United States Inflation Experience across the Income Distribution

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WORKING DRAFT

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Abstract

The Bureau of Labor Statistics (BLS) produces the Consumer Price Index (CPI) as a measure of price change faced by consumers. The CPI for All Urban Consumers (CPI-U) targets the inflation experience of nearly all consumers in the United States which may not reflect the inflation experience of an individual household or group of households. Increasingly there is user demand for CPIs across the income distribution. This paper builds on the authors' prior research by modifying the cohort definition and extending the period of analysis. From 2006-2022, lower income households generally faced larger inflation rates than higher income households. The short-term gap between lower and higher income household's inflation rates changes when the cohort definition accounts for varying family sizes.

JEL Codes: C43, E31

Executive Summary

The Bureau of Labor Statistics (BLS) produces the Consumer Price Index (CPI) as a measure of price change faced by consumers. The CPI for All Urban Consumers (CPI-U) targets the inflation experience of urban consumers which covers over 90 percent of the total population of the United States. This broad-based coverage may not reflect the inflation experience of an individual household or groups households[1]. Increasingly there is user demand for CPIs across the income distribution. These indexes paint a full picture of inflation for users interested in the state of the economy. Other users demand an index limited to lower income households for escalation purposes[2].

This paper builds on the authors' prior research by modifying the cohort definition[3]. The prior analysis defined income quartile (four) cohorts based on unadjusted total household before tax income. This analysis defines income quintiles (five) cohorts based on equivalized (household size-adjusted) total family income. Adjusting household size is standard practice in income inequality literature. By adjusting household income to a single-member equivalent, income levels are more comparable across households. For example, an $80,000 household income does not convey the same level of resources available to a 4-person family as it does a single-person household.

While this adjustment did not impact the long-term results, there are several notable short-term differences. Lowest income households almost always faced larger inflation rates than highest income households during the study period, however there are several spans when the opposite occurred. This anomalous result occurred more frequently and during different months for the adjusted indexes than the unadjusted indexes.

This paper extends the period of analysis to December 2022 for the CPI indexes. The 12-month change in the CPI-U for All Items was 1.9 percent in December 2018, the last month included in the prior analysis. Since mid-2021, inflation accelerated to a peak of 9.1 percent in June 2022. The average annual inflation rate from December 2005 to December 2022 was largest for the lowest income quintile and smallest for the highest income quintile. The gap in inflation rates between lowest and highest income households was 0.27 percentage points per year.

Background and Issues

The BLS publishes consumer price indexes for subgroups of the target urban population. The CPI for Wage Earners and Clerical Workers (CPI-W) became a subgroup index in 1978 when the BLS adopted an urban population target and began calculating the CPI-U. In 1988, the BLS introduced a research series measuring price change for older Americans, the CPI-E. Research conducted by BLS on inflation rates for

[1] While the population target is the urban population, the measurement unit is households rather than persons.
[2] The BLS is researching a new index product for escalation purposes. Research in this paper describes a low-income subgroup definition that could be applied to the new index product.
[3] Klick, Stockburger, "Experimental CPI for Higher and Lower Income Households," March 2021, BLS working paper 537

low-income consumers began in the 1990s[4]. Prior research is briefly summarized in an earlier working paper published in March 2021[5].

Interest in income-based inflation measures continues. In June 2021, an Interagency Technical Working Group convened by the Office of Management and Budget issued a report recommending the BLS produce a new consumer price index to be used in the calculation of the U.S. Official Poverty Measure. The group recommended a low-income Chained CPI. In April 2022, The National Academy of Sciences issued a report recommending development of price indexes by income group[6].

In the author's March 2021 working paper, we outline numerous caveats and limitations with the current methodology to calculate subgroup indexes. Other researchers have shown using the same underlying microdata to calculate indexes for both target population and subgroups underestimates the gap in inflation rates between highest and lowest income households[7]. The methodological improvements presented in this paper do not account for consumer heterogeneity at lower levels of index aggregation, and so the same caveats and limitations from the March 2021 working paper apply.

Methodology

Income Cohort Definition

The March 2021 working paper describes the index methodology and data sources in detail. We use data collected in the Consumer Expenditure Surveys (CE) from 2004 to 2021[8]. We estimate expenditures on the full market basket of items using integrated data from the Diary and Interview surveys. We use elementary price indexes, for example Bananas in Boston, that form the foundation of Consumer Price Index aggregation from 2006 to 2022. We derive implicit quantities for the modified Laspeyres formula indexes from biennial expenditures lagged two to three years. For example, we use expenditures from 2019 and 2020 to weight modified Laspeyres indexes in 2022. We refer the reader to the March 2021 working paper for additional information on index methods and formulas.

This paper improves the income group cohort definition. First, we employ a household weighted ranking to distribute the sample weights relatively equally across quintiles. Previously, we used an unweighted income ranking that did not reflect an equal distribution of household weights across quartiles. The BLS calibrates CE sample weights to the Current Population Survey to control for several demographic characteristics such as age, race, owner or renter, geography, and Hispanic ethnicity.[9] Weighting

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[4] Thesia Garner, David Johnson, and Mary Kokoski 1996, "An experimental Consumer Price Index for the poor" https://www.bls.gov/opub/mlr/1996/09/art5full.pdf

[5] Klick, Stockburger, "Experimental CPI for Higher and Lower Income Households," March 2021, BLS working paper 537

[6] National Academies of Sciences, Engineering, and Medicine. 2022. *Modernizing the Consumer Price Index for the 21st Century*. Washington, DC: The National Academies Press. https://doi.org/10.17226/26485.

[7] Many examples include Broda and Romalis (2009), Broda, Leibtag, and Weinstein (2009), Agente and Lee (2017), Jaravel (2017), and Kaplan and Schulhofer-Wohl (2017).

[8] BLS began imputing missing values of income in 2004, and income data from 2003 are not comparable. To initialize this research, we used a single year of expenditures in 2004 to calculate spending shares used in index calculation for 2006 and 2007. The remaining spending shares use two years of expenditures, consistent with CPI-U methodology.

[9] See CE Handbook of Methods, Calculation Methodology https://www.bls.gov/opub/hom/cex/calculation.htm#calculation-methodology

methods also control for subsampling, and a non-interview adjustment that controls for geography, household size, number of contacts, and average gross income for a household's zip code. The use of sample weights reflects known urban population totals, particularly relevant when comparing owners and renters, so that the weights are equivalent across quintiles, and are comparable to CE's weighted ranking of the total population.[10,11] An inherent benefit to this approach is that weights are relatively evenly distributed across defined quantiles. CE processes this income ranking variable for the total population. Therefore, urban and rural population differences across the CE quintiles (the rural proportion is higher for lower quintiles) provide motivation for CPI to calculate a weighted income distribution so that weights are distributed relatively equally for the urban population. This improvement did not substantively change the results at the All-Items US City Average level.

Second, we divide the CE respondents into quintiles of equivalized income, rather than quartiles as in the prior analysis. We determined that the proportion of quintile households is comparable to the wage-earner population (W) as summarized in Figure 1. Additionally, coverage of item-area weight cells for consumer price index estimation was sufficient to calculate five income groups rather than four as described in the results section. More detailed income groups provide greater granularity to data users and facilitate comparisons of lowest, median, and highest quintiles.

Figure 1. Household respondent summary from 2021 collection quarter 4

	Count	Proportion relative to U (Percentage)						
	U	W	E	Q1	Q2	Q3	Q4	Q5
Interview	4,515	21.4	36.5	20.2	20.2	19.8	19.9	19.9
Diary	2,694	22.8	38.5	20.3	20.9	19.5	18.8	20.5

Third, we equivalize household income to account for differing family sizes. There is a long literature using equivalence scales to adjust household income to account for different characteristics across households[12].

Household size and composition varies across respondents. Equivalized income defined as income divided by the square root of family size, adjusts income to make this comparable across households, as a better measure of household economies of scale.[13] The first and fourth quintile maximum income cut points from the Diary and Interview are greater than the corresponding maximum equivalized income

[10] See CE Table 1101. Quintiles of income before taxes https://www.bls.gov/cex/tables/calendar-year/mean-item-share-average-standard-error/cu-income-quintiles-before-taxes-2021.pdf

[11] For CE income distribution methodology see https://www.bls.gov/cex/csxguide.pdf. CE creates a before tax income ranking variable as a distribution over the interval (0,1] so that weights are relatively equally distributed across defined quantiles. The income ranking variable is created by sorting by income and a random number, used to break ties for CUs reporting the same income, in ascending order for each collection quarter and survey source. The total sum of FINLWT serves as the denominator, and cumulative sum of FINLWT21 serves as the numerator to create the distribution that ranges from greater than 0 to less than 1, to 7 decimal places of precision.

[12] Angela Daley, Thesia Garner, Shelley Phipps, Eva Sierminska, "Differences Across Place and Time in Household Expenditure Patterns: Implications for the Estimation of Equivalence Scales," BLS Working Paper, 2020 https://www.bls.gov/osmr/research-papers/2020/pdf/ec200010.pdf

[13] https://www.brookings.edu/blog/up-front/2019/04/17/whats-in-an-equivalence-scale

summarized in Figure 2. The median income and equivalized income for the third quintile is equivalent to the urban population. The median equivalized income is less steep from the first to fifth quintile than median income reflecting the improved comparability across households as displayed in Figure 3.

Figure 2: Household maximum income and equivalized income summary from 2021 collection quarter 4 (in terms of Thousands)

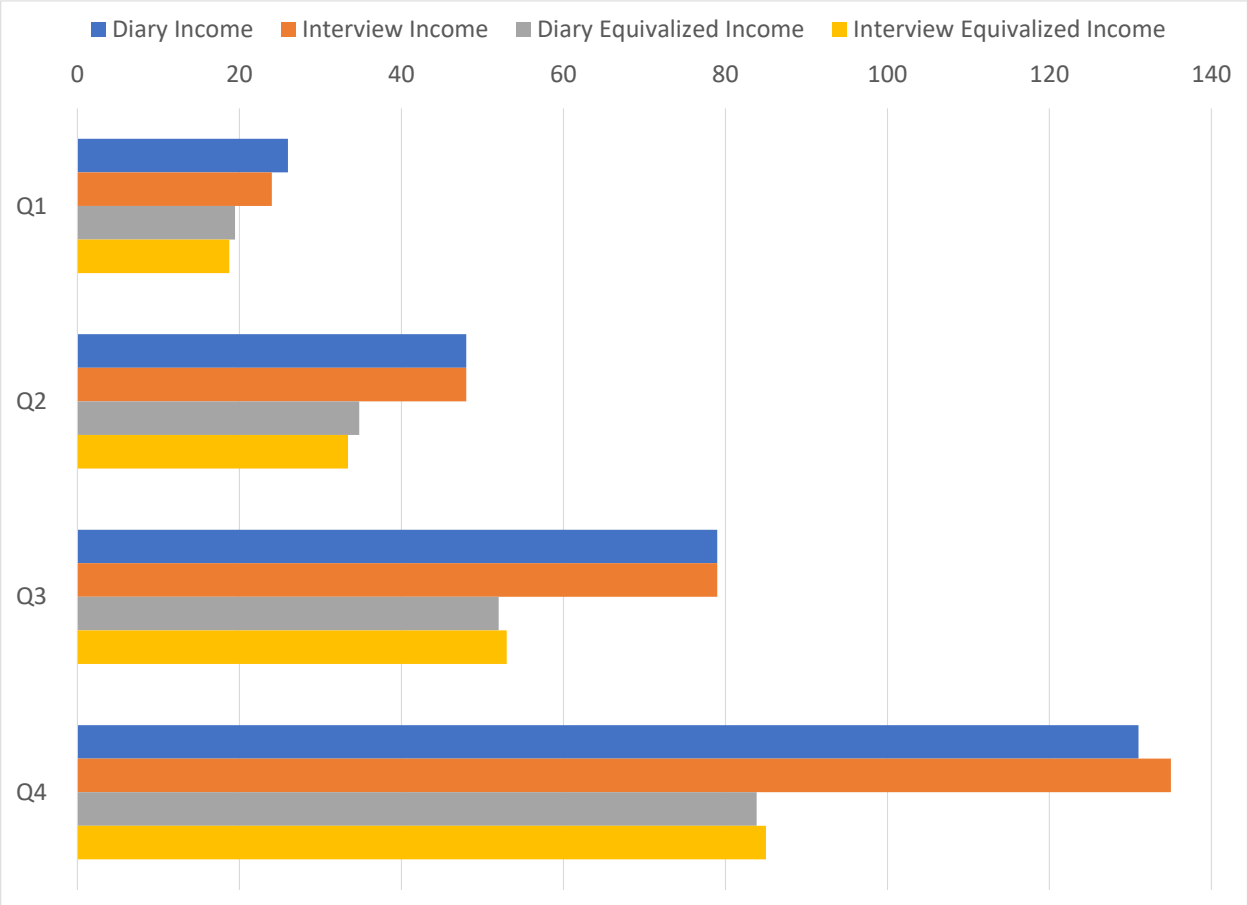
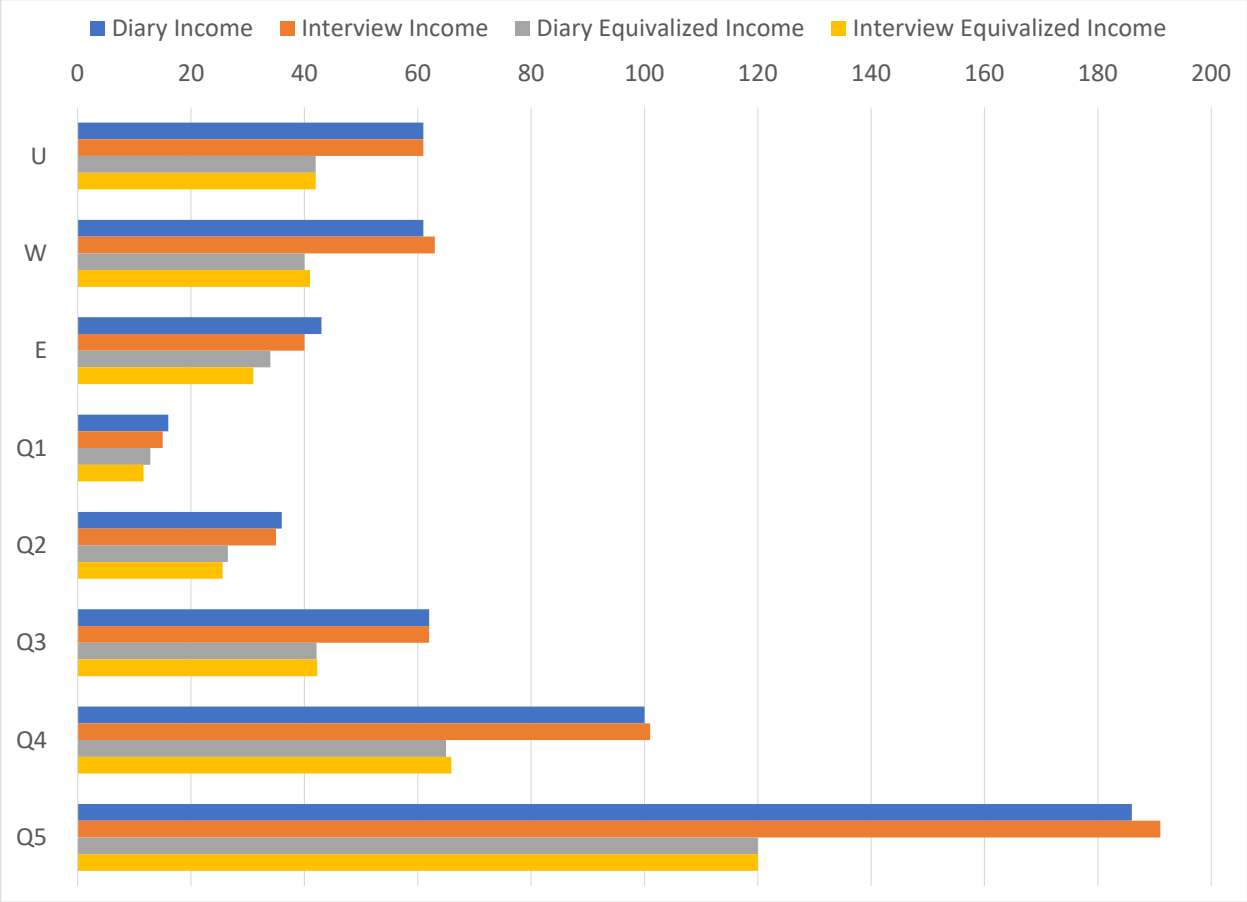


Figure 3. Household median income and equivalized income summary from 2021 collection quarter 4 (in terms of Thousands)



The household weighted ranking described above is used to evaluate equivalized income quintiles (E1:E5) and non-equivalized income quintiles (N1:N5). The counts of households for CPI weighted income quintiles can be compared to those same households for other income definitions to highlight the degree of similarity between subpopulation definitions as summarized in Figure 4. Overlap is the proportion of same households relative to the respective CPI weighted non-equivalized income ranking quintiles (N1:N5). The All group represents sum of the 5 quintiles. When the urban portion of CE total population income weighted ranking is compared to non-equivalized income rankings, there is a high degree of overlap ranging from 94% to 100%. When the equivalized income groups are compared to the non-equivalized income rankings the degree of overlap ranges from 53% to 83% highlighting definitional differences of household income, and potential differences for weighting these respective indexes.

Figure 4: Proportion of counts of same households relative to non-equivalized income across quintile definitions (Percentage)

	D						I					
	All	Q1	Q2	Q3	Q4	Q5	All	Q1	Q2	Q3	Q4	Q5
CE	97	98	97	95	97	100	96	97	95	94	96	100
CPI-(E1:E5)	67	80	62	54	55	83	67	82	62	53	55	82

An additional improvement is the smoothing of expenditure cells comparable to production weight processing. The CE collected survey data are subject to sampling error across geography and unreliable for index estimation, particularly relevant for subpopulation quintiles. The CPI smooths basic item area cell weights to reduce variance across geography. Local area annual weights are composite estimated with more stable broader level of geography (self-representing-regions and non-self-representing-regions). The composite estimate weight is between 0 and 1 and is based on minimizing the mean squared error between the local area versus broader geography.[14] The impact of smoothing is described below as expenditure weight cell coverage as the proportion of missing basic item area cells.

With an improved definition of income incorporating population weights and equivalization, we considered how to divide households into quintiles. The BLS produces consumer expenditure estimates by income quintile. Those income quintiles are defined by cut points that are rarely adjusted[15]. To produce a time-series consistent definition of income groups for index estimation of 243 items by 32 geographic area cells, we chose to define income quintiles that shift to include a fifth of CE households in each group rather than defining cut-points that would need to be revised over time.

We also considered defining income quintile groupings by geography such that CE respondents are classified into income quintiles within a city (Primary Sampling Unit, PSU) selected for inclusion in the CPI. We ultimately concluded a nationally defined income distribution was preferred to represent all households as a single distribution for a national level index, that is methodologically consistent with Bureau of Economic Analysis (BEA) Personal Consumption Expenditures (PCE) and BLS PCE income quintile products.[16] Area stratification of the income distribution has a minimal impact to national level indexes and changes the overarching definition/purpose of the product. A limitation of this method is that subnational indexes are not feasible because the weights are not equivalent across quintiles. We will continue research geographic considerations for weighting CPIs by income.

[14] For details see https://www.bls.gov/osmr/research-papers/1999/pdf/st990050.pdf

[15] For example, the nominal income bounds of the lowest income quintile were less than $3,000 from 1960-1983, and less than $5,000 to present. Historically, the income definitions are subject to change based in part on inflation particularly relevant beginning 2021. These weights are not equivalent across groups limiting distributional comparisons. Also, households are not equivalized based on the number of people within a consumer unit resulting in dissimilar measures of income groups. Income as a standalone variable is not sufficient for weighting subpopulation indexes.

[16] See BEA Measuring Inequality in the National Accounts https://www.bea.gov/system/files/papers/measuring-inequality-in-the-national-accounts_0.pdf, and BLS Distribution of U.S. Personal Consumption Expenditures Using Consumer Expenditure Surveys Data: Methods and Supplementary Results https://www.bls.gov/cex/pce-ce-distributions.htm

Income Cohort Demographic Characteristics

In addition to income and expenditures, the CE Surveys collect a variety of demographic information about survey respondents. In this section, we present the demographic differences between income quintiles. By construction, the average household size and number of children is more consistent across income quintiles after equivalizing income. Other demographic differences give further context for the expenditure share differences presented in the next section.

Using household size to equivalize income results in more consistent household sizes and number of children across income quintiles (figure 5). Without accounting for household size, more single person households and households without children are included in the lowest income quintile. Conversely, fewer single person households and households without children are included in the highest income quintile. When adjusting for household size, more families with children are included in the lowest income quintile and less families with children are included in the highest income quintile. These changes are consistent across income quintiles, and we include only the first- and fifth-income quintiles to simplify the presentation of results.

Figure 5: Average Family Size and Number of Children, Urban and by Income Quintile, 2020

	Urban	Q1		Q5	
		Unadjusted	Equivalized	Unadjusted	Equivalized
Family Size					
1 person	30%	63%	45%	7%	20%
2 people	33%	22%	25%	34%	40%
3 or more people	37%	15%	30%	59%	40%
Number of Children					
None	62%	80%	66%	43%	61%
1-2 children	30%	16%	24%	46%	34%
3 or more children	8%	4%	10%	11%	5%

This data confirms the importance of equivalizing income to adjust for varying household sizes. The expenditure pattern differences between unadjusted income quintiles are reflective more of household composition differences. By standardizing household sizes, the expenditure pattern differences presented in the next section are more reflective of income differences.

Households grouped by income quintile have different rates of home ownership, working status, and educational attainment (figure 6). Households earning the lowest quintile of income are more likely to rent their home and not work for pay than higher income households. Of the households with retired members, 65% report incomes that fall in the first and second quintile. The large number of retired individuals in the lower income quintiles explains why more than half of households earning income in the first and second quintiles own their home with no mortgage. Higher income households are more likely to own their home with an outstanding mortgage. Higher income households are also more likely to hold advanced degrees.

Figure 6: Housing tenure, working status, and educational attainment by population

	Urban	Q1	Q5
Housing Tenure			
Owner with a mortgage	41%	18%	63%
Owner with no mortgage	25%	29%	20%
Renter	34%	53%	17%
Working status			
Not working (due to disability or taking care of family)	9%	23%	3%
Not working (retired)	21%	34%	6%
Working	70%	43%	91%
Educational Attainment			
Less than high school degree	8%	18%	1%
High school degree or some college	41%	55%	17%
Advanced degree	51%	28%	81%

Data Inputs

CPI Basic Item-Area Expenditure Weight coverage

The above household coverage analysis indicates that each of the quintiles has approximately the same number of households as the wage earner subpopulation. The expenditure weight coverage measures the proportion of missing item area cells used to weight basic indexes for 2nd stage estimation. When price change occurs, weighting basic indexes accurately relative to the All-Items US level is imperative to construct aggregate indexes. Coverage is measured as the proportion of item-area cells less than $1 as missing. There are 32 areas cells multiplied by each item series. There are 243 basic item area indexes that can be divided into priced item series and non-sampled item series. The non-sampled series are subject to infrequent number of expenditures reported and the price movement is based on aggregate priced series. Coverage of overall results are distorted when combining the non-sampled items and priced items. An additional adjustment occurs for health insurance which are excluded from this data quality metric. We display results in figure 7.

The urban population collected proportion of missing overall is 3.6% versus priced items is 0.5%; smoothing reduces the proportion of priced items missing to 0.0%. The wage earner collected proportion missing of priced items is 7.1%, and smoothing reduces this proportion to 0.6%. The lowest income quintile collected proportion missing of priced items is 13.7%, and smoothing reduces this proportion to 0.0%. The highest income quintile collected proportion of missing priced items is 4.6%, and smoothing reduces this proportion to 0.0%. Smoothing therefore has a larger impact on the lowest income quintile and improves weighting coverage for index estimation.

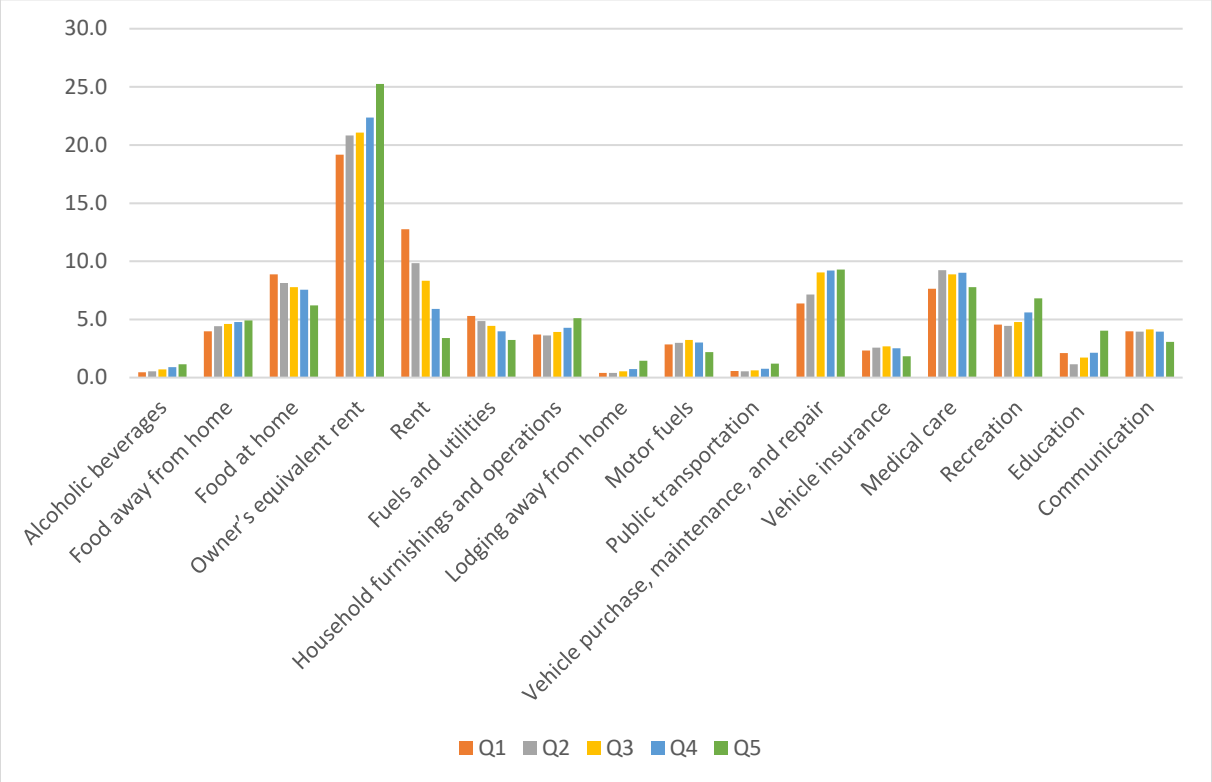
Figure 7: 2021 Reference year expenditure weight basic cell coverage as proportion missing (percentage)

	Collected					Smoothed				
	# Items	U	W	Q1	Q5	# Items	U	W	Q1	Q5
Overall	209	3.6	13.1	19.9	10.0	225	0.4	1.4	0.4	0.4
Non-sampled	26	25.2	55.4	63.3	48.3	26	3.8	7.7	3.8	3.8
Priced	183	0.5	7.1	13.7	4.6	199	0.0	0.6	0.0	0.0

Income Quintile Spending Weights

We produce price indexes, which use spending weights to calculate an average price change. While the spending weights for the urban population reflect average spending, they may not reflect spending of any individual household or groups of households. Spending weights vary across the income distribution. Overall, households earning the lowest quintile of income devote a larger share of their spending on essential goods and services. Households earning the highest quintile of income allocate a larger share of their spending on recreational and leisure goods and services. Figure 8 shows a snapshot of these spending differences in 2019-2020 for select categories. We present more categories in the appendix. We used spending weights constructed from these data to calculate indexes in 2022.

Figure 8: Snapshot of spending weights by population, 2019-2020 biennial expenditure weight share, equivalized income



These spending weights reflect the differences between quintiles of equivalized income. There are a few notable shifts in these spending weights from unadjusted income we used in an earlier analysis. The

share of spending on owner's equivalent rent by households classified in the first quintile of equivalized income is 2 percentage points lower than households classified in the first quintile of unadjusted income. The households shifting out of the first income quintile after adjusting for household size are more likely to be retired and own their own homes without a mortgage. The households shifting into the first income quintile after adjusting for household size are more likely to rent their homes or own their homes with a mortgage. Although homeowners without mortgages pay less out of pocket to live in their home than other households, the owners' equivalent rent approach to owned housing imputes an implicit rent. For retirees, who are more likely to own their home without a mortgage than other households, owner's equivalent rent constitutes a large share of their spending weights. This is evidenced by the spending shares for the CPI-E population, nearly 60 percent of whom are retired. The net effect of households shifting into and out of the first income quintile is a reduction in spending on shelter services.

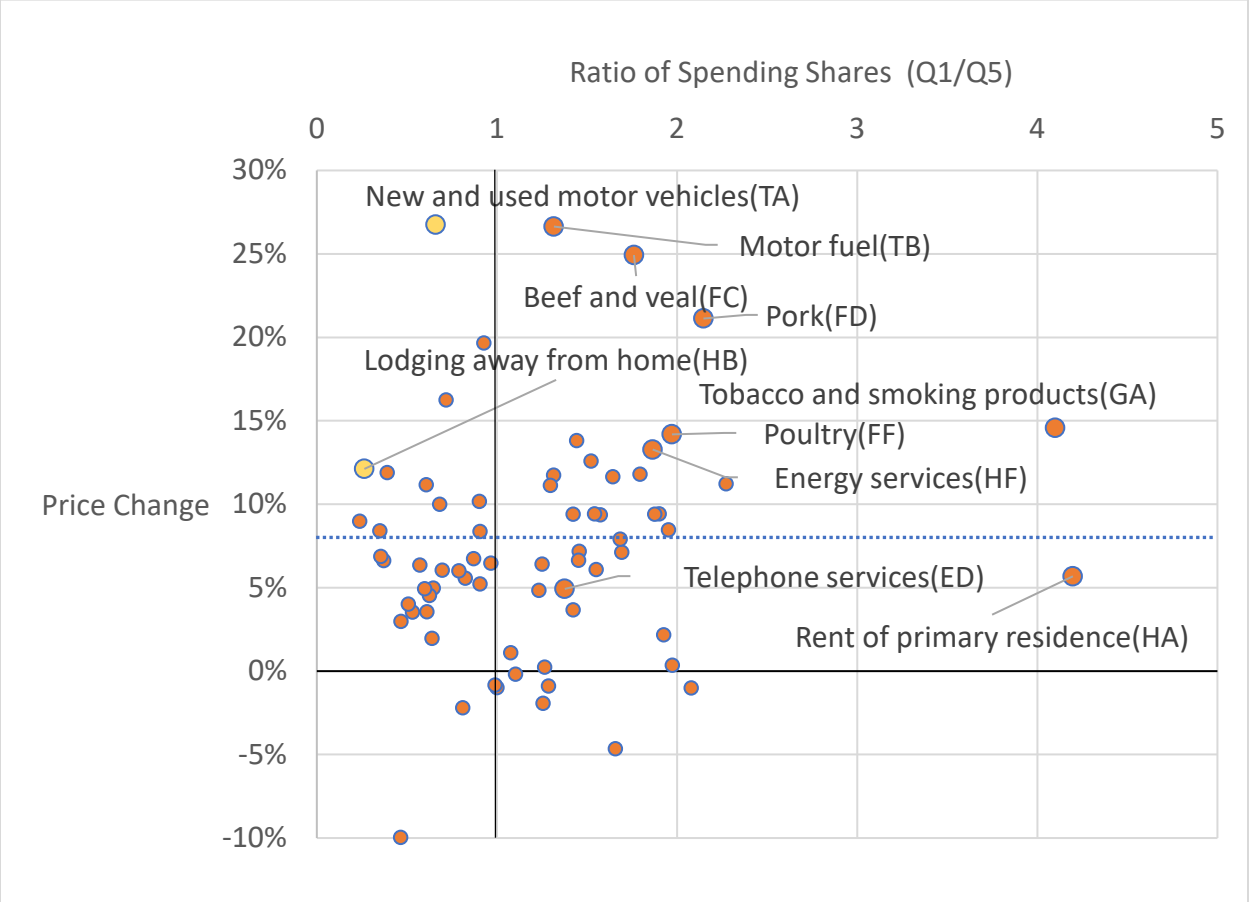
We also observe a notable shift in transportation spending weights from unadjusted income we used in an earlier analysis. Spending on all vehicle-related categories (new and used vehicles, motor fuels, and vehicle insurance) is 1.1 percentage points higher for the households categorized in the first quintile of equivalized income relative to their unadjusted counterparts. Again, retirees are likely the cause of this shift. Households included in the CPI-W population typically spend a larger share of their budget on vehicle-related expenses than urban households. The wage-earner and clerical worker population includes very few retirees (4 percent). With more households with members who are working included in the lowest quintile of equivalized income, they dedicate more of their budget to vehicle-related expenses.

Price Analysis

As noted in the methodology section, the BLS calculates price indexes for different populations by applying varying spending weights to the same set of underlying basic price indexes. That is, when averaging price changes across all items, the price change for rent has a greater impact on overall price change for lowest-income versus highest-income households. If prices changed at the same rate for all item categories, there would be no difference in inflation rates by population. In this section we present price changes by item category which will explain overall index differences.

In figure 9, we show the price change relative to the spending share differences between first and fifth quintile income groups for select components of the CPI. The y-axis shows price change from January 2020 to December 2021 and shows new and used motor vehicles and motor fuel had the largest price increases during that period (nearly 27%). The x-axis shows the ratio of spending shares (first quintile divided by fifth quintile) using 2019-2020 spending shares. Compared to fifth income quintiles households, first income quintile households spent four times their budget share on rent and a quarter their budget share on lodging away from home.

Figure 9: Price change and spending share scatterplot, first and fifth quintile (price change January 2020-December 2021, spending shares 2019-2020 ratio Q1/Q5)



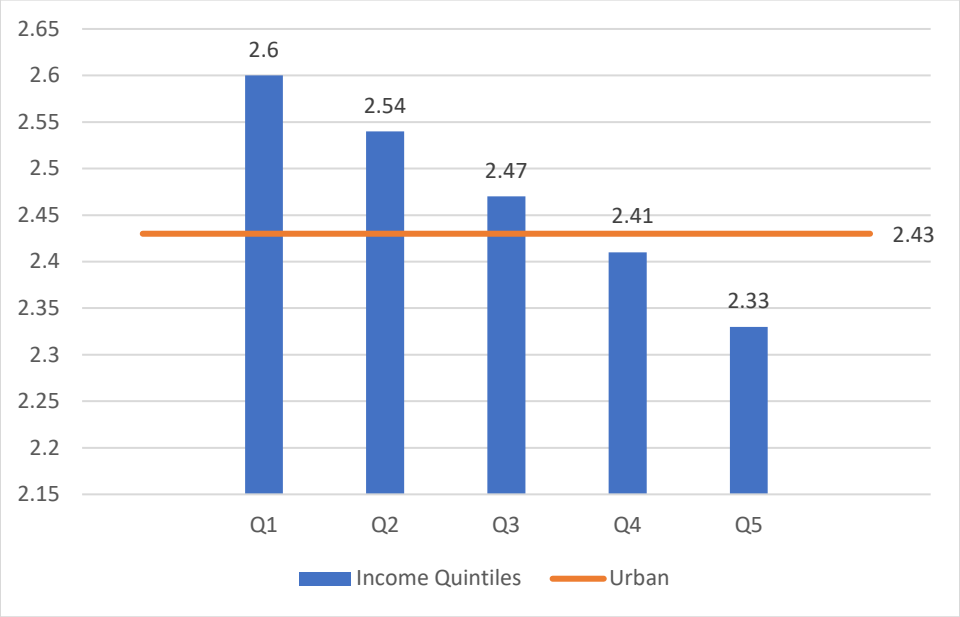
Results

In this section we present indexes by income quintile. Overall, the trends we observe in previous analysis continued in 2019-2022. Lowest-income households tend to experience larger inflation rates than highest-income households. In this section we present index results and further analyze periods that defy the overall trend.

Overall Index Results

Lowest-income households tend to experience larger inflation rates than highest-income households. We show the annualized inflation rates over the period in Figure 10. Lowest-income households faced inflation rates that were on average 0.27 percentage points larger than highest-income households every year over this period. Cumulatively, the inflation gap is 5.18% over 17 years.

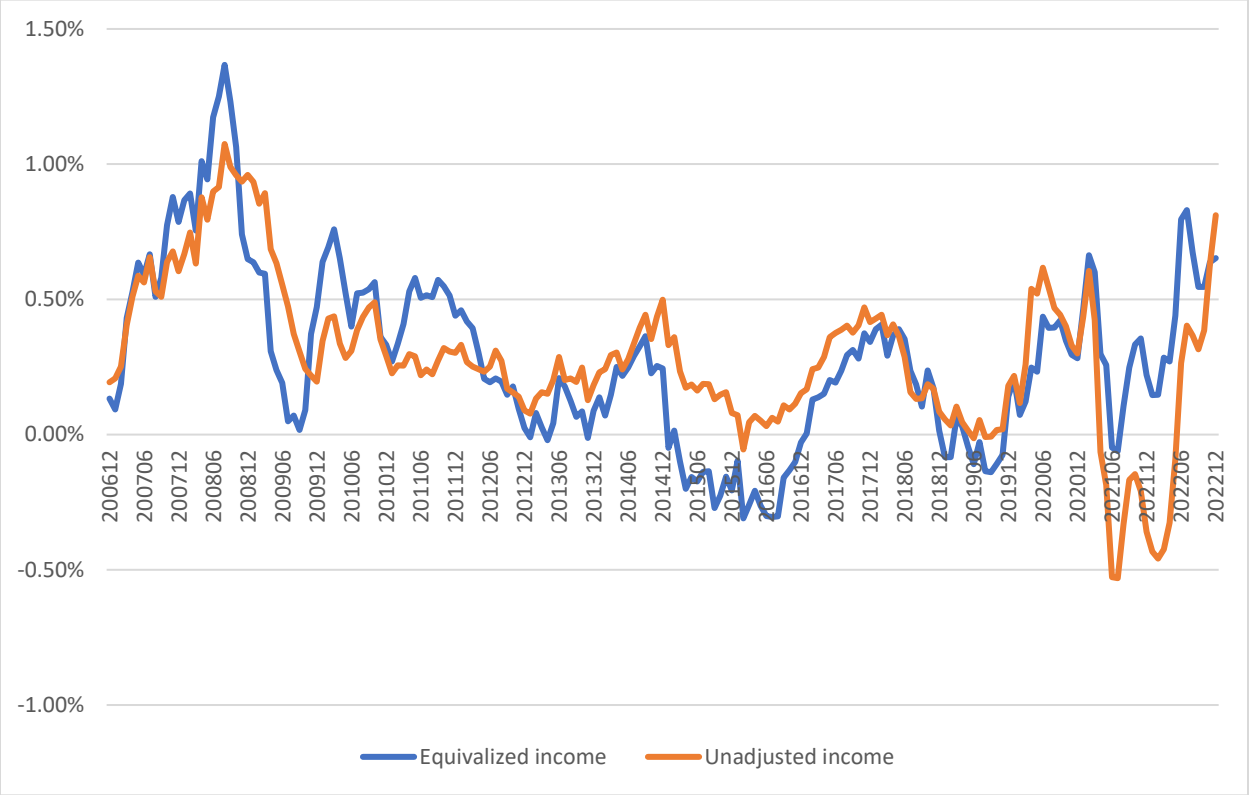
Figure 10: Annualized inflation rate, CPI by income quintile, Lowe Formula, December 2005 - December 2022



Variation of income inflation gap over time

On average from 2006 through 2022, lowest-income households faced larger inflation rates than highest-income households. At its peak in August 2008, the gap in inflation rates was 1.37 percentage points. At its trough in February 2016, the gap in inflation was reversed with highest-income households facing inflation rates 0.31 percentage points larger than lowest-income households. The long-term gap in the average inflation rate is the same whether classifying households using equivalized income or unadjusted income. In the short-term, the magnitude and direction of the inflation gap differs depending on the income definition we use to classify households. We show the difference in annual 12-month percent change between lowest- and highest-income households in Figure 12.

Figure 12: Annual 12-month percent change in CPI, difference between lowest and highest income quintile, December 2006 – December 2022



Variation in inflation gap by item category

Over the period studied, lower income households faced larger inflation rates than higher income households aggregated across all items in the market basket. Which item categories drive this difference? In this section, we present inflation rates by eight broad classifications called major groups. In the next section we decompose the contribution of each of these major groups to the overall inflation gap between lowest and highest income households.

Figure 13 displays inflation rates (annualized 12-month change) for each major group and the inflation gap between lowest and highest income households. For Apparel and Medical Care, highest income households faced larger inflation than lowest income households. The inflation gap was the smallest for Education and Communication and Food and Beverages. Lowest income households faced larger inflation rates than highest income households for Other Goods and Services, Housing, and Transportation. How much each major group contributed to the overall inflation gap depends on the spending shares. We present contribution information in the next section.

Figure 13: Inflation gap by CPI major group; Annualized inflation rate, Lowe Formula, December 2005 - December 2022

Item Category - Major Group	Urban	Lowest Income Quintile (Q1)	Highest Income Quintile (Q5)	Inflation Gap (Q1-Q5)
Apparel	0.35	0.25	0.42	-0.17
Education and Communication	1.34	1.63	1.67	-0.04
Food and Beverages	2.89	2.90	2.89	0.01
Other Goods and Services	2.90	3.38	2.43	0.95
Housing	2.66	2.85	2.53	0.32
Medical Care	3.07	2.89	3.16	-0.27
Recreation	1.13	1.18	1.14	0.04
Transportation	2.33	2.52	2.23	0.29

To interpret these results, recall our methodology adjusts spending shares on item categories such as women's dresses, men's pants, and children's clothing to reflect the shopping behavior of households in each income quintile. Price change at the major group level reflects different averages of price change across those item categories. Highest income households faced larger apparel inflation than lowest income households because they spent a larger share on item categories whose prices were rising faster than average (or smaller shares on item categories whose prices were falling or rising slower than average). These results do not indicate any differences in shopping behaviors below the item strata level.

The BLS calculates the CPI including all goods and services purchased by consumers. For some uses of the CPI, users prefer calculating a CPI over a smaller set of goods and services. The BLS calculates a CPI Less Food and Energy index which some users refer to as "core" inflation since it excludes some volatile item categories. Another subset calculation is the CPI for Food, Clothing, Shelter, and Utilities (FCSUti). The BLS uses this index to calculate a research poverty measure and can be considered an "essentials" index[17]. We show inflation gap results for these indexes in Figure 14.

[17] The Supplemental Poverty Measure website explains the SPM methodology and use of the FCSUti CPI. https://www.bls.gov/pir/spmhome.htm

Figure 14: Inflation gap for "core" and "essentials" items; Annualized inflation rate, Lowe Formula, December 2005 - December 2022

Special Aggregation Index	Urban	Lowest Income Quintile (Q1)	Highest Income Quintile (Q5)	Inflation Gap (Q1-Q5)
All Items	2.43	2.60	2.33	0.27
"Core" All Items Less Food and Energy (X)	2.35	2.57	2.23	0.34
"Essentials" Food, Shelter, Clothing, and Utilities (FCSUti)	2.63	2.71	2.60	0.11

Excluding food and energy, the inflation gap is wider between lowest and highest income households than when those categories are included. The inflation gap is less for the "essentials" index.

Which items explain the inflation gap?

In the previous section, we showed the variability in the inflation gap below the All-Items level. To understand how different components of the market basket contribute to the All-Items inflation gap, we need a measure that incorporates relative weights across item categories. These measures are called contributions and effects.[18] If the price change for an item category was unchanged instead of the value measured, then the effect is the resulting change in the all-items price change. The contribution scales items effects relative to the all-items price change.

These contributions and effects can be extended to explain inflation rates for income groups. In figure 15, we display the top and bottom three contributing items to the urban, first income quintile, and fifth income quintile populations. For example, inflation in owner's equivalent rent was the largest contributor of any single item stratum for the urban, lowest income quintile, and highest income quintile populations inflation rate in 2022. If owner's equivalent rent had not changed in 2022, the all-items price change would have been 0.5 percentage points lower for the urban population, 1.2 percentage points smaller for the lowest income quintile, and 1.4 percentage points smaller for the highest income quintile.

Figure 15: 2022 Year over year item ranking of contribution and effect (percentage) for U, Q1, and Q5

	U: All Items 8.0			Q1: All Items 8.3			Q5: All Items 7.7		
Rank	Item	Effect	Contribution	Item	Effect	Contribution	Item	Effect	Contribution
1	HC01	1.3	16.6	HC01	1.2	15.2	HC01	1.4	18
2	TB01	1.1	13.9	TB01	1.2	14.5	TB01	0.9	11
3	TA02	0.5	6.0	HA01	0.9	10.8	TA01	0.5	7.0
209	ED03	-0.0	-0.1	ED03	-0.0	-0.1	ED03	-0.0	-0.1
210	RA01	-0.0	-0.2	RA01	-0.0	-0.2	RA01	-0.0	-0.2
211	EE04	-0.1	-0.7	EE04	-0.1	-0.7	EE04	-0.0	-0.6

[18] See Footnote 1 https://www.bls.gov/news.release/cpi.t07.htm

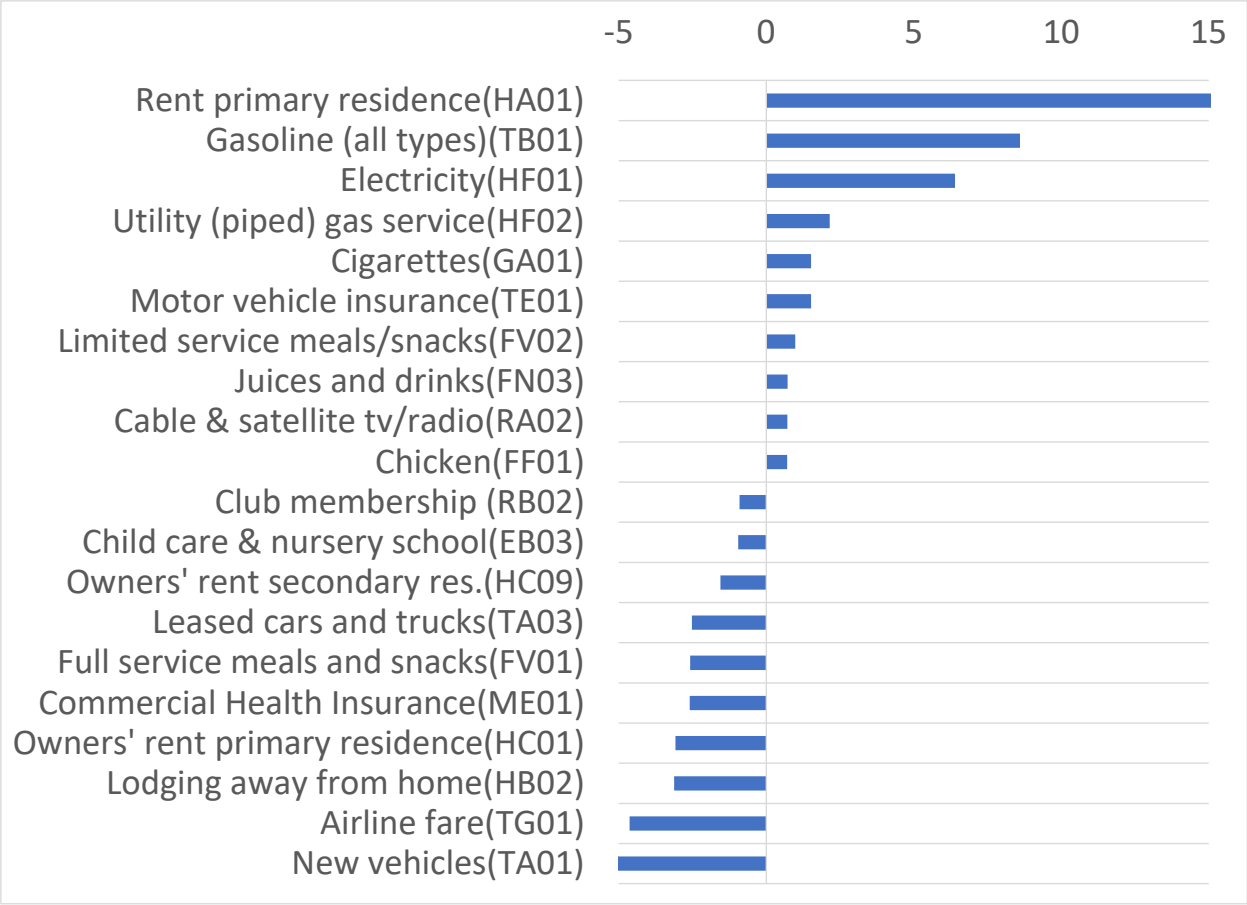
Gasoline is the second largest contributor to inflation for all three populations in 2022. The third ranked items differ across populations: used vehicles for the urban population, rent for lowest income households, and new vehicles for highest income households.[19] The bottom three ranked items display the small negative effects and contributions.

Since owner's equivalent rent is an important contributor to all populations, what explains the inflation gap between lowest and highest income quintiles? To home in on this question, we redefine the contribution and effect measure to identify the item categories that most contribute to widening the inflation gap (positive effect) and narrowing the inflation gap (negative effect). Formulas used for this analysis are described in Appendix 2. The 2022 year over year change inflation gap is 0.5%, with a positive effect of 2.1% and a negative effect of -1.6%.

We show in figure 16 the item categories contributing most to the positive effect (greater than 0) and the negative effect (less than 0). Rent, gasoline, and electricity had the largest contributions to the positive effect. The lowest income quintile of households spends more of their budget share on these categories than the highest income quintile of households. New vehicles and airline fares had the largest contributions to the negative effect. The highest income quintile of households spends more of their budget share on these categories than the lowest income quintile of households.

[19] See Appendix 7 Consumer Price Index items by publication level for item definitions https://www.bls.gov/cpi/additional-resources/index-publication-level.htm

Figure 16. 2022 Year over year inflation gap (Q1-Q5) CPI contributions to All-Items (percentage)



Summary/Conclusion/Future analysis/Next Steps

BLS produces different measures of inflation used to assess the health of the American economy. With this research, we add additional measures of consumer inflation across the distribution of household income. This paper builds on the authors' prior research by modifying the cohort definition and extending the period of analysis to 2022. As with earlier periods studied, lower income households generally faced larger inflation rates than higher income households through 2022. The long-term inflation gap between lowest and highest income households is unaffected by the cohort definition changes to better account for varying household sizes (however short-term differences in the inflation gap emerge).

The inflation gap is the result of differences in spending shares across households. Prices for rent, gasoline, electricity, new vehicles, and owner's equivalent rent rose faster than average in 2022. The impact of rent, gasoline, and electricity spending share differences generated larger inflation measures for lowest income households. The larger spending shares highest income households dedicated to new vehicles and owner's equivalent rent had a moderating impact on the inflation gap. Modifying the set of item categories over which inflation measures are calculated changes the spending share differences across households, leading to differences in inflation gap measures.

Throughout this paper, we have identified potential areas for future research. Perhaps most importantly, we recognize the importance of capturing price change differences at the lower level by income quintile. As other researchers have demonstrated, there may be considerable heterogeneity in the prices paid and unique items purchased that can have an impact on the overall measure of inflation. Previous research has found little difference in rent inflation by income group. We are interested in exploring this finding further and the impact of rent subsidies that have a larger impact on the lowest quintile of households.

We define cohorts by income quintile but recognize there may be other cohorts better suited for different uses. For example, cohorts defined by expenditure can lead to reclassification of some households into different quintiles (some lowest quintile households would fall into the highest quintile of expenditure, for example). There could also be different geographic stratifications that would be helpful (below the national level). Furthermore, there could be measures of wealth that are more useful for categorizing households.

Finally, this research is limited to the income group cohort definition. BLS is developing another product, Household Cost Indexes, that could be calculated for different subgroups. It would also be useful to develop confidence intervals and standard errors to identify statistically significant differences between inflation measures for different populations.

Appendix 1

Snapshot of spending weights by population, 2019-2020 biennial expenditure weight, equivalized income

Item Category	Urban	Q1	Q2	Q3	Q4	Q5
Food and beverages	**14.2**	**14.9**	**14.6**	**14.2**	**14.5**	**13.5**
Alcoholic beverages	0.9	0.5	0.6	0.8	1	1.3
Food away from home	5.1	4.5	4.9	5	5.2	5.4
Food at home	8.1	9.9	9.1	8.5	8.3	6.8
Housing	**42.9**	**46.6**	**44.6**	**42.1**	**41.3**	**42.5**
Owner's equivalent rent	24.7	21.4	23.3	22.9	24.5	27.6
Rent	7.6	14.3	11	9.1	6.5	3.7
Fuels and utilities	4.5	5.9	5.4	4.8	4.4	3.5
Household furnishings and operations	4.8	4.1	4	4.3	4.7	5.6
Lodging away from home	0.9	0.5	0.5	0.6	0.8	1.6
Apparel	**2.7**	**2.5**	**2.5**	**2.4**	**2.7**	**2.9**
Transportation	**16.5**	**13.9**	**15.3**	**17.5**	**17.6**	**16.5**
Motor fuels	3	3.2	3.4	3.5	3.3	2.4
Public transportation	0.9	0.6	0.6	0.7	0.8	1.3
Vehicle purchase and maintenance and repair	9.4	7.1	8	9.8	10.1	10.2
Vehicle insurance	2.5	2.6	2.9	2.9	2.8	2
Medical care	**8.8**	**7.9**	**10**	**9.7**	**9.1**	**7.9**
Health insurance, retained earnings	0.8	0.5	0.7	0.9	0.9	0.8
Professional services	3.8	3.5	4.3	4.1	3.9	3.5
Recreation	**5.3**	**4.3**	**4.2**	**4.7**	**5.5**	**6.4**
Education and communication	**6.9**	**6.8**	**5.7**	**6.4**	**6.7**	**7.8**
Education	2.8	2.4	1.3	1.9	2.4	4.4
Communication	4.1	4.5	4.4	4.5	4.3	3.4
Other goods and services	**2.8**	**3.1**	**3**	**2.9**	**2.7**	**2.6**

Snapshot of spending weights by population, 2019-2020 biennial expenditure weight, unadjusted income

Item Category	Urban	Q1	Q2	Q3	Q4	Q5
Food and beverages	**14.2**	**14.1**	**14.2**	**14.4**	**14.5**	**13.8**
Alcoholic beverages	0.9	0.6	0.7	0.8	0.9	1.2
Food away from home	5.1	4.4	4.7	5.2	5.1	5.5
Food at home	8.1	9.2	8.8	8.4	8.4	7.2
Housing	**42.9**	**48.4**	**45.4**	**43.2**	**40.8**	**41.4**
Owner's equivalent rent	24.7	23.4	22.9	23.2	23.8	27.2
Rent	7.6	14.3	12	9.7	6.7	3.2
Fuels and utilities	4.5	5.7	5.4	4.9	4.4	3.6
Household furnishings and operations	4.8	4.1	4.1	4.5	4.7	5.4
Lodging away from home	0.9	0.5	0.5	0.6	0.8	1.5
Apparel	**2.7**	**2.3**	**2.3**	**2.6**	**2.7**	**3**
Transportation	**16.5**	**12.8**	**15.3**	**17.1**	**18.1**	**16.7**
Motor fuels	3	2.8	3.3	3.5	3.4	2.6
Public transportation	0.9	0.7	0.6	0.7	0.8	1.3
Vehicle purchase and maintenance and repair	9.4	6.6	8.1	9.4	10.5	10.2
Vehicle insurance	2.5	2.3	2.8	2.9	2.8	2.1
Medical care	**8.8**	**8.8**	**9.6**	**9.3**	**9.2**	**8**
Health insurance, retained earnings	0.8	0.5	0.7	0.8	0.9	0.8
Professional services	3.8	3.9	4.1	3.9	4	3.5
Recreation	**5.3**	**4**	**4.6**	**4.6**	**5.3**	**6.4**
Education and communication	**6.9**	**6.5**	**5.6**	**5.9**	**6.6**	**8.1**
Education	2.8	2.3	1.2	1.4	2.3	4.7
Communication	4.1	4.2	4.4	4.5	4.4	3.5
Other goods and services	**2.8**	**3**	**3.1**	**2.9**	**2.7**	**2.6**

Appendix 2

Subpopulation difference of effects and contribution formulas

Effects:

When pivot month the same across 12-month average (odd index years):

$$Effect^{p}_{t-n\to t;a,i\to i,A} = \left[\frac{(cw_{t,A,i} - cw_{t-12,A,i})}{(cw_{t,A,I} - cw_{t-12,A,I})} * \frac{(\overline{IX}_{t,A,I} - \overline{IX}_{,t-n,A,I})}{\overline{IX}_{t-n,A,I}} * 100\right]$$

When pivot month is revised across 12 month average (**even index years**):

$Effect^{p}_{t-12\to t;a,i\to i,A} =$

$$\left[\frac{\left(cwt_{t,A,i} - cwt_{t-n,A,i} * \left(\frac{CW_{v,AWnew,A,i}}{CW_{v,AWold,A,i}}\right)\right)}{\left(cwt_{t,A,I} - cwt_{t-n,A,I} * \left(\frac{CW_{v,AWnew,A,I}}{CW_{v,AWold,A,I}}\right)\right)} * \left(\frac{CW_{t,A,I}}{CW_{t-n,A,I}} * \frac{CW_{v,AWold,I,A}}{CW_{v,AWnew,I,A}} - 1\right) * 100\right]$$

$Effect_i^{Q1,Q5} = Effect_i^{Q1} - Effect_i^{Q5}$ *(Normalized based on absolute value).*

Contributions: For an individual population contribution the terms highlighted in gray are removed. For subpopulation contribution difference the absolute value of item $Effect_i^{Q1,Q5}$ is evaluated relative to the sum representing the subpopulation proportional effect. The sum of subpopulation proportional effects equals 100%. Positive subpopulation item effects represent items where Q1>Q5. Negative subpopulation item effects represent items where Q1<Q5.

$$Subpopulation\ proportional\ Effect_i^{Q1,Q5} = \frac{\left|Effect_i^{Q1,Q5}\right|}{\sum\left|Effect_i^{Q1,Q5}\right|}$$

t = current period	CW= cost weight	*p = Q1 or Q5*	*A* = aggregate All US	*i* = lower-level item
t –12 = period 12 months prior	AWnew = new aggregation weight	AWnew = new aggregation weight	*v = pivot month index*	*I* = aggregate All items