Methodology

Data

The American Community Survey (ACS) program of the U.S. Census Bureau is the primary data source for estimates presented in this tool. Through the ACS, the Census Bureau surveys roughly 3 million households nationwide each year to assess key housing, demographic, and economic characteristics. Data from this survey sample — which represents about 2.5 percent of households nationwide — are used to produce estimates reflecting one and five years' worth of survey data for geographies of various sizes. Additionally, the Census Bureau releases a set of anonymized individual responses to ACS questionnaires in what are known as Public Use Microdata Sample (PUMS) files. This analysis relies on one-year (2011 and 2018) and five-year (2007–2011 and 2014–2018) PUMS files, accessed via the Minnesota Population Center IPUMS-USA database (IPUMS-USA, University of Minnesota, www.ipums.org).

The lowest level of geography at which PUMS data are available is a specialized census geography called a Public Use Microdata Area (PUMA). These are areas with populations of at least 100,000 that were developed to preserve the privacy of individual respondents. Densely populated geographies, such as the city of Philadelphia, are split into multiple PUMAs that fit together within their boundaries, whereas PUMAs in less dense areas generally contain multiple counties or parts of counties. In this analysis, PUMAs were matched to metropolitan statistical area (MSA) and state boundaries using information provided by the Missouri State Data Center's MABLE/Geocorr2K and MABLE/Geocorr12 applications.

Changes in the PUMA geographies following the 2010 Census were implemented in the 2012 ACS, presenting major cross-year comparability challenges for this update. As a result, estimates were only produced for geographies that could be wholly or very closely reconstructed with both sets of PUMA geographies (discussed further under Estimates).

The determination of whether to use the one-year or five-year files was made based on the number of renter households in a given geography. Although the one-year files allow for more timely estimates, the five-year files produce more reliable estimates for less populous geographies where the single-year sample is small. The one-year files were used for geographies with at least 200,000 renter households, and the five-year files were used for all other geographies.

ACS estimates of median family income (MFI) were used to categorize the individual housing unit/household records contained in the PUMS file into relative affordability and income categories. PUMAs that were wholly contained within an MSA were assigned the MFI of that MSA. Single-county, nonmetro PUMAs were assigned the county's MFI. PUMAs containing multiple nonmetro counties or parts of counties were assigned the PUMA MFI. Last, PUMAs containing a mix of MSA geographies or

MSA and nonmetro geographies were assigned a weighted average of the MSA(s) and/or county MFIs based on the proportion of housing units falling within each. The time periods of the MFI estimates used for MSA-level analyses correspond to those of the PUMS file (e.g., if analysis of the State College MSA uses the five-year ACS PUMS, the five-year ACS MFI estimate was used as the underlying PUMA income). In order to produce one-year rental housing estimates for New Jersey and Pennsylvania, one-year estimates were used for all PUMAs and aggregated to develop estimates for these larger geographies.

Analysis

PUMS data are available in person- and housing unit-level files, with unique household identifiers matching individuals to the units in which they reside. For occupied units, analysis of the person-level file was performed first. Person-level characteristics were aggregated to the household level and merged with the housing unit file for additional analysis (along with vacant units). Some estimates presented in the data tool are reported for individual renters, while others are reported for households or housing units (discussed further under Estimates).

By comparing household-level income reported in the PUMS file with the MFI for the broader geographic region, renter households were divided into the following income categories to enable closer analysis of different income segments:

- Extremely low-income (ELI): households with incomes ≤30 percent of the regional MFI
- Very low-income (VLI): households with incomes 31–50 percent of the regional MFI
- Low-income (LI): households with incomes 51–80 percent of the regional MFI
- Not low-income: households with incomes >80 percent of the regional MFI

Households reporting zero or negative income that paid more than the Fair Market Rent (FMR)[1] for their units during the survey year were reclassified as "not low-income," since their income situation was assumed to be either temporary or not indicative of broader economic hardship. To assign FMRs to PUMAs, county-level FMRs were merged to PUMA boundaries based on the survey year, then the appropriate FMR was assigned to housing units based on the number of bedrooms. For PUMAs covering multiple counties or MSAs, the highest applicable FMR value was assigned. For five-year ACS PUMS files, the FMR that corresponds to the actual year the household was surveyed was applied, then adjusted for inflation to be consistent with the dollar values in which estimates are reported (e.g., for households in the 2014–2018 files, FMRs were adjusted to 2018 dollars). In accordance with the FMR methodology of the U.S. Department of Housing and Urban Development (HUD), FMRs for unit sizes larger than four bedrooms were calculated by adding 15 percent for each extra bedroom to the four-bedroom FMR.

To account for the variation in income needs of households of various sizes, we adopted HUD's approach to adjusting MFI estimates based on household size.[2] An unadjusted MFI was used to categorize households of four, with a downward adjustment of 10 percent for each person fewer than

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[1] As defined by the U.S. Department of Housing and Urban Development. For more information, see www.huduser.gov/portal/datasets/fmr.html.

[2] U.S. Department of Housing and Urban Development, Office of Policy Development and Research, "FY 2018 Income Limits Briefing Material," April 1, 2018; available at www.huduser.gov/portal/datasets/il/il18/IncomeLimitsMethodology-FY18.pdf. See page 7 for the description of household size income adjustments. It should be noted that HUD's income limits are subject to additional adjustments that were not included in this analysis, such as caps on year-to-year growth and adjustments for areas in which housing costs or incomes are exceptionally high.

four. For each person in a household exceeding four, the MFI was adjusted upward by 8 percent. The table summarizes the adjustments to households consisting of one to eight residents:

Number of Persons in Household and Percentage Adjustments to MFI

1	2	3	4	5	6	7	8
70%	80%	90%	Base	108%	116%	124%	132%

Source: Adapted from U.S. Department of Housing and Urban Development, Office of Policy Development and Research, "FY 2018 Income Limits Methodology," April 1, 2018.

Once households were sorted into income categories, the ratio of their monthly gross housing costs to their monthly income was calculated to assess the variation in housing cost burdens across income levels. For units in which utility costs were separate from rent, gross housing costs were calculated as the sum of rent and utility costs. Households for which monthly gross rent exceeded 30 percent of monthly income were considered burdened by their housing costs, whereas those paying more than 50 percent of their monthly income were considered severely cost burdened.

The housing units themselves — including those that were vacant — were also sorted into affordability categories to enable analysis of the supply of affordable rental units. Utility costs for vacant units were imputed based on the median utility costs for similarly sized units in the associated state for the given sample year and added to the reported contract rent to produce an estimate of gross rent. To be considered affordable, monthly gross rent could not exceed 30 percent of monthly household income. Units were categorized using the MFI-based income thresholds outlined previously. Again, adjustments were made to reflect the variation in income sufficiency for different household sizes. Following HUD's methodology, the applicable household size was inferred from the number of bedrooms in a unit. Efficiencies were assumed to accommodate one person, one-bedroom units were assumed to accommodate 1.5 persons, and each additional bedroom was assumed to accommodate an additional 1.5 persons.

It may be instructive to include an example of how a unit would be categorized. Assume there is a two-bedroom unit with a gross rent of $900 in an area with an MFI of $50,000. The applicable income thresholds in that community would be:

- ELI threshold: 30% × $50,000 × 90%[3] = $13,500
- VLI threshold: 50% × $50,000 × 90% = $22,500
- LI threshold: 80% × $50,000 × 90% = $36,000

At a rent of $900 per month, the unit is affordable at an annual income of $32,400 ($900 monthly rent / 30 percent to calculate the monthly income needed to afford the unit, multiplied by 12 months to produce the annual income, multiplied by 90 percent to adjust for a three-person household), placing it above the ELI and VLI thresholds but affordable to a three-person household in the LI category.

Estimates

While many of the estimates produced in this analysis were the result of simple cross tabulations (e.g., rates of cost burden by household income category, race/ethnicity of individuals in cost-burdened,

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[3] This represents the three-person household adjustment factor, since a two-bedroom unit is assumed to comfortably house three people.

lower-income households, etc.), others required additional calculations. Where changes in the PUMA boundaries affected the ability to construct consistent MSA geographies throughout the study period, household and unit estimates from the PUMAs containing both MSA and nonmetro geographies were allocated based on the proportion of housing units that fell within the MSA.[4] This proportion was added to the estimates from PUMAs that were wholly contained within the MSA, providing an approximation of the estimate for the full geography.

Since it assumes uniformity of household and housing unit characteristics across the mixed PUMA, this approach was used only if less than 5 percent of an MSA's housing units were subject to this adjustment in order to preserve the integrity of the MSA-level estimates. In MSAs where more than 5 percent of the housing units were in PUMAs that combined MSA and nonmetro counties (as was the case for the Scranton–Wilkes-Barre–Hazleton MSA), estimates were not produced. Nonmetropolitan Greene County was included in the Pittsburgh MSA estimates to avoid exceeding this 5 percent threshold.

Most economic and demographic indicators are reported at the person level for individuals in cost-burdened, lower-income households (income ≤ 80 percent MFI). The exceptions to this are the estimates for the number of employed residents in cost-burdened, lower-income households; the household type of cost-burdened, lower-income renters; and the rates of cost burden for selected vulnerable groups, which are reported at the household level. To calculate the number of employed persons in cost-burdened, lower-income households, employed individuals were identified in the person-level files, then aggregated to households. Similarly, rates of cost burden among senior-headed households and households including one or more residents with a disability were calculated by aggregating person-level indicators. The remaining vulnerable groups as well as the household types were identified using household-level indicators. All affordability measures are calculated at the household- or housing unit-level in the income and affordability categories outlined previously.

The median rent gap, or the gap between a household's maximum affordable rent and the actual gross rent paid by the household, was calculated for cost-burdened households in each income category. Following the housing cost-burden analysis described previously, the threshold for the maximum affordable rent was set to 30 percent of monthly household income. For each cost-burdened household, this threshold rent was subtracted from the actual gross rent reported in the ACS. The median of these differences is reported for cost-burdened ELI, VLI, and LI households. Unlike all other tabulations in this analysis, it was not feasible to incorporate the mixed-PUMA adjustment described in the preceding two paragraphs into this calculation. For the purposes of this analysis, a PUMA was included in the calculations if it was entirely contained within the target MSA.

Following the methodology outlined in HUD's "Worst Case Housing Needs" series of reports to Congress,[5] the ratio of affordable and available units for households at or below the three income thresholds developed in the analysis (≤ 30 percent MFI, ≤ 50 percent MFI, and ≤ 80 percent MFI) were calculated to assess the sufficiency of the existing affordable rental stock relative to demand. A unit was considered affordable if gross rent would not exceed 30 percent of the monthly household income at

[4] The Missouri Census Data Center's Geocorr applications provided housing unit-based allocation factors for all counties within a PUMA. These applications are available at http://mcdc2.missouri.edu/applications/geocorr.html.

[5] For the latest in this series, see Nicole Elsasser Watson, Barry L. Steffen, Marge Martin, David A. Vandenbroucke, *Worst Case Housing Needs 2019: Report to Congress*, Washington, D.C.: U.S. Department of Housing and Urban Development, June 2020. Available at www.huduser.gov/portal/publications/worst-case-housing-needs-2020.html.

the given income level (e.g., 30 percent of the monthly income of a household at 50 percent of the regional MFI). A unit was available if it was either vacant or currently occupied by a household at or below the given income level. For example, if there were 1,000 renter households with income at or below 30 percent of the regional MFI and 900 units affordable to a household at that income threshold, there would be 90 units affordable for every 100 renter households.[6] However, if 400 of those units were occupied by households with income greater than 30 percent of the regional MFI, there would only be 500 affordable and available units for households at or below the income threshold, or 50 for every 100 renter households.[7] It is important to note that these ratios were cumulative for each income level, including all housing units and households that fell at or below a given affordability or income category.

Additionally, the overall deficit or surplus of units affordable and available at different income thresholds is reported for the most recent estimate year or period. These estimates were calculated by subtracting the number of households at or below a given income threshold from the number of available units at or below the corresponding affordability category. Like the ratios, these estimates are cumulative. This analysis only presents surplus/deficit estimates for the most recent period (2018 or 2014–2018) because more recent ACS data are "controlled" to the 2010 census, whereas prior data use population estimates based on the 2000 census, complicating comparisons of housing counts across these years.[8] In keeping with Census Bureau guidelines, this analysis focuses on change over time in characteristics (such as percent cost burdened), testing only these estimates for significant difference.[9]

Comparability with Prior Reports

In 2010, the Community Development and Regional Outreach (CDRO) Department of the Philadelphia Fed published a special report, *Affordability and Availability of Rental Housing in Pennsylvania*[10] that utilized both ACS data from 2005 and 2006 as well as HUD-produced Comprehensive Housing Affordability Strategy (CHAS) data sets from 1990 and 2000. This report was subsequently updated in 2011 using CHAS data from 2005–2007 that were based on ACS data collected during those three years.[11] Estimates in these prior reports *should not be compared* with the estimates presented in this analysis. The CHAS data included in the 2010 report were based on the long-form survey administered in

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[6] Because these affordability categories are based on *ranges* relative to MFI, this calculation assumes a similar distribution of units and households within these ranges. Where these distributions are dissimilar, there is the potential to overstate or understate the affordability of the rental stock.

[7] These calculations likely overestimate the level of affordability, since housing units occupied by households that reported paying no cash rent were categorized as affordable to ELI households. If arrangements that make this possible for current occupants were not available to the broader population, these units may not fall into this affordability category.

[8] U.S. Census Bureau, "American Community Survey Research Note: Change in Population Controls," U.S. Census Bureau, September 22, 2011. Available at www.census.gov/newsroom/releases/pdf/acs_2010_population_controls.pdf.

[9] U.S. Census Bureau, *A Compass for Understanding and Using American Community Survey Data: What PUMS Data Users Need to Know*, Washington, D.C.: U.S. Census Bureau, February 2009. Available at www.census.gov/content/dam/Census/library/publications/2009/acs/ACSPUMS.pdf.

[10] Erin Mierzwa, Kathryn P. Nelson, and Harriet Newburger, *Affordability and Availability of Rental Housing in Pennsylvania*, Special Report, Federal Reserve Bank of Philadelphia, March 2010. Available at www.philadelphiafed.org/community-development/publications/special-reports/rental-housing.

[11]Community Development Studies & Education Department, *New Rental Housing Data Based on the 2005-07 American Community Survey (ACS)*, Special Report, Federal Reserve Bank of Philadelphia, 2011. Available at www.philadelphiafed.org/community-development/publications/special-reports/rental-housing/acs-data.

conjunction with the decennial census. Differences between long-form and ACS estimates have been observed in reported income levels and rents[12] as well as in vacancy rates.[13]

In addition to the 2010 report and 2011 updates, CDRO published two subsequent reports: "Affordability and Availability of Rental Housing in the Third Federal Reserve District: 2012"[14] and "Affordability and Availability of Rental Housing in the Third Federal Reserve District: 2015."[15] Although the data sources and analyses in these earlier reports are largely consistent with those outlined here, adjustments made in response to changes in PUMA boundaries (such as the efforts to reconstruct consistent MSA geographies over time as described previously), the treatment of households reporting zero or negative income, and the imputation of utilities for vacant units limit comparison with these estimates as well.

[12] Gregg J. Diffendal, Rita Jo Petroni, and Andre L. Williams, *Meeting 21st Century Demographic Data Needs — Implementing the American Community Survey, Report 8: Comparison of the American Community Survey Three-Year Averages and the Census Sample for a Sample of Counties and Tracts*, Washington, D.C.: U.S. Census Bureau, 2004.

[13] Deborah H. Griffin, *Comparing 2010 American Community Survey 1-Year Estimates of Occupancy Status, Vacancy Status, and Household Size with the 2010 Census — Preliminary Results*, Washington, D.C.: U.S. Census Bureau, December 2011.

[14] Keith Wardrip, Thomas Hylands, and Joshua Strazanac, "Affordability and Availability of Rental Housing in the Third Federal Reserve District: 2012," *Cascade Focus*, Federal Reserve Bank of Philadelphia, December 2012. Available at www.philadelphiafed.org/community-development/publications/cascade-focus/affordability-and-availability-of-rental-housing-in-third-district/affordability-and-availability-of-rental-housing-in-third-federal-reserve-district.

[15] Eileen Divringi, "Affordability and Availability of Rental Housing in the Third Federal Reserve District: 2015," *Cascade Focus*, Federal Reserve Bank of Philadelphia, February 2015. Available at www.philadelphiafed.org/-/media/community-development/publications/cascade-focus/cascade-focus_4.pdf?la=en.