# Is US Inflation Underestimated? Evidence from Engel Curves*

Abstract

Yoko Oguro†
Meikai University

In the aftermath of the COVID-19 pandemic, the United States has experienced a rapid surge in prices, particularly in food, energy, and rent, raising concerns about the disproportionate impact on economically vulnerable households. While nominal wages have risen, these increases vary by industry and real wage growth has not kept pace with inflation. Although the Federal Reserve has implemented monetary tightening measures (rate hikes), there are concerns that the second Trump administration's tariff increases could exacerbate US inflation. The aim of this paper is to demonstrate that the official CPI statistics, while reflecting the sharp rise in prices, underestimate the cost of living for people residing in the US.

The model used to estimate inflation bias is based on Oguro (2020), which extends the work of Nakamura (1996), Hamilton (2001), and Costa (2001) with the advancements by Nakamura et al. (2016). The core logic of the estimation model assumes the stability of Engel curves and interprets shifts unexplained by control variables as biases in the Consumer Price Index (CPI). The Engel curve estimation uses the Engel coefficient (the proportion of food expenditure in total consumption expenditure) in region i at time t as the dependent variable, formulated as the logarithmic-linear model shown in equation (1). Control variables explaining shifts in the Engel curve include household size and household head's age, as discussed in Oguro (2020).

$$\omega_{i,t} = \psi_i + \beta \log\left(C_{i,t}/P_{i,t}\right) + \gamma \log\left(P_{i,t}^{food}/P_{i,t}\right) + \sum_x \xi_x \boldsymbol{X}_{i,t} + \in_{i,t} \qquad (1)$$

Where:

- $P_{i,t}$: True price level
- $P_{i,t}^{food}$ : True food price level
- $C_{i,t}/P_{i,t}$: Real total consumption expenditure
- $P_{i,t}^{food}/P_{i,t}$: Relative food price
- $X_{i,t}$: Control variables (household size, household head's age, etc.)
- $\psi_i$: Constant term
- $\in_{i,t}$: Residual

The estimated coefficient $\beta$ represents how households adjust expenditures in response to income changes. Since true price levels and true food price levels are unobservable, they are replaced with cumulative inflation (deflation) and cumulative bias differences over the period 0 to t（$\log P_{i,t} - \log P_{i,0}$, $\log P_{i,t}^{food} - \log P_{i,0}^{food}$）. The cumulative bias（$\mu_{i,t}$, $\mu_{i,t}^{food}$）is extracted as a shift in the Engel curve, assuming it is constant across regions i and categories (prices, food prices). Accordingly, equation (1) can be reformulated to include the inflation (deflation) bias term $\mu_t$, as shown in equation (2).

$$\omega_{i,t} = \widehat{\psi}_i + \beta \log C_{i,t} - \beta\tilde{\pi}_{i,t} - \beta\mu_t + \gamma(\tilde{\pi}_{i,t}^{food} - \tilde{\pi}_{i,t}) + \sum_x \xi_x \boldsymbol{X}_{i,t} + \epsilon_{i,t} \qquad (2)$$

Where:

- $\log P_{i,t} - \log P_{i,0} = \tilde{\pi}_{i,t} - \mu_{i,t}$
- $\log P_{i,t}^{food} - \log P_{i,0}^{food} = \tilde{\pi}_{i,t}^{food} - \mu_{i,t}^{food}$
- $\tilde{\pi}_{i,t}$、$\tilde{\pi}_{i,t}^{food}$: Measured cumulative inflation (deflation) from period 0 to t for region i
- $\mu_{i,t}$、$\mu_{i,t}^{food}$: Cumulative bias in inflation (deflation) estimates

In practice, $\beta\mu_t$ is replaced by time fixed effects, and the inflation (deflation) bias $\mu_t$ is derived by dividing the estimated time fixed effects by $\beta$. The adjusted inflation rate based on Engel curves is then calculated from the CPI inflation rate and the estimated bias.

The data used in this study are sourced from the Bureau of Labor Statistics (BLS) Consumer Price Index (CPI) and the Consumer Expenditure Survey (CES). Control variables (household size, household head's age, etc.) are also sourced from the CES. Cross-sectional data from four regions (Northeast, Midwest, South, West) are analyzed in a panel framework using annual data.

The robustness of this analysis is verified by applying the Engel curve method to subcategories of food and non-food categories (e.g., clothing, housing).

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† Email: yoguro@meikai.ac.jp