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Abstract

We offer a new home affordability estimate (HAE) that focuses on the share of housing stock that is affordable to certain households in the United States. The methodology considers affordability as it relates to funds available for down payments, initial monthly housing-related payments, and future projections of household income and costs. The HAE builds upon existing industry statistics in two ways. First, existing affordability indexes make certain assumptions for one or more of those funding factors. We can observe actual investment and expense values. Second, existing industry statistics consider “typical” families that earn the median household income level. The HAE is sufficiently more flexible for evaluating families at different places in the income distribution. This paper discusses the assumptions and processes for creating the HAE indexes; compares the national time series for very low-income, low-income, and median-income families; and then documents trends across metropolitan areas. We offer the data for public usage and leave commentary about implications to future research.

Keywords: affordability, housing, mortgage, personal finance, real estate

JEL Classifications: C43 • D14 • D31 • R21 • R31

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1. Introduction

Housing affordability is an often-mentioned concern when describing the current health and future outlook of real estate markets. Affordability plays a critical role in qualifying a borrower in the purchase of a home. “What can I afford to buy?” is among the first questions a prospective home buyer asks herself.¹ There are numerous “rules of thumb” on what one can afford, ranging anywhere from 2 to 2.5 times to as high as 4 to 5 times a person’s annual salary.² Online calculators, found on websites like Zillow, Redfin, Trulia, and Realtor.com, offer to output an affordable home price (or a range of them) based on user inputs. The required user inputs vary, but all of the interfaces require a minimum of three inputs—income, debt, and down payment. Some of the calculators have advanced options to refine individual inputs or consider specific geographic locations. The tools may differ in complexity but they share a simple goal of providing an output value that is, purportedly, affordable to a potential homebuyer.

At a more macro level, housing analysts and researchers examine affordability trends over time, with a keen interest in urban areas with constrained supply and rapidly rising house prices.³ Several industry participants already construct affordability statistics in the United States. For example, the National Association of Realtors® (NAR) Housing Affordability Index (HAI) measures the share of income that a “typical” family has to purchase a median-priced home.⁴ With the HAI, a value of 100 indicates that a family has the necessary income to purchase a median-priced home, and a value of 125 indicates that a household has 25 percent more income than required to purchase a median-priced home. In general, values greater than 100, indicate that more typical families can afford to purchase a median-priced home, while lower values indicate more constrained affordability (i.e., fewer typical families can afford a typical home).

¹ This paper concentrates on affordability as it relates to financial means for purchasing a house. We acknowledge that rental affordability could be a complementary concern. The decision is driven out by access to extensive resources on house price transactions and mortgages but very limited rental data. The share of renters varies across income distributions and areas in the United States, which makes it ripe for research but outside our scope.

² CNN Money and Investopedia suggest the lower range whereas Lending Tree, the now-defunct Washington Mutual Bank, and others, have recommended as high as 4 to 5 times a prospective borrower’s gross annual income.

³ This paper focuses on the technical steps to creating an affordability index and does not delve into the academic literature. Interested readers might refer to the list of further related reading at the end of the manuscript.

⁴ A “typical” family is defined as making the area median income by NAR and other industry participants.

This paper aims to build upon existing industry statistics and it extends the coverage of home affordability estimates across the United States. To foreshadow, we select two areas where we believe improvements are possible with detailed financial and mortgage data.

First, other estimates calculate the share of housing stock that a family can afford. Regardless of whether an index examines income available to purchase a home or the share of affordable housing stock, available statistics often focus on affordability for a typical family. Few of the existing industry indexes consider how low-income families fare in the housing market.

Second, most of the existing affordability estimates proxy, by way of broad-based assumptions, for critical affordability factors. For instance, it is common to assume a certain availability of funds for making a down payment. The NAR's HAI utilizes a 20 percent down payment for all households. As another example, simple ratio-based assumptions are commonly used to determine whether monthly payments are affordable given other households expenses. Ratios might reflect the belief that actual expenses should not exceed 25, 28, or 30 percent of gross income. Finally, to our knowledge, none of the existing estimates have a "look ahead" component. Why is this important? The current approaches calculate whether monthly payments are affordable at the inception of the loan but not do consider affordability shortly thereafter when borrowers might face resets to property taxes, insurance, or other expenses.⁵

This paper presents a new home affordability estimate (HAE) that focuses on the share of housing stock that is affordable to certain households.⁶ We offer two potential improvements to existing industry estimates. First, we utilize actual investment and expense values and improve upon assumptions about funding factors. The HAE index relies on real contemporary and historical data on income, debt, and funds available for down payments. Second, our methodology allows us to

⁵ One of the riskiest periods of a loan is in its first 60 to 90 days. An inability to pay the future mortgage payments is an obvious risk factor for immediate default and a potential put-back. Although not as likely today, immediate put-backs did occur a decade ago when underwriting and origination standards were looser.

⁶ Affordability in this paper implies affordability in terms of homeownership and does not include rental affordability. The share of housing stock is based on all single-family homes in an area instead of the flow of properties that are listed for sale or that have sold recently. By focusing on the entire housing stock, our calculations are less susceptible to issues with seasonality and volatility but they may not always reflect an ability to purchase available properties, especially when there is a low percentage of new or existing homes for sale. To be abundantly clear, our estimate reflects affordability for a typical household in a certain area and a particular income group during a given period; it does not track individual homeowners or their actual wealth, income, and expenses.

evaluate families at other places in the income distribution that might not reflect a typical household. We produce affordability estimates for both median-income, low-income, and very-low-income households, but our approach can determine affordability for households of any income level.⁷ With those two contributions, the general production process offers improved accuracy and increased granularity for measuring affordability concerns. The HAE data are available for public download as quarterly indexes for the nation and metropolitan markets at <https://www.fhfa.gov/hae>. Comments and feedback are welcome via HAE@fhfa.gov.

The paper has six sections. In Section 2 we consider features of existing affordability statistics and compare to our new home affordability estimate. In Section 3 we outline the general steps and underlying processes for generating our new affordability estimate. In Section 4 we discuss key assumptions and important data calculations. In Section 5 we present our new home affordability estimate and discuss findings at national and metropolitan levels. Concluding remarks are provided in the last section.

2. Features of Existing Affordability Statistics

Affordability estimates are available from both public and private sources.⁸ Generally, these estimates assess affordability to a typical family while not addressing affordability to lower income families. For example, the NARHAI assesses the share of income a typical family has to purchase a typical home. Other common industry statistics include the National Association of Home Builders / Wells Fargo Home Opportunity Index (NAHB HOI) and the California Association of Realtors (CAR) Housing Affordability Index (HAI). Those sources concentrate on the share of available affordable housing stock (rather than available income to purchase a home), but they still examine affordability options of typical families.

Another prominent estimate is the U.S. Department of Housing and Urban Development (HUD) Location Affordability Index (LAI), which combines housing and transportation costs, and

⁷ For the purposes of the methodological descriptions we focus on three income groups that are most prominent in policy programs and affordability discussions. Definitions do vary across the industry. Future paper and data updates could offer additional groupings, or focus on distribution percentiles, and we welcome input on use cases.

⁸ Such industry statistics are listed under “useful websites” at the end of this paper.

provides affordability data for various income brackets. One of the key features of the HUD LAI is that it uses data on homes that have already sold, instead of examining the total inventory of homes in assessing affordability. In addition, it is a backward-looking approach and model-driven. For instance, the most recent estimates calculate the expected housing cost of families living at a location between 2010 and 2014.

One of the common methodologies of these indexes is that the down payment amount, likely the single largest expense for many families seeking homeownership, is assumed and not observed. The HUD LAI and other affordability estimates rely on the availability of funds for making such a payment. To provide a further complication, the assumed amount varies by index. For instance, the NAR HAI assumes borrowers have funds available to make a 20 percent down payment, while the NAHB HOI uses a 10 percent down payment assumption.

A newer index by NAR partnered with REALTOR.COM, the REALTORS® Affordability Distribution Curve and Score (ADC), considers the affordability of low-income households in addition to other income groups. It evaluates the share of affordable housing stock across different income percentiles, including low-income families. Like the other estimates, the REALTORS ADC assumes the existence of funds for making a down payment. However, instead of using a fixed down payment assumption, the approach uses statistics from actual borrowers—individuals who already qualified for and obtained mortgages. Although that calibrated down payment information could potentially estimate down payment assumption more accurately over more arbitrary down payment assumptions, the ADC index applies the same assumption for families across all income brackets.

In addition to down payment assumptions, existing affordability indexes are constructed using initial monthly payment determinants, such as income, mortgage rates, and house prices. To our knowledge, however, industry statistics do not directly measure non-housing expenses. Rather, ratios or models are used to determine whether households have sufficient financial wherewithal to pay all their bills. For instance, the NAR HAI assumes housing expenses are 25 percent of gross income while the NAR ADC assumes 30 percent. The NAHB HOI uses ratio-based housing

expenses of 28 percent. On the other hand, the HUD LAI forgoes ratios to compute model driven housing expenses for different household profiles.

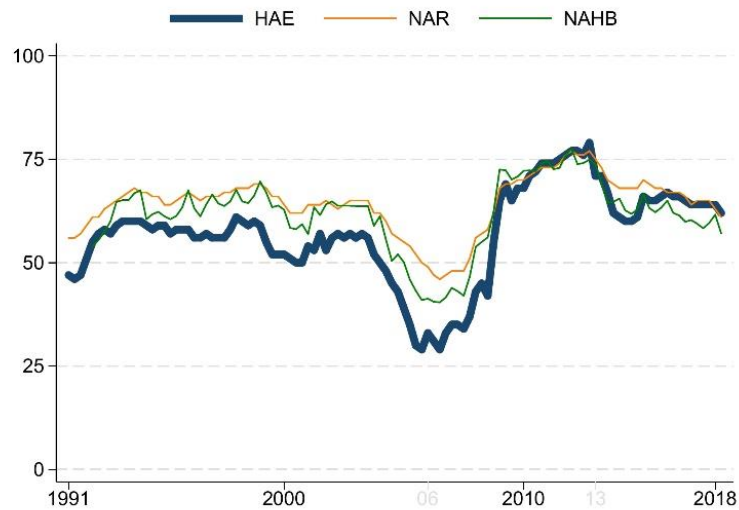
Upon reflection, existing statistics often share two assumptions that could be more flexible: their values are meant to reflect a typical family or a median-income household, and they assume the outcomes of important financial decisions (like down payment amounts or how much monthly income should be devoted to housing). On the other hand, we design our new HAE approach to improve upon existing indexes and offer additional flexibilities in *how* and *where* affordability is calculated. While the HAE and existing statistics assess affordability for a typical household, our new index can offer data about low-income and other households. We directly estimate funds available for down payment, monthly payment factors, and non-housing expenses utilizing real data. Finally, unlike existing industry statistics that do not consider the sustainability of payments over time, the HAE incorporates future expenses for housing and non-housing expenses in addition to projected income trends.

Although foreshadowing our resulting index, Figure 1 graphs the HAE with the main existing industry statistics and that helps motivate the discussion about why we chose the particular modeling processes as described in the next section. Panel (a) compares the median-income HAE with the NAR HAI equivalent and NAHB HOI indexes for the United States.⁹ The three indexes trend similarly overtime; however, the HAE is relatively lower on average due in part by our methods to estimating inputs based on real data and consideration of future affordability. By the end of 2006, the affordability values reach the lowest levels across all three indexes but the HAE is lower than the other two representative indexes as a result of the increase in projected future housing expenses. Panel (b) illustrates the processes to construct the HAE and we consider each of these steps in detail in the next section.

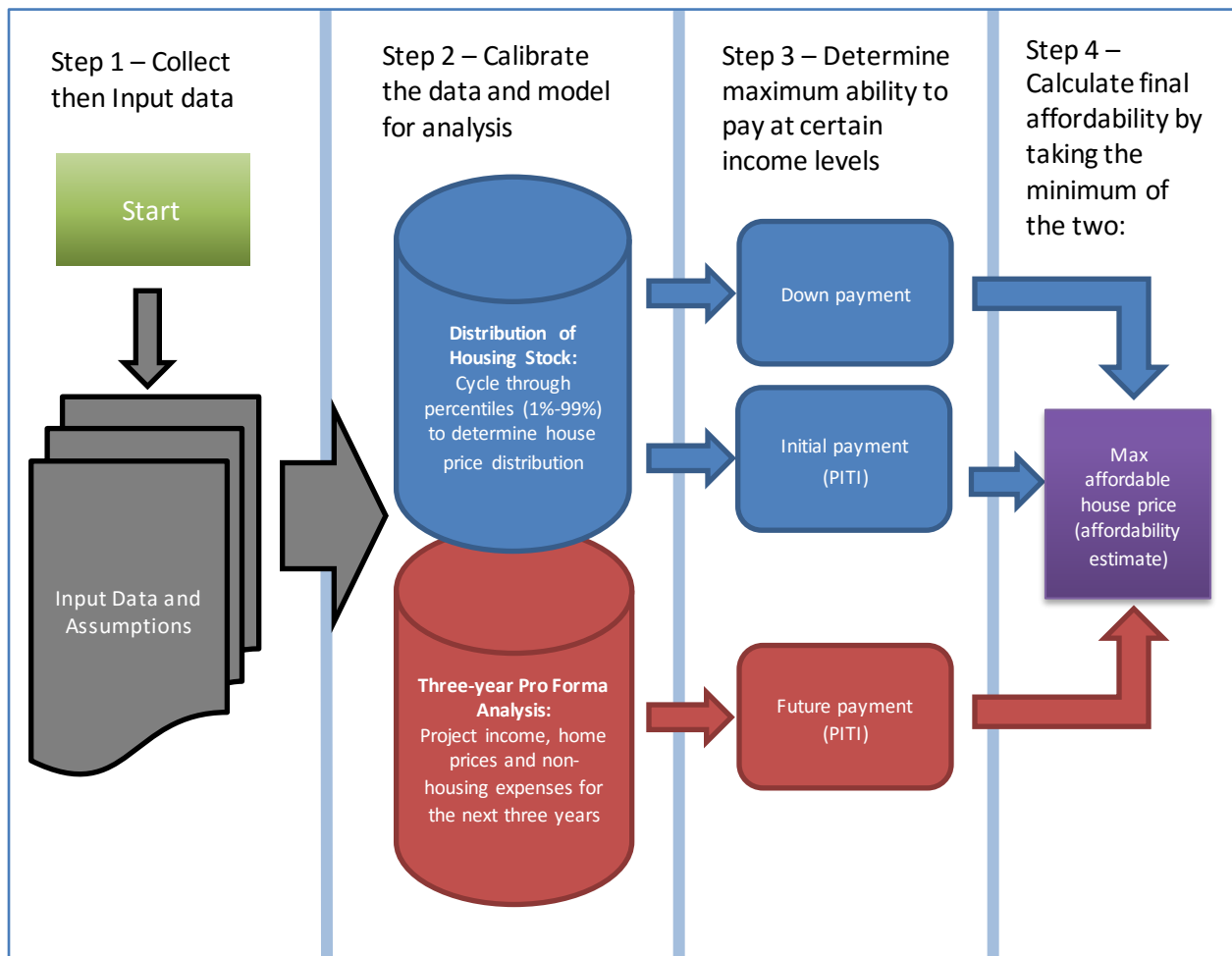
⁹ NAR HAI calculates affordability based on share of income that a typical family has to purchase a median-priced home. We convert NAR HAI by applying a few key assumptions such as a 20 percent available down payment, a 25 percent cap on principal and interest of PITI, and “at origination” approach to our HAE to reverse engineer and construct NAR HAI equivalent index based on housing stock.

Figure 1: Making a new home affordability estimate

(a) Comparing HAE with other equivalent indexes



(b) Process flow of modeling the HAE index



3. General Steps and Processes

Several distinct processes guide the production of the HAE. Figure 1(b) models the flow with four general steps: collection, calibration, determination, and calculation. Steps are discussed below.

Step 1 – Collect then input data

We gather, input, and transform data into our model. These include, but are not limited to, house prices, income levels, available funds (for down payment), mortgage rates, and growth rates for future payments. Table 1 displays the variables, lists their sources, and briefly mentions assumptions or comments about the inputs with more discussion following in subsequent sections. The data are gathered from those primary sources, stored on a UNIX server, merged together by Metropolitan Statistical Area (MSA) and quarterly observation period from 1991 to 2018, and then modeled with the SAS software suite as noted below.¹⁰

Step 2 – Calibrate the data and model for analysis of available housing and ability to pay

An advantage of the HAE approach is that it offers flexibility to examine affordability at various points of the distribution of household income. To calculate housing stock, we need to calibrate house price distributions. A series of code is run for nearly 400 metropolitan areas from 1990 to present time. The loop generates percentiles of home prices from 1 to 99 percent of the housing stock, assuming normal distributions specified by the mean and standard deviation of the local geography.¹¹ This will enable us to understand whether a borrower could afford a particular house at a current moment. We also are interested in whether such a borrower will be able to remain in good financial standing shortly after beginning loan payments. To conduct a pro forma analysis, we need forecasted information about future income, home prices and non-housing expenses. Each series is projected out three years (12 quarters) at the MSA level.

¹⁰ We follow MSA delineations and codes issued by the Office of Management and Budget (OMB). According to the OMB, an MSA is the central county or counties containing the core, plus adjacent outlying counties having a high degree of social and economic integration. The most recent bulletin (from April 2018) is available online at <https://www.whitehouse.gov/wp-content/uploads/2018/04/OMB-BULLETIN-NO.-18-03-Final.pdf>.

¹¹ This assumption may be relaxed in revised versions of this paper and after we have performed additional statistical tests. House prices do not necessarily follow normal distributions, especially when they may be impacted by non-market price controls (e.g., conforming loan limits, property tax exemptions, or land use regulations).

Table 1: Data sources and assumptions

Variable	Data Source	Assumptions/Comments
Funds available for down payment	<p>Survey of Income and Program Participation (SIPP) topical modules including Economic Stimulus, Assets & Liabilities, Real Estate, Shelter Costs, Dependent Care, & Vehicles, Interest Earning Accounts, Rental Property, Stocks & Mutual Fund Shares, Mortgages, Other Financial Investments, and Value of Business.</p> <p>Median financial assets for households in second income quintile from Federal Reserve’s Survey of Consumer Finances (SCF).</p>	National number available for each panel. Metropolitan Statistical Area (MSA) estimate is derived as national number multiplied by the income ratio of the local median income to national income from HUD.
Down payment requirement	Federal Housing Administration (FHA) minimum.	3.0 percent until 2008, 3.5 percent thereafter.
Income	HUD’s median family income estimates based on ACS and Consumer Price Index (CPI) forecast by the Congressional Budget Office (CBO).	<p>HUD’s MSA median household income estimates for median-income.</p> <p>No greater than 80 percent of HUD’s MSA median household income estimates for low-income.</p> <p>No greater than 50 percent of median household income estimates for very low-income.</p>
House price and distribution of housing stock	Federal Housing Finance Agency (FHFA) House Price Index (HPI) sourced from transactions in county records, mortgages insured or guaranteed by FHA, and mortgages	Home values are assumed to be normally distributed.

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	acquired by Fannie Mae and Freddie Mac (the Enterprises).	
Loan amount	FHFA HPI sourced from county records, FHA, and the Enterprises.	97 percent of home value until 2008, 96.5 percent of home value thereafter.
Mortgage rate	FHFA Mortgage Interest Rate Survey (MIRS).	30-year fixed rate mortgage.
Property tax rate		1.15 percent of home value, average effective tax rate.
Homeowner's insurance		0.35 percent of home value, rough estimate based on Federal Reserve's rule-of-thumb of \$3.50/\$1,000.
Non-housing expenses	Housing cost burden from HUD's Housing Affordability Data System (HADS) sourced from American Housing Survey. Personal savings from Bureau of Economic Analysis (BEA).	Non-housing expense is residual income net of housing cost burden. Non-housing expense ratio is non-housing expense divided by income.
Income growth	HUD's median family income estimates. SIPP core data. Federal Reserve's SCF.	Expected income growth rate is rolling five-year average. Income estimates from HUD and observe income growth rates of these income cohorts from SIPP and SCF. Three-year look ahead window.
House price growth	FHFA HPI sourced from county records, FHA, and the Enterprises.	Expected house price growth rate is five-year average growth rate for each MSA. Three-year look ahead window.
Non-housing expenses growth	BLS Consumer Price Index.	Expected non-housing expenses growth rate is five-year average growth rate of inflation. Three-year look ahead window.

Step 3 – Determine maximum ability to pay at certain income levels

The ability to pay depends on a tradeoff between what an individual can afford financially and what is available to purchase. Concretely, the maximum affordable percentage of housing stock is based on funds available for down payment, initial payment, and future payment. We create these values in two ways. First, we calculate the maximum house price affordable for each MSA given specific funds available for down payment and the initial payment. We determine the maximum affordable percentile from the model generated distribution based on the FHA minimum requirement for down payment and estimated funds available for down payment. Then, we calculate the initial payment of principal, interest, taxes, and insurance (PITI) based on each MSA specific income, non-housing expenses, loan amount, mortgage rate, property taxes, and home insurance premium derived from house prices for each percentile of the housing stock. The maximum affordable percentile is the highest percentile of housing stock, which has positive residual income net of housing and non-housing expenses. We refer to this as the “at origination” approach. Second, we repeat the same iterative process for future payments subject to projections in income, home prices, and non-housing expenses. If future affordability is less than initial affordability based on PITI calculations for a respective period, the maximum affordable percentile is adjusted downward to the maximum affordable percentile taken from future payments. This is referred to as our “future affordability” approach.

Step 4 – Calculate final affordability

Final affordability is an outcome for a respective period for each MSA where we select the minimum of the two maximum affordability estimates as derived from the “at origination” approach and the “future affordability” approach. The national affordability index is produced by aggregating MSA affordability values with weighted averages of MSA shares as a percentage of total share of housing stock. The next section explores the details behind the specific assumptions leading up to this last step.

4. Key Assumptions and Important Data Calculations

Affordability can be calculated in various ways. The HAE considers a home is affordable if:

- (a) the household has sufficient funds to make the down payment;

(b) at the time of loan origination, income is sufficient to cover housing-related and non-housing expenses; and

(c) forecasts from historical trends suggest that future household income will be sufficient to cover future housing and non-housing expenses. A three-year look-ahead period is examined given the uncertainty associated with forecasting trends for distant periods.¹²

Using the above definition, we estimate the *share* of the housing stock in the local area that is affordable. The geographic location is defined as the metropolitan area where a home is located. The magnitude of an affordable index reflects its affordable stock. To be clear, a value “25” would indicate that roughly 25 percent of the housing stock is estimated to be affordable.¹³ We refine this definition another degree by constructing indexes for the typical median-income household and for two types of other households.

Household income

We begin with household income data published by the HUD in determining whether a home is affordable.¹⁴ The data are published on a yearly basis back to 1990 for individual MSAs.¹⁵ To demonstrate that our affordability estimate could reflect different points in the income distribution,

¹² Shorter or longer look ahead periods could have been used. Shorter periods would have less uncertainty, but would fail to flag cases in which the mortgage will likely become unaffordable soon after origination. Longer periods would entail more forecast uncertainty, both in modeling and unforeseen behavioral changes. Indexes using a 0-year (no look ahead) and 3-year look ahead are shown later in Figure 6. Based on our sensitivity analysis modeling additional look ahead periods between one- and seven-year windows, our preliminary results suggest that beyond four years, we observe counterintuitive results where the very low-income group’s affordability is sometimes higher than the median-income group. For internal consistency, we use a three-year look ahead period. Potential negative shock episodes become more probable over longer periods. A modeling concern is that low-income households could be more likely to remain unemployed after suffering a job loss. The future income streams assume employment over three years, which is less likely during recessionary periods. For behavioral changes, demographics can evolve in ways that affect income streams and household formation. News stories have linked lower homeownership rates of millennial cohorts with increased educational debt and lower marriage rates. Our methodology estimates affordability of households who are fundamentally able to pay the necessary obligations and, as such, we ignore any zero income and wealth during the sampling process. This also implies that our model does not account for levels and changes in certain macro-economic conditions such as unemployment, population, and household formation, which could influence affordability. Finally, we do not presently account for potential changes to household size.

¹³ This number does not mean households that *could* afford to buy such housing stock would actually *want* to do so. Even if they were able to purchase a house, low-income households may prefer paying rent instead of a mortgage because rentals have less hassles, more amenities, nicer locations, or better mobility.

¹⁴ Data come from the HUD’s income limits that determine eligibility for various assisted housing programs. HUD develops income limits based on median family income estimates and fair market rent area definitions for each MSA, parts of some metropolitan areas, and each non-metropolitan county.

¹⁵ Some missing MSA-level income data are derived by applying Moody’s income ratio to the national median family income from HUD for each missing MSA. Moody’s income ratio is defined as MSA median income divided by national median income.

we define income groups as representing “median-income”, “low-income”, and “very low-income” households. A median-income household’s earnings match the HUD’s MSA median household income estimates. Low-income households and very low-income households earn no greater than 80 percent and no greater than 50 percent of the median income, respectively.¹⁶

As mentioned before, existing estimates do not consider the sustainability of payments over time but adjustments can happen where income and costs are not the same as they were at mortgage origination. A borrower’s ability to make future monthly mortgage payments may be impacted by shifts in housing or non-housing related expenses. We address this potential issue using a residual income approach, where the future residual income is the remaining income after subtracting future non-housing expenses and future principal, interest, taxes, and insurance (PITI) payments from expected future income. Then, we run our pro forma model for every quarter using a three-year look ahead window to determine the residual income during these forecasted periods.¹⁷

To estimate expected future income, we start with the SIPP core data files. These core data files consist of four survey panels with each panel tracking several years of survey participants’ data. We perform two tasks. First, to capture the correct sample for median-, low-, and very low-income households, we create a range of household income values in the beginning of each survey panels based on HUD’s income data. We assume median-income household to be survey participants who reported household income of HUD’s national median family income plus or minus 10

¹⁶ As mentioned earlier, we could have selected a different percentage, or even a certain percentile of the income distribution. A variety of programs (e.g., public housing, housing vouchers, low-income housing tax credits) have eligibility criteria that are based on certain fractions of area median income (AMI) or individual income limit. The HUD have income limits that determine the eligibility for assisted housing programs. They are based on HUD estimates of median family income broken into the following four categories: AMI, low income as defined by no greater than 80 percent of AMI, very low income as defined by no greater than 50 percent of AMI, and extremely low income as defined by no greater than 30 percent of AMI. AMI does not reflect the number of persons in the household but the other three categories do have adjustments. We analyze the low-income and very-low income equivalent for demonstrative purposes and we do not adjust for household size. Future data releases may include additional cuts for users to choose an index that best fits a program’s definition.

¹⁷ Commonly believed average life of a mortgage is between three to seven years. We use a three-year look ahead period for our analysis. Several data sources help determine growth in expected household income and costs. To calculate residual income, we rely on the United States Census Bureau’s Survey of Income and Program Participation (SIPP), HUD’s area median income, U.S. Department of Commerce Bureau of Economic Analysis’ (BEA) GDP & Personal Income, U.S. Department of Labor Bureau of Labor Statistics’ (BLS) Consumer Price Index, and Federal Housing Finance Agency’s (FHFA) House Price Index (HPI).

percent.¹⁸ Similarly, we assume low-income and very low-income as participants who reported household income of no greater than 80 percent and 50 percent of the national median family income plus or minus 10 percent, respectively. Second, for each survey panel, we track median-, low- and very low-income households longitudinally to observe the change in income for these households. Then, we merge all four panels and interpolate the missing data:

- For the missing periods before the first quarter of 1997, we assume an annual income growth rate of 3 percent.
- For the missing periods after the fourth quarter of 2014, we derive the income growth rate from the Federal Reserve's SCF.¹⁹

Finally, we smooth out the income growth rate with rolling five-year averages. Then, we apply these rates for the corresponding quarters as their income growth rates.²⁰ Figure 2 has several panels that display time series for future payment input growth rates. Panel (a) shows the future income growth rates for both the median-income and the low-income families. Both groups exhibit similar patterns but the low-income growth rate is slightly higher and appears to be a leading indicator. The graphic only shows positive expected future income growth rates for the last 25 years.²¹

Housing-related expenses

When determining the cost side of affordability, we begin by calculating the likely mortgage payment, including taxes and insurance. To find principal payment, we estimate the overall loan amount with the assumption of a 3.5 percent down payment and a 30-year fixed rate mortgage to

¹⁸ We do not observe significant differences in results using wider calibration bands of plus or minus 25 percent and 50 percent. However, using a wider calibration band creates ranges that overlap and risks double-counting participants as we produce indexes for similar shares of AMI.

¹⁹ Initial calibration values come from the Federal Reserve Board's Survey of Consumer Finances Table 1 (drawing from before-tax family income, percentage of families that saved, and distribution of families by selected characteristics of families, 2001–2016 surveys, 20-39.9 percentile of income, and median income).

²⁰ To reiterate, we calculate the household income in two steps that incorporates current and future income. First, we take income from the HUD from 1990 to current as a baseline level for all the MSAs. These levels are used for affordability at origination. Second, we adjust for the repayment affordability by multiplying the baseline income by the income growth rates derived from the other data sources mentioned above (SIPP, Federal Reserve's SCF). The adjusted levels represent future income that is used for future affordability estimates for repayment affordability or our look ahead models.

²¹ Future methodological revisions may consider sensitivities to other forecasting methods and projections. When using a longer look ahead window, like a five-year instead of a three-year window, there is an increased influence on the final affordability metric but that comes with greater model risk which might not be as desirable.

Figure 2: Future payment input growth rates

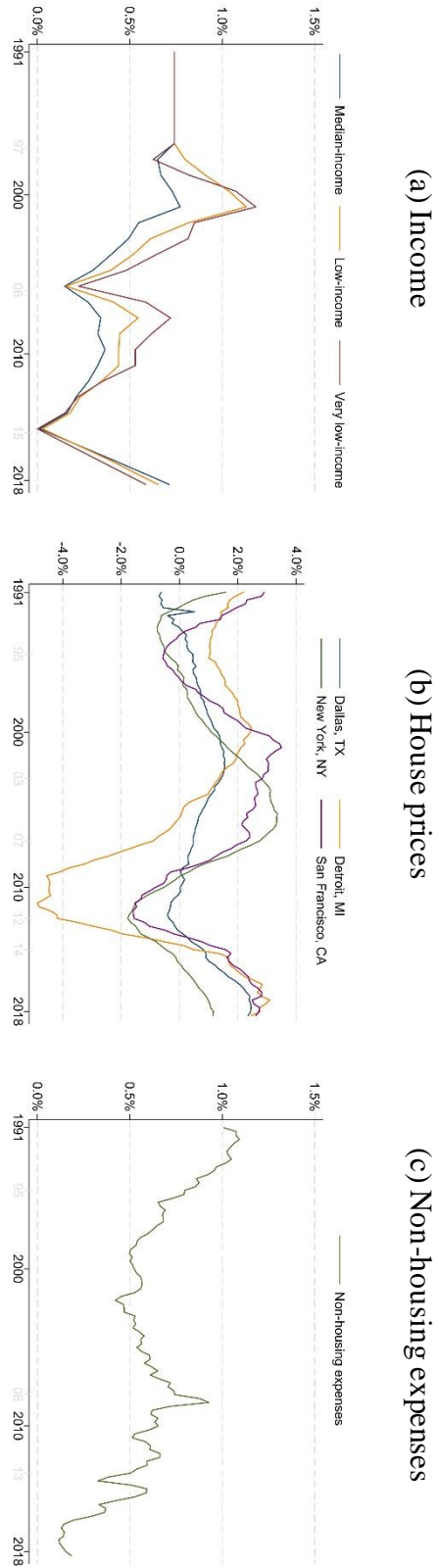
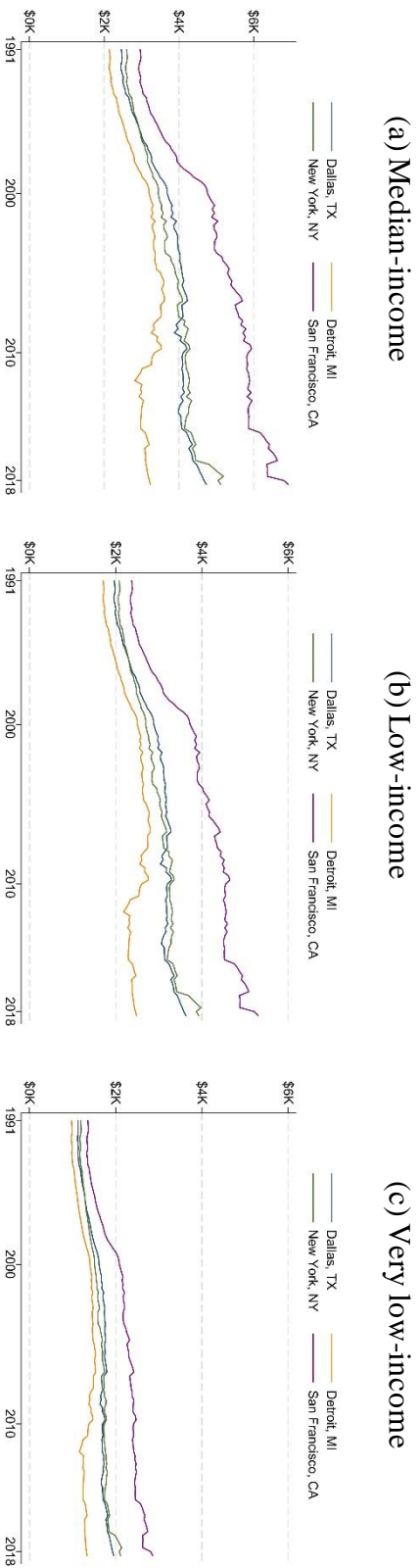


Figure 3: Baseline non-housing borrower expenses (for select MSAs)



finance the remaining amount.²² FHFA's Monthly Interest Rate Survey (MIRS) allows us to estimate average interest rates.²³ For the monthly payment of the property taxes, we use 1.15 percent as an effective property tax rate across all municipalities and a 0.35 percent home insurance premium.^{24,25}

The first two components, principal and interest, of the future PITI payments are not affected by changes in future economic conditions per our 30-year fixed rate mortgage assumption. The last two components, though, are modified to some extent when home value changes. We use our internal FHFA HPI, tracking back five years and applying the same growth rate in HPI for the future quarters to determine the change in property taxes and insurance in the future quarters. Tax rates and the home insurance premium rates remain constant at 1.15 percent and 0.35 percent, respectively. The chart in Figure 2(b) depicts house price growth rates for four select MSAs.²⁶ Growth rates are highest for the San Francisco area when house prices peak in the early 2000s. During this period, nearly all cities observe rates fall to negative values, but metropolitan areas in Texas are essentially flat. Recently, rates are back to positive, ranging from 1 to 3 percent.

Non-housing expenses

Once we determine the likely mortgage payment in the form of PITI, we calculate whether households would have enough income net of non-housing expenses to cover the mortgage

²² We currently cap the down payment at 3.5 percent and do not consider access funds to be applied for higher down payment. Future work may further test the sensitivity of the 3.5 percent down payment to income group and location and the sensitivity of change in affordability if different down payment percentages or if access funds are applied toward the down payment assumption. Our preliminary analyses suggest that the sensitivity of down payment assumption varies by different income groups. Lower income groups tend to have disproportionately less wealth compared to the median income households. Also, each location (or MSA) has unique combinations of housing stock and economic characteristics that can impact borrowers' expenses and ability to accumulate sufficient funds. Down payment assumptions could be calibrated by income and location after further research and validations.

²³ The survey collects information on interest rates and loan terms for savings institutions, commercial banks, and mortgage loan companies on all single-family, fully amortized, purchase-money, nonfarm loans that have closed in the last several days of a month. The survey excludes FHA-insured and VA-guaranteed loans, multifamily loans, mobile home loans, and loans created by refinancing another mortgage.

²⁴ Effective tax rates should be simple to construct with property tax assessment data. Unfortunately, those data contain valuation information that do not consistently include tax amounts, millage rates, or consistent tax authority codes. Instead, we assume an average annual property tax is \$3,296, which is effectively a 1.15 percent property tax rate as of April 2017 according to ATTOM Data Solutions. Future work might obtain more precise estimates because there is variation among rates for metropolitan areas and that impacts housing-related expenses.

²⁵ According to the Federal Reserve Board, the average cost of an annual premium for homeowners insurance is between \$300 and \$1,000. The rule of thumb is 0.35 percent of the home value.

²⁶ MSAs are picked to illustrate regional differences in model inputs (not based on a statistical selection or criteria).

payment. This is unlike existing estimates which use simple ratios to determine whether households have sufficient financial wherewithal to pay all their financial obligations. To compute non-housing expenses, we first establish the historical non-housing expense ratio as a percentage of income. We derive this ratio by calculating the median housing cost burden whose incomes are greater than 80.1 and at or below 100 percent of Area Median Income (AMI) for median-income households, between 60.1 and 80 percent of AMI for low-income households, and between 30.1 and 50 percent of AMI for very low-income households from the HUD's Housing Affordability Data System (HADS).²⁷ Then, we net out the personal savings rate.²⁸ Non-housing expense ratio is calculated by netting the housing expenses and savings and dividing this amount by income. This ratio is multiplied by income estimates from HUD for each MSA to compute the dollar amount of non-housing expenses for each period. Figure 3 shows the baseline non-housing expenses for median-income borrowers (panel a) and low-income borrowers (panel b) in select MSAs. Growth rates are similar but levels are higher, as expected, for median-income borrowers, with San Francisco indicating the greatest expenses. Taking those series, the newly generated baseline non-housing expenses are multiplied by the five-year average inflation to forecast the future non-housing expenses.²⁹ Figure 2(c) summarizes the growth rate used for non-housing expenses. The series begins above 1 percent in 1990 then declines until around 0.6 percent when it flattens out for a dozen years until recently dropping below 0.2 percent.

Assets available for down payment

Likely one of the major reasons that existing affordability statistics have largely “assumed away” the issue of down payments is the dearth of financial information. It is extremely difficult to find data about the financial assets that consumers have available for making down payments. Because the availability of funds is so important to affordability, however, we assemble those data that do

²⁷ HUD's housing cost burden is a household's monthly housing cost including utilities divided by its monthly income. In the sampling process, we exclude households with zero or negative income. All households, or both renters and owners, are included in these calibrations because of their potential to be home purchasers.

²⁸ Personal savings rate as a percentage of gross income is in BEA's Table 2.6. Personal Income and Its Disposition. We apply a savings rate proportionally to the income. For instance, we assume a low-income household's savings rate is 20 percent less than the savings rate of median-income households. This assumption is based on our observation from the SIPP data, which suggest that the lower income households have disproportionately lower financial wealth compared to their median-income counterparts.

²⁹ The Consumer Price Index is the all items less shelter (CUUR0000SA0L2) that comes from the BLS.

exist and make various assumptions where necessary. We draw from three sources: the United States Census Bureau's SIPP, HUD's median family income, and the Federal Reserve's SCF.

Assets data in the SIPP are the starting point for our estimates. The dataset shows information on household financial assets of various types for four points in time in the past.³⁰ We use the assets information from these periods as "anchor points," interpolating and extrapolating information for other periods as needed.

To determine funds available for down payment, we use the same definition as HUD based on our 3.5 percent down payment assumption and the industry standard for acceptable down payment sources. These include earnest money deposit, savings and checking accounts, cash, savings bonds, IRAs, 401(k) and Keogh accounts, stocks and bonds, thrift savings plans, gift funds, sales proceeds, sale of personal property, commissions from sale, trade equity, rent credit, sweat equity, collateralized loans, grants and loans, employer's guarantee plans, and employer assistance plans.³¹ We recognize that other funds might be available for making down payments (e.g., money from gifts), but we lack data for those other financial resources.

When determining funds available to median-, low-, and very low-income households, we start with the SIPP data. First, we use the same technique as described above to identify the sample for median-, low-, and very low-income households. Second, we use the same definition as HUD for sources of borrower funds for down payments. Based on those two tasks, we analyze four SIPP survey panels, and Table 2 shows the summary of the survey participants' median funds available for down payment who had (1) median-, low- and very low-income and (2) more than zero funds available for down payment. From these four data points, we apply the following data interpolation methodology to fill in missing data in the time series:

- For the missing periods before the first quarter of 1997, we discount the down payments from the 1996 Panel by the annual long-term rate of 3 percent.

³⁰ The SIPP collects source and amount data related to various types of income, labor force participation, and assets and liabilities. The survey design is a continuous series of national panels, with sample size ranging from approximately 14,000 to 52,000 interviewed households. The duration of each panel ranges from 2.5 to 4 years. More information is at <https://www.census.gov/programs-surveys/sipp/about/sipp-introduction-history.html>.

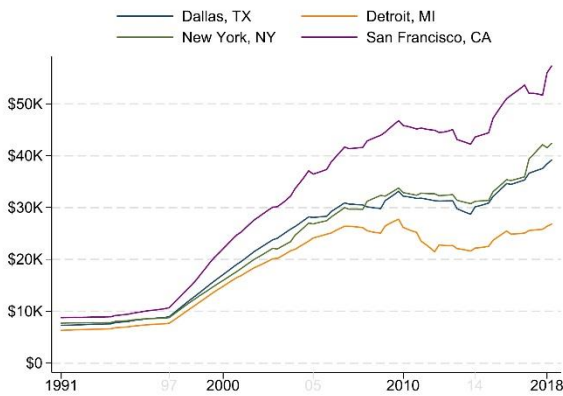
³¹ HUD's acceptable sources of borrower funds from Document 4155.1, Chapter 5, Section B.

Table 2: Funds available for down payments pre-interpolation

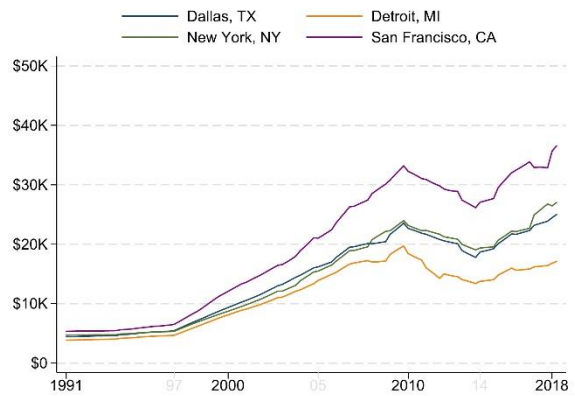
SIPP Panel	As of Date	Median Down Payment: Median-Income Household	Median Down Payment: Low-Income Household	Median Down Payment: Very Low-Income Household
1996	Q1 1997	\$7,771	\$4,742	\$2,232
2001	Q4 2001	\$18,788	\$10,000	\$4,200
2004	Q4 2004	\$25,000	\$14,200	\$4,800
2008	Q4 2009	\$30,150	\$21,400	\$7,000

Figure 4: Final funds available for borrower down payments (for select MSAs)

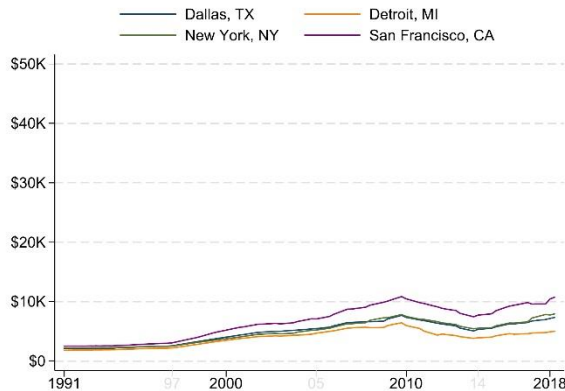
(a) Median-income



(b) Low-income



(c) Very low-income



- For the missing periods between the first quarter of 1997 and the fourth quarter of 2009, we apply a simple straight line using the two points (e.g., for Q2 1997, we used Q1 1997 and Q4 2001 funds for down payment).
- For the missing periods after the fourth quarter of 2009, we derive the down payments by applying the rate of growth in down payment from the Federal Reserve’s SCF to the baseline down payment from the 2008 Panel to each missing period.³²

Finally, we construct the MSA level funds for down payment by multiplying the national level of funds available for down payment by the income ratio (defined by MSA median income divided by national median income). Figure 4 graphs computed funds available for down payments for selected MSAs for both median-income borrowers (panel a), low-income borrowers (panel b) and very low-income borrowers (panel c). In a relative sense, the funds are four times larger for median-income borrowers. Delving further, we regress income on income from financial assets across a cross-section of all states and find a near-perfect positive correlation (explaining over 90 percent of the variation). The relationship indicates that higher income levels are associated with greater income from financial assets and larger available funds for down payments.³³

Local market affordability including local income and the distribution of local home prices

Incomes and home prices vary geographically, and measuring at a more local level could provide more insight for policymakers. For income, we use HUD’s area median income at the MSA level. For home prices, we compute mean and median home values in each MSA from a database of transaction prices used to construct the FHFA HPIs. Then we use MSA-specific standard deviations to compute home values for each percentile in an MSA. To produce HAE indexes for MSAs, other series are converted as needed.³⁴

An example of one MSA: Phoenix, Arizona

We summarize this section by providing an example to demonstrate how the key assumptions and data calculations come together in an actual example. Figure 5 shows selected inputs for low-

³² Rate of growth is calibrated with the 20 to 39.9 percentile of income’s “Any financial Asset” from family holdings of financial assets, by selected characteristics of families and type of asset using 1989-2016 surveys in the SCF.

³³ Income is drawn from the BEA’s Personal Income by Major Component.

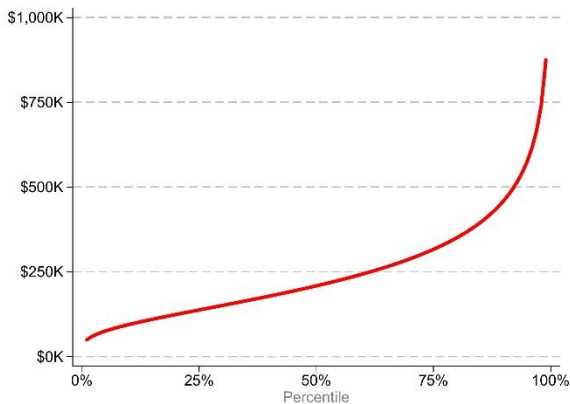
³⁴ For example, down payment funds are initially calculated at the national level and then converted with the income ratio while other inputs, such as taxes and insurance, remain constant to simplify the analysis.

Figure 5: Example of model outputs for Phoenix, Arizona

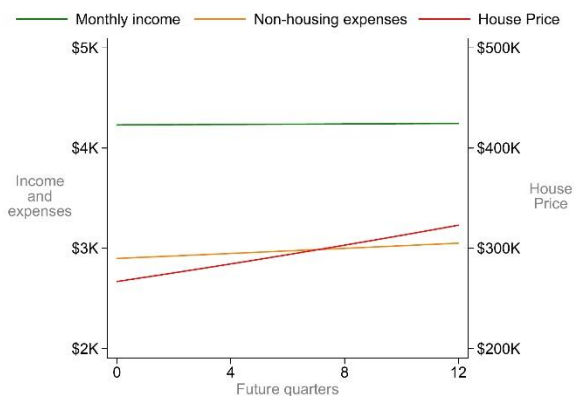
(a) Initial calibration

Inputs	Values
Income (80% of AMI)	\$50,774
Down payment funds	\$17,767
Mortgage rates	4.20%
Monthly gross income	\$4,231
Monthly non-housing expenses	\$2,899
Monthly maximum housing expenses	\$1,332
Maximum PITI	31%

(b) Cumulative distribution of house prices



(c) 3-year look ahead projections



income households in Phoenix, Arizona in the fourth quarter of 2014.³⁵ The example provides more detail on calibrated inputs (panel a), the distribution of housing stock prices (panel b), and estimates for future inputs (panel c).

Panel (a) provides summary information about how low-income households are able to afford 44 percent of the single-family housing stock in Phoenix, Arizona, adjusted for future affordability (i.e. with a 3-year look ahead period).³⁶ During this period, the average home price is \$266,990 and 80% of area median income is \$50,774 annually or \$4,231 monthly with estimated \$2,899 spent on non-housing expenses. We calculate the maximum PITI in two steps. First, we compute the maximum housing expenses or residual income by subtracting the non-housing expenses from the gross income. Second, we divide the residual income by gross income to derive the maximum PITI ratio. Panel (b) shows the distribution of housing stock using the MSA-specific house prices and standard deviations. Panel (c) presents projected input streams that can affect future affordability. Projected house prices drive calculations of future property taxes and insurance premiums (using growth rates shown in Figure 2). The projected income and expense streams both affect calculations of the future monthly maximum housing expenses.

Using all these values, we calculate two sets of affordability estimates; one at origination and one including the adjustments for future affordability. At origination, low-income households can afford 54 percent of the housing stock or 10 percentage points higher than the affordability with a 3-year look ahead period. We project non-housing expenses and house prices to grow faster than the income for this period. In effect, this reduces the future monthly maximum housing expenses and increases the future taxes and insurance premium, both negatively affecting the typical family's ability to make future payments. This is a single example; MSAs differ by input trends and final affordability estimate values. The next section presents the entire suite of HAE indexes.

³⁵ We assume a normal distribution based on MSA specific home prices and standard deviations. The projected inputs are based on historical five-year rolling averages and follow steps as described earlier.

³⁶ For illustrative purposes, we select Phoenix, Arizona and use its low-income household HAE index for 2014Q4. The panels in the figure are selected to provide a more detailed demonstration about how affordability estimates are calculated (at origination and with a 3-year look ahead).

5. New Home Affordability Estimates

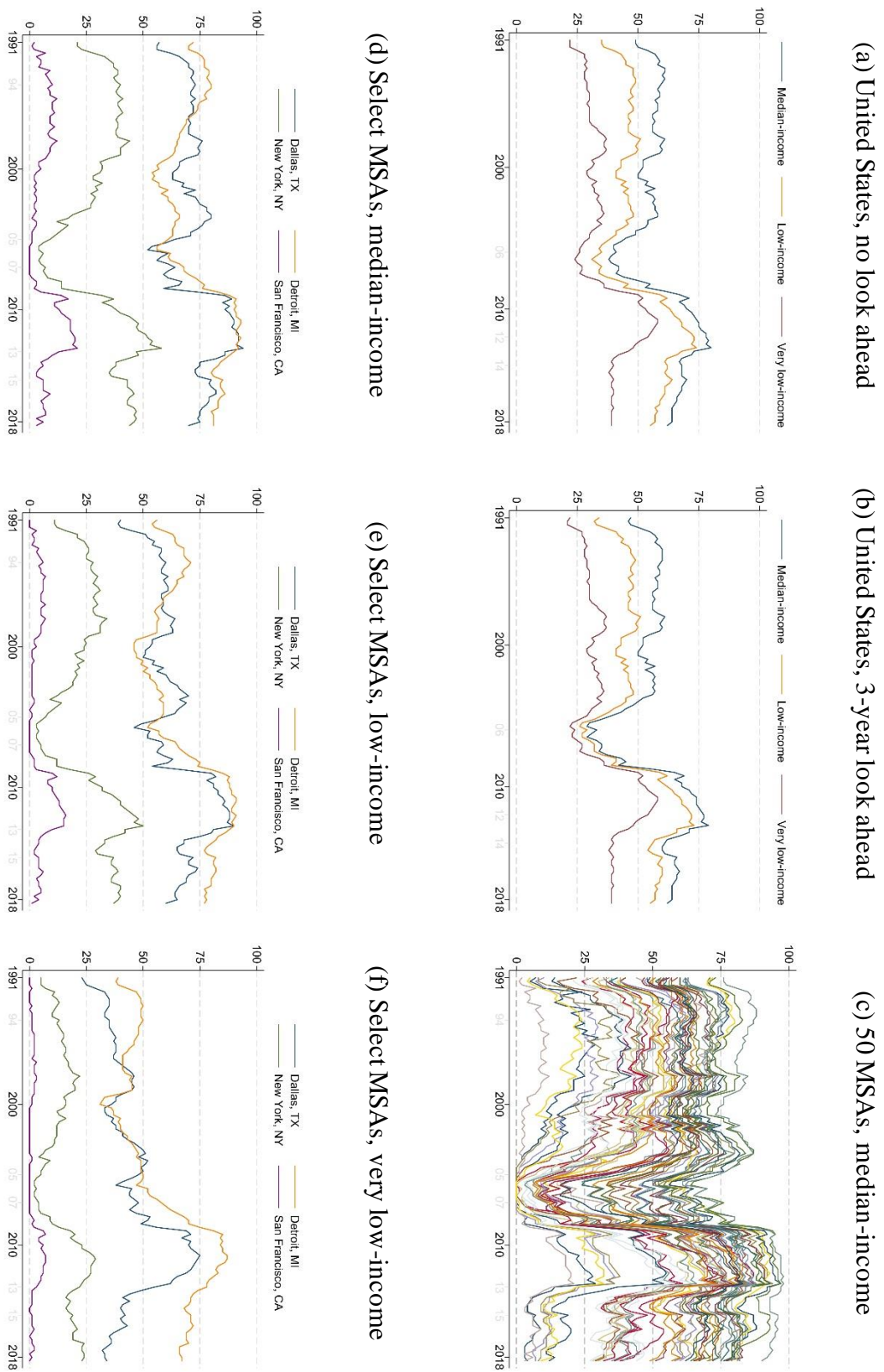
The HAE indexes are produced as an aggregated national index and disaggregated MSA indexes. Figure 6 displays their trends in multiple panels with colored lines denoting either the type of index or a particular location. A discussion is provided below for the data and figures in each panel.

United States

Panels (a) and (b) portray the median-income, low-income, and very low-income HAE indexes for the United States. The two graphics differ in whether affordability is calculated at origination (i.e., without a look ahead period) or if the series include adjustments for future affordability (i.e., with a 3-year look ahead period). The former is more common in existing industry metrics while the latter is a contribution we make in this paper and the method we prefer. No matter which is used, for the first ten years of the sample, affordability is rather constant. The indexes for all three income groups begin to decline as house prices rise during the first part of this century. Notably, median-income affordability drops at a sharper rate, which is consistent with reports that the stock of higher-priced homes accelerated at faster rates relative to lower-priced homes.

By 2005, affordability falls to similar levels for the three series, showing values of 26 for median-income households, 26 for low-income households and 22 for very low-income families in the United States in panel (b). But, over the next dozen years, the recovery is not be the same. Affordability more than doubles for median-income households but improves at a lesser degree for low- and very low-income households by mid-2018. The divergences of these lines echoes popular media coverage that has been raising concerns about affordability for certain, or relative, groups of individuals. A typical median-income household would have been able to buy 62 percent of the single-family housing stock in the nation (and could adequately make future payments), while a low-income household and very-low income household would have afforded 55 and 39 percent, respectively, of the nation's single-family housing stock. Why has affordability risen recently for median-income households but remain unchanged for lower income households? Prospects for median-income households have improved more while the wage increases for the lower income group have not kept pace with recent house price gains.

Figure 6: New home affordability estimate indexes



The gaps between the three lines, though, are driven largely by differential changes to income and wealth, along with a host of other factors. We note that our affordability estimates are purely quantitative and do not take behavioral aspects into consideration such as prospective homeowner's appetite for homeownership and loosening or tightening of lending standards. A presence of affordability does not necessarily drive home purchases. A high estimate of affordability, like in 2011, is not a sufficient condition to higher home ownership.

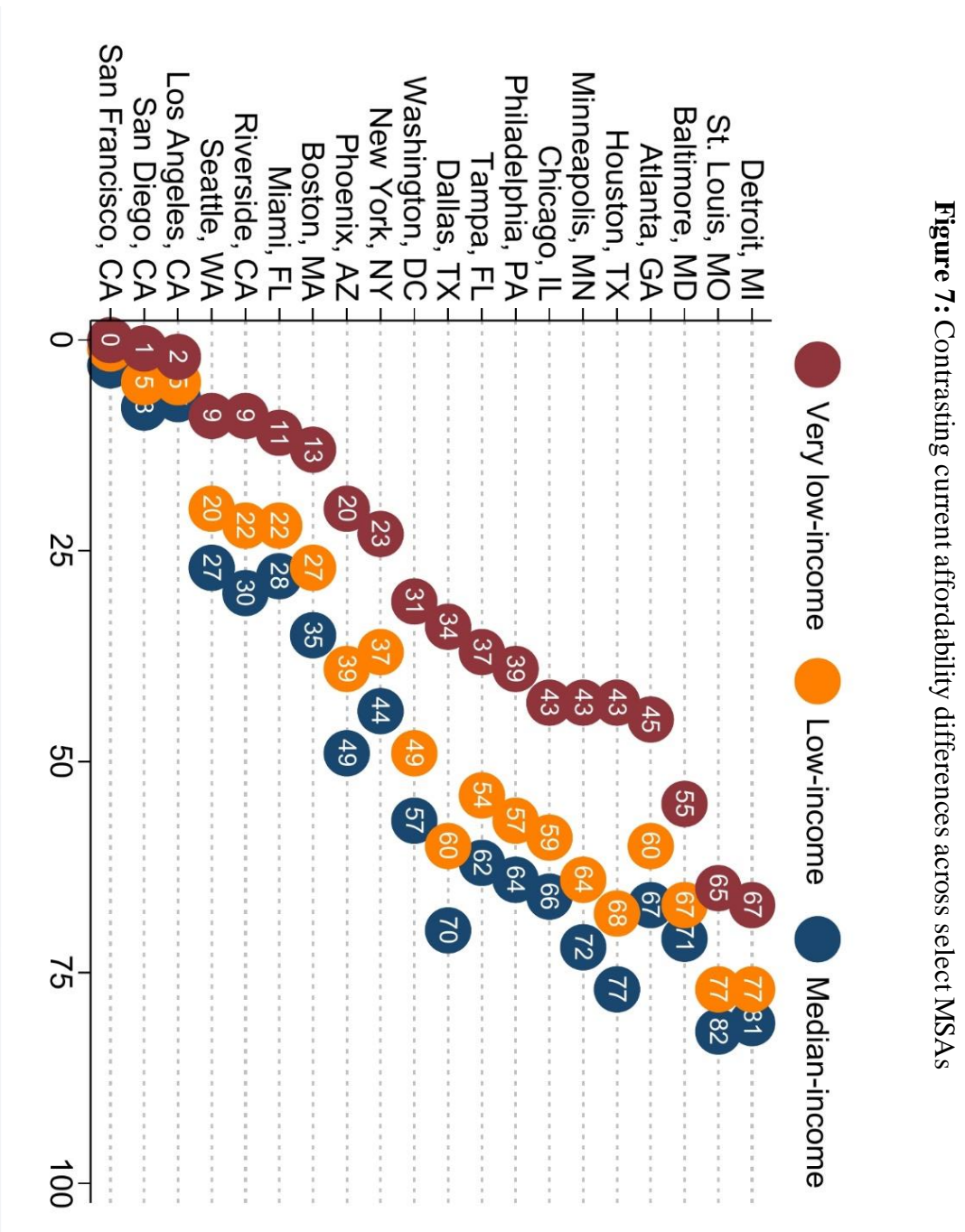
Select Metropolitan Statistical Areas

We calculate HAE indexes for 50 MSAs, as alluded in panel (c), and those data are available in the datasets posted online with this paper.³⁷ The lower three panels (d, e, and f) illustrate the HAE indexes (median-income, low-income, and very low-income, respectively) for select MSAs of Dallas, TX; Detroit, MI; New York, NY; and San Francisco, CA.³⁸ We show affordability levels for these four cities for illustrative purposes to demonstrate that affordability levels and growth rates vary across geographies. Although not likely a surprise, the San Francisco area is the least affordable, and that remains true over the entire sample for median-, low-, and very low-income HAE indexes. While levels of affordability vary, the other three MSAs exhibit similar trends, a sharp drop in affordability during the housing boom and then a much quicker rise during the recovery.

House prices remain much more stable in Texas throughout that entire period, but that is not without consequences. If we graph the current values for the median-income, low-income, and very low-income series together for the top 20 MSAs, as is done in Figure 7, then it becomes apparent that Texas has the largest separation between the three affordability values (with both Dallas and Houston having the largest gaps between the very low-income and median-income affordability metrics). Another observation is that California locations exhibit extremely low

³⁷ Panel (c) shows the median-income series for the largest 20 MSAs. The online data files actually have data for the top 50 MSAs, and that information covers low-income and very low-income indexes. Several other MSAs, like Kansas City and Pittsburgh, have greater affordability levels than Detroit in some quarters but it is still among one of the more affordable areas of the country when we add in the additional cities.

³⁸ The select MSAs are chosen to demonstrate that affordability levels vary across regions of the United States and that affordability levels may differ between income groups (i.e., local policies can influence whether there is more or less affordability for households in specific income categories).



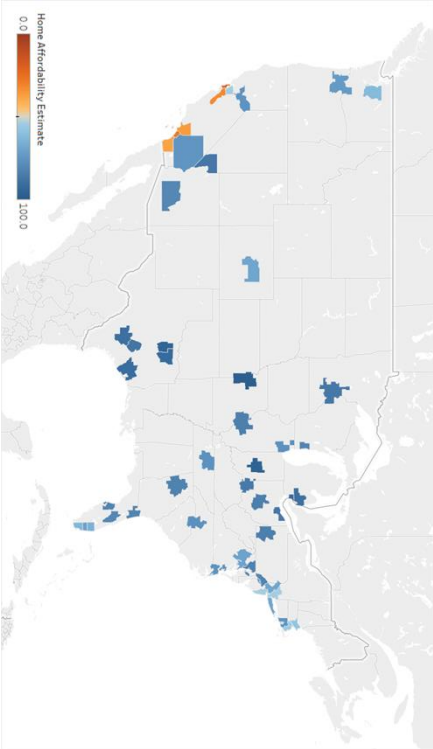
affordability, no matter the metric. Detroit has continually led the MSAs in having the highest levels of affordability with all three of our series.³⁹ To summarize, the visualization shows that there is a wide amount of variation among places; affordability ranges greatly between MSAs because of unique local economic drivers such as home prices, income, and wealth.

Affordability values vary significantly both geographically and over time. Figure 8 maps out the top 50 MSAs over four periods (1997, 2006, 2012, and 2018) to illustrate how the HAE indexes evolve over parts of a housing cycle for median-income households.⁴⁰ Low affordability is denoted with an orange shade while high affordability is shown with a blue color. The map visualization makes it even more apparent that are distinct regional differences in affordability. The least affordable values tend to appear concentrated around coastal areas but exceptions exist.

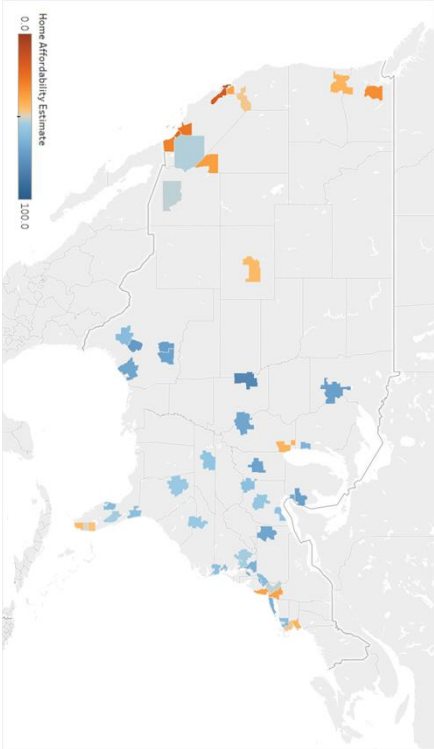
Panel (a) shows that in 1997 lower affordability levels exist in MSAs that are located in California, Florida, the New England region while there are high affordability levels almost everywhere else (outliers being Chicago and Denver). A decade later, panel (b) depicts that affordability levels decrease in most of the country as house prices reach their peak levels and drive up housing expenses. Several years later, with house prices at some of their lowest levels and coupled with record low mortgage rates, panel (c) shows that affordability levels increase throughout the country, except in California. Finally, in the last year of our data, panel (d) illustrates that affordability has once again reached lower levels in many MSAs but the trends are not as drastic as might be expected. The HAE values resemble what we saw in 1997 and have not returned to the 2006. Although current real house prices have either reached or exceed their peak price levels, the low interest rate environment has been working to keep down housing expenses. Overall, the cyclical behavior across the panels seems concentrated to the same MSA locations with California usually showing the lowest affordability across all years.

³⁹ We caution, though, on extrapolating these results to normative conclusions. High affordability does not necessarily mean that very low-income people are finding more economic or financial success in a particular location. The value also does not indicate that borrowers would even be interested in buying the housing stock that they could afford. In other words, the HAE does not account for quality, desirability, or functionality of the stock.

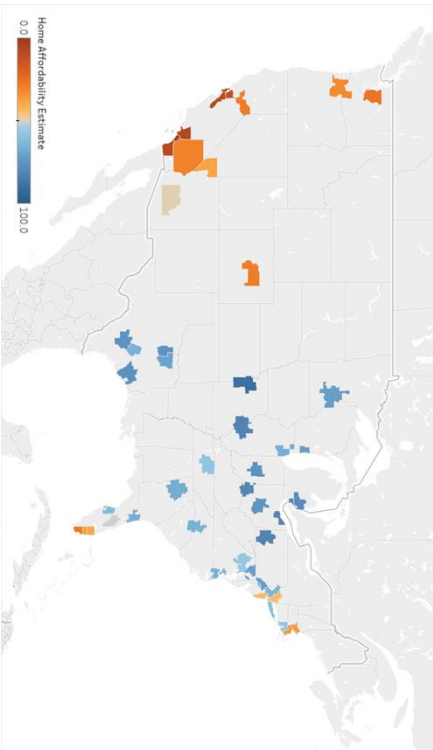
⁴⁰ All four panels show data as of second quarter in those years.



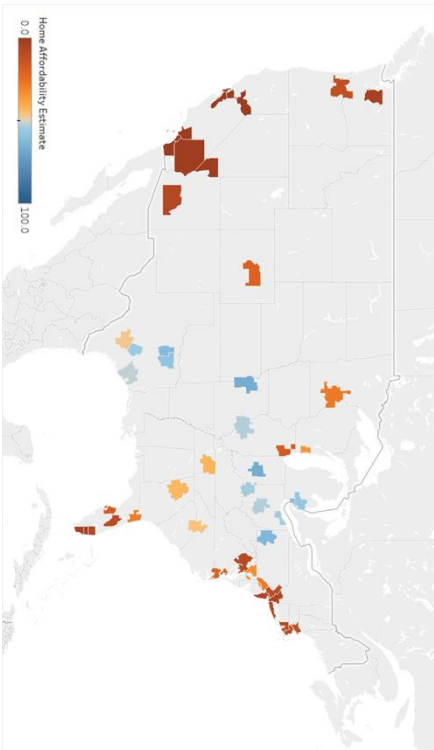
(a) 1997



(b) 2006



(c) 2012



(d) 2016

Figure 8: New home affordability estimate for top 50 MSAs (median-income)

6. Conclusion

This paper presents a new home affordability estimate that tracks the share of housing stock that is affordable to certain households. We can show that the HAE operates in the same fundamental way as existing industry affordability indexes. However, this new approach is able to make two potential improvements because of our access to individualized data. First, we calculate actual funding and expense streams instead of making assumptions for important calculations, like the size of a mortgage down payment. The difference provides more variation across cross-sectional areas, which allows affordability levels to vary among cities for a variety of reasons. Second, we construct indexes for particular points in the distribution of household income instead of being forced to choose the median-income level. This advantage could be helpful for exploring why inequities exist in certain areas of the country or for implementing policies that are directed to particular groups.⁴¹ We leave such further explorations to future research.

The HAE indexes have been produced on a quarterly frequency for a subset of cities in the United States. We recognize that affordability may change over time; it may also differ greatly between large and small cities, or even within a single place. The data are being released for download at <https://www.fhfa.gov/hae> to stimulate public discussion but they should be considered developmental in nature. We welcome public feedback. The analysis and conclusions in this paper are the authors' and should not be represented or interpreted as conveying an official FHFA position, policy, analysis, opinion, or endorsement. Depending on comments, we may consider updating the indexes on a more regular production schedule. If the data are updated, methodological improvements could render refinements to future releases and revisions to existing series. Comments, questions, or suggestions about this paper may be sent to HAE@fhfa.gov.

⁴¹ Our methodology has the ability to provide other data that could help inform policy work or rule-making decisions. For example, programs dealing with affordable lending or housing goals might be more interested in the estimated house price that is affordable for certain income groups in an area. Our work has already derived that kind of information and future data releases could include such information if feedback indicates that it would be useful.

Further Related Reading

Anthony, Jerry. 2003. "The Effects of Florida's Growth Management Act on Housing Affordability." *Journal of the American Planning Association*, vol. 69, no. 3, pp. 282–295.

Been, Vicki. 2005. "Impact Fees and Housing Affordability." *Cityscape: A Journal of Policy Development and Research*, vol. 8, no. 1, pp. 139–185.

Bogdon, Amy S. and Ayse Can. 2003. "Indicators of Local Housing Affordability: Comparative and Spatial Approaches." *Real Estate Economics*, vol. 25, no. 1, pp. 43–80.

Dougherty, Ann and Robert Van Order. 1982. "Inflation, Housing Costs, and the Consumer Price Index." *The American Economic Review*, vol. 72, no. 1, pp. 154–164.

Fingleton, Bernard. 2008. "Housing Supply, Housing Demand, and Affordability." *Urban Studies*, vol. 45, no. 8, pp. 1545–1563.

Fisher, Lynn M., Pollakowski, Henry O. and Jeffrey Zabel. 2009. "Amenity-Based Housing Affordability Indexes." *Real Estate Economics*, vol. 37, no. 4, pp. 705–746.

Gan, Quan and Robert J. Hill. 2009. "Measuring Housing Affordability: Looking Beyond the Median." *Journal of Housing Economics*, vol. 18, no. 2, pp. 115–125.

Glaeser, Edward L. and Joseph Gyourko. 2002. "The Impact of Zoning on Housing Affordability." NBER Working Paper Series, No. 8835.

Green, Richard K. and James D. Shilling. 1994. "Do Teaser-Rate Adjustable-Rate Mortgages Make Owner-Occupied Housing More Affordable?" *Journal of Housing Economics*, vol. 3, no. 4, pp. 263–282.

Gyourko, Joseph and Peter D. Linneman. 1993. "The Affordability of the American Dream: An Examination of the Last 30 Years." *Journal of Housing Research*, vol. 4, no. 1, pp. 39–72.

Haffner, Marietta and Kristof Heylen. 2011. "User Costs and Housing Expenses. Towards a More Comprehensive Approach to Affordability." *Housing Studies*, vol. 26, no. 4, pp. 593–614.

Hancock, Karen E. 1993. "Can Pay? Won't Pay? Or Economic Principles of 'Affordability'." *Urban Studies*, vol. 30, no. 1, pp. 127–145.

Harkness, Joseph and Sandra J. Newman. 2005. "Housing Affordability and Children's Well-Being: Evidence from the National Survey of America's Families." *Housing Policy Debate*, vol. 16, no. 2, pp. 223–255.

Hulchanski, J. David. 1995. "The Concept of Housing Affordability: Six Contemporary Uses of the Housing Expenditure-to-Income Ratio." *Housing Studies*, vol. 10, no. 4, pp. 471–491.

Kutty, Nandinee K. 2005. "A New Measure of Housing Affordability: Estimates and Analytical Results." *Housing Policy Debate*, vol. 16, no. 1, pp. 113–142.

- Lerman, Donald L. and William J. Reeder. 1987. "The Affordability of Adequate Housing." *AREUEA Journal*, vol. 15, no. 4, pp. 389–404.
- Linneman, Peter D. and Isaac F. Megbolugbe. 1992. "Housing Affordability: Myth or Reality?" *Urban Studies*, vol. 29, no. 3-4, pp. 369–392.
- Matlack, Janna L. and Jacob L. Vigdor. 2008. "Do Rising Tides Lift All Prices? Income Inequality and Housing Affordability." *Journal of Housing Economics*, vol. 17, no. 3, pp. 212–224.
- McClure, Kirk. 2008. "Deconcentrating Poverty with Housing Programs." *Journal of the American Planning Association*, vol. 74, no. 1, pp. 90–99.
- Meen, Geoffrey. 2011. "A Long-Run Model of Housing Affordability." *Housing Studies*, vol. 26, no. 7-8, pp. 1081–1103.
- Miceli, Thomas J., Sazama, Gerald W. and C. F. Sirmans. 1994. "The Role of Limited-Equity Cooperatives in Providing Affordable Housing." *Housing Policy Debate*, vol. 5, no. 4, pp. 469–490.
- Quigley, John M. and Steven Raphael. 2004. "Is Housing Unaffordable? Why Isn't It More Affordable?" *Journal of Economic Perspectives*, vol. 18, no. 1, pp. 191–214.
- Quercia, Roberto G., McCarthy, George W. and Susan M. Wachter. 2003. "The Impacts of Affordable Lending Efforts on Homeownership Rates." *Journal of Housing Economics*, vol. 12, no. 1, pp. 29–59.
- Sirmans, Stacy and David Macpherson. 2003. "The State of Affordable Housing." *Journal of Real Estate Literature*, vol. 11, no. 2, pp. 131–156.
- Stone, Michael E. 2006. "What is Housing Affordability? The Case for the Residual Income Approach?" *Housing Policy Debate*, vol. 17, no. 1, pp. 151–184.
- Thalmann, Philippe. 2003. "'House Poor' or Simply 'Poor'?" *Journal of Housing Economics*, vol. 12, no. 4, pp. 291–317.
- Weicher, John C. 1978. "New Home Affordability, Equity, and Housing Market Behavior." *Real Estate Economics*, vol. 6, no. 4, pp. 395–415.

Useful Websites

California Association of Realtors. Housing Affordability Index – Traditional. Website, <https://www.car.org/marketdata/data/haitraditional>

Federal Housing Finance Agency. Monthly Interest Rate Survey. Website, <https://www.fhfa.gov/DataTools/Downloads/pages/monthly-interest-rate-data.aspx>

Federal Housing Finance Agency. House Price Index. Website, <https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index.aspx>

The Federal Reserve. Survey of Consumer Finances. Website, <https://www.federalreserve.gov/econres/scfindex.htm>

Moody's Analytics. Data Buffet. US Metropolitan Areas median household income. Website, <https://www.economy.com/products/tools/data-buffet>

National Association of Home Builders. National Association of Home Builders and Wells Fargo Home Opportunity Index. Website, <https://www.nahb.org/en/research/housing-economics/housing-indexes/housing-opportunity-index>

National Association of Realtors. Housing Affordability Index. Website, <https://www.nar.realtor/research-and-statistics/housing-statistics/housing-affordability-index>

National Association of Realtors. REALTORS® Affordability Distribution Curve and Score. Website, <https://www.nar.realtor/research-and-statistics/housing-statistics/realtors-affordability-distribution-curve-and-score>

Redfin. How Much House Can I Afford? Website, <https://www.redfin.com/how-much-house-can-i-afford>

Realtor.com. Home Affordability Calculator. Website, <https://www.realtor.com/mortgage/tools/affordability-calculator/>

Trulia. Affordability Calculator. Website, <https://www.trulia.com/house-affordability-calculator/>

U.S. Bureau of Labor Statistics. Consumer Price Index. Website, <https://www.bls.gov/cpi/>

U.S. Census Bureau. Survey of Income and Program Participation. Website, <https://www.census.gov/sipp/>

U.S. Department of Commerce. Bureau of Economic Analysis. Personal Income and Its Disposition. Website, <https://www.bea.gov/itable/>

U.S. Department of Commerce. Bureau of Economic Analysis. Personal Income by Major Component (SQ4). Website, <https://www.bea.gov/itable/>

U.S. Department of Housing and Urban Development. Acceptable sources of borrower funds. Document 4155.1, Chapter 5, Section B. Website, https://www.hud.gov/sites/documents/4155-1_5_SECB.PDF

U.S. Department of Housing and Urban Development. American Housing Survey: Housing Affordability Data System. Website, <https://www.huduser.gov/portal/datasets/hads/hads.html>

U.S. Department of Housing and Urban Development and Department of Transportation. Location Affordability Index. Website, <https://www.hudexchange.info/programs/location-affordability-index/>

Zillow. Affordability Calculator. Website, <https://www.zillow.com/mortgage-calculator/house-affordability/>