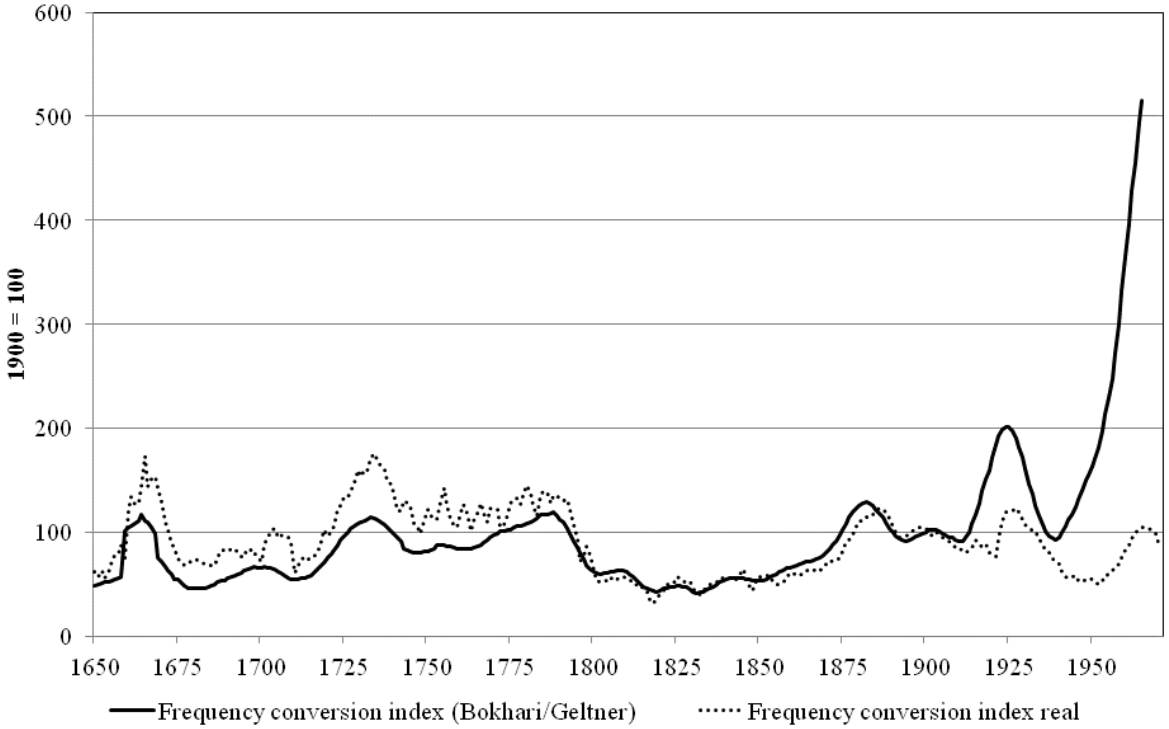

Table 1: Descriptive Statistics for Sample and Index

A: Sales Sample				
Period	*# houses with transactions*	*# sales total*	*# sales with price*	*# bequests*
1650-1973	614	6644	4919	3273
1650-1799	606	2437	1565	1912
1800-1899	608	2175	1651	950
1900-1973	593	2032	1703	411

B: House Price Index				
	Mean annual return (nominal)	*% years with positive nominal return*	*Mean annual return (real)*	*% years with positive real return*
1650-1973	0.91%	61.60%	0.45%	51.25%
1650-1799	0.38%	60.10%	0.52%	49.33%
1800-1899	0.53%	62.00%	0.72%	61.00%
1900-1973	2.60%	62.90%	-0.07%	41.43%

Table 2: Annual Sales Rates for Houses with Unrealized Paper Gains and Losses

Period	Annual sales rate for houses valued at …		Difference	t-value
	paper losses	paper gains		Difference
1650-1973	3.01%	3.80%	0.79%	8.64
1650-1799	2.19%	2.51%	0.32%	2.30
1800-1899	3.23%	4.09%	0.87%	6.24
1900-1973	3.92%	5.42%	1.49%	6.17

Notes: We flag a house as having accumulated "paper gains" ("paper losses") whenever the overall house price index experienced positive (negative) cumulative returns since the house's last sale.

Annual sales rates for each sub-period are calculated by dividing the number of sales at paper gains (or losses) for the given time period by the number of years each house was marked at paper gains (or losses). The third column presents the difference of columns1 and 2. Overall, the sales rate is about a quarter higher for houses that have accumulated paper gains. The difference is positive throughout the centuries and is statistically significant, as indicated by high t-values.

Table 3: Means for Explanatory Variables

Variable	*Mean value*
$D_{\text{Paper loss}}$	0.52
Years since purchase	18.47
Realized losses nearby	0.24
$D_{\text{Inheritance since purchase}}$	0.29
$D_{\text{War since purchase}}$	0.35
$D_{\text{Occupation since purchase}}$	0.14

Notes: $D_{\text{Paper loss}}$ is defined as 1 for house *i* in a given year *t* if the cumulative return of the overall price index since the last sale of house *i* is negative – and 0 otherwise.

We segment houses along the canal by subdividing each bank into "natural blocks", each separated by crossing bridges. $D_{\text{realized losses in proximity}}$ is defined as 1 for house *i* in year *t* if more than average realizations of paper losses took place in the block of house *i* in year *t-1*.

$D_{\text{Inheritance since purchase}}$ is set to 1 for all years *t* after house *i* has been inherited. Whenever a sale takes place, the variable is set back to 0 for subsequent years. In a similar fashion, $D_{\text{War since purchase}}$ is set to 1 whenever the city has been occupied by foreign troops. Again, the variable is reset to 0 for all houses that have traded since that disruptive event. $D_{\text{Occupation since purchase}}$ is constructed accordingly.

Table 4: Estimates from Logistic Panel Regressions

var	*Pooled Regression*	*Base Model*	*General Price Effect*	*Neighbor Effect*	*Individual Shock: Inheritance*	*Societal Shock: War*	*Societal Shock: Occupation*
Intercept	0.033 ***	-	-	-	-	-	-
	[0.003]						
log(Years since	0.000	-0.003 **	-0.003 **	-0.003 **	-0.002 *	-0.002 *	-0.002 *
purchase)	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
$D_{\text{Paper loss}}$	-0.012 ***	-0.010 **	-0.010 **	-0.012 ***	-0.012 ***	-0.012 ***	-0.010 **
	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]	[0.004]
log(Years since	-0.001	0.002	0.002	0.002	0.002	0.003 *	0.003 *
purchase)	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.002]
log(Years since	0.004 ***	0.004 **	0.004 **	0.004 **	0.004 **	0.004 **	0.003 *
purchase) · $D_{\text{Paper loss}}$	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
log(CPI change			0.003	0.003	0.003	0.008	0.014 **
since sale)			[0.006]	[0.006]	[0.006]	[0.006]	[0.007]
log(CPI change			-0.015 **	-0.014 **	-0.014 **	-0.016 **	-0.024 ***
since sale) · $D_{\text{Paper loss}}$			[0.007]	[0.007]	[0.007]	[0.007]	[0.008]
Realized losses				-0.002	-0.002	-0.002	-0.002
nearby				[0.003]	[0.003]	[0.003]	[0.003]
Realized losses				0.007 **	0.007 **	0.007 **	0.007 **
nearby ·$D_{\text{Paper loss}}$				[0.003]	[0.003]	[0.003]	[0.003]
$D_{\text{Inheritance since purchase}}$					0.000	0.001	0.000
					[0.002]	[0.002]	[0.002]
$D_{\text{Inheritance since purchase}}$					0.002	0.001	0.002
·$D_{\text{Paper loss}}$					[0.003]	[0.003]	[0.003]
$D_{\text{War since purchase}}$						-0.007 **	-0.002
						[0.003]	[0.004]
$D_{\text{War since purchase}}$						0.003	0 .000
·$D_{\text{Paper loss}}$						[0.003]	[0.004]
$D_{\text{Occupation since purchase}}$							-0.023 ***
							[0.006]
$D_{\text{Occupation since purchase}}$							0.018 ***
·$D_{\text{Paper loss}}$							[0.006]
Fixed year effects	NO	YES	YES	YES	YES	YES	YES

Notes: Standard errors in parentheses. The stars ***, ** , * indicate significance at 1%, 5% and 10% confidence levels.