THE IMPORTANCE OF A HOUSEHOLD LIVING BUDGET IN THE CONTEXT OF MEASURING ECONOMIC VULNERABILITY: A CENSUS CURATED DATA ENTERPRISE USE CASE DEMONSTRATION

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Abstract

The proposed **Curated Data Enterprise (CDE)** is a transformative approach for how the Census Bureau could accomplish its mission to develop and provide high-quality, timely, and geographically detailed statistical products by changing how it manages its data assets, incorporates information from external sources, and leverages them for the public good. The CDE explicitly focuses on curating not only the enterprise's data but also all of the processes associated with creating purpose-driven statistical products, including context, curation, and analyses, on platforms that permit public accessibility. The CDE would move the Census Bureau into a position to meet the challenges confronting statistical agencies in the 21st Century.

This report presents a Use Case on constructing geographic household living budgets (HLB) to identify capabilities for the CDE and to produce a statistical product that responds to the equity concerns of policymakers and researchers regarding social benefit thresholds. The concern is over the inequity of social benefit thresholds that over the decades have failed to account for cost differences among geographic areas. In a recent report from the Congressional Research Service (2022, p. 1), Weinstock stated,

> "… *policies that do not account for COL (cost of living) differences across places may inadvertently benefit some more than others. Additionally, policies that rely on data unadjusted for place in order to determine who qualifies for certain benefits, for example, may also inadvertently benefit some more than others*."

This Use Case is guided by principles and research steps in the CDE framework. It was selected because of the variety of publicly available data to construct the HLB and the need to construct it at a small geographic level. The lessons learned are twofold. HLBs can be constructed at the census tract level to incorporate geographic price differences that can lead to more equitable social benefit thresholds. The second is that it would be unrealistic to fill in data gaps by conducting new surveys at small geographic levels, rather it suggests that partnerships with for-profits and not-for-profits would need to be forged to resolve the data gaps highlighted in this Use Case.

The Importance of a Household Living Budget in the Context of Measuring Economic Vulnerability: A Census Curated Data Enterprise Use Case Demonstration

Introduction

The Curated Data Enterprise Framework (Exhibit 1) provides a guide for creating statistical products that enable the integration of data from many sources (Keller et al., 2020). At the heart of the framework are the purposes and uses, which provides the context for developing the statistical product. The outer rectangle in Exhibit 1, identifies the guiding principles for ethical, transparent, and reproducible product development and dissemination. The inner rectangle identifies the steps in the statistical product development that includes the integration of primary and secondary data sources. The arrows convey this is an iterative process where new information may be discovered at any point in the process which requires reevaluating and updating prior steps.

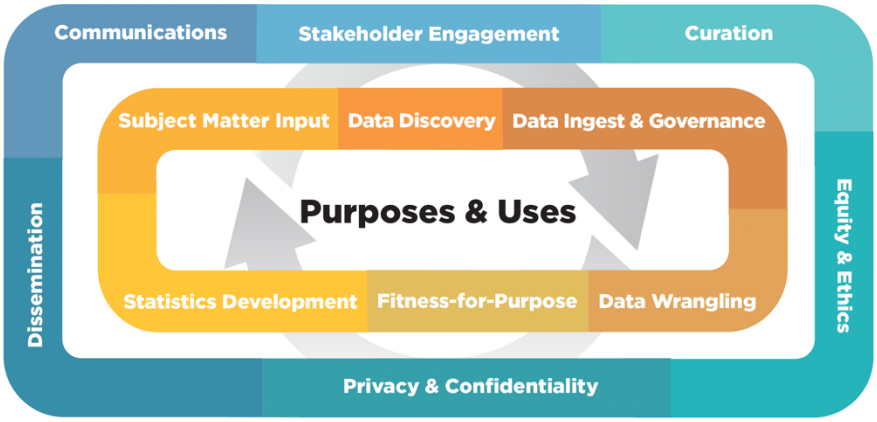


Exhibit 1. Curated Data Enterprise Framework
The CDE framework (Keller et al., 2020) starts with the purposes & uses of the statistical products. The outer rectangle identifies the guiding principles for ethical, transparent, and reproducible product development and dissemination, and the inner rectangle identifies the product development. The arrows indicate the iterative nature of this work. This is reflected in our report as well.

This Use Case employs the CDE framework to construct the HLB for all household combinations within a census tract. We define the HLB as the amount of income necessary to meet a household's needs to function at a modest yet adequate standard of living and to pay federal and state income taxes in the community in which they reside. We include "living" in our designation to connect this to a "living wage" and to emphasize that the HLB is not a deprivation budget. Instead, it is a budget that could be used to back out a living wage. The basic needs include housing, food, transportation, healthcare, childcare, broadband, and other necessities such as clothing, household supplies, personal care, nonprescription medicine, and school supplies. It is a "no frills" budget, that does not include meals outside the home, entertainment, or savings for retirement, education, and vacations.

We begin with a description of the HLB and illustrate how we developed this statistical product by following the steps in the CDE Framework in Exhibit 1. We provide an application of the HLB using it to estimate the prevalence of economically vulnerable households for the 274

census tracts in Fairfax County, Virginia. The final section highlights what we learned about the capabilities needed to develop the CDE.

Curated Data Enterprise Framework

In this section, we describe the CDE steps used to develop the statistical product. Not all CDE steps are used in every Use Case (Exhibit 1). For example, in developing the HLB the Privacy & Confidentiality step is not covered since no data on individuals were used.

Purpose and Use – Creating a Household Living Budget

Our purpose in constructing a household living. budget is to estimate the prevalence of economically vulnerable households at the census tract level. Currently, measures of economic vulnerability, such as the Official Poverty Measure (OPM) and the Supplemental Poverty Measure (SPM), are at the national, state, and county levels. These estimates are essential for identifying the degree of the problem and how it changes over time.

Our HLB evaluates the feasibility of creating a budget that captures a household's basic needs. This approach is being promoted as an alternate measure of poverty in the NASEM (2023) report on redrawing the poverty line. We chose to construct the HLB as our use case because it is a statistical product that highlights many of the capabilities that will be needed in the CDE. The HLB is constructed from many different data types, administrative, opportunity, and procedural – how can they be integrated across different geographic levels, collected at different times, and for different analysis units? Some data sources are updated monthly, some are updated every three years, which raises the question of how often should a statistical product be updated? It also uses a statistical product, a transportation index, to create another statistical product, the HLB. What sort of metadata and benchmarking should be required for a statistical product like a transportation index to be housed in the CDE?

The approach we have taken to construct the HLB has three main strengths, its focuses on a household's basic needs, transparency, and the ability to construct budgets for small geographic areas and any household combination. The steps in creating our HLB required us to choose and then justify what qualifies as a basic need for the specified budget standard, translate those needs into budget components, establish the component adequacy standard or threshold, and then calculate the income required to meet the specified standard for the various household combinations and locations. These adequacy standards can be used as a benchmark to assess the impact of benefit programs. Another advantage of this approach is that various decisions can be subjected to sensitivity analysis. In light of the sequence of steps involved in developing the HLB, the decisions and assumptions at each stage are provided in order to be subjected to external scrutiny and debate.

HLB Components – the foundations for creating a statistical product

Equity and ethical (Exhibit 1) considerations impact the selection of each budget component. The HLB is an example of a "…comprehensive approach to advancing equity for all." (White House 2021). It is a transparent approach to ensuring the equitable treatment of all households by incorporating geographic price differences. HLB is comprehensive in that it includes all the components needed in a budget for a modest, yet adequate standard of living and it is computed for all household combinations within a census tract level. Our rationale for selecting each budget component is described below.

HOUSING: Safe, affordable housing is a basic necessity for everyone. It has even been cited as a social determinant of health since the lack of housing affects health and well-being (Rolfe et al., 2020). This was recognized in the George W. Bush Administration when Housing First[1] was adopted as a federal policy to combat homelessness.

FOOD: Good nutrition is essential to keep individuals healthy across their lifespan. A healthy diet helps children grow and develop and reduces their risk of unhealthy weight, bone growth problems, and deficits in brain function. Adults who eat a healthy diet live longer and have a lower risk of diet-related noncommunicable diseases and certain cancers (USDA and HHS, December 2020).

TRANSPORTATION: Reliable and safe transportation is needed to reach jobs, shop for groceries, take children to childcare, and accomplish other household tasks. Due to spatial mismatch (Dowell, 2020), transportation affordability can be an issue for low-wage workers who cannot afford housing near their workplace, which can result in long and costly commutes.

HEALTHCARE: Medical care expenditures as a percentage of GDP has increased from 5.6% in 1965 to 19.75% in 2020, with an average costs per person of $12,530 in 2020 (Catlin and Cowan, 2015; Hartman et al., 2022). Access to healthcare is widely viewed as a right since it provides preventative care, treats life-threatening conditions, and can keep households from falling into poverty because of health-related expenses. Healthcare is essential for every household member, if adults are unable to work due to health problems, they are unable to support their household.

CHILDCARE: For single-parent households and households where both parents work, childcare is a necessity. But the current state of childcare in the U.S. is referred to by some economists[2] as

[1] DeParle J. (June 20, 2023). New Federal Policy on Homelessness Becomes New Target of the Right. New York Times. https://www.nytimes.com/2023/06/20/us/politics/federal-policy-on-homelessness-becomes-new-target-of-the-right.html

[2] Adams K. (September 15, 2021). Treasury says U.S. childcare system is a market failure. Marketplace: https://www.marketplace.org/2021/09/15/treasury-says-us-childcare-system-is-a-classic-market-failure/

a "classic market failure," the price point is too expensive for low- and middle-income households with children and the cost to operate a childcare business is often too expensive for the childcare owners to sustain and pay their workers a living wage.

BROADBAND: Broadband's connection to essential services is so wide ranging that it has become part of our infrastructure. During the pandemic, broadband was the platform that allowed students to continue their education, some employees to continue to work and draw a paycheck, the unemployed to access job postings, and the sick to access healthcare providers. The Biden administration acknowledged broadband as necessary in 2023 when the Affordable Connectivity Program[3] was enacted to help low-income households secure broadband access.

OTHER NECESSITIES: This component includes the other basic needs not accounted for in the previous six larger components. These needs include telephone, clothing, household supplies, personal care, nonprescription medicine, school supplies and fees, furniture, life insurance, etc., make up a nontrivial portion of the budget. These items are widely accepted as necessary expenses (Bernstein et al., 2000).

Challenges & Capabilities Needed to Create the Household Living Budget – Addressing Ethics and Equity Issues

The challenges we faced when constructing the HLB at the census tract level all center around data availability and adjusting the data (when possible) to the census tract level. They also address the equity and ethics guiding principle and data discovery research on the CDE framework (Exhibit 1).

1. Housing – Housing data were retrieved from the Housing and Human Development Fair Markets Rents at the ZIP code level. To bring these costs down to the census tract level, demographic redistribution was done when a census tract was contained in more than one ZIP code using the HUD-USPS ZIP Code Crosswalk files for 2020 Census geographies.

2. Food – These data have one limitation for our purpose and use, food costs are published every month at the national level by the USDA Food and Nutrition Service for fifteen demographic groups and four different food plans. The only publicly available data at the county level is from the nonprofit Feeding America. We were able to bring the national costs down to the county level using annual data from Feed America's Map the Meal Gap (Feeding America, 2023). Feeding America uses in-store scanning data from Nielsen to construct the cost of the Thrifty Food Plan purchased by males 20-50. These data are used to create a multiplier that differs by county and that we used to adjust the national estimates to

[3] The White House Fact Sheet: Biden-Harris Administration Announces Over $40 Billion to Connect Everyone in America to Affordable, Reliable, High-Speed Internet. (June 26, 2023).

the county level.

3. Transportation – Transportation costs are from the non-profit Center for Neighborhood Technology (CNT). Their Housing and Transportation Affordability Index is provided at the census tract level (CNT, 2022). These data have two limitations for our purpose and use.
   a. Transportation costs are calculated for a single adult.
   b. The costs are not adjusted for household size.

   There is the potential to adjust the transportation costs in the future to more accurately reflect the household combination. CNT has worked with the Economic Policy Institute to modify these costs for their budget calculator to include household size and assumptions made about trip purposes.

4. Healthcare – The Affordable Care Act Market Place was used to provide estimates of healthcare premium costs and out-of-pocket expenses based on the market rating area the household was located in and for household combinations.

5. Childcare – This is a data gap that may require a new data source. The only publicly available data on childcare at the county level is from a market survey collected every three years. The Department of Labor Women's Bureau have provided these data to the public along with a technical document (DOL, 2020) that describes the data collection and wrangling process (e.g., numerous imputation steps). As stated in their document, these data have several limitations for our purpose and use.
   a. States use different methods for conducting the survey that may impact the precision of the price estimates.
   b. States are collecting data at three year cycles.
   c. Some states only provide data at the state level and some states provide no data.
   d. Child age categories (infants, toddlers, preschoolers, schoolers) were not consistent across states.

   After reading the technical report, we made the decision to use these data to construct the HLB but acknowledge that the policy implications of the rising price of childcare requires annual surveys at the county level by all states.

6. Broadband – The cost of broadband required us to scrape data from BroadbandNow to get cost estimates at the census tract level. BroadbandNow is a private data aggregation company that combines public (Federal Communication Commission and Census Bureau) and private records to provide broadband availability, speeds, and costs at the census block level.

The assumptions that were required to use these data sources are provided in Table 2.

Purpose and Use - Restated as Research Questions

We have two objectives with the budget standard approach.

1. Provide prevalence estimates of economically vulnerable households at the sub-county level, which is necessary for informing policies and interventions. Such knowledge would permit local officials to better address the problem in identifiable small geographies with targeted outreach and mitigation strategies, such as social service referrals.
2. Provide a baseline budget that stakeholders can use to assess the impact of various benefits programs. By tailoring benefit amounts to raise a household to or above the HLB, households may be less likely to rely on negative coping strategies such as buying cheaper unhealthy food and forgoing necessary medications and doctor visits. In addition, the HLB can be used by employers to back out a living wage.

The questions intrinsic to these objectives and the validity of our prevalence estimates are:

1. Can we construct defensible household living budget (HLB) estimates at the census tract level for all household combinations?
2. Can we create a synthetic population using iterative proportional fitting with Public Use Microdata Sample (PUMS) household data and the marginal distributions from the American Community Survey (ACS) by household income and household size categories at the census tract level?
3. Can we model economic vulnerability as a function of HLB and household income, size, and composition in the census tract where the household resides?
4. Can we validate our estimates?

We start with a literature review of household budgets that we used to inform our data discovery process.

Literature Review - A Brief History of Budgets

There is an active debate (Saunders, 2017; Weinstock, 2022; NASEM, 2023) on how much income a household needs to achieve a modest yet adequate standard of living in the community where they reside. The debate revolves around defining an "adequate standard of living", the components to be included in the budget, and the component adequacy standards. What is not subject to debate is that the income needed by a household is a function of household size, composition, and geographic location (see Box 1). **Household composition is defined as the number of adults, teens, schoolers, preschoolers, toddlers, and infants in a household.**

The following discusses the history of this debate and the two methodologies that have been used to construct budget standards.

What we refer to in this Use Case as the household living budget, in the past, has been referred to as a family budget, basic family budget, basic needs budget, budget standard, standard budget, cost-of-living, self-sufficiency standard, real cost measure, prevailing family standard, and this is not an exhaustive list. These budgets represent "… what is needed in a particular place at a particular time to achieve a specific standard of living." (Saunders et al., 1998, p. ii).

Box. 1 The Bureau of Economic Analysis' Regional Price Parity (RPP)[4] is the primary public data source on state differences in price levels for all consumption goods and services, including housing rents. The RPP for a state is the weighted average of price levels for a given year expressed as the percentage of the overall national price level with the national level set to 100. For example, the District of Columbia has a 2021 RPP value of 111.3, indicating that prices are 11.3% higher than the U.S. on average. In contrast, Mississippi has a 2021 RPP value of 86.6, indicating that prices in Mississippi are 13.4% lower than in the U.S. on average.

Two methods have been described (Saunders, 1998; Johnson et al., 2001) for constructing budgets, prescriptive and descriptive. Both specify the income needed to achieve a specified standard of living, prescriptive, by choosing multiple components and adequacy standards, and descriptive, by choosing a single point on the low-income distribution.

- The *prescriptive* (market-basket or budget-based) method identifies the components and adequacy standards to achieve a specific standard of living based on a combination of empirical evidence (i.e., scientific standards), non-empirical value judgments, and expert opinions. With public data that is now available, prescriptive budgets can be constructed at the census tract level for any family size and composition.
- In contrast, *descriptive* budgets are expenditure based, what households spend to achieve a specific standard of living. These are constructed using the Bureau of Labor Statistics (BLS) Consumer Expenditure Survey, which produces average expenditures for various consumer units such as household combination and income categories at the national level and four regions, divisions, five states, selected Metropolitan Statistical Areas, and urban areas by six population size categories.

Both methods have their critics. In the case of the prescriptive method, the concern is that "It reflects value judgments outside the realm of science…" (Winship, 2023, p. 1) and that "… ordinary people, not experts, know what they need in order to get along or to prosper." (Watts, 1980, p. 9). In the case of low-income descriptive budgets, the assumption is made that these budgets are sufficient to meet basic household needs. However, Bernstein et al. (2000, p. 2) noted in their research that "Data from the Consumer Expenditure Survey (CES) reveal that low-income families tend to spend less on necessities than recommended by basic family budgets…", this suggests low-income families are resource constrained and are not meeting their basic needs. In a recent survey by the Bipartisan Policy Center[5], 59% of low-income families with children

[4] Bureau of Economic Analysis (2021) Regional Price Parities: https://www.bea.gov/news/2022/real-personal-consumption-expenditures-state-and-real-personal-income-state-and

[5] Bipartisan Policy Center. (November 06, 2019). Nationwide Child Care Poll: Child Care Costs Impact Families' Employment, Savings, and Future Planning. https://bipartisanpolicy.org/blog/child-care-poll/

under age five report cutting back on necessities, such as food and transportation, to pay for childcare.

Another drawback of the CES is the small sample size (~12,000). This prohibits using the CES to construct budgets at small geographic levels. Since local decision makers use household budgets, it is important to provide budgets that consider local conditions. According to Bernstein et al. (2002), household budgets at local levels using local data are generally better received by policymakers than those using national data.

The budget standard approach was developed by Seebohm Rowntree in 1899. He surveyed the living conditions of 11,560 working-class families (those households unable to afford a domestic servant) in York, England. It was the first attempt in sociological research to quantify the poverty line. He determined this level using social science research methods that had never been applied to the study of poverty. He used his survey data to establish the budget standard for a subsistence level of existence. The budget standard included adequacy standards for fuel and light, rent, food, clothing, household, and personal items, adjusted based on family size. His conclusions went against the prevailing assumption at the time that poverty was a moral failing but rather showed that the families' chief wage-earner was employed in regular work at a wage that was unable to sustain a healthy standard of living. Rowntree's findings, *Poverty, A Study of Town Life* (1901), were instrumental in changing public perception regarding the causes of poverty and serve today as an exemplar of evidence-based policy. His work influenced William Beveridge, the economist and social reformer, and helped pave the way for British Welfare State (Hatton & Bailey, 2000).

Early budgets in the U.S. were in response to congressional inquiries that focused on specific populations or events. The first budget was developed by the Bureau of Labor Statistics (BLS) for a congressional investigation into the conditions of cotton-mill workers that included women and children. The Congressional committee requested a definition of two living standards a "minimum standard of living of bare essential" and a "fair standard of living" (Johnson et al., 2001, p. 29). Both were prescriptive with components and thresholds chosen from the goods and services used by communities of cotton-mill workers.

Later BLS budgets in 1919 and the '30s and '40s, were in response to changing economic conditions due to the Depression and two world wars. The budgets were prescriptive, set at maintenance or subsistence levels for specific household sizes and compositions. After WWII, members of Congress, in response to an increase in Federal income taxes to finance the war effort and concern that employers were using BLS subsistence budgets to justify wage stagnation, requested BLS determine the cost-of-living for working families in large cities across the U.S. Up until the autumn of 1981, BLS budget standards were based on the prescriptive method and the belief that scientific standards and expert judgment could be used to derive lists

of components and adequacy standards required for a specified standard of living. However, with the advent of the BLS's annual Consumer Expenditure Survey[6] and the recommendations from the Expert Committee on Family Budget Revisions tasked with reviewing BLS's methodology, they turned away from a prescriptive budget to a descriptive budget constructed from what households actually spend. In the Committee's 1980 report, their principal recommendations included constructing four budget levels for six family combinations; updating the budgets annually based on the CES; and continuing research on the cost-of-living problem (Watts, 1980).

Today prescriptive budgets are constructed by think tanks and universities[7] as a tool to highlight the inadequacies of the OPM and to backout a living wage. Today there is a greater acceptance that all poverty measures embody a normative element and a trend towards trying to accurately reflect the basic needs of and resources available to households. This is the approach advocated in the 2023 NASEM report, *An Updated Measure of Poverty: (Re)Drawing the Line*. Their report recommends (p. SUM-3 and SUM-4),

> "RECOMMENDATION 2.2: *For the Principal Poverty Measure, the set of threshold categories should be expanded beyond the current food, clothing, shelter, utilities, telephone, and internet (FCSUti[8]) to explicitly recognize that minimum basic needs—as well as policies designed to help households meet those needs—have evolved since the establishment of the Supplemental Poverty Measure*."

Their report goes on to recommend including healthcare, childcare, transportation, and broadband, as minimum basic needs.

Data Discovery

Data discovery is the identification of potential data sources that could be related to the specific topic of interest. Our literature review and evaluation of other budget calculators guided our data discovery process. We focused on what components were included in a budget and the data sources used to estimate the adequacy standards for each component. Deciding on the budget components is the first step in determining data needs. For example, what data can we use to estimate the housing adequacy standard for a particular census tract and household combination?

We evaluated the components in the budgets calculators from:

- Economic Policy Institute's Family Budget Calculator (EPI)[9];

[6] Prior to 1979, BLS conducted the Consumer Expenditure Survey at approximately 10-year intervals. BLS Handbook of Methods: Consumer Expenditures and Income: History. https://www.bls.gov/opub/hom/cex/history.htm

[7] Economic Policy Institute's Family Budget Calculator; Massachusetts Institute of Technology's Cost of Living Calculator; and University of Washington, Center for Women's Welfare, Self Sufficiency Standard Calculator.

[8] FCSUti = Food, Clothing, Shelter, Utilities, telephone, internet

[9] Family Budget Calculator from the Economic Policy Institute. https://www.epi.org/resources/budget/budget-map/.

- Massachusetts Institute of Technology's Living Wage Calculator (MIT)[10];
- Washington State Center for Women's Welfare's Self Sufficiency Standard (SSS)[11]; and
- components recommended by Bernstein et al. (2000) and NASEM (2023).

Based on our findings, we included the following components in the HLB: housing, food, healthcare, childcare, transportation, broadband, other necessities such as clothing, household supplies, personal care, nonprescription medicine, and school supplies, along with a household's tax liability. Table 1 lists the components and data sources used by the three budget calculators referenced in the previous paragraph along with our choices for the HLB.

Our data discovery process was made easier by the existence of these calculators. Each of the three calculators provides a technical document (Gould & Mokhiber, 2022; Manzar & Kucklick, 2022; Nadeau et al., 2023) which includes a description of the methodology, assumptions, and data sources. Our criteria for selection were based on the source of the data, coverage, frequency of updates, aggregation categories, the ability to adjust for inflation, geography, and demographics, and the assumptions we had to make to provide budgets for all household combinations at the census tract level.

In all but two components, transportation and broadband, the data sources are from federal agencies, and in all but one instance, childcare, the data are updated at least once a year and in some cases every month. In the case of broadband, the price for 100 Mbps at each address[12] were scraped from the Broadband Now[13] website, and the median reported for each census tract.

[10] Living Wage Calculator from Massachusetts Institute of Technology. https://livingwage.mit.edu/.
[11] Self Sufficiency Standard from Washington State Center for Women's Welfare. https://selfsufficiencystandard.org/washington.
[12] Addresses are from the DOT National Address Database https://www.transportation.gov/gis/national-address-database
[13] BROADBANDNOW: https://broadbandnow.com/

Table 1. Economic Policy Institute (EPI), Massachusetts Institute of Technology (MIT), Washington State (SSS), and University of Virginia (HLB) Budget Components and Data Sources

Component	Names of Calculator			
	EPI	**MIT**	**SSS**	**HLB**
Housing	HUD Fair Market Rents	HUD Fair Market Rents	HUD Fair Market Rents; State data sources	HUD Fair Market Rents
Food	USDA Center for Nutrition Policy and Promotion, Food Plans: Cost of Food at Home	USDA Center for Nutrition Policy and Promotion, Food Plans: Cost of Food at Home	USDA Center for Nutrition Policy and Promotion, Food Plans: Cost of Food at Home; Feeding American Map the Meal Gap; Consumer Price Index	USDA Center for Nutrition Policy and Promotion, Food Plans: Cost of Food at Home; Feeding American Map the Meal Gap; Consumer Price Index
Healthcare	The Henry J. Kaiser Family Foundation's 2021 Health Insurance Marketplace Calculator; HHS Medical Expenditure Panel Survey	HHS Agency for Healthcare Research and Quality, Health Insurance Component Analytical Tool; BLS Consumer Expenditure Survey	HHS Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends and Medical Expenditure Panel Survey; Centers for Medicare & Medicaid Services, The Center for Consumer Information & Insurance Oversight; State data sources	U.S. Centers for Medicare & Medicaid Services, Health Insurance Market Place;
Childcare	Child Care Aware's 2020 State Child Care Resource and Referral Network Survey	DOL Department of Labor's Women's Bureau, The National Database of Childcare Prices	Census Bureau, Survey of Income and Program Participation; State data sources	DOL Department of Labor's Women's Bureau, The National Database of Childcare Prices
Transportation	Center for Neighborhood Technology, Housing and Transportation Affordability Index	BLS Consumer Expenditure Survey	Census Bureau American Community Survey 5-Year; National Household Travel Survey; American Automobile Assoc.; BLS Consumer Expenditure Survey; National Assoc. of Insurance Commissioners; State data sources	Center for Neighborhood Technology, Housing and Transportation Affordability Index
Other Necessities	BLS Consumer Expenditure Survey	BLS Consumer Expenditure Survey	10% of all other costs	20% of Housing, Utilities, and Food costs
Tax Liability	National Bureau of Economic Research's TAXSIM	National Bureau of Economic Research's TAXSIM	IRS, Revenue Procedure and Publications; Tax Foundation State and Local Data Sales Tax Rates; State data sources	National Bureau of Economic Research's TAXSIM
Emergency Savings			DOL Employment and Training Administration; State data sources	
Civic Engagement		BLS Consumer Expenditure Survey		
Broadband		BroadbandNow		BroadbandNow

The transportation cost is the only index component (H+T Affordability Index[14]). It is modeled based on transportation behavior, auto ownership, auto use, and transit use, using neighborhood and housing characteristics (Center for Neighborhood Technology, November 2022). Data sources include BLS's Consumer Expenditure Survey, DOT's National Transit Database, Census's American Community Survey, LEHD Origin-Destination Employment Statistics, and other publicly available data. The transit model has been reviewed by practitioners and researchers[15] specializing in transportation modeling and household travel behavior. Costs are provided at the census tract level but do not account for the different family combinations or trip purposes and are only calculated for adults. The adjustments to harmonize the year, geography, and demographics, along with the assumptions that were made are discussed in the Data Wrangling section.

Data Governance and Ingestion

Literature, metadata, and code used to download the data sources are publicly shared in a GitHub repository. Only publicly available data were used to construct the HLB estimates in order to support future efforts to maintain the HLB over time.

Data Wrangling

Data wrangling is the process of cleaning and readying the data sources found in the data discovery process for analysis. This Use Case involved adjusting these data sources so that component costs were for the same unit of analysis, adjusting for inflation to a common year, and adjusting for the unique household combinations within a particular census tract. The unit of analysis is the household combination, defined as the number of household members within six categories: adult, teenager, schooler, preschooler, toddler, and infant. Within Fairfax County there are 363 unique household combinations. In assigning component adequacy standards to household combinations, assumptions are required. Some assumptions are based on empirical research, some on subjective recommendations, and others are assumptions adopted by similar budget calculators. Our assumptions for each component are provided in Table 2 and discussed in more detail after the table.

[14] Housing and Transit Affordability Index: https://htaindex.cnt.org/

[15] Practitioners and researchers include Metropolitan Council in Minneapolis-St. Paul, fellows with the Brookings Institution, and academics from the University of Minnesota, Virginia Tech, Temple University, and the University of Pennsylvania who specialize in transportation modeling, household travel behavior, community indicators, and related topics (https://htaindex.cnt.org/about/).

Table 2. Household Living Budget Component Assumptions

Component	Cost by Category Combinations	Assumptions
Housing	□ Year □ Apartment sizes: studio, 1, 2, 3, and 4 bedrooms	□ all households rent □ 1-person in a studio □ 2-people in a 1 bedroom □ 3-people in a 2 bedroom □ ≥4-people in a 3 bedroom
Food	□ Month □ Four food plans: low, moderate, and liberal □ Gender: female and male □ Age: Child 1, 1-3, 4-5, 6-8, 9-11; Female 12-13, 14-18, 19-50, 51-70, 71+; Male 12-13, 14-18, 19-50, 51-70, 71+	□ half of the people in a household are female and half are male □ infants < 1 □ toddlers 1-3 □ preschoolers 4-5 □ schoolers 6-11 □ teenagers 12-18 □ adults ≥19 □ costs adjusted based on economies-of-scale
Transportation	□ Year	□ includes auto ownership, auto use, and transit use for adults only □ independent of family combination and transit use
Healthcare	□ Year □ Household size □ Household composition □ Age □ Employment status □ Marital status	□ all households receive health insurance through an employer □ the share paid by employer based on the BLS National Benefits Survey □ infants, toddlers, preschooler, schoolers 0-14 □ teenagers 15-18 □ assume all adults are 40
Childcare	□ Biennial changed to Triennial in 2016 □ Type: center and home-base □ Age: infant, toddler, preschool, schoolers	□ parents use home-based childcare □ teenagers do not require childcare □ infants are < 1 year old □ toddlers are ages 1-3 □ preschoolers are ages 4-5 □ schoolers are ages 6-18
Broadband	□ NA	□ price for 100 Mbps download speed
Other Necessities		□ 20% the housing, utilities, and food adequacy standards
Taxes	□ Year □ Household size □ Household composition □ Age of children □ HLB income	□ all households are renters; therefore, they do not pay property taxes □ tax liability includes federal and state income tax, and FICA (federal payroll tax) □ there are no household deductions

FOOD: The Official USDA Food Plans for the cost of food at home, is a monthly national average for four different food plans (thrifty, low, moderate, and liberal) by fifteen different demographic groups. The low-cost food plan was used in the HLB budget. To bring the costs down to a smaller geographic level, Feeding America's (Feeding America, 2023) latest Map the Meal Gap estimates from 2021 were used to adjust the national estimates to the county level, but first these estimates were adjusted for inflation using the Consumer Price Index for "food at home" in the Washington-Arlington-Alexandria, DC-VA-MD Metropolitan Statistical Area. For this component, the national estimates for the low-cost food plan, were adjusted for inflation and geography to provide adequacy standards for Fairfax County. We made the assumption that food costs are the same across the 274 census tracts within the county. In addition, we include an economies-of-scale adjustment for food purchases by household size. For example, for a 1-person household there is a +20 percent adjustment; 2-person household a +10 percent; 3-person household a +5 percent; 4-person no adjustment, 5- or 6- person household a -5 percent, and 7 or more person household a -10 percent adjustment (Carlson et al., 2007). The demographic assumptions that are made to construct the food adequacy standards for household combinations within a census tract are displayed in Table 2.

HOUSING: We assume that all households rent. Rental costs are taken from the HUD Small Area Fair Market Rents which provide rental costs for efficiency, 1-, 2-, 3-, and 4- bedroom units by ZIP code within the Washington-Arlington-Alexandria, DC-VA-MD Metropolitan Statistical Area. To bring these costs down to the census tract level, demographic redistribution was done by averaging the cost by ZIP code weighted by ZIP code populations, when a census tract was contained in more than one ZIP code. The HUD-USPS ZIP Code Crosswalk files for 2020 Census geographies was used to locate the census tracts within a Zip code. The demographic assumptions that are made to construct the housing adequacy standards for household combinations within a census tract are displayed in Table 2.

TRANSPORTATION: The Center for Neighborhood Technology's transit index does not include children when estimating their transportation costs for a household. We therefore made the assumption that transportation costs for a household are a function of the number of adults in the household.

HEALTHCARE: Healthcare is different from the other components. Where food is a daily need, you never know when you might need healthcare and buying health insurance once you need it is too late. Health insurance is the need to mitigate the risk incurred from high medical costs when healthcare is required. Our healthcare threshold is based on recommendation 3.2 from *An Updated Measure of Poverty: (Re)Drawing the Line* (NASEM, 2023, p. 49). Total healthcare costs include the premium cost of the second lowest Silver Plan listed on the federal government Healthcare Marketplace plus the standard out-of-pocket expenses. In order to include a healthcare adequacy standard in the budget, we assume that all households have employer-provided healthcare and that the employer pays 76 percent of the premium. This percentage is

based on the Bureau of Labor Statistics 2022 National Compensation Survey averaged across employer types (civilian, private, and government) for the Northeast Middle Atlantic region.

CHILDCARE: For childcare cost, we assume that parents use home-based childcare as reported by Capizzano & Adams (2003), *Children in Low-Income Families Are Less Likely to Be in Center-Based Child* Care and that teenagers do not require childcare. The demographic assumptions that are made to construct the childcare adequacy standards for households with children are displayed in Table 2.

OTHER NECESSITIES: The multiplier of 20% for "other necessities" is a recommendation proposed in *An Updated Measure of Poverty: (Re)Drawing the Line* (NASEM, 2023, p. SUM-3), with the caveat the spending categories included in the multiplier (housing, utilities, clothing, and food) be evaluated against current spending patterns and updated for future spending pattern changes. We deviate from this recommendation by only including housing, utilities, and food in this version of the HLB.

TAX LIABILITY: To estimate a households tax liability we make the following assumptions: all households are renters and have no deductions; two adult households are married and filing jointly; and only the youngest three children are included factored into the tax calculation. Tax liability estimates are for federal and state income taxes and FICA. The tax liability is calculated on the yearly HLB for the seven components.

Fitness-for-Purpose

Fitness-for-purpose is a function of statistical product development that includes the data quality and coverage (representativeness). The data sources that were discovered, evaluated for fitness-for-purpose, and selected for the Use Case are displayed in Table 3. The data sources and statistics used in this pilot are a combination of publicly available data that will be integrated to create a public-access statistical product. Links to the data sources are provided in Table 3, the metadata and code used to download the data sources are in the GitHub repository.

Table 3. Components of the Household Living Budget Date, Data Source, Geographic Area, and Adjustments

Component	Data Updates	Data Source	Original Geographic Area	Geographic Area Adjustment	Inflation (Time) Adjustment	Final Geographic Area
Housing	Yearly	Washington-Arlington-Alexandria, DC-VA-MD HUD Metro FMR Area Advisory Small Area FMRs by Unit Bedrooms (includes utilities)	ZIP code	ZIP codes are distributed to census tracts based on demographic data	NA	Census tract
Food	Monthly	USDA Food Plans: Cost of Food Reports (monthly reports) Low-Cost Food Plan adjusted for Economies of Scale (Methodology)	National	National adjusted to the county or city level using Feeding America's Map the Meal Gap 2021 data	Consumer Price Index, CBSA Washington DC – March 2022; (used to adjust the 2021 Feeding America's Map the Meal Gap data)	County
Transportation	Yearly	H+T (Housing + Transit Affordability Index) non-profit Center for Neighborhood Technology (Methodology)	Census tract	NA	NA	Census tract
Healthcare	Yearly	U.S. Centers for Medicare & Medicaid Services, Health Insurance Market Place 2nd lowest Silver Plan; 2022 Bureau of Labor Statistics National Compensation Survey	State geographic market rating area	NA	NA	County
Childcare	Biennial	Department of Labor Women's Bureau National Median Home-Based Childcare (Methodology)	County	NA	DOL Women's Bureau National Methodology used to impute the Washington, D.C. childcare costs from 2012 to 2022	County
Broadband	NA	Scraped from BroadbandNow; Department of Transportation, National Address Database	Address at the center of a Census block	NA	NA	Census tract
Other Necessities	NA	20% of the cost of housing, utilities, food	NA	NA	NA	Census Tract
Tax Liability	Yearly	National Bureau of Economic Research's TAXSIM Version 35 R interface usincometaxes	State	NA	NA	State

Statistical Analyses

Iterative Proportional Fitting and Creating a Synthetic Population

To bring the prevalence of economically vulnerable households down to the census tract level using the HLB as the threshold, we generated a synthetic population for each of the 274 census tracts in Fairfax County for a total of 408,649 households. The data used to generate the synthetic population were a combination of individual household data at the American Community Survey (ACS) Public Use Microdata Series (PUMS) level and aggregated household income and size data at the census tract level from the American Community Survey (ACS). First, IPF was used to estimate the number of households in each income by size category within a census tract. This estimate determined the number of households randomly selected from the ACS PUMS to create the synthetic population.

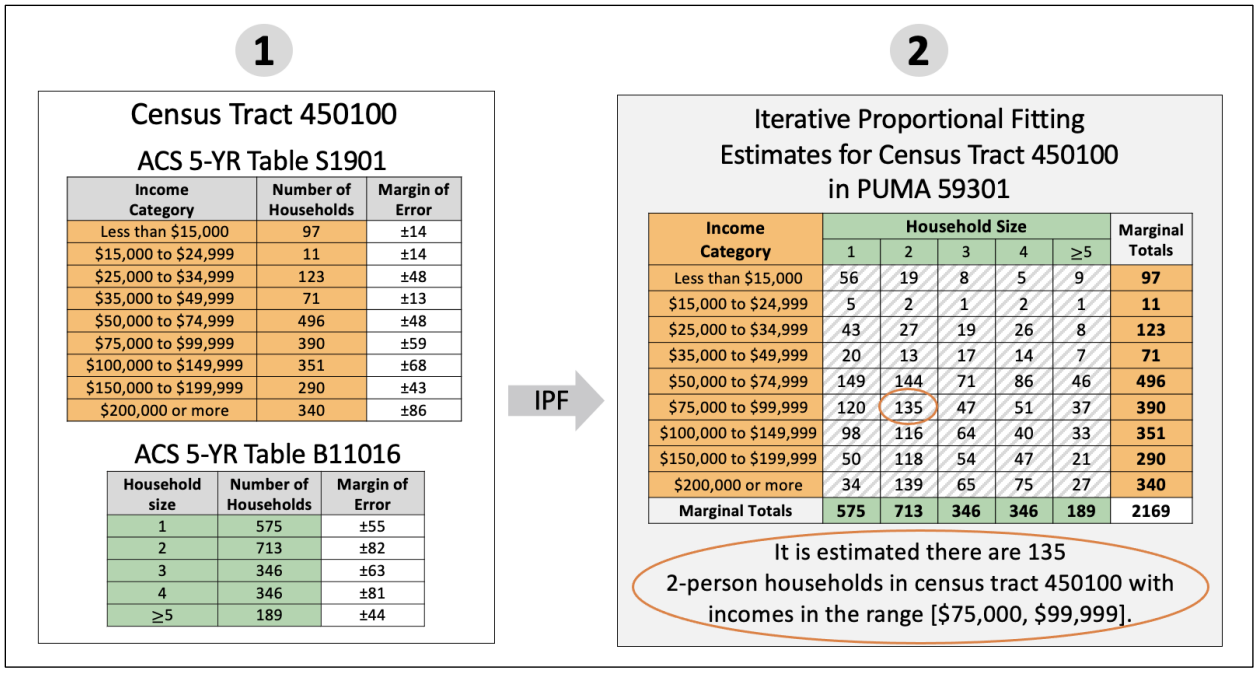


Figure 2. Diagram of an Example of Iterative Proportional Fitting
ACS 5-YR 2021 Tables S1901 and B1106 for Census Tract 450100, Fairfax County, VA

The IPF cell counts in the contingency table (Figure 2) are subject to constraints from known and fixed marginal row and column totals (Deming & Stephan, 1940; Beckman et al., 1996). In this Use Case, the known and fixed marginal row and column totals are household income (ACS Table S1901) and household size (ACS Table B11016) at the census tract level. For each census tract we:

1. filled the body of the table (Figure 2, panel 2) with starting values (seeds) which were adjusted iteratively to match the row and column marginal totals;
2. adjusted the cells in each row by multiplying each cell by the ratio of the (fixed row marginal / actual row sum);

3. adjusted the cells in each column by multiplying each cell by the ratio of the (fixed column marginal / actual column sum).

Iterations between (2) and (3) were performed until the stop criterion was reached, either when the difference between iterations was less than 10^{-11} or the number of iterations reached 1,000. The estimates for census tract 450100 are displayed in Figure 2, right panel. For example, there are 135 two-person households with an income in the range [75,000 to 99,999] for census tract 450100. For Fairfax County, 274 2-way tables each with 45 cells were estimated. All computations were done using the R-package for Multidimensional Array Fitting (mipfp) (Barthélemy & Suesse, 2018).

The synthetic population for each census tract was constructed by randomly sampling the household microdata from the PUMS in which the census tract resides (Beckman et al., 1998). The number of households selected for each income category by household size was based on the IPF estimates. When randomly selecting households (with replacement) from the PUMS, they were weighted based on the distribution of household combinations for a particular household size and income category combination (See Figure 3). For example, for PUMA 59301, the frequency of household combinations for two-person households with an income in the range [$75,000, $99,999] is displayed in Figure 3, panel 2. To construct the synthetic population for census tract 450100, 135 households were randomly selected from this distribution.

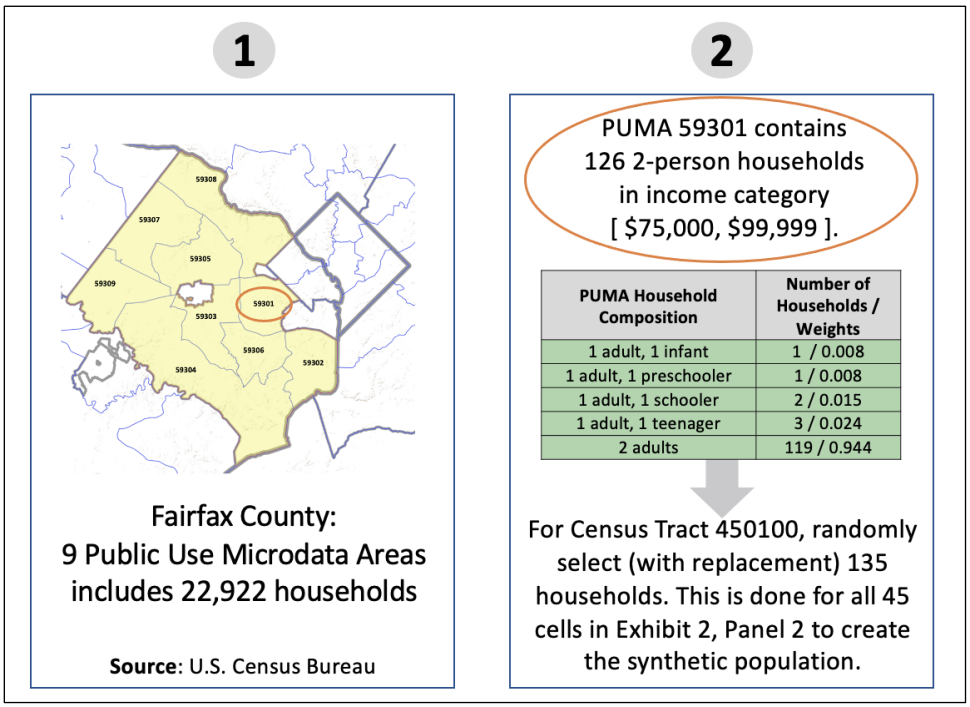


Figure 3. Diagram of Synthetic Population Generation
ACS PUMS 5-YR 2021 Household Data for Fairfax County, VA

The code used to calculate the IPF estimates and generate the synthetic population are provided in the GitHub repository. All analyses were done in R (2023). The layout of the repository and a diagram of the process used to construct the synthetic populations for the HLB estimates are in Appendix A.

Constructing the HLB

The adequacy standards for every household combination within a census tract are estimated using the demographic variables in the synthetic population, the assumptions in Table 2, and the data sources listed in Table 3. How the adequacy standards were calculated are described below.

The broadband adequacy standard only depends on location and not household combination. We assume all households have broadband with a download speed of 100 Mbps and the adequacy standard is the median price within a census tract scraped from the BroadbandNow website.

Housing depends on both location and household size. If the household size is three, we assume the householders rent a 2-bedroom apartment or house and the adequacy standard is the HUD Fair Market Rent for a 2-bedroom rental in that census tract.

There are two components, food and childcare, that are a function of location and the age of the householders, in the case of childcare just the age of the children. Both of these adequacy standards are at the county level. For childcare, we make the assumption the household uses the cheapest childcare type, home-based, and teenagers do not require childcare. The adequacy standard is the age group median from the National Database of Childcare Prices assembled by DOL's Women's Bureau from the HHS Market Rate Survey.

For the food component, the age of every householder is taken into account. USDA Food and Nutrition Service provides a table of monthly food prices for fifteen gender by age groups categories for four different food plans at the national level. We use the low-cost food plan and bring the price down to the county level using Feeding America's Map the Meal Gap. Since there is no gender identification in the PUMS data we make the assumption half the householders are female and half are male. The adequacy standard for the household is the sum of the adjusted monthly low-cost food plan for each member of the household which is then adjusted for economy of scale (see page 16 under Food for more detail).

The adequacy standard for transportation is the Transportation Affordability Index produced by the Center for Neighborhood Technology at the census tract level. The index includes auto ownership, auto costs, and transit use, it is not a function of household size and is only calculated for adults. The adequacy standard is the sum of the index for all the adults in the household.

Healthcare costs are a function of the market rating area which are set by the state (all of Fairfax County is in Rating Area 10) and the age of the householders. In order to include a healthcare adequacy standard in the budget a number of assumptions were made. All households:

- have the 2nd lowest cost Silver Health Insurance Plan;
- spend the standard amount for maximum-out-of-pocket (MOOP) expenses;
- have employer-provided healthcare;
- pay 24 percent of their premium;
- the age of the householder is 40.

The cost of the 2nd lowest silver plan and the amount of the MOOP expenses are from the Health Insurance Market Place. The percentage the household pays for health insurance is based on the BLS's 2022 National Compensation Survey. The adequacy standard is the sum of the percentage paid for health insurance plus the MOOP expenses.

The monthly HLB is constructed for every household combination in a census tract by summing the monthly adequacy standards of the seven nontax liability thresholds, multiplying the sum by twelve to get the annual budget, using the HLB annual budget to estimate the tax liability for a particular household combination within a census tract, and then adding that tax liability to the yearly budget. We used the R-package usincometaxes (V 0.7.0) which acts a wrapper to the National Bureau of Economic Research TAXSIM 35 tax simulator (Feenberg & Coutts, 1993) to estimate the federal and tax liability. A data table with the adequacy standards for each component and the annual HLB for every household in the synthetic population is located in the GitHub repository.

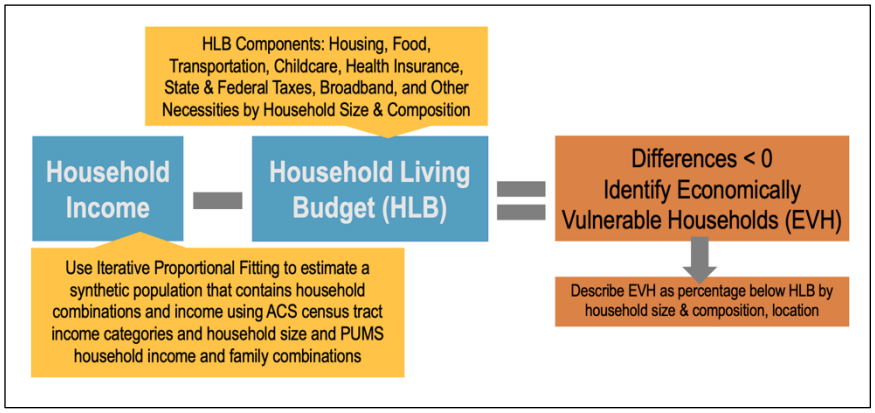
HLB Application: Economically Vulnerable Households

The book *Minimum Income Standards and Reference Budgets International and Comparative Policy Perspectives* (2020) describes the budget standard research conducted in over a dozen counties. In Chapter 20, Fisher provides a comprehensive review of the basic needs budgets in the U.S. at the national and state levels that have been used to influence poverty measures. With the publication of NASEM's *An Updated Measure of Poverty: (Re)Drawing the Line* (2023), the U.S. moved closer to acknowledging the role a budget standard could play in measuring poverty.

> "*The measurement of economic poverty involves estimating two components: (1) a basic needs level — a budget or threshold; and (2) the economic resources available to families, individuals, or households. …The threshold is determined by the cost of acquiring a specific bundle of basic goods, as represented by the level of spending on the items."* (p. SUM2 – SUM3).

This statement acknowledges that a yardstick for measuring poverty requires knowledge of a household's basic needs.

Figure 4. Definition of economically vulnerable households.



The household living budget estimates the first component in the previous quote, "*a basic needs level — a budget or threshold*." In the following sections, we use the poverty status of families in the past 12 months to benchmark the HLB. Although the unit of analysis is different – household versus family – the prevalence of families in poverty defined by poverty thresholds and the prevalence of economically vulnerable households defined by the HLB (see Figure 4) are the only reasonable comparisons at the census tract level. In addition to different analysis units, there is also a difference in the data being used, one is a synthetic population, and the other is a statistical sample.

HLB ratio versus Family Poverty Ratio

To make comparisons at the census tract level, we used the 2021 5-YR ACS Table C17002 (families) for Fairfax County, Virginia. Table C17002 provides an estimate of a family's poverty status defined as the total family income divided by the poverty threshold, the ratio of income to poverty threshold. Poverty thresholds are provided for 48 family combinations. The ratios are grouped into seven categories; two categories are below one, an indication the family is in poverty, and five categories are above one, up to 1.99 times the poverty ratio. We construct these same categories using the total household income divided by the HLB threshold, HLB ratio, which is constructed for all household combinations in the census tract. The comparisons are displayed in Figure 5.

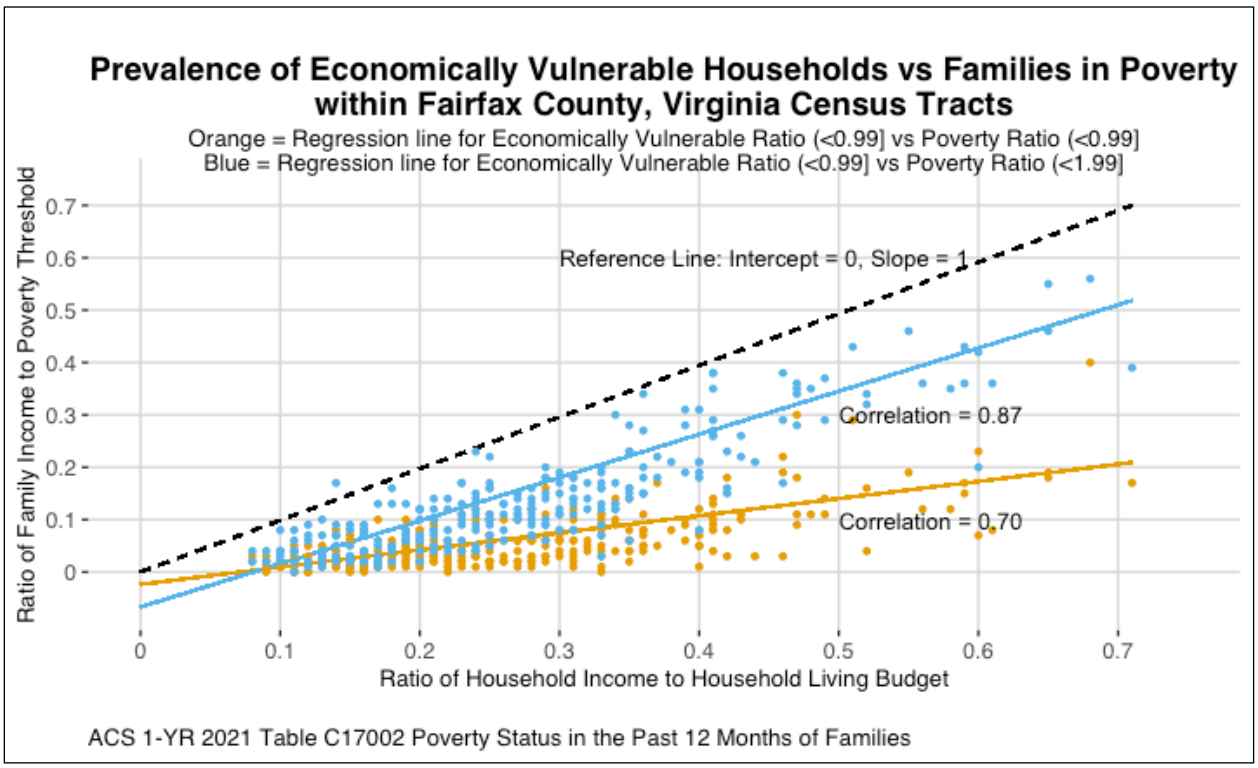


Figure 5. The prevalence of economically vulnerable households, as defined by Figure 4, is compared to that of families below a poverty ratio of 0.99 (orange) and 1.99 (blue) using simple linear regression.

There are two comparisons in Figure 5 using simple linear regression, the prevalence of economically vulnerable households versus the prevalence of families with a poverty ratio below 0.99 (orange line) and 1.99 (blue line). Both comparisons align with the HLB ratio, but the prevalence estimates that includes both families below the poverty threshold along with families whose incomes are up to 1.99 the poverty threshold are closer to the HLB ratio (black dashed line is an indication of a perfect relationship). This is similar to the results reported in Bernstein et al. (2000). In their review of 19 budget standards at the regional and state levels, they found standard budgets were approximately twice the poverty threshold. In a recent review of budget standards, Fisher (2022) found these budgets to be between 1.5 and 3.5 times the poverty threshold for a family of the same composition and noted that for particular family compositions these numbers are even higher.

The HLB prevalence estimates at the census tracts level for economically vulnerable households displayed in Figure 5 range from [0.00, 0.771] with a median of 0.25. The prevalence of families with a poverty ratio below one range from [0.00, 0.40] with a median of 0.04 and for families with a poverty ratio below 1.99, [0.00, 0.56] with a median of 0.11. The higher prevalence estimates for the HLB reflect the fact that it is an adequacy benchmark that does not refer to poverty, whereas poverty thresholds "… in some sense reflect a family's needs, they are intended

for use as a statistical yardstick, not as a complete description of what people and families need to live."[16]

HLB and Geographic Variability

Our ability to construct budget standards at the sub-county level is evidence that data constraints are no longer an issue, but raises the question just how specific do geographic adjustments need to be? To explore this question, we constructed maps at the tract level for the prevalence of households with incomes less than half the HLB (Figure 6) and two component thresholds, housing and transportation (Figure 7). Figure 6 displays the prevalence of the 51,204 households that have incomes below half the amount necessary to function at a modest yet adequate standard of living. This number more than doubles, 113,869, when you count the household with incomes below the HLB.

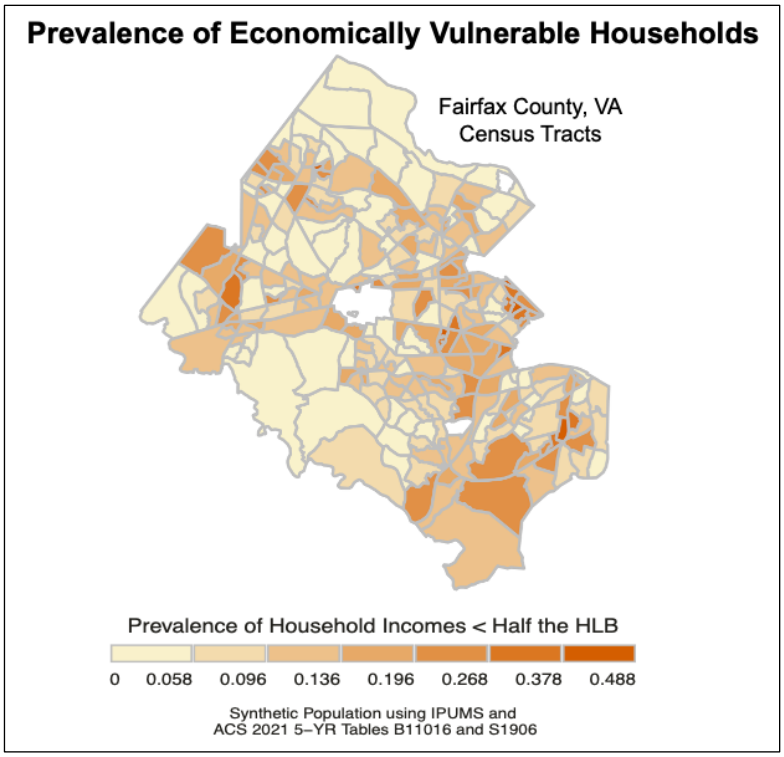


Figure 6. Prevalence of economically vulnerable households in Fairfax County, Virginia at the census tract level.

In Figure 7 we control for one source of variability, family combination, by looking at component adequacy standards for households of size four, two adults, a toddler, and schooler, and explore the variation in the HLB adequacy standards across census tracts. There are only three components that vary across census tracts, housing, transportation, and to a lesser extent broadband. Figure 7 displays the variation for housing and transportation. The range in housing costs is $1,390, transportation $566, whereas the range in broadband costs is $30, [29.99, 59.99]. Comparing Figures 6 and 7 you can see areas where the housing costs are the highest (dark turquoise) aligns with the areas where the prevalence of economically vulnerable households is the lowest (light orange).

[16] How the Census Measures Poverty - Poverty Thresholds: Measure of Need
https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.htm

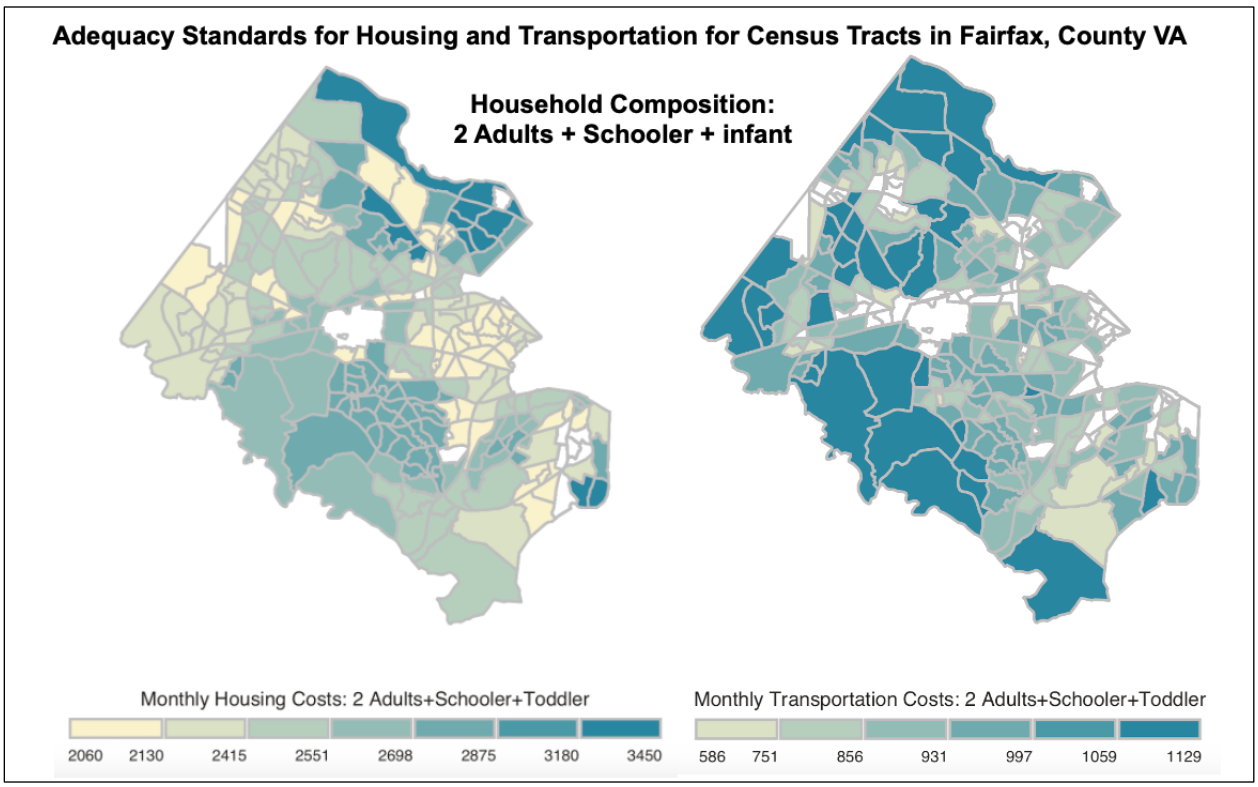


Figure 7. Geographic variation at the census tract level in the housing and transportation adequacy standards for a household of two adults and two children, a schooler and a toddler.

With publicly available data, we cannot account for within county variability for food and childcare – in this demonstration of the HLB they vary only as a function of household combination. In the case of food costs, USDA provides 15 monthly estimates at the national level – five age groups for each category, children, males, and females. We adjusted those estimates using Feeding America's Map the Meal Gap down to the county level. The lack of geographic variability for childcare and healthcare costs are a function of the policies regarding their collection. The Department of Health and Human Services' Administration for Children and Families (ACF) requires states to conduct a childcare market survey to evaluate the adequacy of state reimbursement rates. The survey provides price data by provider type and age of the child at the county level. Prior to 2016, ACF rules required states to conduct a market survey every two years which changed to every three years post 2016. In the case of healthcare costs, we used data from the Department of Health and Human Services' Centers for Medicare & Medicaid Services, Health Insurance Market Place. The Market Rules and Rate Review Final Rule (45 CFR Part 147) requires that each state establish a set number of geographic rating areas and that within the rating area variation in premiums is a function of age and whether the enrollee is a tobacco user. Since all of Fairfax County lies in geographic rating area 10, the premiums are a function of family combination and whether the adults in the household have employer provided healthcare. A summary of the components and the geographic levels they are measured at is provided in Table 4.

Table 4. Geographic Level of the Components of the Household Living Budget

HLB Components	Measured at…	Adjusted to…
Housing	ZIP code	Census Tract
Food	National	County
Transportation	Census Tract	
Healthcare	County	
Childcare	County	
Broadband	Household	Census Tract
Other Necessities	Mixed	Census Tract
Tax Liability	State	

By calculating the HLB for all household combinations in Fairfax County, we are able to explore the impact of the poverty threshold on various sub-groups. Figure 8 displays the HLB for households with one to five members along with the corresponding poverty threshold. The variation in the HLB includes both the variation between census tracts and the variation between different household combinations with the same household size and number of children. Only when the household has no children is the HLB variation solely a function of geography.

Poverty thresholds do not take into account the age of the children. The poverty threshold for a household of size two with one child (2:1 = household of size two, one adult and one child) includes households with an infant which requires childcare as well as households with a teenager that does not. Ignoring the age of the children discriminates against households with young children that require childcare. In Fairfax County the yearly cost of childcare for an infant is $13,500, and this is for home-based childcare which is the cheapest type. For example, for a single parent with three children (4:3) there are twelve different household combinations determined by the age of the children, infant, toddler, preschooler, schooler, and teenager (Figure 10). For a single parent household with three children, the ratio of the cost of childcare as a percentage of the HLB ranges from zero percent when all the children are above 12 and the assumption is made that children do not require childcare, to 42 percent when all the children require childcare. The ratio of the minimum monthly HLB for this household combination (4:3) to the poverty threshold is 1.9 and the ratio of the maximum monthly HLB for this household combination to the poverty threshold is 4.3. Figure 9 displays the poverty threshold minus the HLB, income deficit, for the twelve 4:3 household combinations. The difference between the threshold and the HLB ranges from $98,000 for households with three children who require childcare to $28,000 for a household with three teenagers. The first seven boxplots show the largest income deficit (household income minus HLB) because they have three nonteenage children that require childcare (household combinations 101011 to 103000).

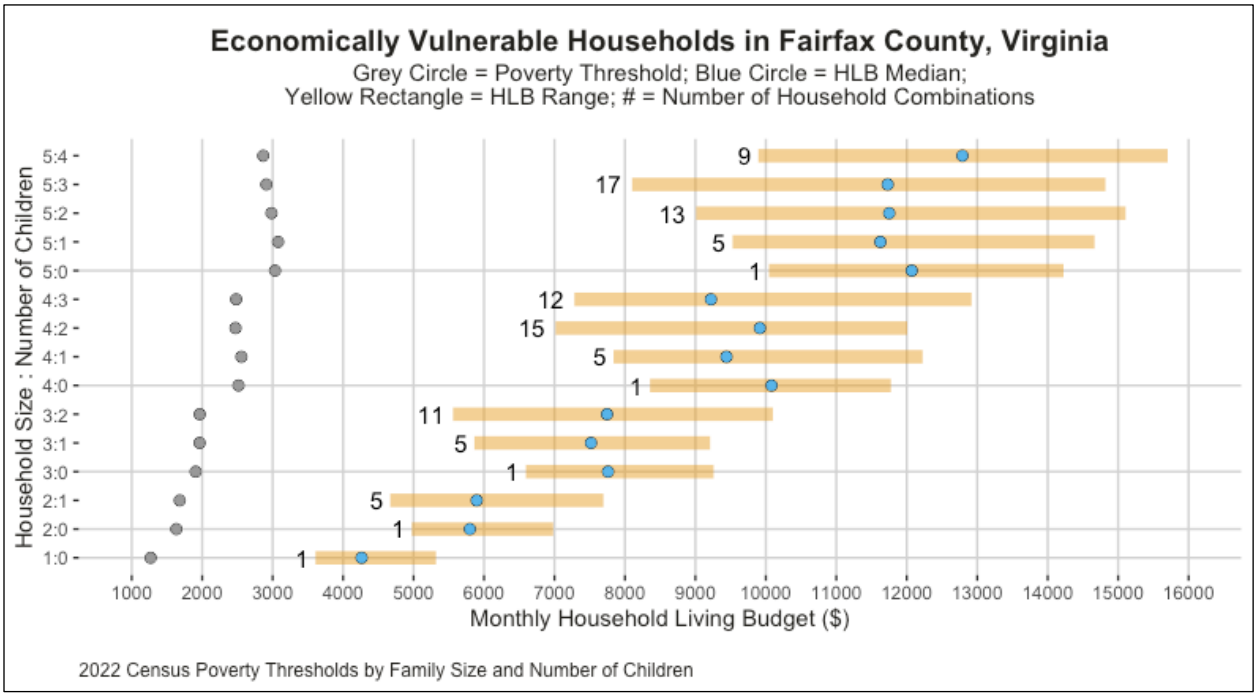


Figure 8. Monthly HLB descriptive statistics for various household sizes and number of children combinations in Fairfax County, Virginia. The number to the right of the range identified with a yellow rectangle is the number of household combinations included in the range.

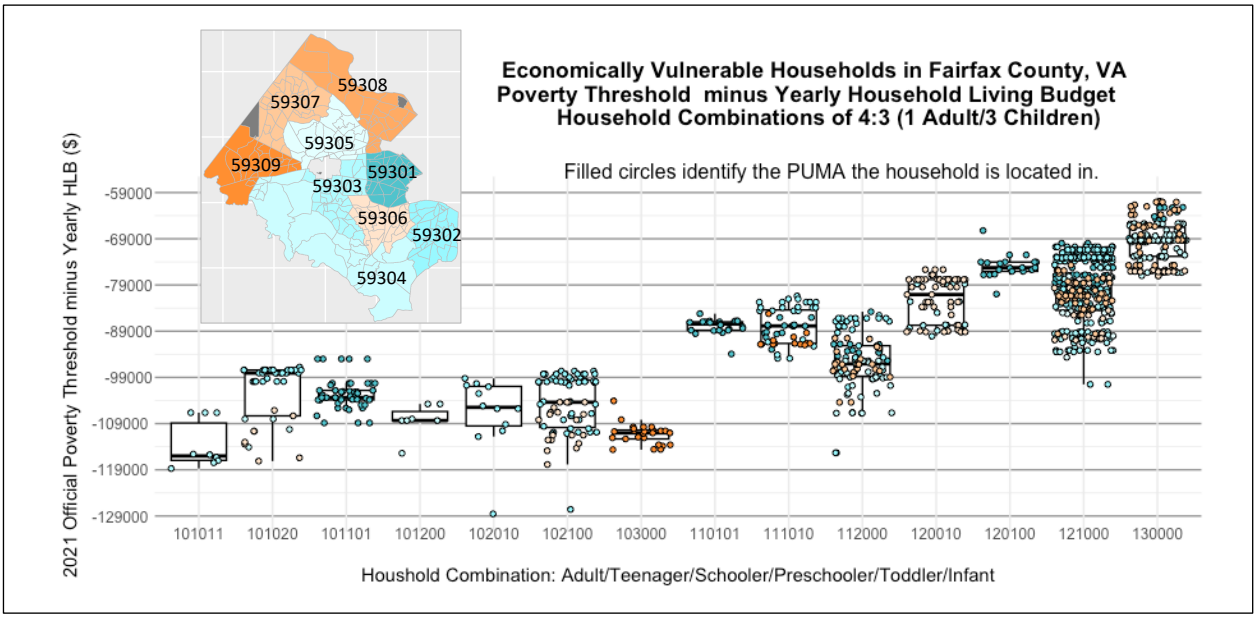


Figure 9. Boxplots for the difference between the poverty threshold of $26,500 for a household of one adult and three children and the HLB for the various combinations of child categories, teenage, schooler, preschooler, toddler and infant. The color of the filled circles identifies the PUMA the household is in.

CDE Capabilities

This Use Case highlights capabilities to develop in the CDE. We developed criteria to assess the feasibility of the Use Case. These criteria (left-hand column) were evaluated against this Household Living Budget Use Case (right-hand column in Table 5).

Table 5: Criteria for Selecting & Implementing a Use Case/Did this Use Case Meet the Criteria?

Initial Criteria for Use Case	How did the Use Case meet or not meet the criteria?
Assess relevancy of the research domain	□ Developed a new poverty threshold based on a budget standard, proposed in An Updated Measure of Poverty: (Re)Drawing the Line on (NASEM 2023). □ Addressed ethical concerns that current social benefit thresholds do not account for geographic price differences and therefore, benefit some more than others.
Determine availability of data from multiple sources across multiple frames	Discovered and used data sources to set adequacy standards. All component data sources are publicly available, they include: □ CMS Health Insurance Market Place for calculating health insurance and maximum-out-of-pocket costs □ BLS National Compensation Survey percentage of employer contribution of health insurance □ Broadband cost data scraped from the internet □ DOT National Address Database to locate households within a census block for scraping household broadband costs □ DOL Women's Bureau National data on childcare □ non-profit Feeding American Map the Meal Gap data to bring food costs down to the county level □ USDA Low-Cost Food Plan □ HUD Metro Area Advisory Fair Market Rent by Unit Bedrooms □ BLS Consumer Price Index □ Center for Neighborhood Technology Transit Affordability Index
Identify computing measurement requirements	□ Iterative proportional fitting to construct a synthetic population of households □ Computation of HLB components and overall HLB measure
Seek advice from Subject Matter Experts on data sources, the research approach, and implementation	□ US Census Bureau Geography Division, Enterprise Leadership Team, and others. □ University of Virginia Census Curated Data Enterprise team (2 former Census Bureau Directors, Communications Director, several well-known academics) □ NASEM, Connie Citro □ Duke University, Joe Hotz
Curate and document each step in the CDE process and describe outputs produced	All outputs, products, and references are included in the GitHub repository. □ Curation report: The Importance of a Household Living Budget in the Context of Measuring Economic Vulnerability: A Census Curated Data Enterprise Use

Table 5: Criteria for Selecting & Implementing a Use Case/Did this Use Case Meet the Criteria?

Initial Criteria for Use Case	How did the Use Case meet or not meet the criteria?

	Case Demonstration
	- Application: The Cost-of- Living to Determine Food Insecurity.
	- A repository: HLB Use Case GitHub Repository
	  - Data Tables and Derived Variables
	  - Data
	  - Codes
	  - Documents (literature, presentations, reports)

Assess processes and data sources with an ethical and equity lens	The HLB - an example of a "comprehensive approach to advancing equity for all." (White House 2021). - resolves the inequity of one-size-fits-all social benefit thresholds by include geographic price differences and taking into account family composition. - Ensures transparency to creating a standard budget that is available to outside scrutiny.
Develop partnerships to access data from multiple types of organizations	Partnerships with - Feeding American to bring food costs down to the county level. - Center for Neighborhood Technology to get transit adequacy standards by household size and composition at the census tract level. - BroadbandNow to get broadband adequacy standards at the census tract level.
Viability of proposed platforms for interactive access to integrated data products for all interested in accessing the data while adhering to confidentiality and privacy rules.	- All data are publicly available. - The cost data to construct the HLB are a function of location and household combinations – not an individual.
Identify statistical product gaps and propose new data collection	Data Gaps - Adequacy standards for childcare costs. Data are collected every 3 years by DOL and are based on state participation. In some cases, data were imputed due to lack of participation (more detail on the quality issues are on page 7. - Other than childcare costs, this use case demonstrated that it would be unrealistic to fill in data gaps by conducting new surveys since data are needed at a small geographic level. Rather, it suggests that partnerships with for-profits and not-for-profits would need to be forged to resolve these data gaps.

Conclusions and Policy Implications

Twenty-eight years after NASEM (1995, p. 8) drew attention to the lack of data to make geographic costs adjustments, we demonstrated public data are now available to make these adjustments even at geographic levels as small as the census tract. Although most component adequacy standards do not vary among census tracts, the ones that do, for example housing and transportation, have sufficient variability to warrant adjustments to this level (See Figure 7). Not only has this Use Case shown the importance of adjusting for geographic cost differences, we also demonstrated the cost-of-living burden for households with preschool children. This is due to the soaring cost of childcare, which has risen 220% since 1990.[17] In Fairfax County, the median cost of infant home-based childcare is $18,213 for an infant and $12,741 for a toddler.[18] For households with incomes below the lower quartile, $73,333, childcare for a single infant or toddler represents more than 24 (infant) or 17 (toddler) percent of their household budget.

We have shown that for measures that identify economically vulnerable households to be useful, they must be at small geographic areas. A recent commentary from Brookings[19] highlighted work from the World Data Lab[20] which used a synthetic population to calculate an overall poverty rate of approximately 26 percent for a PUMA in Brooklyn, NY. Since PUMAs are required to have a population of at least 100,000 persons, they can be composed of communities that vary greatly in socioeconomic characteristics. While an average over a diverse geographic area is useful to track trends over time, the loss of information by taking an average can conceal tracts of deprivation. Within the PUMA, World Data Lab found census tracts with poverty rates lower than 10 and higher than 40 percent. This Use Case takes a similar perspective, but goes one step further, by using the HLB instead of the Official Poverty Measure as the threshold and found census tracts in Fairfax County where the prevalence of economically vulnerable households was over 60 percent.

It is important to note that more research in this area is essential. Our next step is to assess the reliability of the adequacy standards at the census tract level against the assumptions that we made to justify them. Despite the need for assumptions, this budget represents an important advance over current measures that rely on simple thresholds to assess the complex and geographically nuanced living costs confronted by households. Given the availability of a wide array of public data on costs, combined with advances in the ingestion and curation of data, it is now possible to create small area measures that are sensitive to factors that allow for customized

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[17] Fillion J. (2022, October 13). New data finds child care prices continue to rise ahead of midterm elections, outpacing inflation & following decades-long trend of annual increases. Washington, D.C.: First Five Years Fund. s

[18] Landivar C. (January 24, 2023). New Childcare Data Shows Prices Are Untenable for Families. Department of Labor, Women's Bureau.

[19] Gisby J, Kiknadze A, Mitterling T, Roitner-Fransecky, I. (June 20, 2023). Fighting poverty with synthetic data. The Brookings Institution, Washington D.C. https://www.brookings.edu/articles/fighting-poverty-with-synthetic-data/

[20] World Data Lab: https://worlddata.io/

intervention approaches at a local level. This will become easier to do as more data become available for smaller and smaller geographies.

The Use Case demonstrated the variability of household standard budgets among census tracts within a county for various household combinations - this has two obvious takeaways. The first is that these budgets provide stakeholders with a more accurate tool to locate vulnerable households and assess the impact of various benefit programs. The second is that it would be unrealistic to fill in data gaps by conducting new surveys. Rather, it suggests that partnerships with for-profits and not-for-profits would need to be forged to resolve these data gaps.

This demonstration also showed the need for methods such as iterative proportional fitting (IPF), synthetic populations, and demographic redistribution. Using IPF to construct a synthetic population provides a more accurate assessment of economically vulnerable households. Demographic redistribution and multipliers were used to adjust data sources to cover smaller geographic areas.

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Appendix A: HLB Use Case GitHub Repository

There are three main folders in the GitHub Repository,

1. **Data**
   - Demographic (subfolders: ACS PUMA, ACS, Crosswalks)
   - Household Living Budget (subfolders: broadband, childcare, food, healthcare, housing, taxes, transportation)
2. **Source Code**
   - Analyses (see schematic below for the code used to construct the HLB and the data products)
   - Visualization
3. **Documents**
   - Literature (sub folders: curated data environment, budget standards, and statistical methods)
   - Products (subfolders: data tables, derived variables, visualizations, presentations, and reports)

Schematic of the code and data used to construct the HLB