America Treasury Yields and Economic Indicators: A Multivariate Linear Regression Analysis

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Abstract:

This article provides a comprehensive analysis by employing multivariate linear regression to examine the intricate relationship between U.S. Treasury yields and several crucial economic indicators, with a particular focus on the year-over-year growth rate of the Consumer Price Index (CPI) and the size of the Federal Reserve's balance sheet. The research spans a decade, analyzing data from 2014 to 2024, offering a robust time frame to evaluate long-term trends. The primary goal of the research is to identify how these economic factors influence Treasury yields, which are key indicators for understanding government borrowing costs and broader financial conditions. In particular, Treasury yields are crucial for determining the cost of financing public debt, while the CPI growth rate serves as a reliable measure of inflation, and the Federal Reserve's balance sheet reflects its monetary policy stance. By investigating these relationships, the research aims to provide valuable insights for policymakers, investors, and financial analysts into how inflationary pressures and monetary policy actions interact to shape financial markets, potentially affecting investment strategies and economic decision-making. These findings offer actionable knowledge for managing economic risks and opportunities.

Keywords: Treasury Yields, CPI, Federal Reserve Balance Sheet, Multivariate Linear Regression.

1. Introduction

Treasury yields, representing the returns on government bonds, are pivotal economic indicators reflecting the expenses associated with government borrowing. These yields function as benchmarks for risk-free interest rates in financial markets, exerting influence over a wide array of economic factors such as investment decisions, economic forecasts, and the formulation of monetary policies. Therefore, comprehending the fluctuations in Treasury yields is imperative for policymakers and investors alike. These fluctuations offer valuable insights into government borrowing costs and broader economic trends, which

are essential for informed decision-making [1].

Treasury yields serve as a crucial instrument for policy-makers to assess the efficacy of monetary policies. These yields are utilized to evaluate the impact of interest rate decisions and determine whether monetary policies are achieving their intended objectives. The interplay between Treasury yields, the year-over-year growth rate of the Consumer Price Index (CPI), and the size of the Federal Reserve's balance sheet holds particular significance. By comprehending how these factors influence yields, policymakers can tailor their strategies to align with prevailing economic conditions and inflation targets. This comprehension is especially vital during periods of economic uncertainty, where even minor adjustments in inflation or monetary policy can have substantial repercussions for the overall economy [2]. For example, an increase in inflation expectations typically leads to higher Treasury yields as investors seek greater returns to offset anticipated declines in purchasing power. Conversely, a reduction in the Federal Reserve's balance sheet may indicate tighter monetary policy, potentially resulting in higher yields as well.

Investors closely monitor Treasury yields to inform their asset allocation and risk management strategies. The yields on Treasury bonds are widely regarded as a benchmark for other interest rates and can significantly influence investment decisions. By understanding the impact of inflation and monetary policy on Treasury yields, investors can better anticipate yield movements and make strategic decisions that optimize their portfolios. For instance, during periods of high inflation, investors may reallocate their investments towards assets that typically perform well in inflationary environments, such as commodities or inflation-protected securities. Conversely, in a low-interest-rate environment, investors may seek higher returns in equities or corporate bonds. Understanding the interplay between Treasury yields, inflation, and monetary policy helps investors mitigate risk and enhance their financial strategies, particularly in volatile markets [3].

The fluctuations in Treasury yields provide valuable insights into future economic conditions by reflecting investor expectations. Changes in yields can serve as indicators of how investors perceive the economic outlook, including their expectations regarding inflationary pressures, growth prospects, and global financial stability. For instance, a steepening yield curve, where long-term yields rise faster than short-term yields, may indicate investor optimism about future economic growth. Conversely, an inverted yield curve, where short-term yields exceed long-term yields, could signal concerns about a potential economic slowdown. Analyzing Treasury yields alongside CPI growth and the Federal Reserve's balance sheet can enhance predictions of broader economic trends, which

are essential for both public and private sector strategies. This research aims to investigate the relationship between U.S. Treasury yields and CPI growth, specifically examining the impact of changes in the Federal Reserve's balance sheet on Treasury yields. By delving into these interconnections, the research seeks to offer deeper insights into how these economic indicators influence government borrowing costs and financial markets. A comprehensive analysis of these factors not only aids in interpreting current economic conditions but also facilitates anticipation of future trends, thereby assisting policymakers and investors in navigating the complexities of the financial landscape with greater precision.

2. Methodology

Multivariate linear regression is a statistical method employed to establish the correlation between a dependent variable and several independent variables. The standard format of the regression equation is utilized for this purpose [4]

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + ? \qquad (1)$$

In this research, the relationship between the 10-year Treasury rate (Y) and several explanatory variables including the year-over-year growth rate of the U.S. Consumer Price Index (CPI), the federal funds rate, and the size of the Federal Reserve's assets (X1, X2 and X3) is being analyzed. A multiple linear regression model will be used to examine how these variables are related, with β0 as the intercept term, β1, β2, and βk as regression coefficients for each explanatory variable, and ε representing the error term.

In order to ensure the accuracy of the regression findings, it is crucial that certain key assumptions are satisfied. Firstly, the model assumes a linear connection between the dependent variable and the explanatory variables, suggesting that changes in the 10-year Treasury rate should be proportionally linked to variations in the CPI growth rate, federal funds rate, and the size of the Fed's assets. Secondly, adherence to the independence assumption requires that observations in the dataset are not influenced by each other; thus, one observation's value should not impact or be impacted by another, thereby preventing autocorrelation in residuals and ensuring unbiased estimates. It is also important to make sure that the assumption of homoscedasticity holds true, meaning that the variance of the residuals remains consistent across different levels of the explanatory variables. In simpler terms, regardless of how large or small the explanatory variables are, the spread of residuals should be uniform. This is crucial for preventing certain observations from being disproportion-

ately weighted and ensuring reliable coefficient estimates. Additionally, it is assumed that the residuals follow a normal distribution, which is essential for the validity of statistical tests related to regression coefficients and for guaranteeing unbiased model predictions.

The research utilizes data from 2014 to 2024, including Treasury yield data from the U.S. Treasury, CPI growth data from the U.S. Bureau of Labor Statistics, and asset size data from the Federal Reserve. The analysis begins with creating time series plots for each variable to observe temporal changes and patterns in the data. Descriptive statistical methods are then used to summarize the distri-

bution and dispersion of each variable, providing insights into central tendencies and variability.

The main focus of the analysis is on using the multiple linear regression model to evaluate how explanatory variables impact the 10-year Treasury bond yield. The effectiveness of the model is assessed by examining the R^2 value, which indicates how well the model explains variations in the Treasury rate. To determine if each regression coefficient has statistical significance, p-values are used to assess whether observed relationships are meaningful or could have occurred by chance.
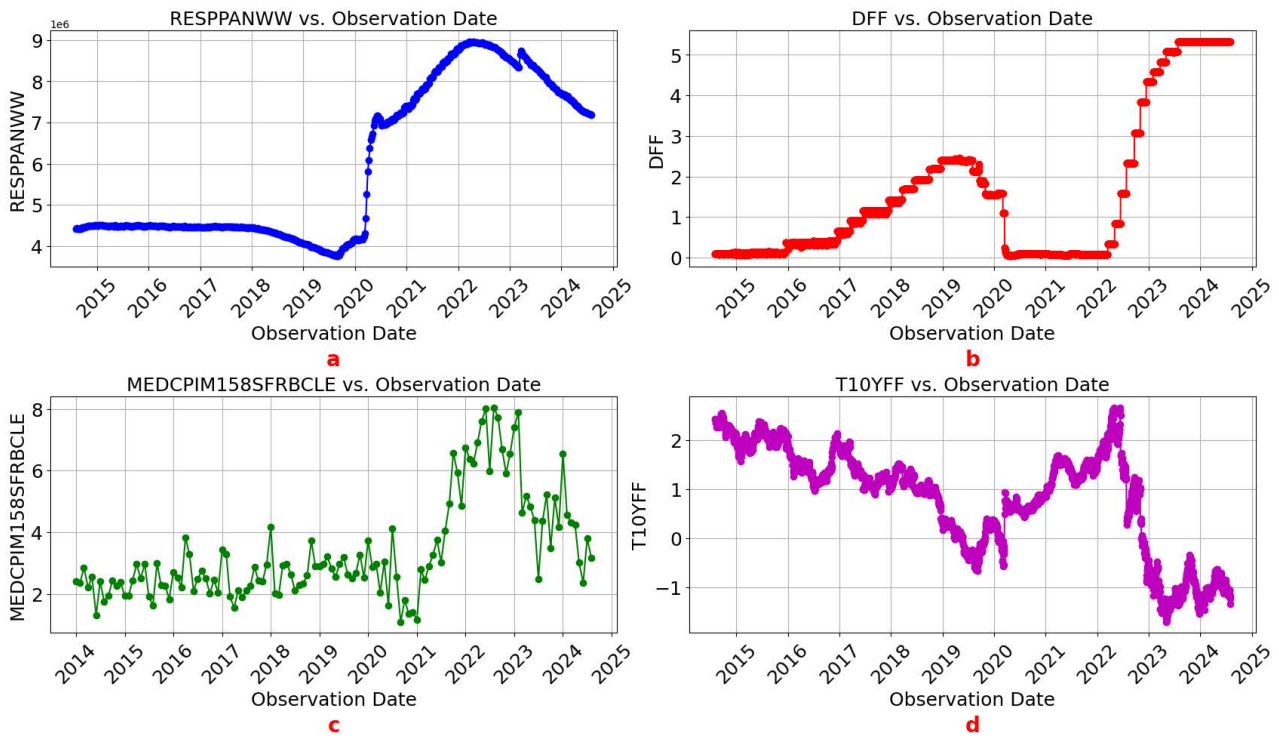

Fig. 1 Subchart a (blue line), subchart b (red line), subchart c (green line), and subchart d (purple line) look at changes in the Federal Reserve asset size, the federal funds rate, the U.S. CPI year-on-year, and the 10-year Treasury rate over time, respectively.

To support the analysis, several figures are included. Fig. 1 displays a time series analysis of key economic variables from 2014 to 2024. Subchart a illustrates the trend in the size of the Fed's assets and provides insights into its monetary policy operations during this period. Subchart b shows the relationship between the federal funds rate and time, reflecting changes in interest rate policy. Subchart c depicts changes in the CPI growth rate, an important indicator for monitoring inflation trends, while subchart d emphasizes the size of the Fed's assets to highlight its correlation with other variables. Fig. 2 assesses model fit through the R^2 value, evaluating how well the regression model explains fluctuations in the 10-year Treasury rate. Fig. 3 presents fitted plots from regression analysis, illus-

trating linear relationships between explanatory variables and Treasury rates. These visual aids enhance understanding of temporal changes and their impact on dependent variables, providing valuable insights into economic dynamics affecting Treasury bond yields [5].

Reaching a deep understanding of the relationship between economic indicators and Treasury yields is crucial for investors to develop informed investment strategies and effectively manage risk. Having a thorough understanding of how CPI growth and Federal Reserve policies affect yields allows investors to make strategic decisions that maximize portfolio performance. By predicting yield movements based on economic trends, investors can adjust their investment strategies to align with anticipated

market conditions, thus improving their risk management practices.

Potential future research has the opportunity to further improve the insights provided by this research in various ways. Adding more economic variables, such as unemployment rates or GDP growth, could help to conduct a more comprehensive analysis of the factors influencing Treasury yields. These additional factors may reveal more complex relationships between different economic indicators and Treasury yields, leading to a deeper understanding of the mechanisms driving yield fluctuations. Expanding the time frame of the analysis to include historical data from earlier periods or incorporating forecasts could also be beneficial. This approach would allow for an evaluation of how the relationships between variables change over time and under different economic conditions, providing a more dynamic perspective on Treasury yield determinants.
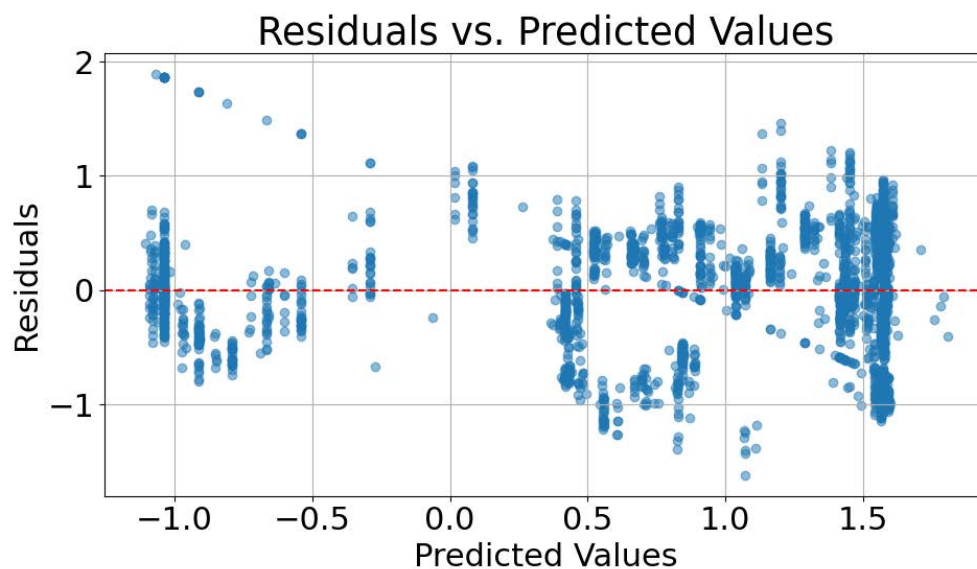

Fig. 2 Multiple linear regression function R^2 residuals.

Moreover, valuable comparative insights could be gained by conducting similar analyses in other major economies. Researchers can determine whether the observed patterns are specific to the U.S. or indicative of broader global trends by examining the impact of inflation and monetary policy on government bond yields across different countries. This comparative research has the potential to enhance the generalizability of findings and contribute to a more comprehensive understanding of international financial markets [6].
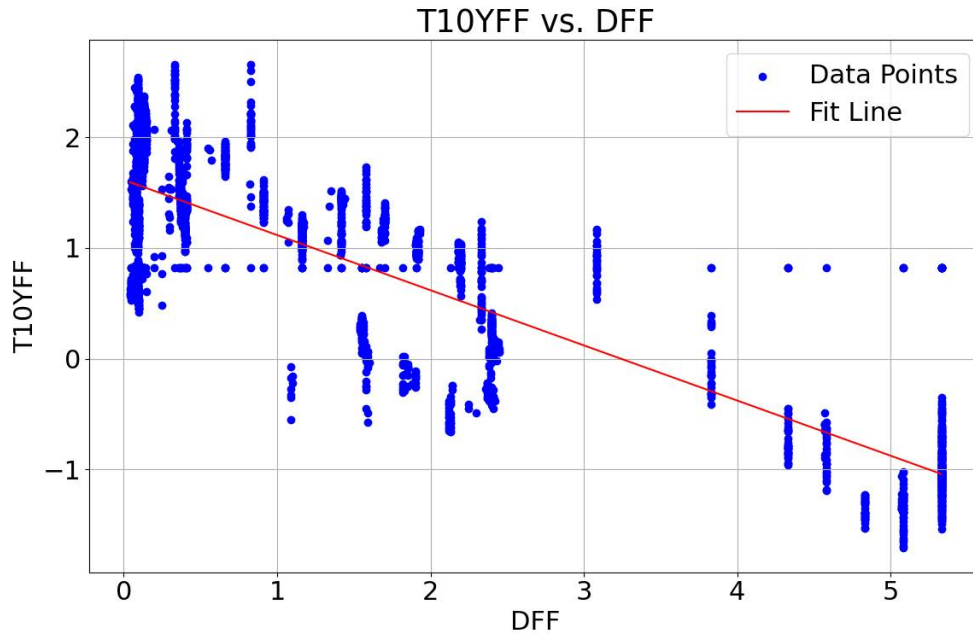
Fig. 3 Multiple linear regression function image.

This research offers a significant contribution to the comprehension of how Treasury yields are affected by inflation and monetary policy. The findings are beneficial for policymakers and investors, providing a foundation for making well-informed decisions and strategic plans in financial markets. The research highlights the importance of considering various economic indicators when assessing government debt costs and creating investment strategies, paving the way for future studies to expand on these results and further clarify the complex dynamics of financial markets.

3. Results and Discussion

A visual examination of US Treasury yields from 2014 to 2024 shows patterns that align with economic circumstances. Yields generally rise during periods of economic expansion and fall during recessions or times of economic uncertainty. The peaks and troughs in the graph reflect the impact of changes in fiscal and monetary policy on the market. Additionally, the year-on-year growth rate chart for CPI demonstrates fluctuations in inflation levels, particularly during periods of an overheated economy or significant disruptions in the supply chain, highlighting the influence of inflationary pressures on investor expectations and government borrowing costs. Furthermore, the chart depicting the Fed's balance sheet illustrates a pattern of substantial expansion during financial crises such as COVID-19, indicating how Fed's monetary policy responds and its effect on market liquidity. The expansion of balance sheet typically signifies a more accommodating monetary policy and may also exert upward pressure on Treasury yields.

Based on the results of the regression analysis, the R² value of the model is 0.7342, indicating that approximately 73% of the variability in Treasury yields can be accounted for by the model. This suggests that independent variables (such as the year-on-year growth rate of the US CPI, the federal funds rate, and the Federal Reserve asset size) possess a strong explanatory power for Treasury yields. The derived regression equation is as follows:

$$y = 1.4918 + 0.0745 \cdot X_1 - 0.4976 \cdot X_2 - 0.00202 \cdot X_3 \quad (2)$$

The variable y represents the US Treasury yield, with X1 denoting the year-on-year growth rate of the US CPI, X2 representing the federal funds rate, and X3 indicating the size of the Fed's assets. The regression coefficient for the year-on-year CPI growth rate is 0.0745, suggesting that a one-unit increase in inflation is associated with an expected rise in Treasury yields by approximately 0.0745 units. This finding aligns with economic theory positing that investors seek higher yields to offset inflation risk when faced with rising inflation. The coefficient for the Fed funds rate is -0.4976, indicating that a one-unit increase in this rate corresponds to a decrease in Treasury yields by about 0.4976 units. This negative correlation may reflect market response to monetary policy easing (i.e., lower interest rates), resulting in reduced Treasury yields. The coefficient on the Fed's asset size is -0.00202, implying that a one-unit increase in asset size leads to a decline in

Treasury yields by approximately 0.00202 units, suggesting that expansion of the Fed's balance sheet as part of its accommodative monetary policy may exert slight downward pressure on yields. Taken together, these findings offer valuable insights into how inflation and monetary policy impact Treasury yields, highlighting the pivotal role of inflation expectations and monetary policy on government bond returns.

4. Conclusion

This research employs a comprehensive multivariate linear regression analysis to explore the intricate connections among U.S. Treasury yields, the year-over-year growth rate of the Consumer Price Index (CPI), and the magnitude of the Federal Reserve's balance sheet. By utilizing a robust statistical framework, the research seeks to elucidate how fluctuations in inflation rates and monetary policy impact Treasury yields, which are crucial for understanding broader financial market dynamics. The findings offer valuable insights into how CPI growth and the size of the Federal Reserve's balance sheet influence government borrowing costs, providing essential information for policymakers, investors, and financial analysts. This knowledge is vital for evaluating the effects of economic conditions and monetary policy decisions on Treasury yields. The analysis findings suggest that Treasury yields are significantly impacted by both inflation and monetary policy. In particular, an increase in CPI growth rates is linked to higher Treasury yields, reflecting the market's need for greater returns to counteract inflation risk. As inflation increases, investors demand higher yields to offset the decrease in purchasing power, leading to an increase in Treasury yields. Similarly, the expansion of the Federal Reserve's balance sheet is associated with elevated Treasury yields, indicating that shifts in monetary policy and liquidity conditions can have a substantial effect on government bond returns. The expansion of the balance sheet typically signals a more accommodating monetary policy, which paradoxically may put upward pressure on Treasury yields. The results highlight the critical need for policymakers to find a careful balance between controlling inflation targets and carrying out monetary policy measures. Effectively handling inflation expectations and monetary policy has the potential to stabilize Treasury yields and borrowing costs, thus contributing to creating a more stable economic environment. This stability is crucial for developing fiscal policies and ensuring efficient government financing. By understanding the impact of inflation and monetary policy on Treasury yields, policymakers can skillfully navigate the complexities of economic management and reduce potential financial instability.

References

[1] Rangotra Rahul. Treasury yield in India: A theoretical framework. International Journal of Research in Finance and Management, 2022, 5(2): 96-103.

[2] Etuk Ette. Seasonal ARIMA model to Nigerian consumer price index data. American Journal of Scientific and Industrial Research, 2012, 3(5): 283-87.

[3] Krishnamurthy Arvind, et al. Panel on Shrinking the Federal Reserve Balance Sheet. Brookings Papers on Economic Activity, 2022, 2: 231-80.

[4] Suzuki, Frank S., et al. Multivariate linear regression analysis to evaluate multiple-set performance in active and inactive individuals. Motriz: Revista de Educação Física, 2019, 25(2): e101919.

[5] Altman, Naomi and Martin Krzywinski. Simple Linear Regression. Nature Methods, 2015, 12(11): 999–1000.

[6] Wiedermann, Wolfgang, et al. Heteroscedasticity as a Basis of Direction Dependence in Reversible Linear Regression Models. Multivariate Behavioral Research, 2017, 52(2): 222–41.