Polynomial Analysis of U.S. Real Wage using U.S. CPI and Weekly Earnings Data

Yuhong Dai [1], Chenyi Hu [2,*], Zixuan Li [3]

[1] Hefei Thomas School, Hefei, China

[2] Shanghai World Foreign Language Academy, Shanghai, China

[3] Nanjing Xianlin Foreign Language School, Nanjing, China

* Corresponding Author Email: chenyihu_2027@thestudentbuddy.org

Abstract. The United States has been concerned with inflation ever since early 2019. Inflation is a rise in prices that reduces purchasing power. When the nominal wage growth fails to keep up with price growth, it weakens the real purchasing power and puts pressure on the living standards of households. This paper utilized official data from the U.S. Bureau of Labor Statistics, including monthly CPI-U figures and quarterly median weekly income statistics. Two quantitative techniques were used: an exact sequence model for measuring cumulative inflation and purchasing power loss, and a polynomial least squares fit to measure the shape of price and wage movements over time. The results indicate that the cumulative CPI-U inflation is about 26.1% from December 2019 through December 2025, increasing to about 27.2% in February 2026. During that same time, nominal weekly earnings increased meaningfully, while real weekly earnings only increased marginally and fell during the inflation spike.

Keywords: Polynomial analysis; Wage analysis; CPI.

1. Introduction

Polynomial fitting suggests that prices followed a continuous upward curve, nominal wages exhibited a smooth increase, and real wages displayed a non-linear dip and recovery pattern. A mathematical exercise of combining thus gives a clearer interpretation of post-2019 inflation by linking measurement and trend-shaping.

The real value of money is one of the main economic problems of inflation. Also, inflation directly affects household well-being. When the general level of prices rises, a given amount of income will buy fewer goods and services than before. Inflation thus affects day-to-day consumption, outlook towards savings, as well as living standards. When price growth outpaces wage growth, the effect is more serious because income might rise in nominal terms but fall in real terms. Inflation, especially if it persists, weakens financial planning because it makes future costs less predictable and money a weaker store of value. Purchasing power really does give a useful insight into the impact of inflation on the economy. Following 2019, a clear examination of inflation and purchasing power is especially important because the recent U.S. price movement has been unusually large and raised broad concerns about living costs, wage adequacy, and real income.

Fisher's The Purchasing Power of Money [1] gives the idea that the value of money depends on the price level. Other references tell of the negative influences of inflation. Shiller did survey about people who don't like inflation because they think it lowers their standard of living [2]. Others, such as Shapiro and Wilcox, explain that CPI is not a perfect measurement of the cost of living [3]. Stantcheva had a similar result, that many people think rising prices will decrease their buying power [4]. To find the change in real payment, the pay measures, inflation measures, and the reference period used are necessary [5]. Same as that, real income is the proxy for the standard of living. Also, the reason why the deflator is not concerned is that CPI can show how the price level of everything produced in an economy change over time, while the deflator includes the non-consumer items like the national defence [6]. Therefore, the deflator, which includes many non-market expenditures, is not a good measurement.

This study uses two quantitative approaches to investigate shifts in household purchasing power since 2019. The first is sequence analysis, which quantifies cumulative inflation and directly estimates its impact on purchasing power. The second, polynomial regression, utilizes monthly CPI and quarterly earnings data to identify underlying long-term trends amid short-term fluctuation. Combining the two methods provides a more accurate measure of real changes in purchasing power, highlighting the widening divergence between nominal and real wage trends.

2. Method

This paper uses only official U.S. Bureau of Labor Statistics (BLS) data. For prices, this study uses the historical CPI table for the U.S. city average, all items, not seasonally adjusted [7]. The monthly series extends through February 2026 and reports index values with the base year 1982–1984. The main values utilized in subsequent analyses are 256.974 in December 2019, 324.054 in December 2025, 325.252 in January 2026, and 326.785 in February 2026 [7].

For wages, this paper references BLS Table 1, which shows the usual median weekly earnings of full-time wage and salary workers (quarterly averages, seasonally adjusted) [8]. This table includes both current dollar earnings and earnings in 1982–1984 dollars. Therefore, nominal and real weekly pay are compared directly without using a separate deflation series.

To facilitate shape comparison, the CPI is normalized to 100 in December 2019, and the wage series is normalized to 100 in 2019 Q1. This normalization places prices, nominal weekly earnings, and real weekly earnings on the same indexed scale, even though the original data differ in units and frequencies.

The first mathematical approach is an exact sequence model. Let P_t signify the price level at period t, and let π_t denote the inflation rate between periods $t-1$ and t. The price level thus follows the recursion:

$$P_t = (1+\pi_t)P_t - 1 \tag{1}$$

$$P_t = P_0 \prod_{i=1}^{t}(1+\pi_i) \tag{2}$$

This formulation is exact: cumulative inflation is multiplicative rather than additive. If a basket cost A_0 in the base period, the equivalent nominal amount for period t is $A_{eq}, t = A_0(P_t/P_0)$. The purchasing power of a fixed nominal amount measured in base-period dollars is $PP_t = A_0(P_0/P_t)$. The BLS factsheet on purchasing power and constant dollars describes the same ratio logic underlying these formulas [9].

$$haty_t = a_0 + a_1 t + a_2 t^2 + a_3 t^3 \tag{3}$$

The second mathematical method is polynomial least-squares fitting. Baseline linear, quadratic, and cubic models of the form specified below are estimated for each normalized series y_t, with lower-degree terms excluded from linear and quadratic specifications. These distinct models are applied to the normalized monthly CPI figures and to the normalized nominal and real weekly earnings. The simplest specification is a straight line; quadratic models allow for curvilinear shapes; and cubic models are included to capture potential post-pandemic patterns such as acceleration followed by moderation, or a dip followed by recovery. The objective is descriptive rather than causal: this study neither claims that a cubic law governs inflation nor infers causal relationships but instead evaluates which simple curve best interprets the shape of the observed data.

3. Results and discussion

The coefficient of determination (R^2)and root mean squared error (RMSE) are reported for fit comparison.R^2indicates the proportion of variance explained by the fitted curve, while RMSE reflects the average size of the fitting error in index points. A superior model is characterized by a lower

RMSE. Employing both metrics is advantageous as it discourages overreliance on visual impressions in the discussion. Related results are provided in Table 1, Fig. 1, and Fig. 2.

The calculations of the sequences clearly show a decline in purchasing power post December 2019. CPI-U rose from 256.974 to 324.054 in the period between December 2019 and December 2025, constitute cumulative inflation of about 26.1percent. If the timeline of the comparison is stretched to include February 2026, the figure increases to around 27.2 percent [7]. A basket whose cost was $100 in December 2019 would cost about $126.10 by December 2025 and about $127.17 by February 2026. Reading that same ratio backwards, a basket costing $100 in December 2025 only had about $79.30 worth of December 2019 purchasing power, which fell to about $78.64 by February 2026.

The comparison of wages shows that, in isolation, nominal values may be misleading. Median nominal weekly earnings rose from $934 in 2019 Q4 to $1,215 in 2025 Q3, a rise of about 30.1%. During the same period, real weekly earnings increased from $362 to $376, a rise of 3.9 percent [10]. The difference becomes even more apparent during the inflation surge. Nominal weekly earnings increased from $996 to $1,048, while real weekly earnings, meanwhile, decreased from $371 to $359. Between 2021 Q2 and 2022 Q2, consumers had more dollars in their wallets, but for short periods, those dollars were buying less and less.

The additional fitted curves provided an extra layer of evidence. Table 1 shows linear, quadratic, and cubic fits for the three normalized series. The cubic fit is best for CPI, with statistics R2=0.986 and RMSE=1.083, while the linear fit is R2=0.964 and RMSE=1.712. It implies that the post-2019 price trajectory is distinctly curved rather than being nearly straight. The linear model already works very well: according to the present analysis, R2 = 0.981, and higher-order polynomials improve the fit only a little. Nominal wages thus increased in a relatively smooth fashion. Real weekly earnings are the most interesting case. The linear fit in this case hardly explains anything, with an R2 = 0.040, while the cubic fit rises to R2 = 0.422. Real wages showed a fluctuating pattern rather than a consistent increase or decrease. The prices instead dropped when the inflation surged and then partly recovered.

Table 1. The evaluation results.

Series	Linear R^2	Quadratic R^2	Cubic R^2	Best RMSE	Interpretation
Normalized CPI	0.964	0.981	0.986	1.083	Curved rise with acceleration and later moderation
Nominal weekly earnings	0.981	0.982	0.982	1.399	Smooth upward trend; almost linear
Real weekly earnings	0.040	0.046	0.422	1.749	Dip-and-recovery pattern;clearly non-linear
Series	Linear R^2	Quadratic R^2	Cubic R^2	Best RMSE	Interpretation

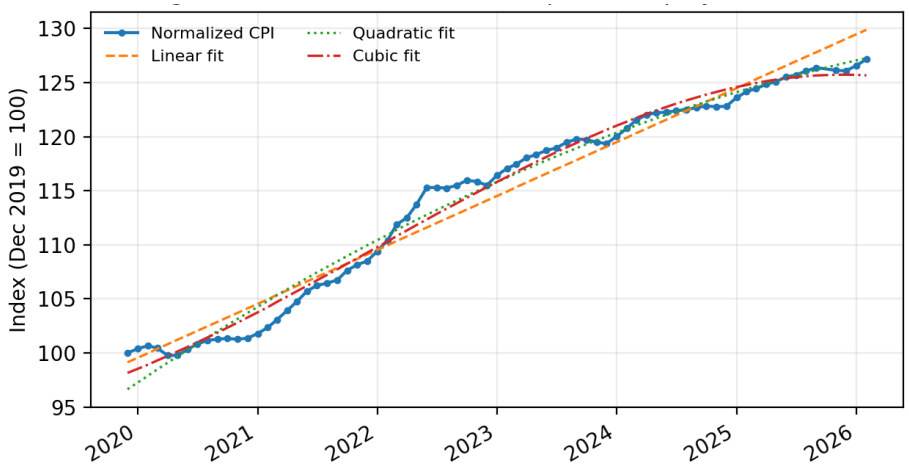


Fig 1. Normalized CPI-U from December 2019 to February 2026, with linear, quadratic, and cubic polynomial fits (Picture credit: Original).

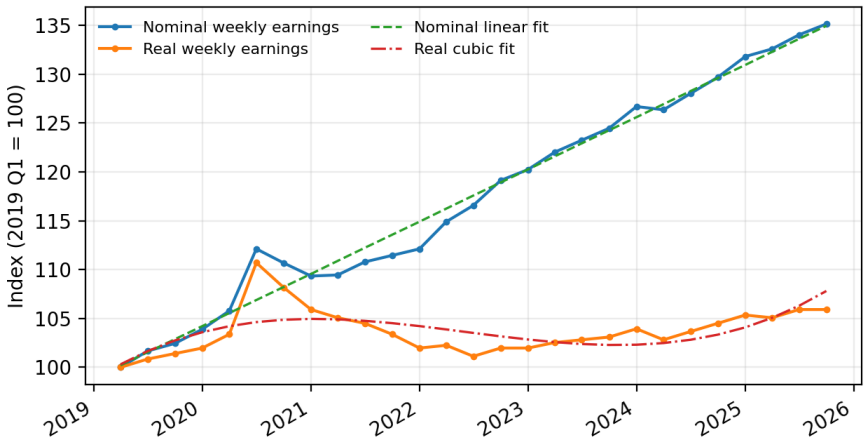


Fig 2. Normalized nominal and real median weekly earnings from 2019 Q1 to 2025 Q3, with a linear fit for nominal earnings and a cubic fit for real earnings (Picture credit: Original).

Results show why the two mathematical methods can assist each other. The sequence model is precise and closely connected with the economic definition of cumulative inflation. It is the correct tool for answering questions about the change in the price of a basketball's real value and the calculation of the remaining purchasing power. Sequence compounding is therefore mathematically clean and economically meaningful.

A polynomial fitting does something else. It is not a substitute for precise calculation and does not elucidate the rationale for inflation. Rather, it offers a compact statistical description of shape. This is useful because the three series studied here do not move in the same way. Prices increased over a clearly curved path. Nominal wages increased more steadily. Real wages fell and then partially recovered. Thus, a simple descriptive fit clarifies the relationship between money values and real values, which cannot be done by one cumulative inflation calculation.

The contribution of the paper is most visible here, too. According to existing literature, there are reasons that people dislike inflation and why real wages matter [2, 4, 6, 7]. Both CPI and weekly earnings are already published by official statistics. The information that is supplied by this paper is a direct, primary comparison of recursive compounding vs polynomial fitting using the same official post-2019 data. The inflation episode cannot be summed up adequately by a single straight trend; the shape of the path matters, especially for real wages.

There are many limitations. CPI-U is an aggregate index and does not reflect the personal inflation rate of each household. Second, the polynomial fits are descriptive rather than structural. Shape might be summarized by a higher-order polynomial, but this does not pin down a causal mechanism. The price analysis was monthly recorded, while the wage data was quarterly recorded; the analysis contrasts two related frequencies rather than one common sampling interval. Ultimately, it cannot include October 2025 CPI data and Q42025 earnings because the federal government was shut down and inappropriately lapsed [4, 7]. These constraints do not negate the central outcome, yet they do delimit the paper's depth and breadth.

4. Discussion

This study uses two different mathematical approaches, which are complementary to each other. The sequence model precisely measures inflation accumulation, which gives an accurate reflection of the changes in purchasing power over time. This makes the fixed-basket CPI particularly effective for showing how much more expensive a fixed basket of goods became after the base period, and how much real value now remains in a fixed nominal amount of money. In this perspective, the sequence method both captures mathematical rigour as well as the 'economic' meaning that is in conformity with the basic notion of cumulative inflation.

Polynomial regression also has a different purpose. It does not substitute the accurate measurements of inflation, nor does it identify the structural causes behind inflation. As an alternative, researchers can erect a simple statistical account of the shape of each series with respect to time. Because the three series examined in this paper do not move the same way, it is important to use these descriptive roles. There is a clear upward trend in the consumer price index, the nominal weekly earnings undergo a more or less smooth progression, while weekly real earnings are on an uneven path of decline and partial recovery. It's hard to capture these differences through one cumulative inflation figure alone. Consequently, the fitted curves enhance interpretive significance by manifesting the distinct temporal patterns observable in prices, nominal income, and inflation-adjusted income.

Additionally, the findings have an economic implication. Though nominal weekly earnings increased over the years, this didn't mean that real purchasing power gained anywhere near as much. Interpreting the living standards hinges on this distinction. An increase in money wages may present the appearance of an improvement, and this could be correct. But it could be misleading if inflation rises at the same or a faster rate. Wages did not simply increase post-2019. This analysis shows that more was involved. The crucial aspect was whether those higher wages were enough to counterbalance the escalating cost of goods and services. The evidence suggests that for much of the period, this offset was limited, particularly during the inflation surge, when nominal wage growth was accompanied by weaker real outcomes.

The importance of this relationship helps explain why the comparison between nominal and real wages. The money value is the actual amount of money received. While real value is the amount of goods and services money could actually command. When talking about economics, the latter relates more closely to material welfare and purchasing power. As a result, the divergence identified in this paper reinforces the view in the literature that inflation should never be regarded as arising solely from prices or money wages taken in isolation. A more complete understanding needs to focus on duality. The current study adds to that understanding in two ways. It first presents a clear inflation calculation and then offers a statistical picture of the way the relevant series has evolved through time.

This paper does not offer a new dataset but applies two mathematical techniques to the same official post-2019 U.S. data and shows that they capture different dimensions of the same economic episode. The sequence model accurately captures magnitude, while the polynomial fitting generates shape in an effective and interpretable manner. These approaches offer a more coherent explanation of inflation since 2019 than either would on its own. Results suggest that the inflation episode should not be reduced to a single average change or a simple linear trend. The adjustment process is important, especially regarding real wages; temporary losses in purchasing power may not be revealed when only end comparisons are considered.

The discussions also sustain the notion that in post-2019, inflation did not unfold as a uniform phenomenon. The growth in prices was highly non-linear; nominal earnings grew steadily, while real wages varied erratically. It shows that some households may have experienced a period of instability rather than just decline or improvement. Later information shows some recovery in real wages, even if earlier losses remain analytically important as they show that wage growth lagged inflation for part of the period. A simple linear summary would downplay this instability and would fail to show the timing of the deterioration and recovery.

However, it must be acknowledged that this measure has several limitations. CPI-U, being an aggregate, means that it does not reflect the experience of many households since having different spending patterns based on income, age, region, and consumption structure. Moreover, the polynomial models are descriptive, not structural. Each of these explanations reveals patterns in the data. But they do not explain the mechanisms that caused that pattern. The fitted curves should be interpreted as descriptive tools rather than as tools of causal explanation. In the third place, the price series is monthly while the wage series is quarterly, so that the comparison is made across related but different frequencies. This does not negate the analysis but puts limits on how directly precision can

be compared. Moreover, the lack of October 2025 CPI data and Q4 earnings data 2025 limits the time period of the analysis and somewhat limits the final comparison's comprehensiveness.

The primary conclusion is, however, unambiguous. After 2019, inflation in the United States resulted in a substantial decline in purchasing power. As a result, nominal wage growth was insufficient to represent an improvement in real economic growth. Calculations with exact sequences quantify the scale of the loss in purchasing power, and the polynomial fits bring out the fact that the underlying adjustment paths of prices, nominal earnings, and real earnings were not the same. As a result, a combined mathematical approach provides a more powerful interpretation of the period than a single cumulative figure or a simple trend line alone.

5. Conclusion

US inflation after 2019 significantly eroded household purchasing power, based on the official BLS CPI-U and weekly earnings statistics. A model with an exact sequence characterized the cumulative scale of inflation and the associated loss of real value, while polynomial fitting illustrated the differing adjustment paths of prices, nominal wages, and real wages. The price curve shows significant sharpness after the year 2019; nominal weekly earnings have increased steadily after the year 2019, real weekly earnings have improved overall slightly, and real weekly earnings declined during peak inflation. The findings imply that nominal wage growth cannot adequately reflect the changes in living standards since higher income did not bring about similar real gains in purchasing power. The presence of several limitations is important to note CPI-U is an aggregate index, wage and price series use different frequencies, and polynomial models are descriptive and not causal. In the future, some of the research presented could entail the assessment of aspects like regional variations. Furthermore, an alternative would be to explore the measures of real income and welfare.

Authors Contribution

All the authors contributed equally, and their names were listed in alphabetical order.

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