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# AMERICAN LIVING STANDARDS, 1888-1994: EVIDENCE FROM CONSUMER EXPENDITURES

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## ABSTRACT

I use micro data on food and recreation expenditures from 1888 to 1994 to provide the first estimates of overall CPI bias prior to the 1970s and new estimates of bias since the 1970s and to reassess long-run growth rates. I find that CPI bias was -0.1 percentage points per year between 1888 and 1919 and rose to 0.7 percentage points per year between 1919 and 1935. CPI bias was low in the 1950s and 0.3 percentage points per year in the 1960s and then rose to 2.7 percentage points per year between 1973 and 1982 before falling to 0.6 percentage points per year between 1983 and 1994. Inadequately accounting for the introduction of new consumer goods probably was the biggest source of bias between 1919 and 1935. Revised growth rates suggest that despite the Great Depression real per capita personal income was not falling but was rising by 0.5 percentage points per year between 1919 and 1935 and that growth rates were not stagnant in the 1970s but were almost as high as in the 1960s (4.0 and 3.2 in the 1960s and 1970s, respectively).

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# 1 Introduction

Accurately measuring changes in the cost of living is central to calculating real growth rates; but, there has been no work quantifying the extent of overall CPI bias prior to the 1970s. The 1961 Stigler Commission concluded that virtually all economists would agree that there was upward bias in the various price indexes that they reviewed but the Commission presented no numerical estimates of bias (National Bureau of Economic Research. Price Statistics Review Committee. 1961). The Boskin Commission (Boskin et al. 1998) argued that CPI bias is probably greater now than it was in the past because the number of goods has grown, because a greater rate of technological change is leading to more rapid price shifts, and because demand has shifted towards services and quality, making the task of measurement much harder. However, studies of CPI bias in specific goods or commodities suggest that bias may have been greater prior to the 1950s than afterwards. Nordhaus (1997) estimates that the largest changes in the quality adjusted price of lighting between 1800 to 1992 occurred between 1860 and 1950. Raff and Trajtenberg's (1997) study implies that most of the real change in the quality adjusted price of autos between 1906 to 1982 occurred prior to 1940.

This paper uses micro data on food and recreational expenditures from as far back as 1888 and Engel's Law to provide the first estimates of overall annual bias in the Consumer Price Index (CPI) prior to the 1970s as well as new estimates of bias since the 1970s. Engel's Law states that as income rises the budget share spent on such necessities as food falls and the share spent on such luxuries as recreation rises. Controlling for changes in relative prices and in demographic characteristics, trends in food and recreation budget shares should therefore mirror increases in real income. Deviation in trend between food shares and income growth suggests that the CPI does not adequately account for quality changes that increase the durability of foods, the late introduction of new goods into the CPI, consumer substitution, and changes in the distribution

network. Deviation in trend between recreation shares and income growth additionally indicate improvements in the standard of living arising from increases in leisure time.

I begin the paper with a discussion of long-term trends in real per capita income and in expenditure shares devoted to food and to recreation. The empirical methodology is outlined in the next section. I then describe the data and present the results. Before concluding, I discuss the implications of the findings for measured growth rates.

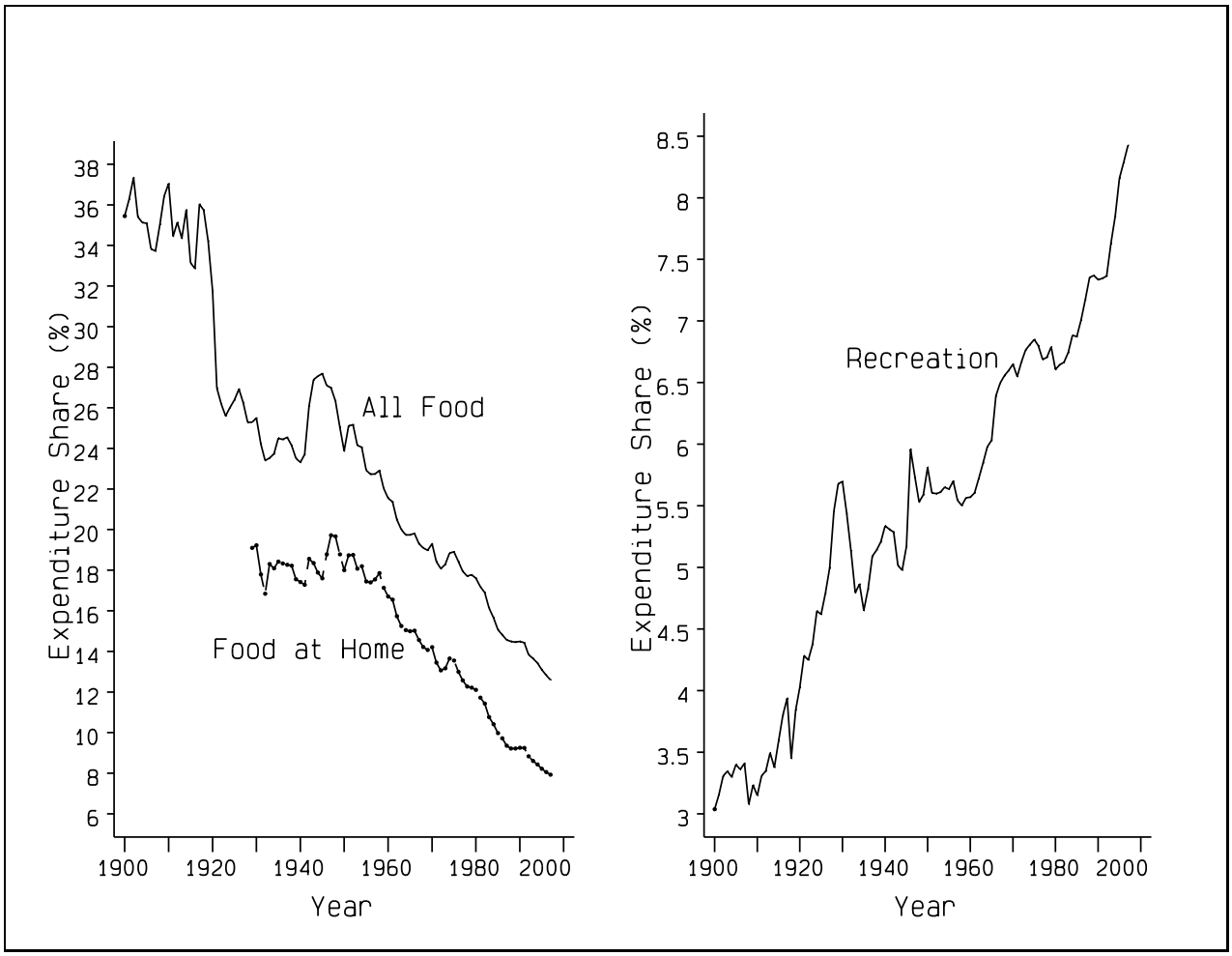
## 2 Trends

Trends in the share of expenditures devoted to food and to recreation from the National Income and Product Accounts contraindicate trends in real per capita income and expenditures deflated by the CPI in the 1920s, 1970s, and 1980s (see Figures 1 and 2). After growing at a rate of 2.7 percentage points per year between 1899 and 1919, real personal income per capita grew only by 1.3 percentage points per year between 1919 and 1929 before declining during the Great Depression. But, although in 1935 real income per capita was below its 1919 level, the expenditure share of food fell from 34 to 26 percent between these years and the share of recreation increased from 4 to 5 percent, implying that real incomes were higher. Trends in food and recreation shares between 1973 and 1994 are comparable to those observed between 1950 and 1972 and suggest that growth rates between 1973 and 1994 were as high as those between 1950 and 1972 (3.5 percentage points per year) even though measured growth rates were lower (1.4 percentage points per year).[1]

Inconsistency between trends in real income and trends in food and recreation shares could arise from either CPI bias, changes in demographic characteristics, or declines in the

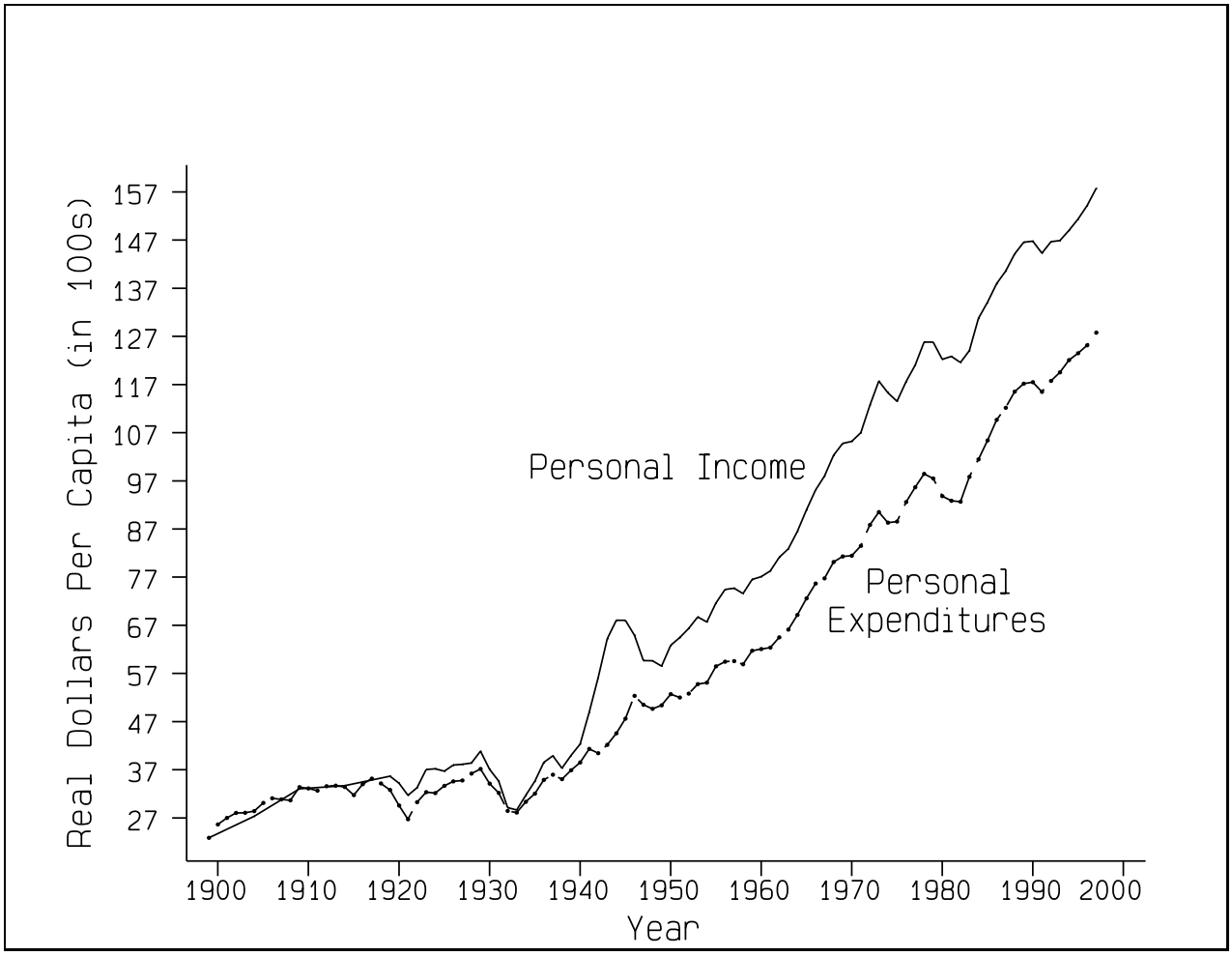
[1]Between 1950 and 1972 the share of food at home fell from 15 to 11 percent and the share of recreation rose from 6 to 7 percent. By 1994 the share of food at home stood at 7 percent and the share of recreation at 8 percent.

Figure 1: Share of Personal Expenditures Devoted to Food and Recreation, 1900-1997




*Note.* Figures for 1929-1997 are from the National Income and Product Accounts and were obtained as a machine readable file from the U.S. Department of Commerce. Expenditures on food and recreation prior to 1929 are from Lebergott (1996: 148-153). Recreation includes entertainment and reading. Expenditures include not only those of individuals but also those of non-profit institutions, private trust funds, and private health and welfare funds.

Figure 2: Real Personal Income and Expenditures Per Capita, 1899-1997




*Note.* All numbers are in constant 1982-1984 dollars and are deflated using the CPI (see the BLS web page and series E 135-166 in U.S. Bureau of the Census 1975: 210). Figures for 1929-1997 are from the National Income and Product Accounts and were obtained as a machine readable file from the U.S. Department of Commerce. The earlier figures for personal expenditures are from Lebergott (1996: 148-153). The figures for personal income prior to 1929 used the growth rates in Series F 6-9 in U.S. Bureau of the Census (1975: 224). Personal income and expenditures include not only those of individuals but also of non-profit institutions, private trust funds and private health and welfare funds.

relative prices of food and of recreation. The relative price of food fell sharply during the Great Depression and the relative price of recreation fell during the first quarter of the twentieth century. In the next sections I therefore formally control for price changes and for changes in demographic characteristics.

# 3 Empirical Methodology

I document trends in the standard of living by tracking trends in the share of food eaten at home, total food, and recreation. The advantage of using food and recreation as indicator goods is that because their income elasticities are substantially different from one, their budget shares are sensitive to the mismeasurement of income. Food has the additional advantages of being a non-durable and of arguably being strongly separable from other goods in consumers' utility functions, implying that CPI bias in such goods as cars will not affect food's budget share through any complementarities or substitutabilities (Hamilton 1998). The advantage of food at home over total food as an indicator is that an equation in which the expenditure share on all food is the dependent variable should include the relative price of restaurant meals on the right hand side unless food at home and food eaten out are perfect substitutes. Because price indices for restaurant meals will suffer from CPI bias, this will complicate estimates of bias. However, I use total food as an indicator as well (omitting the relative price of restaurant meals in estimation) because it is the only food indicator available in 1888-90.[2] The advantage of recreation is that because recreation requires time and because many of the complements to recreation such as public parks and sports facilities are publically provided, estimated CPI bias will reflect changes in hours of work and in public investments as well and therefore provide a broader measure of

[2]Because the share of food eaten out was small in the 1910s and probably even smaller in the 1890s, this should not materially affect the bias results for the end of the nineteenth century and the beginning of the twentieth.

changes in the standard of living.

Hamilton (1998) shows how to use different years of cross-sectional micro data and geographic and temporal varation in inflation rates of all goods and of the indicator good to identify CPI bias. He begins with the basic demand structure,

$$w_{i,j,t} = \phi + \gamma(\ln P_{I,j,t} - \ln P_{N,j,t}) + \beta(\ln Y_{i,j,t} - \ln P_{j,t}) + \mathbf{X}'\theta + u_{i,j,t} \tag{1}$$

where the subscripts refer to an individual household i, to region j, to time period t, to the indicator good I, and the non-indicator good N; and where w is the share, P is the true but unobserved price, X is a vector of individual household characteristics, and u is an error term. Because the true cost of living is a weighted average of food and non-food and because all prices are measured with error, Equation 1 can be written as

$$\begin{aligned} w_{i,j,t} \quad = \quad & \phi + \gamma(\ln(1+\Pi_{I,j,t}) - \ln(1+\Pi_{I,j,t})) + \\ & \beta(\ln Y_{i,j,t} - \ln(1+\Pi_{j,t})) + \mathbf{X}'\theta + \\ & \gamma(\ln(1+E_{I,t}) - ln(1+E_{N,t})) - \beta E_t + \\ & \gamma(\ln P_{I,j,0} - \ln P_{N,j,0}) - \beta P_{j,0} + u_{i,j,t} \end{aligned} \tag{2}$$

where $\Pi$ is the cumulative percent increase in the CPI measured price and E is the year-t percent measurement error in cumulative inflation. The empirical specification then becomes

$$\begin{aligned} w_{i,j,t} \quad = \quad & \phi + \gamma(\ln(1+\Pi_{I,j,t}) - \ln(1+\Pi_{I,j,t})) + \\ & \beta(\ln Y_{i,j,t} - \ln(1+\Pi_{j,t})) + \mathbf{X}'\theta + \\ & \sum_{t=1}^{T} \delta_t D_t + \sum_{j=1} \delta_j D_j + u_{i,j,t} \end{aligned} \tag{3}$$

where the $D_t$ are time dummies and the $D_j$ are regional dummies. Because

$$\delta_t = \gamma(\ln(1 + E_{I,t}) - ln(1 + E_{N,t})) - \beta E_t \,, \tag{4}$$

then, assuming that the relative bias between the indicator and non-indicator good is constant across years and that the prices of the indicator good and the non-indicator good are equally biased,

$$\ln(1 + E_t) = \frac{-\delta}{\beta} \,. \tag{5}$$

Cumulative percent CPI bias at time t is therefore

$$1 - \exp(\frac{-\delta}{\beta}) \,. \tag{6}$$

If the indicator good is less badly biased than the non-indicator good (as is arguably true for food), then Equation 6 will understate the bias. If the indicator good is more badly biased, then Equation 6 will overstate the bias.

Hamilton (1998) also shows how to control for relative price changes when geographic variation in the price of the indicator good is unavailable. Without geographic variation in the price of the indicator good, Equation 3 becomes

$$w_{i,t} \;=\; \phi + \beta(\ln Y_{i,t} - \ln(1 + \Pi_t)) + \mathbf{X}'\theta + \sum_{t=1}^{T} \delta_t D_t + u_{i,t} \,. \tag{7}$$

Given $\gamma$ and relative price changes, cumulative percent CPI bias at time t is

$$1 - \exp(\frac{\delta - \gamma(\ln(1 + \Pi_{I,t}) - \ln(1 + \Pi_{N,t}))}{-\beta}) \,. \tag{8}$$

An advantage of the specification given in Equation 7 is that it easily accomodates different functional form, such as

$$\begin{aligned} w_{i,t} &= \phi + \beta_1(\ln Y_{i,t} - \ln(1+\Pi_t)) + \beta_2(\ln Y_{i,t} - \ln(1+\Pi_t)^2 + \\ &\quad \mathbf{X}'\theta + \sum_{t=1}^{T} \delta_t D_t + u_{i,t}\,. \end{aligned} \tag{9}$$

Correcting for relative price changes, cumulative CPI bias at time t becomes

$$1 - \exp\left(\frac{\beta_1 \pm \sqrt{\beta_1^2 - 4\beta_2(-\delta_t + \gamma(\ln(1+\Pi_{I,t}) - \ln(1+\Pi_{N,t}))}}{2\beta_2}\right). \tag{10}$$

I can roughly estimate CPI bias without controlling for relative price changes in years when consumer expenditure surveys are unavailable. First estimate the single cross-section in year T,

$$w_i = \phi + \beta \ln Y_i + \mathbf{X}'\theta + u_i \tag{11}$$

where $Y_i$ is inflation adjusted (with CPI bias) income. Then, predict inflation adjusted income for a household given the share of the indicator good from the NIPA numbers and given demographic characteristics for year $T$ and year $T+1$ and obtain the percent increase. The difference between the predicted increase and the actual increase will yield a rough measure of CPI bias.

# 4 Data

In 1888-90 the United States Department of Labor undertook the first nationwide consumer expenditure survey. I use this survey, as well as those of 1917-19, 1935-36, 1960-61, 1972-

73, and 1980-94.[3] The post-war surveys cover a representative sample of the United States population. As detailed in the Data Appendix, the pre-war surveys were more specialized. One major difference is that the early surveys did not cover "slum or charity" families and those before 1935 did not cover higher income families. These differences in population coverage will not affect estimates of CPI bias, provided that there is enough overlap in income across surveys, because identification comes from comparing food and recreation expenditure shares of households with the same inflation adjusted income controlling for demographic characteristics.

I impose several restrictions on the samples both to exclude suspect observations and observations where food demand may be unusual and to obtain more comparable populations across surveys. I restrict all surveys to urban families, to husband and wife families, to families in the post-war period who were not receiving welfare or food stamps, to families where the husband was age 21-64, and to families where the husband was in the labor force. I exclude observations in which the share of expenditures devoted to food was less than 0.05 or greater than 0.8 and in which the share of expenditures devoted to recreation was greater than 0.7. In the post-war period I also exclude families containing adults over age 25 other than the husband and wife.

I create regional price indexes for 4 census regions for all items, for food, and non-food beginning in 1917 and for recreation and non-recreation beginning in 1960. These indexes can be used to compare changes in the cost of living across census regions. The Data Appendix details their construction. Inflation adjustment for the 1972-73 and 1960-61 surveys is for two different years, for the 1935-36 survey for one year only (the survey predominately covers expenditures in 1935), and for the 1917-19 survey on a monthly basis because of high war-time inflation and

[3]The surveys used in this paper are the Department of Labor's *Cost of Living of Industrial Workers in the United States and Europe, 1888-1890*; the Bureau of Labor Statistics' *Cost of Living in the United States, 1917-1919*; the Department of Labor and Department of Agriculture's *Study of Consumer Purchases in the United States, 1935-1936*; the Department of Labor's *Consumer Expenditure Survey, 1960-61*; the *Survey of Consumer Expenditures, 1972-1973*; and John Sabelhaus' *Consumer Expenditure Survey: Family Level Extracts, 1980:1–1995:1*.

variation in starting months. The exact survey dates of individual households in the 1888-1890 study are not known, but this should not affect estimates of CPI bias because the price level was fairly constant between these years.

The dependent variables that I use in the estimation are the share of expenditures devoted to food eaten at home, the share of expenditures devoted to all food, and the share of expenditures devoted to recreation. Expenditures for food at home are not known in 1888-90. Recreation includes entertainment and reading expenditures, but not expenditures on vacation lodging, food, or travel. Beginning in 1972-1973 it also includes expenditures on such items as boats, aircraft, and wheel goods.

Control variables include real total expenditures, relative price changes, the share of food eaten out (when the dependent variable is food eaten at home), demographic characteristics, time dummies, and region dummies (3 for 4 census regions). I use total expenditures rather than income because expenditures better reflect permanent income. The full set of time dummies consists of dummies for 1888-90, 1917-19, 1935, 1960, 1961, 1972, 1973, and individual dummies for each of the years 1980-1994. Demographic controls include the age of the husband, the age of the wife (unknown in 1960-61), and a dummy variable equal to one if the husband is nonwhite (unknown in 1888-90). With the exception of the 1960-61 survey I know the total number of children and the total number of household members other than the husband and wife above age 18. In all years except for 1960 I also know the number of children under age 2, the number of boys age 2-15, the number of girls age 2-15, the number of boys age 16-17, and the number of girls age 16-17. When I use the 1960-61 survey I therefore use a more limited set of demographic controls and in all other years I use a fuller set of demographic controls.[4]

[4]Using a more limited set of controls does not materially affect the bias estimates. I do not include the work status of the wife as a control variable. Only 3 percent of wives in the early surveys worked. In the later surveys the inclusion of wife's work status leads to collinearity problems with the share of food eaten out and the year dummies.

The final step in the construction of the data set requires merging two or more years of consumer expenditure data. But, how many years of data can be pooled? There have been tremendous changes over the course of the century in the types of food consumed (e.g. purchase of a whole, feathered chicken instead of deskinned and deboned chicken breasts). The time dummies will reflect these changes in functional form and I may therefore mismeasure the extent of CPI bias. The rule that I follow in determining which consumer expenditure surveys can be pooled is to pool if the inclusion of an additional survey does not change the CPI bias results. This procedure suggests that I can legitimately pool the 1960 through 1994 data and the 1888 through 1935 data. This procedure also suggests that I cannot pool the 1935 data with later data. I therefore use Hamilton's (1998) methodology to ascertain the extent of CPI bias for 1888-1935 and 1960-1994, but not for 1935-1960. I estimate CPI bias for 1950-1960 by using the 1960-61 Engel curve and comparing actual and predicted income between 1950 and 1960.[5]

# 5 Results

I estimate CPI bias between 1888-1935 and 1960-94 using both the empirical specification that allows for geographic variation in relative price changes (Equation 3) and the empirical specification with no geographic variation (Equation 7). Because regional price indexes for all items and for food are unavailable prior to 1917 and for recreation prior to 1952, I use the specification without geographic price variation for the 1888-1917 data when the dependent variable is either all food or recreation and for the 1917-1935 data when the dependent variable is the recreation expenditure share. I use the specification with geographic price variation for the 1917-1935 data and the 1960-1994 data when the dependent variable is the food expenditure

[5]This procedure assumes that the functional form of the Engel curve did not change in the span of ten years and that relative price movements were small.

share. I also use this specification for the 1972-1994 data when the dependent variable is the recreation expenditure share, limiting myself to these years because the definition of recreation in the 1960-61 survey was not comparable to later definitions. I use the 1960-61 Engel curve for food to estimate CPI bias between 1950 and 1960.

Selected regression coefficients and selected cumulative bias estimates are given in Table 1 for 1888-1919, in Table 2 for 1917-35, and in Table 3 for 1960-94 for food, and in Table 4 for recreation. Engel curves for food in 1960-61 are given in Table 5. Two different specifications are shown for recreation in 1972-94. In all years, the specification in which the expenditure share of food at home is the dependent variable has the best fit and the specification in which the dependent variable is recreation has the poorest fit. The control variables have the expected sign. The greater the share of food eaten out, the lower the share of food eaten at home. The greater the number of children in the household, the greater the food expenditure share. Older children increase the share of expenditures devoted to food by more than children under age 2. Children decrease the share of recreational expenditures, but in the 1917-1935 and the 1972-94 data the number of boys in some age groups increase the share of recreational expenditures. Both food and recreation expenditures are lower for non-whites (though neither significantly nor materially for recreation in 1917-35).

The regression results yield reasonable estimates of expenditure and price elasticities. The estimated expenditure elasticities for food at home are 0.47 in 1960-94 and 0.62 in 1917-35. Those for total food are 0.65 in 1960-94 and 0.68 in 1917-35 and in 1888-1917. The expenditure elasticities for recreation are 1.37 in 1972-94, 1.41 in 1917-35, and 1.82 in 1888-1917.[6] The price elasticities for food eaten at home are -0.87 in 1960-94 and -0.85 in 1917-35. Those for all food

[6]Expenditure elasticities were calculated as $1 + \frac{\beta}{w}$. If $\beta$ is biased because total expenditures are measured with error, then CPI bias will be measured with error as well. Using household income as an instrumental variable would entail making assumptions about the relationship between permanent and transitory income. Hausman et al. (1995) used future consumption and found that both the IV and OLS results accurately estimated the elasticities.

Table 1: Regression Coefficients, 1888-1919 Sample

| | Dependent Variable is Share of Expenditures Spent on | | | |
|---|---|---|---|---|
| | All Food | | Recreation | |
| | Coefficient | Cumulative Bias | Coefficient | Cumulative Bias |
| Log(total expenditures) | -0.129 | | 0.023‡ | |
| | (0.002) | | (0.001) | |
| Age husband $\times 10^{-1}$ | 0.003† | | -0.001 | |
| | (0.001) | | (0.001) | |
| Age wife $\times 10^{-1}$ | 0.011‡ | | -0.001‡ | |
| | (0.001) | | (0.001) | |
| Number children under 2 $\times 10^{-1}$ | 0.113‡ | | -0.050‡ | |
| | (0.012) | | (0.004) | |
| Number boys age 2-15 $\times 10^{-1}$ | 0.197‡ | | -0.031‡ | |
| | (0.006) | | (0.002) | |
| Number girls age 2-15 $\times 10^{-1}$ | 0.206‡ | | -0.027‡ | |
| | (0.006) | | (0.002) | |
| Number boys age 16-17 $\times 10^{-1}$ | 0.176‡ | | -0.041‡ | |
| | (0.013) | | (0.005) | |
| Number girls age 16-17 $\times 10^{-1}$ | 0.227‡ | | -0.035‡ | |
| | (0.015) | | (0.005) | |
| Number over age 18 $\times 10^{-1}$ | 0.184‡ | | -0.023‡ | |
| (excludes husband and wife) | (0.008) | | (0.003) | |
| Dummy=1 if year is 1917-1919 | 0.004 | -0.032 | 0.003‡ | 0.089 |
| | (0.002) | (0.012) | (0.005) | (0.021) |
| Constant | 1.146‡ | | -0.109‡ | |
| | (0.013) | | (0.004) | |
| Adjusted $R^2$ | 0.354 | | 0.153 | |

*Note.* Standard errors in parentheses. The total number of observations is 14,653. The omitted year dummy is 1888-90. Population weights were created and used in the estimation. The symbols ‡, †, and $*$ indicate significance at the 1, 5, and 10 percent level, respectively.

Table 2: Selected Regression Coefficients, 1917-1935 Sample

| | Dependent Variable is Share of Expenditures Spent on | | | | | |
|---|---|---|---|---|---|---|
| | Food Eaten at Home | | All Food | | Recreation | |
| | Coefi-cient | Cumul-ative Bias | Coefi-cient | Cumul-ative Bias | Coefi-cient | Cumul-ative Bias |
| Log(total expenditures) | -0.128‡ | | -0.114‡ | | 0.015‡ | |
| | (0.001) | | (0.001) | | (0.005) | |
| Log(relative food price) | 0.005‡ | | 0.006† | | | |
| | (0.002) | | (0.002) | | | |
| Share food eaten out | -0.306‡ | | | | | |
| | (0.017) | | | | | |
| Age husband $\times 10^{-1}$ | 0.003† | | 0.003∗ | | -0.004‡ | |
| | (0.001) | | (0.001) | | (0.001) | |
| Age wife $\times 10^{-1}$ | 0.006‡ | | 0.007‡ | | -0.000 | |
| | (0.001) | | (0.001) | | (0.001) | |
| Number children under age 2 $\times 10^{-1}$ | 0.200‡ | | 0.180‡ | | -0.066‡ | |
| | (0.014) | | (0.015) | | (0.006) | |
| Number boys age 2-15 $\times 10^{-1}$ | 0.279‡ | | 0.255‡ | | -0.019‡ | |
| | (0.007) | | (0.007) | | (0.003) | |
| Number girls age 2-15 $\times 10^{-1}$ | 0.281‡ | | 0.256‡ | | -0.016‡ | |
| | (0.006) | | (0.007) | | (0.002) | |
| Number boys age 16-17 $\times 10^{-1}$ | 0.248‡ | | 0.246‡ | | 0.026† | |
| | (0.025) | | (0.026) | | (0.010) | |
| Number girls age 16-17 $\times 10^{-1}$ | 0.251‡ | | 0.227‡ | | 0.004 | |
| | (0.020) | | (0.022) | | (0.008) | |
| Number over age 18 $\times 10^{-1}$ | 0.156‡ | | 0.136‡ | | -0.002 | |
| (excludes husband and wife) | (0.009) | | (0.010) | | (0.004) | |
| Dummy=1 if nonwhite | -0.026‡ | | -0.024‡ | | -0.007 | |
| | (0.002) | | (0.002) | | (0.001) | |
| Dummy=1 if year is 1935 | -0.016‡ | 0.118 | -0.009‡ | 0.076 | 0.003‡ | 0.191 |
| | (0.001) | (0.010) | (0.002) | (0.013) | (0.001) | (0.033) |
| Adjusted $R^2$ | 0.609 | | 0.472 | | | |

*Note.* Regional dummies (3 for 4 census regions) and constant not shown. Standard errors are in parentheses. The total sample size is 14,284 observations. The omitted year dummy is 1917-19. Population weights were created and used in the estimation. The symbols ‡, †, and ∗ indicate significance at the 1, 5, and 10 percent level, respectively.

Table 3: Selected Regression Coefficients, 1960-1994 Sample

| | Dependent Variable is Share of Expenditures Spent on | | | |
|---|---|---|---|---|
| | Food Eaten at Home | | All Food | |
| | Coefi-cient | Cumul-ative Bias | Coefi-cient | Cumul-ative Bias |
| Log(total expenditures) | -0.090‡ | | -0.076‡ | |
| | (0.001) | | (0.001) | |
| Log(relative food/recreation price) | 0.007 | | -0.008 | |
| | (0.018) | | (0.020) | |
| Share food eaten out | -0.181 | | | |
| | (0.010) | | | |
| Age husband $\times 10^{-1}$ | 0.014‡ | | 0.013‡ | |
| | (0.000) | | (0.000) | |
| Total number children under age 18 | 0.027‡ | | 0.021‡ | |
| | (0.001) | | (0.007) | |
| Total number children squared | -0.001‡ | | -0.001‡ | |
| | (0.000) | | (0.000) | |
| Number over age 18 $\times 10^{-1}$ | 0.153‡ | | 0.149‡ | |
| (excludes husband and wife) | (0.006) | | (0.007) | |
| Dummy=1 if nonwhite | -0.014‡ | | -0.018‡ | |
| | (0.001) | | (0.000) | |
| Dummy=1 if year is | | | | |
| 1972 | -0.004‡ | 0.043 | 0.002 | -0.022 |
| | (0.001) | (0.015) | (0.003) | (0.033) |
| 1982 | -0.034‡ | 0.313 | -0.036‡ | 0.372 |
| | (0.002) | (0.015) | (0.002) | (0.019) |
| 1994 | -0.044‡ | 0.386 | -0.047‡ | 0.455 |
| | (0.002) | (0.015) | (0.002) | (0.018) |
| Adjusted $R^2$ | 0.516 | | 0.409 | |

*Note.* The complete set of year dummies (1961, 1972-73, 1980-94), the regional dummies (3 for 4 census regions), and the constant are not shown. Year dummies are relative to 1960. Standard errors are in parentheses. Regressions are weighted using population weights. The sample contains 26,420 observations. The symbols ‡, †, and $*$ indicate significance at the 1, 5, and 10 percent level, respectively.

Table 4: Selected Regression Coefficients, 1972-1994 Sample

| | Dependent Variable is Share of Expenditures Spent on Recreation | | | |
|---|---|---|---|---|
| | Coefi-cient | Cumul-ative Bias | Coefi-cient | Cumul-ative Bias |
| Log(total expenditures) | -0.023‡ | | 0.053‡ | |
| | (0.001) | | (0.017) | |
| Log(total expenditures) squared | | | -0.002* | |
| | | | (0.001) | |
| Log(relative food/recreation price) | 0.046‡ | | | |
| | (0.018) | | | |
| Age husband $\times 10^{-1}$ | -0.002‡ | | -0.002‡ | |
| | (0.001) | | (0.001) | |
| Age wife $\times 10^{-1}$ | -0.002‡ | | -0.002† | |
| | (0.001) | | (0.001) | |
| Number children under age 2 $\times 10^{-1}$ | -0.071‡ | | -0.071‡ | |
| | (0.011) | | (0.011) | |
| Number boys age 2-15 $\times 10^{-1}$ | 0.011‡ | | 0.012‡ | |
| | (0.004) | | (0.004) | |
| Number girls age 2-15 $\times 10^{-1}$ | -0.004 | | -0.003 | |
| | (0.004) | | (0.004) | |
| Number boys age 16-17 $\times 10^{-1}$ | -0.027‡ | | -0.025‡ | |
| | (0.010) | | (0.010) | |
| Number girls age 16-17 $\times 10^{-1}$ | -0.031‡ | | -0.029‡ | |
| | (0.010) | | (0.010) | |
| Number over age 18 $\times 10^{-1}$ | -0.061‡ | | -0.060‡ | |
| (excludes husband and wife) | (0.006) | | (0.006) | |
| Dummy=1 if nonwhite | -0.012‡ | | -0.013‡ | |
| | (0.001) | | (0.001) | |
| Dummy=1 if year is | | | | |
| 1982 | 0.011‡ | 0.378 | 0.003 | 0.045 |
| | (0.004) | (0.002) | (0.002) | (0.051) |
| 1994 | 0.019‡ | 0.566 | 0.012‡ | 0.199 |
| | (0.004) | (0.067) | (0.002) | (0.185) |
| Adjusted $R^2$ | 0.072 | | 0.069 | |

*Note.* The complete set of year dummies (1973, 1980-94), the regional dummies (3 for 4 census regions), and the constant are not shown. Year dummies are relative to 1972. Standard errors are in parentheses. Regressions are weighted using population weights. The sample contains 23,412 observations. The symbols ‡, †, and $*$ indicate significance at the 1, 5, and 10 percent level, respectively.

Table 5: Selected Regression Coefficients, 1960-61 Sample

| | Dependent Variable is Share of Expenditures Spent on | |
|---|---|---|
| | Food Eaten at Home Coefi-cient | All Food Coefi-cient |
| Log(total expenditures) | -0.098‡ | -0.086‡ |
| | (0.002) | (0.002) |
| Share food eaten out | -0.298 | |
| | (0.022) | |
| Age husband $\times 10^{-1}$ | 0.018‡ | 0.016‡ |
| | (0.001) | (0.001) |
| Total number children under age 18 | 0.028‡ | 0.017‡ |
| | (0.001) | (0.002) |
| Total number children squared | -0.001‡ | -0.001† |
| | (0.002) | (0.000) |
| Number over age 18 $\times 10^{-1}$ | 0.161‡ | 0.166‡ |
| (excludes husband and wife) | (0.014) | (0.002) |
| Dummy=1 if nonwhite | -0.014‡ | -0.024‡ |
| | (0.001) | (0.003) |
| Constant | 1.032 | 0.954 |
| | (0.020) | (0.021) |
| Adjusted $R^2$ | 0.414 | 0.289 |

*Note*. Standard errors are in parentheses. Regressions are weighted using population weights. The sample contains 5,705 observations. The symbols ‡, †, and $*$ indicate significance at the 1, 5, and 10 percent level, respectively.

are -0.96 in 1960-94 and -0.87 in 1917-35. The price elasticity of recreation is -0.29 in 1960-94.[7] The coefficient on the price of food relative to non-food is not precisely estimated in 1960-94. Restricting the data to 1972-94 yields statistically significant and somewhat larger coefficients on relative prices and these coefficients, together with the specification without geographic price variation, can be used to obtain alternative estimates of CPI bias.

Table 6 summarizes cumulative bias estimates and, where applicable, presents estimates corrected for relative price changes. The estimate of CPI bias between 1950 and 1960 was derived by using the NIPA shares and the 1960-61 Engel curve to obtain predicted household total expenditures in both 1950 and 1960 and, controlling for demographic change, comparing the trend in these predicted shares with the trend in actual household personal expenditures (from the NIPA numbers). Because the price of food rose less than the price of non-food in this period, this estimate will be a rough upper bound for CPI bias.

CPI bias was minimal during the 1888-1919 period. Using the specification for food yields bias estimates of -0.1 percentage points per year, even after correcting for relative price changes using the estimate of $\gamma = .006$ from the 1917-35 regression. Dropping from the sample individuals who had income from gardens or animals and therefore may have had some self-sufficiency in food yields an estimate of 0. Using recreation as an indicator good and not adjusting for prices suggests that CPI bias was 0.3 percentage points. Adjusting for relative price changes using the estimate of $\gamma = .046$ from the 1972-94 regression suggests that CPI bias was 1.3 percentage points per year. However, differences in the total expenditure elasticity of recreation between 1888-1919 and 1960-94 suggest definite changes in functional form, so it may not be possible to use an estimate of $\gamma$ derived from modern data.

The CPI was biased between 1917-1935. The specification that uses the share of food

[7] Price elasticities are calculated as $-1 + \frac{(\gamma - \alpha\beta)}{w}$ where $\alpha$ is the share of the indicator good in the total price index.

Table 6: Summary of Bias Estimates, 1888-1994

| | Cumulative Bias Based On | | | | Annual |
|---|---|---|---|---|---|
| | Food at | All | Recreation | | Bias |
| | Home | Food | (1) | (2) | (% Points) |
| 1888/90-1917/19 | | -0.032 | 0.089 | | -0.1-0.3 |
| (no price adjustment) | | (0.012) | (0.021) | | |
| 1888/90-1917/19 | | -0.035 | | | -0.1 |
| (price adjusted) | | (0.013) | | | |
| 1917/19-1935/36 | 0.118 | 0.076 | 0.191 | | 0.4-1.1 |
| (recreation not price adjusted) | (0.010) | (0.013) | (0.033) | | |
| 1950-60 | 0.014 | 0.098 | | | 0.1-0.9 |
| 1960-72 | 0.043 | -0.022 | | | -0.2-0.3 |
| | (0.024) | (0.033) | | | |
| 1973-82 | 0.269 | 0.394 | 0.378 | 0.187 | 1.9-3.9 |
| | (0.025) | (0.034) | (0.103) | (0.034) | |
| 1983-94 | 0.073 | 0.014 | 0.188 | 0.122 | 0.1-1.6 |
| | (0.018) | (0.021) | (0.032) | (0.033) | |
| 1973-94 | 0.343 | 0.408 | 0.566 | 0.309 | 1.4-2.6 |
| | (0.033) | (0.033) | (0.067) | (0.033) | |
| 1960-94 | 0.386 | 0.455 | | | 1.1-1.3 |
| | (0.015) | (0.018) | | | |

*Note.* Standard errors in parentheses. No standard error is given for 1950-60 because this is only a rough estimate. The price adjustment for 1888/90-1917/1919 used the value of $\gamma = .006$ from the 1917/19-1935/36 regression and assumed that movement in the relative CPI price of food mirrored that in the relative wholesale price of food (Series E 40-51 in U.S. Bureau of the Census 1975: 200). Using a larger value of $\gamma$ would yield a larger, negative estimate of annual bias. Using the value of $\gamma = .046$ from the 1960-94 recreation equation to adjust for declines in the relative price of recreation yields a cumulative bias estimate of 0.384 ($\hat{\sigma}$ =0.011) for 1888/90-1917/1919 and one of 0.561 ($\hat{\sigma}$ =0.023) for 1917/1919-1935/36. The second specification that used recreation as an indicator good contained a quadratic term in total expenditures. The cumulative bias estimate is corrected for relative price changes using $\gamma = .046$. For a price index for recreation prior to 1935 see Owen (1970: 85).

at home as a dependent variable suggests that annual bias was 0.7 percentage points per year. The specification that uses all food as an indicator good yields the smaller annual bias estimate of 0.4 percentage points. Dropping from the sample individuals who had incomes from gardens or animals yields annual estimates of CPI bias of 0.8 and 0.6 using food at home and total food, respectively, as indicator goods. The specification that uses recreation as an indicator good yields the larger estimate of 1.1 percentage points per year with no relative price adjustment. Correcting for relative price changes using the estimate of $\gamma$ from the 1972-94 regression suggests that CPI bias was an even larger 3.1 percentage points per year. Excluding from the sample households who in 1917-19 lived in smaller cities and therefore may have had fewer opportunities for market recreation does not change the results. Using the Engel curve specification that is quadratic in total expenditures yields estimates of CPI bias (after correcting for relative price movements) of 0.9, 0.7, and 3.3 percentage points using food at home, all food, and recreation as indicator goods, respectively. Using recreation rather than food as an indicator good may lead to a bigger estimate of CPI bias because recreation may be more badly biased than non-recreation or because estimated CPI bias is additionally indicating improvements in household living standards arising from increases in leisure time and in the public provision of recreation.

CPI bias has fluctuated in the post-war period. Using food at home and food as an indicator good suggests that CPI bias was at most 0.1 percentage points per year from 1950 to 1960. Using total food yields a larger estimate of bias.[8] Bias was relatively low in the 1960s and high thereafter. Using the share of food eaten at home as an indicator good suggests that CPI bias was only 0.3 percentage points per year between 1960 and 1972; but, it was 2.7 percentage points

[8]The bias estimate is 0.9 percentage points per year. Because the price of restaurant meals relative to food at home is likely to vary by across cities, the Engel curve that uses at home and controls for the share of food eaten out is the preferred specification. Results for recreation are not presented. The expenditure share of recreation in the NIPA numbers was slightly lower in 1960 than in 1950, suggesting that we are overestimating income growth during the 1950s.

per year between 1973 and 1982 and 0.6 percentage points per year between 1983 and 1994. Overall bias between 1973 and 1994 was 1.6 percentage points per year. Using the specification without geographic price variation and an estimate of 0.031 for $\gamma$ (derived from the 1972-94 data) implies that CPI bias was 0.5 percentage points between 1960-72 and 1.5 percentage points between 1973 and 1994. Using all food as an indicator good yields a larger estimate of bias between 1960 and 1994. When I use recreation as an indicator good and use the specification given in Equation 3, I obtain a larger overall estimate of CPI bias between 1973 and 1994. When I use the Engel curve specification that is quadratic in the logarithm of total expenditures (Equation 9) and correct for relative price changes I obtain an estimate of bias of 1.4 percentage points per year between 1973 and 1994.

What explains the observed pattern of CPI bias? CPI bias may have been greater in the 1920s than from 1890 to 1919 because many new consumer goods were introduced in the 1920s and these were only slowly introduced in the CPI. For example, radio sales were insignificant in 1919 but rose eight fold between 1923 and 1929 and continued to rise even during the Great Depression (Owen 1969: 88). The rise of electricity in the home led to the widespread diffusion of such other appliances as refrigerators. The growth of car ownership allowed consumers to move to cheaper suburban land and shop at a wider variety of stores, including chain stores. These grew rapidly in the 1920s and became the standard instruments for mass retailing (Chandler 1977: 233). But, refrigerators were only introduced in the CPI in 1934, new autos in 1940, and used autos in 1952. Other goods that became common in the 1920s but were only slowly introduced in the CPI include light bulbs, washing machines, vacuum cleaners, and auto repair and supplies.[9]

The Boskin Commission (Boskin et al. 1998) estimated that the biggest source of CPI bias between 1975 and 1994 was in the late introduction of new goods into the CPI and quality

[9]See United States Bureau of Labor Statistics 1940 and the Stigler Commission report (National Bureau of Economic Research. Price Statistics Review Committee. 1961.)

Table 7: Usual and Revised Growth Rates in Real Per Capita Personal Income, 1899-1994

| | Annual Growth Rate | |
|---|---|---|
| | Usual | Revised |
| 1899-1919 | 2.7% | 2.6% |
| 1919-35 | -0.2 | 0.5 |
| 1950-60 | 1.6 | 1.8 |
| 1960-72 | 3.6 | 4.0 |
| 1973-82 | 0.3 | 3.2 |
| 1983-94 | 1.7 | 2.4 |

*Note.* "Usual" growth rates are derived from per capita personal income deflated by the CPI. See Figure 2 for sources. "Revised" growth rates correct for CPI bias using the estimates of bias based on all food for 1899-1919 and food at home for all other years.

improvements in existing goods. The post-war pattern of higher bias in the 1970s than in the 1960s or 1980s may arise from the greater price volatility of the 1970s relative to the 1960s (Baily 1981) and from extensive improvements made to the CPI in the 1980s, including changing the homeowner's component from cost of purchase to value of rental services and quality adjustment of used car prices (see Greenlees and Mason 1996 for a full list).

# 6 Implications

Estimates of CPI bias suggest that we are mismeasuring growth rates. Table 7 shows annual growth rates in per capita personal income deflated by the CPI ("usual" growth rates). It also shows "revised" annual growth rates that account for CPI bias (estimated using food at home as an indicator good). Revised growth rates are very similar to usual growth rates between 1899 and 1919. They are more favorable than usual growth rates between 1919 and 1935. Instead of a negative growth rate, we obtain the positive (though still small) growth rate of 0.5 percentage points per year. Increases in the standard of living during the 1920s may have been so high that even the income shock of the Great Depression was not enough to reduce per capita income

back to 1919 levels. Growth rates during the Great Depression could also have been better than indicated by the usual income numbers. Even during the Great Depression the proportion of families owning radios and refrigerators increased (Owen 1969: 89; Lebergott 1993: 113).

Table 7 also shows that although growth rates in the 1970s were not as high as those in the 1960s, they were substantial. Revised and usual growth rates are similar between 1950 and 1972, but then deviate sharply between 1973-1982. Instead of the low growth rate of 0.3 percentage points per year we obtain one of 3.3 percentage points per year. Revised growth rates then fell to 2.4 percentage points per year during the 1980s and early 1990s.

Estimates of CPI bias derived from using recreation as an indicator good suggest that in the pre-war period we are underestimating the increase in living standards because we are accounting for neither the rapid decrease in hours worked nor the increased public investment in parks and recreational facilities. The average work week fell by 20 hours between 1890 and 1940 (Series D 765-778 and D 802-810 in U.S. Bureau of the Census 1975: 168-69). Because of declines in family size and innovations in household technology the weekly hours of housewives spent in meal preparation declined from 44 in 1900 to 22 at the end of the 1920s (Lebergott 1993: 51). From 1921 to 1930 the number of public golf courses and swimming pools tripled and the number of public baseball diamonds more than doubled (Series H 849-861 in US Bureau of the Census 1975: 398). The true growth in real per capita income, corrected for increases in recreation, may have been from 3.1 to 5.5 percentage points per year between 1899 and 1919. Between 1919 and 1935 true growth rates may have ranged from 0.9 to 3.0 percentage points per year.[10]

[10]The rationing of work hours during the Great Depression suggests that these estimates represent upper bounds.

# 7 Conclusion

This paper has used consumer expenditure surveys from 1888 to 1994 to provide the first estimates of overall CPI bias prior to the 1970s and to reassess long-run growth rates in per capita income. CPI bias was small between 1888 and 1919 and between 1950 and 1972, but was high in the 1920s, 1970s, and 1980s. CPI bias was -0.1 percentage points per year between 1888 and 1919 and rose to 0.7 percentage points per year between 1919 and 1935. CPI bias was low in the 1950s and 0.3 percentage points per year in the 1960s and then rose to 2.7 percentage points per year between 1973 and 1982 before falling to 0.6 percentage points per year between 1983 and 1994. Overall bias between 1973 and 1994 was 1.6 percentage points per year, in the upper end of the Boskin Commissions' (Boskin et al. 1998) range of 0.8 to 1.6 percentage points per year and similar to Nordhaus' (1998) and Hamilton's (1998) respective estimates of 1.5 and 1.6 percentage points per year. The estimates are also consistent with Hamilton's (1998) bias estimates of 2.5 percentage points per year between 1974 and 1980 and 0.9 percentage points per year between 1981 and 1991.

Both the 1961 Stigler Commission (National Bureau of Economic Research. Price Statistics Review Committee. 1961) and the 1998 Boskin Commission (Boskin et al. 1998) concluded that the biggest defect in the CPI was its failure to account adequately for new goods and improvements in existing goods. Quality adjusted price indices of specific goods (e.g. Nordhaus 1997; Raff and Trajtenberg 1997) and the timing of the pre-war increase in bias (coinciding with the consumer revolution of the 1920s) suggests that this is likely to be the biggest source of bias in the 1920s as well. Factors that may help explain the post-war pattern of increasing and then decreasing bias include the greater price volatility of the 1970s relative to the 1960s and improvements to the CPI throughout the 1980s.

This paper's findings suggest that we are underestimating real annual growth rates

between 1919 and 1935 and after 1972. Correcting for CPI bias (estimated using food at home as an indicator) and recalculating growth rates suggests that despite the Great Depression real per capita incomes were rising by 0.5 percentage points between 1919 and 1935 and that growth rates were almost as high in the 1970s (3.2 percentage points per year) as in the 1960s (4.0 percentage points per year). These revised rates undoubtedly underestimate increases in living standards between 1919 and 1935 because they only account for CPI bias arising from the late introduction of new goods into the CPI, the increased durability of existing goods, consumer substitution, and changes in the distribution network. Additionally accounting for increases in leisure and in public recreational expenditures in the first half of the twentieth century suggests that growth rates were even higher.

Many historians (e.g. Schlesinger 1957: 135; Dobson 1988: 248-49) have argued that the prosperity of the 1920s was "flawed" because employers and investors were the primary beneficiaries whereas workers received only partial compensation for increases in productivity. Certainly the decrease in work hours and the concomittant increase in personal income would suggest otherwise. But, even the more modest revisions to growth rates suggest that it may be time to reassess not only the 1970s but also the 1920s.

# Data Appendix

## The Pre-War Consumer Expenditure Surveys

The pre-war consumer surveys are generally comparable with each other and with the post-war surveys. All provided a thorough accounting of family sources of income and outlays of that income and were extensively checked for completeness and consistency. All utilized roughly similar interview techniques – multiple visits, strong encouragement to keep written records, and the use of home surroundings to stimulate accurate recall of expenditure data. All used schedules

that strongly resembled each other. And, trends in the budget shares of most broad categories of goods in all of the surveys are consistent with the national income and product accounts. There are, however, differences in population coverage.

In 1888-90 the sample was limited to workers in nine protected industries (bar iron, pig iron, steel, bituminous coal, iron ore, cotton textiles, woolens, and glass) and appears to have been stratified by the proportions employed in each industry. Twenty-three states were covered, none of them in the west. Sample families were selected from employer records and were limited to families of two or more persons.

Families from the 1917-1919 study were also selected from employer records and were restricted to those where both spouses and one or more children were present, where salaried workers did not earn more than $2,000 a year ($13,245 in 1982-84 dollars), where families had resided in the same community for a year prior to the survey, where families did not take in more than three boarders, where families were not classified as either slum or charity, and where non-English speaking families had been in the United States five or more years. Ninety-nine cities in 42 states were covered.

The 1935-1936 Consumer Purchases Study was limited to native-born husband and wife families in which families in metropolises and white families in large cities had a minimum income of at least $500 ($3,650 in 1982-84 dollars) and families in other cities had one of at least $250 ($1,825 in 1982-84 dollars). There was no upper income limit. The survey covered the self-employed as well as wage and salary workers. The communities covered by the study include 51 cities, 140 villages and 60 farm counties, representing 30 states. Both urban and farm families were covered.

## Price Indexes

The Bureau of Labor Statistics (BLS) has been measuring changes in retail prices of goods and services purchased by city wage earners and clerical workers since 1913. Indexes from 1800 through 1912 are estimated from price data from sources other than the BLS (see Series E 135-166 in U.S. Bureau of the Census 1975: 210-211).

The BLS provides regional price indexes up to the present day for urban consumers for all items and for food beginning in 1967 and for food at home, nonfood, and recreation beginning in 1978.[11] Price indexes for earlier years are given for selected cities only. I weight the price indexes for cities on the basis of their populations to create regional price indexes. For 1917 through 1950 I use the cities and price indexes given in *Handbook of Labor Statistics: 1950* to create regional price indexes for all items and for all food. For 1950 through 1967 for all items and for food, for 1953 through 1978 for food at home, and for 1960 through 1978 for recreation I use the smaller sample of cities for which continuous price indexes are available.[12] The food index used in the estimation is based upon the price of all food. The results were not sensitive to the use of a price index for food at home instead of all food.

[11]Price indexes for all items, for food, and non-food are available from the BLS web site. Price indexes for recreation are available from various issues of *CPI Detailed Report*.

[12]For all items and food, see the BLS web site. For recreation see various issues of *CPI Detailed Report* and *The Consumer Price Index*.

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