The Paradox of the Joneses: Superstar Houses and Mortgage Frenzy in Suburban America *

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Abstract

Despite a major upscaling of single-family houses since 1980, house satisfaction has remained steady in American suburbs. At any point in time, however, house satisfaction increases with size. I show this paradox can be explained by upward-looking comparisons in the size of houses. Combining data from the American Housing Survey from 1984 to 2009 with an original dataset of three millions suburban houses built between 1920 and 2009, I find that an increase in size at the top of the distribution after a household moved in offsets the house satisfaction gains from an equivalent rise in own housing size. The relative size externality is stronger for bigger houses and decreases with the geographical distance to newly built superstar houses. Furthermore, homeowners who experienced a relative downscaling of their house are more likely to upscale and subscribe to new loans. I estimate the relative size effect can explain up to 10% of the rise in mortgage debt to income ratio since 1980. Overall, this paper sheds new light on the consequences of inequality and positional externalities on housing market dynamics.

Keywords: subjective well-being, housing, inequality, social preferences, household debt

JEL Classification: D01, D03, I30, R20

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"A house may be large or small; as long as the neighboring houses are likewise small, it satisfies all social requirement for a residence. But let there arise next to the little house a palace, and the little house shrinks to a hut."
— Karl Marx, *Wage, Labor and Capital*, 1847

1 Introduction

In his analysis of economic growth and competition, Hirsch (1976) argued consumption choices are ultimately positional. They are driven by how individuals compare to others in their consumption of material goods. If needs are relative, income and wealth inequalities may generate dissatisfaction for those individuals who cannot keep up with the status of higher ranked groups (Frank, 2013). This article provides the first empirical estimation of housing size comparisons in American suburbs, and their consequences on housing market dynamics. Exploiting homeowners' experienced increase in the size of newly built houses during their tenure period, it shows that a fall in the relative size of a house lowers its valuation, and estimate the contribution of positional externalities to the mortgage debt expansion over the period that preceded the Great Recession.

From 1940 onward, suburbs accounted for more population growth than central cities and, by 2000, half of the entire U.S. population lived in the suburbs of metropolitan areas. The period simultaneously saw an impressive upscaling in size of suburban single-family houses. From an original dataset of 3.2 millions houses built between 1920 and 2009, I document that the median newly built suburban house doubled in size since 1945, while the ten percent biggest houses built experienced an upscaling of nearly 120%. Typically, the latter used to average 4000 square feet in the years preceding the Great Depression and fell to 3000 square feet in 1945. They did not recover their 1930s level until the 1980s, with "superstar houses" reaching 7000 square feet on average at the eve of the 2008 financial crisis. Since the number of people per household decreased from 3.3 in 1960 to an average of 2.6 in 2007, the amount of private space per person considered to be socially desirable has been increasing at an even higher rate. Meanwhile, the mortgage debt to income ratio in the US went from 20% of total household income in 1945 to 90% in 2008, following a trend that closely matched this historical variation in housing size.

The Easterlin paradox posits that increasing the income of all does not increase the happiness of all (Easterlin, 1974, 1995, 2001; Easterlin et al., 2010)[1]. I provide evidence of a "Paradox of the Joneses", which echoes the Easterlin Paradox in the realm of visible wealth. Namely, since 1980 and despite the large upscaling in size of American homes, the average house satisfaction of new movers has remained steady. However, within a given year, movers choosing a bigger house

[1]It has been reconsidered by Stevenson and Wolfers (2008, 2013) who show that some of the previous results were statistical artifacts. However, the critique largely comes from a misunderstanding regarding the definition of the Paradox, which results from the contradiction between a positive correlation in cross-sectional data and an absence of positive longitudinal correlation in the long-run.

systematically report higher house satisfaction[2]. A first explanation for the Easterlin paradox is the presence of hedonic adaptation in the utility function (Loewenstein and Ubel, 2008). However, adaptation cannot explain the absence of a positive long-run trend for new movers. A second explanation for the paradox is the importance of income comparisons (Clark et al., 2008). The latter depends on the capacity of individuals to observe others' income, either through a direct revelation of information, or through its indirect impact on visible choices (Card et al., 2012; Winkelmann, 2012). Since housing ranks among the most visible items in both lab experiments or survey analysis, comparisons are likely to be at play (Alpizar et al., 2005; Solnick and Hemenway, 2005; Heffetz, 2011)[3].

To identify the presence of comparison in size, I exploit cross-sectional differences in the size of new houses built experienced by homeowners over their tenure period[4]. Suppose two similar households who lived in the same suburb and are both surveyed in 1995. Very big houses were built between 1980 and 1990 but there has been no change in top housing size since then. The only difference between household A and household B is that A moved in 1980 while B moved in 1990. When B moved, the very big houses were already in place. Unless both households perfectly internalized future variations in housing size when buying a house, household A, who experienced a strong increase in top housing size should be less satisfied than household B who experienced no change at all. I hence match homeowners from a representative American survey to their personal experience in the construction of new houses built in their suburb since they moved in. This methodology answers Manski (1993)'s classical reflexion problem as it focuses on variations in neighborhood characteristics after the moving choice has been made. It also allows me to introduce county-year fixed effects to account for any suburb characteristics at the time households are being surveyed, from congestion costs to better amenities or land prices, and tenure length fixed effects to control for hedonic adaptation.

The analysis reveals two main results. First, I find evidence of upward comparison effects in housing size. An increase in the size of newly built houses at the top of the distribution offsets the satisfaction gains from a similar increase in own housing size. Top housing size is defined as houses belonging to the top decile of the size distribution. I find smaller or no significant impact for lower deciles. The relative size effect is stronger for households living in bigger houses, and decreases with the distance to top decile houses within suburbs. These results support the trickle-down consumption (or expenditure cascade) hypothesis discussed by Frank et al. (2010) and evidenced by Bertrand and Morse (2013) for aggregate consumption. I complement the analysis with a hedonic

[2]This is robust over the income and size distributions and, for the whole sample of old and new movers, to the inclusion of household, house and neighborhood controls.

[3]The measure of visibility used by Heffetz (2011) corresponds to socio-cultural visibility, not physical visibility as his survey asks how quickly one would notice another person's expenditures across commodities. Heffetz (2012) argues "an expenditure is considered culturally visible as long as it is the case that in the socio-cultural context in which it is made, society has direct means to correctly assess the amount spent."

[4]This methodology is similar to Malmendier and Nagel (2011, 2016).

regression and run individual and house fixed effect estimator on a panel subsample of my dataset. The hedonic and panel fixed effects results are consistent with the main specification. Second, I find that relatively deprived households "keep up with the Joneses". They react to the relative downscaling of their house by increasing its size, and subscribe to new mortgage loans. Controlling for household and house fixed effects, I find that a 1% rise in top housing size during the length of tenure is associated to a 0.6% rise in own housing size though home improvements, and to a 0.26% increase in mortgage debt. The relative size effect can explain up to 10% of the rise in the mortgage debt to income ratio since 1980.

A legitimate concern is that the relative size effect captures more general externalities associated with the construction of big houses, which lower neighborhood and house satisfaction. First, an increase in top housing size could be associated to higher population density and congestion costs within counties. This should be accounted for by the suburb-year fixed effects, but I address this concern directly by including the households' experienced increase in population density as an additional control. I also replicate the analysis with subjective neighborhood satisfaction as the dependent variable. Neighborhood satisfaction is positively and not significantly associated with experienced increase in top housing size. Second, the construction of big houses could block the view or be considered unaesthetic. Though I cannot directly exclude this possibility, there is no reason to expect such negative aesthetic externalities to vary positively with own housing size.

The article first contributes to the literature on the relative income hypothesis. Housing satisfaction being a significant component of general life satisfaction (Van Praag et al., 2003), positional externalities in housing markets may explain previous findings on the negative impact of neighbor's income on life satisfaction (Luttmer, 2004; Dynan and Ravina, 2007; Brodeur and Flèche, 2012), or top income shares (Burkhauser et al., 2016). The impact of relative deprivation on conspicuous consumption has been studied by Frank and Sunstein (2001), Charles et al. (2009) or Ordabayeva and Chandon (2010). Regarding the link between top income and household debt, the existing evidence is mixed. Bertrand and Morse (2013) provide evidence of trickle-down consumption and show it relates to financial distress. Christen and Morgan (2005) provides evidence that the income inequality effect on consumer borrowing is a result of conspicuous consumption. Carr and Jayadev (2014) find positive effects between debt and inequality at the state level using PSID data while Coibion et al. (2014) find a negative impact at the county level, using different datasets. Using lottery winners as a natural experiment, Agarwal et al. (2016) also find a positive effect of relative income on financial distress. However, neither these studies look at the housing market specifically, nor do they relate choices to happiness measures, despite evidence that subjective wellbeing measures are good predictors of individual choices and that individuals discontinue activities which reduce well-being (Benjamin et al., 2012, 2014; Kahneman et al., 1993). The literature on housing and subjective wellbeing shows a low effect of prices on life satisfaction Ratcliffe et al. (2010) and adaptation to home ownership. The relative size effect identified in the paper provides an explanation for the fact that home buyers systematically over-estimate the impact of home ownership on their future life satisfaction (Odermatt and Stutzer, 2017). The paper also relates to the urban economics literature on neighborhood effects and housing externalities. Using a different methodology, Ioannides and Zabel (2003) provide evidence of social interaction effects on home improvements. However, this literature tends to emphasize the contribution of positive neighborhood externalities (Glaeser and Shapiro, 2002; Ioannides and Zabel, 2003; Guerrieri et al., 2013), while I provide evidence of a possible trade-off between positive and negative housing externalities through the relative size effect.

The rest of the paper proceeds as follows. Section 2 presents the two main datasets along with important stylized facts. Section 3 presents the methodology and results on house satisfaction and prices, and discusses their behavioral impact on individual choices. Section 4 presents a series of robustness checks. Section 5 concludes.

2 Data and Stylized Facts

2.1 Presentation of the databases

The main dataset used for the empirical analysis is the American Housing Survey (AHS), one of the most comprehensive longitudinal survey about the characteristics and conditions of the American housing stock. Besides providing extensive information on house and neighborhood quality, house prices as well as home mortgages, the longitudinal nature of the AHS also permits the analysis of changes in housing and occupancy characteristics for the same housing unit. An important feature is the presence of a subjective house satisfaction index, related to the following questions:

- *Resident's satisfaction with the house as a residence. 10 is best on a scale of 1 to 10, 1 is worst.* (1984-1995 surveys)
- *Rating of the unit as a place to live. 10 is best on a scale of 1 to 10, 1 is worst.* (1996-2009 surveys)

Both refer to an evaluative (or cognitive) measure of satisfaction, as opposed to hedonic (or affective) measures that do not require the cognitive effort necessary to answer evaluative questions (Diener et al., 1999; Deaton and Stone, 2013). In 1997, the phrasing of the question changed, though it continued to ask respondents for a subjective valuation of their house within a one to ten scale. There is no sign of discontinuity before and after 1995 as for the way respondents answered the question, but the inclusion of survey-year fixed effects should account for any phrasing bias. Suburban households are generally satisfied with their house, as the average house satisfaction index in the sample takes a value of 8.2 out of 10. The house satisfaction index takes a value of 5 or below in 7% of cases only. For values above 5, the distribution is the following: 5% of households say 6, 11% say 7, 26% say 8, 16% say 9 and 35% say 10. Another advantage of this dataset is that a similar question is asked regarding the subjective valuation of one's neighborhood. This is important as it allows me to control for any change in the neighborhood environment of the household that would be correlated to house satisfaction.

I combine 18 waves of the metropolitan samples of the AHS from 1984 to 2009. These surveys are conducted annually, but with a different set of metropolitan areas (MSA) each year. Each MSA comprises an average of five counties. On average, the 154 counties are surveyed three times with a gap of four years between each survey. I also merge 15 waves of the national samples for the period 1985-2013 to construct nationally representative figures on the evolution of size and house satisfaction of American movers. The national surveys are biannual and continuous data on square footage of houses are only available starting 1984 for the Metropolitan samples and 1985 for the National samples. I further restrict the analysis to the suburban area of the counties surveyed, hereafter called "suburbs". After removing observations with missing values, this leaves me with a sample of about 134,000 individual observations, corresponding to 88,000 individual houses distributed in 154 suburbs between 1984 and 2009. These suburbs represent about 54% of the total American population, and covers close to the entire suburban population. Importantly, I restrict the analysis to homeowners, who accounted for 90% of suburban households in 2007. Table 9 in appendix summarizes the main characteristics of suburban households from 1985 to 2009 using the National samples of the AHS. Compared to the average American household, they are somewhat richer and less representative of racial minorities. In 2009, the median household income of new suburban movers was $62,621, which was about 14% higher than the national median at that time, and the proportion of racial minorities (Blacks and Hispanics) was 14%, compared to a national average of 19.5%.

The AHS does not allow me to construct representative levels of reference housing size within suburbs, as I wish to match each household to the set of new houses built during his tenure period. Besides, a substantial fraction of households moved in before 1984. I therefore collect an original dataset from Zillow.com, a leading online real estate compagny in the US. Zillow regroups publicly available information on millions of houses for sale or rent. Using web scrapping techniques, I gather a sample of 3.2 millions suburban houses located in each of the 154 counties present in the AHS longitudinal surveys, which gives me an average of 20,000 observations per county. Figure 13 in appendix C maps the location of the three millions web-scrapped houses. In order to span the tenure periods and locations of AHS households, I restrict the scrapping program to suburban houses built between 1920 and 2009. I collect information on the location of the house (latitude and longitude), the year the house was built, the size of the house and the lot size. From this large sample of houses, I can construct the evolution and distribution in size of the flow of newly built houses (and the housing stock) from 1920 to 2009 in the suburban area of each county.

One possible concern regarding Zillow is the presence of an attrition bias. Assuming the biggest houses built got progressively destroyed, there should be an increasing downward bias as we go further back in time. This would alter the distribution of houses in a systematic way. This concern is addressed in Annexe C. Comparing Zillow to the Census Survey of Construction (SOC), I find no evidence of attrition.

2.2 The Paradox of the Joneses

From Zillow, I can construct time series for various measures of housing size in each suburban county between 1920 and 2009. Figure 1 plots the 90th percentile size and median size of all houses in my dataset by construction year. Over the last 50 years, the median size of newly built houses doubled in size while the biggest ten percent houses saw an increase of 120%. The biggest ten percent houses built have at least 5000 square feet of living surface today (about 500 square meters), compared to 2000 square feet (200 square meters) in 1940. Considering that average household size has decreased by about 20% since 1960, the amount of private space per person has been increasing at an even higher rate. Variations in the flow of newly built houses similarly altered the American housing stock, as illustrated by figure 17 in appendix C.

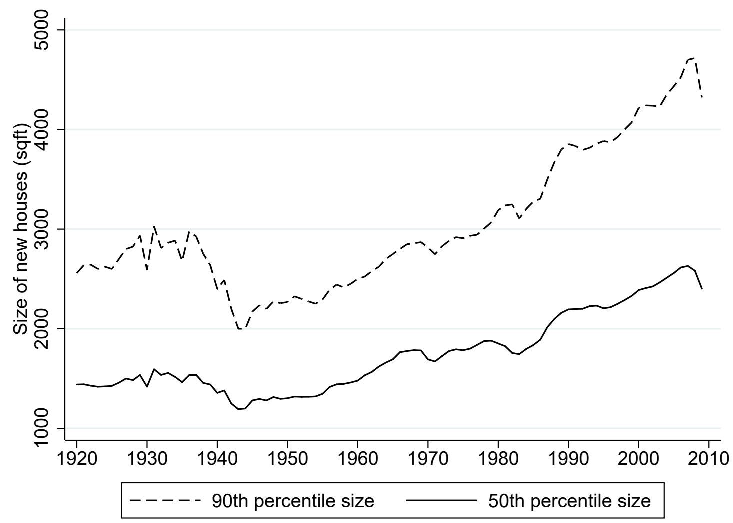
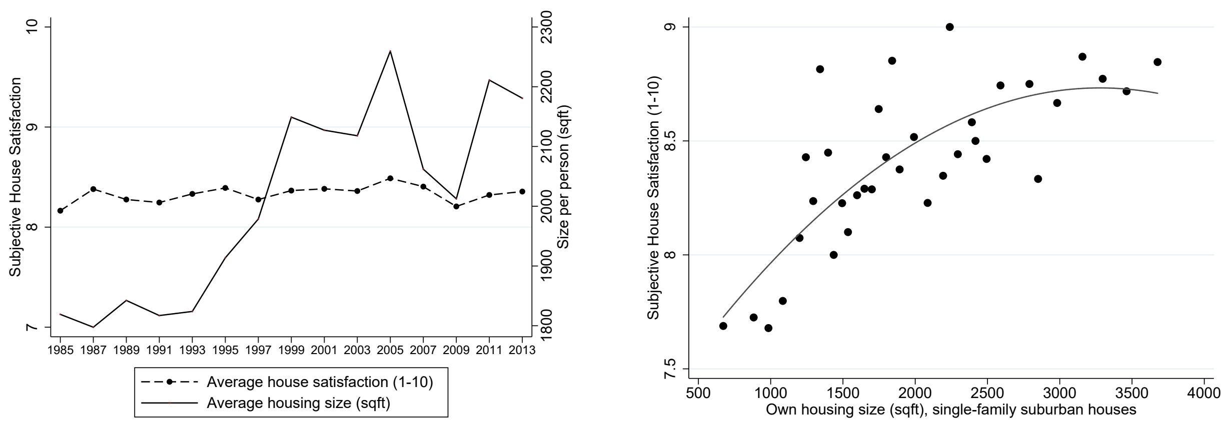


Figure 1: Size upscaling of newly built suburban houses (1920-2009)

The vertical axis shows the variation in 90th percentile size and median size of newly built houses each year. (Source: author's own calculation from Zillow.com)

If households value the size of their house, one should expect this general increase in housing size to be associated with a similar rise in suburban house satisfaction over the period. The national samples of the American Housing Survey provides a representative sample of home owners between 1985 and 2013. I first restrict the analysis to new suburban movers in order to abstract from other dynamical effects that could have played a role, such as house depreciation or hedonic adaptation.

Figure 2a shows the evolution of average house satisfaction and housing size per capita of new movers in suburban areas between 1985 and 2013. New homeowners' satisfaction towards their house has remained steady over the period, despite an increase in housing size of about 400 square feet. Figure 15a in appendix plots the residuals of house satisfaction for all homeowners (old and new) after controlling for objective characteristics except housing size. It gives similar results[5].



(a) House satisfaction and housing size, AHS longitudinal 1985-2013 (new movers)

(b) House satisfaction and housing size, AHS cross-section 2011 (new movers)

Figure 2: The Paradox of the Joneses

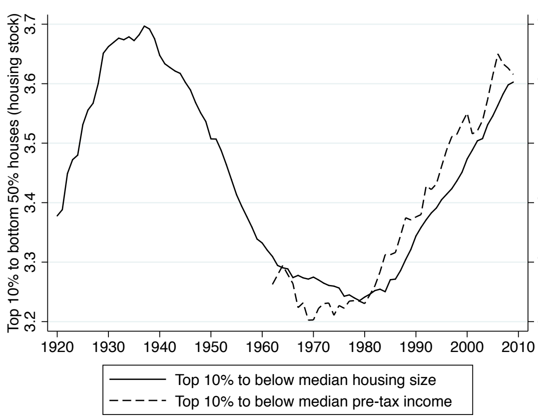
The vertical-left axis of figure 2a indicates the average house satisfaction of new movers, while the vertical-right axis shows the average size of their house. The two measures are constructed from the national surveys of the AHS for each year. Each dots on figure 2b corresponds to houses belonging to a given size quantile (from 1 to 50) within the overall housing size distribution in 2011. The vertical axis indicates the average house satisfaction of new movers in 2011 for each size quantile. The horizontal axis shows the size corresponding to each quantile. All averages are weighted using AHS sample weights (Sources: AHS national surveys).

The paradox comes from the fact that a cross-sectional regression of house satisfaction on housing size systematically produces a positive correlation, as can be seen in figure 2b and 15b (appendix C) using the 2011 AHS survey. Typically, a 1% increase in own housing size leads up to a 0.1% rise in house satisfaction (down to 0.05% with controls). Subjective satisfaction flattens out above 3000 square feet, which indicates decreasing marginal returns to housing size, in line with the literature on income and subjective well-being (Kahneman and Deaton, 2010). But decreasing marginal returns cannot explain the absence of longitudinal trend for houses with size below 3000 square feet. The positive correlation result holds for every cross-sections of old and new movers between 1985 and 2013, as shown in figure 16 (appendix C).

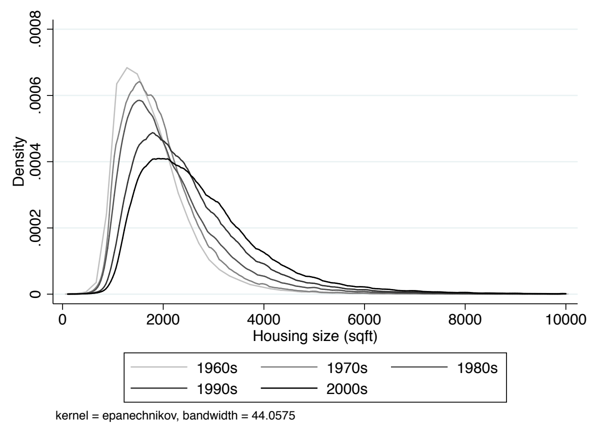
The Easterlin Paradox is usually explained by hedonic adaptation or comparison effects, in

[5] Controls include household characteristics (time spent in the house, age of household, gender, race, income, household size, number of cars, education), price and age of the house.

particular income inequality. Since the 1980's, the American economy has experienced a period of income and wealth inequality at the top of the distribution (Piketty and Saez, 2003; Saez and Zucman, 2014). If households care about their relative income, an unequal growth may not lead to higher life satisfaction. Similarly, American suburbs may well have experienced a similar pattern of rising housing size inequality. Looking at the stock of houses each year, I propose a simple measure of housing inequality defined as the ratio of the biggest ten percent houses to the below median houses between 1920 and 2009[6]. Figure 3a relates this measure of housing inequality to the top 10% income share computed by Piketty and Saez (2003) over the same period. It shows that the U-shaped pattern of top income inequality almost perfectly matches the pattern of top housing size inequality over a century.



(a) Top income and housing size inequality



(b) Kernel distribution of housing size over time

Figure 3: Distribution of housing size (1920-2009)

The vertical-left axis of figure 3a shows the variation in size inequality of the housing stock, measured by the ratio of the biggest ten percent houses to the below median houses. The vertical-right axis shows the variation of the top ten percent income share. Figure 3b plots the kernel density distribution of housing size by decade since 1960 (Sources: author's own calculation from Zillow.com; Facundo Alvaredo, Anthony B. Atkinson, Thomas Piketty, Emmanuel Saez, and Gabriel Zucman. WID- The World Wealth and Income Database, http://www.wid.world/, 6/10/2016).

The period of low income inequality in the US also corresponds to a period of sensible reduction of inequality in the housing stock, the biggest ten percent houses representing 3.7 times the size of the below median houses in American suburbs, this ratio went down to an average of 3.2 in 1980. However, since 1980 the reverse trend can be observed, with housing size inequality rising back towards a value of 3.6 in 2009. Since the 1980s, the rise in average housing size was indeed associated with an increasingly fat-tailed distribution, as can be seen from the kernel density in figure 3b.

[6]Taking the gini coefficient of housing size gives the exact same trends.

3 Empirical analysis

3.1 Empirical specification

Assume a household i who lives in suburb s at time t in a house of size h_{ist}. Following Abel (1990), relative size can be defined as $\tilde{h_{ist}} = h_{ist}/H_{st}^{\sigma}$, where H_{st} is the size of existing houses to which i compares in his suburb. Coefficient $\sigma \geq 0$ captures the extent from which housing size is relative. If $\sigma = 0$, only absolute size matters[7]. I wish to estimate the following Cobb-Douglass specification of house satisfaction:

$$U_{ist} = (h_{ist}/H_{st}^{\sigma})^{\alpha} \prod_{j=1}^{N} z_{jist}^{\beta_j}$$

Where α captures the importance of size for house utility and β_j the effect of any other house or neighborhood characteristics z_{jist}. Note that if individuals "keep up with the Joneses", U_{ist} should be "comparison-concave", i.e. $0 < \alpha < 1$ (Clark and Oswald, 1998).

Cobb-Douglass utility is a common assumption in the analysis of durable consumption like housing and has been shown to fit the data well (Fernandez-Villaverde and Krueger, 2011). I check that it is also the case for house satisfaction looking at non-parametric house satisfaction curves. Figure 18a (appendix C) shows that house satisfaction is a concave function of relative size ($\alpha > 0$). If $\sigma > 0$ and $\alpha > 0$, a ratio specification for relative size implies $sign(\frac{\partial U_{it}/\partial h_{it}}{\partial H_t}) = sign\big(-\alpha^2\sigma\big) < 0$. We obtain the opposite sign if $h_{it} - \sigma H_t$). In other words, the house satisfaction curve should become flatter as other houses become bigger. The drop in house satisfaction following a rise in reference housing size should also be more pronounced for high levels of own housing size. This is what we see in figure 18b. The figure plots house satisfaction as a function of own housing size for bottom quartile suburbs in terms of reference housing size (90th percentile size = 2400 sqft) and top quartile suburbs (90th percentile size = 3400 sqft). As can be seen on the figure, to receive the same level of house satisfaction than a household from suburbs (A) living in a 1500 square feet house, households from suburbs (B) must increase own housing size by 500 square feet. A testable implication is that the interaction term between own housing size and reference housing size should be negative.

Knowing U_{ist}, σ can be estimated directly from a log linear regression:

$$ln(U_{ist}) = constant + \alpha ln(h_{ist}) - \alpha\sigma ln(H_{st}) + \sum_{j}^{N} \beta_j ln(z_{jist}) + u_{ist}$$

However, due to endogenous sorting, σ is hard to identify in practice. Following Manski (1993)'s

[7] In the empirical estimation, I do not restrict σ to be positive. A negative sigma would be indicative of a positive size externality

canonical typology, an endogeneous social effect corresponds to a situation where my own choice is affected by others' choices. This is particularly difficult when a house purchase depends on the observed characteristics of others at the time a household decides to move. Typically, households more negatively affected by social comparisons may sort into suburbs with lower levels of top housing size. By taking the size of all existing houses at time t as the reference point, including those houses already built when the household chose to move in, σ will be biased towards zero.

I follow a different strategy which exploits the fact that within any suburb s at any time t, different movers moved in different years m. The reflection problem is less of an issue if one looks at the impact of variations in others' choices *after* the individual decision has been made. I identify social preferences in relative housing size based on the histories (or personal experiences) of households in the construction of new houses in their suburb[8]. In other words, I replace the measure of reference size at time t, H_{st} by a measure of reference size of houses built between time m and time t, H_{smt}. Under the assumption that households do not perfectly internalize the future construction of houses in their suburb, it has the advantage of being orthogonal to the choice of moving at time m and to any suburb characteristics at time t such as suburban land prices or local amenities correlated with the size of houses.

The reference size of newly built houses is computed at the suburban level. A suburb is defined as the suburban area of a metropolitan county. It is the smallest geographical level available in the Metropolitan files of the AHS. Figure 14 (appendix C) illustrates what a suburb is by mapping the twelve "suburbs" surveyed in the AHS for the state of Maryland. There are two MSA in Maryland. The Washington metropolitan area includes five suburbs (Frederick, Montgomery, Prince Georges, Charles and Calvert) while the Baltimore metropolitan area includes seven suburbs (Baltimore City, Baltimore, Carroll, Harford, Howard, Anne-Arundel and Queen Anne's). There exists substantial variation in top housing size both within and between counties of the same MSA, as shown in figure 20 (appendix C), which plots the 90th percentile size of houses in two suburbs of the Washington metropolitan area (Montgomery and Frederick). 3a in two separate Californian suburbs. Again, consider two home owners interviewed in 1980. This time, they both moved in 1960, but household A moved to Montgomery County while household B moved to Frederick County. They face different levels of top reference housing size at the time they are being surveyed, but this difference will be absorbed by county-year effects. However, household A experienced a strong increase in the size of big houses while household B did not. If both perfectly internalized the impact of past variations in housing size on their current well-being, there should be no difference in house satisfaction between these two households. On the opposite, in the presence of projection bias in relative housing size, A should feel less satisfied about his house than B. Appendix A illustrates this intuition with a model of reference-dependent preferences under projection bias.

[8]This strategy is similar to Malmendier and Nagel (2011, 2016).

3.2 Subjective house satisfaction

I first identify social preferences from the subjective measure of house satisfaction, which can be seen as a direct proxy for house utility. Following the empirical specification previously described, I run the following regression:

$$\begin{aligned}\log(\text{HouseSatisfaction})_{ismt} = \gamma_0 + \gamma_1 \log(\text{OwnSize})_{ist} + \gamma_2 \log(\text{New90thPercentileSize})_{ismt} \\ + \text{SuburbTrends}_{st} + \gamma_3 \text{Controls}_{ismt} + \text{TenureLength}_{mt} + u_{ismt} \quad (1)\end{aligned}$$

where $\text{HouseSatisfaction}_{ismt}$ is the house satisfaction at time t of a household i who moved in suburb s in year m, $\text{New90thPercentileSize}_{ismt}$ corresponds to the 90th percentile size of houses built in his suburb since he moved in, OwnSize_{ist} is the size of the household i's house, SuburbTrends_{st} is a set of about 500 dummies controlling for suburb x year effects, and TenureLength_{mt} time dummies for the length of tenure (in years). A negative γ_2 will be indicative of relative deprivation, and $\sigma = -\gamma_2/\gamma_1$. Unless I control for suburb-specific time trends, γ_2 is likely to be positive as suburbs with bigger houses are also likely to be richer with better amenities. The inclusion of suburb-year fixed effects controls for any interpretation based on time-specific trends within suburbs. Lastly, I include a list of controls for house characteristics[9], household characteristics[10], and neighborhood satisfaction evaluated by the household at time t on a scale from 1 to 10. The latter also controls for possible measurement errors in the way households answer subjective questions.

Social comparison effects usually vary depending on how the reference group is defined. In the existing literature, this is usually based on a likely guess and most empirical analysis use the mean attributes of a reference group. Here, I am able to test various parts of the size distribution. My first hypothesis is the trickle-down effect (or "expenditure cascade"), according to which any reference level can be traced back to the biggest houses built[11]. Figure 4 shows the result of the regression taking the 90th percentile size as the reference group. To ease the interpretation of the regression coefficients, I express the effect of each variable in terms of percent changes in house satisfaction.

[9]House characteristics include the purchased price of the house, its current market value, the age of the house, whether the unit has a balcony, whether the heating equipment is functional, the presence of holes in the floor or roof, whether the unit has extra bathrooms, whether the unit experienced any water leak in the past twelve months, and whether there has been home remodeling since the house was bought.

[10] Households control are the age of the household's head and its square, his race, sex and level of education, the log of the household's annual income, the log of mortgage debt, the number of persons in the household and the number of cars in the household.

[11]This hypothesis has also been studied by Bowles and Park (2005); Frank et al. (2010) or Bertrand and Morse (2013)

Figure 4: Impact of selected house characteristics on house satisfaction

The figure shows the effect size of selected house characteristics on percent change in house satisfaction from regression (1) (Sources: AHS and Zillow).

Own housing size or improvements in neighborhood satisfaction are positively related to house satisfaction, while the age of a house or the presence of water leaks are negatively related to house satisfaction. Controlling for other house characteristics like its price, a doubling in the size of one's house leads to a 4% rise in house satisfaction. This is a sizable effect, which corresponds to about a quarter of a standard deviation of house satisfaction. It is in line with previous studies on the relationship between income and life satisfaction. However, a doubling of the 90th percentile size of new houses during a household's tenure period exactly offsets the satisfaction gains from an equivalent rise in own housing size. The estimated σ coefficient is very close to 1. The full table of results is shown in appendix (Table 10). As expected, the interaction between own housing size and reference housing size is negative and significant. This shows that the negative externality acts by reducing the marginal utility a household gets from an increase in own housing size. Everything else equal, a household experiencing a rise in the construction of big houses must increase the size of his house to obtain the same level of house satisfaction as a similar household who experienced no such increase[12]

However, the 90th percentile housing size could capture a more general effect of size on house

[12]These results are robust to an ordered logit specification. Results available on request.

satisfaction. Also, the externality could be even stronger for lower deciles if people also care about small houses becoming bigger. This relates to a second hypothesis in the social status literature which is the signaling effect. The latter posits households are downward looking and wish to distinguish themselves from smaller units[13]. I therefore estimate the relative size coefficient σ over the entire size distribution of newly built houses. Figure 5 plots the estimated coefficients for by size decile, including the top percentile, with or without controlling for household characteristics and other house characteristics[14].

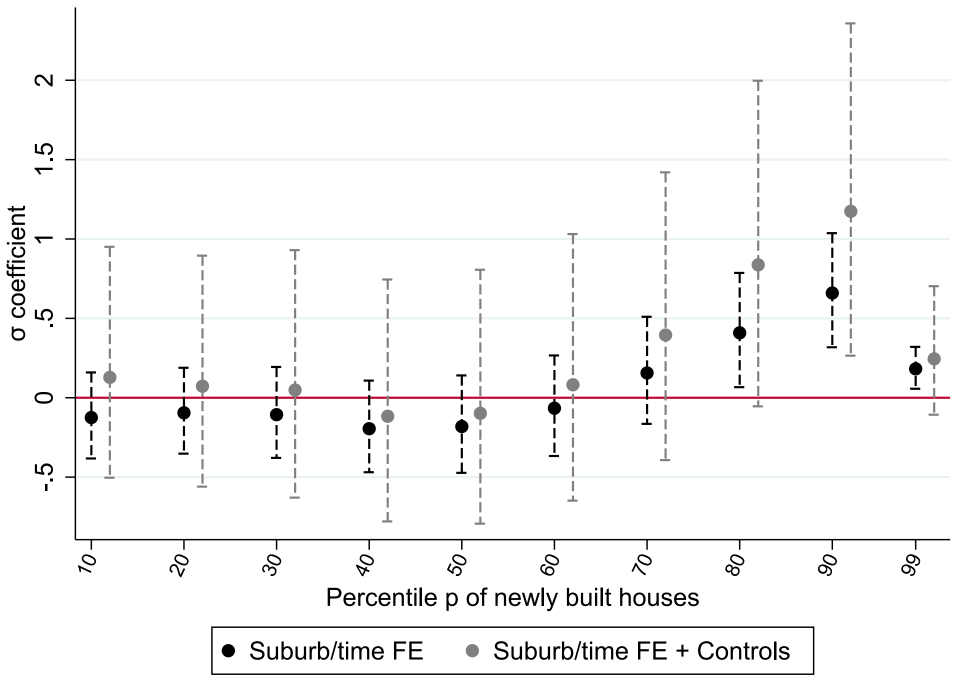


Figure 5: Estimation of relative size coefficient σ across size percentile of new houses

The figure shows the relative size coefficient $\sigma = -\gamma_2/\gamma_1$ estimated from regression (1) in various parts of the size distribution of newly built houses (Sources: AHS and Zillow).

The results provides evidence that upward-looking comparisons dominate in suburban housing markets. The relative size coefficient is only significant for the biggest new houses. It rises significantly above zero around the top quintile of the size distribution, and is highest for the top decile. However, the coefficient on the biggest 1% houses is lower and less significant. This could be explained by the lower visibility of such houses, which tend to be highly isolated in very exclusive areas. The coefficients in figure 5 are estimated separately by changing the reference size group in

[13] Ireland (1994); Glazer and Konrad (1996)

[14] Adding other house characteristics as controls generates less precise estimates of relative size. This is due to the fact that own housing size correlates with other attributes of the house.

regression (1). However, the results hold if we estimate various reference size group simultaneously, as can be seen in table 11 in the appendix. To account for collinearity, I choose sufficiently spaced percentile, though the results on top decile houses are robust to the inclusion of the whole distribution. Table 11 shows only the 90th percentile size of new houses built affect house satisfaction significantly. Overall, the evidence on social preferences support the trickle-down effect as only the size of the biggest houses built really matter. In the rest of the paper, I therefore use superstar houses as the measure of reference housing size.

The relative size externality of top housing size is an average effect. It is likely to be highly heterogeneous depending on how a given house compares to the biggest houses built in the suburb. I therefore estimate the σ coefficient by sub-groups as a function of how they compare in size to the newly built superstar houses. Results are shown in figure 6.

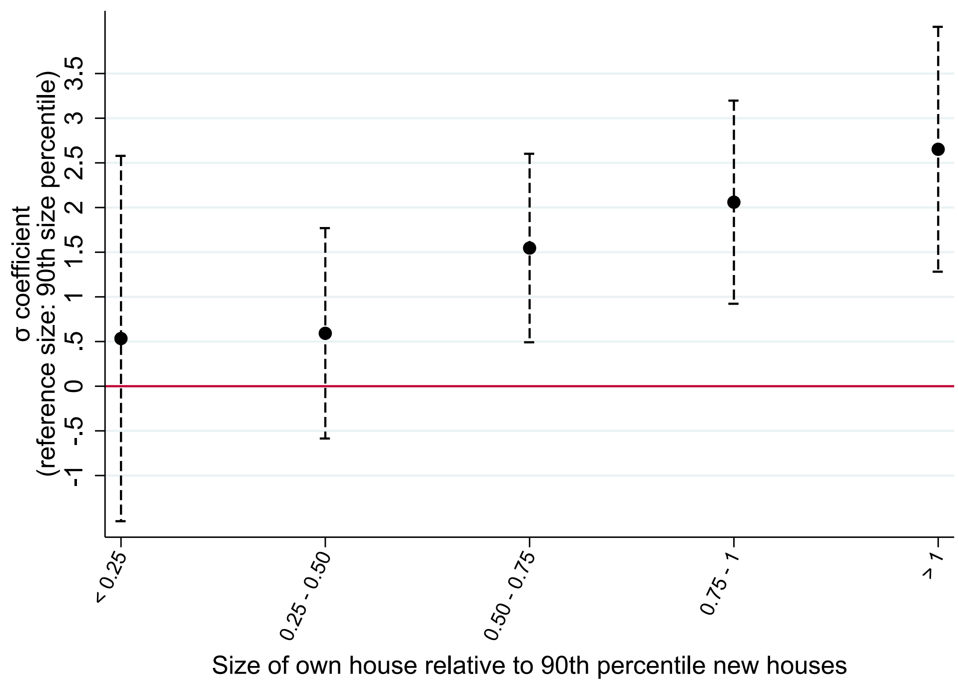


Figure 6: Coefficient σ depending on size of own house relative to 90th size percentile

The figure shows the relative size coefficient σ estimated from regression (1) by sub-groups of own housing size. Own housing size is expressed relative to the 90th percentile size of newly constructed houses. For instance, households whose house amounts to less than half the size of the newly built houses are not significantly impacted. (Sources: AHS and Zillow).

The figure shows the construction of big houses more strongly affects households living in houses comparable in size: the negative externality more than offset a similar rise in own housing size, with a σ coefficient higher than 2. This is indicative that social status competition is stronger at the top, perhaps because such households are also more sensitive to social comparisons in the first place. The relative size coefficient is higher than one and significant for houses up to half the size of the top decile houses, but households who live in houses of less than half the size of the newly built superstar houses are not significantly impacted. These results are consistent with the trickle-down consumption (or expenditure cascade) hypothesis which posits that households ranked below in the hierarchy are less affected by the higher ranked group than households right below it (Frank et al., 2005; Bertrand and Morse, 2013).

None of the previous specifications control for household specific fixed effects, which may bias the results if an individual trait v_i is linearly related to H_{ismt}. This should not be a concern if the construction and size of new houses is exogenous to the household's initial moving decision. However, households more sensitive to social comparison may also be better at forecasting the construction of bigger houses, and so be less likely to experience unpredicted future changes in relative housing size. This would bias the σ coefficient towards zero, so the fact that I find significant estimates indicates that if such effects exist, they may not be very strong. Still, I re-run the house satisfaction regression on a smaller sub-sample of households interviewed more than once. This allows me to run an (unbalanced) fixed effect estimator with panel robust standard errors, controlling for household fixed effects. The FE estimator eliminates v_i by demeaning the variables between survey years using the within transformation.

The household panel includes 24,494 households surveyed at least twice. Coefficient γ_2 now captures the relative downscaling effect due to houses built between two survey years. Since the panel is unbalanced and to account for general time trends in preferences, I include year fixed effects γ_t in addition to the length of tenure. I use the same specification to study the effect of relative housing size on house upscaling and mortgage debt. Results are shown in table 1.

Table 1:
Fixed effect estimator of relative housing size on house satisfaction

	(1)	(2)	(3)
	Log(HouseSatisfaction)$_{ismt}$		
Log(OwnSize)$_{ist}$	0.0394***	0.0360***	0.0333***
	(0.00226)	(0.00990)	(0.0101)
Log(90thPercentileSize)$_{ist}$	-0.0465***	-0.0829*	
	(0.00573)	(0.0480)	
Log(90thPercentileSize)$_{ist}$ $\times$ Own size $\leq$ 0.5 x reference size			-0.0511
			(0.0551)
Log(90thPercentileSize)$_{ist}$ $\times$ Own size > 0.5 x reference size			-0.0886*
			(0.0487)
Own size > 0.5 x reference size			0.305
			(0.270)
Observations	64063	64063	64063
Adjusted R^2	0.189	0.422	0.422
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Household FE	No	Yes	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The impact of top housing size is negative and significant. The heterogeneity persists, with a stronger comparison effect for households living in bigger houses. The σ coefficient is close to 2, in line with the main specification estimates. In the following section, I explore the contribution of distance to superstar houses within suburbs.

The non-linear effect shown in figure 6 may either come from a tendency of households living in bigger houses to compare more, or from a social interaction effect related to distance. Indeed, bigger houses tend to be built closer to other big houses. They are therefore more visible to households living in comparably big houses. In particular, if the rise in top housing size is associated to a simultaneous increase in segregation between big and small houses within counties, the social comparison effect may be a lower bound estimate.

To illustrate this concern, I first compute for each year and within each county the geodetic distance in kilometers separating the average biggest ten percent houses from below median houses, using latitude and longitude information from Zillow.com. Figure 19 in appendix C relates this measure of housing segregation averaged over all counties to the variation in the relative size of the biggest 10% houses shown in figure 3a. It clearly appears that the two trends are serially correlated since 1960. Any empirical estimation of a social comparison effect at the county level must therefore account for such a striking fact.

Unfortunately, the AHS does not provide the exact location of a house within each suburb. I therefore impute the location of each house from the overlapping variables between American

Housing Survey and Zillow. I impute an AHS house's location within each suburb based on house size, lot size, and their interaction to the year in which the house was built. This relies on the assumption that houses of similar size in a given year are generally built closer from each other. It is usually the case in American suburbs, where houses are built following a block pattern or grid plan. This methodology may therefore capture different neighborhoods within suburban counties. As multiple imputations based on a linear regression can easily generate outliers in predicted longitude and latitude, I used a truncated regression. The upper and lower bound chosen corresponds to the minimum and maximum latitude and longitude of the suburb. Imputed longitudes and latitudes correspond to the average of 50 imputations. To check the robustness of the imputation, I simulate random missing values for each suburbs in Zillow in the same proportions as the corresponding AHS missing values. I can then compare the imputed values to the true values and see how well they correlate within each suburbs. Figure 21 in the appendix plots the distribution of correlation coefficients for all suburbs. The median correlation is 0.4. I therefore restrict the analysis to above median suburbs where the predicted location is more likely to be accurate. Figure 7 shows the distribution of estimated average distance between a household's house and all new superstar houses built during his tenure period.

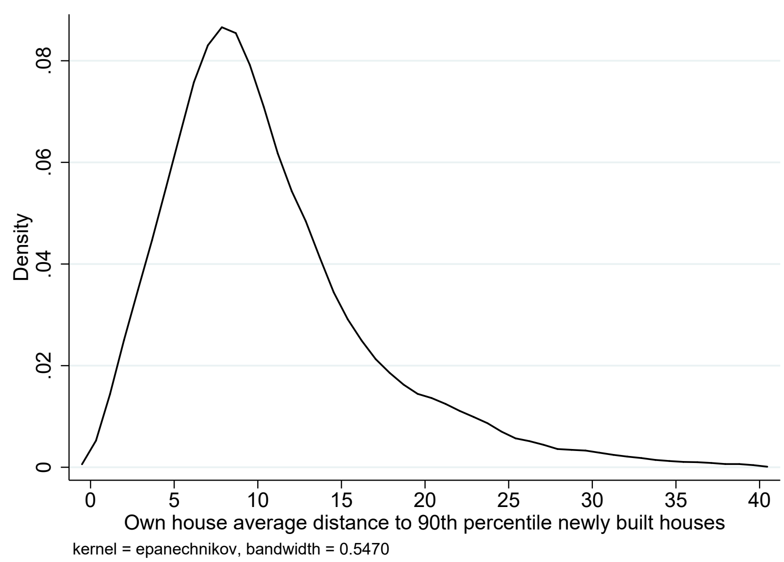


Figure 7: Distribution of estimated average distance between AHS house and new superstar houses built (Sources: AHS and Zillow)

The average house is located about 10 miles away from newly built superstar houses. To see whether the relative size coefficient varies with distance, I run the following regression:

$$\begin{aligned}\log(\text{HouseSatisfaction})_{ismt} = \gamma_0 + \gamma_1 \log(\text{OwnSize})_{ist} + \gamma_2 \log(\text{New90thPercentileSize})_{ismt} \\ + \gamma_3 \text{Distance}_{ismt} + \gamma_4 \log(\text{New90thPercentileSize})_{ismt} \times \text{Distance}_{ismt} \\ + \gamma_5 \text{Controls}_{ismt} + \text{SuburbTrends}_{st} + \text{TenureLength}_{mt} + u_{ismt} \quad (2)\end{aligned}$$

The size of superstar houses built during the household's tenure period is interacted with the estimated average distance between his house and all newly built superstar houses in his suburb. Table 2 shows the result of the estimation for the coefficients of interest.

Table 2:
Impact of distance to superstar houses

	(1) Log(HouseSatisfaction)$_{ismt}$
Log(OwnSize)$_{ist}$	0.0323***
	(0.00423)
Log(90thPercentileSize)$_{ismt}$	-0.0754***
	(0.0287)
Distance from top decile houses (miles)$_{ismt}$	-0.0121***
	(0.00342)
Log(90thPercentileSize)$_{ismt}$ × Distance from top decile houses (miles)$_{ismt}$	0.00150***
	(0.000430)
Observations	39059
Adjusted R^2	0.217
Suburb x Year FE	Yes
Length of tenure FE	Yes
Controls	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The interaction coefficient γ_4 is positive and significant. To provide more intuitive estimates and to account for possible non-linearities with distance, figure 8 plots the σ coefficient of relative housing size obtained from a similar regression than (2), where $\log(\text{New90thPercentileSize})_{ismt}$ is interacted with sub-groups of households defined by their estimated distance to newly constructed superstar houses.

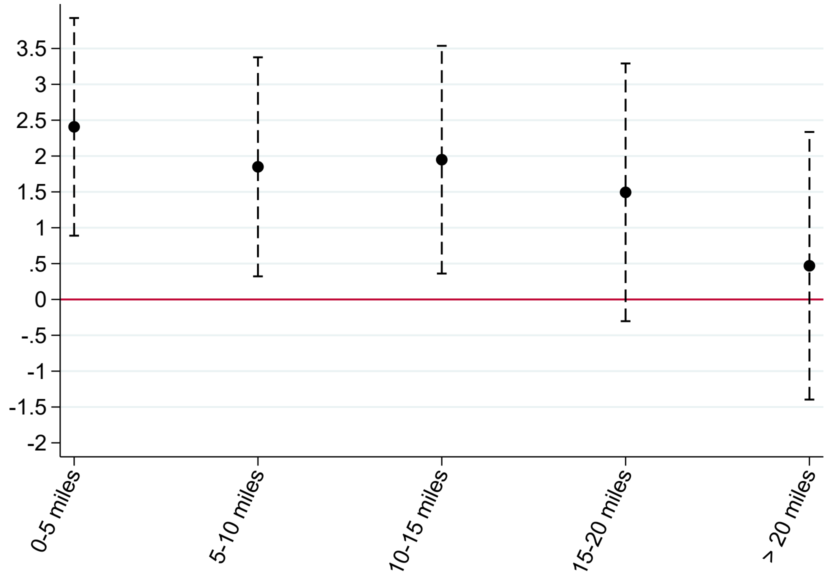


Figure 8: Relative size coefficient σ as a function of distance to newly built superstar houses within suburbs (Sources: AHS and Zillow)

As before, an increase in size of superstar houses during tenure period reduces house satisfaction. However, the more distant superstar houses are from a household's predicted location, the lower is the relative size externality. Beyond 15 miles, the effect of top housing size is not significant.

3.3 Price expectations and hedonic regression

All previous regressions were controlling for house prices but not for price expectations. If a negative link exists at the county level between top housing size and the general level of house prices, the relative deprivation effect may simply be the result of a negative permanent income shock affecting old and new houses through lower price expectations. It seems reasonable to assume that the construction of superstar houses is associated with higher levels of housing prices, especially in metropolitan areas where housing supply is more inelastic (Gyourko et al., 2006; Mian and Sufi, 2009). However, it may still be that relatively deprived areas with lower land prices lead to a rise in top housing size.

I first check whether representative time series of housing prices at the county level are positively correlated to variations in size of superstar houses. Zillow.com provides representative time series of house prices for all counties in my dataset between 1997 and 2009. I regress the log of Zillow Home Value Index (ZHVI) on the log of the biggest ten percent and median housing size, controlling for county and year effects.

Table 3:
Regression of Reference Housing Size on Zillow Home Value Index (1997-2009)

	OLS (1)	OLS (2)
Top 10% housing size	1.184***	1.332***
	(0.443)	(0.424)
Median housing size	-1.013**	-0.429
	(0.508)	(0.452)
Top 10% housing size × Inelastic counties	-	1.309***
		(0.432)
Top 10% housing size × Elastic counties	-	-1.665***
		(0.377)
County fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	1793	1793
Adjusted R^2	0.943	0.950

Notes. The table reports estimates of a regression of the log home value index on the log size of the biggest ten percent and median houses between counties over the period 1997-2009. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 confirms the positive relationship. Controlling for median housing size, a 1% increase in size of superstar houses increases the level of home prices in the county by 1.2%. This positive effect on house prices is even stronger in counties with inelastic housing supply. This reduces the concern that previous findings result from lower housing price expectations.

The housing market provides information on the selling price (or market value) of homes, which represents the discounted present value of the total services provided by the house. These services incorporate the structure services along with the service flows coming from neighborhood amenities or disamenities. Market values as assessed by the household in the AHS are generally higher in levels from transaction prices, but have quite similar time-series patterns (DiPasquale and Somerville, 1995; Kiel and Zabel, 1999). The underlying assumptions distinguishing the hedonic pricing method from the house satisfaction method are discussed in appendix B.

The specification used for the house satisfaction regression allows me to identify the relative size effect separately. Indeed, in the presence of upward comparison effects, households who experienced a stronger increase in top housing size over their tenure period should value their house relatively less compared to households who experienced a smaller increase. To derive a hedonic cost of relative downscaling, I follow the common log linear approach of estimating the hedonic house price function (Ioannides and Zabel, 2003; Zabel, 2004). I hence replace the subjective house satisfaction index from regression (1) by the current market value of the house:

$$\begin{aligned}\log(\text{MarketValue})_{ismt} &= \gamma_0 + \gamma_1 \log(\text{OwnSize})_{ist} + \gamma_2 \log(\text{New90thPercentileSize})_{ismt} \\ &\quad + \gamma_3 \log(\text{Controls})_{ismt} + \text{SuburbTrends}_{st} + \text{TenureLength}_{mt} + u_{ismt} \quad (3)\end{aligned}$$

Assuming that the equilibrium condition (2) holds, I can estimate the relationship between the current market value of the house, its structure and neighborhood characteristics, and the housing externality H_{ismt}. Hence if markets are in equilibrium, the relative deprivation externality directly estimated from the house satisfaction regression should also be internalized in the current market value of the house. Therefore, the positive first order effect on land values (as a proxy for better amenities and richer neighbors) does not exclude the presence of a negative second-order effect of relative housing size. Results are shown on table 4.

Table 4:
Impact of experienced increase in top housing size on market value of the house

	(1)	(2)	(3)
	$\text{Log(HouseMarketValue)}_{ismt}$	$\text{Log(HouseMarketValue)}_{ismt}$	$\text{Log(HouseMarketValue)}_{ismt}$
$\text{Log(OwnSize)}_{ist}$	0.475***	0.528***	0.252***
	(0.0177)	(0.0131)	(0.0102)
$\text{Log(90thPercentileSize)}_{ismt}$	0.952***	-0.162**	-0.355***
	(0.253)	(0.0768)	(0.0819)
$\text{Log(50thPercentileSize)}_{ismt}$	0.707**	0.141**	0.404***
	(0.279)	(0.0588)	(0.0561)
Observations	163736	163736	136939
Adjusted R^2	0.233	0.455	0.586
Length of tenure FE	Yes	Yes	Yes
County x Year FE	No	Yes	Yes
House characteristics	No	No	Yes
Household characteristics	No	No	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Without controlling for county-year effects, the median and top housing size are both positively related to the current market value of the house, as can be seen in column (1). This corresponds to the general equilibrium effect seen in table 3. In column (2), I introduce county-year fixed effects. The coefficient on median housing size remains positive and significant, but households who experienced an increase in top housing size record lower house values. These results are robust to the inclusion of controls for household and other house characteristics (column (3)). Controlling for suburb-year fixed effects, households who experienced a 10% higher increase in top housing size value their houses 3.5% less. There is also evidence that this effect is stronger for comparable houses, and not significant for very small houses, as can be seen in figure 9.

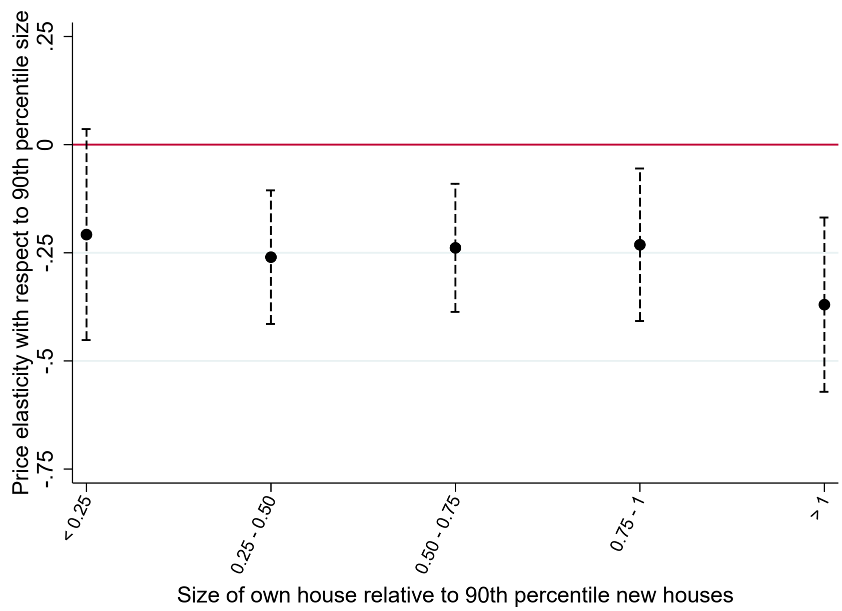


Figure 9: Estimation of coefficient γ_2 from equation (3) depending on size of own house relative to new superstar houses (Sources: AHS and Zillow)

3.4 Impact on individual choices

Between 1945 and 2009, mortgage debt went from 20% to 90% of households' annual income. Figure 10 shows the mortgage debt to income ratio and mean housing size of suburban houses over time. It appears mortgage debt followed the same trend as the variation in size of suburban houses. This last section discusses the contribution of the relative size effect to the mortgage frenzy that led to the 2008 financial crisis.

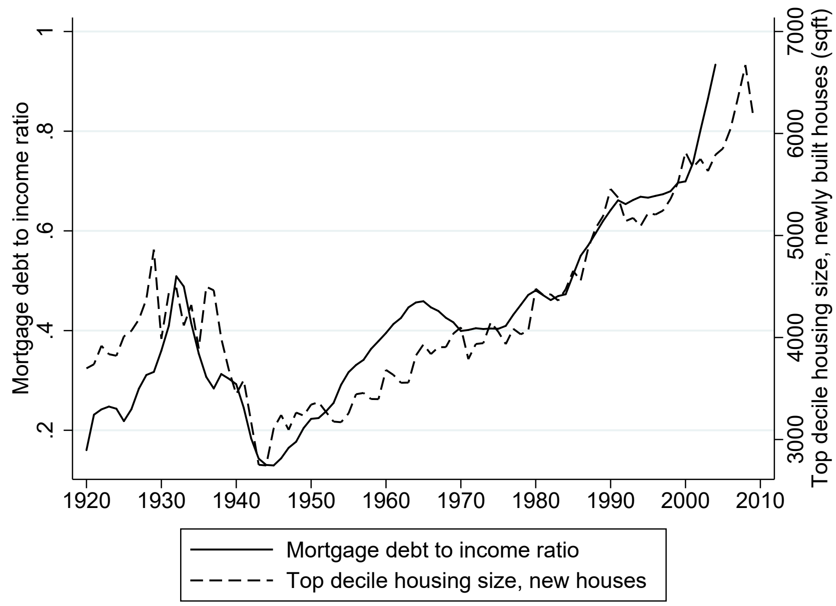


Figure 10: Mortgage debt to income ratio vs. mean housing size (1920-2009)

The vertical left axis shows the variation in average mortgage debt to annual income ratio. The vertical right axis shows the variation in the average size of houses built each year over the same period (Source: Lustig and Van Nieuwerburgh (2005) and author's own calculation from Zillow.com)

I first test whether the size of new movers' houses and the amount of their mortgage at the time of purchase depends on the size of existing superstar houses in that same year. Importantly, the demand for housing size depends on the level of house prices at the time the household moved in. The purchase value of each individual house is largely endogenous to its size and to the household's level of mortgage debt. The housing demand literature therefore relies on estimating local house price indexes, which is what I do here. Ioannides and Zabel (2003) estimate the price of housing services from a log-linear hedonic house price function with MSA year fixed effects. I follow this same approach and estimate:

$$\ln P_{ijt} = \alpha_0 + \sum^{S} \alpha_{1jt}\text{MSA}_{ijt} + \beta_1 q_{it} + \beta_2 n_{it} + u_{ijt} \tag{1}$$

where P_{ijt} is the purchase price of the house. Housing markets are defined as suburban MSA j every five years between 1920 and 2009, which corresponds to about 700 markets. These markets are indexed by MSA-time dummy variables α_{1jt}[15]. I add neighborhood satisfaction and the full

[15] Yearly indexes at the county level would not be reliable considering the small number of observations per cells in earlier time periods. Indeed, the AHS is a representative sample at the time of survey, and I am looking at time of moving for this part of the analysis. Ioannides and Zabel (2003) also argues housing data across MSAs produces

list of house characteristics at the time of survey. The MSA-time intercepts can be interpreted as housing price indexes. I set the price for the excluded suburb-year to be 100 and those for the others to be 100 times the antilog of the corresponding coefficient estimate. Figure 22 in appendix plots the log house price index in four MSAs.

To account for the effect of endogenous sorting, I also control for future neighbourhood quality and future household characteristics such as income[16]. Indeed, households who decide to move in areas with relatively bigger houses are also movers with higher levels of permanent income or who expect better neighbourhood quality. Lastly, results are estimated controlling for year of purchase fixed effects and suburban county fixed effects. Table 5 shows the estimated coefficients on reference housing size for own housing size and the amount of mortgage debt.

Table 5:
Regression of housing size and mortgage debt on top housing size at time of purchased

	Own housing size$_{ist}$			Mortgage loan$_{ism}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Top 10% housing size_*ism*	0.516***	0.422***	0.301***	0.445***	0.622***	0.454***
	(0.0476)	(0.0513)	(0.0487)	(0.129)	(0.114)	(0.107)
Price index		-0.0287**	-0.0185		0.679***	0.687***
		(0.0133)	(0.0123)		(0.0274)	(0.0255)
Observations	212195	164210	164210	123111	114001	114001
Adjusted R^2	0.094	0.095	0.221	0.441	0.471	0.527
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year of purchase FE	Yes	Yes	Yes	Yes	Yes	Yes
House and household controls	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Higher levels of top housing size are associated with higher demand for housing size and levels of mortgage debt for new movers. Coefficients remain positive and significant controlling for the house price index, future neighborhood quality and future household characteristics. Each 1% increase in size of existing superstar houses at the time of moving in raises new movers' choice of own housing size and levels of mortgage debt by about 0.4%.

However, these results cannot be interpreted as causal. They do not address the reflection problem. Typically, households moving in areas which experienced a rise in top housing size could sort into these areas based on unobserved characteristics such as higher sensitivity to status comparison. The evidence shown before on house satisfaction supports the view that households do not internalize future variations in housing size at the time they take their home investment decision. This implies that for high enough changes in the housing stock, they may decide to remodel their own house and subscribe to additional sources of credit. If households who experienced a relative

more variation in the price of housing services than data from sub-markets within a single MSA. Each price index is constructed from an average of 500 observations.

[16]Household controls include the full list of household characteristics at the time of survey listed in footnote 10

downscaling of their house react by keeping up with the Joneses, one should expect a significant and positive correlation between experienced increases in top housing size after the date of purchase and higher levels of mortgage debt.

To estimate the effect of upward comparison on housing choices, I therefore look at changes in housing size and mortgage debt between two survey years. This allows me to run a household fixed effect model. Besides household characteristics, house characteristics and neighborhood satisfaction, I control for the change in the market value of the house and the average interest rate on mortgages signed by the household. I also include the median housing size in addition to 90th percentile housing size to test whether results on keeping up with the Joneses are in line with the upward looking comparisons identified in the house satisfaction regression. Results are shown in table 6 below.

Table 6:
Household fixed effect estimator of relative housing size on upscaling and mortgage debt

	(1) $\text{SizeImprovement}_{ist}$	(2) NewMortgage_{ist}	(3) $\text{Log(SizeImprovementAmount)}_{ist}$	(4) $\text{Log(NewMortgageAmount)}_{ist}$
$\text{Log(90thPercentileSize)}_{st}$	0.0507***	0.0179**	0.636***	0.266**
	(0.0134)	(0.00859)	(0.143)	(0.126)
$\text{Log(50thPercentileSize)}_{st}$	-0.0447***	-0.0118	-0.535***	-0.188
	(0.0156)	(0.00979)	(0.167)	(0.143)
Log(HouseMarketValue)	0.0145***	0.00734***	0.161***	0.117***
	(0.00152)	(0.00103)	(0.0167)	(0.0162)
$\text{InterestRate}_{ist}$	-0.000719***	0.00194***	-0.00886***	0.0278***
	(0.000211)	(0.000118)	(0.00221)	(0.00171)
Observations	64063	64063	64063	64063
R^2	0.031	0.021	0.032	0.022
Household FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Following a 1% rise in 90th percentile size of housing stock, existing homeowners are 5 percentage points more likely to improve the size of their home, leading to a 0.6% increase in own housing size. The effect is also positive and significant for mortgage debt. These same homeowners are in turn 1.8 percentage points more likely to subscribe to a new mortgage, leading to a 0.26% increase in their mortgage debt. The coefficients on median housing size are either negative or non significant. These results are consistent with the trickle-down consumption hypothesis. Households react to relative downscaling by signing up to additional mortgages in order to keep up with top housing size. On average, the 90th percentile size of the housing stock went from 2650 square feet to 3350 square feet between 1980 and 2007, which corresponds to a 26% rise (figure 17). These estimates indicate that in the absence of any increase in housing size at the top of the distribution, the debt to income ratio would have been about 4 percentage points lower at the eve of the 2008 financial crisis. Since the latter increases by 40 percentage points from 1980 to 2008, the relative size effect can explain up to 10% of the rise in the mortgage debt to income ratio over the period.

3.5 Robustness checks

3.5.1 Neighborhood satisfaction

The upward-looking effect on house satisfaction and house prices may hide a more general effect on neighborhood quality. For instance, an increase in housing size inequality may be related to more segregated neighborhood within a suburb. I controlled for such effects by including neighborhood satisfaction as a control variable. However, the presence of neighborhood effects can be directly tested using neighborhood satisfaction as a dependent variable. In particular, the sign of the coefficient on upward reference size will tell whether the effect previously captured is exclusively due relative deprivation in housing size, or if it expresses a more general feeling of unhappiness. The results in table 12 (appendix D) confirms that I am capturing a relative size effect. If anything, only median housing size is significant and positively correlated to neighborhood satisfaction.

3.5.2 Population density

Besides economic segregation, an experienced increase in housing size is usually correlated to an experienced increase in population density within counties, as it also capture the construction of additional houses. The fact that only the size of big houses is driving my result lowers the concern, but it may still bias the coefficient. The impact of population density on house satisfaction is theoretically ambiguous. Higher density increases the price of land for existing home owners, which can lead to higher house satisfaction, but may also be associated with higher congestion costs not necessarily captured in prices, which is likely to reduce house satisfaction. To address this concern, I compute county-specific trends in population density between 1920 and 2009 for each AHS county from US Census population data and NHGIS and control for experienced rise in population density over the length of tenure. The inclusion of population density does not affect any of the results on relative housing size.

3.5.3 Land use restrictions

The rise in size of superstar houses and house segregation are likely endogenous (Loury et al., 1977). To identify the relative size effect separately from endogenous segregation of superstar houses from other houses, I associate each county to a measure of the share of developable land, or housing supply elasticity, computed by Saiz (2010). This measure has the advantage of being exogenous to regulations as it is based on terrain elevation and the presence of water bodies. It is estimated using geographical information system (GIS) techniques on areas within 50-kilometer radii from metropolitan central cities, which includes all the suburban areas from which the AHS households are surveyed. A high scarcity of developable land in a given county should imply a much smaller variation in economic segregation over time, as superstar houses cannot be built too far away from smaller houses without overpassing the county limits. The effect of supply elasticity on housing size is theoretically ambiguous: a smaller area of developable land can lead to a fall in housing size through higher land prices. But it can also lead to a rise in average housing size through a change in the composition of households[17].

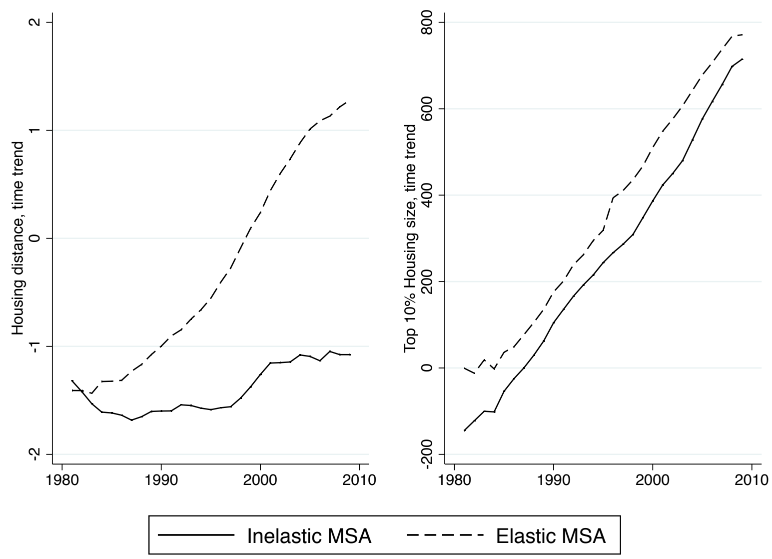


Figure 11: Residual historical variation in top 10% housing size and economic segregation after controlling for county fixed effects (1980-2009), inelastic vs. elastic counties

On the left-hand side panel, the vertical axis shows the residual distance in kilometers separating the biggest ten percent houses built from below median houses within suburban counties, averaged over inelastic and elastic counties. On the right-hand side panel, the vertical axis shows the corresponding residual variation in size of the biggest ten percent houses built. Inelastic and elastic counties are defined respectively as the bottom-quartile and top-quartile of housing supply elasticity (Sources: Saiz (2010) and author's own calculation from Zillow.com)

Figure 11 plots the average residual variation in size and segregation of superstar houses between inelastic and elastic counties, after controlling for county fixed effects. Inelastic and elastic counties are defined respectively as the bottom-quartile and top-quartile counties of my dataset in terms of housing supply elasticity. Differences in housing supply elasticity generates variations in top housing size unrelated to variations in segregation: if there is no clear difference between inelastic and elastic counties in terms of residual change in top housing size, inelastic counties see almost no change in residual segregation. Table 7 tests the prediction that the coefficient on reference housing size should be stronger in inelastic areas. It runs the same regression as in table **??** but the

[17]Evidence for this latter effect are discussed in Gyourko et al. (2006) who show that an increasing number of high-income households nationally lead to the progressive crowding out of lower-income households in inelastic areas.

experienced increase in top housing size is now interacted with a dummy for elastic and inelastic counties.

Table 7:
Experienced variation in top housing size, inelastic and elastic counties

	OLS regression (1)	Ordered logit model (2)
Top 10% housing size$_{ismt}$	-0.155*	-0.291**
	(0.0912)	(0.148)
Top 10% housing size$_{ismt}$ × Inelastic counties$_s$	-0.307**	-0.405*
	(0.145)	(0.225)
Top 10% housing size$_{ismt}$ × Elastic counties$_s$	0.0532	0.146
	(0.106)	(0.169)
County × Year FE	Yes	Yes
Time FE	Yes	Yes
Household characteristics	Yes	Yes
House and neighborhood quality	Yes	Yes
Price controls	Yes	Yes
Observations	133980	133980
Adjusted R^2	0.297	-
Pseudo R^2	-	0.126

Notes. Columns (1) and (2) reports the OLS and ordered logit estimation of equation (**??**), which regresses the subjective house satisfaction index on logged experienced variations in the average size of the biggest ten percent houses built since the household moved in. The measure of reference housing size is interacted with dummy variables indicating whether the household lives in an elastic or inelastic county. Inelastic and elastic counties are defined respectively as the bottom-quartile and top-quartile counties in housing supply elasticity. All regressions control for the full list of controls listed in table **??** (notes). Sampling weights are included in all regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results are in line with predictions. The more inelastic is the housing supply, the stronger is the deprivation effect. In inelastic suburbs, a doubling in size of superstar houses reduces house satisfaction by a third of a standard deviation, which more than offset the effect of a similar rise in own housing size.

3.5.4 Relatively smaller or relatively older?

The absence of any effect on neighborhood satisfaction and the fact that the interaction between top housing size and reference housing size is negative supports the view that I am capturing an upward comparison effect in size. However, as bigger houses also tend to be newer, variation in size may correlate with unobserved quality, capturing better design, more efficient heating technologies, or the mere value of novelty. Controlling for the age of the household's own house partly addresses the issue. But variations in top housing size may still capture a relatively higher proportion of newer houses, which in the presence of a relative novelty effect would bias the coefficient on reference housing size upward. A more convincing test is to look at the interaction term between the age of the household's house and his experienced variation in the size of newly built houses. If the relative deprivation effect is driven by relative novelty, it will be more negative on older houses, so the sign of the interaction term will be negative. Table 13 in appendix D shows the interaction term between top housing size and the age of the house is small and positive for both house satisfaction and the market value of the house, dismissing the relative novelty explanation.

4 Conclusion

Combining a large survey of American home owners with historical data on the distribution of housing size across counties, this article documents that despite a major upscaling in size of single-family houses in US suburbs, households have not experienced any increase in subjective housing satisfaction since the 1980s. However, cross-sectional analysis suggests households living in bigger homes tend to be more satisfied with their house. This result echoes the Easterlin paradox, which is usually explained by adaptation and rising aspirations due to the presence of social comparison effects. I test for the presence of comparison effects in the size of neighboring houses using a methodology which exploits experienced increase in the size of houses built in the household's suburb after the purchase decision has been made. The methodology allows me to control for county-year effects and length of tenure effects. Results are supportive of a projection bias in reference housing size, as households who experienced higher increases in top housing size feel less satisfied than similar households who experienced smaller changes. I find that the comparison effect is upward-looking, as households are not affected by houses smaller than their own. More precisely, social comparison are driven by the size of superstar houses, defined as houses belonging to the top decile of the size distribution, which is supportive of the literature on trickle-down consumption. The utility gains from living in a bigger house are offset by a similar rise in size of houses at the top of the distribution, and the effect is stronger for households living in bigger homes.

My findings on relative housing size are robust to alternative specifications and explain the decision to improve the size of one's house. The variation of top housing size experienced by the same household between two survey years give results of similar magnitude, even after controlling for household fixed effects. Using the current market value of the house instead of subjective house satisfaction, I also show households value their house relatively less if they experienced higher increase in top housing size. The relative size effect is concentrated in inelastic areas, which experienced similar levels of housing inequality but almost no change in housing segregation between big and small houses. Households react to relative deprivation by increasing the size of their house at the cost of higher levels of mortgage debt. Controlling for household fixed effects, a 1% rise in size of superstar houses leads to a 0.6% rise in size through home improvements and a 0.26% rise in the level of outstanding mortgage debt. In the absence of keeping up with the Joneses, the level of mortgage debt to income ratio would have been 4 percentage points lower at the eve of the 2008 financial crisis. This accounts for 10% of its rise since 1980.

These results suggest a behavioral channel between inequality and mortgage debt. They also argue in favor of zoning regulations aimed at reducing the gap between small and big houses at the local level. On that regard, the extensive use of minimum lot size requirements in suburban communities may have amplified upward comparison effects and increased financial distress, with no long-run improvements in house satisfaction overall. More generally, these results show positional externalities can have important implications for the dynamics of housing markets.

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Appendix

A Theory: projection bias in relative housing size

Suppose a person decides to buy a suburban house at time τ. The opportunity cost of buying the house is P, which includes any other goods that could have been bought had the house not been purchased. The person has just one opportunity to purchase the house. Assume her valuation of the house depends on its size compared to the size of other houses in the area. The latter can be considered as a consumption externality. Typically, a person may experience lower house satisfaction if her house looks comparatively smaller than neighboring houses, but the externality may also be positive, for instance if bigger houses are associated with aesthetic amenities. A house is a durable good which can last for several periods. The satisfaction the person will experience is therefore likely to change. First, the person may adapt to the house so that her absolute valuation decreases over time[18]. Second, the housing stock may look very different after new houses get built. Formally, the satisfaction u_τ corresponding to a house bought in period τ is

$$u_\tau \equiv \begin{cases} h_\tau - \nu H_\tau & \text{at the time } \tau \text{ the house is purchased} \\ \gamma^{k-\tau} h_\tau - \nu H_k & \text{if the house has been purchased } k > \tau \text{ periods ago} \end{cases}$$

where h_τ is the size of the house at time of purchase and H_τ is the average size of houses in the suburb at that time, or the initial value of the average housing size. Coefficient ν characterizes the housing externality, which can be positive or negative and the term $\gamma^{k-\tau}$ captures the rate at which the person adapts to his house, with $\gamma \in [0, 1]$ a constant. I assume the average size of houses follows an autoregressive process of order one, so that

$$H_k = \phi H_{k-1} + \epsilon_k \quad \text{for all } k > \tau$$

where $\phi > 0$ captures the growth rate of the average housing size between two periods, and ϵ_t is a random, independent and identically distributed term with zero mean and constant variance σ_ϵ^2. Define $T = \tau' - \tau$ the length of tenure between the purchase date and some later period τ'. The person does not discount future levels of house satisfaction, which does not affect the intuition of the model. Her true expected inter-temporal house satisfaction between period τ and τ' corresponds to

$$E\left[U_\tau^{\tau'}\right] \quad = \quad E\left[\sum_{k=\tau}^{\tau'} \left[\gamma^{k-\tau} h_\tau - \nu H_k\right] - P\right]$$

[18] Assuming physical depreciation would have a similar effect, which is why we identify separately the two in the empirical analysis. Evidence on hedonic adaptation is surveyed by Loewenstein and Ubel (2008).

This formulation assumes the person predicts her future instantaneous utility correctly. She fully accounts for adaptation and has perfect beliefs regarding how the suburb in which she decides to live may change. In reality, both are hard to anticipate. In particular, one may overestimate the long-term satisfaction of moving in an area facing changes in comparison groups. Typically, as argued by Loewenstein et al. (2003), a person buying a big house in a wealthy suburb may not fully appreciate the reaction of future movers to her own decision to move, and the resulting change in the housing stock. A classical example of imperfect beliefs is projection bias, where a person's evaluation of the future depends on the state of the world at the time the decision is made. Theoretically, a person exhibiting simple projection bias will behave as if she was maximizing

$$E\Big[\tilde{U_\tau^{\tau'}}\Big] \quad = \quad E\Bigg[\textstyle\sum_{k=\tau}^{\tau'}\big[(1-\alpha)(\gamma^{k-\tau}h_\tau - \nu H_k) + \alpha(h_\tau - \nu H_\tau)\big] - P\Bigg] \quad \text{with} \quad 0 \leq \alpha \leq 1$$

When $\alpha = 0$, the person experiences no projection bias so that $E\Big[\tilde{U_\tau^{\tau'}}\Big] = E\Big[U_\tau^{\tau'}\Big]$. When $\alpha = 1$, the person exhibits full projection bias towards her house: she perceives her future valuation as identical to her present valuation. The cumulative dissatisfaction $D_\tau^{\tau'}$ measured in period τ' of a person who chose a house in period τ, then exactly equals the difference between her perceived intertemporal utility and her true intertemporal utility, which after some computations equal

$$D_\tau^{\tau'} \equiv E\Big[\tilde{U_\tau^{\tau'}}\Big] - E\Big[U_\tau^{\tau'}\Big] \quad = \begin{cases} \alpha\big[T - \frac{1-\gamma^T}{1-\gamma}\big]h_\tau & \text{if } \phi = 1 \\ \alpha\big[T - \frac{1-\gamma^T}{1-\gamma}\big]h_\tau \quad + \quad \alpha\nu\big[\frac{1-\phi^T}{1-\phi} - T\big]H_\tau & \text{otherwise} \end{cases}$$

This expression is a function of two terms. The first term reflects the person's misperception of her future adaptation to living in a house of size h_τ. Since $T > \frac{1-\gamma^T}{1-\gamma}$, the person will systematically overvalue a given house at the time it is bought, leading to investments she may regret in the future. In the presence of adaptation, the effect of own housing size h_τ on house satisfaction measured in period τ' will be a decreasing function of the length of tenure T. This is in line with evidence on how owners evaluate the current market value of their house[19]. The second term captures the cumulative impact of the housing externality due to misperceived variations in the size of the housing stock after the date of purchase. In the case of a negative externality, it predicts that a misperceived increase in future housing size should imply a lower valuation of the house by the household in time τ'. This corresponds to the cost of experienced relative downscaling. Typically, the person imperfectly accounts for future increase in housing size at the date of purchase and buys a house that ends up being too small. The second term disappears in the absence of any change in the size of the housing stock ($\phi = 1$), is positive when the size of the housing stock is growing over time ($\phi > 1$), but negative in the case of a declining size of the housing stock ($\phi < 1$).

[19] Goodman and Ittner (1992) find that owners over-estimate its value by 5% on average but Kiel and Zabel (1999) show that this over-valuation is greater for new owners and declines with the length of tenure.

Now, suppose two households, A and B, interviewed in time $\tau + 1$ who moved in the same suburb. A bought his house at time τ while B bought his house one year later, at time $\tau + 1$. Both houses are comparable in size $h^A_\tau = h^B_{\tau+1} = h$. For $T > 1$, the difference in relative dissatisfaction of household A compared to household B is

$$D_\tau - D_{\tau+1} = \alpha(1 - \gamma^{T-1})h + \alpha\nu(T-1)(\phi - 1)H_\tau$$

First, household A will be less satisfied than household B simply because of the additional year of adaptation. This is captured by the first term, and the difference is a decreasing function of the length of tenure. The second term also shows household A will be less satisfied than household B in a suburb with growing housing size ($\phi > 1$), but this time the difference is an increasing function of the length of tenure. This result is due to the interaction between projection bias and reference-dependent preferences. Because the late mover has a higher reference point than the early mover, the gap between his perceived and his true inter-temporal utility is relatively lower. This simple set-up makes it clear that in the presence of projection bias, one should expect variations in construction histories between households to affect their subjective well-being, even controlling for the housing stock at the time of survey. It also shows that without controlling for households' length of tenure, any cross-sectional estimation of relative size effects may simply capture adaptation to the house, or any other general time trends[20].

B Theory: house satisfaction vs. hedonic pricing

Assume a household with income y has the choice between two similar houses in suburbs s_1 and s_2 at time τ'. The only difference between the two suburbs is the size of the other houses at that time $H^1_{\tau'} > H^2_{\tau'}$ (hereafter called H^1 and H^2). The household chooses h to maximize

$$\max U(x, h, H^s) \text{ such that } y = x + ph$$

with x a composite commodity, h the size of the house, H^s the housing size externality in suburb s and p the housing price per square feet. The marginal utility is positive in own housing size $U_h > 0$ and negative in reference housing size $U_{H^s} < 0$. In a perfectly competitive economy, the housing market internalizes the externality so p and y adjust to variations in H^s. In equilibrium, utility is equalized across the two suburbs so that the household is equally happy in both places, with no incentive to move. The problem can be rephrased from the indirect utility function V as

$$V\big(y(H^s), p(H^s), H^s\big) = k \qquad \forall \quad s \tag{2}$$

[20]Note that the model also generates different predictions regarding the sign of the interaction term between length of tenure and each of the two effects.

where k is a constant. This market equilibrium condition is the starting point of the hedonic pricing (HP) approach introduced by Rosen (1974) or Roback (1982). The indirect utility of housing is an increasing function of income ($V_y > 0$) and a decreasing function of housing prices for new movers ($V_p < 0$)[21]. The marginal impact of a change in the housing size stock depends on whether the externality is positive ($V_{H^s} > 0$) or negative ($V_{H^s} < 0$). The implicit cost of relative downscaling C experienced by an existing home owner can be defined as the increase in income required to make new movers indifferent net of the variation in the market value of houses:

$$C = dy/dH^s - h(dp/dH^s) \quad \text{with} \quad h = -V_p/V_y \quad \text{(Roy's identity)} \tag{3}$$

Taking the total derivative of equation (2) gives

$$dV/dH^s = V_y(dy/dH^s) + V_p(dp/dH^s) + V_{H^s} = 0 \tag{4}$$

And combining equation (4) and (3), the implicit hedonic cost of the housing externality equals

$$C = dy/dH^s - \big(V_p/V_y\big)(dp/dH^s) = -V_{H^s}/V_y > 0 \tag{5}$$

When the labor and housing markets are in equilibrium, the implicit cost of relative deprivation exactly equals the marginal willingness to pay (MWTP) to avoid feeling relatively deprived. Therefore, by regressing housing prices and households' income on the experienced variation in reference housing size, one can recover the MWTP of relative deprivation.

However, if a direct proxy of house utility is available, the right hand side of equation (5) can be estimated directly. This method is known as the life satisfaction (LS) approach[22]. Typically, it consists in regressing a subjective measure of house satisfaction on income and the externality, holding house prices and income constant, to recover respectively V_y and V_{H^s}. In the case presented above, it requires that the subjective measure of house satisfaction at time τ' be a function of the cumulative instantaneous utility flows over the T periods since the person moved in[23]. If the two methods give similar estimates, one can claim the market perfectly internalizes the externality through higher price differentials between relatively small and relatively big houses.

There exist various reasons why the market equilibrium condition is unlikely to hold. A classical issue is the presence of moving costs. This generates a downward bias in the cost of the relative size externality, as households who would like to move to a relatively bigger house must also pay

[21]The fact that higher income allows for better house quality logically leads to a positive marginal utility of income. The estimation of the later is therefore very sensitive to the inclusion of dwelling specific controls for quality, an issue I address later in the paper.

[22]For a discussion of the LS approach, see Van Praag and Baarsma (2005); Luechinger and Raschky (2009); Luechinger (2009); Frey et al. (2009) or Ferreira and Moro (2010).

[23]Evidence that happiness differs from flow utility is reviewed by Kimball and Willis (2006).

an extra moving cost. A similar bias may arise in the presence of loss aversion, which is typically associated with reference dependent preferences (Genesove and Mayer, 2001). Loss aversion can be experienced by existing home owners but not by potential buyers.

Formally, if condition (2) does not hold, house satisfaction is not equalized across all counties, so that $dV/dH^s < 0$. It follows that the new implicit cost of relative deprivation estimated through the HP approach $\tilde{C}$ is in fact lower than the true MWTP as estimated by the LS approach:

$$\tilde{C} = dy/dH^s + \big(V_p/V_y\big)(dp/dH^s) = -V_{H^s}/V_y + (dV/dH^s)/V_y < -V_{H^s}/V_y \tag{6}$$

The hedonic cost of relative deprivation computed from the wage and price gradients would therefore give a downward biased estimate of the true cost, as it neglects the residual effect $(dV/dH^s)/V_y$ not capitalized in private markets.

C Data and Stylized Facts

C.1 Measurement errors in reference housing size

One way to test whether Zillow.com does well at measuring variations in historical housing size is to compare my measures to the US Census Survey of Construction (SOC). The Survey of Construction (SOC) provides measures for the mean and median size of new single-family housing units constructed each year since 1971. Figure 12 plots the mean housing size of newly built houses from Zillow.com and SOC datasets over the period 1971-2009. The trend correlation between both datasets is very close to one over the forty years period. This is reassuring as the empirical analysis exploits time trend changes within counties rather than differences in levels. The figure also shows that on average, Zillow captures bigger houses than the SOC. There are at least two important reasons why the SOC measure of housing size is downward bias. First, the SOC estimates regroup both urban and rural single-family houses, while the Zillow sample is restricted to urban suburbs, where houses are on average bigger. A better comparison is to restrict the SOC to houses built within MSA (though suburban and central city houses still cannot be distinguished), which reduces part of the gap[24]. Second, the SOC is top-coded for the top 1% biggest houses, which means Zillow does a better job at measuring the true size of the biggest houses built. If I truncate the Zillow sample to exclude the top percentile, the gap is also reduced.

[24]The Census Bureau does not compute averages at the MSA level for the period 1971-2009, and access to the micro data of the SOC is restricted to the 1999-2009 period, which explains the restriction in the time trend.

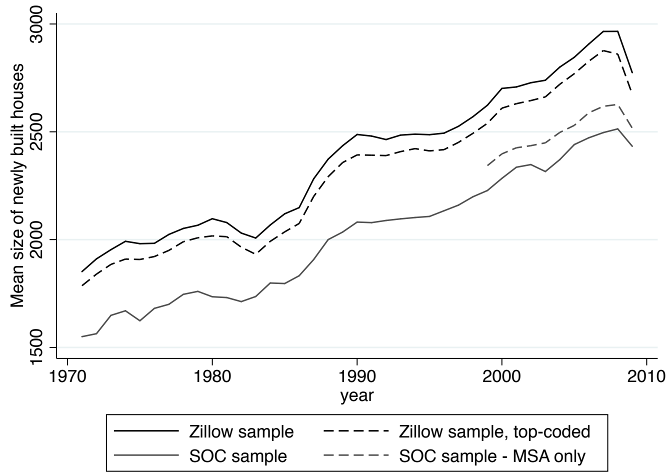


Figure 12: Average size of newly built detached family houses 1971-2009, Zillow vs. SOC

The SOC data allows me to compare time series at the level of a census region. To further check for the presence of an attrition bias affecting the distribution of houses over time, I take the ratio of mean to median size in each census region for each year t as a first approximation of the size distribution for both datasets. I then compute the difference between these two measures and see whether the gap varies over time in a systematic way. The right hand side variable used to test for attrition is therefore:

$$\text{Attrition measure}_t = (\frac{\text{Mean}}{\text{Median}})_{Zillow,t} - (\frac{\text{Mean}}{\text{Median}})_{SOC,t}$$

Table 8 regress this measure on the number of years past since houses were built and region fixed effects. There is no evidence of a change in the size distribution over time between Zillow and the SOC, which further reduces the attrition concern.

	Attrition measure between Zillow and SOC
Time since the house was built	-0.000127
	(0.000201)
Census Region 2 FE	-0.0446***
	(0.00625)
Census Region 3 FE	-0.0202***
	(0.00620)
Census Region 4 FE	-0.0171**
	(0.00677)
Constant	0.0526***
	(0.00557)
N	156
adj. R^2	0.279

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Testing for attrition over time, SOC vs. Zillow

C.2 Location of suburban houses within Metropolitan Statistical Areas

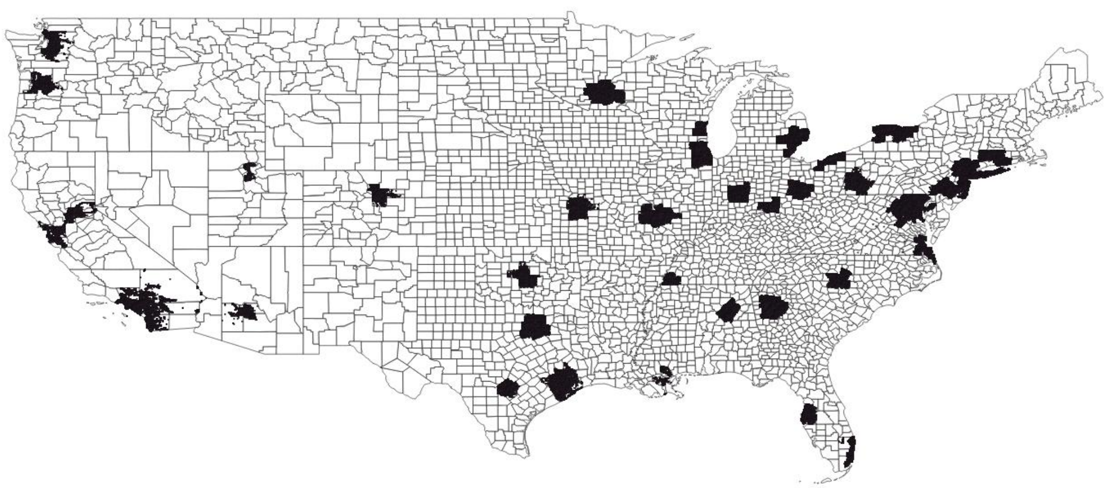


Figure 13: Mapping of suburban houses considered within MSA counties

The figure maps all three millions houses web-scrapped from Zillow.com to their exact location within counties using latitude and longitude coordinates. All 154 counties considered are located within the Metropolitan Statistics Areas surveyed in the AHS.

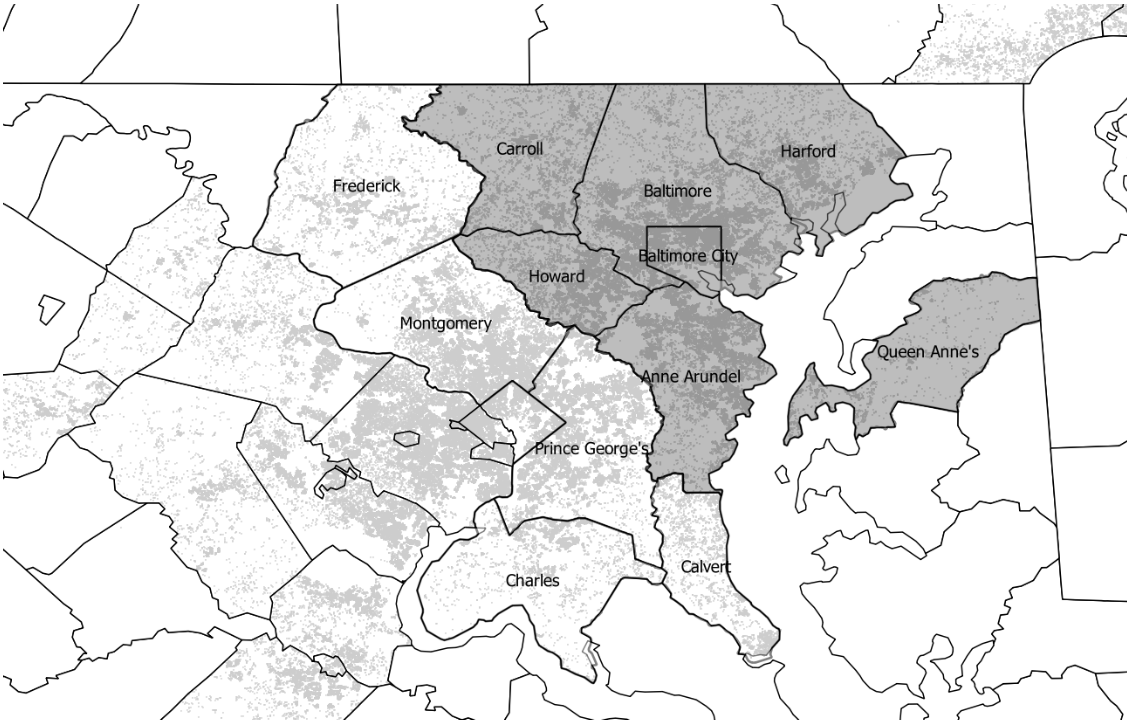


Figure 14: Mapping of Maryland suburbs considered by AHS

The figure maps the suburban houses web-scrapped from Zillow.com to their exact location around the state of Maryland. There is a total of twelve suburbs within the two MSA surveyed by the AHS for the state of Maryland: seven in the Baltimore metropolitan area (shaded area) and five in the Washington metropolitan area (white area)

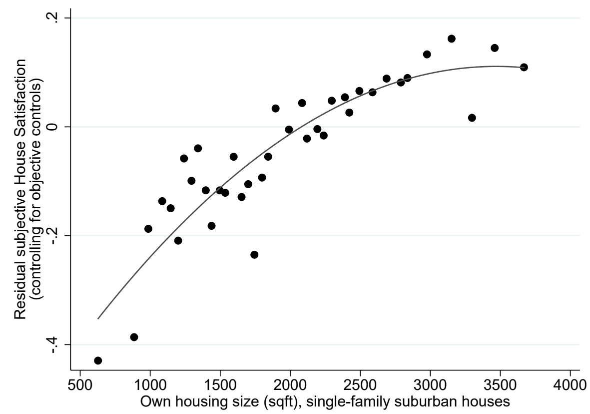
C.3 Descriptive Statistics

Survey	Median Income	Mortgage Debt Over Income	Age	Household Size	% Bachelor	% Graduate	% Hispanics	% Blacks
1985	27200	.48	50.1	2.9	.12	.1	.03	.05
1987	30000	.5	50.3	2.9	.13	.11	.03	.05
1989	33400	.5	50.7	2.9	.13	.11	.04	.05
1991	35000	.55	50.9	2.8	.14	.11	.04	.05
1993	37260	.58	51.3	2.8	.14	.12	.04	.05
1995	40500	.68	51.4	2.8	.16	.09	.05	.06
1997	44720	.63	51.4	2.8	.17	.1	.05	.06
1999	49643	.72	51.5	2.8	.17	.1	.05	.06
2001	52500	.79	51.5	2.8	.18	.11	.06	.06
2003	55000	.86	51.6	2.7	.19	.11	.06	.06
2005	56204	.93	52	2.7	.2	.11	.07	.06
2007	60800	.92	52.5	2.7	.2	.12	.08	.06
2009	62621	.97	53	2.7	.2	.12	.08	.06

Table 9: Descriptive Statistics, AHS National Surveys 1985-2013

C.4 Paradox of the Joneses, robustness checks

(a) Longitudinal surveys, all movers



(b) Cross-section 2011, all movers

Figure 15: Residuals of house satisfaction after controlling for objective house and household characteristics but size, AHS national surveys.

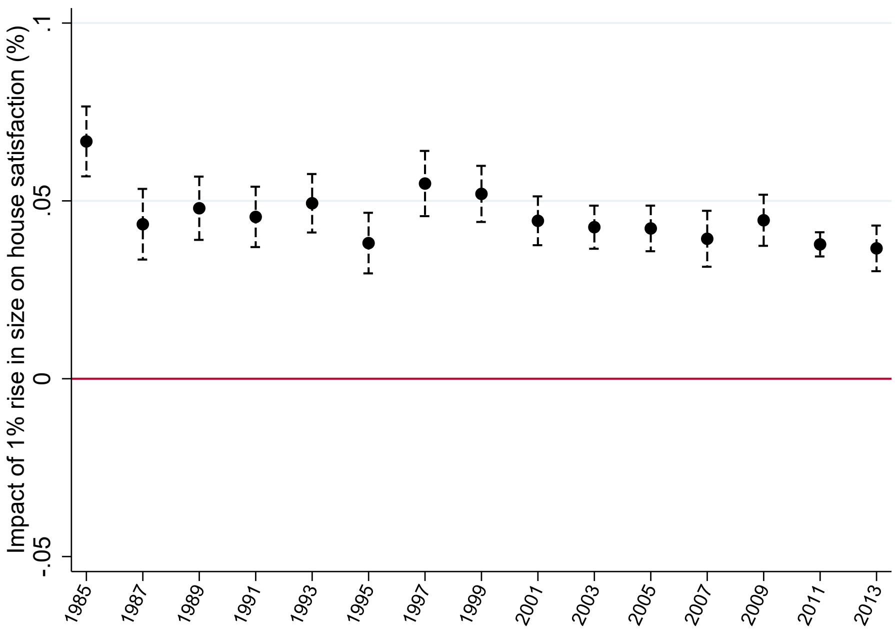


Figure 16: Regression coefficient of log size on log house satisfaction controlling for household characteristics (including time spent), price and age of the house. Cross-sections 1985-2013

C.5 Other Stylized Facts

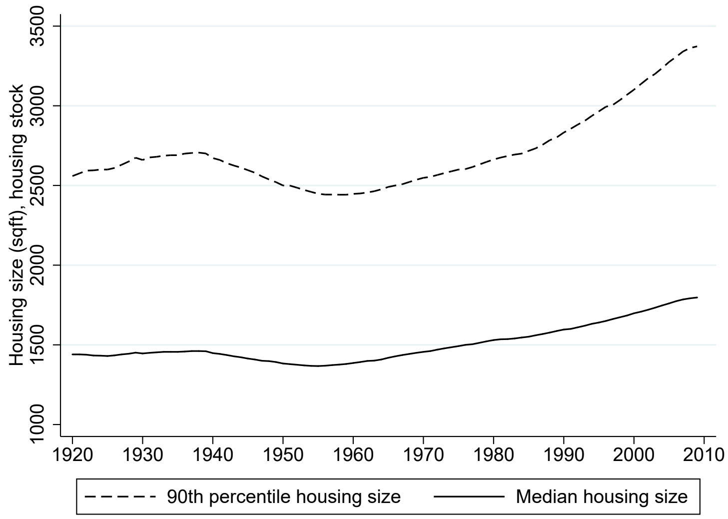
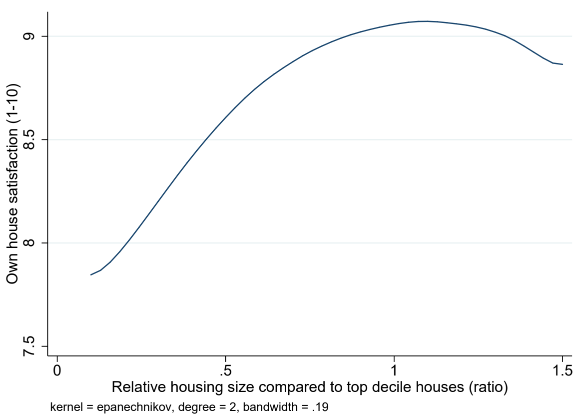
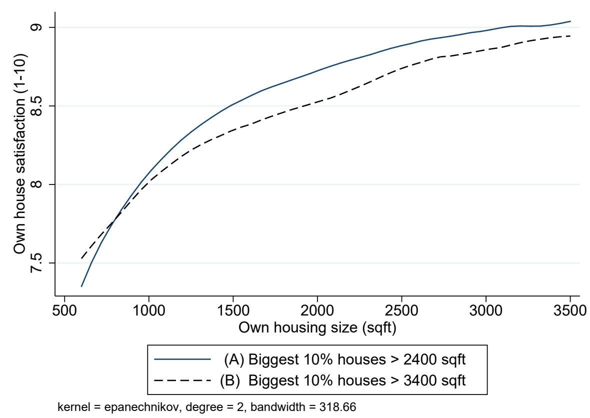


Figure 17: Size upscaling of suburban houses, housing stock (1920-2009)



(a) Concavity in relative size



(b) Ratio specification of relative size

Figure 18: Non-parametric house satisfaction curves

Figure 18a plots house satisfaction as a function of relative size, taking top decile houses as the reference size group. Figure 18b plots house satisfaction as a function of own housing size for bottom quartile suburbs in terms of reference housing size (90th percentile size = 2400 sqft) and top quartile suburbs (90th percentile size = 3400 sqft). To receive the same level of house satisfaction than a household from suburbs (A) living in a 1500 square feet house, households from suburbs (B) must increase own housing size by 500 square feet (Sources: author's own calculation from Zillow.com)

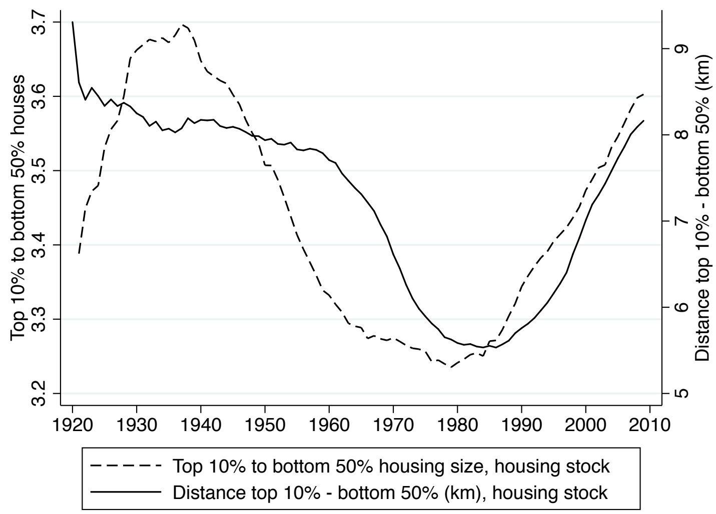


Figure 19: Spatial segregation vs. size inequality in suburban America, 1920-2009

The vertical-right axis shows the distance in kilometers separating the biggest ten percent houses built from below median houses within suburban counties, averaged over all suburban counties. The vertical-left axis shows the variation in size inequality of the housing stock, measured by the ratio of the biggest ten percent houses to the below median houses. (Sources: author's own calculation from Zillow.com)

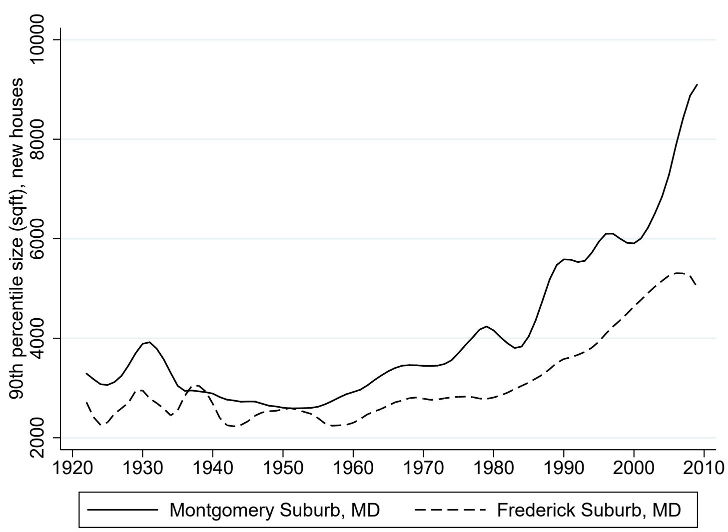


Figure 20: Frederick suburb vs. Montgomery suburb

The vertical axis shows the variation in 90th percentile housing size of newly built houses in two suburbs of the Washington metropolitan area (Maryland). (Sources: author's own calculation from Zillow.com).

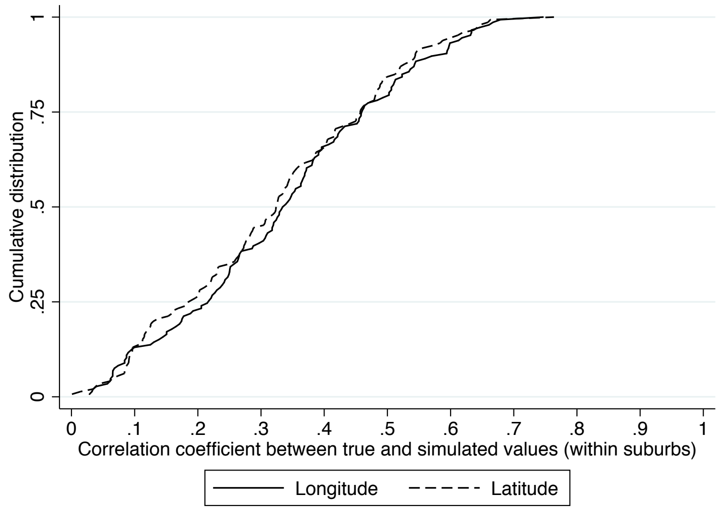


Figure 21: Cumulated distribution of correlation coefficients between true and simulated location

D Empirical Analysis

Table 10: Impact of experienced variations in reference housing size on house satisfaction (full table)

	(1)	(2)	(3)	(4)	(5)
			Log(HouseSatisfaction)$_{ismt}$		
Log(OwnSize)$_{ist}$	0.0968***	0.0977***	0.0857***	0.0326***	0.378***
	(0.00279)	(0.00291)	(0.00290)	(0.00261)	(0.0826)
Log(90thPercentileSize)$_{ismt}$	-0.0289***	-0.0654***	-0.0561***	-0.0386**	0.285***
	(0.00745)	(0.0194)	(0.0190)	(0.0174)	(0.0811)
Log(90thPercentileSize)$_{ismt}$ × Log(OwnSize)$_{ist}$					-0.0422***
					(0.0102)
Ln household annual income			0.0222***	0.00334***	0.00336***
			(0.00131)	(0.00122)	(0.00122)
Number of cars			0.00309***	0.000812	0.000729
			(0.000803)	(0.000864)	(0.000868)
Household size			-0.00709***	-0.00501***	-0.00498***
			(0.000656)	(0.000616)	(0.000617)
Age of householder			0.00225***	0.000957***	0.000964***
			(0.0000819)	(0.0000804)	(0.0000807)
Education of householder			0.000735	-0.00313***	-0.00322***
			(0.000467)	(0.000417)	(0.000414)
Latino			0.0225***	0.0242***	0.0239***
			(0.00387)	(0.00307)	(0.00305)
Black			-0.00476	0.0169***	0.0169***
			(0.00383)	(0.00315)	(0.00314)
Sex of householder			0.00374**	0.00371**	0.00383**
			(0.00161)	(0.00157)	(0.00157)
Upgrade in size				0.0184***	0.0190***
				(0.00550)	(0.00554)
Log(PurchasePrice)$_{ism}$				0.00177	0.00166
				(0.00162)	(0.00162)
Log(HouseMarketValue)				0.0239***	0.0238***
				(0.00265)	(0.00265)
Number of full bathrooms in unit				0.0133***	0.0136***
				(0.00115)	(0.00114)
Log(NeighborhoodSatisfaction)$_{ismt}$				0.273***	0.273***
				(0.00688)	(0.00688)
Age of the house				-0.00116***	-0.00117***
				(0.0000544)	(0.0000546)
Any inside water leaks in last 12 months				-0.0319***	-0.0319***
				(0.00251)	(0.00250)
Main heating equipment broke down				-0.0320***	-0.0320***
				(0.00692)	(0.00692)
Unit has porch/deck/balcony/patio				0.0217***	0.0215***
				(0.00290)	(0.00290)
Observations	168018	168018	168018	135891	135891
Adjusted R^2	0.044	0.056	0.073	0.214	0.215
Length of tenure FE	Yes	Yes	Yes	Yes	Yes
County x Year FE	No	Yes	Yes	Yes	Yes
Household Controls	No	No	Yes	Yes	Yes
House and Neighborhood Controls	No	No	No	Yes	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11:
Estimation of relative size controlling for lower parts of the size distribution

	(1)
	Log(HouseSatisfaction)$_{ismt}$
Log(OwnSize)$_{ist}$	0.0325***
	(0.00257)
Log(10thPercentileSize)$_{ismt}$	-0.0126
	(0.0196)
Log(30thPercentileSize)$_{ismt}$	0.0162
	(0.0269)
Log(70thPercentileSize)$_{ismt}$	0.0376
	(0.0299)
Log(90thPercentileSize)$_{ismt}$	-0.0760***
	(0.0282)
Observations	136787
Adjusted R^2	0.216
Suburb x Year FE	Yes
Length of tenure FE	Yes
Controls	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

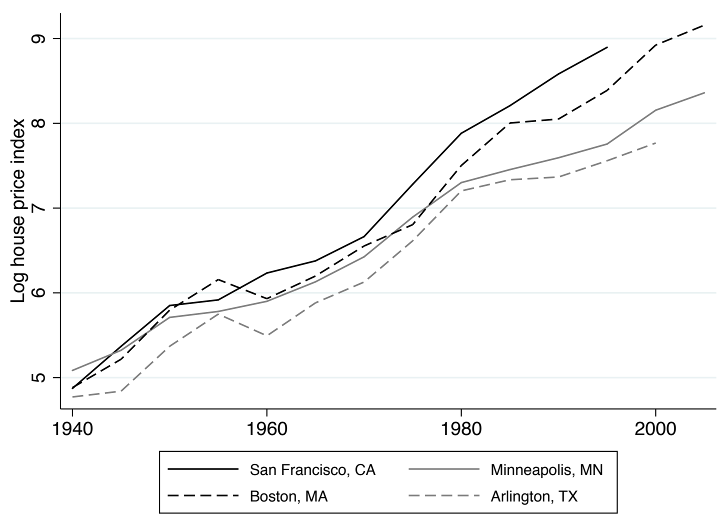


Figure 22: Log house price index (1940-2009)

The figure plots the logged house price index in four MSAs. The unlogged coefficients corresponds to the MSA-time intercepts of equation (1). I set the price for the excluded suburb-year to be 100 and those for the others to be 100 times the antilog of the corresponding coefficient estimate. (Sources: AHS)

Table 12:
Placebo test of relative size effect on neighborhood satisfaction

	(1)	(2)	(3)	(4)	(5)
		Log(NeighborhoodSatisfaction)_ist			
$\text{Log(OwnSize)}_{ist}$	0.0262***	0.0261***	0.0260***	0.0261***	0.0260***
	(0.00288)	(0.00288)	(0.00288)	(0.00288)	(0.00288)
$\text{Log(90thPercentileSize)}_{ismt}$	0.0209				-0.0313
	(0.0271)				(0.0432)
$\text{Log(70thPercentileSize)}_{ismt}$		0.0449*			0.00301
		(0.0244)			(0.0468)
$\text{Log(30thPercentileSize)}_{ismt}$			0.0613***		0.0483
			(0.0198)		(0.0378)
$\text{Log(10thPercentileSize)}_{ismt}$				0.0583***	0.0279
				(0.0179)	(0.0294)
Observations	136939	137604	137604	137604	136939
Adjusted R^2	0.068	0.068	0.068	0.068	0.068
Suburb x Year FE	Yes	Yes	Yes	Yes	Yes
Length of tenure FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13:
Interaction between age of the house and experience variation in top housing size

	House satisfaction$_{ismt}$ OLS (1)	Market value of the house$_{ismt}$ OLS (2)
Top 10% housing size$_{ismt}$	-0.426***	-0.136***
	(0.0825)	(0.0518)
Age of the house$_{it}$	-0.0625***	-0.0200***
	(0.0147)	(0.00575)
Top 10% housing size$_{ismt}$ × Age of the house$_{it}$	0.00643***	0.00214***
	(0.00173)	(0.000682)
County × Year	Yes	No
Time FE	Yes	Yes
Household characteristics	Yes	Yes
House and neighborhood quality	Yes	Yes
Observations	133980	134131
Adjusted R^2	0.297	0.607

Notes. Columns (1) and (2) runs the same regressions as, respectively, column (6) of table **??** and column (2) of table 4, but interact experienced variation in top housing size over the tenure period with the age of the house in years. Sampling weights are included in all regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$