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INFLATION INEQUALITY IN THE UNITED STATES

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Different spending patterns across households and differences in price increases across goods and services lead to unequal levels of inflation faced by different households. In this paper we measure the degree of inequality in inflation across U.S. households for the period 1987–2001. The broad picture that emerges from our results is that over our whole sample period there are substantial differences in the inflation experiences across U.S. households. We find that the cost of living increases were generally higher for the elderly, in large part because of their health care expenditures, and that the cost of living of poor households is most sensitive to the, historically large, fluctuations in gasoline prices. Still, when looking at the whole population, we find that individual households that are confronted with high inflation in one year do not generally face high inflation in the subsequent year as well.

1. Introduction

The Consumer Price Index (CPI) measures the continuously changing cost of the basket of goods and services purchased by the "typical" American household. Price changes in this "typical" goods basket have fluctuated dramatically over the past five decades. Inflation peaked at about 15 percent in the early 1980s and was actually negative in the early 1950s. Inflation is generally considered a macroeconomic variable and most of macroeconomic theory treats CPI inflation as being faced by all households.

In this paper we dive under the surface of the CPI as a measure of aggregate inflation and address the question: how representative is the "typical" household on the aggregate CPI measure of inflation. Because the basket actually purchased by each household potentially differs from the CPI's basket, the inflation rate faced by any given household might be very different from the CPI inflation rate. The focus of this paper is on the evolution of the distribution of household-specific inflation rates over time, specifically over our sample period of 1987–2001. We use data on household expenditures from the Consumer Expenditure Survey along with price data from the Consumer Price Index.

Ever since the report by Boskin *et al*. (1996) there has been a renewed emphasis on the potential measurement biases in the CPI, as reflected by, among others,

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Bils and Klenow (2001) and Lebow and Rudd (2003). However, the question of whether the CPI actually reflects the inflation experience of the average American household has received less attention.

We are not the first to address the issue of unequal inflation across American households. Earlier work by Michael (1979) and Hagemann (1982) has also focused on differences in changes in the cost of living across U.S. households. Later studies, like Amble and Stewart (1994), Garner *et al*. (1996), Idson and Miller (1999), and Hamilton (2001) have focused on the inflation experience of particular groups.

Our analysis in this paper is in large part an update and refinement of the results presented in Michael (1979) and Hagemann (1982), both of whom focus on relatively short time periods from the early 1970s. We update these previous studies by considering a larger sample and a longer and more recent time frame. We refine these studies by introducing a unifying framework for interpreting aggregate inflation measures as summary statistics of the underlying distribution of inflation rates. Our overall approach in this paper is most closely related to Crawford and Smith (2002), who explore inflation inequality across households in the U.K.

The results in this paper confirm some of the earlier results on U.S. inflation inequality from the 1970s. Namely, there are large differences in the inflation experiences of households in the United States in most years. For the period 1987–2001 we find that major contributors to inflation inequality are, on the upside, increasing costs of education and health care. Downside contributors are apparel prices, new and used vehicle prices, and the prices of household equipment. A large part of the fluctuations in these inflation disparities turns out to be due to the most volatile price of all, which is the price of gasoline. Poor households have the highest cost-of-living increases when gasoline prices rise. Throughout our sample period we find that elderly households generally faced a higher-than-average inflation rate, and that households with children under 18 generally faced lower-than-average inflation. To our surprise, we do not find a high degree of persistence of household-specific inflation rates. That is, we find that individual households that are confronted with higher-than-average inflation in one year are not very likely to be confronted with the same inflation disparity the year afterwards.

2. CPI and Household-Specific Inflation Rates

At the heart of our analysis is the concept of a "household-specific inflation rate." In this section we explain our definition of this term and show how it is related to the definition of inflation as commonly calculated in the CPI. It is easiest to start off with the definition of inflation as it is measured by the CPI and then illustrate the respects in which our definition of household inflation deviates from the CPI measure.

In principle we would like to measure the proper changes in the cost of living for each household. It is well known from price index theory that calculating an exact index of the cost of living is not feasible, however.[1]

[1]See Diewert (2001) for an extensive survey of the Consumer Price Index and index number theory.

Throughout, we will assume that the relevant change in the cost of living is calculated by combining the price changes of m goods categories.[2] The overall CPI measures inflation in period t, which we will denote by π_t^{CPI}, as the ratio of weighted averages of the percentage price changes of each of the item strata between period t and a base period in the numerator and between period $t-1$ and a base period in the denominator. Let $p_{j,t}$ be the price index for item stratum j at time t, and let $t = b$ denote the base period. Furthermore, let $w_{j,b}$ be the aggregate expenditure share of goods category j in the base period. Using this notation, CPI inflation is measured as

$$\pi_t^{CPI} = \frac{\sum_{j=1}^{m} w_{j,b} \frac{p_{j,r}}{p_{j,b}}}{\sum_{j=1}^{m} w_{j,b} \frac{p_{j,t-1}}{p_{j,b}}} - 1 \tag{1}$$

The above equation implies that CPI inflation measures the percentage change in the price of the base-period goods basket between periods $t-1$ and t.

Until recently the Bureau of Labor Statistics (1997) updated the base period b relatively infrequently. Greenlees and Mason (1996) list the changes in the expenditure base period that have occurred for the CPI since 1940. From 1940 to 2000, the expenditure base period was changed five times. This infrequent updating of the base period is widely thought to be a major source of substitution bias in the CPI. It implies that the CPI does not properly account for people substituting goods that become relatively cheaper for more expensive goods.[3] See Lebow and Rudd (2003) for a recent discussion of this bias.

One difference between our household-specific inflation rates and the CPI inflation rate is that we update the expenditure weights in every time period, rather than use weights from some base period. Besides limiting the dependence of our results on the particular choice of base period, it also reduces the substitution bias in our calculations.

By updating the base period in every period, i.e. by setting $b = t-1$ in (1), for the overall CPI we obtain an alternative measure of inflation of the form

$$\pi_t^{(I)} = \sum_{j=1}^{m} w_{j,t-1} \frac{p_{j,t}}{p_{j,t-1}} - 1 = \sum_{j=1}^{m} w_{j,t-1} \left(\frac{p_{j,t}}{p_{j,t-1}} - 1 \right) = \sum_{j=1}^{m} w_{j,t-1} \pi_{j,t} \tag{2}$$

where $\pi_{j,t}$ is the inflation measured for item stratum j. The result is that we are actually calculating a chain-weighted index.

When one applies (2) to monthly price data that are not seasonally adjusted, as we will do in Section 3, there are large seasonal fluctuations in inflation rates. However, these seasonal fluctuations are not what we are interested in. There are,

[2]A goods category is also often referred to as an "item stratum" (plural is "item strata"). We will use both terms interchangeably.

[3]Since January, 2002 the CPI base period has been updated every two years; this change represents a major improvement in BLS methodology.

in principle, many ways to get rid of the seasonality in the calculated inflation rates. The approach that we choose in this paper is to consider annual inflation rates. That is, we do not compare current prices with those a month earlier, but rather twelve months earlier. This is a second major difference between CPI inflation and our household inflation rates. If t indexes time in months, making this change to (2) gives us an inflation measure of the form

$$\pi_t^{(II)} = \sum_{j=1}^{m} w_{j,t-12}\left(\frac{p_{j,t}}{p_{j,t-12}} - 1\right) = \sum_{j=1}^{m} w_{j,t-12}\pi_{j,t} \tag{3}$$

where the item stratum specific inflation, $\pi_{j,t}$, is now measured as a year/year inflation rate.

By using annual inflation rates, we get rid of the seasonal fluctuations in the stratum specific inflation rates, $\pi_{j,t}$. However, (3) still yields seasonal fluctuations in $\pi_t^{(II)}$ because of seasonal fluctuations in the spending patterns reflected in the budget shares $w_{j,t}$. In practice, the remaining seasonal fluctuations turn out to be minimal and not to affect the main results that we present below.

Essentially, (3) represents the way we will define our household inflation rates. However, we will focus on household-specific inflation rates and (3) does not contain any household-specificity. In principle, we would like to measure household-specific expenditure weights as well as household-specific price changes. For each household, which we will index by i, we can and do observe its specific expenditure shares, $w_{i,j,t}$ for each of the m goods categories. However, we are not able to observe the specific prices that households pay for the item strata. Therefore, we must assume that all households face the same price increases, $\pi_{j,t}$, for each item stratum. This is not to say that each item stratum has the same price increase in a given period, but that each household faces the same price increase as all other households *for any particular goods category* at each point in time. This is an assumption that is commonly made when constructing group price indices, as in Amble and Stewart (1994) and Garner *et al*. (1996).[4]

When we apply the assumption above, namely that households face the same price increases but that they choose different expenditure patterns in response to these prices, to (3) we arrive at our definition of a household inflation rate, which we denote as $\tilde{\pi}_{i,t}$ for household i in month t. That is,

$$\tilde{\pi}_{i,t} = \sum_{j=1}^{m} w_{i,j,t-12}\pi_{j,t} \tag{4}$$

Here $w_{i,j,t-12}$ is household i's expenditure share on good category j twelve months before month t, while $\pi_{j,t}$ is the inflation in goods category j over the year preceding month t.

In sum, the household inflation rate that we measure represents the change in the price, over the past year, of the goods basket that a household bought a year earlier.

[4]There is relatively little empirical work that addresses the question whether different groups of households face different price changes for specific goods categories. Kokoski *et al*. (1996) consider regional price differences for a small number of food items. Another study, by Berndt *et al*. (1998), found that the elderly do not face very different price changes for prescription drugs than other people, even though they tend to use very different drugs.

3. Aggregate Inflation and the Underlying Distribution

In this section we consider the distribution of household inflation, and discuss how aggregate inflation measures, such as computed by the CPI, can be interpreted as summary statistics of this distribution of household inflation rates. We also discuss in detail how our data set is constructed.

As a basis for the analysis in this paper we consider the joint density of household-specific inflation rates and household characteristics. It is convenient to split the vector with household characteristics into the household's total expenditures, which we denote by $y_{i,t-12}$, and its other characteristics, which we denote by the vector $\mathbf{x}^*_{j,t-12}$. We denote the joint density of the household-specific inflation rate and these characteristics by $g(\tilde{\pi}_{i,t}, y_{i,t-12}, \mathbf{x}^*_{j,t-12})$. Note that we consider the household characteristics at the beginning of the year over which the inflation rate is calculated.

General aggregate price indices do not consider household characteristics, besides total expenditures, in their calculation. Hence, in order to interpret some of the aggregate price indices that are studied and published it suffices to consider the joint distribution of household-specific inflation rates and total expenditures. We will denote the density associated with this distribution by, $g_{\pi,y}(\tilde{\pi}_{i,t}, y_{i,t-12})$.

Based on this density, one can calculate two aggregate inflation rates. The first is known as the plutocratic price index while the second is known as the democratic price index. The plutocratic index is a weighted average of all the household-specific inflation rates, where each household's contribution is proportional to the household's total expenditure level. Mathematically, the measured inflation corresponding to the plutocratic price index $\tilde{\pi}^p_t$, is the sample equivalent of the population moment

$$\tilde{\pi}^P_t = \int \left[\int \tilde{\pi}_{i,t} g_{\pi|y}(\tilde{\pi}_{i,t} | y_{i,t-12}) d\tilde{\pi}_{i,t} \right] \left(\frac{y_{i,t-12} g_y(y_{i,t-12})}{\int y g_y(y) dy} \right) dy_{i,t-12} \tag{5}$$

Here, the plutocratic weight

$$\left(\frac{y_{i,t-12} g_y(y_{i,t-12})}{\int y g_y(y) dy} \right) \tag{6}$$

represents the share of households with total expenditure level $y_{i,t-12}$ in aggregate expenditures. The expression in square brackets represents the average inflation rate for households with total expenditure level $y_{i,t}$.

In practice, the calculation of the sample equivalence of (5) does not require the calculation of all the household-specific inflation rates. Instead, it amounts to calculating a weighted sum of the item-strata-specific inflation rates. The weight of each stratum is equal to its share in aggregate expenditures. This is also the way that the CPI is calculated, except that, as can be seen in (1), the CPI is not chained but instead is normalized to a base year. Because the CPI is also a plutocratic index, it weighs each household by a weight that is proportional to its expenditure level.

Prais (1959) argued that there is, in principle, no reason to treat households asymmetrically in the measure of aggregate inflation. As an alternative to the plu-

tocratic index, Prais proposed an index that measures aggregate inflation as an unweighted average of the household inflation rates. This aggregate is known as a democratic price index, which we will denote by $\tilde{\pi}_t^D$. It corresponds to the sample equivalent of the population moment

$$\tilde{\pi}_t^D = \int \left[\int \tilde{\pi}_{i,t} g_{\pi|y}(\tilde{\pi}_{i,t}|y_{i,t-12}) d\tilde{\pi}_{i,t} \right] \cdot g_y(y_{i,t-12}) dy_{i,t-12} = \int \tilde{\pi}_{i,t} g_{\pi}(\tilde{\pi}_{i,t}) d\tilde{\pi}_{i,t} \tag{7}$$

Thus, the democratic price index measures inflation as the mean of the marginal distribution of household-specific inflation rates.

Does it really matter whether we use the CPI, i.e. (1), our plutocratic index, i.e. (5), or the democratic index, i.e. (7), as measure of aggregate inflation? This is an empirical rather than a theoretical question. Before addressing this question, we first discuss the data that we employ in our study.

The data that we use throughout this paper are obtained from two sources. Data on household expenditures and demographic characteristics are obtained from the interview survey of the Consumer Expenditure Survey (CE). The CE survey is a quarterly rolling panel of about 5,000 households before 1999 and around 7,500 since then. Each household in the panel reports monthly expenditure data for four consecutive quarters (if they respond on all interviews). In addition to the four interviews, the households also participate in an initial interview, in which they report demographic characteristics of the household and its members. In each quarter, one third of the panel is interviewed in each month. Each household reports on the expenditures made over the previous three months.

Since it is impossible to observe households over our entire time period, and since many households report expenditure data in less than four quarters, we treat our sample of households as a collection of cross-sections rather than a panel of households. In any given month our cross-section of households consists of all households that report expenditure data in that month. If expenditure data is available for a household in multiple months we include that household in the cross-sectional sample in each month for which data is available. We take this approach so as to maximize the number of households in the sample in each month. One limitation of this approach is that households that report expenditures in more months are included in more cross-sections than households that report in fewer months.[5]

Price data are obtained from the CPI series for all urban consumers (CPI-U), for the specific goods categories that we choose. Matching the expenditure categories reported in the CE and the CPI series, we end up with $m = 19$ categories. They are: Food at Home, Food Away from Home, Alcohol, Owned Dwellings,[6] Rented Dwellings, Other Lodging, Utilities, Household Furnishings and

[5]In Section 6 we present estimates of inflation differentials for several different pairs of population subgroups, along with confidence intervals for these groups. One potential result of our treatment of the CE data as a sequence of cross-sections, rather than a panel of households, is that our confidence intervals might appear tighter than they really are.

[6]As a measure of the expenditure on owned dwellings we use the implied rental cost of a household's owned dwelling (if they own one at all). Homeowner households in the CE report the approximate monthly rental value of their owned dwellings in each interview. This choice of measure then allows a compatible match to the CPI price-index "owner's equivalent rent," which measures the implied rental cost to owners of owned housing units.

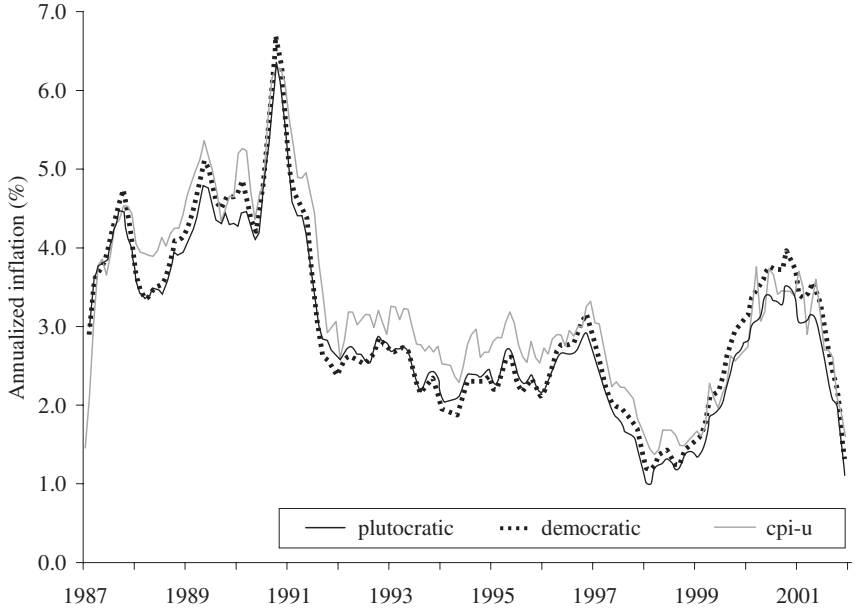

Figure 1. CPI-U and Plutocratic and Democratic Inflation Measures

Operations, Apparel, Vehicles, Gasoline, Other Vehicle Expenses, Public Transportation, Medical, Entertainment, Personal Care, Reading, Education, and Tobacco. The Appendix contains a detailed description of these categories, as well as details of the mapping between the CPI and CE used to construct these categories. Our match between CPI and CE categories represents the most reasonable match that we could find between the two data sources that was feasible in each year of our sample period. The resulting measured inflation rates cover the period January 1987 through December 2001.

Figure 1 depicts the evolution of the CPI-U, as well as the plutocratic and democratic inflation rates over our sample period. Three main observations stand out from this figure. First, the differences between these three measures of aggregate inflation are small compared to the fluctuations in these measures over time. Second, although differences between the plutocratic and democratic indexes do exist for certain time periods, all in all inflation measures from the two indexes are fairly comparable. The democratic index is higher in the periods 1990–92 and 1999–2001, both of which were periods in which gasoline price inflation reached double-digit levels. Hence, when gas prices go up at a double-digit rate, households that spend a relatively larger share of their expenditures on gas tend to be hit harder in terms of cost-of-living increases. Note that these households tend to be households with lower expenditure levels.

Our results for the U.S. difference between the plutocratic and democratic index are similar to those obtained for Spain for 1992–97 by Izquierdo *et al*. (2002). They find that the average difference between the democratic and plutocratic indexes for Spain was less than 0.06 percentage points. Over the same period, we

find that the average difference in the U.S. is 0.07 percentage points; however for our entire time period we find the average to be 0.1 percentage points. This average is higher for the whole period because the two periods of high gas-price inflation are not included in the 1992–97 period. Kokoski (2000) also concludes that democratic and plutocratic inflation measures are comparable. Her results suggest an average difference of –0.05 percentage points, with yearly differences ranging from around –0.6 to 0.3 percentage points over the period 1987–97.

The third point worth noting from Figure 1 is that CPI-U inflation is most of the time higher than inflation as measured by either the plutocratic or the democratic index. The difference between CPI-U inflation and the plutocratic-index inflation, which is 0.2 percentage points per year on average, can be interpreted as an estimate of the average substitution bias in the CPI. Our estimate is very much comparable to a comprehensive study on substitution bias in the CPI by Cage and Jackman (1999), who find an average yearly bias of 0.15 percentage points.[7] One thing is worthwhile noting: in some periods inflation as measured by the plutocratic index outpaces CPI-U inflation. This is true in the last quarter of 2000 for example. According to standard classical price index theory, introduced by Konüs (1939) and Frisch (1936), this can not be possible. However, in practice the demand for some goods, particularly gasoline, might be so inelastic, or rather inflexible, that increases in the prices of these goods result in a negative substitution bias. This is the case at the end of the 1990s when the aggregate expenditure share of gasoline went up over the decade and consumers were hit more by gas price increases than reflected in the CPI.

4. Shape and Moments of Cross-Household Inflation Distribution

In the previous section we have presented several alternative measures of aggregate inflation. We have shown how each of these can be interpreted as a summary statistic of the underlying distribution of household inflation rates, $g(\tilde{\pi}_{i,t}, y_{i,t-12}, \mathbf{x}^*_{j,t-12})$. In this section we dive below the surface of this distribution and consider what its main properties are and whether and how it has changed over time.

To start off we present some summary statistics of the distribution of household inflation rates over our sample period. Specifically, in Figure 2 (left-axis) we present the evolution of the mean, median, 5th and 95th percentiles of $g_\pi(\tilde{\pi}_{i,t})$. Note that the mean household inflation rate here coincides with the inflation rate as calculated under a democratic price index, see equation (7). The first thing that jumps out from this figure is that the mean and median inflation rates[8] are virtually identical over time, suggesting that the cross-household distribution of inflation rates is rather symmetric. The second observation from this figure is that there is a substantial variation in inflation rates across households. The width of the range between the 5th and 95th percentiles of the distribution varies between about 1 percentage point in 1996 to 5 percentage points in 1991.

[7]See Lebow and Rudd (2003) for a comprehensive review of measurement error in the CPI.

[8]The median inflation rate considered here is very different from the "median CPI" introduced by Cechetti (1997). Our definition of median inflation considers the median across households, while the "median CPI" measures the (weighted) median across item strata.

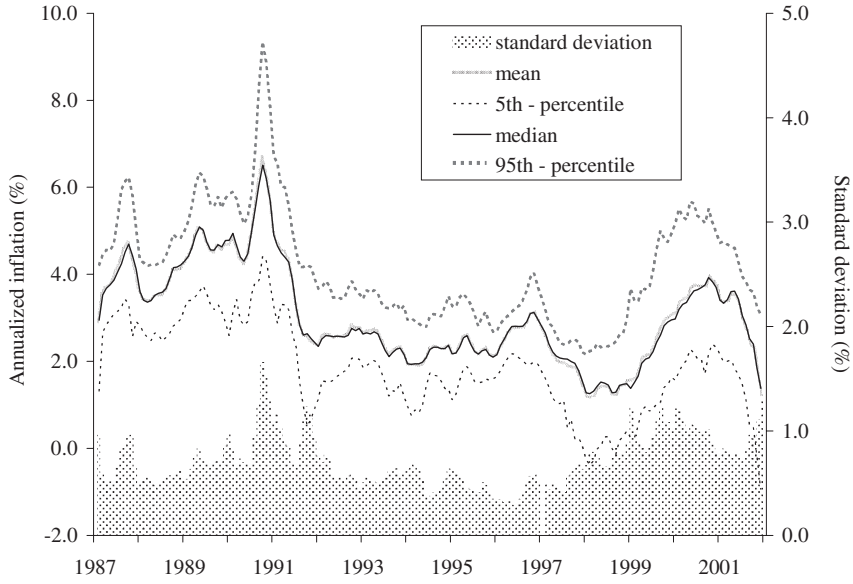

Figure 2. Moments of Household Inflation Distribution and Democratic Mean Inflation Rate

In order to put this variation in perspective, we consider the behavior of the standard deviation of $g_\pi(\tilde{\pi}_{i,t})$ over time. This is depicted in the lower portion of Figure 2, using the right axis. The standard deviation varies between about 0.3 percentage points in early 1996, and 1.7 percentage points in the beginning of 1991. The overall average standard deviation of household inflation is around 0.7 percentage points. As it turns out here, as well as for many other results in this paper, the driving force behind the behavior of this standard deviation seems to be in large part gasoline prices.

The summary statistics above give us a perspective on some of the main properties of the household inflation distribution. In order to consider the shape of the distribution, we present kernel density estimates of the inflation distribution for three select periods. We choose a low-inflation period (December 2001), an average inflation period (June 1994), and a high-inflation period (December 1990). These estimates are plotted in Figure 3. As the results for the mean and median already suggested, the distribution is relatively symmetric in all three months. The support of the densities is bounded, since by definition all household inflation rates must fall between inflation for the lowest goods category and inflation for the highest goods category, i.e.

$$\min_{j=1,\ldots,m} \pi_{j,t} \leq \tilde{\pi}_{i,t} \leq \max_{j=1,\ldots,m} \pi_{j,t} \tag{8}$$

Although our results cover a different period, it is worthwhile to compare them with the results presented by Michael (1979). Michael finds that the cross-household inflation distribution for 1973 has many of the same properties that we

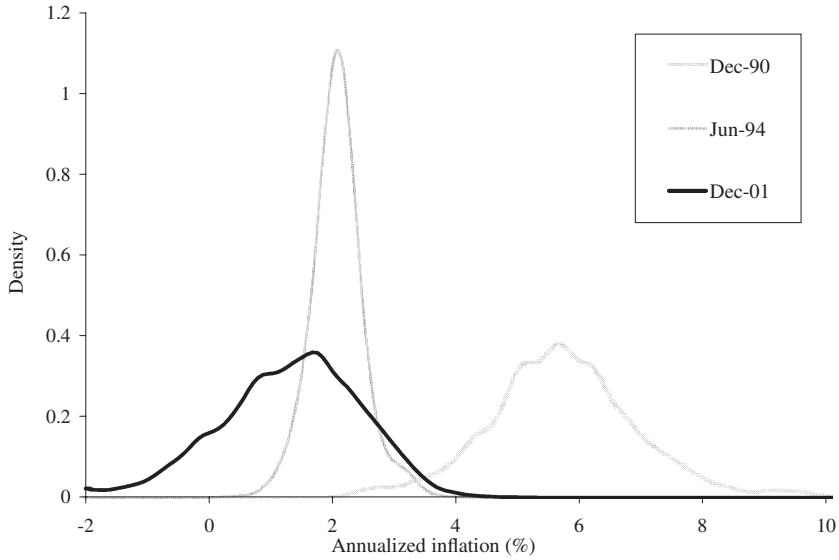

Figure 3. Cross-Household Distribution of Inflation for Three Select Months

found for the same distribution over our sample period. He also finds that the mean and median are almost the same, 0.1 percentage points apart, and finds a standard deviation of 2.3 percentage points. This is higher than the standard deviation that we find and might be partly due to the oil crisis and the associated gas-price inflation of 1973.

One of the conclusions of Crawford and Smith (2002) is that the distribution of household inflation tends to be more varied when inflation is higher. Our Figure 3 suggests otherwise: the high-inflation period and low-inflation period have more dispersion than the average-inflation period. Furthermore, the standard deviation of household inflation does not appear to be systematically higher for our time period in the higher-inflation periods (see Figure 2). The period of highest average inflation in our sample takes place between 1987 and 1991, and except for the relatively brief period in late 1990 when inflation spiked due to gasoline prices, the standard deviation is about average over this period. The period of lowest average inflation is between 1998 and 1999, and the standard deviation is about average then as well. Although inflation does tend to vary substantially across households, we cannot conclude that variation in household inflation rates is systematically related to a high or low average inflation rate.

The general picture that emerges from the results in this section is that inflation rates not only vary a lot over time but also across households. Thus, it is important to consider what causes these variations across households and whether there are particular types of households that tend to face higher or lower than average inflation rates. In the next section, we evaluate the sources of cross-household heterogeneity in inflation rates.

5. Sources of Heterogeneity

If households face different inflation rates, a natural question is whether we can pinpoint the source of this heterogeneity. In order to be able to do so, it turns out to be illustrative to reconsider (7). This equation implies that the average inflation rate, i.e. the democratic mean, is

$$\begin{aligned}\pi_t^D &= \int \tilde{\pi}_{i,t} g_\pi(\tilde{\pi}_{i,t}) d\tilde{\pi}_{i,t} \\ &= \sum_{j=1}^{m} \left[\int w_{i,j,t-12} g_{w_j}(w_{i,j,t-12}) dw_{i,j,t-12} \right] \pi_{j,t} \\ &= \sum_{j=1}^{m} \mu_{w_{j,t-12}} \pi_{j,t}\end{aligned} \tag{9}$$

where $\mu_{w_{j,t-2}}$ is the average expenditure share of item stratum j. This representation allows us to write the deviation of a specific household's inflation rate from the mean as

$$\begin{aligned}(\tilde{\pi}_{i,t} - \tilde{\pi}_t^D) &= \sum_{j=1}^{m} (w_{i,j,t-12} - \mu_{w_{j,t-12}}) \pi_{j,t} \\ &= \sum_{j=1}^{m} \underbrace{(w_{i,j,t-12} - \mu_{w_{j,t-12}})}_{(A)} \underbrace{(\pi_{j,t} - \tilde{\pi}_t^D)}_{(B)}\end{aligned} \tag{10}$$

This decomposition illustrates that there are two things necessary for heterogeneity in household-specific inflation rates. First, there must be differences in inflation rates across item strata, as represented by part (B) of this decomposition. Since household-specific inflation rates are a weighted average of the inflation rates of the item strata, if there is no difference in the cross-strata inflation rates then this weighted average does not depend on what weights are applied. Second, households must have different-from-average expenditure patterns, otherwise each household's inflation rate is based on the same expenditure weights and is thus the same. This is represented by part (A) in the decomposition, which is the deviation of the household's expenditure share from the average expenditure share.

The results that pertain to this decomposition are presented in Table 1 and Figure 4. The top line of Table 1 lists the (1993–95 base year) CPI-U weights of the various item strata,[9] and the second row of Table 1 lists the average shares $\overline{w}_j$ in our data. Our average shares match up quite closely to those of Cage *et al.* (2002), who employ CE data for an earlier period (1981–91). Whereas we employ only expenditure data from the CE interview survey, Cage *et al.* present a new methodology for using the CE diary survey to impute missing expenditure information for households in the interview survey.

[9]Our matching between the CPI and CE expenditure categories excludes a very small percentage of the expenditure categories in the CPI (less than 1 percent) and hence the CPI relative importance weights in the table do not sum to 100 percent.

TABLE 1

AVERAGE, STANDARD DEVIATION, CPI WEIGHT AND CORRELATIONS OF STRATA INFLATION RATES, 1987–2001

j	1 Food At Home	2 Food Away From Home	3 Alcoholic Beverages	4 Owned Dwellings	5 Rented Dwellings	6 Other Lodging	7 Utilities	8 Household Equip. And Oper.	9 Apparel	10 Vehicles	11 Gasoline	12 Other Vehicle Expenditures	13 Public Transportation	14 Health Care	15 Entertainment	16 Personal Care	17 Reading	18 Education	19 Tobacco
CPI weight and ANOVA of expenditure shares																			
CPI weight (%)	9.61	5.74	0.99	21.06	7.30	2.06	7.08	4.68	4.24	7.33	2.58	5.38	1.36	6.00	5.33	3.51	0.58	2.91	1.40
avg. share (%)	14.87	4.48	1.10	18.56	10.20	1.08	9.56	4.74	4.73	3.53	4.33	6.46	1.04	6.21	4.76	1.10	0.62	1.28	1.35
$s^2_{\text{within periods}}$*	10.29	2.99	0.64	15.74	27.20	1.34	4.24	6.09	2.96	19.69	1.70	5.06	1.10	34.60	3.49	0.23	0.10	3.16	0.81
$s^2_{\text{between periods}}$ **	8.79	1.15	0.31	24.33	2.08	0.81	6.08	2.13	7.81	3.38	1.81	1.33	0.17	5.26	2.34	0.03	0.09	2.89	0.19
Mean and standard deviation of strata specific inflation rates over sample period																			
Mean	3.31	2.88	3.30	3.71	3.27	5.26	2.49	0.87	1.27	1.83	3.82	3.80	4.09	5.57	2.79	2.82	3.45	6.61	8.75
Std. dev.	1.78	1.01	2.20	0.88	0.75	3.68	2.67	1.06	2.42	1.81	13.06	1.62	4.10	2.04	1.36	0.95	1.58	1.48	7.84
Correlations of strata specific inflation rates over sample period																			
1 Food at home	1	0.71	0.15	0.59	0.51	0.20	0.13	0.42	0.34	0.06	0.22	0.44	0.31	0.42	0.61	0.56	0.24	0.24	–0.05
2 Food away from home	0.71	1	0.46	0.80	0.75	0.39	0.04	0.41	0.60	–0.12	0.09	0.57	0.15	0.56	0.72	0.72	0.27	0.38	0.24
3 Alcoholic beverages	0.15	0.46	1	0.41	0.36	0.73	0.20	0.47	0.51	–0.03	0.07	0.48	0.10	0.63	0.62	0.46	0.56	0.51	0.21
4 Owned dwellings	0.59	0.80	0.41	1	0.71	0.39	0.00	0.62	0.70	0.11	0.07	0.72	0.16	0.74	0.77	0.75	0.44	0.63	0.11
5 Rented dwellings	0.51	0.75	0.36	0.71	1	0.23	0.31	0.28	0.26	–0.12	0.11	0.44	0.05	0.44	0.40	0.59	0.05	0.21	0.22
6 Other lodging	0.20	0.39	0.73	0.39	0.23	1	0.04	0.48	0.57	0.05	0.23	0.44	0.32	0.60	0.52	0.31	0.49	0.44	0.09
7 Utilities	0.13	0.04	0.20	0.00	0.31	0.04	1	0.04	–0.13	–0.18	0.43	0.00	0.16	0.07	0.05	0.15	–0.19	–0.10	–0.07
8 Household equip. and operat.	0.42	0.41	0.47	0.62	0.28	0.48	0.04	1	0.72	0.50	0.01	0.80	0.13	0.72	0.76	0.48	0.68	0.76	–0.30
9 Apparel	0.34	0.60	0.51	0.70	0.26	0.57	–0.13	0.72	1	0.24	0.05	0.74	0.21	0.74	0.79	0.57	0.55	0.77	–0.02
10 Vehicles	0.06	–0.12	–0.03	0.11	–0.12	0.05	–0.18	0.50	0.24	1	–0.10	0.42	0.01	0.36	0.23	–0.02	0.41	0.48	–0.39
11 Gasoline	0.22	0.09	0.07	0.07	0.11	0.23	0.43	0.01	0.05	–0.10	1	–0.12	0.35	0.07	0.04	0.16	–0.22	–0.11	0.15
12 Other vehicle expenditure	0.44	0.57	0.48	0.72	0.44	0.44	0.00	0.80	0.74	0.42	–0.12	1	0.13	0.85	0.79	0.48	0.61	0.87	–0.22
13 Public trans	0.31	0.15	0.10	0.16	0.05	0.32	0.16	0.13	0.21	0.01	0.35	0.13	1	0.30	0.25	0.24	0.05	0.16	–0.04
14 Health care	0.42	0.56	0.63	0.74	0.44	0.60	0.07	0.72	0.74	0.36	0.07	0.85	0.30	1	0.81	0.68	0.64	0.90	0.06
15 Entertainment	0.61	0.72	0.62	0.77	0.40	0.52	0.05	0.76	0.79	0.23	0.04	0.79	0.25	0.81	1	0.68	0.70	0.76	–0.08
16 Personal care	0.56	0.72	0.46	0.75	0.59	0.31	0.15	0.48	0.57	–0.02	0.16	0.48	0.24	0.68	0.68	1	0.35	0.49	0.32
17 Reading	0.24	0.27	0.56	0.44	0.05	0.49	–0.19	0.68	0.55	0.41	–0.22	0.61	0.05	0.64	0.70	0.35	1	0.66	–0.18
18 Education	0.24	0.38	0.51	0.63	0.21	0.44	–0.10	0.76	0.77	0.48	–0.11	0.87	0.16	0.90	0.76	0.49	0.66	1	–0.09
19 Tobacco	–0.05	0.24	0.21	0.11	0.22	0.09	–0.07	–0.30	–0.02	–0.39	0.15	–0.22	–0.04	0.06	–0.08	0.32	–0.18	–0.09	1

Note: *multiplied by 10^3, **multiplied by 10^5.

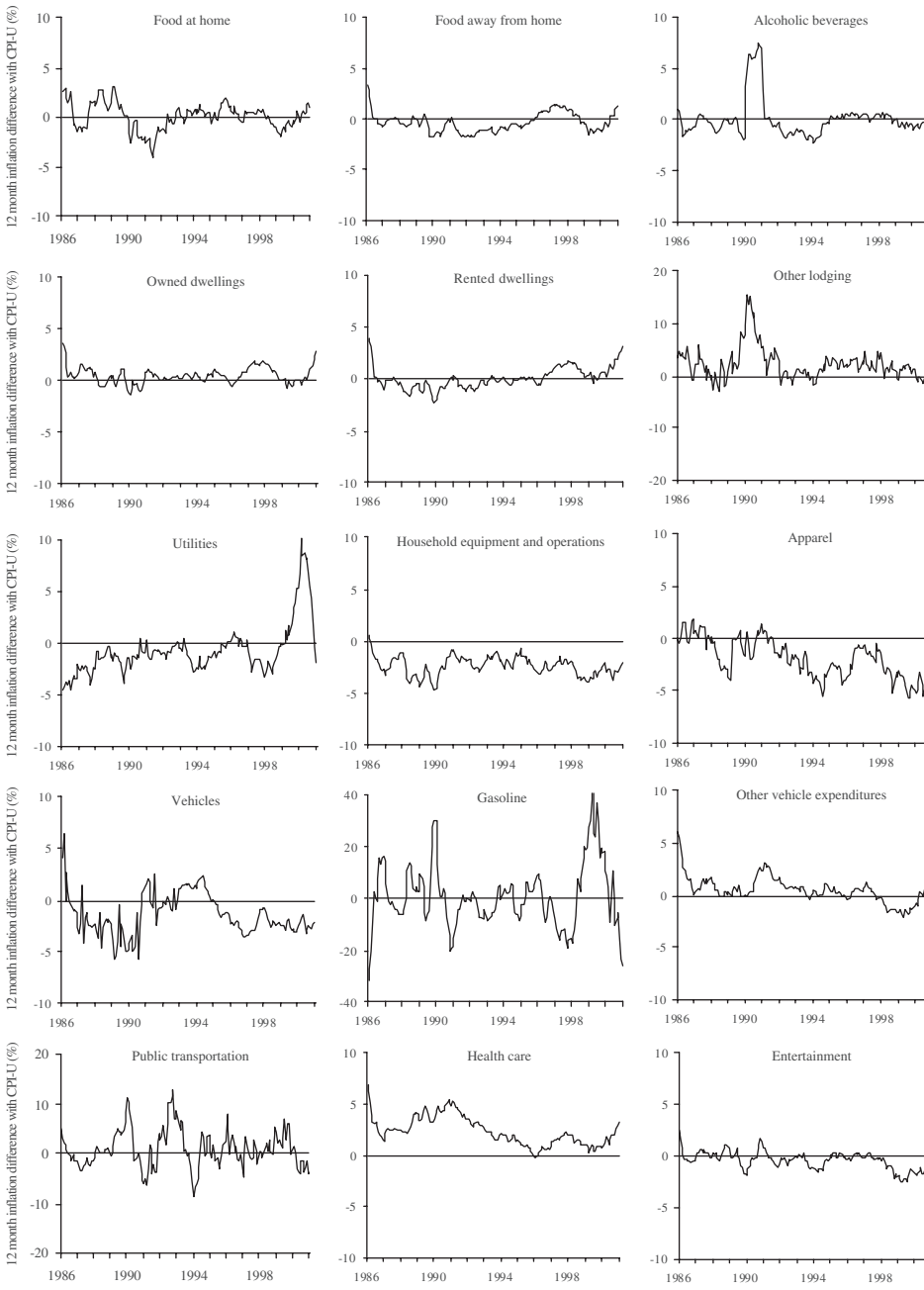

Figure 4. Cross-Strata Percentage-Point Deviation of Inflation from Overall CPI-U

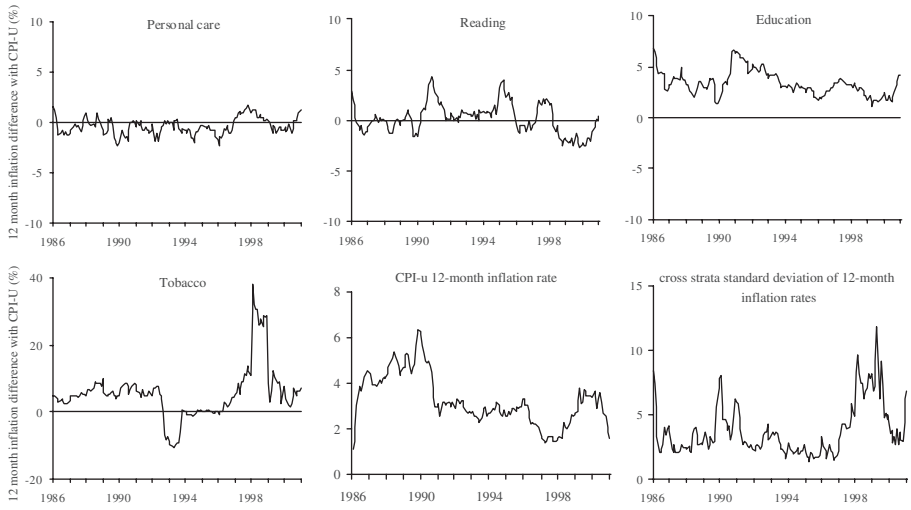

Figure 4. Continued

Variation in Expenditure Patterns

For our analysis of part (A) of equation (10) we perform an ANOVA of the expenditure shares of the households. That is, we decompose the expenditure share variance according to

$$s^2 = \frac{1}{\sum_{t=1}^{T} n_t} \sum_{t=1}^{T} \sum_{i=1}^{n_t} (w_{ijt} - \overline{w}_j)^2 \tag{11}$$

$$= \underbrace{\frac{1}{\sum_{t=1}^{T} n_t} \sum_{t=1}^{T} \sum_{i=1}^{n_t} (w_{ijt} - \overline{w}_{jt})^2}_{\text{within period variance}} + \underbrace{\frac{1}{\sum_{t=1}^{T} n_t} \sum_{i=1}^{T} n_t (\overline{w}_{jt} - \overline{w}_j)^2}_{\text{between period variance}}$$

where n_t is the number of households in the sample at time t,

$$\overline{w}_{jt} = \frac{1}{n_t} \sum_{i=1}^{n_t} w_{ijt} \tag{12}$$

is the average expenditure share of category j at time t, while

$$\overline{w}_j = \frac{1}{\sum_{i=1}^{T} n_t} \sum_{t=1}^{T} n_t \overline{w}_{jt} \tag{13}$$

is the average expenditure share over the whole sample period.

The ANOVA gives us an insight into the relative importance of fluctuations of average budget shares of different strata over time, i.e. the between-period variance, versus the variation in budget shares across households, i.e. the within-period variance. Equation (10) suggests that it is the latter that is necessary for cross-household heterogeneity of inflation rates.

The third and fourth rows in Table 1 list the within-period and between-period variance of the expenditure shares. We find that the cross-household variation of expenditure shares far outweighs the variation in average expenditure shares over times: The within-period variance for most categories is more than 100 times higher than the between-period variance. Consequently, part (A) of decomposition (10) gives rise to potentially large differences in cross-household inflation rates.[10]

Cross-Strata Variation in Inflation

In this subsection we will focus on the cross-strata inflation rates, as represented by part (B) of decomposition (10). To this end, we present some descriptive statistics on the inflation time series for the various goods categories.

This evidence is presented in two forms. The fifth and sixth rows of Table 1 list the average inflation rate and standard deviation for each of these series for the period 1987 through 2001. The importance of these series in the CPI is reflected by the listed CPI weights. Finally, Table 1 also contains the correlations between the item strata inflation rates over the same time period.

There are substantial differences between the average inflation rates across strata. On the lower end, with an average inflation rate below 2 percent, there are household operations and equipment, apparel and vehicles. On the high end we find health care (5.57 percent), education (6.61 percent), other lodging (5.26 percent) and tobacco (8.75 percent).[11] Tobacco inflation rates, however, are mainly driven by excise tax increases. These major differences in the average inflation rates of the various goods categories suggest that part (B) of the decomposition in (10) gives rise to large potential inflation differences.

Only considering average inflation rates, however, does not tell the whole story. The standard deviations reported in Table 1 suggest that there are large fluctuations over time in the inflation rates of the various goods categories. Furthermore, these fluctuations are highly correlated for the various categories. Many strata inflation rates have cross-correlation coefficients of 0.6 or higher, suggesting that the inflation rates for these categories have more than 60 percent of their fluctuations in common. This is not completely surprising if one believes that common price shocks, due to monetary policy actions, are one of the most important causes of inflation. There are a few categories that exhibit much lower correlation with other strata. These are the gas prices, and the price of tobacco.

Since there are such big fluctuations in cross-strata inflation rates, it seems worthwhile to consider inflation behavior over time for these categories. Doing so allows us to determine the periods in which part (B) of decomposition (10) has the biggest potential of driving cross-household heterogeneity in inflation rates.

[10]Several item strata stand out as having a particularly high within-period variation of shares, for example vehicles, food at home, and owned and rented dwellings. Owned and rented dwellings are high because a household is most likely either to own or to rent their home, but not both. Hence, a household's expenditure shares for these categories are generally positive for one and zero for the other. Vehicle expenditures vary a lot across households for a related reason. Households that operate a car but do not purchase one in a given period have relatively little expenditure on vehicles compared to those households that actually purchase a car in the period.

[11]"Other lodging" is comprised mainly of hotel and motel expenses, and living accommodations away from home for students.

Figure 4 plots the inflation rates for the 19 goods categories in deviation from overall CPI-U inflation. Each graph shows the 12-month percentage-point difference between inflation for a particular goods category and inflation for the CPI-U. Figure 4 also plots CPI-U inflation for the sample period (bottom row, middle column), as well as the sample standard deviation of the cross-strata inflation rates over time (bottom row, right column). It is worth noting that the cross-strata standard deviation is fairly constant at about 2.5 percent for most of the sample period. It shoots up in 1991 in response to gas price increases, and during the 1998–2000 period in reaction to gas price increases as well as taxes on tobacco. For two of the other item strata that had high average inflation besides tobacco, i.e. health care and education, we find the following. Medical care inflation was between 3 and 6 percentage points higher than CPI-U inflation for most of the 1987–94 period. However, after 1994 the inflation rate for medical care exceeded overall inflation by only between about 1 and 2 percentage points. For education, we find that its inflation rate was persistently between 2 and 6 percentage points higher than overall inflation over the whole sample period.

There are many categories whose inflation rate follows the overall CPI-U fairly closely. These categories are food at home, food away from home, owned dwellings, rented dwellings, entertainment, personal care and reading. As can be seen in Figure 4, these categories show relatively small (between –2 and 2 percentage point) deviations from the overall CPI. For these categories, which comprise a total of 53 percent of the CPI, part (B) of decomposition (10) will not be a significant source of differences in household inflation rates. In other words, these 53 percent of expenditures will give rise to very little inflation inequality across households.

Of the remaining categories, inflation rates seem to be substantially different from the overall CPI-U (at least at certain points) and are a likely source of cross-household differences in inflation rates. The most important item strata in this regard are those that are consistently higher or consistently lower than the CPI. From Figure 4 it can be seen that medical care, education and tobacco (consistently higher) and apparel, household operations and equipment, new and used vehicles (consistently lower) are the categories that most fit this description. Gasoline prices are by far the most volatile.

6. Inflation Differentials and Household Characteristics

So far, we have used our results to illustrate that there is substantial inequality in the changes of the cost of living faced by individual households. Is it possible to pinpoint particular groups of households that consistently face a different cost-of-living change than the representative household captured in the CPI-U? In order to answer this question we slice our sample according to various household characteristics and calculate group price indices.

Pollak (1980) was one of the first to propose the use of group price indices. Two examples of empirical work on group price indices are Amble and Stewart (1994) and Garner *et al*. (1996). They calculate such indices for the elderly and the poor respectively. In order to be comparable with the CPI, which is a plutocratic

index, group indices are generally constructed as plutocratic indexes as well. In order to contrast our results with earlier studies, in the analysis below we use *plutocratic* price indexes as well.

Let a specific group be defined as having household characteristics in a set G. That is, these are the households with $\mathbf{x}_{i,t-12} \in G$. The inflation rate measured by their plutocratic group price index is the sample equivalent of the population moment

$$\tilde{\pi}_t^G = \int_{x_{i,t-12} \in G} \left[\int \tilde{\pi}_{i,t} g_{\pi|y,\mathbf{x}}(\tilde{\pi}_{i,t}|y_{i,t-12}, \mathbf{x}_{i,t-12}) d\tilde{\pi}_{i,t} \right] \cdot \left(\frac{y_{i,t-12} g_{y|\mathbf{x}}(y_{i,t-12}|\mathbf{x}_{i,t-12})}{\int y g_{y|x}(y|\mathbf{x}_{i,t-12}) dy} \right) \cdot \tag{14}$$

$$\cdot dy_{i,t} \left(\frac{g_{\mathbf{x}}(\mathbf{x}_{i,t-12})}{\int_{x \in G} g_{\mathbf{x}}(\mathbf{x}) d\mathbf{x}} \right) d\mathbf{x}_{i,t-12}$$

This equation consists of three parts. The first part, i.e.

$$E[\tilde{\pi}_{i,t}|y_{i,t-12}, \mathbf{x}_{i,t-12}] = \left[\int \tilde{\pi}_{i,t} g_{\pi|y,\mathbf{x}}(\tilde{\pi}_{i,t}|y_{i,t-12}, \mathbf{x}_{i,t-12}) d\tilde{\pi}_{i,t} \right] \tag{15}$$

is the expected inflation rate faced by a household with expenditures $y_{i,t-12}$ and characteristics $\mathbf{x}_{i,t-12}$. The second part, i.e.

$$\int E[\tilde{\pi}_{i,t}|y_{i,t-12}, \mathbf{x}_{i,t-12}] \cdot \left(\frac{y_{i,t-12} g_{y|\mathbf{x}}(y_{i,t-12}|\mathbf{x}_{i,t-12})}{\int y g_{y|\mathbf{x}}(y|\mathbf{x}_{i,t-12}) dy} \right) dy_{i,t} \tag{16}$$

is the inflation rate given by a plutocratic index for households with characteristics $\mathbf{x}_{i,t-12}$. Finally, (14) is obtained by integrating out the household characteristics over the set of characteristics, G, that defines the group under consideration.

We will focus on four particular divisions of the sample of households: (i) elderly households versus non-elderly households; (ii) households whose reference person is white versus households with a non-white reference person; (iii) poor versus non-poor households; and (iv) households with children less than 18 years old versus other households. The results for the group price indexes for these four groups are presented in Figures 5–8. Each of these figures plots the *differential* between the two group inflation rates (i.e. elderly inflation minus non-elderly inflation, etc). The figures also provide 95 percent confidence intervals for each of the group differentials, which appear as a shaded region on each graph.

Figure 5 contains our results for elderly versus non-elderly households. Similar to Amble and Stewart (1994), we define elderly households as those that have a reference person or spouse over the age of 61. We find that elderly households faced inflation rates roughly 0.2 to 0.3 percentage points higher than non-elderly households over our sample period, on average. This differential is statistically significant from zero throughout most of the period. Our results for the earlier part of our sample period are very similar to those of Amble and Stewart who found that for the period 1987–94 the elderly faced an inflation rate that was generally between 0.2 and 0.4 percentage points higher than that of others.

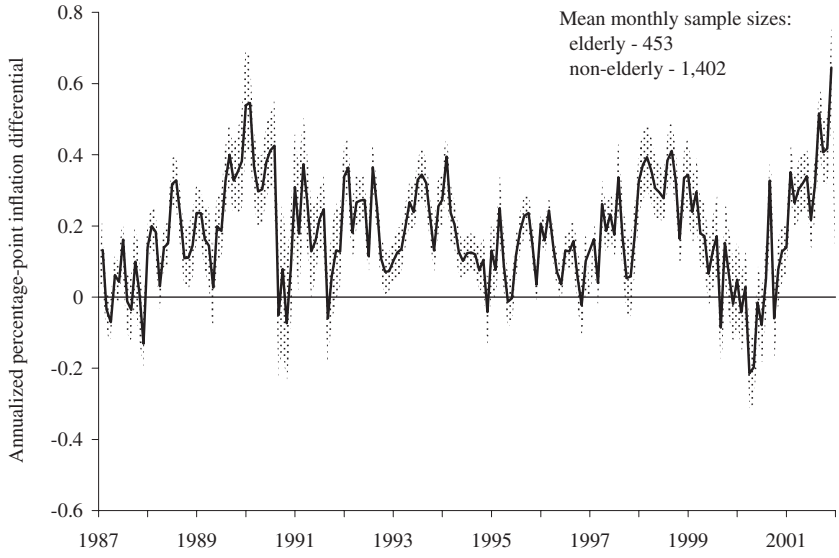

Figure 5. Inflation Differential for Elderly and Non-Elderly Households

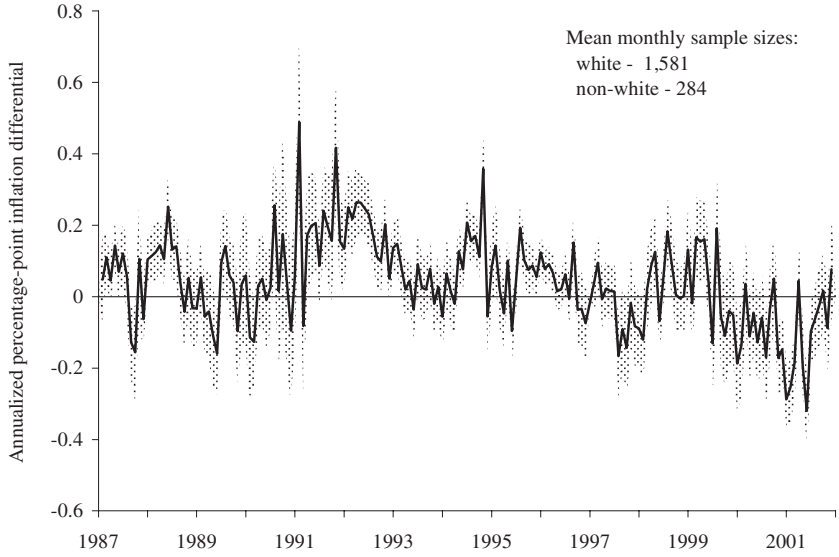

Figure 6. Inflation Differential for White and Non-White Households

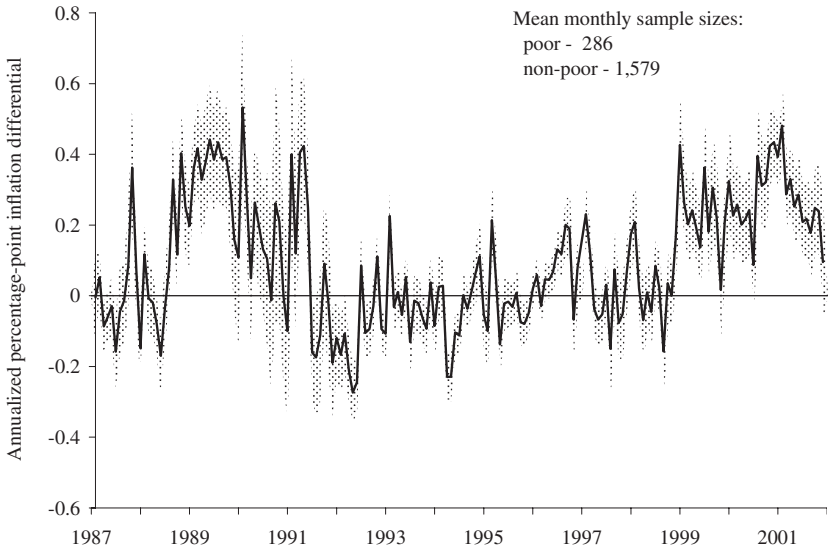

Figure 7. Inflation Differential for Poor and Non-Poor Households

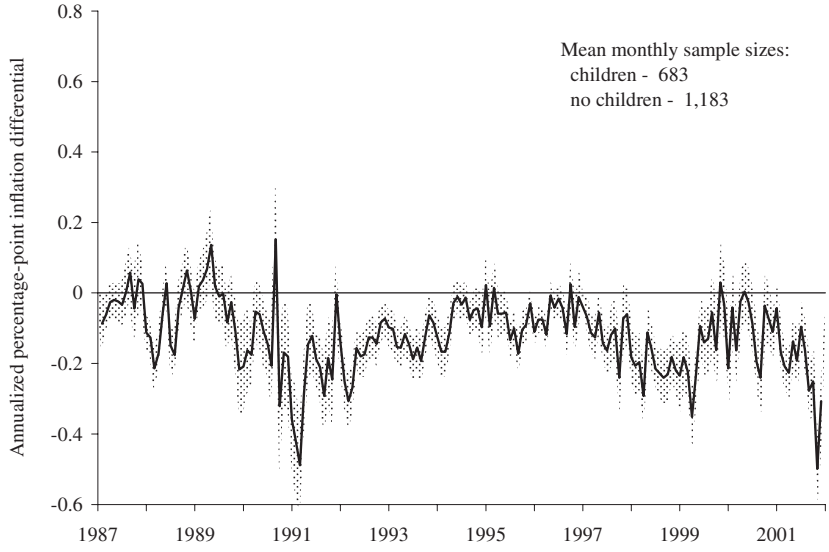

Figure 8. Inflation Differential for Households with Children Less Than 18 and Other Households

The question whether the elderly face different inflation from other groups is particularly important because Social Security benefits are indexed to inflation using the CPI-W, which is a consumer price index for urban wage earners and clerical workers. The reasoning for such indexation is to prevent an erosion of the purchasing power of the benefits paid to the elderly. However, if the CPI-W does not properly reflect the cost of living changes that the elderly face, then the CPI-W would not be the appropriate price index on which to base Social Security indexation. In particular, in the face of higher-than-average price rises for the elderly, indexation to the CPI-W, as opposed to price index that exclusively captures the spending patterns of the elderly, would lead to an erosion of the real purchasing power of the elderly. For this reason, a current proposal in the House of Representatives (H.R.2035, 2001) would require the Bureau of Labor Statistics to produce an official CPI for the elderly (CPI-E).

To give a sense of how substantial this purchasing power erosion is in practice, Hobijn and Lagakos (2003) consider the following question. If the Social Security system would have indexed Social Security benefits to a CPI for the elderly (instead of the CPI-W) starting in 1984, how much higher would the average Social Security benefit be today? We find that under this alternative indexing, the average Social Security recipient today would receive roughly 3.8 percent more in benefits than they currently do, which amounts to $408 per year per recipient, on average. This suggests that the decline in the purchasing power of the elderly under the current system is in fact substantial, and that the elderly/non-elderly inflation differentials found in the present study are significant in an economic sense.

One question that arises is the source of these higher inflation rates for the elderly. From what we can tell, the difference appears to be mainly driven by higher medical care expenditure shares for the elderly. This share is about 10 percent for the elderly, which is almost twice as high as for the overall sample. Interestingly, Crawford and Smith (2002) find that in the U.K., because of the presence of the National Health System, elderly households have not faced higher increases in their cost of living. In fact, elderly British elderly households have faced a slightly lower increase in their cost of living than other households.

Turning to the next group comparison, Figure 6 shows the differences in inflation between whites and non-whites. In this comparison, "whites" are taken to be households whose reference person in the CE reports him/herself to be white. As can be seen from the lower panel of Figure 6, we do not find substantial differences between inflation rates for these two groups; the average differential is small in magnitude, and is statistically insignificant from zero for much of the sample period. Our results differ from those of Hamilton (2001) who found that blacks tended to face lower inflation than whites over the period 1974 through 1991. Hamilton found that cumulative inflation for blacks was around 15 percent lower than for whites, which amounts to a yearly average difference of around –0.8 percentage points. However, our methods as well as time period are different from Hamilton, who uses PSID data and only two goods categories: food and all other expenditures.

Figure 7 displays our results for poor and non-poor households. We define poor households here to be households whose reported incomes qualified as being

below the official Census Bureau poverty threshold.[12] Just as in Garner *et al*. (1996), we include only those households that the CE survey deems to be complete income reporters. We find that, although the average difference in inflation for these two groups is small (less than 0.1 percentage points on average), poor households face substantially higher inflation rates in certain periods. These periods are when gas price inflation is particularly high, like 1989–91 and 1999–2001. This is consistent with the evidence presented in Garner *et al*. (1996), who document that the poor faced above-average inflation in 1990 and 1991. For the period 1984–94, Garner *et al*. find cumulative inflation for poor households roughly 0.5 percentage points higher than for all households, which amounts to an average annual differential of 0.05 percentage points per year. In contrast to our findings, Cage *et al*. (2002) find that between 1981 and 1991, for most sized households, households with lower expenditures (and hence less income, most likely) faced *lower* inflation than households with higher expenditures. However, again these differences are not too large. For example, for households with three members, households with low total expenditures had cumulative inflation from 1981 to 1991 around 1.4 percentage points lower than households with higher expenditures, which is around –0.1 percentage points per year.

Figure 8 displays our results for households with children under 18 versus other households. We find that households with children under 18 faced lower inflation than other households, in general. The average difference was around –0.2 percentage points per year, and was statistically significant from zero for much of the sample period. This result seems mainly due to these households generally having lower health care expenditures and lower expenditures on college tuition than households with college-aged children. It is also quite possible that our results can be largely accounted for by elderly households, who form a large component of the households without children under 18, and who had higher-than-average inflation over our time period. Our results complement the results of Idson and Miller (1999) who find an average annual differential of around –0.1 percentage points in the earlier period 1969–87.

7. Persistence of Inflation Differentials

In this final part of our analysis we consider how persistent inflation differentials are over time at the household level. Specifically, we ask whether households that face above-average (below-average) inflation in one year tend to face above-average (below-average) inflation in the next year as well. Although we have already seen that certain groups exhibit substantial persistence over time (e.g. the elderly and households with younger children), the question remains to what extent, in the whole population, households tend to have inflation rates that are persistently different from the average over time.

One motivation for this question is the following: as we have discussed, the CPI can be thought of as a summary statistic of the underlying distribution of

[12]Note that the poverty thresholds are a function of not only income but number of members in the household and number of children in the household. Poverty thresholds are higher for households with larger numbers of children and other household members.

household inflation rates. Since monetary policy makers commonly base decisions at least in part on a CPI measure of inflation, it is worthwile to consider the extent to which the CPI actually reasonably captures the inflation experiences of most households. If a majority of households have inflation experiences that are consistently different from the CPI year after year, we have reason to be concerned about what the CPI-U is actually capturing.

We are not the first to consider the issue of inflation persistence. Michael (1979) measured household inflation rates for the two years 1972 and 1973 for the same set of households and found that the correlation of inflation rates in the two years was 0.65. This suggests that, at least in some periods, households that face above-average inflation one year also face above-average inflation the next.

Since we do not observe each household at two periods twelve months apart, we address the issue in a different manner from Michael. Our approach is as follows. Consider, at a fixed month t, the distribution of household inflation rates, $\tilde{\pi}_{i,t}$. Recall that these inflation rates were calculated using the expenditure weights for the households in the sample exactly twelve months earlier, w_{ijt-12}. What we do is to assume that this same set of households each purchased the same basket of goods and services one year later, i.e. $w_{ijt-12} = w_{ijt}$. Then, using these new household-level weights w_{ijt} we calculate a second inflation rate for each household, for the period twelve months after month t, $\tilde{\pi}_{i,t+12}$. We then measure how far above or below average each household's inflation rate was in each of the two consecutive periods. We do this for all households in the sample. Finally we follow Quah (1997) and present non-parametric kernel density estimates for the conditional distribution of the next year's deviation from average inflation conditional on this year's deviation from average inflation. This density estimate allows us to measure what a household's deviation from average inflation is likely to be next year given this year's deviation from average inflation.

A limitation of this analysis is that it is likely to *overstate* inflation in the second year ($\tilde{\pi}_{i,t+12}$) since households update their expenditure weights by substituting away from more expensive goods. In contrast, we explicitly assume that no substitution takes place. In other words, our analysis is subject to the standard substitution bias introduced in any fixed-weight inflation measure. However, this bias cannot be avoided as we do not observe each household at two periods twelve months apart.

Figure 9 plots the isoprobs of the conditional distribution (thin lines) as well as the conditional expectation (thick line). The figure also contains two dashed lines which represent two polar cases. The first line is the 45-degree line which represents full persistence. Full persistence would imply that the conditional expectation of next year's deviation from average inflation would equal the current deviation from average inflation. The second line represents zero deviation from average inflation one year hence, and represents no persistence. No persistence implies that no matter how different from average a household's inflation experience is in one year, the household is likely to experience average inflation in the following year.

What we observe is far from full persistence. In fact, for households that currently face below-average inflation we find that the expected deviation from average inflation is virtually zero a year from now. Households with higher than average

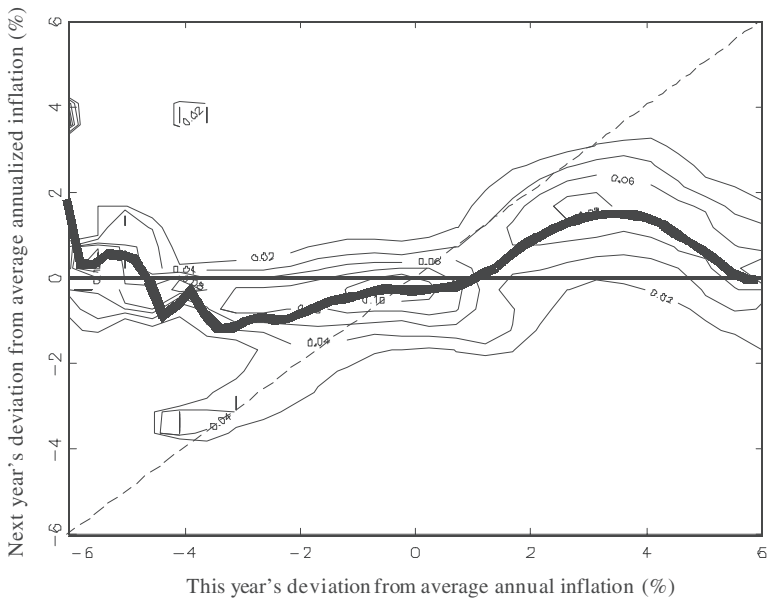

Figure 9. Persistence of Inflation Differentials across Households—Estimate of Conditional Density

inflation this year tend to face slightly higher than average inflation next year. For example, we estimate that a household with inflation of 2 percentage points above average this year will have inflation 0.5 percentage points above average next year. This suggests that inflation is somewhat persistent for households with above-average inflation today, at least for some household groups, although this persistence does not appear to be too drastic. Given that our measure of next year's inflation is probably biased upwards due to substation bias, there is even less reason to feel that there is much persistence in inflation differentials for the whole population. We definitely find much less persistence in inflation rates across households than Michael (1979) did for 1972 and 1973.

8. Conclusion

Does the CPI-U capture the inflation experience of the average American household? Our results suggest that the answer is affirmative. Apart from the substitution bias induced by the infrequent updating of the expenditure weights, the CPI methodology yields inflation estimates that closely follow the mean, median, and mode of the cross-household distribution of inflation rates. Furthermore, we find that, when looking at the whole population, individual households that are confronted with above-average inflation in one year are not likely to experience inflation that is as high in the subsequent year.

However, household-specific inflation rates tend to vary substantially around the mean inflation rate. The disparities in household-specific inflation rates are in large part due to relative price changes of three goods categories. These are education and health care, which both exhibited persistently higher-than-average

inflation over our sample period, and gasoline prices, for which inflation tended to fluctuate drastically.

We find that the cost of living increases were generally higher for the elderly over the last 15 years, in large part because of their substantial health care expenditures. Furthermore, the cost of living of poorer households is most sensitive to (the historically large) fluctuations in gasoline prices. Finally, households with children under the age of 18 faced lower-than-average inflation rates over our sample period.

This combination of results leads us to believe that the CPI-U is a reasonable measure of aggregate inflation, but that one has to be careful when assuming that CPI-U inflation accurately represents cost-of-living changes for particular subgroups.

Appendix

Households

We use the word "household" to mean "consumer unit" (CU), the term used in the CE. Any individual that makes his/her purchasing decisions alone, or any such group of people, be they related or unrelated, comprises a consumer unit. We use the CE variable NEWID as a unique identifier for each CU. We included an observation in our data for each CU for each month in which the CU reports expenditure data.

Consumer Expenditure Survey

The Consumer Expenditure survey is a comprehensive survey on the buying patterns of American Consumers. The survey consists of two components, a quarterly Interview Survey and a weekly Diary Survey. For this paper, we use only the quarterly Interview survey, for the years 1986 through 2000.[13] In each quarter, approximately 5,000 households are interviewed (7,500 after 1999). Each household in the survey is interviewed for five quarters consecutively (every three months). In the initial interview, information is collected on demographic and family characteristics, among other things. In the subsequent four interviews, expenditure data is collected for the three months prior to the month of the interview.

Price Indexes

As much as possible we have matched up expenditure categories with CPI price indexes. In cases where expenditure categories do not match exactly with available CPI price indexes, we create our own indexes by combing the CPI series that most appropriately match our categories. The weights used to combine the CPI series are the base "relative importance weights" in a base year, and those base year weights adjusted for changes in relative prices in all other years. In most cases base weights can be found in the BLS table "Relative Importance in the CPI." In all cases the CPI series we use are the non-seasonally adjusted "US City Average" series for all urban consumers.

[13]Since the inflation rates we construct use Laysperes (forward-looking) price indexes, the sample period for our household inflation rates is 1987–2001, i.e. shifted one year ahead of our data from the interview survey.

TABLE A1

DESCRIPTION OF GOODS CATEGORIES AND MATCHING BETWEEN CE AND CPI

	CE Expenditure Category(s)	CPI Series
1	**Food at Home** (food purchased at grocery or other food stores, excluding alcoholic beverages)	**Food at Home**
2	**Food Away from Home** (excluding alcoholic beverages)	**Food Away from Home**
3	**Alcoholic Beverages** (purchased for consumption at or away from home)	**Alcoholic Beverages**
4	**Rental Equivalence Value of Owned Dwellings** (as reported by the consumer unit)	**Owners' Equivalent Rent of Primary Residence**
5	**Rented Dwellings** (includes rent, renter's insurance, expenses for repairs and maintenance, and other housing expenses)	**Rent of Primary Residence**
6	**Other Lodging** (lodging away from primary residence)	**Lodging away from home** (since 1997) **Lodging while out of town** (before 1997)
7	**Utilities** (includes electricity, natural gas and other fuels, water, garbage collection, telephone charges)	**Fuels and Utilities** **Telephone Service**
8	**Household Equipment** (furniture, household decorations, personal computers, household appliances) **Household Operations** (domestic services, child care, etc)	**Household Equipment and Operations** **Information Processing other than Telephone** (personal computers and peripherals, computer hardware and software)
9	**Apparel** (clothing purchases and upkeep)	**Apparel**
10	**Vehicles** (new and used cars, trucks and other vehicles)	**New and Used Motor Vehicles** (since 1993) **New Motor Vehicles** (before 1993) **Used Motor Vehicles** (before 1993)
11	**Gasoline** (and motor oil)	**Motor Fuel**
12	**Other Vehicle Expenses**	**Vehicle Parts and Equipment** **Vehicle Maintenance and Repair** **Motor Vehicle Insurance** **Motor Vehicle Fees**
13	**Public Transportation**	**Public Transportation**
14	**Health Care** (health insurance, medical services, drugs, medical supplies)	**Medical Care**
15	**Entertainment** (includes fees and admissions, television, audio and video equipment, pets, toys, hobbies, other entertainment equipment)	**Recreation**
16	**Personal Care** (includes hair products and services, cosmetic and bath products, other personal goods and services)	**Personal Care** (hair, dental and shaving goods and services, funeral expenses, financial services, laundry services)
17	**Reading** (includes magazine and newspaper subscriptions, books)	**Recreational Reading Materials**
18	**Education** (includes tuition and fees for universities, primary, secondary, and nursery schools; textbooks, educational equipment)	**Educational Books and Supplies** **Tuition, Fees, and Child Care**
19	**Tobacco**	**Tobacco**

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