Home Size, Residential Density, and Aggregate Demand *

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Abstract

This paper documents that smaller homes and denser neighborhoods are associated with higher household saving rates. This relationship is apparent within and across U.S. households, across countries, and over time in the U.S. The micro data indicate the importance of complementarity between housing and non-housing consumption. Incorporating complementarity into a macroeconomic model implies that denser countries with smaller homes have higher household savings rates, a lower natural rate of interest, and lower sensitivity of non-housing consumption to monetary policy. Furthermore, growth in the non-housing sector alongside stable home sizes is associated with a declining natural rate of interest. High density and small homes may contribute to Japan's lost decade and persistent stagnation.

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1 Introduction

Over recent decades, concerns about high household saving causing persistently low global interest rates (Secular Stagnation) have brought a renewed focus on the the underlying drivers of household saving rates. Yet the relevant determinants of household saving rates remains an open question. Studies of quantitative life-cycle models emphasize the importance of demographic factors (e.g., Eggertsson, Mehrotra, and Robbins, 2019; Rachel and Summers, 2019; Carvalho, Ferrero, and Nechio, 2016), for example. However, studies of micro data have found mixed evidence of demographic factors driving household-level saving rates (e.g., Chamon and Prasad, 2010; Hayashi, 1986; Dynan et al., 2009).[1]

This paper contributes to the understanding of household and national saving rates by documenting the significance of residential density and home size as determinants of household spending and saving. Upon initial consideration, one might expect that residential density is associated with lower saving rates, given that denser areas such as Manhattan, NY tend to be very expensive.[2] However, Table 1 presents evidence contrary to such expectations. Residents of high-density areas like central New York City (NYC) exhibit *lower* total household spending rates out of income compared to their suburban counterparts. This is despite the fact that rental and mortgage payments are nearly twice as high in the city center. Suburban households more than compensate for the lower housing costs by purchasing more durables, maintenance services, and other goods. This pattern extends beyond

Table 1
Consumption Rates and Residential Density (NYC).

	Consumption Rates (C/I)	
	NYC	**NYC suburbs**
Total Expenditure	0.72	0.79
Durables & Maintenance	0.11	0.19
Rent and Mortgage	0.16	0.10

Created using data from Consumer Expenditure Survey. Data aggregated across residents with incomes between 35k and 200k. Rates are defined as expenditure divided by after-tax income.

NYC. In the U.S., personal savings rates have paralleled population-weighted density —a measure of density faced by the typical household —over decades (Figure 1). And internationally, personal saving rates are considerably higher in countries that have smaller homes and higher population density (Figure 2).

The robust correlation between residential density and household saving motivates an

[1]Relatedly, there is ongoing debate on whether demographics are important drivers of time series and cross-country variation in interest rates (e.g., Del Negro et al., 2019; Kiley, 2020; Lunsford and West, 2019).

[2]Prior literature (Murphy, 2018) has documented that residents of dense, expensive neighborhoods spend more on local services than do their observationally equivalent suburban counterparts.

Population-Weighted Density and Personal Saving in U.S.

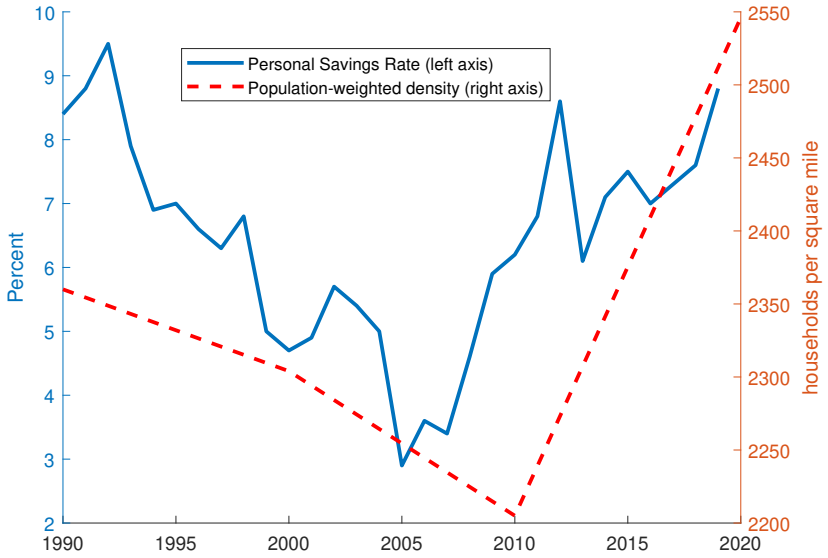


Figure 1

Data source: FRED (personal savings rate); Jed Kolko's website (population-weighted density). Saving rate series is through 2019 (pre-pandemic).

investigation of underlying mechanisms. I propose an explanation based on complementarity between housing and other consumption, where housing consists of the bones of a housing structure and the land it occupies. Other consumption consists of the durable goods (that occupy the housing), maintenance, and all other categories of expenditure. Larger structures and more land cause higher marginal utility of the goods and services associated with utilizing the housing. For example, larger plots of land increase the utility of lawn furniture and lawn care services. Likewise, larger structures increase the benefits of furniture and appliances to fill the home, and they require more energy and maintenance to heat and cool.

To isolate this mechanism empirically, I rely on two separate household-level datasets, each of which contains comprehensive information on expenditure, income, and demographic characteristics, alongside measures of home size. These measures of home size include single-family-home status, number of rooms, and —depending on the dataset —indicators of plot size. Conditional on these observable measures, residential density is a proxy for unobservable room size.

The Consumer Expenditure Survey (CEX) provides the most detailed and comprehensive measure of household-level expenditure. It covers nearly 15,000 households per year who recall expenditure over three-month periods. The large sample size permits analysis by various income and demographic subgroups. However, it is primarily suitable for cross-sectional analysis, and the information on location of residence is available at only the metropolitan statistical area (MSA) level (and, within the NYC metro area, by central city versus suburbs

Home Size and Saving Rates across Countries

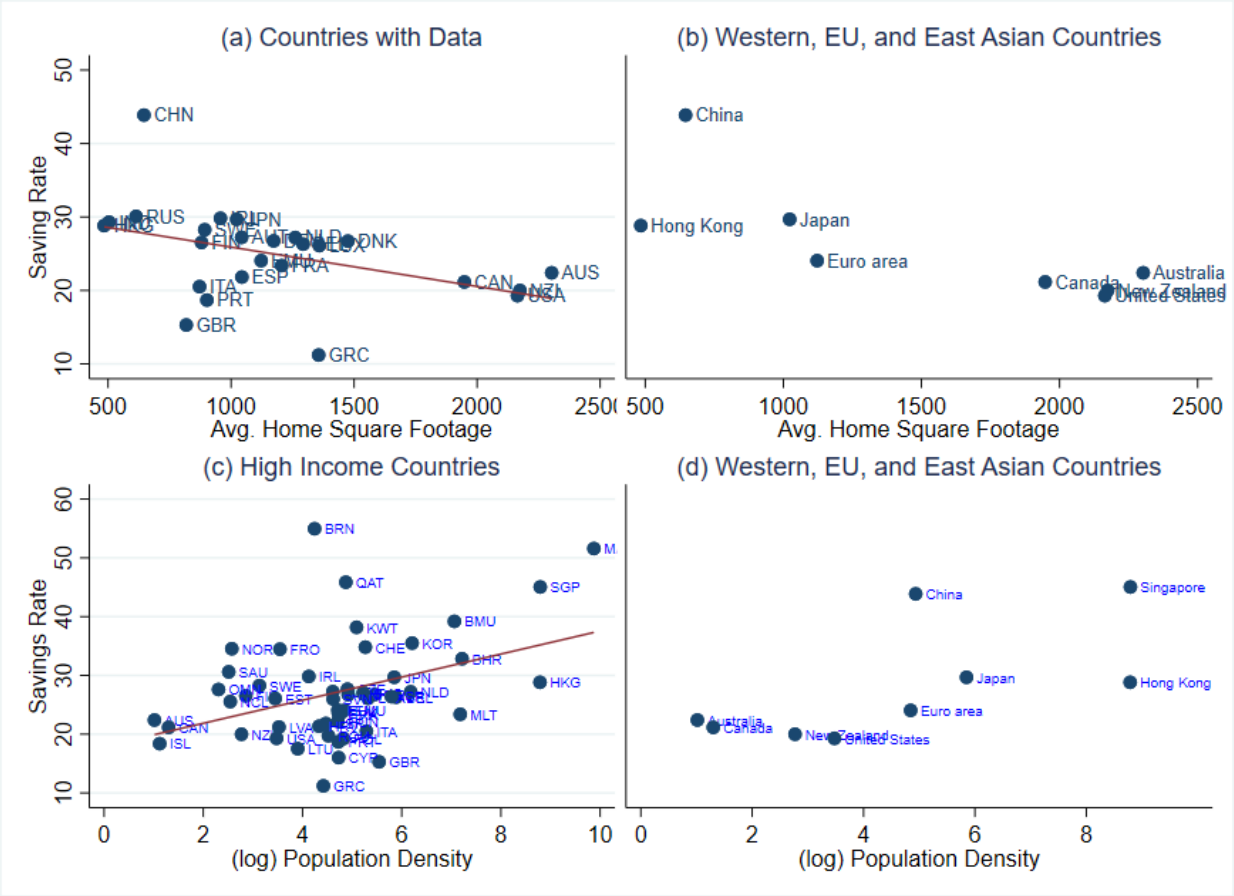


Figure 2

Data source: World Development Indicators (saving rate, population density), average values over 1990, 2000, 2007, 2015, 2019. Gross saving (% of GDP) is gross national income less consumption, plus net transfers on savings rate. Average home sizes are sizes of new homes from shrinkthatfootprint.com and are collected from various country-level data sources. Panel (c) is restricted to high-income, non-Caribbean countries.

between 2006 and 2014). Therefore, I also examine the Panel Study of Income Dynamics, which contains detailed information on households' consumption, expenditure, and assets over time since 1999. I exploit restricted-access information (Survey Research Center, Institute for Social Research, University of Michigan, PSI) on respondents' census tract of residence to approximate respondents' housing characteristics based on tract-level measures of lot size and residential density. This tract-level information, along with respondent-level information on home type and number of bedrooms, provides a comprehensive and granular measure of relevant housing characteristics.

The microdata help isolate the complementarity mechanism by conditioning on plausible alternative explanations for the relationship between housing and consumption rates. The regressions include a rich set of income, wealth, and demographic controls, which condition on explanations related to life cycle or income-based saving rates, for example. Alternatively, households in dense, expensive cities might save more to purchase homes they anticipate will

be expensive. To condition on this potential explanation, I limit the analysis to elderly households (who are unlikely to anticipate a future home purchase) and, separately, to households who already own a home and never move. I also include CBSA fixed effects that absorb city-wide housing factors.

Yet another potential explanation is that spending is correlated with home size preferences for reasons unrelated to complementarity. For example, a desire for enhanced consumption may cause households to move to larger homes and to spend more. I limit the influence of this possibility by examining the effect of moving shocks to and from large homes due to job-related reasons. Households report the reason for moving, which permits me to omit moves related to enhanced consumption desires and to focus on job-related shocks. Furthermore, to avoid the potentially confounding effect of moving itself on spending (Benmelech, Guren, and Melzer, 2022), I examine the effect of moves that occurred over two years prior.

In the moving shock specifications, household fixed effects capture persistent preferences for housing and consumption. Nonetheless, even conditional on a moving shock and household fixed effects, the choice of home size may be due to correlated changes in preferences for housing and spending. To limit the possible influence of correlated preference changes, I also examine an instrumental-variable specification in which I instrument for the change in home size after a moving shock with changes in the average home size at the county level. The identification assumption is that the new county of residence depends on job-related factors rather than home size preferences. I also extend the IV specification to examine the differential effect of moving shocks on goods that are complementary to housing and, separately, on goods that are substitutes for housing. Living in a larger home years after a job-related moving shock is associated with higher spending on utilities and furniture (which are complementary to housing) but not on food away from home (which prior literature has identified as a substitute for home production and housing). This placebo test indicates the importance of complementarity rather than, for example, consumption preference shocks that drive choices of home size and broad consumer spending.

Finally, I address the possibility that home-size-dependent spending reflects households' saving in housing as an asset, rather than spending purely to obtain utility flow benefits.[3] To limit the potential influence of asset-preservation motives, I examine renters' dependence of spending on home size separately from that of homeowners. Renters demonstrate a strong and economically meaningful dependence of spending on home size and are different from homeowners only in their spending on home repairs. Among other categories of spending that do not preserve asset value (e.g., vehicles and furniture), the effect of home size on spending for renters is similar to that of homeowners.

[3]Even if asset-preservation motives are present, it is not clear that they are distinct from utility flow motives. In asset-pricing models of housing such as Poterba (1984), the asset value of maintenance is fundamentally linked to its utility flow.

Across the specifications, there is a robust dependence of total spending and non-housing spending on both indirect measures of home size (residential density) and on direct measures such as plot size and number of bedrooms —conditional on income, wealth, and demographic characteristics. Furthermore, housing characteristics and residential density explain a significant fraction of variation in household expenditure. In particular, a Shapley-Owen decomposition of variance indicates that home size is as important as demographic characteristics.

To rationalize these results, I propose a model in which households have utility over housing and non-housing goods. The model implies parameter restrictions such that non-housing expenditure is positively associated with housing consumption in the microdata. In particular, the positive relationship between housing and non-housing consumption emerges when housing and other goods are strong complements and when households have utility over saving. Each of these modeling elements has been explored, in isolation, in the prior literature.[4] I demonstrate that modeling both of these elements can rationalize evidence from microdata.

To assess the aggregate implications of the model, I calibrate parameter values to match housing expenditure shares and household saving rates in NYC and the NYC suburbs, based on data from the CEX. The calibration indicates that housing and non-housing goods are complements and that the elasticity of substitution (EOS) between bonds and the consumption bundle is greater than unity. The suburban location with more housing has higher marginal utility over non-housing goods. But it also faces a lower price of consumption due to the lower housing costs in the suburbs. Since consumption and bonds are substitutes, residents of the suburban location respond to the lower price of consumption by demanding more bonds (relative to the demand for bonds in the dense city).

Aggregating the model to a national closed economy implies that countries with smaller homes in denser neighborhoods have lower natural rates of interest, since smaller homes and plot sizes lead to lower marginal utility from complementary goods and services relative to the marginal utility of saving. To provide a ballpark assessment of the quantitative importance of home size, I consider the calibrated home size for the New York suburbs to be representative of average home sizes in the United States. I compare the natural rate of interest in the U.S. to the natural rate of interest that would prevail under average home sizes in Japan. Differences in home sizes alone can account for fifty basis points of the difference in natural rates between the U.S. and Japan.

The model also indicates housing complementarity as a potentially contributing factor to the secular decline in interest rates that has been emphasized by Eggertsson, Mehrotra,

[4] Flavin and Nakagawa (2008), for example, document that complementarity between housing and non-durables can rationalize the smoothness of nondurable consumption. Separately, several macroeconomic models (e.g., Mehrotra and Sergeyev, 2021; Mian, Straub, and Sufi, 2022; Michaillat and Saez, 2021) incorporate savings in the utility function as a reduced-form representation of underlying microfoundations, including liquidity and safety premiums, wealth as a market of social status, and bequest motives.

and Robbins (2019). I document that average home sizes in the U.S. and Japan have *decreased* between the 1990s and 2018 in spite of an approximate doubling of real GDP. The model indicates that growth in the non-housing sector alongside stagnant home size causes a substantial decline in the natural rate of interest. In particular, a 40% increase in the size of the non-housing sector (approximately 13 years' worth of growth at an annual rate of 2.5%) is associated with a percentage point decline in the natural rate. This is because growth in the non-housing sector without a corresponding increase in the complementary housing sector leads to substantially lower marginal utility of non-housing consumption, which implies that lower interest rates are required to clear the goods market.

A typical concern with low natural rates is that they are associated with a frequently-binding effective lower bound on nominal interest rates. The model predicts that even in the absence of lower-bound considerations, smaller homes and lower natural rates are associated with a weaker effect of interest rates (such as those influenced by monetary policy) on non-housing consumption. Intuitively, a small housing stock causes lower marginal utility of non-housing consumption, which leads to weaker pass-through from monetary policy (or other sources of interest rate fluctuations) to consumer spending.

Related Literature. This paper proposes a new determinant of household savings that bridges the literature on Secular Stagnation with the literature on housing complementarity.

One strand of the housing complementarity literature has focused on quantifying the elasticity of substitution between housing and nondurables (e.g., Khorunzhina, 2021; Li et al., 2016), motivated by the observation that complementarity is relevant for asset pricing and other macroeconomic puzzles (Ogaki and Reinhart, 1998; Flavin and Nakagawa, 2008). My classification of housing is more narrow and my classification of complementary goods more broad than in this literature, and it maps housing into the relatively inelastically supplied components of the consumption bundle (e.g., land) and other goods into the components that respond to macroeconomic conditions.

The other strand of the housing complementarity literature examines how home *purchases* affect household spending. In particular, Benmelech, Guren, and Melzer (2022) exploit the CEX and PSID to document that purchasing a new home spurs short-run spending on home-related goods and repairs. My analysis documents the importance of home *size* as a determinant of spending, and that the effect of home size persists years after moving residences.[5]

The secular stagnation literature includes a growing body of work that examines determinants of the natural rate of interest (e.g., Obstfeld, 2023; Carvalho et al., 2023) and household saving rates. This work has emphasized that slow-moving determinants of the natural rate, such as demographics, are likely to continue to pull down the natural rate.

[5]Note that the relationship between home size and spending is distinct from the well-documented effect of housing wealth on expenditure.

My paper emphasizes the importance of urban density and home size, which could either exacerbate the downward trend or act as a countervailing force if, over time, the distribution of the housing stock shifts toward suburbs (e.g., due to a shift toward working from home).

Finally, this paper is related to the literature that highlights the benefits of urban neighborhoods (e.g., Couture et al., 2023; Couture and Handbury, 2020; Glaeser et al., 2001). Much of this literature is based on models that abstract from saving and borrowing. My evidence indicates that residential density facilitates household saving in addition to providing consumption and amenity benefits. And although the model presented in this paper suggests that dense neighborhoods provide lower utility due to a smaller and more expensive housing stock, modeling extensions that incorporate amenity and sharing benefits of urban density could indicate that dense neighborhoods provide higher utility.[6]

Additional extensions that incorporate pollution externalities may indicate further social welfare benefits of urban neighborhoods. For example, Eeckhout and Hedtrich (2021) document that energy use and waste per capita are decreasing in city size, suggesting that large cities are environmentally beneficial. An open question in this line of research is whether urban residents effectively import energy from smaller cities, contributing to environmental externalities through their consumption patterns. The findings in my paper indicate that residents of large, dense cities consume less than their suburban counterparts, amplifying the green benefits of cities indicated by Eeckhout and Hedtrich (2021).

The remainder of this paper proceeds as follows. Section 2 presents evidence on the relationship between spending and home size from the CEX and PSID. Section 3 presents a model of consumer behavior to rationalize the evidence from microdata, and Section 4 derives aggregate implications. Section 5 concludes.

2 Empirical Evidence from Microdata

The household-level empirical analysis presented in this section documents that household-level total expenditure and non-housing expenditure are positively associated with home size. An ideal experiment to isolate the role of complementarity would randomly assign identical workers (in terms of wages, work location, etc.) to live in neighborhoods with different land endowments and home size, and would restrict workers' ability to move across neighborhoods. In the absence of such a natural experiment, I instead isolate the complementarity channel by limiting the influence of likely alternative mechanisms.

I first establish baseline statistics by demographic group on the relationship between

[6]For example, incorporating the insights in Murphy (2018) that residents of dense neighborhoods effectively share factors of production (e.g., ovens for cooking and furniture in restaurants) may imply that by sharing fixed costs of consumption, urban residents face a lower price of non-housing consumption and are able to allocate more of their income to saving.

spending and indicators of home size, including number of bedrooms and residential density (conditional on income and wealth). I then exploit the PSID to isolate the role of complementarity between housing and other consumption by conditioning on likely alternative explanations. In the subsequent section, I derive a household Euler equation that links non-housing consumption to housing, and I discuss how the theory maps into the empirical results presented in this section.

In this study, housing consists of land and the bones of the housing structure built on top of that land. Some prior studies of housing (e.g., Khorunzhina, 2021) categorize housing more broadly to include repairs and maintenance to the housing structure, while others are consistent with the narrow categorization (e.g., Murphy, 2024; Albouy and Ehrlich, 2018). I focus more narrowly on the size of the structure and land because I am interested in the aggregate effects of the relatively inelastic component of housing. I document that the size of structures has not increased over decades in the U.S. or Japan in spite of economic growth. This relative stability of home sizes motivates modeling housing as inelastically supplied at the national level.[7]

The non-housing category of expenditure is broader in this study than in prior studies (which tend to focus on nondurables). This broader classification is useful because it enables me to aggregate across all non-housing components of expenditure that respond elastically to macroeconomic conditions. It is also reasonable from an empirical perspective, since the components of expenditure that are substitutes for home size (primarily food away from home and public transportation —see Murphy, 2018) are a small share of total expenditure.

2.1 Data and Empirical Specification

The analysis examines household-level expenditure from the CEX and, separately, from the PSID. The CEX contains detailed information on expenditure, income, and demographics, along with respondents' city of residence. There are over 70,000 households in the CEX between 2006 and 2014, the time span during which the CEX contains information on whether New York City MSA residents live in New York City or the surrounding suburbs. The large sample size of the CEX enables documentation of the relationship between spending and housing by detailed demographic subgroup.[8] However, the housing information in the CEX is limited to the number of rooms in a house along with Central NYC status as a proxy for residential density (and hence land and home size). Conditional on the observable housing

[7]It may seem surprising that home sizes in the land-abundant U.S. have not grown with GDP. One possible explanation is that growth in the U.S. has been biased toward cities with inelastic housing supply (e.g., Hsieh and Moretti, 2019; Eckert et al., 2024).

[8]All nominal variables are deflated by the PCE price index. To limit the potential influence of respondents with extreme levels of income, I limit the CEX sample to those with after-tax income between $\$35,000$ and $\$200,000$ (in 2012 USD). The results are similar when including all households.

characteristics in the CEX (e.g., number of rooms), homes in Central NYC tend to have smaller plots and smaller rooms (as documented in Appendix D).

I supplement the analysis with data from the PSID, a biennial panel dataset of households' income, assets, and expenditure. In 1999 the PSID began collecting information on broad consumption categories, including health, housing, food, transportation, and education. In 2005, the PSID added information on clothing, travel, household repairs, household furnishing, telephone, and internet; thus constituting broad coverage of expenditure categories comparable to that in the CEX.

The PSID offers several advantages for isolating the importance of complementarity between housing and other consumption. It enables a broader set of controls that are related to households' expectation of future marginal utility (e.g., wealth and future income). Furthermore, I am able to identify respondents' census tract of residence from a restricted-access version of the dataset, which I combine with tract-level data on lot sizes from Davis et al. (2021) and population density from U.S. Census. This, along with information on respondents' housing type and number of bedrooms, provides detailed measures of the quantity of residents' housing components. Homes in dense areas tend to have smaller plots of land and smaller bedrooms. Therefore, residential density is a proxy for these components of home size, conditional on single-family-home status and the number of bedrooms.

With these detailed measures of housing in hand, I am able to estimate the within-city dependence of non-housing consumption on housing, the within-household dependence of non-housing consumption on housing, and how households that remain in a city vary their spending as they move across neighborhoods and home types. The Davis et al. (2021) data also provide a census-tract-level measure of land prices, which I use to condition on unobservable amenities that are capitalized into land prices. Table 2 provides summary statistics of each dataset, and Appendix Table A1 summarizes the relative benefits of the CEX and PSID.

The baseline relationship between spending and housing is based on the specification:

$$\log C_{ijt} = \kappa_t + \alpha_i + \phi_j + \beta \text{HomeSize}_{it} + X_{it}\Gamma + \epsilon_{ijt}, \tag{1}$$

where C_{ijt} is expenditure of household i living in location j in year t, HomeSize_{it} includes measures of housing (e.g., rooms, plot size, residential density), and κ_t, ϕ_j, and α_i are year, location (CBSA or county), and household fixed effects. X_{it} is a vector of controls that includes a quadratic in age of the respondent, indicators for marital status and family type, family size, and high-dimensional polynomials in income and wealth.[9] The inclusion of fixed

[9]Specifically, I include controls for a six-degree polynomial in income and a six-degree polynomial in wealth. Controlling for polynomials, rather than logarithms, retains households with non-positive income or wealth and permits consumption to depend more flexibly on these determinants. Results are similar when using log(income) and log(wealth).

effects and the set of controls varies across specifications and datasets, depending on the variation (e.g., cross-sectional or time-series) of interest. The PSID permits household fixed effects and controls for wealth, land price, and future income, for example.

These and other specifications permit me to condition on alternative explanations for the dependence of total (and non-housing) consumption on housing. One possibility is that households in dense, expensive cities save in anticipation of a home purchase. I condition on the influence of anticipated home purchases by a) including CBSA fixed effects, which absorb city-wide determinants of spending behavior, b) limiting the sample to elderly households who are unlikely to anticipate a new home purchase, and c) limiting the sample to those who already own a home and never move.

Another possibility is that individual preferences for residential density are correlated with saving behavior for reasons independent of complementarity. To limit the influence of this possibility, I run specifications with individual fixed effects, which absorb individual preferences. In these specifications, identification of complementarity relies on variation in individuals' housing consumption over time.

It is possible that moving is a result of a change in individual preferences that is also associated with a change in saving behavior. To address this possibility, I exploit the information in the PSID on the timing and reason for a change in residence. Specifically, I examine the effect of a job-related moving shock that is associated with a change in home size. To limit the short-term influence of moving on expenditure (Benmelech et al., 2022), I examine the relationship between home size and spending two to four years after moving.

Even though moving is likely to be independent of households' spending preferences, the choice of home size may nonetheless be a reflection of changing preferences that are unrelated to complementarity. To further limit the possible influence of changing preferences, I instrument for the change in home size with the change in county-level average home size. The new county of residence is likely to be driven by job-related considerations, and a household's choice of home within a county will be limited by the availability of home sizes there.

As a placebo test, I examine the effect of a moving-shock-induced change in home size on spending on food away from home, which has been identified as a substitute for home production (Murphy, 2018). I compare the effect of moving shocks interacted with home size changes on food away from home to the effect on housing complements —furniture and utilities. This specification isolates the complementarity channel by differencing the response of housing complements from the response of housing substitutes in response to a moving shock that causes households to face housing markets with homes of different sizes.

Finally, I address the possibility that the relationship between spending and home size is driven by homeowners' desire to preserve the home's asset value in the event of a future sale. I find that renters (who do not benefit from asset preservation) also exhibit a strong

dependence of spending on home size, indicating the relevance of housing complementarity.

I present the results by first documenting the robust relationship between spending and housing in the CEX, including how subcategories of spending depend on housing. I then turn to the PSID to isolate the complementarity channel by conditioning on plausible alternatives and to exploit the detailed home size and land value information. To maximize the time dimension of the panel regressions, C_{ijt} is total household spending across the categories that were covered by the PSID as of 1999. Results from the post-2003 data (which overlap in coverage with the CEX) are similar. In the subsequent section (3), I interpret the evidence in this section through the lens of a household's Euler equation.

2.2 Housing and Expenditure in the CEX

Table 3 documents that the inverse relationship between total household spending and residential density (NYC status) is apparent across demographic groups (young and old, renters and homeowners, etc.) and conditional on income and demographic controls. It is especially apparent when limiting the sample to residents of the New York Metro Area (column 2), demonstrating strong differences within the CBSA in spending / saving behavior.[10]

The lower spending rates in dense NYC are in spite of the significantly higher housing expenditure (rent and mortgage payments) there, as demonstrated in column 1 of Table 4. Residents of NYC also spend more on local services (restaurant meals and public transportation —columns 2 and 3). However, these expenditure categories together account for only 1.5% of household spending. The far larger expenditure categories —durable goods, auto and home maintenance, and utilities —exhibit a strong negative dependence on density (columns 4 through 6), such that households' total non-housing spending is nearly 20% lower in central NYC (column 7).

NYC homes tend to have less of each component of housing (size of the housing structure and lot size), and the CEX contains direct measures of the first of these components. According to Table 5, expenditure is increasing in the housing structure measures, single-family-home status and number of rooms. Including these measures of housing attenuates the coefficient on NYC, although there remains a negative conditional dependence of spending on NYC status, which is likely a reflection of the influence of unobserved lot size and room size.

These results establish a clear relationship between spending and home size that is apparent across demographic groups and holds conditional on income and other demographic characteristics. The differential dependence on home size and central NYC status across

[10]The dependence of spending on NYC status is somewhat weaker among renters. This likely reflects the fact that NYC-versus-suburb differences in rental home sizes are smaller than differences in owner-occupied home sizes (in both absolute and percentage terms). Section 2.3.2 explores the dependence of spending on home size among renters in more detail.

expenditure categories (substitutes for home production versus other goods and services) suggests that the majority of non-housing consumption is complementary to home size. To establish the robustness of these facts across datasets, and to isolate the role of complementarity, I turn to an analysis of PSID data.

2.3 Isolating Complementarity: Housing and Expenditure in the PSID

The PSID analysis exploits variation across and within households to isolate the relationship between housing and household spending. I begin by presenting results that exploit both types of variation. In these specifications, CBSA fixed effects absorb city-wide factors that influence spending but retain the influence of within-CBSA variation in home size and neighborhood density. Whereas the CEX analysis was limited to the within-CBSA comparison of NYC and its suburbs, the PSID enables comparison across census tracts within many CBSAs. I then present results that are based solely on across-household variation by focusing on respondents who own a home and never move. Finally, to isolate the role of within-household variation, I present results from regressions with individual fixed effects. Among this subset of results based on within-household variation, I examine the effect of job-related moving shocks.

To isolate the role of complementarity, I present specifications that remove the potential influence of plausible alternative explanations, as discussed above. Finally, I examine the relative importance of housing for driving spending behavior (conditional on income and wealth) compared to the importance of demographic factors.

Baseline Results. Table 6 documents that the strong conditional dependence of spending on each housing characteristic in the PSID: tract-level density, single-family home (SFH) status, number of rooms, and tract-level lot size. Spending in the top decile of census tracts is 7.5% lower than in other census tracts (column 2). Spending is also increasing in number of rooms, SFH status, and lot size (columns 3 through 6). For example, a 100% increase in the number of rooms is associated with 29.6% higher spending, conditional on observables. The dependence of spending on density attenuates but does not disappear when controlling for these other housing characteristics, consistent with the notion that otherwise similar homes (in terms of number of bedrooms and lot size) are smaller in high-density neighborhoods. For example, homes in Central NYC have approximately 20% less square feet per room than those in the suburbs, as documented in Appendix D.1. Column 7 reports results for household spending net of housing costs. Spending on non-housing goods is increasing in each measure of home size, consistent with the CEX results.

Removing the influence of anticipated home purchases. A potential explanation for the results in Table 6 is that residents of dense neighborhoods in small homes save in

anticipation of purchasing larger, expensive homes. The inclusion of CBSA fixed effects limits the influence of anticipated home prices, but the possibility remains that conditional on housing costs, residents of small homes anticipate upgrading in the future. Table 7 removes this factor by limiting the sample to respondents over age 70 as of 1999 (the beginning of the total expenditure measure). These respondents are unlikely to anticipate a home purchase, and among this sample there is a similar dependence of expenditure on home size measures and density. This dependence is apparent when omitting land value controls (columns 1 and 2) and when including (log) land value as a control (columns 3 through 6). Appendix Table A2 reports similar results among households over age 55 as of 1999.

Table 8 evaluates an alternative approach to limiting the influence of future home purchases. Here, I limit the sample to respondents who own a home as of their entry to the PSID and do not subsequently move. Since home size does not change among this sample, the relationship between spending and home size is based on variation across households. Among this sample, there is a large and significant dependence of total spending (columns 1 through 3) and non-housing expenditure (columns 4 though 6) on various measures of home size and neighborhood density.

Limiting the influence of location preferences. An alternative explanation for the relationship between spending and housing is that preferences for living in dense neighborhoods are correlated with preferences for saving for reasons other than complementarity. To help limit the influence of unrelated preference correlation, Appendix Table A4 limits the sample to respondents who live in the same county where they grew up and, in columns (3) and (6), includes both county and respondent fixed effects.[11] In these specifications, the dependence of spending on home size is driven by respondents' changing location within a county. When respondents move to single-family homes and/or homes with larger lots, they spend more conditional on other determinants of household spending.

2.3.1 The effect of job-related moving shocks.

Although the results in Appendix Table A4 limit the potential influence of correlated preferences, the possibility remains that households move when their preferences for both housing and spending change for reasons unrelated to complementarity. For example, households may move to bigger homes when their preference for consumption increases.

To limit the influence of preference-induced moves, I examine the effects of job-related moving shocks. The PSID asks respondents if they moved since the prior interview wave, and if so, to indicate the reasons for moving. The PSID enumerates the following reasons for a move:

[11] The restricted-access version of the dataset includes information on the county in which respondents grew up along with the county in which they live at the time of the interview.

1. **Purposive productive reasons: to take another job; transfer; stopped going to school**
2. To get nearer to work
3. Purposive consumptive reasons–expansion of housing: more space; more rent; better place
4. Purposive consumptive reasons–contraction of housing: less space; less rent
5. Purposive consumptive–other house-related: want to own home; got married
6. Purposive consumptive–neighborhood-related: better neighborhood; go to school; to be closer to friends and/or relatives
7. Response to outside events (involuntary reasons): HU coming down; being evicted; armed services, etc.; health reasons; divorce; retiring because of health
8. Ambiguous or mixed reasons: to save money; all my old neighbors moved away; retiring

I consider reason #1 —job change/transfer or stopping going to school —to indicate a shock that is independent of households' preference for housing. To assess the effect of a new home size on spending, I examine the effect of a moving shock between two and four years ago (prior to the preceding biennial interview wave). As emphasized by Benmelech et al. (2022), moving to a new home is associated with a short-run increase in spending. This might occur for reasons unrelated to complementarity between housing and non-housing goods. Therefore, to remove any causal effect of moving (rather than the new home size), I examine the effect of lagged moving shocks.

In particular, the empirical model is

$$\log C_{it} = \kappa_t + \alpha_i + \beta^s \left(\text{MovingShock}_{i,-1<t<-2} \times \Delta\text{HomeSize}^s_{it}\right) + \xi \log C_{i,t-2} + X_{it}\Gamma + \epsilon_{it}, \quad (2)$$

where $\text{MovingShock}_{i,-1<t<-2} \times \Delta\text{HomeSize}^s_{it}$ indicates that the respondent moved for job-related reasons between one and two waves prior to the current wave, that she moved from a home of size type $s \in S = \{large, small\}$ to type $s' \neq s$ and has not moved again as of the current interview wave t. Therefore, β^{large} indicates the effect of moving from a small home to a large home after a job-induced moving shock between four years ago and two years ago, and β^{small} indicates the effect of moving from a large home to a small home. In the moving shock specifications, I include pre-move (log) expenditure in the vector of controls, so that β^s captures the effect of the move on spending beyond pre-move spending levels.

Table 9 reports the effect of lagged moving shocks on current expenditure. Moving from a single-family home to an apartment between two and four years ago is associated with 12.3% lower total expenditure (column 1) and 13.9% lower non-housing expenditure (column 4). Moving from a small home to a large home has the opposite effect on spending: total spending increases by 9.2%, and expenditure net rent and mortgage increases by 6.8%. The last row examines a continuous measure of home size. It reports the effect of a moving shock that is associated with a change in (log) number of bedrooms.[12] According to column

[12] In this specification, $\Delta\text{HomeSize}_{it} = \log \text{rooms}_{it} - \log \text{rooms}_{i,t-2}$. As in prior specifications, I take the logarithm of rooms to enable the interpretation of regression coefficients as an elasticity of spending with respect to home size.

6, the elasticity of non-housing expenditure with respect to number of rooms in response to a moving shock is 12.3%.

Even when moves are independent of consumption/saving preferences, the choice of new home size may be endogenous to correlated changes in preferences between home size and saving. To further limit the possible influence of correlated preference changes, I instrument for the change in home size with the change in the county-level average home size. The identification assumption is that the new county of residence depends on job-related factors rather than home size preferences (correlated with saving preference). Households may desire a certain type of home, but their options are limited by the housing stock in that county. I also examine moving shocks among members of the military (those that report an industry indicating military service), for whom moves are likely based on military assignments and therefore exogenous to housing preferences.

In this IV specification, the first-stage regression is

$$\begin{aligned}\text{MovingShock}_{i,-1<t<-2} \times \Delta\text{HomeSize}_{it} = \kappa_t^{FS} + \alpha_i^{FS} \\ + \beta^{FS}\left(\text{MovingShock}_{i,-1<t<-2} \times \Delta\text{CountyHomeSize}_{it}\right) \\ + \xi^{FS} \log C_{i,t-2} + X_{it}\Gamma^{FS} + \epsilon_{it}^{FS}, \qquad (3)\end{aligned}$$

where $\text{CountyHomeSize}_{it}$ is the (log) average number of rooms in a home in the respondent's county of residence at time t.

Table 10 reports the results from the IV specifications. The First-stage F-statistics indicate that county-level average home sizes have strong predictive power for the size of the new home. Households moving to counties with larger homes are less likely to move to an apartment, more likely to move to a single-family home, and tend to move to homes with more rooms. The coefficient estimates indicate large effects of home size on spending. For example, the estimate in column 3 indicates the elasticity of spending with respect to home size (as measured by number of rooms) is 31.8% The estimate is even stronger for members of the military, although the estimate is less precise due to the much smaller number of PSID respondents who moved for military reasons.

Placebo. To further address the possibility that correlated changes in savings and home size preferences drive home size choices after a moving shock, I run placebo tests that replace the measure of broad expenditure with spending on food away from home, which is a substitute for home production (Murphy, 2018). If correlated changes in preferences are driving the estimate of the effect of moving shocks on total expenditure, we should observe positive effects on food away from home. If, instead, the estimates of the effects on broad expenditure are driven by housing complementarity, we should not observe positive effects on food away from home (a housing substitute). As a point of comparison, I also examine

the effects on utilities and furniture, which are strong housing complements.[13]

Table 11 reports the results of the Placebo tests. The empirical specification is the same as above (Equation 2), with the exception of the different dependent variable. According to column 1, which reports the OLS estimate, there is no detectable effect of moving to a larger home on spending on food away from home. This suggests that unobserved correlated changes in preferences are not driving the relationship between home size and total spending. Column 2 reports the estimate when changes in home size are instrumented with changes in county-level home size, and column 3 includes land price controls. There is a large *negative* effect of moving to a county with larger homes on spending on food away from home. This is consistent with the notion that eating outside the home is a substitute for home size and with the lower availability of restaurants in suburban areas (as documented in Murphy, 2018).

Although moving shocks to a larger home are not associated with more spending on food away from home, they are associated with substantial increases in spending on furniture and utilities (columns 3 through 6). Therefore, moving to larger homes over two years ago is associated with higher spending on complementary goods but not on food away from home. This differential effect is difficult to reconcile with mechanisms other than housing complementarity.

Additional Specifications. Table A5 reports the robustness of the dependence of spending on home size to alternative definitions of expenditure and to additional controls. Columns (1) and (2) use the comprehensive measure of expenditure that began in the 2005 PSID. Even though this specification limits the time dimension of the panel, there is a strong and statistically significant dependence of expenditure on home size, even in the presence of respondent fixed effects (column 2). The specifications in columns 2, 4, and 6 examine the effect of a moving shock interacted with the change in number of rooms (rather than the percent increase in number of rooms in the prior specifications). For example, the estimate in column 4 indicates that a moving shock between 2 years ago and 4 years ago (with no subsequent moves) that added a room to home size is associated with 2.1% higher expenditure, conditional on respondent fixed effects and other observables. This estimate is stable and more precise using the 1999 measure of total expenditure (column 4).

Estimates are also stable to the inclusion of CBSA $\times$ year fixed effects (rather than CBSA and year fixed effects), which condition on determinants of expenditure that vary over time within a CBSA (such as city-specific changes in expected cost-of-living). They are also stable to the inclusion of (log) future income as a control (columns 4 through 6), which helps to absorb anticipated changes in income that could affect contemporaneous expenditure. Finally, the Appendix includes additional robustness specifications mentioned above. Figure 3 summarizes the PSID-based estimates of the elasticity spending with respect to home size

[13] An additional advantage of examining furniture and utilities is that they exclude home repairs, which could be considered a form of saving by retaining the value of the home.

for each of the main specifications. For ease of interpretation, (log) number of rooms is the only measure of home size.

2.3.2 Limiting the influence of housing as a form of saving.

Under asset-market approaches to housing markets (e.g., Poterba, 1984), spending on repairs and maintenance is required to preserve the value of the home. Therefore, PSID respondents' spending on items such as home repairs could reflect asset-preserving investments rather than increases in contemporaneous utility flow. The analysis in this section limits the influence of asset-preserving spending by focusing on renters (who have no asset claim on the home) and by comparing spending on home repairs, which preserves asset value, to spending that does not directly preserve the home's value.

First, I examine whether the dependence of spending (net of housing costs) on home size differs between renters and homeowners. To do so, I expand the baseline empirical specification (Equation 1) to include interactions between all independent variables and an indicator of renter status. For ease of exposition, I focus on number of rooms as the primary measure of home size. According to column 1 of Table 12, renters' dependence of spending on home size is weaker than the dependence among homeowners, but this difference is economically insignificant ($0.01/0.22 \approx 5\%$).

Next, columns 2 and 3 compare the effect of job-related moving shocks on different types of spending. Column 2 reports the effect on spending on vehicles, furniture, and utilities, which are unlikely to preserve the home's value, and column 3 reports the effect on household repairs. Each category exhibits a strong response to shock-induced changes in home size, which limits the possibility that the dependence of spending on home size is driven primarily by asset preservation.

The remaining columns examine the effects of moving shocks among households that rent after the move. For renters, spending on vehicles, furniture, and utilities increases with home size (column 4), but spending on household repairs does not (column 5). Given the absence of asset-preservation motives among renters, it is not surprising that their spending on home repairs is independent of home size.[14] And, among the categories that don't preserve home value, renters exhibit a dependence of spending on home size that is statistically indistinguishable from that of homeowners.

Columns 6 and 7 report the response of renters' total spending (net housing costs) to shock-induced changes in home size. Renters exhibit a strong dependence of spending on home size (including in the IV specification in column 7), indicating a strong role for housing complementarity independent of asset-preservation motives.

[14] For many renters, costs of routine maintenance and repairs may be subsumed in their rental payments.

2.4 The relative importance of home size and demographics.

Demographic factors are typically considered to be a primary determinant of household saving rates, and as such they play a prominent role in quantitative models of Secular Stagnation (e..g, Eggertsson et al., 2019; Rachel and Summers, 2019). Here I exploit the CEX and PSID microdata to evaluate the importance of home size compared to the importance of demographics in driving household spending/saving behavior in the U.S. To do so, I compare the variance in household spending that is attributed to housing versus demographic variables, conditional on income and wealth. In particular, I decompose the variance using the classic approach of Shapley (1953), Owen (1977), and Shorrocks (1982), which yields additive marginal R-squareds for sets of (potentially correlated) independent variables.

I consider a flexible set of demographic controls that include a quadratic in family size, indicator variables for family type (including marital status), and (following Dynan et al., 2009) a high-dimensional polynomial in age and indicator variables for age cohort. The housing variables include a quadratic in number of rooms, indicators for home type (e.g., apartment, SFH), and other measures of lot and home size. For the CEX regressions, this measure is an indicator for living in central NYC.[15] For the PSID regressions, the other housing measures are tract-level lot size and an indicator for living in a high-density census tract. The other independent variables are polynomials in income (and wealth in the PSID analysis) and time fixed effects.

Table 13 reports the Shapley-Owen-Shorrocks marginal R-squared contributions from demographic controls (columns 1 and 3) and housing controls (columns 2 and 4) in the PSID (first row) and the CEX sample restricted to residents of the New York City metropolitan area (bottom row). In the PSID, housing variables account for a larger share of the variation in household spending. In the CEX, housing accounts for slightly less of the overall R-squared, which is perhaps not surprising given that the CEX contains less information on home size. If anything, the fact that the marginal contributions are similar is shocking given the vast demographic information and the sparse housing information.

3 Model

Here I propose a model that will be used to understand the macroeconomic implications of home size. The model combines two features that the literature has considered in isolation: 1) complementarity between housing and other goods, and 2) benefits from saving beyond standard consumption smoothing motives. In this section, I demonstrate that incorporating

[15] CEX survey respondents report expenditure at a quarterly frequency. For the marginal R-squared analysis, I run regressions at the household level based on households' average expenditure across quarters in the survey. This increases the R-squared of each regression by aggregating over higher-frequency (and potentially noisy) observations.

both of these features can rationalize results from Section 2. In the subsequent section, I derive implications for the natural rate of interest. The objective is not to decompose the historical evolution of the natural rate, but rather to demonstrate that housing complementarity, along with other modeling features that can match the microdata, have important macroeconomic implications.

The first modeling feature, complementarity between housing and non-housing goods, has been demonstrated to be useful for rationalizing consumption and asset pricing puzzles, for example (Flavin and Nakagawa, 2008). This and other papers (e.g., Khorunzhina, 2021) consider housing to include repairs and maintenance, and they focus on complementarity between housing (including of repairs and maintenance) and nondurable goods. I define housing more narrowly to include land and the bones of the housing structure, and I define non-housing goods to include all other consumption, including home repairs, maintenance, and durables. This alternative classification corresponds to the notion of housing in the Section 2 analysis of microdata and to the definition of housing in studies of household spatial sorting. The narrow definition of housing and broad definition of non-housing consumption is also appealing for the current analysis because it distinguishes the relatively fixed housing stock (land and the stock of housing structures) from goods and services that respond elastically to macroeconomic conditions (e.g., repairs and maintenance).

Modeling complementarity is necessary but not sufficient for rationalizing a relationship between housing and saving rates. For example, if households have access to credit markets and income shocks are independent of home size, then households will simply smooth consumption such that in steady state there will be no relationship between housing and saving rates.

Complementarity is not even sufficient to generate a positive relationship between housing and non-housing consumption. For example, consider the strong empirical relationship between non-housing consumption and housing among households who do not move (Table 8). As demonstrated in Appendix B, a typical Euler equation for these households (one that does not include utility over bonds) predicts that non-housing consumption is independent of housing, conditional on expected future non-housing consumption and prices. Intuitively, when housing consumption is constant, households' desired non-housing consumption is influenced only by the desire to smooth non-housing consumption over time and is therefore independent of current-period housing consumption.

Proposition 1. *Suppose that households do not have utility over bonds and that their housing consumption is fixed. Then current-period non-housing consumption is independent of home size, conditional on expectations of future non-housing consumption and prices.*

Proof. Appendix B.2

Therefore, to rationalize the evidence from the PSID, I incorporate utility over saving.

Modeling utility over saving or wealth is typical in the literature on debt sustainability (e.g. Mehrotra and Sergeyev, 2021), for example, and is a reduced-form way of parsimoniously capturing several microfoundations, including liquidity premia (Angeletos, Collard, and Dellas, 2020), safety premia (Mian, Straub, and Sufi, 2022), wealth as a marker of social status (Michaillat and Saez, 2021), and bequest motives. Furthermore, recent evidence indicates that modeling utility over wealth or savings is important for rationalizing the tails in the distributions of consumption and wealth in microdata (Gaillard et al., 2023).

The standard approach to incorporating bonds in the utility function is to model preferences over bonds as separable from preferences over consumption. However, the theoretical relationship between saving and housing depends on the elasticity of substitution between bonds and the consumption bundle, which under separable preferences is non-constant. Therefore, for the sake of parsimony, I present a model with constant-EOS (nonseparable) preferences between consumption and bonds. As demonstrated in the Calibration section (3.2.1), an EOS greater than unity is required to fit geographic variation in spending rates. In the Appendix, I present a separable-preference version of the model.

An alternative approach to generating an inverse relationship between housing and saving rates could be to explicitly model incomplete markets and frictions that would yield a positive relationship between precautionary savings and housing. However, the underlying microfoundations (beyond those that can be captured by bonds in the utility function) are not readily apparent. For example, it might seem that incorporating a role for housing collateral would yield less precautionary savings among households with more housing. However, collateral value is based on home value rather than home size, and the empirical evidence indicates a strong role for home size conditional on land values, along with less saving among households living in less-valuable suburban homes. Furthermore, the relationship between housing and non-housing consumption is evident even among renters (Table 3, Table 12, and Appendix Table A3), which cannot be rationalized by housing collateral.

I calibrate the parsimonious model to match housing expenditure shares and saving rates in New York and its suburbs. The calibrated model indicates complementarity between housing and other consumption. Furthermore, rationalizing the higher saving rate in NYC requires that bonds and the consumption bundle (over housing and non-housing goods) are substitutes (EOS>1). Under calibration approaches that account for demographic differences across locations, the difference in saving rates (and hence the required EOS) is similar or larger.

The model predicts that, in an open-economy setting, countries with more land (and hence more housing) per capita have lower saving rates. I then consider a closed-economy version of the model and demonstrate that a larger per-capita housing stock is associated with a higher natural rate of interest.

The macroeconomic implications of housing complementarity depend on the size of homes

relative to the size of the non-housing sector. I document that average home sizes in the U.S. and Japan have not increased relative to the 1990s (perhaps shockingly). Therefore, I model housing as inelastically supplied. Several factors that are beyond the scope of this study may drive the stable size of homes. For example, in Japan, the consistently small size of homes may be driven by geographic constraints. In the U.S., stable home sizes may be driven by growth that is concentrated in cities with inelastic housing supply (e.g.. Hsieh and Moretti, 2019), such that working households cannot move to land-abundant locations without a large loss of income. My model abstracts from the causes of a stable aggregate housing stock and instead focuses on its macroeconomic implications. I also abstract from households' location choice within a country, since the model admits aggregation, and macroeconomic implications depend on the aggregate (inelastic) stock of housing. In short, my model focuses on the features that can rationalize the microdata from Section 2, and I demonstrate that these straightforward modeling features, along with stable home sizes, have important macroeconomic implications that have been previously overlooked.

3.1 Households

A representative household maximizes

$$U = \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} \left(\left(H_t^{\frac{\gamma-1}{\gamma}} + X_t^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}\frac{\psi-1}{\psi}} + bB_{t+1}^{\frac{\psi-1}{\psi}} \right) \right]^{\frac{\psi(1-\sigma)}{\psi-1}} \tag{4}$$

subject to the budget constraint

$$p_{Ht} H_t + p_{Xt} X_t + Q_t B_{t+1} = I_t + B_t, \tag{5}$$

where H_t is housing consumption in period t, X_t is consumption of other goods, I_t is household income, and B_{t+1} is a bond that costs Q_t and pays a unit of the numeraire in period $t+1$. The real interest rate r is implicitly defined by $Q = \frac{1}{1+r}$, and the consumption bundle (over housing and non-housing goods) is $C \equiv \left(H^{\frac{\gamma-1}{\gamma}} + X^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}$. γ is the elasticity of substitution (EOS) between housing and non-housing goods, ψ is the EOS between the consumption bundle and bonds, b is a bond preference parameter, and σ influences the responsiveness of consumption to changes in the interest rate.

The household's Euler equation can be written as:

$$\begin{aligned} \log X = &\left((\psi - \gamma) + \frac{\gamma(1-\psi\sigma)}{\psi} \right) \log H + f\left(\frac{p_H}{p_X} \right) + g\left(\frac{bp_c}{Q-\beta} \right) \\ &+ \gamma \log Q - \gamma \log p_X - \gamma \log(U_B + \beta \mathbb{E}\left[\lambda'\right]), \end{aligned} \tag{6}$$

where I have omitted subscripts, U_B is the derivative of intratemporal utility with respect to B, $\mathbb{E}$ is the expectations operator, and $'$ indicates a variable's value in the subsequent period. $p_C \equiv \left(p_H^{1-\gamma} + p_X^{1-\gamma}\right)^{\frac{1}{1-\gamma}}$ is the price of a unit of the consumption bundle, λ is the multiplier on the household's budget constraint, and $f\left(\frac{p_H}{p_X}\right)$ and $g\left(\frac{bp_C}{Q-\beta}\right)$ are functions of prices that depends on the parameters of the utility function.

It is apparent from Equation 6 that non-housing consumption is positively associated with housing (conditional on prices and future marginal utility of income) when there is a sufficiently low EOS between them. When X and H are strong complements ($\gamma < 1$), more housing leads to higher marginal utility of non-housing consumption. Furthermore, a low σ implies less curvature of utility over within-period total consumption such that households are more willing to pull forward non-housing consumption when marginal utility of non-housing consumption is high.[16]

Equation 6, along with the positive relationship between non-housing consumption and housing in the microdata from Section 2, imply that non-housing consumption and housing are strong complements. In the empirical specification (equation 1), time fixed effects capture the level effects of bond and non-housing prices, land prices proxy for p_H, and high-dimension polynomials in income and wealth may approximate the last term in equation 6. But even if $\hat{\beta}$ in specification 1 provides a consistent estimate of the coefficient on $\log H$ in the Euler equation (equation 6), it does not permit independent estimation of the individual parameters of the household problem, each of which influences the aggregate implications of home size. To obtain these parameters, I instead calibrate an aggregate (open-economy) version of the model to match differences in expenditure shares and saving rates in NYC and its suburbs.

3.2 Small Open Economy

I first consider a small open economy version of the model to calibrate parameter values based on differences in expenditure shares and saving rates between central NYC and the suburbs. Differences in spending rates between locations could reflect demographic differences as well as differences in home size. Therefore, I consider several alternatives to remove the influence of demographic characteristics from the calibration. I explore these alternatives in Appendix C. Removing demographics tends to lead to parameter estimates that increase the dependence of spending on home size. Therefore, here I present the baseline calibration

[16] If I had instead modeled bonds as separable from consumption in the utility function, the coefficient on $\log H$ would be $(1-\gamma\sigma)$, and the same intuition would apply, as demonstrated in Appendix B. With separable preferences, $\frac{1}{\sigma}$ is typically associated with the elasticity of intertemporal substitution (EIS). However, as emphasized by Flavin and Nakagawa (2008), the responsiveness of non-housing to the interest rate depends also on the EOS (between housing and non-housing goods) and housing adjustment costs. This implies, for example, that households' observed spending can be unresponsive to the interest rate even if σ is low.

that yields more conservative set of parameters based on a calibration that does not account for demographic differences. In Section 4, I will consider a closed-economy version of the model to derive implications for the natural rate of interest.

The small open economy represents cities or other contiguous localities with relatively consistent population density and home size. H is endowed, X consists of tradable goods, and p_X and Q are set on international markets (and hence taken as given).[17] In the open-economy steady state, the housing stock and non-housing consumption are constant. This implies that the steady-state Euler equation is

$$u_B = \lambda (Q - \beta), \tag{7}$$

where u_B is the derivative of intratemporal utility with respect to B_{t+1} and λ is the multiplier on the household's budget constraint.

The open-economy equilibrium is determined by the steady state of household intertemporal optimization (Equation 7), the first-order condition between housing and non-housing consumption,

$$\frac{X}{H} = \left(\frac{p_H}{p_X}\right)^{\gamma}, \tag{8}$$

and the aggregate budget constraint (equation 5). Given the housing endowment H, income I, and international prices Q and p_X, these equilibrium equations determine the model's endogenous variables p_H, X, and B.

3.2.1 Calibration

I calibrate the model parameters γ, ψ, and b to match housing expenditure shares and saving rates in NYC versus the NYC suburbs. The two locations represent small open economies that have different housing endowments and face the same set of international prices. The economies may also differ in aggregate income, population size, and/or average household income. I do not impose restrictions on mobility across locations; nor do I impose spatial equilibrium. One could infer features of spatial mobility (e.g., location preferences and transportation costs) based on differences in real incomes across the locations, although one could also assume immobility and therefore consider income differences to represent differences in productivity in the non-housing sector.

The calibration proceeds in two steps. The first step yields a value for γ (the EOS between housing and non-housing consumption) based on housing expenditure shares and home price differentials across the two locations. Specifically, the housing expenditure share in location $\ell \in \{\text{NYC,Suburbs}\}$ can be written implicitly as

[17] To rationalize trade in X, it is sufficient to assume that it is a bundle that consists of goods produced in the small economy and other goods produced internationally.

$$\frac{1}{\text{Hshare}_\ell} = 1 + \left(\frac{p_{H\ell}}{p_X}\right)^{\gamma-1}, \tag{9}$$

where I have substituted the first-order condition between H and X (equation 8) into the identity Expenditure $= p_X X_\ell + p_{H\ell} H_\ell$ and rearranged. I normalize p_X to unity, and I jointly obtain values for $p_{H,\text{NYC}}, p_{H,\text{Suburbs}}$, and γ by finding the set of values that solves for Equation 9 in NYC, Equation 9 in the NYC suburbs, and the ratio of home prices in NYC to home prices in the NYC suburbs: $\frac{p_{H,\text{NYC}}}{p_{H,\text{Suburbs}}} = 1.5$, where I obtain the home price ratio 1.5 by aggregating zip-code-level home price indices across zip codes within each location. This results in a value for γ of 0.79.[18]

In the second step of the calibration, I obtain values for ψ (the EOS between bonds and consumption) and b (the bond preference parameter) by matching saving shares of income in each location. Specifically, write the budget constraint as

$$I_\ell = p_{C\ell} C_\ell + Q B_\ell, \tag{10}$$

where I_ℓ is net income and includes returns on assets and earnings from exports.[19] Substituting the first-order condition between bonds and consumption and rearranging yields

$$\frac{1}{1 - \text{Srate}_\ell} = 1 + Q p_{C\ell}^{\psi-1} \left(\frac{b}{Q - \beta}\right)^{\psi}, \tag{11}$$

where Srate_ℓ is the saving rate in location ℓ. I set $Q = 0.995$ (based on the natural rate of interest in the U.S. in 2015, according to Holston et al. (2017)) and $\beta = 0.95$. The values of $p_{H\ell}$ from the first step yield values of $p_{C\ell}$. With these values in hand, along with saving rates in each location, I find b and ψ that solve for equation 11 for each location. The resulting values are $b = 0.013$ and $\psi = 2.17$. Table 14 summarizes the calibration procedure and the calibrated parameter values.

The low calibrated EOS between housing and non-housing consumption ($\gamma < 1$) and the high calibrated EOS between the consumption bundle and saving ($\psi > 1$) explains the positive relationship between spending and housing documented in Section 2. Complementarity between housing and non-housing consumption implies that the suburban location with more land and lower home prices will have higher expenditure shares on non-housing consumption than the denser location, given the higher marginal utility of non-housing consumption there. And substitutability between consumption and saving implies that the suburban location with lower home prices (and hence lower consumption prices) will substitute toward

[18] This value is close to the estimate of the EOS between housing and nondurables in Khorunzhina (2021), which is based on a different estimation strategy and a broader classification of housing consumption.

[19] I equate I_ℓ with net income reported in the CEX. This measure includes rental income from ownership of housing in the resident's location and in other locations.

consumption and away from saving, relative to the dense (high-housing-cost) location.

Quantities. With parameter values and home prices in hand, I solve for quantities X_ℓ, H_ℓ, and B_ℓ in each location. Specifically, the first-order condition between C_ℓ and B_ℓ, the first-order condition between X_ℓ and H_ℓ, and the first-order condition between B_ℓ and X_ℓ (given Q,p_X, $p_{H\ell}$ and the parameters of the utility function) yield values for each of the equilibrium quantities.[20] This yields a set of quantities in the suburban location that can be used to determine across-location aggregate (closed-economy) implications.

4 Implications for the Natural Rate of Interest

With parameter values in hand, I aggregate the model to a closed economy in which the bond price equates supply and demand for consumption. I then examine how much differences in housing supply between the U.S. and Japan can account for differences in the natural rate of interest.

In the closed economy, the aggregate housing stock H is endowed and bonds are in fixed net supply.[21] In the aggregate steady state, the housing stock and non-housing consumption are constant ($H = H',\ X = X' \ \Rightarrow \lambda = \lambda'$). Substituting into the Euler Equation yields the steady-state relationship

$$Q = \frac{u_B}{\lambda} + \beta, \tag{12}$$

which yields the bond price that clears the goods markets. Note that equation 12 nests the standard assumption that u_B=0, in which case the bond price is pinned down by the discount factor ($Q = \beta$). The bond price (and hence the real interest rate) is in terms of the consumption bundle C, and in Appendix B.1 I examine the real interest rate in terms of non-housing consumption (similar to the approach in Guerrieri et al., 2022) when households have separable preferences over consumption and saving.

To determine implications of housing for the real interest rate, I first solve for the real rate in the U.S. and I consider how the rate would adjust to changes in housing supply. The bond price in equation 12 depends on the quantities H, X, and B, and to determine these values for the U.S. I assume that the representative suburban household from the open-economy calibration is representative of the U.S. household. Specifically, I set $Z = Z_{\text{Suburbs}}\ \forall\, Z \in \{H, X, B\}$.

Figure 4 reports how the interest rate depends on H, conditional on the calibrated values for B and X. In the baseline calibration (solid line), the U.S. real interest rate is approximately 1%, consistent with the estimate of the U.S. real rate as of 2015 in Holston et al. (2017). A smaller housing stock leads to a lower real rate, based on the same intuition as

[20] Note that even though H_ℓ is considered to be endowed, its value is unknown. Since we can observe the endogenous variable $p_{H\ell}$, we use it to solve for unobserved H_ℓ.

[21] Net supply can exceed zero under the assumption of a government that issues debt.

the dependence of saving rates on housing in the open-economy model. Less housing leads to lower marginal utility of non-housing consumption and a lower marginal utility of the consumption bundle relative the marginal utility of saving.

Han (2019) reports that the natural rate in Japan has been persistently below the natural rate in the U.S., and as of 2015 the Japanese natural rate was still below zero (Figure 5). To determine how much of this difference can be explained by differences in housing supply, I compute the ratio of housing square footage per capita in the U.S. to housing square footage in Japan. Data for the U.S. are from the American Housing Survey, and data for Japan are based on the Japanese Housing and Land Survey. Details on the data and the construction of housing per capita are in Appendix D. The average U.S. home size is 220% larger than the average Japanese home size, which is nearly identical to the ratio depicted in Figure 2 based on data on *new* homes. According to Figure 4, the model implies that 50 basis points of the difference in real rates can be explained by differences in housing supply.

4.1 Effect of Non-housing Production on the Natural Rate

Home sizes have remained relatively fixed since the 1990s (Table 15) even though real GDP has roughly doubled since 1990. Figure 4 (dashed line) shows the natural rate of interest predicted by the model if X were at levels consistent with relative real GDP in the 1990s (half its calibrated size). The model implies a substantial contribution of the smaller size of the non-housing sector to the higher natural rate that prevailed in the 1990s. Holston et al. (2017), for example, estimate that the natural rate fluctuated between between 2.5% and 3.5% in the 1990s, which is in line with the model's prediction for the natural rate based on the size of the non-housing sector in 1990.

The model also implies that if new production continues to be concentrated in the non-housing sector, then natural rates will decline below zero. Specifically, the dotted line in Figure 4 depicts model-implied rates (as a function of home size) if the non-housing sector were 40% larger than its calibrated value (which would take approximately 13 years at an annual growth rate of 2.5%).

4.2 Effectiveness of Monetary Policy

A potential concern with low natural rates of interest is the increased likelihood that monetary policy becomes constrained by an effective lower bound (ELB) on nominal rates. Here I demonstrate that even in the absence of ELB concerns, the determinants of a low natural rate (specifically, a small housing stock) imply limited pass-through from interest-rate changes to spending.

To evaluate the effectiveness of monetary policy, I assume that the bond price is controlled

by a central bank and that the price of non-housing consumption is rigid. Differentiating the first-order conditions for bonds and for non-housing consumption yields the following expression for the responsiveness of non-housing consumption to the bond price:

$$\frac{\hat{X}}{dQ} = \frac{1}{\kappa p_X b} B^{\frac{1}{\psi}} X^{-\frac{1}{\gamma}} \left(H_{ijt}^{\frac{\gamma-1}{\gamma}} + X_{it}^{\frac{\gamma-1}{\gamma}} \right)^{-\frac{\gamma}{1-\gamma}\frac{\psi-1}{\psi}}, \tag{13}$$

where $\hat{X} \equiv \frac{dX}{X}$ and $\kappa \equiv 1 + \frac{\gamma}{1-\gamma}\frac{\psi-1}{\psi}$.

Figure 6 shows how the magnitude of this responsiveness depends on home sizes. For calibrated home sizes in the U.S. and Japan (solid line), non-housing consumption is approximately a percentage-point more responsive in the U.S. Furthermore, the model predicts that the responsiveness will decline for both countries as the non-housing sector grows, with even stronger declines in Japan (dashed line). When housing is small relative to the non-housing sector, marginal utility from non-housing consumption is low, and therefore non-housing consumption is even less responsive to changes in the real interest rate.

5 Conclusion

The persistence of low global real interest rates has sparked a growing interest in understanding the factors influencing household saving rates. However, the determinants of household saving rates remains an open question. In this paper I present evidence on a new determinant of household saving —home size —and I demonstrate that it explains as much variation in consumption and saving as demographic characteristics.

The relationship between home size and household spending is strikingly apparent in a variety of contexts: at the aggregate level over time, across countries, and across cities. To investigate the underlying reasons for this pervasive correlation, I examine microdata on household consumption, housing characteristics, income and demographics. The evidence indicates that denser areas and smaller homes are associated with lower spending, even after controlling for other determinants of household spending. The analysis isolates the importance of complementarities between housing and non-housing consumption in driving this relationship by limiting the influence of other potential mechanisms and by examining the effects of job-related moving shocks to areas that vary in the available housing stock.

To rationalize the evidence that cities and countries with larger homes have lower spending rates, I develop a model that incorporates two elements that have previously been modeled in isolation: 1) complementarity between housing and other goods and 2) utility over saving. My classification of housing departs from several prominent studies that have focused on housing complementarity by limiting the definition of housing to land and the bones of the housing structure. This narrow classification permits an analysis of the macroeconomic

effects of home size (which has remained relatively fixed in the U.S. and Japan) on the natural rate of interest and on the responsiveness of spending to changes in interest rates.

The macroeconomic model implies that countries with higher population density and smaller homes on average, like Japan, have higher savings rates and lower natural rates of interest. The model also implies that monetary policy is less effective in stimulating consumption in dense, housing-constrained economies, and that it will become less effective as the non-housing sector grows.

This paper highlights a novel mechanism connecting urban density to aggregate savings and interest rates. The findings suggest that dense housing and lack of space could be a contributor to Japan's persistent stagnation and low policy rates. They could also help explain the post-COVID rise in aggregate consumption and interest rates, as households moved to larger homes in suburban neighborhoods.

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Tables and Figures

Table 2
Summary Statistics

	Mean	Median	SD	p10	p90
	(1)	(2)	(3)	(4)	(5)
CEX					
Spending ($, quarterly)					
Total	14,947	12,503	9,567	6,834	25,656
Rent and mortgage	1,935	1,584	2,031	0	4,278
Food away from home	720	524	886	0	1,505
Public transportation	166	0	672	0	437
Durables	4,145	2,481	6,115	863	7,717
Maintenance	314	70	759	0	875
Utilities	1,090	1,020	564	465	1,776
Income ($, annual)	78,863	78,863	78,863	78,863	78,863
Number of Rooms	6.23	6.00	1.89	4.00	9.00
Single family home	0.63	1.00	0.48	0.00	1.00
PSID					
Spending ($, annual)					
Total (2005 onward)	46,323	40,116	32,255	16,013	82,026
Total (1999-2003 coverage)	31,469	7,408	31,424	0	67,347
Total net rent, mortgage	24,752	20,931	25,576	0	54,040
Income ($, annual)	75,241	55,462	101,137	14,074	148,200
Number of Rooms	5.72	6.00	2.33	3.00	9.00
Single Family Home	0.52	1.00	0.50	0.00	1.00
Tract-level data					
Population-weighted density (per meter sq)	4,848	2,239	9,671	125	113,332
Lot size (square feet)	17,751	13,720	12,187	6,350	37,060
Land value ($ per acre)	432,420	128,100	1,116,855	29,600	886,200

Table 3
Household Expenditure and Residential Density

	Dependent Variable: (log) Total Expenditure							
Sample:	All	New York Metro Area	Not Married	Married	Homeowner	Renter	Age 25-65	Age 65-85
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Central NYC	-0.093***	-0.168**	-0.094***	-0.093***	-0.096***	-0.038***	-0.084***	-0.116***
	(0.013)	(0.029)	(0.013)	(0.013)	(0.018)	(0.009)	(0.014)	(0.019)
N	103666	19193	50252	53414	63538	40128	79272	16860
R2	0.57	0.59	0.47	0.52	0.53	0.51	0.57	0.48

This table reports coefficients from regressions of total household expenditure categories on an indicator for whether the household lives in central New York City. All regressions include the following controls: a six-degree polynomial in after-tax income, a quadratic in age of the respondent, number of family members, and indicators for family type. The sample is restricted to households with income between $35k and $200k. Standard errors clustered at the PSU level are reported in parentheses. Standard errors clustered at the PSU level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4
Expenditure Categories

		Housing Substitutes		Housing Complements			Total Net
Dependent variable (logs):	Rent and Mortgage	Food away from home	Public Transportation	Durables	Home/Auto maintenance	Utilities	Rent and Mortgage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Central NYC	0.304***	0.190***	0.251***	-0.768***	-0.448***	-0.228***	-0.184***
	(0.059)	(0.020)	(0.040)	(0.025)	(0.024)	(0.042)	(0.016)
N	46123	47359	14825	52988	38188	52965	53219
R2	0.09	0.13	0.05	0.19	0.07	0.25	0.40

This table reports coefficients from regressions of alternative expenditure categories on an indicator for whether the household lives in central New York City . All regressions include the following controls: a six-degree polynomial in after-tax income, a quadratic in age of the respondent, number of family members, and indicators for family type. The sample is restricted to households with income between $35k and $200k. Standard errors clustered at the PSU level are reported in parentheses. Standard errors clustered at the PSU level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5
Housing Characteristics

Dependent variable (logs):	Total expendture			Total Net Rent, Mortgage		
	(1)	(2)	(3)	(4)	(5)	(6)
Central NYC	-0.086***	-0.062***	-0.029**	-0.181***	-0.144***	-0.102***
	(0.012)	(0.012)	(0.012)	(0.015)	(0.015)	(0.014)
Single-Family Home		0.062***	0.008		0.097***	0.029**
		(0.009)	(0.013)		(0.010)	(0.011)
log(Number of rooms)			0.176***			0.224***
			(0.016)			(0.018)
N	63013	63013	62460	63009	63009	62456
R2	0.396	0.398	0.408	0.381	0.386	0.398

All regressions include the following controls: a six-degree polynomial in after-tax income, a quadratic in age of the respondent, number of family members, and indicators for family type. The sample is restricted to households with income between $35k and $200k. Standard errors clustered at the PSU level are reported in parentheses.

Table 6
Expenditure And Housing

Dependent variable (logs):	Total Expenditure						Expenditure Net Rent, Mortgage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(density)	-0.005***						
	(0.001)						
High Density (>p90)		-0.075***				-0.011*	-0.021***
		(0.005)				(0.006)	(0.007)
Single-Family Home			0.129***			0.078***	0.112***
			(0.003)			(0.003)	(0.003)
log(number of rooms)				0.296***		0.275***	0.275***
				(0.004)		(0.004)	(0.005)
log(Lot Size)					0.051***	0.039***	0.050***
					(0.003)	(0.003)	(0.003)
CBSA fixed effects	✓	✓	✓	✓	✓	✓	✓
N	394283	394283	396479	388322	308802	302897	302821
R2	0.54	0.54	0.54	0.56	0.54	0.57	0.53

This table reports how (log) expenditure in the PSID depends on census-tract-level density and direct measures of home size. All regressions include controls for family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and CBSA and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table 7
Expenditure and Housing: Over Age 70

	Dependent variable: (log) Total Expenditure					
Age in 1999:	Over 70					
	(1)	(2)	(3)	(4)	(5)	(6)
Single-Family Home	0.105***		0.105***			0.064***
	(0.010)		(0.011)			(0.012)
log(Rooms)		0.208***		0.213***		0.195***
		(0.011)		(0.013)		(0.014)
log(Lot size)					0.055***	0.071***
					(0.014)	(0.014)
High Density						-0.036*
						(0.022)
Control for Land Value			✓	✓	✓	✓
N	29310	28631	22758	22282	22758	22282
R2	0.51	0.52	0.52	0.53	0.51	0.53

This table reports how (log) expenditure in the PSID depends on tract-level density and direct measures of home size. All regressions include controls for family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and CBSA and year fixed effects. Columns 3 through 6 also control for (log) land value. Standard errors clustered at the respondent level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8
Respondents Who Own Home and Do Not Move

Expenditure (logs):	Total			Total Net Housing		
	(1)	(2)	(3)	(4)	(5)	(6)
log(Rooms)	0.286***	0.273***	0.246***	0.196***	0.187***	0.171***
	(0.026)	(0.026)	(0.026)	(0.024)	(0.024)	(0.024)
log(Lot size)		0.085***	0.074***		0.058***	0.049**
		(0.022)	(0.023)		(0.022)	(0.022)
Single-family home			0.133***			0.074**
			(0.038)			(0.034)
High density			-0.090***			-0.067*
			(0.034)			(0.037)
CBSA fixed effects	✓	✓	✓	✓	✓	✓
N	15276	15276	15276	15276	15276	15276
R2	0.58	0.58	0.59	0.52	0.53	0.53

All regressions include controls for land value, family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and CBSA and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table 9
Effect of Moving Shock between 2 and 4 Years ago

(log):	Total Expenditure			Exp. Net Rent, Mortgage		
	(1)	(2)	(3)	(4)	(5)	(6)
Move to Apartment	-0.123***			-0.139***		
	(0.042)			(0.050)		
Move to Single-Family Home		0.092***			0.068**	
		(0.029)			(0.033)	
Move×%Δ Number of Rooms			0.131***			0.123***
			(0.019)			(0.022)
Respondent fixed effects	✓	✓	✓	✓	✓	✓
N	236155	236155	227420	236087	236087	227367
R2	0.72	0.72	0.73	0.70	0.70	0.71

This table reports the effect on total expenditure of a moving shock due to work-related reasons. All regressions include demographic controls, log(expenditure) prior to the move, high-dimensional polynomials of income and wealth, and respondent and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table 10
Effect of Moving Shock: IV specification

	Exp. Net Rent, Mortgage				
	Moving Shock			Military Moving Shock	
	(1)	(2)	(3)	(4)	(5)
Move to Apartment	-1.870***				
	(0.636)				
Move to Single-Family Home		1.045***		0.489**	
		(0.301)		(0.191)	
Move×%Δ #of Rooms			0.318***		0.831*
			(0.070)		(0.480)
Respondent fixed effects	✓	✓	✓	✓	✓
N	233319	233319	225960	233319	225960
First-stage F stat	8.58	30.01	132.99	13.84	5.28

This table reports the effect on total expenditure of a moving shock due to work-related reasons. In each specification, the interaction between moving shock and change in housing status (either move to SFH or change in log rooms) is instrumented with the moving shock interacted with the change in (log) county-level average room size. All regressions include demographic controls, log(expenditure) prior to the move, (log) income and wealth, and respondent and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table 11
Placebo: Effect of Moving Shock on Housing Substitutes vs. Complements

(log):	Food Away From Home			Utilities and Furniture		
	OLS	IV		OLS	IV	
	(1)	(2)	(3)	(4)	(5)	(6)
Move×%Δ # of Rooms	-0.012	-0.828***	-0.929***	0.439***	0.363**	0.723***
	(0.073)	(0.242)	(0.217)	(0.075)	(0.166)	(0.210)
Land Price Controls			✓			✓
Respondent fixed effects	✓	✓	✓	✓	✓	✓
N	226031	226031	294280	226031	226031	294280
R2	0.48			0.43		
First-stage F stat		132.89	167.63		133.02	167.72

This table reports the effect on total expenditure of a moving shock due to work-related reasons. In columns 2, 3, 5, and 6, the interaction between moving shock change in log rooms is instruments with the moving shock interacted with the change in (log) county-level average room size. All regressions include demographic controls, log(expenditure) prior to the move, (log) income and wealth, and respondent and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table 12
Limiting the Influence of Housing as a form of Saving: Estimates for Renters

Expenditure (logs):	Exp. Net Rent, Mortgage	Vehicles, Furniture, Utilities	Household Repairs	Vehicles, Furniture, Utilities	Household Repairs	Exp. Net Rent, Mortgage	Exp. Net Rent, Mortgage
	OLS						IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
log(Rooms)	0.221***						
	(0.004)						
log(Rooms)× Renter	-0.012*						
	(0.006)						
Move×%Δ # of Rooms		0.367***	0.423**				
		(0.081)	(0.168)				
Move×%Δ # of Rooms × Renter				0.431***	0.152	0.165***	0.419***
				(0.126)	(0.216)	(0.034)	(0.081)
CBSA fixed effects	✓						
Household Fixed Effects		✓	✓	✓	✓	✓	✓
N	306680	140975	140900	196418	196364	225960	225960
R2	0.56	0.50	0.53	0.47	0.50	0.72	
First-Stage F-Statistic							66.69

The coefficient on Move×%Δ # of Rooms × Renter indicates the estimated effect of experiencing a moving shock between 2 and 4 years ago on (log) number of rooms among households that have rented since the move. All regressions include controls for family size and type, other demographic controls, (log) income and wealth and year fixed effects. The specification in column (1) flexibly controls for the interaction of rental status with household characteristics. In column (7), the interaction between moving shock and change in log rooms is instrumented with the moving shock interacted with the change in (log) county-level average room size. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table 13
Marginal R-squared: Shapley-Shorrocks-Owens Decomposition

(log) Spending:	Total		Net Rent, Mortgage	
Add'l Controls:	Demographics	Housing	Demographics	Housing
Dataset	(1)	(2)	(3)	(4)
PSID	0.181	0.209	0.172	0.200
CEX (New York)	0.215	0.186	0.186	0.177

This table reports the Shapley-Owens-Shorrocks marginal R-squared from demographic controls (columns 1 and 3) or housing controls (columns 2 and 4) in regressions that include high-dimensional polynomials in income (and wealth in the PSID sample), and time fixed effects. The bottom row reports results from the CEX subsample of households that live in the New York City Primary Sampling Unit. The CEX regressions at the respondent level based on averages across quarters the respondent is in the survey.

Table 14
Calibrated Parameters

	Description	Equations	Data Inputs	Calibrated Values
Step 1: γ				
	Housing Expenditure Shares	Equation 9	$\text{Hshare}_{NYC} = 0.26$	$\gamma = 0.79$
	Relative Housing Costs	$\frac{p_{H,\text{NYC}}}{p_{H,\text{Suburbs}}} = 1.5$	$\text{Hshare}_{\text{Suburbs}} = 0.21$	
Step 2: ψ, b				
	Saving Rates	Equation 11	$1 - \text{Srate}_{\text{NYC}} = 0.72$	b=0.013
			$1 - \text{Srate}_{\text{Suburbs}} = 0.79$	$\psi = 2.17$

The data inputs are from Table 1. Solving for endogenous quantities using calibrated parameters yields $H_D = 210.04, H_S = 490.33, X_D = 3.30, X_S = 2.55$. See Appendix Table C.1 for calibrated parameter values under approaches that remove the influence of demographics and home ownership on location-specific spending rates.

Table 15
Home Sizes in U.S. and Japan

	Square Feet Per Home			Square Feet Per Person		
	U.S.	Japan	Ratio	U.S.	Japan	Ratio
1998	1885	880	2.14	808	383	2.11
2008	1940	911	2.13	852	435	1.96
2018	1723	782	2.20	798	370	2.16

This table is constructed using data from the American Housing Survey and the Housing and Land Survey of Japan, as described in Appendix D

Figures



Figure 3

This figure summarizes the elasticity of spending with respect to number of rooms in the PSID specifications. Each coefficient is reported along with two-standard-error bands. In each of these regressions, the (log) number of rooms is the only measure of home size. Other details of the model specification are as described in Section 2.3.

Housing Supply and the Real Interest Rate

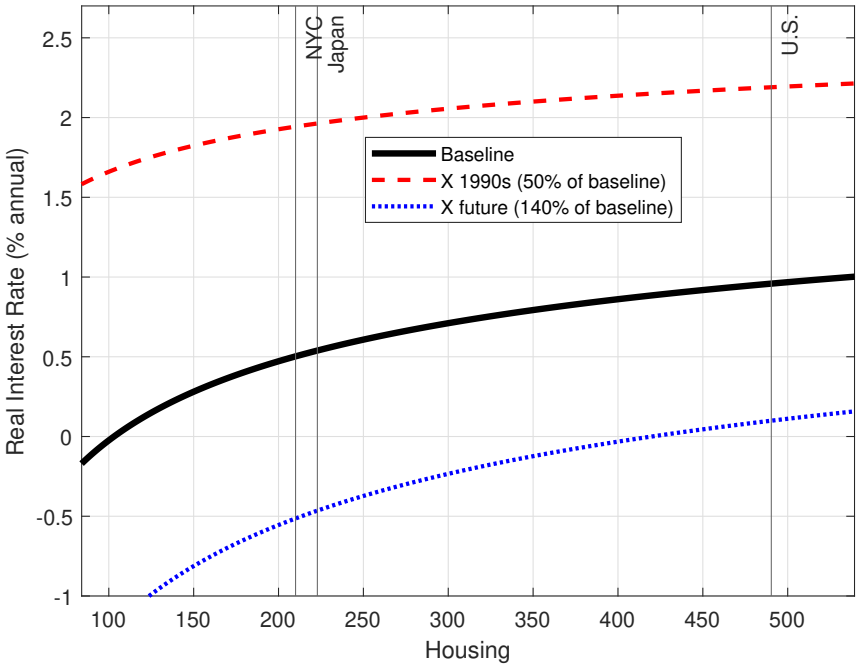


Figure 4

Note: The housing stock for the U.S. is based on H_{Suburbs}, and the housing stock for Japan is scaled based on relative housing per capita in each location. The housing stock for NYC is its H_{NYC}.

Natural Rates of Interest in USA, EMU, and Japan

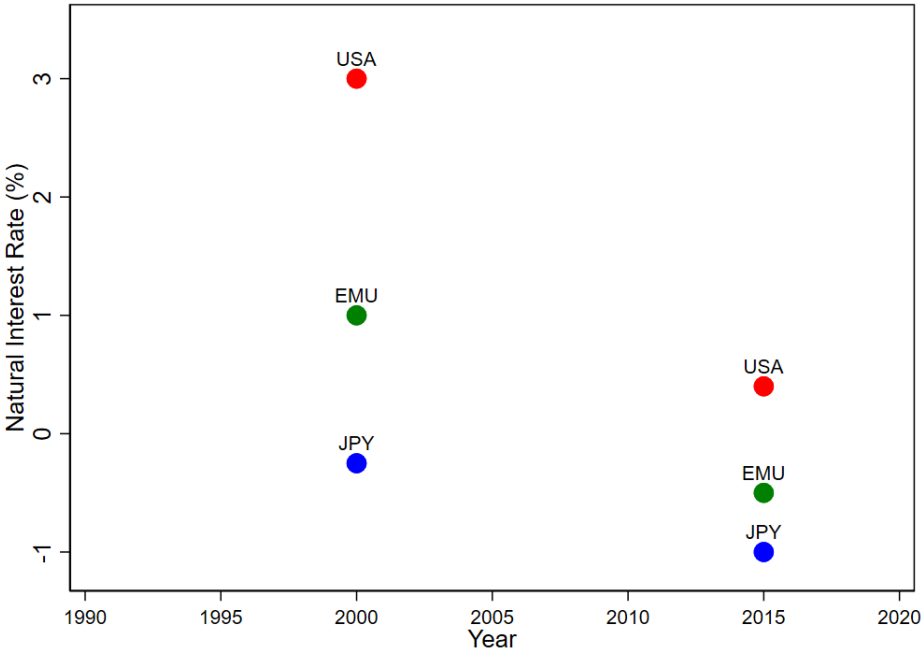


Figure 5

Estimates of the natural rates in the U.S. and EMU are from Holston et al. (2017). Estimates for Japan are from Han (2019) and are based on a similar method to the estimates for the U.S. and EMU.

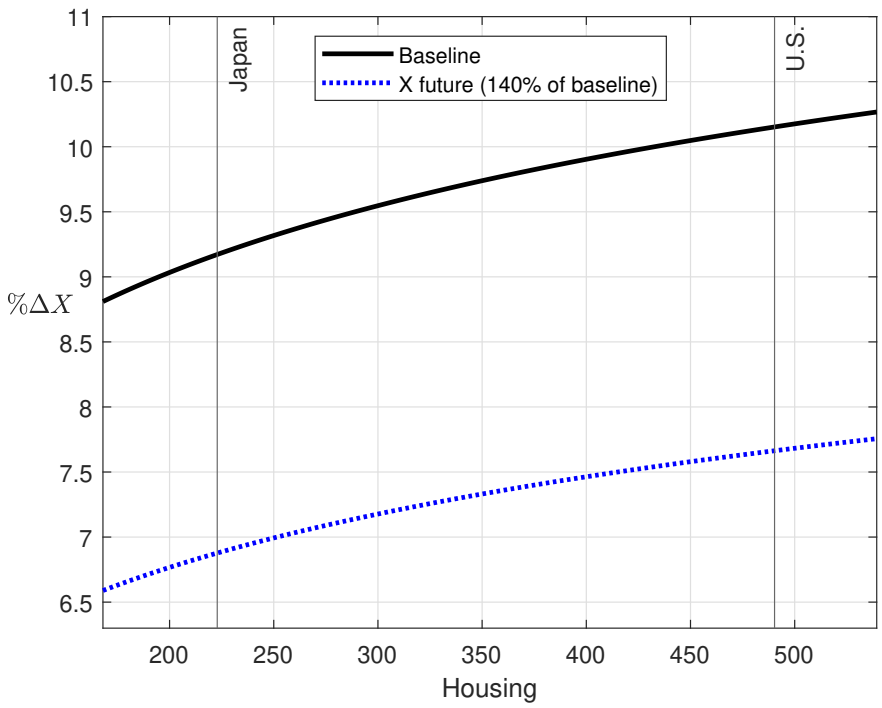


Figure 6

Note: The housing stock for the U.S. is based on H_{Suburbs}, and the housing stock for Japan is scaled based on relative housing per capita in each location.

Appendix

A Appendix Tables and Figures

Table A1
Expenditure Datasets

Dataset:	CEX	PSID
	Repeated Cross-Section	Panel
Frequency	Annual	Biennial
Geographic Information	City	Census Tract (restricted data)
Home Size Indicators		
Residential density (land size proxy)	NYC vs. Suburbs	tract-level density
Home type (SFH vs. Apt.)	✓	✓
Number of rooms	✓	✓
Home Price information	NA	tract-level land values
Years	2006-2014	1999-2021
Expenditure Recall period	3 months	Year
Demographic information	✓	✓
Income	✓	✓
Assets	Limited	✓

Table A2
Expenditure and Housing: Over Age 55

Age in 1999:	(log) Total Expenditure					
	Over 55					
	(1)	(2)	(3)	(4)	(5)	(6)
High Density (>p90)	-0.055***		-0.056***			-0.030*
	(0.014)		(0.017)			(0.017)
log(Rooms)		0.255***		0.249***		0.249***
		(0.009)		(0.011)		(0.010)
log(Lot size)					0.070***	0.077***
					(0.011)	(0.010)
Control for Land Value			✓	✓	✓	✓
N	52055	50798	40402	39433	40402	39433
R2	0.49	0.51	0.49	0.52	0.49	0.52

This table reports how (log) expenditure in the PSID depends on tract-level density and direct measures of home size. All regressions include controls for family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and CBSA and year fixed effects. Columns 3 through 6 also control for (log) land value. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table A3
Respondents who rent and do not move

Expenditure (logs):	Total			Total Net Housing		
	(1)	(2)	(3)	(4)	(5)	(6)
log(Rooms)	0.146***	0.160***	0.167***	0.218***	0.230***	0.216***
	(0.036)	(0.036)	(0.035)	(0.037)	(0.037)	(0.037)
log(Lot size)		0.148***	0.139***		0.140***	0.137***
		(0.033)	(0.034)		(0.035)	(0.036)
Single-family home			-0.054			-0.065
			(0.041)			(0.047)
High density			-0.033			0.037
			(0.026)			(0.030)
CBSA fixed effects	✓	✓	✓	✓	✓	✓
N	4040	4040	4040	4035	4035	4035
R2	0.57	0.58	0.58	0.55	0.55	0.56

All regressions include controls for land value, family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and CBSA and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses. *** p< 0.01, ** p< 0.05, * p< 0.1.

Table A4
Respondents living in same county where grew up

Dependent variable (logs):	Total Expenditure			Total expenditure net rent, mortgage		
	(1)	(2)	(3)	(4)	(5)	(6)
Single Family Home	0.070***	0.072***	0.040***	0.098***	0.101***	0.067***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
log(Rooms)	0.272***	0.275***	0.224***	0.269***	0.273***	0.213***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
log(LotSize)	0.070***	0.056***	0.041***	0.073***	0.058***	0.044***
	(0.005)	(0.006)	(0.008)	(0.006)	(0.006)	(0.009)
CBSA fixed effects	✓			✓		
County fixed effects		✓	✓		✓	✓
Respondent fixed effects			✓			✓
N	128251	128249	124085	128201	128199	124028
R2	0.57	0.58	0.75	0.55	0.56	0.73

This table reports how (log) expenditure in the PSID depends on census-tract-level lot size. All regressions include controls for land value, family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and year fixed effects. Standard errors clustered at the respondent level are reported in parentheses.*** p< 0.01, ** p< 0.05, * p< 0.1.

Table A5
Robustness

Expenditure (logs):	Total post-05		Total post-99		Total Net Housing	
	(1)	(2)	(3)	(4)	(5)	(6)
log(Rooms)	0.254***		0.258***		0.249***	
	(0.004)		(0.004)		(0.004)	
log(Lot size)	0.076***		0.085***		0.069***	
	(0.004)		(0.004)		(0.004)	
Single-family home	0.080***		0.076***		0.105***	
	(0.004)		(0.003)		(0.004)	
High density	-0.009		-0.014**		-0.024**	
	(0.007)		(0.006)		(0.007)	
MovingShock×Δ rooms		0.010***		0.021***		0.022***
		(0.005)		(0.004)		(0.005)
Control for future income			✓	✓	✓	✓
Respondent Fixed Effects		✓		✓		✓
CBSA×Year fixed effects	✓	✓	✓	✓	✓	✓
Control for land value	✓	✓	✓	✓	✓	✓
N	217214	204988	261095	192811	261051	192795
R2	0.62	0.60	0.63	0.78	0.59	0.75

This table reports how (log) expenditure in the PSID depends on home size under alternative measures of expenditure and using alternative controls. The expenditure measure in columns 1 and 2 is the comprehensive measure that began in 2005. The expenditure measure in columns 3 and 4 is the measure as of 1999. The last columns use the 1999 measure net of housing expenditure. The dependent variable in columns 2, 4, and 6 is the change in the number of rooms when a household was subject to a moving shock between 2 and 4 years ago. All regressions include controls for land value, family size and type, other demographic controls, high-dimensional polynomials of income and wealth, and CBSA times year fixed effects. The specifications on columns 3 through 6 also control for future (log) income. Standard errors clustered at the respondent level are reported in parentheses.*** p< 0.01, ** p< 0.05, * p< 0.1.

B Model with Separable Preferences

The baseline model in Section 3 assumes nonseparable preferences between consumption and bonds. Here I present a version of the model featuring the standard (separable) approach to modeling utility over bonds (or other forms of wealth). If a representative household's marginal utility over bonds is constant (as in, e.g., Michaillat and Saez, 2021), then the ability of the model to generate a positive relationship between housing supply and the natural rate of interest depends on the pricing kernel for the natural rate. This section of the Appendix demonstrates that if bonds pay a unit of the non-consumption good, then more housing leads to a higher natural rate.

This model also nests the case in which marginal utility over bonds is zero. Below I demonstrate that in this case, the household Euler equation predicts that non-housing consumption is independent of housing (conditional on home prices and expectations of future marginal utility), as highlighted in Proposition 1 of Section 3.

Household i maximizes

$$U_i = \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\sigma} \left(H_{it}^{\frac{\gamma-1}{\gamma}} + X_{it}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma(1-\sigma)}{\gamma-1}} + v(B_{i,t+1}) \right) \tag{B.1}$$

subject to the budget constraint in equation 5.

where $v(B)$ is utility over saving and σ influences the responsiveness of consumption to changes in the interest rate.

The household's Euler equation can be written as:

$$\begin{aligned} \log \mathbf{X} =& (1-\sigma\gamma) \log \mathbf{H} - \frac{\gamma(1-\sigma\gamma)}{1-\gamma} \log \left(1 + \left(\frac{p_H}{p_X} \right)^{\gamma-1} \right) \\ &+ \gamma \log Q - \gamma \log p_X - \gamma \log(v_B + \beta \mathbb{E}\left[\lambda'\right]), \end{aligned} \tag{B.2}$$

where I have omitted subscripts, v_B is the derivative of $v(B)$ with respect to B, and I have substituted in the first-order condition between housing and non-housing consumption (equation 8)

It is apparent from Equation 6 that non-housing consumption is positively associated with housing (conditional on prices and future marginal utility of income) when there is a sufficiently low EOS between them —in particular, $\frac{\partial \log X}{\partial \log H} > 0$ when $\sigma\gamma < 1$. The intuition corresponds to that in Section 3: when X and H are strong complements ($\gamma < 1$), more housing leads to higher marginal utility of non-housing consumption. Furthermore, a low σ implies less curvature of utility over within-period total consumption such that households are more willing to pull forward non-housing consumption when marginal utility of non-housing consumption is high.

B.1 Aggregate Implications: Natural Rate of Interest

As in the baseline closed-economy model in Section 2, the aggregate housing stock H is endowed and bonds are in fixed net supply. In the aggregate steady state, the housing stock and non-housing consumption are constant ($H = H',\ X = X' \ \Rightarrow \lambda = \lambda'$). Substituting into the Euler Equation yields the steady-state relationship

$$Q = \frac{v_B}{\lambda} + \beta, \tag{B.3}$$

where λ is defined in Equation B.1. Equation B.3 gives the bond price that clears the goods markets.

We have yet to assign a numeraire and therefore we have not yet specified whether the bond is priced against the the consumption bundle or one of its components. Consider, first, that X is the numeraire such that the bond pays a unit of the non-housing good. This assumption is similar to that in Guerrieri et al. (2022), which examines how the supply of one good influences the price of bonds that pay a unit of another good. In this case, an economy with more housing has higher marginal utility of non-housing consumption, which requires a higher bond price to clear the non-housing goods market:

Result 1. *When $\sigma\gamma < 1$ and X is the numeraire, more housing leads to a lower steady-state bond price (higher natural interest rate):*

$$\frac{dQ}{\hat{H}} = -\frac{v_B}{\lambda}\left(\frac{1-\sigma\gamma}{\gamma}\right)\frac{H^{\frac{\gamma-1}{\gamma}}}{H^{\frac{\gamma-1}{\gamma}} + X^{\frac{\gamma-1}{\gamma}}}, \tag{B.4}$$

where $\hat{H} = \frac{d\log H}{H}$

This prediction of the model is consistent with the observed variation in natural rates of interest, documented in Figure 5, and with the relationship between real rates and housing from the baseline model (Figure 4). Japan has very high density and small homes (Figure 2) and has a persistently lower natural rate of interest than the EMU. The U.S. has the largest average home size and has higher natural rates of interest during years for which comparable estimates are available.

It is not clear, however, whether bonds are priced based on marginal utility of the non-housing good or on marginal utility of the entire consumption bundle.[22] The distinction matters in this setting, because more housing is associated with higher marginal utility of non-housing consumption but lower marginal utility over the consumption bundle (relative to marginal utility of bonds). If bonds instead pay a unit of the consumption bundle (specifically, C is the numeraire), then a higher housing endowment causes lower marginal utility

[22]For example, if the marginal investor faces sufficiently large housing adjustment costs, then it may be reasonable to consider that the bond is priced relative to non-housing consumption.

of the consumption bundle relative to marginal utility of bonds (which based on the closed-economy assumption are in fixed supply). The price of the bond increases (interest rate falls) with the housing stock, since the marginal utility of the consumption bundle falls relative to the marginal utility of bonds. The non-housing market nonetheless clears because of upward adjustments in p_X.

B.2 Independence of Non-housing consumption and housing when bonds are not in utility function (Proposition 1).

Here we consider the limiting case in which $v_B = 0$ and demonstrate that, conditional on home prices and expectations of future income, contemporaneous non-housing consumption is independent of housing.

First, note that the first-order conditions with respect to X_t and B_{t+1} in the separable-preference utility function (equation B.1) imply that the household Euler Equation can be written as

$$\frac{U_X}{p_X} Q = v_B + \beta \mathbb{E}\left[\lambda'\right], \tag{B.5}$$

where

$$U_X = \left(H^{\frac{\gamma-1}{\gamma}} + X^{\frac{\gamma-1}{\gamma}}\right)^{\frac{1-\sigma\gamma}{\gamma-1}} X^{-\frac{1}{\gamma}} \tag{B.6}$$

and

$$\lambda = \frac{U_X}{p_X}. \tag{B.7}$$

The first-order condition between H and X implies that we can write

$$U_X = H^{\frac{1-\sigma\gamma}{\gamma}} \left(1 + \left(\frac{p_H}{p_X}\right)^{\gamma-1}\right)^{\frac{1-\sigma\gamma}{\gamma-1}} X^{-\frac{1}{\gamma}}. \tag{B.8}$$

Setting $v_B = 0$ and substituting U_X from equation B.8 and λ' from equation B.7 into the Euler Equation (equation B.5) yields

$$\frac{1}{p_X} H^{\frac{1-\sigma\gamma}{\gamma}} \left(1 + \left(\frac{p_H}{p_X}\right)^{\gamma-1}\right)^{\frac{1-\sigma\gamma}{\gamma-1}} X^{-\frac{1}{\gamma}} Q = \beta \mathbb{E}\left[\frac{1}{p_{X'}} \left(H'^{\frac{1-\sigma\gamma}{\gamma}} \left(1 + \left(\frac{p'_H}{p'_X}\right)^{\gamma-1}\right)^{\frac{1-\sigma\gamma}{\gamma-1}} X'^{-\frac{1}{\gamma}}\right)\right] \tag{B.9}$$

When the housing stock is constant, $H' = H$ and $H^{\frac{1-\sigma\gamma}{\gamma}}$ can be pulled out of the expectations operator and cancels on both sides of equation B.9. In this case, the Euler Equation

can be rearranged to

$$X^{\frac{1}{\gamma}} = \frac{Q}{\beta}\mathbb{E}\left[(X')^{\frac{-1}{\gamma}}\frac{p_X}{p'_X}\left(1+\left(\frac{p'_H}{p'_X}\right)^{\gamma-1}\right)^{\frac{1-\sigma\gamma}{\gamma-1}}\right]^{-1}. \tag{B.10}$$

Equation B.10 states that when households' housing consumption is fixed and bonds are not in the utility function, households smooth over non-housing consumption regardless of the level of housing consumption (conditional on expected future non-housing consumption and prices).■

C Calibration to Remove Influence of Demographic Characteristics.

Here I consider two alternative approaches to purging housing expenditure shares and spending rates across New York City and Suburbs of demographic and homeownership influences. The first approach purges housing expenditures, total expenditures, and income and then uses the purged variables in the steps described in Section 3.2.1. The second approach explicitly models heterogeneous preferences for housing and saving. Under the assumption that demographic characteristics and homeownership status capture preferences, I derive a model-based measure of purged outomes by first aggregating across households that fall into similar demographic categories.

C.1 Approach 1: Residualize Before Aggregating

Under the first approach, I run the following regressions:

$$\log Y_{i\ell} = \alpha_\ell + X_{i\ell}\Gamma_j + \text{error}_{i\ell}, \tag{C.1}$$

where $Y_{i\ell}$ is Housing Expenditure, Spending, or Income by household i in location $\ell \in \{\text{NYC}, \text{NY Suburbs}\}$ and $X_{i\ell}$ is a vector of controls that includes the demographic variables in the CEX specifications and an indicator for homeownership. The ℓ subscripts on α_ℓ and Γ_ℓ indicate that the specification flexibly allows location-specific dependence on controls.

The variables purged of demographic influences can be written as

$$\hat{Y}_{i\ell} = \exp\left\{\hat{\alpha}_\ell + \hat{\text{error}}_{i\ell}\right\}, \tag{C.2}$$

where $\hat{\alpha}_\ell$ and $\hat{\text{error}}_i$ are estimates from Equation C.1. I then use these residualized meaures of housing expenditure, total expenditure, and income to construct location-specific housing expenditure shares and saving rates. The rest of the calibration exercise follows the steps

outlined in Section 3.2.1. Table C.1 reports the target moments and the resulting parameter values. The calibrated value of γ is lower and the calibrated value of ψ is higher than under the baseline calibration, indicating stronger complementarity between hosing and non-housing consumption and higher substitutability between consumption and bonds. Each of these parameters drives a stronger dependence of spending on home size. Therefore, the model-implied ratio of city home size to suburban home size is lower under this calibration (column 8). Column 9 reports the difference in the real interest rate between the U.S. and Japan when the model is aggregated to the closed economy level following the steps in Section 4. The implied difference in the real interest rate is 2.10% (210 basis points). This is much stronger than under the baseline calibration and is a reflection of the higher ψ and lower γ.

Table C.1
Calibration approaches that account for demographic influences

	Targets				Calibrated Parameters			SOE	Closed Economy
	Housing Exp Share		Spending rate					Comparison	Implications
Residualization Method	NYC	NYC suburbs	NYC	NYC suburbs	ψ	γ	b	Housing Ratio	US/JPN RIR diff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Not Residualized (baseline)	0.26	0.21	0.72	0.79	2.17	0.80	0.010	0.43	0.004
Residualize Before Aggregating	0.49	0.30	0.73	0.85	2.36	0.42	0.012	0.70	0.021
Remove category effects	0.24	0.16	0.65	0.70	1.70	0.64	0.018	0.49	0.004

The first row reports calibration targets and paramenter values under the baseline calibration discussed in the main text (Table 14). The second row reports calibration results when spending and income are purged of demographic influences at the household level, as described in Appendix C.1. The third row reports calibration results when spending and income are aggregated across households within demographic categories and then purged of category effects, as discussed in Appendix C.2.

C.2 Approach 2: Model-based residualization (aggregate to categories then remove category effects)

The second approach explicitly models demographic-driven differences in preferences, which are reflected in the following utility function:

$$U_{i\ell} = \sum_{t=0}^{\infty} \beta^t \left\{ \frac{1}{1-\sigma} \left[\left(\theta_{i\ell}^{\frac{1}{\gamma}} H_{i\ell t}^{\frac{\gamma-1}{\gamma}} + (1-\theta_{i\ell})^{\frac{1}{\gamma}} X_{i\ell t}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}\frac{\psi-1}{\psi}} + b_{i\ell}\, b\, B_{i\ell t}^{\frac{\psi-1}{\psi}} \right] \right\}^{\frac{\psi(1-\sigma)}{\psi-1}} \tag{C.3}$$

Here, $\theta_{i\ell}$ captures demographic-specific preferences for housing, $b_{i\ell}$ captures heterogeneity in preferences for saving, and b is the common component of saving preferences.

Given these preferences, the first-order condition between housing and non-housing consumption can be written as

$$\log X_{i\ell} = \log H_{i\ell} + \gamma \left(\log p_{H\ell} - \log p_X \right) + \log \left(\frac{1-\theta_{i\ell}}{\theta_{i\ell}} \right) \tag{C.4}$$

I purge this relationship of demographic-driven (and homeownership-driven) preferences

by aggregating across households within demographic×homeownership categories. I create twenty categories based on five age groups (25-35, 36-45, 46-55, 56-65, and 66-100), marital status, and homeownership status. This categorization captures relevant dimensions of heterogeneity while yielding a large number of observations per category: there are over 100 households in each category, and the average number of households per category is 621.9.

I average across households within a category and run the following regression on the aggregated observations:

$$\log X_{i\ell} = \beta^{H}_{\text{FOC}} \log H_{i\ell} + \text{NYC}_{\ell} + \text{error}_{i\ell}, \tag{C.5}$$

where I use the number of rooms as the measure of H, NYC_{ℓ} is an indicator for Central NYC that absorbs location-specific prices, and the error term captures the preference term $\log\left(\frac{1-\theta_{i\ell}}{\theta_{i\ell}}\right)$. The residualized measure of non-housing consumption is

$$\hat{X}_{i\ell} = \exp\left\{\hat{\beta}_{\text{FOC}} \log H_{i\ell} + \hat{\text{NYC}}_{\ell}\right\}. \tag{C.6}$$

I similarly residualize total spending based on the first-order condition between consumption and saving. Specifically, the first-order condition can be written as

$$\log C_{i\ell} = \log B_{i\ell} + \psi \log\left(\frac{bp_{C\ell}}{Q-\beta}\right) + \psi \log b_{i\ell}. \tag{C.7}$$

I average spending and income across households within a category, and I measure category-level saving $B_{i\ell}$ as the difference between category-level income and spending. Using the following regression,

$$\log C_{i\ell} = \beta^{B}_{\text{FOC}} \log B_{i\ell} + \text{NYC}^{B}_{\ell} + \text{error}^{B}_{i\ell}, \tag{C.8}$$

I construct residualized spending as

$$\hat{C}_{i\ell} = \exp\left\{\hat{\beta}^{B}_{\text{FOC}} \log B_{i\ell} + \hat{\text{NYC}^{B}}_{\ell}\right\}. \tag{C.9}$$

Finally, I also purge income of demographic influences. With residualized measures of total spending, non-housing spending, and income in hand for each location, I proceed as in Section 3.2.1 to calibrate model parameters.

Table C.1 reports the target moments and calibrated parameter values. ψ and γ are slightly lower than in the baseline calibration, indicating stronger complementarity between housing and non-housing consumption and weaker substitutability between consumption and saving. These differences counteract each others' influence on the relationship between saving and home size such that the model-implied ratio of city-to-suburb home size is nearly identical to that in the baseline calibration. This corresponds to an implied U.S.-Japan interest rate differential that is also similar to that in the baseline calibration.

D Home Size Data

The data on home sizes are from tables constructed by statistical agencies from surveys of housing characteristics. Whereas the data used for home size in Figure 2 (panels a and b) are based on average size of new homes and is compiled by shrinkthatfootprint.com, the data on home size in Table 15 is based on the average size of all homes in a country. Here I describe the underlying data sources for Table 15.

American Housing Survey

Average U.S. home sizes are based on tables constructed by the U.S. Census Bureau from American Housing Survey (AHS) data. The AHS is the most comprehensive national housing survey in the United States. The U.S. Census Bureau administers the survey and provides tables that list the number of households living in homes that fall within narrowly defined size ranges. Average home size for the U.S. is computed using the midpoints of these bins. The AHS also provides tables of the number of housing units that fall within narrow ranges of square footage per person. Average U.S. square footage per person is constructed as the weighted average of square feet per person, where the weights are the number of homes in each bin.

The following variables are inputs in the average home size measures:

- **Square feet per person:** This is computed by the AHS by dividing the square footage of the unit by the number of people in the unit. The AHS provides the number of housing units that have the specified square feet per person in 100-square-foot ranges.
- **Square footage of unit:** This measure excludes unfinished attics, carports, attached garages, porches that are not protected from weather, and mobile home hitches. It includes finished and unfinished basements. Square footage is based on the respondent's estimate of the size of the unit, and the AHS provides the number of housing units that have the specified square footage in ranges as small as 250 square feet.
- **Housing units:** A housing unit is defined by the AHS as a "house, apartment, group of rooms, or single room occupied or intended for occupancy as separate living quarters." Occupied and vacant units are counted, except the following vacancies are excluded by the AHS: "(a) tents, caves, boats, railroad cars, and the like; (b) structures intended for nonresidential use; (c) units used for business storage (storage of personal furniture does not disqualify a unit); and (d) units unfit for human habitation (roof, walls, windows, or doors no longer protect the interior from weather, or there is positive evidence, such as a sign on the house or block, that the unit is to be demolished or is condemned."

- **Rooms:** A room is counted by the AHS if the room is "used for living purposes, such as bedrooms, living rooms, dining rooms, kitchens, recreation rooms, permanently enclosed porches that are suitable for year-round use, lodger's rooms, and other finished rooms." This includes home offices. Bathrooms, laundry rooms, and utility rooms are not considered rooms by the AHS.

- **Bedrooms:** The AHS defines a bedroom as a room for "sleeping or designed to be a bedroom, even if used for other purposes." Rooms such as guest rooms, or rooms built to be used as a bedroom but is not used as such (ie playroom), is still considered a bedroom. Rooms not designed to be used as a bedroom but are used as such, are not considered a bedroom.

Housing and Land Survey of Japan

Average Japanese home sizes are based on the Housing and Land Survey of Japan. The Housing and Land Survey is the fundamental statistical survey conducted in Japan on housing conditions and investigates the conditions of dwellings and other occupied buildings. It is conducted by the Statistics Bureau and the Ministry of Internal Affairs and Communications (MIC). The Statistics Bureau provides summary tables that are used to compute average Japanese home size. The following variables are inputs in the average home size measure:

- **Dwelling:** A dwelling is defined by the MIC as "a permanent building or structurally separated part thereof, such as a detached house or unit of an apartment building that, by the way it has been built or altered, is intended for habitation by one household. A structurally separated part should be completely partitioned with fixed concrete or wooden walls. A dwelling for habitation by one household must satisfy the following four requisites with respect to facilities: (1) At least one room; (2) A sink for cooking for exclusive use; (3) A toilet for exclusive use; and (4) An entrance for exclusive use." Abandoned buildings were not treated as dwellings in this survey.

- **Area of Floor Space:** This refers to the area in meters of the floor space encompassing the entrance, kitchen, toilet, bathroom, corridor, earth floor, closets, dwelling rooms, etc. Storehouses, garages, warehouses, workshops, etc. for a business were not included in this calculation. In shared passageways, kitchens, and toilets in apartment buildings were excluded.

- **Household Members:** Household members is defined as the total number of members in a household, including those temporarily away, and live-in housekeeping employees.

The average home size in Japan is the average floor space per dwelling. Floor space is reported in square meters, so it is multiplied by 10.7639 to convert to square feet.

The Housing and Land Survey contains information on the number of household members in each home. To obtain average square feet per person I divide the total square footage across homes by the total number of household members.

D.1 Room Size: NYC vs. suburbs

Here I document an inverse relationship between neighborhood density and room size. To do so, I use the AHS to compare the size of rooms among respondents who live in Central NYC to the size rooms of respondents who live in suburbs of other U.S. cities. The AHS summary data provides information on the number of rooms as of 2021, and information on the number of bedrooms in prior waves.

To calculate the average square feet per (bed)room in the US, I multiply the number of rooms in the "Room" section of the AHS summary data by the number of dwellings with that particular number of rooms. These values are then summed to determine the total number of rooms across all dwellings. I divide this by the total number of square feet, which is the inner product (across number of rooms) of the number of dwellings and the average number of square feet per dwelling.

According to the table below, rooms in Central NYC are approximately 20% larger than rooms in the suburbs.

Table D.1
Room Sizes in New York City and U.S. Suburbs

	Square Feet Per Bedroom	**Square Feet Per Room**
NYC	246	252
Suburbs	308	309
Percent Difference	20.13%	18.45%