The Paradox of the Joneses: Superstar Houses and Mortgage Frenzy in American Suburbs *

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[Preliminary draft, please do not quote]

Abstract

Despite a major upscaling of suburban houses over the last decades, average house satisfaction has remained steady in the United States. I show that upward comparison in size can explain this paradox, as top housing size mirrored the U-shaped pattern of top income inequality. 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 suburban owners who experienced a relative downscaling of their home due to the building of bigger units in their suburb record lower satisfaction and housing values. These homeowners are more likely to upscale and subscribe to extra mortgage loans. Results are robust to household fixed effects and concentrated in counties with low levels of segregation, suggesting a causal link between inequality and mortgage debt.

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

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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 rank in comparison to others in multiple sectors of the economy. Frank (2013) furtherly emphasized that in societies where income and wealth inequalities are constantly increasing, individual competition turns into a positional arms race with no improvements for society as a whole. This article argues positionality has been a key driver of housing market dynamics in American suburbs. Exploiting homeowners' experienced variations in the size of newly built houses after they moved in, it shows that within-suburb changes in the relative size of a house affects its valuation, and estimates 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 more than 3 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 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 the 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, average house satisfaction has remained steady. However, within a given year, living in a bigger house is systematically associated

[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.

with higher satisfaction[2]. The Easterlin paradox can be explained by the presence of hedonic adaptation and income comparisons in the utility function (Clark et al., 2008; Loewenstein and Ubel, 2008). The latter is largely influenced by the level of income inequality and 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, it can be classified as a typical positional good (Alpizar et al., 2005; Solnick and Hemenway, 2005; Heffetz, 2011)[3]. Besides, I show that variations in top housing size inequality displayed a similar U-shaped curve as the variation in top income inequality documented by Piketty and Saez (2003)[4].

To identify the presence of comparison effects in size at the county level, I use a methodology similar to Malmendier and Nagel (2011, 2016) on the past experiences of different birth cohorts. Here the identification is based on the experiences of different cohorts of movers within suburbs. I exploit cross-sectional experienced variations between existing home owners in the size of newly built suburban houses since they moved in. Suppose two similar households who lived in the same suburb and are both surveyed in 1995. The suburb's variation in top housing size saw a sharp increase between 1980 and 1990 but no rise since then. The only difference between household A and household B is that A moved in 1980 while B moved in 1990. Unless they perfectly internalized future variations in housing size when buying a house, household A, who experienced a rise in top housing size should be less satisfied than household B who experienced no change at all. From the American Housing Survey, I know homeowners' county of residence and tenure period, which allows me to match each household to representative time series of the flow of newly built houses obtained via web-scrapping techniques. This method answers Manski (1993)'s 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, cohort fixed effects and length of tenure to control for any general time trend and suburban differences between households at the time they are being surveyed. I complement the analysis with hedonic regression methods and further run an individual and house fixed effect estimator on a panel subsample of my dataset to account for any time-invariant unobservables. The hedonic and panel fixed effects results are consistent with the results obtained with the main specification.

The results confirm the presence of social preferences towards visible wealth inequality in American suburbs, consistent with the literature on difference inequity aversion (Fehr and Schmidt, 1999;

[2]This is robust over the income and size distributions and 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 persons 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]To the notable exception of Albouy and Zabek (2016) who use the gini of home prices and rent to measure housing inequality, this is the first attempt to relate US patterns of income concentration to visible wealth inequality over such a long period.

Charness and Rabin, 2002). A local increase in size of relatively bigger houses reduces my house satisfaction and house value, while a local increase of relatively smaller houses is not significant. The upward comparison effect is driven by the top of the distribution. I define superstar houses as houses belonging to the top decile of the size distribution. Their size is negatively related to house satisfaction, contrary to the median size. Social comparisons supports the trickle-down (or expenditure cascade) hypothesis discussed in Frank et al. (2010) or Bertrand and Morse (2013). A one percent rise in size at the top of the distribution offsets the utility gains from a similar rise in own housing size, and lowers the value of the house as assessed by the household. Competition for size in the housing market is a zero sum game, as further increases in the size of relatively bigger houses depreciates the subjective value of my own house. I also find evidence of hedonic adaptation, though significantly lower than previous results on poor slum dwellers in Latin America (Galiani et al., 2015).

A legitimate concern is that the effect on house satisfaction simply captures a general impact of inequality on life satisfaction, rather than a relative size effect. For instance, increases in average housing size could be associated to higher population density and congestion costs within counties, which would lower life satisfaction and, in turn, house satisfaction. To address this concern, I include experienced variation in population density as an additional control, which do not alter the significance of my results. I also replicate the analysis using a subjective neighborhood satisfaction index as the dependent variable. If anything, this alternative measure of life satisfaction is positively associated with experienced increase in top housing size. I also look directly at the effect of within suburb segregation, computed as the distance separating smaller houses from bigger houses. This spatial concern is critical as the rise in housing size inequality since the 1980s was associated to a simultaneous rise in segregation between rich and poor (Bischoff and Reardon, 2014). Experienced suburban segregation is positively associated to house satisfaction, but lowers neighborhood satisfaction. However, segregation and inequality are likely endogenous. Hence I also study the effect of variations in top housing size unrelated to variations in segregation using geographically constructed measures of developable land computed by Saiz (2010). Inelastic metropolitan areas where land is constrained face similar increase in size inequality than elastic areas, but almost no variation in housing segregation. As expected, the relative size effect is concentrated in these areas.

Lastly, controlling for individual and house fixed effects, I find that relative deprivation in size affected households' choices in terms of future upscaling and borrowings. A 1% rise in top housing size during the length of tenure was associated to a 0.1% rise in size through home improvements, and a 0.5% rise in the level of outstanding mortgage debt. Consistent with my previous findings, these effects are concentrated in areas with lower levels of segregation. Importantly, if higher housing size ends up having no long-term aggregate effect on house satisfaction, it may not be the case for its consequences on over-indebtedness. Indeed, a rise in own housing size may compensate the loss in utility generated by higher levels of outstanding debt to the extent that housing size is not relative. However, if households care about relative size, the negative effect of mortgage debt may prevail in the long-run, and even more so for credit-constrained households unable to rollover their debt.

The article first contributes to the literature on social preferences and relative income. Housing satisfaction being a significant component of general life satisfaction (Van Praag et al., 2003), I provide a likely channel for the understanding of previous findings on the negative impact of neighbor's income and top income shares on life satisfaction (Luttmer, 2004; Dynan and Ravina, 2007; Brodeur and Flèche, 2012; Burkhauser et al., 2016). It also adds to the urban economics literature on neighborhood effects and housing externalities. Using a different methodology, Ioannides and Zabel (2003) also 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 estimate the effect of a negative housing externality. The latter may generally act as a second-order effect on house prices, but previous studies confirm house prices to be weakly correlated to life satisfaction. Despite a doubling in UK property prices, Ratcliffe et al. (2010) finds a very small positive effect on life satisfaction. Regarding the link between measures of subjective well-being and individual choices, Benjamin et al. (2012) and Benjamin et al. (2014) show that subjective life satisfaction measures are good predictors of individual choices. The behavioral effects of relative deprivation on individual choices has been studied by Frank and Sunstein (2001), Charles et al. (2009), or Bertrand and Morse (2013) when it comes to conspicuous consumption. In the later study, the authors also provide evidence that income inequality led to financial distress. Lastly, regarding the link between income inequality and household debt, the existing evidence is mixed. Carr and Jayadev (2014) find positive effects at the state level using PSID data while Coibion et al. (2014) find a negative impact at the county level, using different datasets. However, neither these studies look at the housing market specifically, nor do they relate choices to happiness measures, despite evidence that individuals discontinue activities which reduce well-being (Kahneman et al., 1993; Shiv and Huber, 2000). Overall, the results of this article are consistent with the view of Mian et al. (2010) and Rajan (2011) that the rise of financial innovations in the mortgage market may have been the consequence of increasing social and political pressures due to feelings of relative deprivation.

The rest of the paper proceeds as follows. The next section provides a simple conceptual framework to illustrate the effect of experienced variation in relative housing size on house satisfaction. Section 3 presents the two main datasets along with important stylized facts and describes the methodology. Section 4 shows the results on positional housing size, and discusses their behavioral impact on individual choices. Section 5 concludes.

2 Experienced relative downscaling and house satisfaction

The method developed in the empirical section is based on cross-sectional experienced variations in housing size between households who moved at different periods within the same suburb. This theoretical intuition can be illustrated with a model of simple projection bias, as defined by Loewenstein et al. (2003). 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 could experience lower house satisfaction if her house looks comparatively smaller than neighboring houses, but the externality could also be positive, for instance if bigger neighboring 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 over time. First, the person may adapt to the house so that her absolute valuation decreases over time[5]. 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 size of the housing stock in the suburb at that time. 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 size of the housing stock follows an autoregressive process of order one, so that

$$H_k = \phi H_{k-1} + \epsilon_k$$

where $\phi > 0$ captures the growth rate of the housing stock 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

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

[5] 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

$$E_\tau\left[\tilde{U_\tau^{\tau'}}\right] \quad = \quad E_\tau\left[\sum_{k=\tau}^{\tau'}\left[(1-\alpha)(\gamma^{k-\tau}h_\tau-\nu H_k)+\alpha(h_\tau-\nu H_\tau)\right]-P\right] \quad \text{with} \quad 0\leq\alpha\leq 1$$

When $\alpha = 0$, the person experiences no projection bias so that $E_\tau\left[\tilde{U_\tau^{\tau'}}\right] = E_\tau\left[U_\tau^{\tau'}\right]$. 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 can be shown to equal

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

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[6]. 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 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 ($\phi < 1$).

[6]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 τ' who moved in the same suburb. A bought his house at time τ_1 while B bought his house one year later, at time $\tau_2 = \tau_1 + 1$. Both houses are comparable in size $h^A_{\tau_1} = h^B_{\tau_2} = h$. For $T > 1$, the difference in relative dissatisfaction of household A compared to household B is

$$D^{\tau'}_{\tau_1} - D^{\tau'}_{\tau_1+1} = \alpha(1 - \gamma^{T-1})h + \alpha\nu(T - 1)(\phi - 1)H_\tau$$

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 movers starts from a higher reference point than the early mover, the gap between his perceived and his true inter-temporal utility is relatively lower. Note that this theoretical set-up generates different predictions regarding the interaction between length of tenure and the two effects. Besides, it makes it clear that without controlling for households' length of tenure, any cross-sectional estimation of relative size effects may simply capture adaptation to the house.

3 Data and Methodology

3.1 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 dynamic changes in housing and occupancy characteristics. 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 (Deiner 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. A similar question is asked regarding the subjective valuation of one's neighborhood.

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. 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 counties between 1984 and 2009.

These counties represent about 54% of the total American population, and a much bigger share of the American suburban population. Importantly, 70% of American households were homeowners in 2007, compared to 90% for suburban households. Table 12 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 for each households' tenure period. Besides, a substantial fraction of households moved in before 1984. I therefore construct my own data from Zillow.com, a leading online real estate compagny in the US which regroups publicly available information on millions of houses for sale or rent. Using web scrapping techniques, I gather a sample of more than three 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 9 in annexe B.2 maps the location of the three millions houses scrapped. I restrict my scrapping program to suburban houses built between 1920 and 2009, which corresponds to the time frame during which AHS households moved in their respective houses, and collect information on the location of the house (latitude and longitude), the year the house was built as well as its 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 data is attrition bias. Indeed, assuming the biggest houses built got progressively destroyed. Then there should be an increasing downward bias as we go back in time. This would alter the distribution of houses in a systematic way. This concern is addressed in Annexe B.1. Comparing Zillow to the Census Survey of Construction (SOC), I find no evidence of attrition.

3.2 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 mean, below median and top ten percent housing size in all counties of my dataset. 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 now average 7000 square feet of living surface (650 square meters), compared to 3000 square feet (280 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 12 in appendix C.

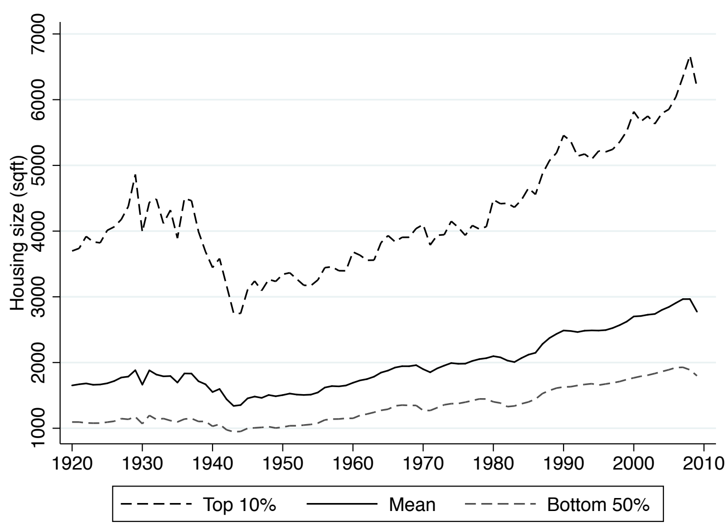
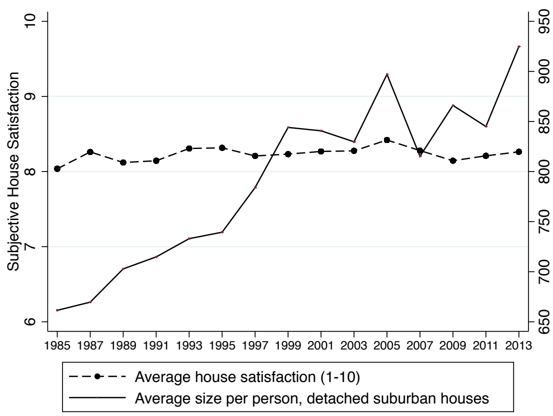


Figure 1: Size upscaling of newly built suburban houses (1920-2009)

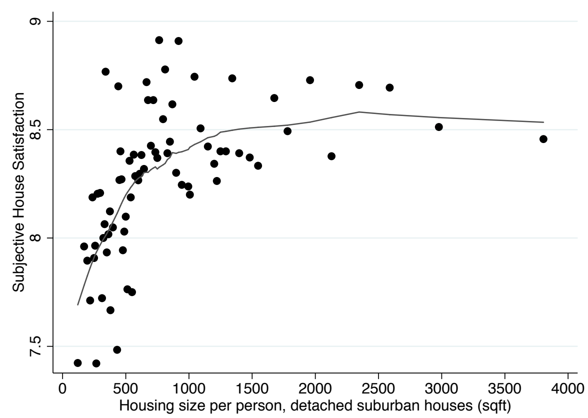
The vertical axis shows the variation in mean, below median and top ten percent size of newly built houses each year. (Source: author's own calculation from Zillow.com)

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[7]. Suburban households' satisfaction towards their house has remained steady over the period, despite an increase in housing size per person of about 50%. This is robust along the income and housing size distributions, as shown in figure 10 of appendix B.4. Figure 11a plots the residuals of house satisfaction after controlling for house and household objective characteristics except housing size and gives a similar result[8], which is also robust to the inclusion of old movers, adding the year the household moved in and the current market value of her house as further controls (figure 11b).



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



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

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 percentile within the overall housing size distribution in 2011. The vertical axis indicates the average house satisfaction of new movers in 2011 for each size percentile. The horizontal axis shows the size corresponding to each percentile. All averages are weighted using AHS sample weights (Sources: AHS national surveys).

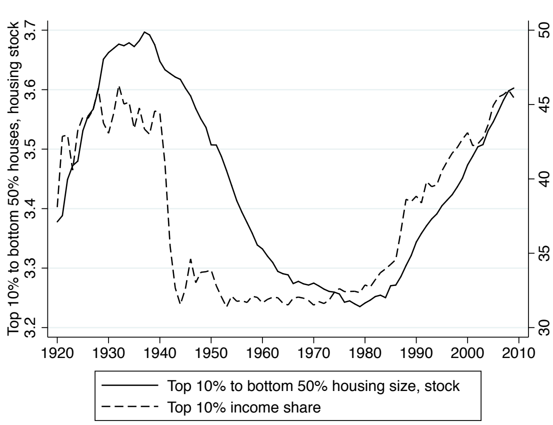
The paradox comes from the fact that a cross-sectional regression of house satisfaction on housing size systematically produces a positive correlation, as can be seen in figure 2b using the 2011 AHS survey. Typically, a 1% increase in own housing size leads up to a 0.1% rise in house satisfaction. Subjective satisfaction flattens out significantly above 1500 square feet per person,

[7]The size of the house is simply divided by the number of persons in the household to get a measure of housing size per capita.

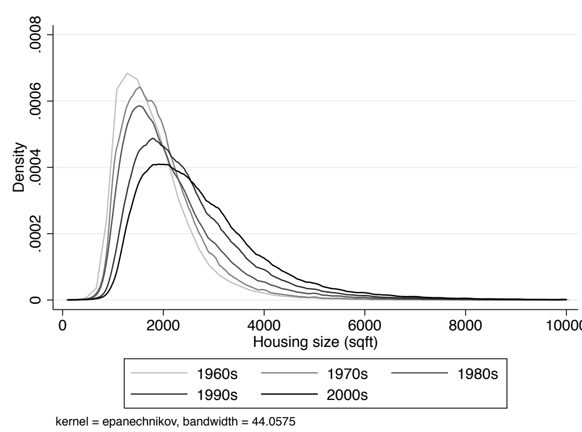
[8]Controls include household income, debt to income ratio, education, race, age, household size, number of cars, the purchase price of the house, distance to work, and the year the house was built.

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 600 square feet per person. The positive correlation result holds for every cross-sections of old or new movers between 1985 and 2013, with or without controls, as shown in tables 13, 14 and 15 for a selected sample of seven waves (appendix B.4).

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

3.3 Methodology

3.3.1 Main specification

Following Manski (1993)'s canonical typology, an endogeneous social effect corresponds to a situation where my own choice is affected by others' choices. The identification challenge then lies in the difficulty to control for contextual exogeneous effects. This is particularly relevant when a house purchase depends on the observed characteristics of others at the time a household decides to move. Typically, individuals expecting to earn a higher income, or more sensitive to social comparisons may endogenously sort into counties with bigger houses. However, this 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. Hence, following a methodology similar to Malmendier and Nagel (2011, 2016), I identify social preferences in relative housing size at the suburban level based on how house satisfaction reacts to cross-sectional differences between households in terms of their *experienced* variation in the size of newly built houses, and of changes in these cross-differences over time.

Assume two households surveyed in 2000. The first moved in 1980 while the second moved in 1990. From figure 3a, it is clear the former experienced a much higher rise in housing size inequality compared to the latter, whose initial reference point was already high when he moved in. Therefore, the former should have lower satisfaction than the latter. Figure 4 illustrates this approach taking the average house satisfaction between old and recent movers computed from the 15 waves of the national AHS surveys between 1985 and 2009. For each year, I plot the difference in the average house satisfaction of both groups of movers against their difference in experienced housing size inequality taken from figure 3a. As expected, the correlation is negative and significant. The higher is a household's experienced change in the relative size of big houses, the less satisfied he is with his own house.

In the empirical section, the measures of households' experienced changes in housing size is computed at the suburban county level, which is the smallest geographical level available in the AHS. It turns out there is substantial variation in relative housing size both within and between counties, as shown in figure 14 (annexe C), which plots the same measure of housing size inequality from figure 3a in two separate Californian suburbs. Again, consider two home owners interviewed in 2000. This time, they both moved in 1980, but household A moved in Orange County while household B moved in Sacramento 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 bigger 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.

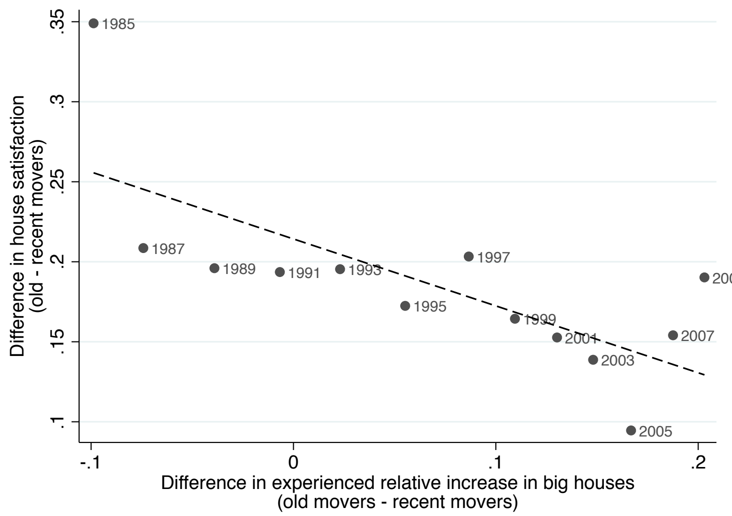


Figure 4: Difference in house satisfaction of old and recent movers plotted against differences in experienced relative increase in top housing size

The vertical axis shows the difference in average house satisfaction of old movers (tenure length $\geq$ 10 years) minus recent movers (tenure length $<$ 10 years). The horizontal axis shows the difference in the experienced change in housing size inequality of old movers during their tenure period minus the experienced change in housing size inequality of recent movers during their tenure period. The measure of housing size inequality is taken from figure 3a. The year labelled refer to the respective AHS survey years. Observations are weighted with AHS sample weights.

This method can be applied to the full sample of households, running the following regression:

$$U_{ismt} = \alpha_0 + \delta \ln H_{ismt} + \sum^{S} \alpha_{1st} \mathrm{S}_{st} + \sum^{T} \gamma_{1mt} \mathrm{T}_{mt} + \beta_1 q_{it} + \beta_2 n_{it} + \beta_3 x_{it} + u_{ismt} \quad (1)$$

where U_{ismt} is the house satisfaction of a household i living in suburb s at time t and who moved in year m, H_{ismt} corresponds to the experienced change in reference housing size of houses built in suburb s since the household moved in, S_{st} is a set of about 500 dummies controlling for suburb x year effects, and T_{mt} time dummies for the length of tenure (in years). A negative δ will be indicative of relative deprivation. Unless I control for suburb effects, δ is likely to be positive as suburbs with bigger houses are likely to be richer. The inclusion of suburb-year fixed effects also controls for any interpretation based on time-specific trends within and between counties. Lastly, I include a detailed list of controls for the quality q_{it} of the unit[9], the neighborhood quality n_{it}[10] and household characteristics x_{it}[11].

Experienced cross-sectional differences in reference housing size may be correlated to experienced variations in measures which also affect house satisfaction, such as population density or economic segregation within counties. The impact of experienced variation in 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, which is likely to reduce it. 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 variations in population density over the length of tenure. Regarding the impact of economic segregation, it is specifically discussed in section 4.2, as it may interact with housing size inequality by reducing comparison effects. Sampling weights and robust standard errors clustered at the county-year level are included in all specifications[12].

3.3.2 Hedonic pricing and fixed effect estimator

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. Hence if markets are in equilibrium, the relative deprivation externality directly estimated from the house satisfaction regression should be fully internalized in the current market value of the house. I also estimate the relative size externality from a hedonic regression on the current market value of houses[13]. The underlying assumptions distinguishing the hedonic pricing method from the house satisfaction method are discussed in appendix A. To derive a hedonic cost of relative deprivation, I follow the common log linear approach of estimating the hedonic house price function (Ioannides and Zabel, 2003; Zabel, 2004). Assuming that the equilibrium condition (5)

[9] Controls on the structure characteristics are the size of the house in square feet, the number of rooms (bathrooms, living rooms, dining rooms, tv rooms, bedrooms, kitchens and total number of rooms), the purchased price of the house, its current market value and monthly housing costs (including energy costs, mortgage payments, and real estate taxes), the year the house was built, whether the unit has a basement, whether the heating equipment is functional, the presence of holes in the floor or roof, whether the house has an offstreet parking, whether the unit experienced any water leak in the past twelve months, and whether there has been home improvements since the house was bought.

[10] Neighborhood quality is evaluated by the household at time t on a scale from 1 to 10, which also controls for possible measurement errors in the way households answer subjective questions. However, results are robust to the inclusion of objective quality measures such as crime or schooling.

[11] 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.

[12] Clustering accounts for random disturbances correlated within groups of houses due to the longitudinal nature of the AHS (Moulton, 1990). This is less of an issue here since I recover reference housing size from a different survey.

[13] 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).

holds, I can estimate the relationship between the current market value of the house, its structure and neighborhood characteristics q_{it} and n_{it} as defined above, and the housing externality H_{ist}. Equation (2) echoes the house satisfaction regression except that it does not include household characteristics, which is the standard approach in hedonic pricing regressions. Hence the new measure of reference housing size H_{ist} does not depend on m.

$$\ln W_{ist} = \alpha_0 + \delta \ln H_{ist} + \sum^{S} \alpha_{1st} \mathrm{S}_{st} + \beta_1 q_{it} + \beta_2 n_{it} + u_{ist} \tag{2}$$

Lastly, none of the previous specifications control for household and house specific fixed effects, which may bias the results if the individual trait v_i is linearly related to H_{ismt}. For instance, happier households may be less sensitive to projection bias at the time they decide to purchase a house, and so be less likely to experience unpredicted future changes in relative housing size, which would bias the δ coefficient downward. Similarly, households experiencing higher increases in reference housing size may also live in houses located in more remote areas within suburb, which would also bias the δ coefficient downward. A house fixed effect controls for the exact location of the house. Hence, I re-run the house satisfaction and hedonic regressions on a smaller sub-sample of houses and households interviewed more than once. This allows me to run an (unbalanced) fixed effect estimator with panel robust standard errors, controlling for house and household fixed effects. The FE estimator eliminates v_i by demeaning the variables between survey years using the within transformation:

$$U_{ist} - \bar{U}_{is} = \delta(\ln H_{ist} - \overline{\ln H_{is}}) + \beta_1(q_{it} - \bar{q}_i) + \beta_2(n_{it} - \bar{n}_i) + \beta_3(x_{it} - \bar{x}_i) + \gamma_t + u_{ist} - \bar{u}_{is} \tag{3}$$

$$\ln W_{ist} - \overline{\ln W_{is}} = \delta(\ln H_{ist} - \overline{\ln H_{is}}) + \beta_1(q_{it} - \bar{q}_i) + \beta_2(n_{it} - \bar{n}_i) + \gamma_t + u_{ist} - \bar{u}_{is} \tag{4}$$

where each uperbar variable corresponds to the variable mean. The house panel is composed of 40,912 individual houses surveyed two to four times, on average avery five years between 1984 and 2009. The household panel includes 24,494 households surveyed at least twice. Coefficient δ now captures the relative downscaling effect due to houses built between two survey years. Since the panel is unbalanced, 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.

4 Empirical results

4.1 Upward comparison in relative housing size

Three main hypotheses are tested regarding social preferences on relative housing size. They can be summarized from a simplified model of interdependent preferences, as proposed by Charness and Rabin (2002). The value of one's house depends on own housing size h_i and other's housing size H_o such that

$$U_i = \begin{cases} (1-\rho)h_i + \rho H_o & \text{if } h_i < H_o \\ (1-\sigma)h_i + \sigma H_o & \text{if } h_i > H_o \end{cases}$$

A 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[14]. Households then only care about houses bigger than their own, so that $\sigma = 0$ and $\rho < 0$. The second hypothesis is the signaling effect, which posits households wish to distinguish from the smallest houses built, so that $\rho = 0$ and $\sigma < 0$[15]. A third hypothesis proposed by Fehr and Schmidt (1999) and related to the first one, is called (difference) inequity aversion so that $\rho < 0 < \sigma$. To test these different hypotheses, I construct four measures of reference housing size since the household moved in: the median housing size, which captures the general increase in housing size regardless of what happens at the top of the distribution, the average size of all houses bigger than the household's own house, the average size of the biggest ten percent houses (or "superstar houses"), and the average size of all houses smaller than the household's own house.

Table 1 below displays the main results of the pooled OLS and ordered logit regressions from specification (1)[16]. Own housing size positively affects subjective house satisfaction. The increase in median housing size is not significant, while the average size of houses bigger than the household's own house is negative and significant. However, the latter is driven by experienced variations at the top of the size distribution: it becomes insignificant once I include the size of the biggest ten percent houses built, which is negative and highly significant. To check for the presence of downward looking effects, I add the average size of houses smaller than the household's own house, which turns out to be positive and weakly significant. This is in line with difference inequity aversion, but appears to be entirely driven by price effects. Indeed, once I control for the current market value of the house, only the top ten percent housing size remains negative and significant. This result is robust to an ordered logit specification. 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 effect

[14] Bowles and Park (2005); Frank et al. (2010); Bertrand and Morse (2013)

[15] Ireland (1994); Glazer and Konrad (1996).

[16] See table **??** in Appendix for the table with the full list of coefficients.

of superstar houses is sizable: it largely offset the positive impact of a similar rise in own housing size. Typically, a doubling of the top percent housing size leads to a 0.35 fall in house satisfaction, which corresponds to about a quarter of a standard deviation.

Table 1:
Impact of experienced variations in reference housing size on house satisfaction

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	Ordered Logit (7)
Own housing size$_{it}$	0.299***	0.363***	0.344***	0.183*	0.183*	0.159	0.208
	(0.0151)	(0.0330)	(0.0332)	(0.0950)	(0.0950)	(0.0964)	(0.132)
Median housing size$_{ismt}$	0.0590	0.0766	0.185	0.148	0.148	0.112	0.184
	(0.113)	(0.112)	(0.119)	(0.121)	(0.119)	(0.115)	(0.165)
Size of houses bigger than own house$_{ismt}$	-	-0.102**	-0.0725	0.0278	0.0278	0.0232	0.177
		(0.0439)	(0.0453)	(0.0708)	(0.0708)	(0.0706)	(0.108)
Top 10% housing size$_{ismt}$	-	-	-0.273***	-0.309***	-0.309***	-0.290***	-0.525***
			(0.0943)	(0.0970)	(0.0976)	(0.0969)	(0.150)
Size of houses smaller than own house$_{ismt}$	-	-	-	0.153*	0.153*	0.131	0.108
				(0.0886)	(0.0885)	(0.0899)	(0.114)
Population density growth$_{ismt}$	-	-	-	-	-0.000400	-0.00207	0.00702
					(0.00941)	(0.00920)	(0.0149)
Current market value of the house	-	-	-	-	-	0.148***	0.219***
						(0.0143)	(0.0225)
County × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
House and neighborhood quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Price controls	No	No	No	No	No	Yes	Yes
Observations	133980	133980	133980	133980	133980	133980	133980
Adjusted R^2	0.294	0.294	0.294	0.294	0.294	0.297	-
Pseudo R^2	-	-	-	-	-	-	0.124

Notes. Columns (1) to (6) reports the OLS estimation of equation (1), which regresses the subjective house satisfaction index on logged experienced variations in reference housing size from Zillow. Column (7) reports the estimates from an ordered logit model. In column (1), reference housing size is the logged average size of houses bigger than i's own housing size in the suburb since the household moved in. Column (2) adds the log size of the biggest ten percent houses built in the suburb since the household moved in. Columns (3) and (4) adds, respectively, the logged average size of houses smaller than i's own housing size and the median housing size. Column (5) adds the experienced change in population density since the household moved in and column (6) controls for the logged current market value of the house. All regressions control for suburb-year fixed effects, a set of dummies for the number of years spent in the house, the size of the house in square feet, the number of rooms (bathrooms, living rooms, dining rooms, tv rooms, bedrooms, kitchens and total number of rooms), the purchase price of the house, monthly housing costs (including energy costs, mortgage payments, and real estate taxes), the year the house was built, whether the unit has a basement, whether the heating equipment is functional, the presence of holes in the floor or roof, whether the house has an offstreet parking, whether the unit experienced any water leak in the past twelve months, whether there has been home improvements since the house was bought, subjective neighborhood quality, the age of the households head and its square, his race, sex and level of education, the log of the households annual income, the log of mortgage debt, the number of persons in the household and the number of cars in the household. Sampling weights are included in all regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Of course, the coefficient on top 10% housing size is an average effect. It could be highly heterogeneous depending on how a given house compares to the biggest houses built in the suburb. I therefore interact my measure of top 10% reference housing size with a dummy capturing whether the household's own housing size lies below the median size of newly built houses or belongs to the top size decile of houses built. I also interact own housing size with this measure of reference housing size and the length of tenure in years, to further identify the relative size and habituation effects discussed in section 2. Indeed, one should expect the interaction coefficient to be negative: the positive correlation between own housing size and house satisfaction should be lower for households who experienced a higher rise in top ten percent housing size (relative deprivation effect) and stayed in their house for a longer period of time (habituation effect). Table **??** shows the decomposition of the relative size effect for the variables of interest using the pooled OLS model (columns 1-2) and the ordered logit model (columns 3-4).

Table 2:
OLS and ordered logit regressions of relative deprivation in size and habituation effect

	OLS (1)	OLS (2)	Ordered logit (3)	Ordered logit (4)
Own housing size$_{it}$	1.592*** (0.549)	0.258*** (0.0241)	2.085** (0.953)	0.368*** (0.0339)
Own housing size$_{it}$ × Top 10% housing size$_{ismt}$	-0.149** (0.0646)	-	-0.191* (0.112)	-
Own housing size$_{it}$ × Time since moving in$_{it}$	-0.00447*** (0.00110)	-	-0.00554*** (0.00173)	-
Top 10% housing size$_{ismt}$	0.870* (0.527)	-0.292*** (0.0794)	1.028 (0.904)	-0.440*** (0.126)
Top 10% housing size$_{ismt}$ × Below median$_{it}$	-	0.0623 (0.0450)	-	0.0727 (0.0752)
Top 10% housing size$_{ismt}$ × Top decile$_{it}$	-	-0.273** (0.126)	-	-0.449** (0.182)
Time since moving in$_{it}$	0.0383*** (0.00823)	0.00460*** (0.000835)	0.0476*** (0.0127)	0.00584*** (0.00134)
County × Year FE	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
House and neighborhood quality	Yes	Yes	Yes	Yes
Price controls	Yes	Yes	Yes	Yes
Observations	133980	133980	133980	133980
Adjusted R^2	0.296	0.296	-	-
Pseudo R^2	-	-	0.125	0.125

Notes. Columns (1) to (4) reports the OLS and ordered logit estimation of equation (1), which regresses the subjective house satisfaction index on the logged experienced variation in the average size of the biggest ten percent houses built since the household moved in. Columns (1) and (3) interact own housing size with the logged average size of the biggest ten percent houses built and the length of tenure. Columns (2) and (4) interact the logged average size of the biggest ten percent houses built with dummy variables for whether the household's own house belongs to below median size houses or to the tenth size decile. All regressions control for the full list of controls listed in table 1 (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 from columns (1) and (3) confirm the trickle-down effect on relative housing size. The positive marginal effect of own housing size on house satisfaction is lower when households experienced a rise in size of other houses at the top of the distribution. Columns (2) and (4) show the effect remains negative and significant for below median houses, but houses at the top of the distribution are much more strongly affected by the relative size effect: the negative externality is twice stronger for houses that belong to the tenth decile of the size distribution. This may come from a social interaction effect, since bigger houses tend to be built closer to each other, or from a tendency of richer households to be more sensitive to social comparisons. One way to distinguish between these two possibilities is to run the fixed effect model described in equation (3). If the heterogeneity is due to a social interaction effect, it will persist with the fixed effect estimator. If it is explained by heterogeneous sensitivity in social comparisons, it will be absorbed by the household fixed effect.

Table 3:
Fixed effect estimator of relative housing size on house satisfaction

	Fixed effect estimator (1)	Fixed effect estimator (2)
Home size improvements$_{it}$	0.316*** (0.0201)	0.291*** (0.0294)
Top 10% housing size$_{ist}$	-0.139*** (0.0386)	-0.131*** (0.0486)
Top 10% housing size$_{ist}$ × Below median$_{it}$	-	0.0166 (0.0685)
Top 10% housing size$_{ist}$ × Top decile$_{it}$	-	-0.413** (0.186)
Household FE	Yes	Yes
Household characteristics	Yes	Yes
House and neighborhood quality	Yes	Yes
Price controls	Yes	Yes
Observations	54597	54597
Within R^2	0.153	0.153

Notes. Columns (1) and (2) reports coefficients from the household fixed effect estimator described by equation (3), which regresses the subjective house satisfaction index on the logged average size of the biggest ten percent houses built at the time of survey. Column (2) interacts the logged average size of the biggest ten percent houses built with dummy variables for whether the household's own house belongs to below median size houses or to the top size decile. All regressions control for the full list of controls listed in table 1 (notes). Sampling weights are included in all regressions. Panel robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.2 Economic segregation within suburbs

The relative size effect should only be experienced when other's choices are visible. Arguably, if the rise was associated with 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 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 13 in annexe B.5 relates this measure of housing segregation averaged over all counties to the variation in housing size inequality from 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.

Table 4:
House Satisfaction, Neighborhood Satisfaction and Economic Segregation

	House satisfaction		Neighborhood satisfaction	
	OLS	Ordered Logit	OLS	Ordered Logit
	(1)	(2)	(3)	(4)
Top 10% housing size$_{ismt}$	-0.243***	-0.381***	0.154	0.0932
	(0.0843)	(0.138)	(0.105)	(0.139)
Distance top 10% - predicted location of own house$_{ismt}$	0.0272***	0.0366***	-0.0290***	-0.0384***
	(0.00760)	(0.0108)	(0.00832)	(0.0111)
County × Year FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
House quality	Yes	Yes	Yes	Yes
Neighborhood quality	Yes	Yes	No	No
Price controls	Yes	Yes	Yes	Yes
Observations	126077	126077	126077	126077
Adjusted R^2	0.299	-	0.273	-
Pseudo R^2	-	0.125	-	0.119

Notes. Columns (1) and (2) reports the OLS and ordered logit estimation of equation (1), 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. In columns (3) and (4), I replace house satisfaction by neighborhood satisfaction as a dependent variable. All regressions control for the full list of controls listed in table 1 (notes), including the logged experienced variation in segregation as an additional control, defined as the distance in kilometers separating the biggest ten percent houses built since the household moved from the predicted location of the household's house. Sampling weights are included in all regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The AHS does not provide the exact location of a house within each county but it is possible to approximate its location from the information provided by Zillow.com. I predict an AHS house's location based on the latitude and longitude of houses built in the same suburban county during the same year and belonging to the same size decile. This method relies on the assumption that houses of similar size are generally built closer from each other than houses of very different size. This is generally the case in American suburbs, where houses are built following a block pattern or grid plan, but it may also capture different neighborhoods within suburban counties. I use the same specification as in columns (6) and (7) of table 1 and include the experienced variation in segregation since the household moved in as an additional control. I also run the same regressions replacing subjective house satisfaction by subjective neighborhood satisfaction as a dependent variable. Table 4 shows the coefficients on the size of superstar houses and their distance from the household's predicted location.

As before, an experienced increase in size of superstar houses reduces house satisfaction. However, the more distant superstar houses are from a household's predicted location, the more satisfied a household is with her house. Interestingly, households favor less segregated neighborhood, as the coefficient on neighborhood satisfaction is negative, but the size of bigger houses does not significantly affect neighborhood satisfaction. This table indicates that if households wish to move into neighborhoods with relatively bigger houses, which are better valued, they must also build bigger houses to feel as satisfied as households who decide to move in areas with lower levels of top housing size.

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].

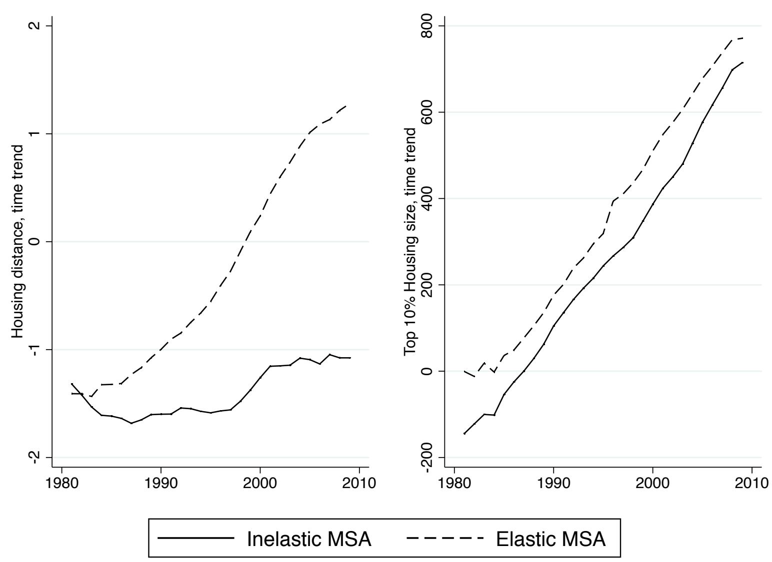


Figure 5: Residual historical variation in top 10% housing size and economic segregation after controlling for county fixed effects (1980-2009), inelastic vs. elastic counties

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)

[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.

Figure 5 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 5 tests the prediction that the coefficient on reference housing size should be stronger in inelastic areas. It runs the same regression as in table 2 but the experienced variation in top housing size is now interacted with a dummy for elastic and inelastic counties.

Table 5:
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 (1), 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 1 (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.

4.3 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 inelastic areas (Gyourko et al., 2006; Mian and Sufi, 2009). However, relatively deprived areas with lower land prices may also 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 6:
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 6 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%. The positive effect on house prices is even stronger in counties with inelastic housing supply, which is where the negative relative size effect is also the strongest. This reduces the concern that previous findings result from lower housing price expectations.

Of course, this positive first order effect does not exclude the presence of a negative second-order effect on relative housing size. In the presence of upward comparison effects, households who experienced a stronger increase in top housing size should value their house relatively less than households who experienced a smaller increase, and this should also be especially true in inelastic counties. I replace the subjective house satisfaction index from the main specification by the current market value of the house as the dependent variable. Results are shown on table 7.

Table 7:
Impact of experienced variation in top housing size on current market value of the house

	OLS (1)	OLS (2)	OLS (3)
Own housing size$_{it}$	0.149***	0.244***	0.243***
	(0.0125)	(0.0102)	(0.0102)
Median housing size$_{ismt}$	0.245**	0.345***	0.285***
	(0.117)	(0.0666)	(0.0619)
Top 10% housing size$_{ismt}$	0.431***	-0.171***	-0.0191
	(0.0696)	(0.0481)	(0.0482)
Top 10% housing size$_{ismt}$ × Inelastic counties$_s$	-	-	-0.472***
			(0.103)
Top 10% housing size$_{ismt}$ × Elastic counties$_s$	-	-	0.0975
			(0.0621)
County × Year FE	No	Yes	Yes
Time FE	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes
House and neighborhood quality	Yes	Yes	Yes
Observations	134131	134131	134131
Adjusted R^2	0.486	0.607	0.608

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. Sampling weights are included in all regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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 6. 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. Column (3) shows this behavioral effect is also concentrated in inelastic counties, in line with previous results on subjective house satisfaction.

Findings are robust to a standard hedonic pricing approach, which excludes household characteristics. I then replaced the experienced variation in reference housing size H_{ismt} by a measure which does not depend on the year m the household moved in. For each survey year and within each county, I follow specification (2) and regress the market value of the house on the size of all houses bigger than the household's own house, which allows me to add county-year effects. I can also apply the hedonic pricing regression on a smaller subsample of houses surveyed more than once, applying the house fixed effect specification described in equation (4). With the fixed effect estimator, all time-invariant unobservable characteristics of houses are controlled for, including their exact location within suburbs. Table 8 summarizes the main results.

Table 8:
Hedonic regression of current market value of the house on reference housing size

	OLS (1)	OLS (2)	Fixed effect estimator (3)
Own housing size$_{it}$	-0.0762	0.414***	0.224***
	(0.0533)	(0.0216)	(0.0531)
Average size of houses bigger than own house$_{ist}$	0.454***	-0.101***	-0.154**
	(0.0706)	(0.0278)	(0.0647)
House and neighborhood quality	Yes	Yes	Yes
County × Year FE	No	Yes	Yes
House FE	No	No	Yes
Observations	134130	134130	94456
Adjusted R^2	0.368	0.580	0.186

Notes. Columns (1) and (2) reports OLS estimates from specification (2) with and without controlling for county-year effects. Columns (3) reports coefficients from the house fixed effect estimator described by equation (4). All regressions control for the full list of controls listed in table 1 (notes). Sampling weights are included and robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns (1) and (2) reports the OLS estimates from specification (2) with and without controlling for county-year effects. Just like in the previous table, the coefficient on the average size of bigger houses is positive without county-year fixed effects, but becomes negative when they are added to the regression. Columns (3) reports coefficients from the house fixed effect estimator. The coefficient on reference housing size is close to the OLS specification with county-year fixed effects. Overall, results are robust to these alternative specifications, with similar levels of magnitude

4.4 Impact on individual choices

Between 1945 and 2009, mortgage debt went from 20% to 90% of households' annual income. This mortgage frenzy, which led to the 2008 financial crisis, followed the same trend as the variation in size of suburban houses, as evidenced in figure 6. In this last section, I discuss the contribution of the relative size effect to this national trend. I first test whether the size of a household's house and the value of her mortgage in the year they decided to move is an increasing function of the top housing size at that time. Results are estimated controlling for county-year effects, time dummies for the year of purchased, and a list of house and household characteristics[18]. Table 9 shows the estimated coefficient on reference housing size for own housing size and the amount of mortgage debt.

[18]These controls include the full list of household and neighborhood characteristics at the time of survey listed in footnote 11, the age of the house at time of purchased, the presence of home size improvements over the twelve months preceding the time of survey, the purchase price of the house, and the suburban population density at time of purchased.

Table 9:
Regression of reference housing size on own housing size and mortgage debt at time of purchased

	Own housing size$_{im}$ (1)	Amount of mortgage debt$_{im}$ (2)
Top 10% housing size$_{ism}$	0.114**	1.696***
	(0.0483)	(0.137)
County × Year FE	Yes	Yes
Moving year FE	Yes	Yes
House and household controls	Yes	Yes
Observations	162563	113216
Adjusted R^2	0.301	0.623

Notes. Column (1) regresses the size of the household's house on the log size of the biggest ten percent houses in his county at the time of purchase. Column (2) regresses the amount of mortgage debt on the log size of the biggest ten percent houses in his county at the time of purchase. Results are estimated controlling for county-year effects, time dummies for the year of purchased, the full list of household and neighborhood characteristics at the time of survey listed in footnote 11, the age of the house at time of purchased, the presence of home size improvements over the twelve months preceding the time of survey, the purchase price of the house, and the suburban population density at time of purchased. Sampling weights are included in both regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Both are positive and significant. However, these results cannot be interpreted as causal, as they do not address the reflection problem, in particular issues of endogenous sorting based on unobserved household and house characteristics. Previous evidence supported the view that households do not internalize future variations in housing size at the time they take their home investment decision. However, once they realize how the housing stock varies, they may decide to remodel their own house and subscribe to additional sources of credit. If households who experienced a relative downscaling of their house react by keeping up with the Joneses, one should expect a significant and positive correlation between experienced variation in top housing size and higher borrowing. This is illustrated in figure 7, where I replace the difference in house satisfaction from figure 4 by the difference in home improvements (measured in square feet) and the difference in the percentage of households who subscribed to new mortgage loans. The correlation is significant and positive in both cases.

To identify the effect of upward comparison on housing choices, I look at whether households choose to increase the size of their house at the cost of higher levels of debt when they experience a rise in top housing size between two survey years. I run the same household fixed effect specification as in equation 3, expect that I replace the house satisfaction index with the size of the household's house and outstanding amount of mortgage debt. For mortgage debt, I use a Poisson fixed effect estimator due to the important number of zeros. Indeed, most households had already reimbursed their mortgage debt when surveyed. Results are shown in table 10 below.

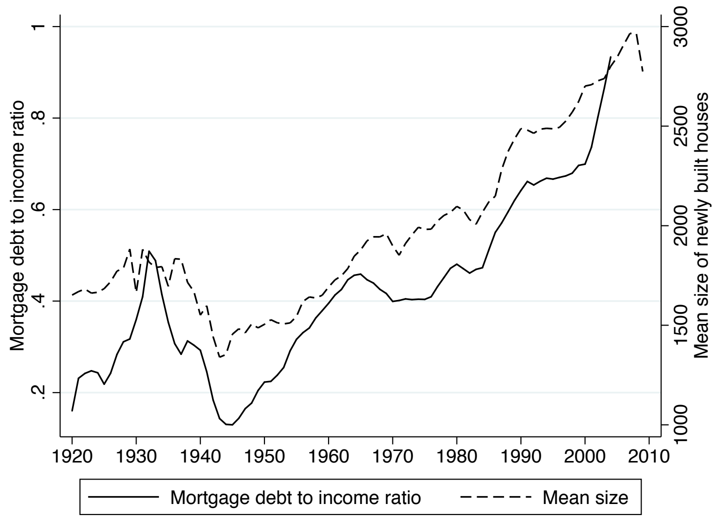
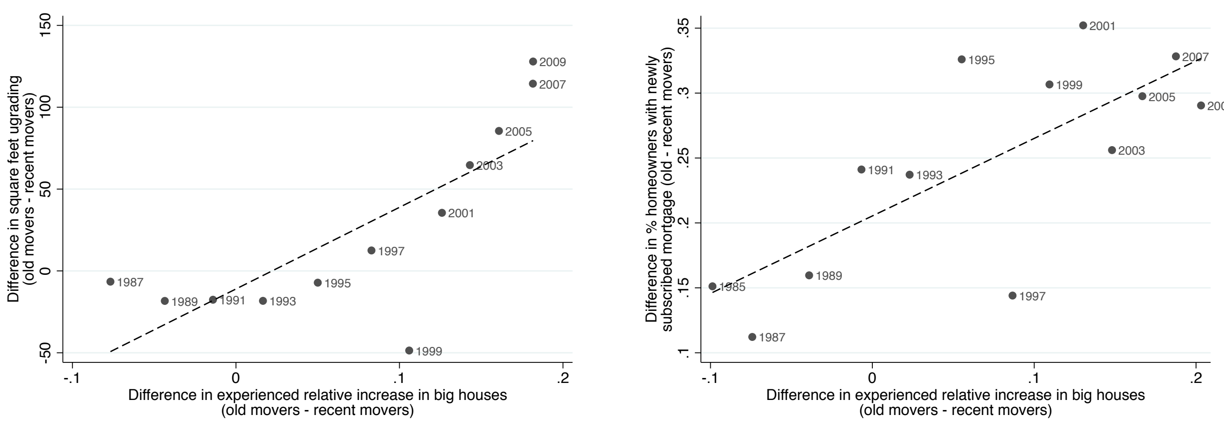


Figure 6: Mortgage debt to income ratio vs. below median housing size (1920-2009)

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



(a) Home improvements

(b) Newly subscribed mortgages

Figure 7: Difference in home improvements and extra mortgage subscription rate of old and recent movers' plotted against differences in experienced relative increase in top housing size

The vertical axes shows the difference in square feet upgrading (figure 7a) and mortgage subscription rate (figure 7b) of old movers (tenure length $\geq$ 10 years) minus recent movers (tenure length $<$ 10 years). The horizontal axes shows the corresponding difference in the experienced change in housing size inequality during their tenure period. The measure of housing size inequality is taken from figure 3a. The year labelled refer to the respective AHS survey years. Observations are weighted with AHS sample weights.

Table 10:
Household fixed effect estimator of relative housing size on upscaling and mortgage debt

	Home size improvements$_{it}$		Mortgage debt change$_{it}$	
	FE estimator	FE estimator	Poisson FE	Poisson FE
	(1)	(2)	(3)	(4)
Top 10% housing size$_{ist}$	0.0574*	0.0319	0.491**	0.521**
	(0.0336)	(0.0351)	(0.204)	(0.222)
Top 10% housing size$_{ist}$ × Inelastic counties$_s$	-	0.0892**	-	0.189
		(0.0354)		(0.221)
Top 10% housing size$_{ist}$ × Elastic counties$_s$	-	0.0492	-	-0.212
		(0.0353)		(0.222)
Household FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes
House and neighborhood controls	Yes	Yes	Yes	Yes
Observations	54801	54801	54801	54801
Within R^2	0.032	0.032	-	-

Notes. The table reports coefficients from the household fixed effect estimator described by equation (3), with a different dependent variable. In columns (1) and (2) the subjective house satisfaction index is replaced by the log size of the house. In columns (3) and (4), the subjective house satisfaction index is replaced by the log outstanding amount of mortgage debt. All regressions control for the full list of controls listed in table 1 (notes), expect that the subjective house satisfaction index is now used as a control and the new dependent variables are excluded from the control list. Sampling weights are included in all regressions. Panel robust standard errors are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A 1% rise in the size of superstar houses leads up to a 0.1% upscaling of suburban houses. Interestingly, the effect is concentrated in inelastic areas, in line with previous findings on relative deprivation. The effect is also positive and significant for the level of mortgage debt, as a 1% rise in top housing size leads to a 0.5% rise in the amount of mortgage debt. These results supports the view that households experiencing relative deprivation due to the downscaling of their house react by signing up to additional mortgages in order to upscale the size of their house.

5 Robustness checks

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 16 (annexe D) confirms that I am capturing a relative size effect. If anything, only median housing size is significant and positively correlated to neighborhood satisfaction.

5.2 Relatively smaller or relatively older?

The fact that the effect is mostly driven by the top of the size distribution and that the interaction between own housing size and reference housing size is negative supports the case that size matters. However, the size of newly built houses may correlate with their unobserved quality, capturing better design, more efficient heating technologies, or the mere value of novelty. Controlling for the age of the 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 house and experienced variation in reference housing size. If the relative deprivation effect is driven by relative novelty, it should more strongly devalue older houses and the sign of the interaction term should be negative. Table **??** in annexe 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 house market value, which goes against the novelty explanation.

6 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 variations 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 0.1% rise in size through home improvements and a 0.5% rise in the level of outstanding mortgage debt. These results suggest a behavioral channel between housing inequality and household debt. They argue in favor of zoning regulations aimed at reducing the gap between small and big houses, focusing mostly on excessive upscaling at the top of the distribution. On that regard, the extensive use of minimum lot size requirements in suburban communities may amplify upward comparison effects and increase financial distress, with no improvement in house satisfaction in the long term.

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Appendix

A 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

$$V\big(y(H^s), p(H^s), H^s\big) = k \qquad \forall \quad s \tag{5}$$

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 ($V_p < 0$)[19]. The marginal impact of a change in the housing size stock depends on whether

[19] 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.

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:

$$C = dy/dH^s - h(dp/dH^s) \quad \text{with} \quad h = -V_p/V_y \quad \text{(Roy's identity)} \tag{6}$$

Taking the total derivative of equation (5) gives

$$dV/dH^s = V_y(dy/dH^s) + V_p(dp/dH^s) + V_{H^s} = 0 \tag{7}$$

And combining equation (7) and (6), the implicit hedonic cost of the housing externality equals

$$C = dy/dH^s - \big(V_p/V_y\big)(dp/dH^s) = -V_{H^s}/V_y > 0 \tag{8}$$

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 (8) can be estimated directly. This method is known as the life satisfaction (LS) approach[20]. 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[21]. 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 exists 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 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. Hence, it is only experienced on one side of the market, which is the side captured by the LS method.

Formally, if condition (5) 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

[20]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).

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

the HP approach $\tilde{C}$ is in fact lower than the true MWTP as estimated by the LS approach:

$$\tilde{C} = dy/dH^s + \big(V_p/V_y\big)(dp/dH^s) = -V_{H^s}/V_y + (dV/dH^s)/V_y < -V_{H^s}/V_y \tag{9}$$

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.

B Data and Stylized Facts

B.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 8 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[22]. 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.

[22]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.

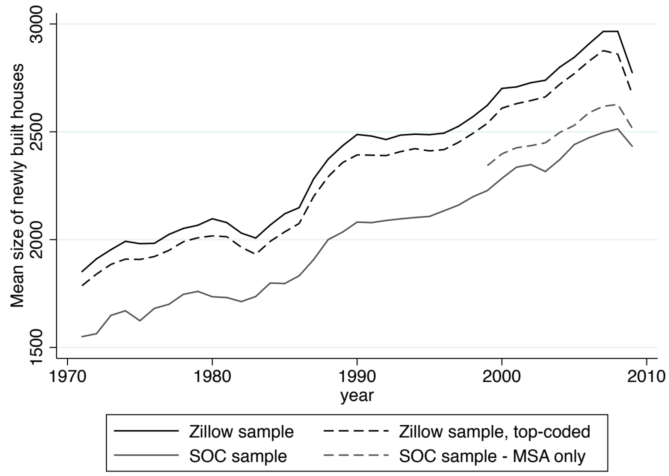


Figure 8: Average size of newly built detached family houses 1971-2009, Zillow vs. SOC

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 11 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 11: Testing for attrition over time, SOC vs. Zillow

B.2 Location of suburban houses within Metropolitan Statistical Areas

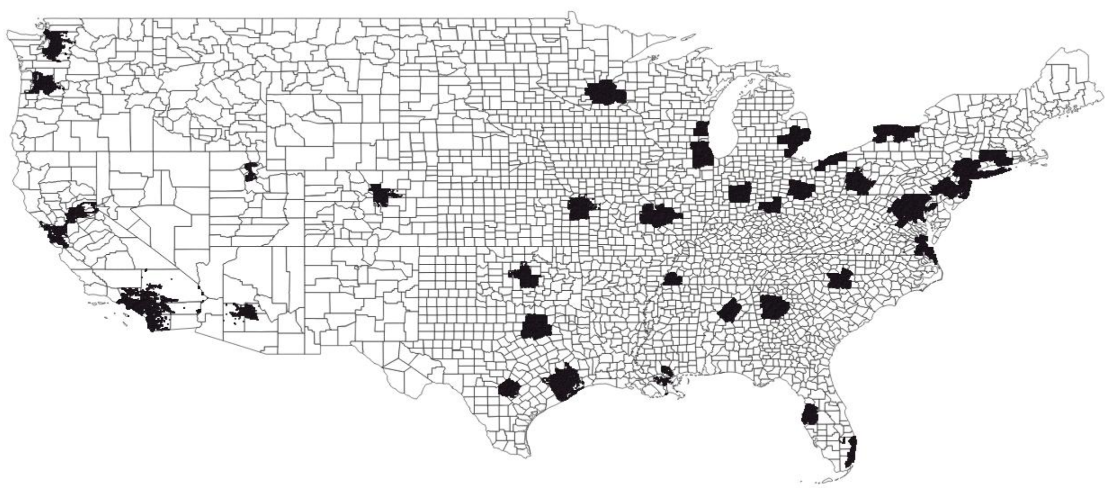


Figure 9: Mapping of suburban houses considered within MSA counties

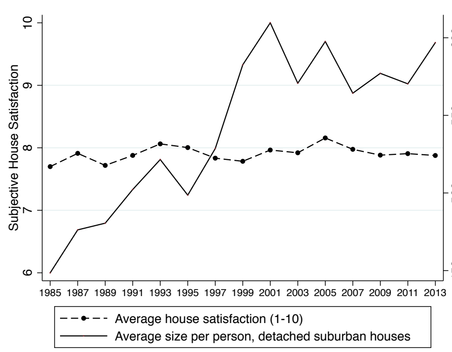
The figure maps all three millions houses scrapped from Zillow.com to their exact location within counties using latitude and longitude coordinates. All 154 counties considered are located within the Metropolitan Statistics Areas surveyed in the AHS.

B.3 Descriptive Statistics

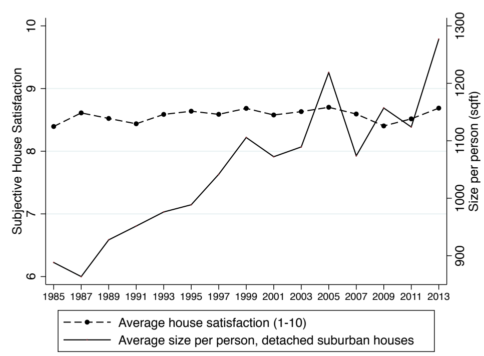
Survey	Median Income	Mortgage Debt Over Income	Age	Household Size	% Bachelor	% Graduate	% Hispanics	% Blacks
1985	27200	.48	50.1	2.9	.12	.1	.03	.05
1987	30000	.5	50.3	2.9	.13	.11	.03	.05
1989	33400	.5	50.7	2.9	.13	.11	.04	.05
1991	35000	.55	50.9	2.8	.14	.11	.04	.05
1993	37260	.58	51.3	2.8	.14	.12	.04	.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 12: Descriptive Statistics, AHS National Surveys 1985-2013

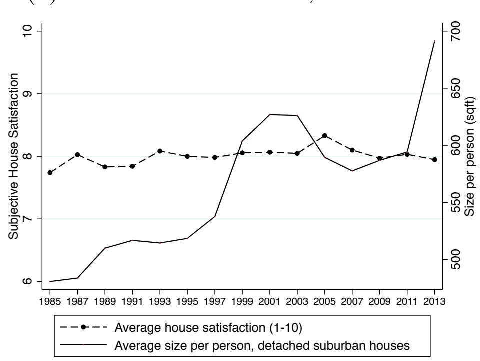
B.4 Paradox of the Joneses, robustness checks



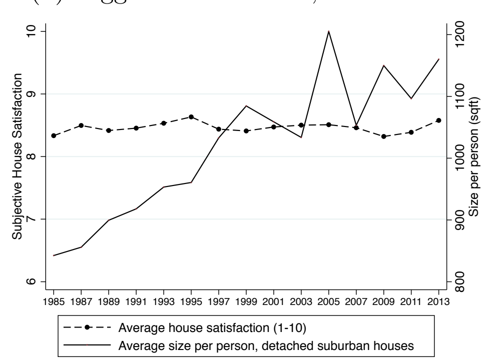
(a) Smallest 50% houses, new movers



(b) Biggest 50 % houses, new movers



(c) Bottom 50% income, new movers



(d) Top 50 % income, new movers

Figure 10: Satisfaction and housing size below or above median size and income, 1985-2007 (AHS)

(a) New movers

(b) New and old movers

Figure 11: Residuals of house satisfaction after controlling for objective house and household characteristics but size, AHS national longitudinal surveys 1985-2013.

	1987 (1)	1991 (2)	1995 (3)	1999 (4)	2003 (5)	2007 (6)	2011 (7)
Own housing size	0.127***	0.125***	0.127***	0.123***	0.107***	0.122***	0.106***
	(0.0177)	(0.0193)	(0.0150)	(0.0145)	(0.0171)	(0.0212)	(0.0190)
Observations	1594	1475	1344	1329	965	653	3194
Adjusted R^2	0.050	0.037	0.062	0.065	0.045	0.069	0.041
Household and House Controls	No	No	No	No	No	No	No

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

Table 13: Selected cross-section correlations between size and house satisfaction, new movers

	1987 (1)	1991 (2)	1995 (3)	1999 (4)	2003 (5)	2007 (6)	2011 (7)
Own housing size	0.0791***	0.0324	0.0662***	0.0889***	0.0724***	0.106***	0.0723***
	(0.0198)	(0.0208)	(0.0170)	(0.0153)	(0.0171)	(0.0239)	(0.0200)
Observations	1594	1475	1344	1329	965	653	3194
Adjusted R^2	0.083	0.105	0.120	0.099	0.077	0.088	0.080
Household and House Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Table 14: Selected cross-section correlations between size and residual house satisfaction, new movers

	1987 (1)	1991 (2)	1995 (3)	1999 (4)	2003 (5)	2007 (6)	2011 (7)
Own housing size	0.0486***	0.0729***	0.0721***	0.0740***	0.0649***	0.0617***	0.0616***
	(0.00481)	(0.00446)	(0.00446)	(0.00380)	(0.00346)	(0.00369)	(0.00312)
Observations	17533	20583	19034	19797	21117	17994	56680
Adjusted R^2	0.110	0.080	0.075	0.050	0.057	0.055	0.053
Household and House Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

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

Table 15: Selected cross-section correlations between size and residual house satisfaction, all movers

B.5 Other Stylized Facts

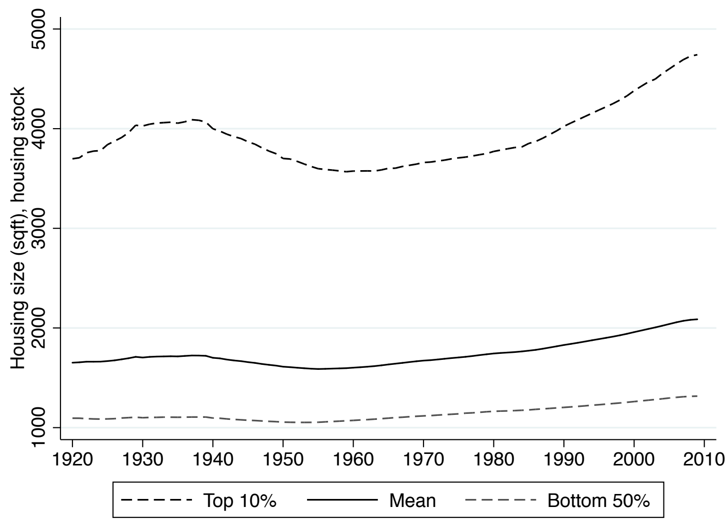


Figure 12: Size upscaling of suburban houses, housing stock (1920-2009)

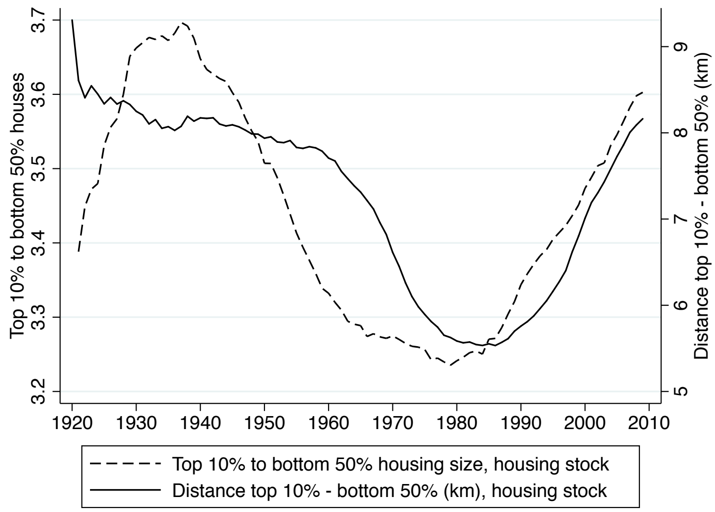


Figure 13: Spatial segregation vs. size inequality in suburban America, 1920-2009

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)

C Method

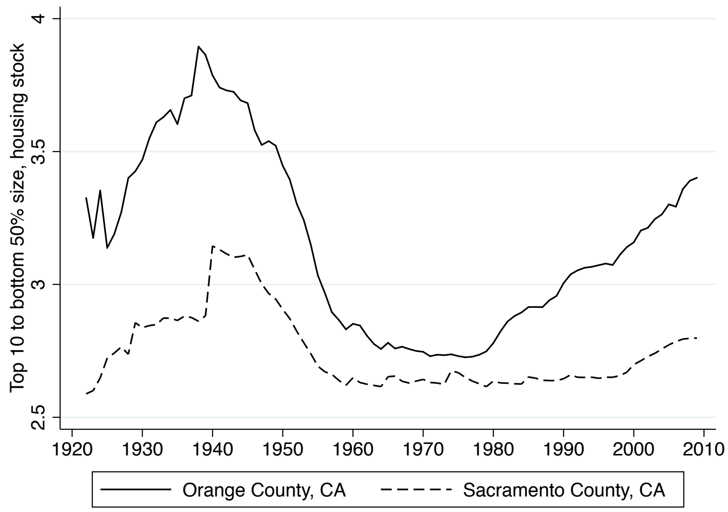


Figure 14: Orange county suburb vs. Sacramento county suburb

The vertical 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 in each of the two suburbs. (Sources: author's own calculation from Zillow.com).

D Empirical Analysis

Table 16:
Placebo test of relative size effect on neighborhood satisfaction

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)	Ordered Logit (7)
Own housing size$_{it}$	0.0917***	0.133***	0.143***	0.216**	0.216**	0.171	0.0652
	(0.0164)	(0.0421)	(0.0419)	(0.102)	(0.102)	(0.104)	(0.133)
Median housing size$_{ismt}$	0.375***	0.387***	0.330***	0.347***	0.338***	0.357***	0.353**
	(0.116)	(0.118)	(0.126)	(0.126)	(0.125)	(0.128)	(0.161)
Average size of bigger houses$_{ismt}$	-	-0.0659	-0.0815	-0.127	-0.127	-0.134	0.0321
		(0.0584)	(0.0586)	(0.0811)	(0.0812)	(0.0819)	(0.107)
Top 10% housing size$_{ismt}$	-	-	0.143	0.160	0.157	0.140	0.0249
			(0.111)	(0.115)	(0.115)	(0.115)	(0.148)
Average size of smaller houses$_{ismt}$	-	-	-	-0.0691	-0.0688	-0.0985	-0.0913
				(0.0909)	(0.0908)	(0.0929)	(0.117)
Population density growth$_{ismt}$	-	-	-	-	-0.00797	-0.00790	-0.0147
					(0.0124)	(0.0126)	(0.0154)
Market value of the house	-	-	-	-	-	0.153***	0.196***
						(0.0156)	(0.0216)
County × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Price controls	No	No	No	No	No	Yes	Yes
Household characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
House quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	133980	133980	133980	133980	133980	133980	133980
Adjusted R^2	0.266	0.266	0.266	0.266	0.266	0.270	-
Adjusted R^2	-	-	-	-	-	-	0.116

Notes. This table reproduces the same regressions as table 1 but replaces the subjective house satisfaction index by the subjective neighborhood satisfaction as the dependent variable. Sampling weights are included in all regressions. Robust standard errors clustered at the county-year level are reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17:
Interaction between age of the house and experience variation in top housing size

	House satisfaction$_{ismt}$	Market value of the house$_{ismt}$
	OLS	OLS
	(1)	(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

Standard errors in parentheses

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