



Exploring the Joint Relationships Between Inflation, Real Personal Income, Unemployment Rate, and the S&P 500

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Introduction

Major economic indicators such as inflation, income, unemployment, and the stock market are deeply interconnected parts of the financial ecosystem. While rising prices typically erode household purchasing power unless balanced by income growth, prior research has often been limited in scope. For instance, Matiur, Muhammad, and Stephen (2014) focused their analysis on how unemployment affects specifics in industries like gambling and tobacco rather than examining the broader market. This leaves a gap in understanding how major economic indicators move together over long periods. Our research bridges this gap by analyzing the relationships between inflation and real personal income and by examining how the association between the unemployment rate and the overall S&P 500 has structurally evolved from the 1960s to the 2020s.

Research Question & Method

1. How does inflation, measured by CPI, influence real personal income over time?

To address this question, we ran a simple linear regression to test whether changes in inflation are associated with changes in real personal income. We reviewed diagnostic plots to check linearity and used the p value for the slope to determine statistical significance.

2. How has the association between the unemployment rate and the S&P 500 differed across decades from the 1960s to the 2020s?

We conducted a multiple linear regression model to evaluate the effects of both unemployment rate and decade on the adjusted S&P 500 value. We included specific interaction terms between the unemployment rate and decades to detect structural shifts in the market's sensitivity to labor data over time.

Variables

- Real Personal Income (RPI): This is the raw quantitative data measuring the inflation adjusted income received by households. It is measured in billions of dollars with 2017 as the reference year for constant purchasing power.
- Real Personal Income Growth (RPI_yoy): This is the transformed variable used in our regression model. It measures the year over year percentage change in Real Personal Income to track the rate of income growth rather than just the total amount.
- Consumer Price Index (CPI): This is the raw monthly index value that measures changes in the cost of consumer goods and services.
- Consumer Price Inflation (CPI_yoy): This is the transformed variable used to represent the inflation rate. It calculates the year over year percentage change in the Consumer Price Index.
- Unemployment Rate (UNRATE): This quantitative variable measures the monthly unemployment rate in the US as a percentage.
- S&P 500 Index (SP500): This is the raw stock market index tracking the stock performance of 500 large companies listed on exchanges in the United States.
- Adjusted S&P 500 (SP500_adjust): This is the transformed variable used in our analysis. We adjusted the raw S&P 500 index for inflation using the CPI to allow for a fair comparison of the market's real value between the past and the present.

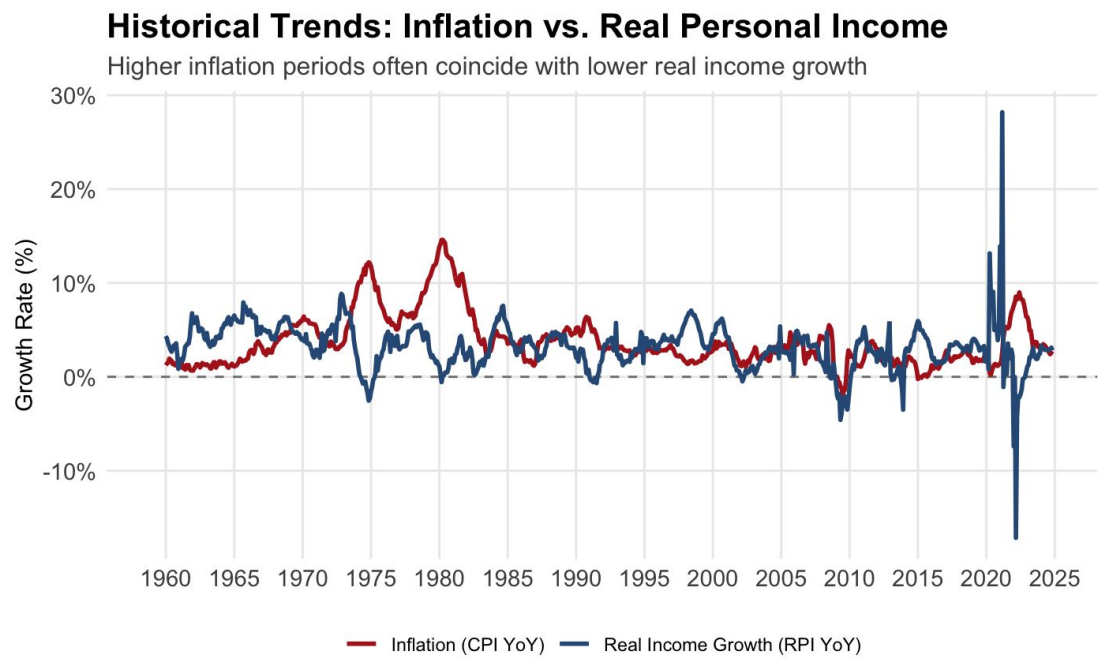
Sample Characteristics

Variables	Summary
RPI_YOY	n=791, Mean=3.20%, SD=2.53%, Range=-17.15% to 28.18%
CPI_YOY	n=791, Mean=3.76%, SD=2.81%, Range=-1.96% to 14.59%
UNRATE	n=791, Mean=5.88%, SD=1.69%, Range=3.4% to 14.8%
SP500_adjust	n=791, Mean=\$1547, SD=\$1204, Range=\$355 to \$5930

How Inflation Drags Down Real Income

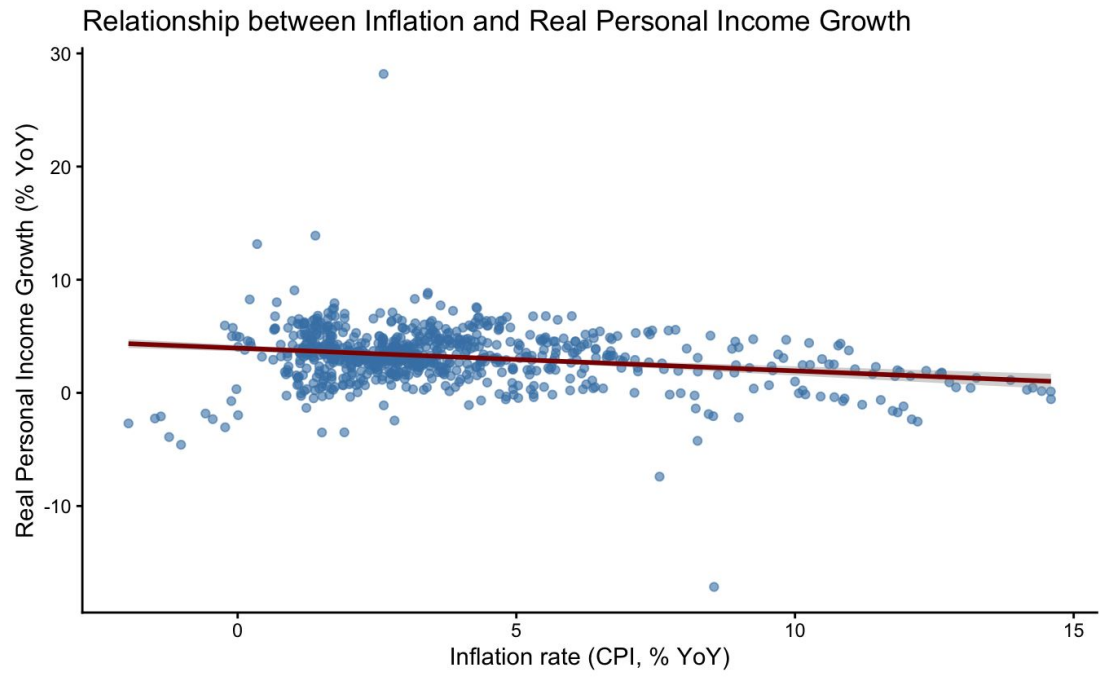
Bivariate analysis:

- Non-Stationarity: A naive correlation of raw index levels yields $r = 0.90$. This is a spurious correlation driven by non-stationarity (both time series trend upward over decades).
- Stationarity Adjustment: To analyze the true structural relationship, we transformed data into Year-over-Year (YoY) growth rates. This reveals a true negative correlation of $r = -0.23$.



Historical Divergence (1959–2024):

The transformed YoY data reveals a counter-cyclical pattern. Notable divergence occurs during high-inflation regimes (e.g., the 1970s Stagflation and the 2022 post-COVID spike), where surges in Inflation coincide with sharp contractions in Real Personal Income.



$$\widehat{RPI_{yoy}} = \beta_0 + \beta_1 \times CPI_{yoy}$$

Relationship between Inflation and Real Personal Income Growth:
Scatter plot with Simple Linear Regression fit. The negative slope (Beta = -0.20) indicates that higher inflation significantly reduces real income growth ($p < 0.001$).

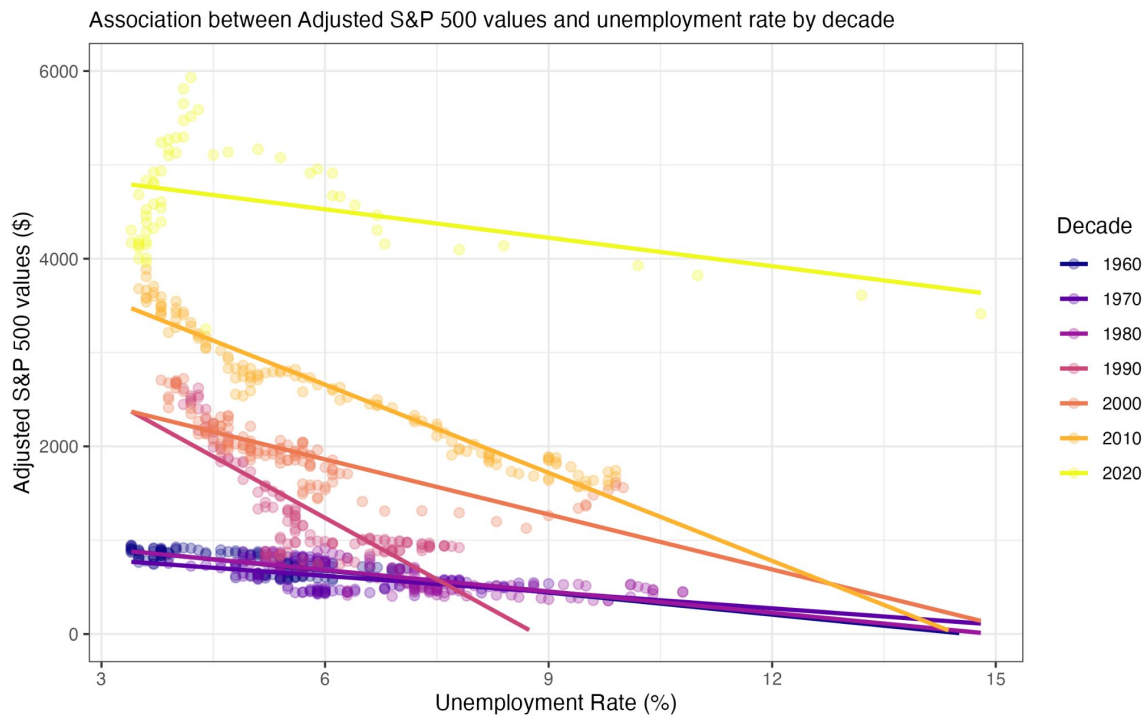
Characteristic	Beta (95% CI)	p-value
(Intercept)	3.953 (3.672 to 4.234)	<0.001
CPI_yoy	-0.201 (-0.261 to -0.141)	<0.001
Abbreviation: CI = Confidence Interval $R^2 = 0.053$		

- Every 1 percentage point rise in inflation reduces real income growth by 0.20 percentage points (Beta = -0.20, $p < 0.001$).
- In a theoretical zero-inflation environment, the model predicts a baseline real income growth rate of 3.95% (Intercept = 3.95).
- Inflation explains roughly 5.3% of the variance in real income growth ($R^2 = 0.053$), indicating it is a significant but not exclusive driver of purchasing power.

Unemployment vs. S&P 500: Decadal Shifts

Bivariate analysis:

- The overall correlation coefficient ($r=-0.35$) indicates a weak negative relationship and we can understand that the value of adjusted S&P 500 increases as the value of unemployment rate decrease.
- The correlation test indicated that there is a statistically significant relationship between S&P 500 and unemployment rate ($p < .0001$, 95%CI (-0.413, -0.291).



According to the figure above, the plotted regression lines show clear differences across decades, with some periods displaying much steeper negative relationships between unemployment and S&P 500 values.

Linear Regression:

We employed the interaction term into our model to examine whether the effect of unemployment rate varies across decade.
The model was specified as: Adjusted S&P 500 ~ unemployment rate * decade

The excerpted regression results below summarize how the effect of unemployment rate on S&P 500 varies across decades relative to the 1960s baseline

Characteristic	Beta (95% CI)	p-value
(Intercept)	1,148 (959 to 1,337)	<0.001
UNRATE	-78 (-117 to -40)	<0.001
UNRATE * decade		
UNRATE * 1970	21 (-32 to 73)	0.44
UNRATE * 1980	2.4 (-45 to 50)	0.92
UNRATE * 1990	-358 (-413 to -303)	<0.001
UNRATE * 2000	-117 (-165 to -69)	<0.001
UNRATE * 2010	-235 (-278 to -191)	<0.001
UNRATE * 2020	-23 (-68 to 23)	0.33
Adjusted R^2	0.963	
No. Obs.	791	
Abbreviation: CI = Confidence Interval		

For controlling all indicators except for unemployment rate, the result showed in the 1960s for one percentage point increase in unemployment rate, the predicted adjusted S&P 500 values drop by \$78 (40, 117). Compared with this baseline, the relationship in the 1990s, 2000s, and 2010s are significantly more negative ($p < 0.001$ respectively), indicating that in those decades, one percentage increase in unemployment rate correspond to much larger drops in SP500_adjust values.

General F test:

A general F-test comparing the reduced model (without interaction) and the full model (including the UNRATE* decade interaction) indicated that the interaction terms significantly improved model fit ($p < .0001$).

This suggests that the effect of unemployment rates on the S&P 500 varies substantially across decades.

Conclusion

RQ1.

- After adjusting for trend, the analysis shows a consistent negative relationship between inflation and real personal income growth.
- The results imply that even modest inflation reduces purchasing power over time.
- Inflation is not the sole driver of income changes, but it remains a meaningful and influential factor.
- Overall, maintaining stable inflation is important for supporting real income growth and long-term financial stability.

RQ2.

- Across descriptive plots, bivariate tests, and regression models, we consistently observed a negative relationship between unemployment and the S&P 500.
- This negative association was much stronger in the 1990s, 2000s, and 2010s compared with the 1960s.
- These findings support our hypothesis that higher unemployment is linked to lower S&P 500 values.
- Unlike prior studies focused on specific industries, our analysis covers the full S&P 500, revealing a broader market-level pattern.

Implications

- Spending shifts to Survival Mode: Since inflation acts as a “tax” on income, households are forced to cut spending on luxuries to afford essentials like food and rent.
- Business Impact: Companies selling non-essential goods likely face lower demand during high inflation, while businesses selling daily necessities remain more stable as consumers prioritize survival over wants.
- The “Wage Lag” Reality: The data confirms that wages do not instantly adjust to price spikes. This means standard annual pay raises often fail to keep up with high inflation, leading to a temporary drop in the standard of living.
- These results can help investors understand how changes in unemployment affect overall stock market performance.
- Investors may adjust their strategies when unemployment begins to rise, anticipating stronger negative impacts on the S&P 500.

Limitations

- Low Explanatory Power(R^2): While the relationship is statistically significant, inflation only explains 5.3% of the variance in real income growth. This implies that other factors such as productivity, technology and tax policy drive the remaining ~95%.
- Omitted Variable Bias: The simple linear regression focuses exclusively on inflation. It does not account for other macroeconomic variables like interest rate or GDP growth that simultaneously influence income.
- Aggregate Data Limitations: The study uses national averages. This masks distributional effects, meaning it does not show how inflation likely hurts lower income households much harder than higher income households.
- One assumption of multiple linear regression—constant variance—was not fully met, which may reduce the reliability of the estimates.
- The model includes only unemployment rate and decade, whereas real financial systems are far more complex.
- Other important factors (e.g., economic growth, demographic trends) should be considered for more accurate prediction of the S&P 500.
- Therefore, the results from this analysis should be interpreted with caution.

Reference

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