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Proceedings of the International Conference on Conference on Business, Management and Finance
Vol. 2, Issue. 1, 2025, pp. 1-8
DOI: https://doi.org/10.33422/icbmf.v2i1.1084
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ISSN: 3030-0959 online

Diamond Scientific Publishing

Rethinking UK Inflation: An Application of Engel Curves

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Abstract

This paper investigates the accuracy of the UK Consumer Price Index (CPI and CPIH) in capturing the true cost of living from 2001 to 2023. Using an Engel curve framework, it examines whether official inflation measures systematically understate living costs, especially during periods of economic disruption. Findings suggest that both CPI and CPIH tend to underestimate inflation, particularly for low-income households, highlighting a potential downward bias in official statistics.

Keywords: Engel Curves, Inflation, CPI Bias

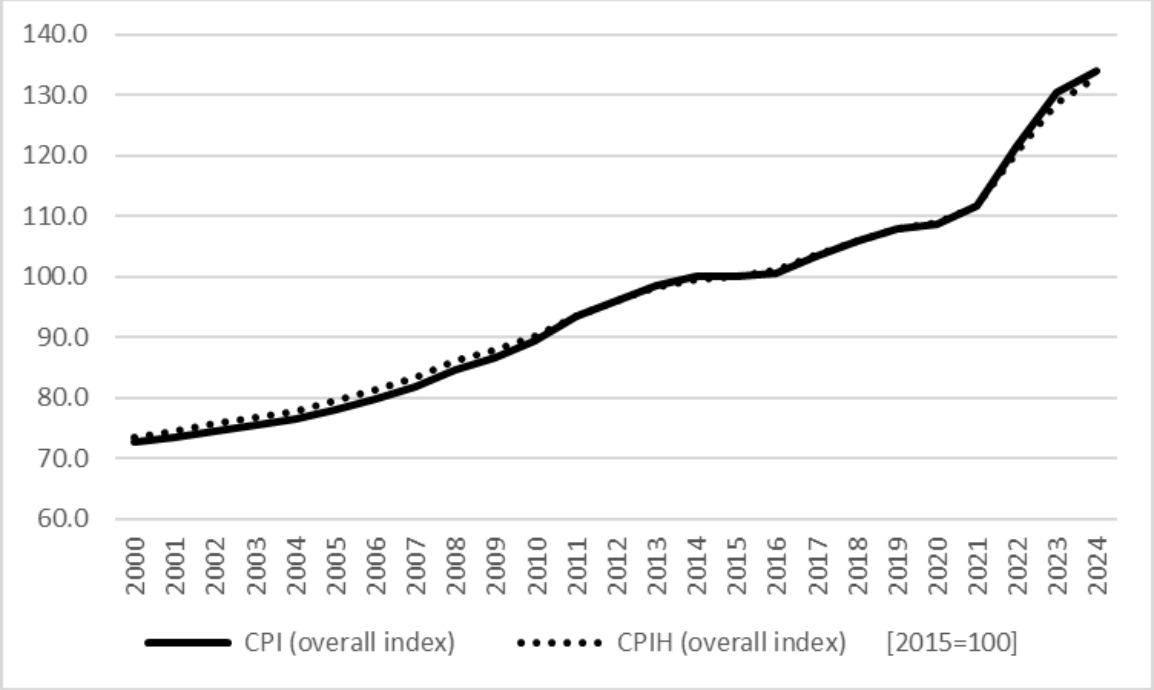
JEL: C82, E21, E31, P24

1. Introduction

Consumer Price Indices (CPI) are central to monetary and fiscal policy. However, there are limitations in fully capturing CPI measurement errors from a micro-level approach (ex. (Filardo 2016)). Also, due to the rigidity of fixed consumption baskets and infrequent updates, these indices may fail to reflect evolving consumption behavior and cost pressures—particularly during periods of economic shocks. Engel curve-based inflation provides a complementary view that helps identify and correct potential biases in official CPI measures.

In the UK, the CPIH has been introduced to address some of the limitations of the standard CPI by incorporating housing costs, but questions remain as to whether either index adequately captures real household expenses. CPIH includes owner-occupiers' housing costs and Council Tax, which are not captured in the standard CPI. While CPI is still used for international comparisons, the Office for National Statistics (ONS) recommends CPIH as the main measure of consumer price inflation for economic analysis and policy-making. As shown in Figure 1, both CPI and CPIH show similar upward trend. This paper applies Engel curve methodology to assess the extent of inflation mismeasurement, with a focus on how official indices have responded to structural disruptions and income-driven consumption changes.

Figure 1: UK CPI and CPIH



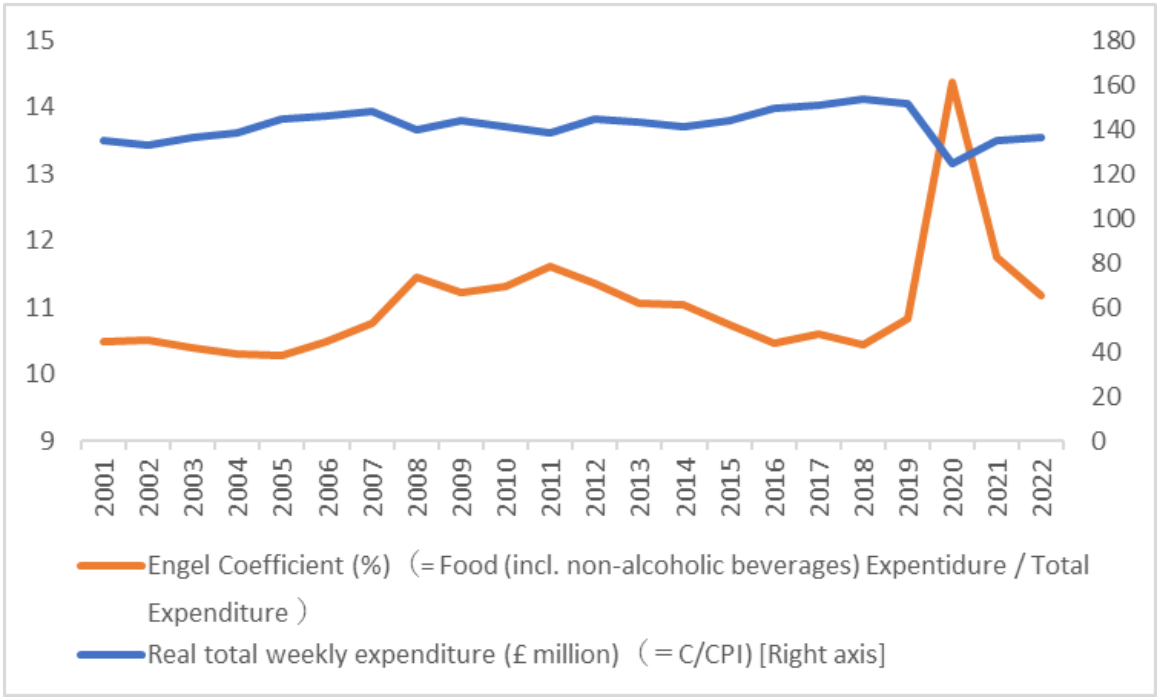
Data Source: Office for National Statistics (ONS)

2. Literature Background and Data

This study extends the empirical framework developed in Nakamura, Steinsson, and Liu (2016), and applied to the Japanese case in Oguro (2020), which builds on foundational studies by Hamilton (2001) and Costa (2001). These studies exploit Engel's law—the inverse relationship between income and food expenditure share—as a stable benchmark for detecting CPI bias. If the Engel curve is stable over time, shifts not explained by income or price controls are interpreted as measurement error in official inflation. This approach allows for the indirect estimation of inflation bias in the absence of 'true' price indices. In general, as discussed in Nakamura et al (2016) and Oguro (2020), inflation tends to be biased upward due to substitution effect and new good bias.

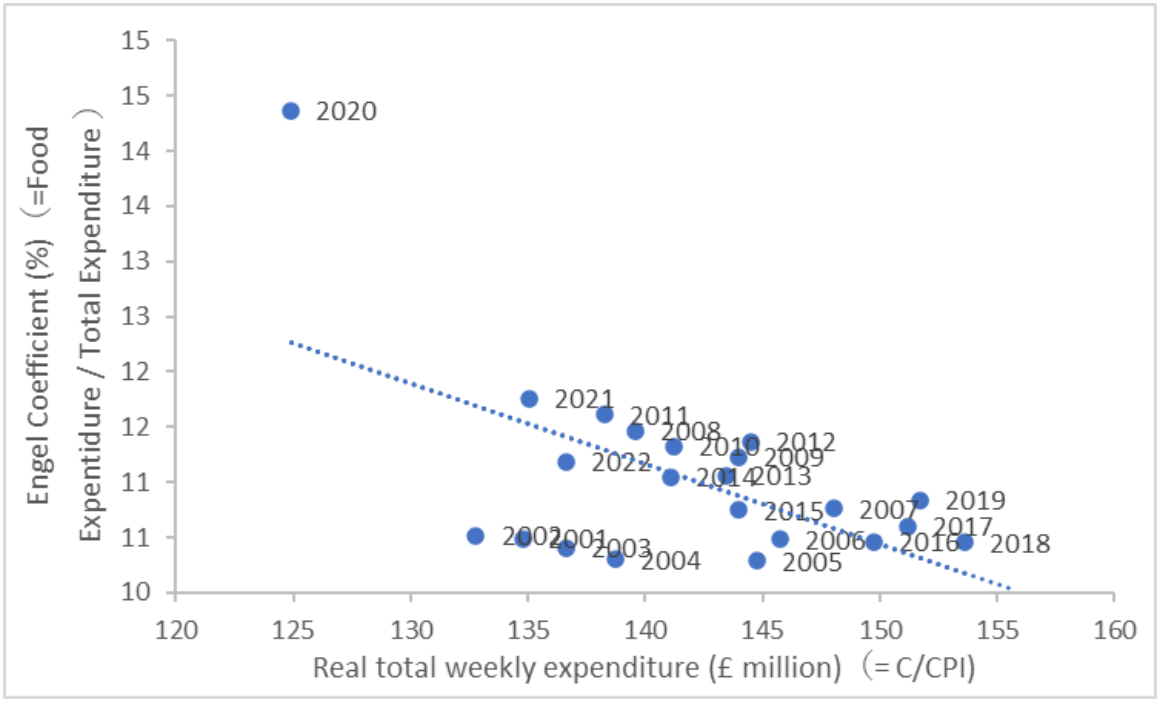
The analysis is based on annual data from the UK Office for National Statistics (ONS), spanning 2001–2023. The dependent variable is the Engel coefficient (food expenditure as a share of total consumption), and the unit of observation is food item i in year t. The cross-sectional dimension includes 13 food categories. Figure 2 shows the trend in the Engel coefficient – that is, the share of food expenditure in total household spending – over time in the UK. This data provides the foundation for estimating Engel curve-based inflation. Basically, Engel Coefficient is considered to be somewhat stable since food is a necessity. Engel Coefficient shows drastic movement in 2020, the year of COVID-19 pandemic. In general, the richer people get, the smaller their Engel coefficient tends to be. Figure 3 clarifies the negative correlation between food share and Real Expenditure in the UK.

Figure 2: UK food share (Engel's Coefficient %) and Real Expenditure



Data Source: Office for National Statistics (ONS)

Figure 3: Correlation between UK food share (Engel's Coefficient %) and Real Expenditure



Data Source: Office for National Statistics (ONS)

3. Theoretical Model and Methodology

The model used in this paper is an adaptation of an existing Engel curve-based estimation framework that has been developed and applied in Nakamura et al (2016) and Oguro (2020). 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). A

previous application of this method has used the Engel coefficient (the proportion of food expenditure in total consumption expenditure) as the dependent variable for region k at time t. In the UK study presented in this paper, regional data are not available. Therefore, an adjustment is made by setting the cross-section (i) to food items instead. The Engel curve in this study is formulated as a logarithmic-linear model, as shown in equation (1), where i represents food items and t represents time.

$$\omega_{i,t} = \psi_i + \beta \log\left(C_t/P_t\right) + \gamma \log\left(P_{i,t}^{food}/P_t\right) + \in_{i,t} \qquad (1)$$

Where:

- P_t: True price level
- $P_{i,t}^{food}$: True food price level
- C_t/P_t: Real total consumption expenditure
- $P_{i,t}^{food}/P_t$: Relative food price
- ψ_i: Constant term
- $\in_{i,t}$: Residual

The estimated coefficient β represents the elasticity of household expenditure adjustment 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 $(\log P_t - \log P_0 , \log P_{i,t}^{food} - \log P_{i,0}^{food})$. The cumulative bias $(\mu_t , \mu_{i,t}^{food})$ is extracted as a shift in the Engel curve, assuming it is constant across food items i and categories (prices, food prices). Accordingly, equation (1) can be reformulated to include the inflation (deflation) bias term μ_t, as shown in equation (2).

$$\omega_{i,t} = \hat{\psi}_i + \beta \log C_t - \beta \tilde{\pi}_t - \beta \mu_t + \gamma(\tilde{\pi}_{i,t}^{food} - \tilde{\pi}_t) + \in_{i,t} \qquad (2)$$

Where:

- $\log P_t - \log P_0 = \tilde{\pi}_t + \mu_t$
- $\log P_{i,t}^{food} - \log P_{i,0}^{food} = \tilde{\pi}_{i,t}^{food} + \mu_{i,t}^{food}$
- $\tilde{\pi}_t , \tilde{\pi}_{i,t}^{food}$: Measured cumulative inflation (deflation) from period 0 to t for i
- $\mu_t , \mu_{i,t}^{food}$: Cumulative bias in inflation (deflation) estimates

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

The methodology is based on a fixed effects model with robust standard errors. Given the high correlation of overall inflation rate with food inflation, including both variables leads to multicollinearity. Therefore, only food inflation(i) is included to avoid collinearity and to capture relative price effects more clearly.

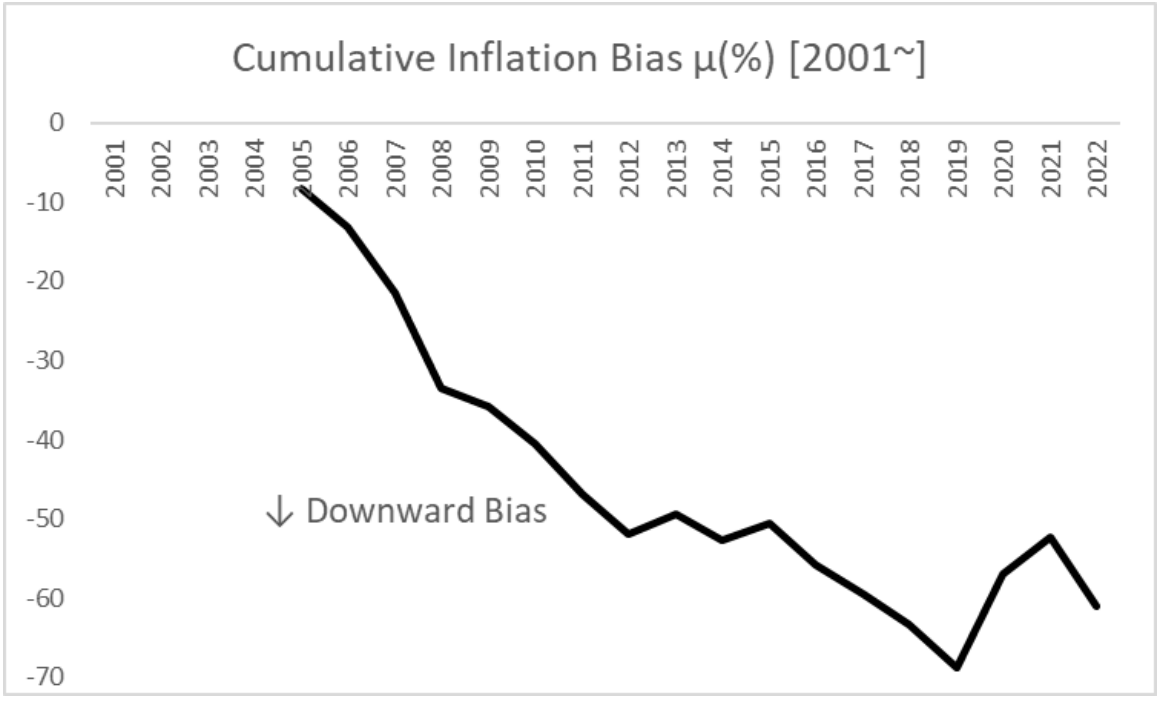
4. Results

The results find that a 1% increase in real income reduces the food share by about 0.7%, supporting the Engel law. The results show a consistent downward bias in official inflation rates since the mid-2000s. Figure 4 shows cumulative inflation bias, which is mostly biased downward. However, in 2020 and 2021, the bias temporarily turned upward due to the impact of the COVID-19 pandemic.

Figure 5 shows cumulative inflation. Engel curve-based cumulative inflation is higher than both the official CPI and CPIH inflation. Cumulative inflation based on CPIH (which includes owner-occupiers' housing costs) is lower than that based on CPI. This means that housing costs, measured by owner-occupiers' imputed rents, haven't pushed up overall inflation very much in recent years. The downward bias in official inflation rates seems to come more from rising costs for low-income households, especially for essential goods, rather than from housing costs being left out.

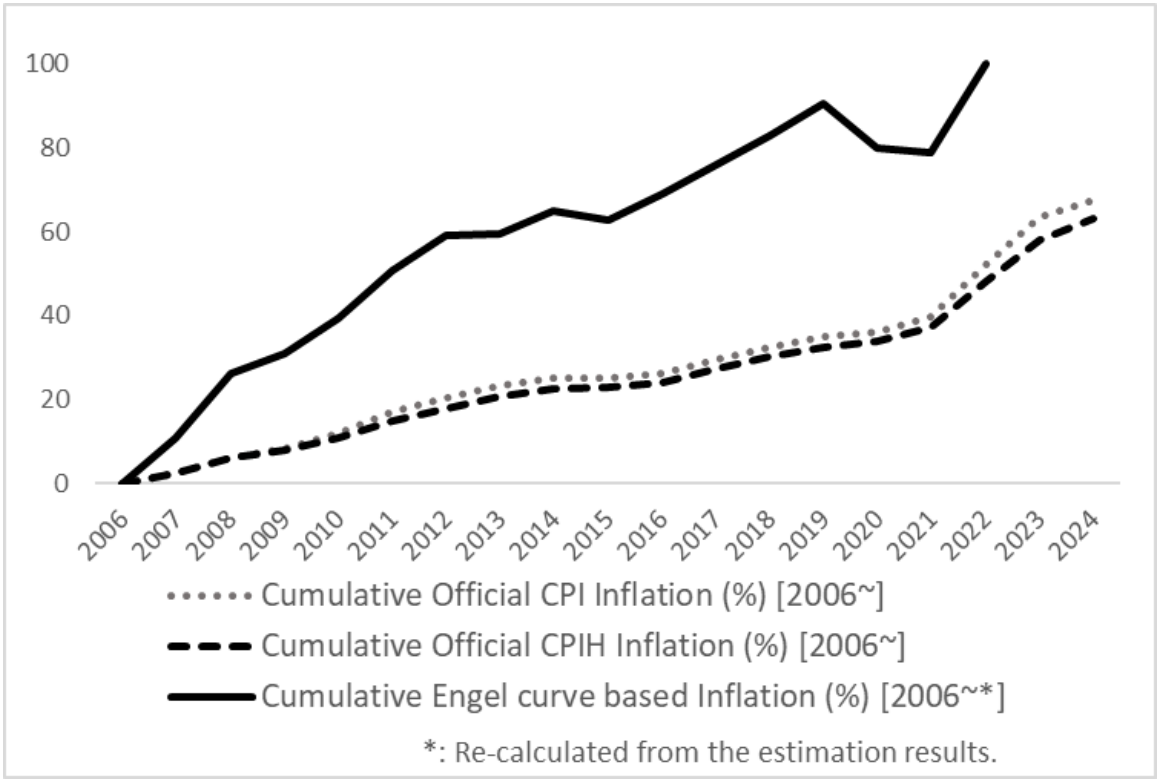
Figure 6 shows the annual inflation bias calculated using the estimation results based on equation (2). In most years, the bias is negative. Figure 7 plots Engel-based inflation compared with CPI. The estimated Engel-curve-based inflation rates display greater fluctuation than official CPI/CPIH rates, particularly during periods of economic turbulence. Also, The Engel-based rate is generally higher than the official inflation, indicating that CPI may understate cost increases. The timeline shows structural factors—like rising inequality and austerity—that contribute to this growing gap.

Figure 4: Cumulative Inflation Bias



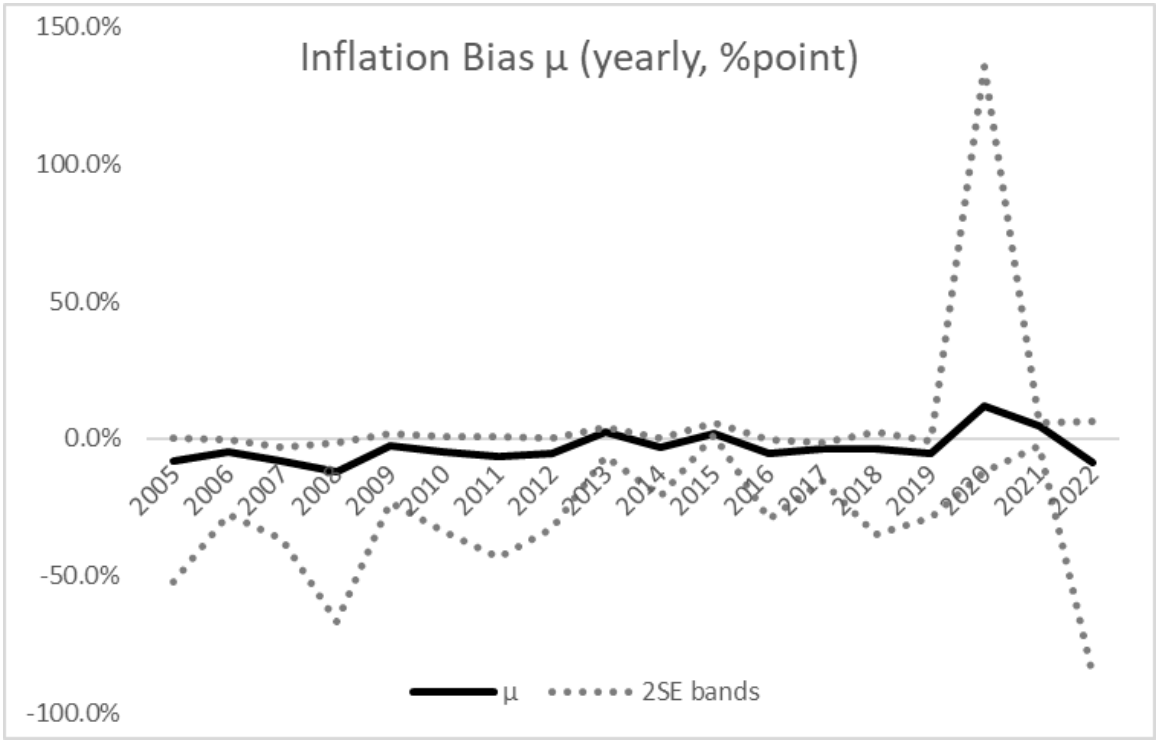
Source: Calculated by the author using the estimation results based on equation (2).

Figure 5: Cumulative Official Inflation and Cumulative Engel Curve based Inflation



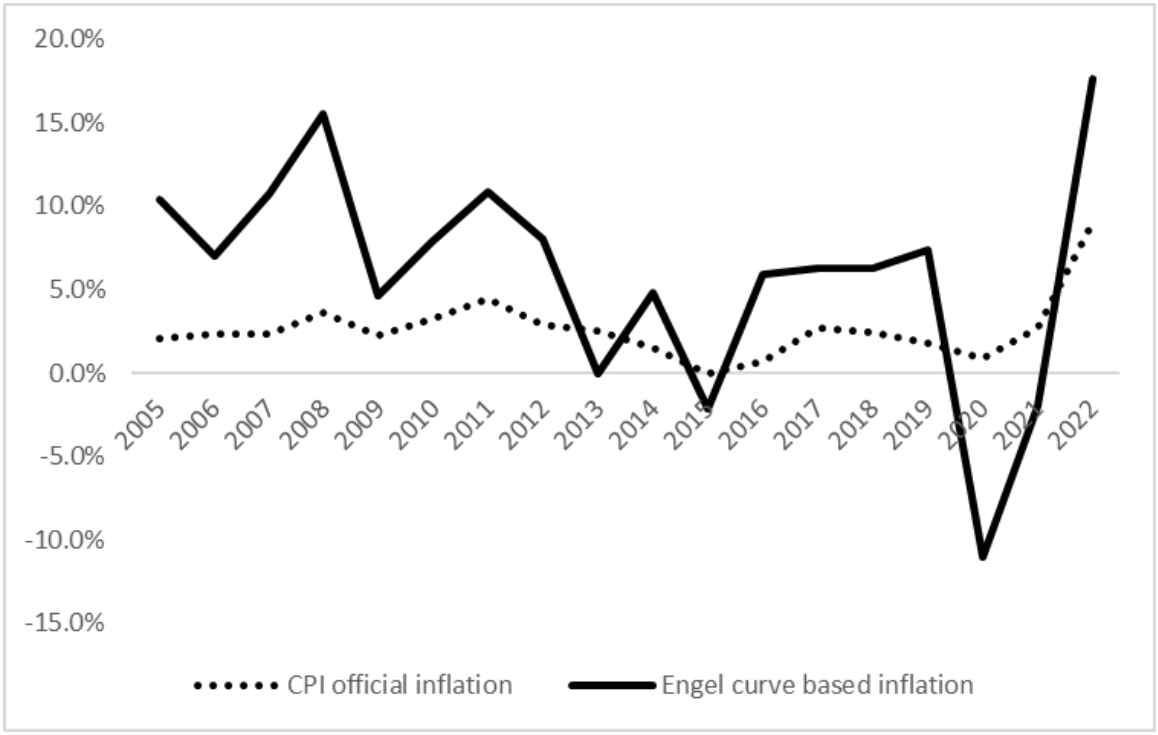
Source: Calculated by the author using the estimation results based on equation (2).

Figure 6: Annual Inflation Bias



Source: Calculated by the author using the estimation results based on equation (2).

Figure 7: Annual Engel curve-based inflation and Official Inflation



Source: Calculated by the author using the estimation results based on equation (2).

5. Conclusion

By adapting an established Engel curve model to UK data, this study reveals significant downward biases in official inflation metrics, especially post-2005. These biases disproportionately affect low-income households and raise questions about the adequacy of CPI and CPIH in representing true cost-of-living dynamics. The results are expected to inform CPI revisions and social welfare policies, highlighting the need for more responsive inflation tracking mechanisms.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number JP20K20761 during the period April 2020–March 2025.

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