The Risk Profile of the Federal Reserve's System Open Market Account Holdings of Domestic Treasury Securities and its Implications for United States Taxpayers

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Definitions

Expectations Theory: Assumes the long-term interest rates to be an average of the short-term interest rates.

Federal Funds Rate: The interest rate at which depository institutions lend funds held at the Federal Reserve to other depository institutions overnight.

Federal Reserve (Fed): the central banking system of the United States (U.S.).

Floating Rate Notes (FRN): Short- to medium-term governmental debt securities paying quarterly interest with variable interest rates tied to a benchmark, adjusting periodically to mitigate interest rate fluctuations.

Interest on Reserve Balances: The interest the Federal Reserve Banks pay on reserve balances.

Macaulay Duration: Weighted average time for a bond's cash flows to repay its original investment, indicating sensitivity to interest rate changes.

Modified Duration: Adjusted version of Macaulay Duration expressing a bond's percentage change in price for a 1 percent interest rate change.

Par Value: Face value of a security, representing the amount repaid to the bondholder at maturity.

Quantitative Easing: Central bank's purchase of financial assets to increase the money supply and lower long-term interest rates, stimulating the economy.

SOMA Portfolio: Portfolio held by the Federal Reserve, reflecting assets and liabilities from open market operations.

Term Premium: The additional yield investors demand for the interest rate risk associated with holding longer-term bonds.

Treasury Bills (T-bills): Short-term government debt securities paying zero interest.

Treasury Bonds (T-bonds): Long-term government debt securities paying semiannual interest.

Treasury Inflation-Protected Securities (TIPS): Medium- to long-term government debt securities paying semiannual interest and designed to protect against inflation by periodically adjusting their principal value.

Treasury notes (T-notes:) Medium-term governmental debt paying semiannual interest with a fixed interest rate and principal adjustments based on changes in the Consumer Price Index, providing inflation protection.

Unrealized Gains (Losses:) Change in value of an asset that has not been realized.

Yield to Maturity: Total rate of return earned by a bond when it makes all interest payments and repays the original principal at maturity, representing the average annual return if held until maturity.

Abstract

The composition of the System Open Market Account Holdings of Domestic Treasury Securities, along with its financial risks, may have implications for the funds transferred to the U.S. Treasury, potentially leading to higher taxes for American citizens. Estimating the market price and duration of the Federal Reserve's Treasury holdings, we find that the portfolio's exposure to interest rate risk amplifies unrealized losses under a stressed scenario. Furthermore, the interest earned and paid on the market value of Treasury holdings have a direct impact on the Fed's net income, particularly in an environment with increasing interest rates. This relationship implies that if the Fed incurs losses, the federal budget may need to further rely on American taxpayers.

This thesis highlights the dynamics between the composition of the Federal Reserve's Treasury portfolio, its exposure to financial risks, and the broader financial implications for the Federal Reserve, the U.S. Treasury, and the American taxpayers, contingent on the Treasury portfolio's position.

1 Introduction

The current monetary tightening to address inflationary pressure by increasing the short-term interest rate target, as first announced on March 16, 2022 (Decision regarding monetary policy implementation, 2022), has resulted in an unrealized loss position in the System Open Market Account (SOMA) Holdings of Domestic Securities. Anderson, Na, Schlusche, and Senyuz (2022) anticipate that continued interest rate hikes will exert downward pressure on the Federal Reserve's (Fed's) net income.

To date, limited research has been conducted on the Fed's unrealized gains or losses position. This may be a consequence of the more recent nature of persistent unrealized losses, observed since the conclusion of September 2021. Approximately one year later, in September 2022, most Reserve Banks suspended their remittance to the U.S. Treasury.

Unrealized gains or losses is linked to the inverse relationship between the term structure of interest rates and the market value of the SOMA portfolio. While Tease (1988) is unable to reject the Expectations Theory, Crump, Eusepi, and Moench (2018), suggest that the Term Premium accounts for the majority of the yield curve's response to macroeconomic shocks. Additionally, Li and Wei (2018) notes that factors beyond fundamental economic indicators can have explanatory power for the yield curve.

Chen (2022) evaluates the interest rate sensitivity of non-governmental bonds. Building upon his insights, we leverage information from Anderson, Marks, Na, Schlusche, and Senyuz (2022) and Anderson, Na, et al. (2022), to assess the Treasury portfolio's sensitivity to a 100 basis points (bps) increase in interest rates. As clarified by Bonis, Noonan, and Fiesthumel (2018), unrealized losses do not affect the Fed's ability to fulfill its monetary objectives of maximum employment and price stability, nor do they impact its ability to meet its financial obligations. However, if a significant amount of Treasury securities were to be sold before maturity, such sales could potentially affect the Fed's net income and, consequently, its remittance to the U.S. Treasury.

This paper investigates the impact of the composition of the SOMA Holdings of Domestic Treasury Securities and its associated financial risks to answer the question *What is the risk profile of the Federal Reserve's System Open Market Account Holdings of Domestic Treasury Securities, and what are the Implications for United States Taxpayers?* It explores potential implications for U.S. taxpayers, such as the prospect of higher taxes based on the funds transferred to the U.S. Treasury. To comprehend the market value and risk profile of the Fed's SOMA portfolio of Treasury holdings, we establish a framework, allowing us to pursue an deductive study by constructing a counterfactual exercise to estimate market price and duration as an idea of exposure to interest risk.

The aim of our model is to enable a stress-test during which the delta of our estimated market value would be investigated through the treatment of an increase in the interest rate as an input factor. Moreover, the exercise serves as a tool for quantifying the potential value loss or gain, which under some circumstances could directly impact the U.S. federal budget. The remittance from the Fed is an important income source for the U.S. Treasury, just as the taxes paid by everyday Americans. This relationship implies that if the Fed has losses, the federal budget may need to further rely on American taxpayers, and vice versa. This is one of the last components of our analysis – translating the potential loss of the Fed into a potential tax increase. Finally, we estimate the difference between the Fed's interest income and interest expenses. This allows us to understand the net impact of interest-related activities, providing insights into the financial performance of the Fed.

2 Scientific Approach

2.1 Data

We utilize data from the Fed's website concerning the SOMA portfolio of Treasury Holdings for the time period between 2003 and 2023. Additionally, we incorporate data on the Market Yields for U.S. Treasury securities between 2001 and 2023 from the same source. The chosen time frames for both datasets are determined by their digital availability on the Fed's website. The dataset regarding Treasury holdings includes information such as security type, maturity date, par value in dollars, percentage outstanding, interest rate in percentage, inflation protection in percentage, and spread in percentage. Meanwhile, the dataset on yields provides information on interest rates for maturities ranging from one month to thirty years. To process and analyze this data, we employ R, a freely available software environment designed for statistical computing and graphical representation. The Appendix includes supplementary and detailed information that supports the main content of this paper.

2.2 Methodology

We categorize the SOMA Treasury holdings into distinct asset classes, namely Treasury bills (T-bills), Treasury notes (T-notes), Treasury bonds (T-bonds), Treasury Inflation Protected Securities (TIPS), and Floating Rate Notes (FRNs). To evaluate the performance of these securities, we pair each asset in the portfolio with its corresponding market yield on U.S. Treasury securities. This pairing is based on the time to maturity for each security on a monthly basis. In cases where an exact match on date is not possible, we use the yield from the most recent available date. This exercise allows us to estimate the market value for all Treasury securities held by the Fed at various points in time.

$$MV_{it} = \sum_{t=1}^{T} \frac{C_{it}}{(1+YTM_{it})^t} + \frac{PV_{it}}{(1+YTM_{it})^T} \tag{1}$$

The estimated market value, denoted by MV, for asset i at time t, is the sum of future cash flows, where C represents the periodic interest payments. The yield to maturity, denoted by YTM, is raised to the power of the frequency of interest payments (t), or to the power of the time until maturity (T). Additionally, the par value at maturity is denoted by PV.

For T-notes and T-bonds, we adjust the calculation to account for semiannual interest payments. Similarly, for TIPS, we make adjustments for semiannual interest payments as well as for inflation compensation. For FRNs, we adjust for quarterly interest payments and for the spread. This approach ensures that all of our calculations are tailored to the specific characteristics of each security type.

Consequently, we are able to estimate the unrealized gains or losses for each individual asset i at time t as well as for the Treasury portfolio as a whole, providing insights at both a granular and aggregated level. We assume the par value to be the purchase value, thus we do not amortize any premiums or discounts on the purchase price.

$$UG(L)_{it} = \sum_{i=1}^{N} (MV_{it} - PV_{it}) \tag{2}$$

Where the unrealized gains (losses), denoted by $UG(L)$, for asset i in portfolio N at time t, is the difference between the estimated market value, denoted by MV, as calculated in (1), and the par value, denoted by PV.

We also analyze how our estimated unrealized gains or losses correlates with changes in interest rates. For this purpose, we use Macaulay duration and modified duration.

$$Macaulay\ Duration_{it} = \frac{\sum_{t=1}^{T} \frac{t \times C_{it}}{(1 + YTM_{it})^{t}} + \frac{n \times PV_{it}}{(1 + YTM_{it})^{T}}}{MV_{it}} \tag{3}$$

Where the $Macaulay\ Duration$, for asset i at time t, is determined by the equation in which t to the power represents the time until each cash flow, C denotes the periodic interest payments, YTM denotes the periodic yield to maturity, T denotes the total number of periods until maturity, and PV denotes the par value of each security. The market value, denoted by MV, is our estimated market value from (1).

$$Modified\ Duration_{it} = \frac{Macaulay\ Duration_{it}}{1 + \frac{YTM_{it}}{t}} \tag{4}$$

The $Modified\ Duration$, for asset i at time t, is calculated from the $Macaulay\ Duration$ in (3), with YTM representing the yield to maturity and t denoting the frequency of interest payments.

In our model, the goal is to estimate the market value of Treasury securities held within the Fed's SOMA portfolio, enabling us to assess unrealized gains or losses over time. We accomplish this by equating the yield to maturity (YTM) to the prevailing Market Yield on U.S. Treasury securities for all our calculations. When calculating the Macaulay duration and modified duration for T-bills, the computation is simplified due to the absence of periodic interest payments. Thus, we solely consider the par value, the yield, and the time to maturity for this calculation.

Furthermore, we conduct a stress test employing modified duration as the key metric. This allows us to estimate the potential change in market value for each asset within the Treasury portfolio in response to a one percent increase in interest rates. Calculating the difference between our estimated value and the par value provides us with a dollar amount symbolizing the Treasury portfolio's sensitivity to interest rate fluctuations.

$$UG(L)\ Stressed\ Scenario_{it} = \sum_{i=1}^{N} [(Modified\ Duration_{it} \times (MV_{it} \times Interest\ Rate\ Change)] + MV_{it} - PV_{it} \tag{5}$$

The Unrealized gains (losses), for asset i in portfolio N at time t, under a stressed scenario, denoted by $UG(L)\ Stressed\ Scenario$, quantify the effect of a change in interest rate adjusted for an increase in interest, denoted by $Interest\ Rate\ Change$, on the market value, denoted by MV from (**??**) using the $Modified\ duration$, as calculated in (4). The par value is denoted by PV.

We use the Pearson correlation coefficient to measure the strength and direction of the linear relationship between our model's estimated unrealized gains or losses and the reported unrealized gains or losses as reported in the Federal Reserve Banks Combined Quarterly Financial Report (Unaudited) (Board of Governors of the Federal Reserve System, 2012–2023).

$$\rho = \frac{\text{cov}(X, Y)}{\sigma_x \sigma_y} \tag{6}$$

The *Pearson Product-Moment Correlation Coefficient* is the ratio of the *covariance* between the variables x and y, in this case representing our estimated respectively reported unrealized gains or losses of the SOMA portfolio of Treasury holdings. Here, σ represent the standard deviation of x and y, respectively.

In addition, we calculate the coefficient of determination to evaluate our model's estimated unrealized gains or losses compared to the reported unrealized gains or losses.

$$R^2 = 1 - \frac{RSS}{TSS} \tag{7}$$

Where R^2 represent the coefficient of determination, the RSS represents the sum of square residuals, and TSS represents the total sum of squares.

We also calculate the standard error of the residuals to measure the average deviation between the reported values and the values predicted by our model.

$$SE = \sqrt{\frac{SRR}{n - 2}} \tag{8}$$

Where the standard error of the residuals is denoted by SE, the square of the sum of the square residuals is denoted by SRR, and the number of observations is denoted by n.

We simulate how our estimated unrealized gains or losses react under a stressed scenario. Assuming the unrealized gains or losses under a stressed scenario are realized over our historical sample period, we calculate the per capita cost for U.S. citizens, considering the U.S. federal budget's size and the reliance on funds from the Reserve Banks.

$$Increase\ in\ Tax_{it} = \frac{\sum_{i=1}^{N}(UG(L)_{it} - UG(L)\ Stressed\ Scenario_{it})}{U.S.\ Population_{t}} \quad (9)$$

Where the $Increase\ in\ Tax$, for asset i in portfolio N at time t, equals the difference in unrealized gains (losses), denoted by $UG(L)$, as calculated in (2), minus the unrealized gains (losses) under a stressed scenario, denoted by $UG(L)\ Stressed\ Scenario$, as calculated in (5), divided by the U.S. population, as estimated by the U.S. Census Bureau.

Finally, to gauge the Fed's interest gains or losses, we calculate the difference between the interest earned and paid on our estimated market values. We exclude T-bills from this calculation since they do not pay any interest.

$$IG(L)_{it} = \sum_{i=1}^{N} C_{it} - \sum_{i=1}^{N}(MV_{it} * IOR_{t}) \quad (10)$$

Here, the interest gains (losses), denoted by $IG(L)$, for asset i in portfolio N at time t, represent the difference between the interest payments, denoted by C, and the estimated market value, denoted by MV, as calculated in (1), multiplied by the interest rate on reserve balances, denoted by IOR.

3 Results

3.1 Estimation of Market Values Using a Bond Valuation Model

Estimating the unrealized gains or losses for the SOMA Treasury holdings, we observe a decline in unrealized losses in 2022 across each asset class as well as for the entire portfolio (Figure 1). We attribute this decline to the recent increase in interest rates. When comparing our estimated market values to the par values of the Treasury holdings, we note that the market values fluctuates in close approximation to the par values. This occurs because the term structure of interest rates typically exhibits a positive correlation between short-term and long-term interest rates, as highlighted by Crump et al. (2018) and Tease (1988).

Leveraging this fact, we observe that this inverse relationship is stronger for T-bills, T-notes, T-bonds, and TIPS than for FRNs. This is because the quarterly payments of FRNs are tied to the Federal Funds Rate. Throughout our sample period, T-notes and T-bonds constitute 82 percent of all historical holdings of Treasury securities, while FRNs represent only 1 percent of the portfolio holdings. Thus, the inverse relationship between the yield curve and the aggregated market value of the SOMA Treasury portfolio is pronounced.

Comparing our estimated unrealized gains or losses with the unrealized gains or losses as reported in the Reserve Banks Board of Governors of the Federal Reserve System (2012–2023), we note that our model is generally less volatile than the reported unrealized gains or losses (Figure 2). Furthermore, our model consistently demonstrates a tendency to underestimate or overestimate the unrealized gains or losses throughout the period of comparison. Most notably, we observe an overestimation in market value of the portfolio at the end of our sample period. We attribute this to the recent rapidly increase in interest rates.

Evaluating the performance of our model, we measure how well its predictions aligns with the reported values of unrealized gains or losses. Examining the strength and direction of the linear relationship over the period of comparison between our estimated values and the reported values, we obtain a correlation coefficient of 0.98. Measuring the dispersion between the predicted and observed values, we obtain an

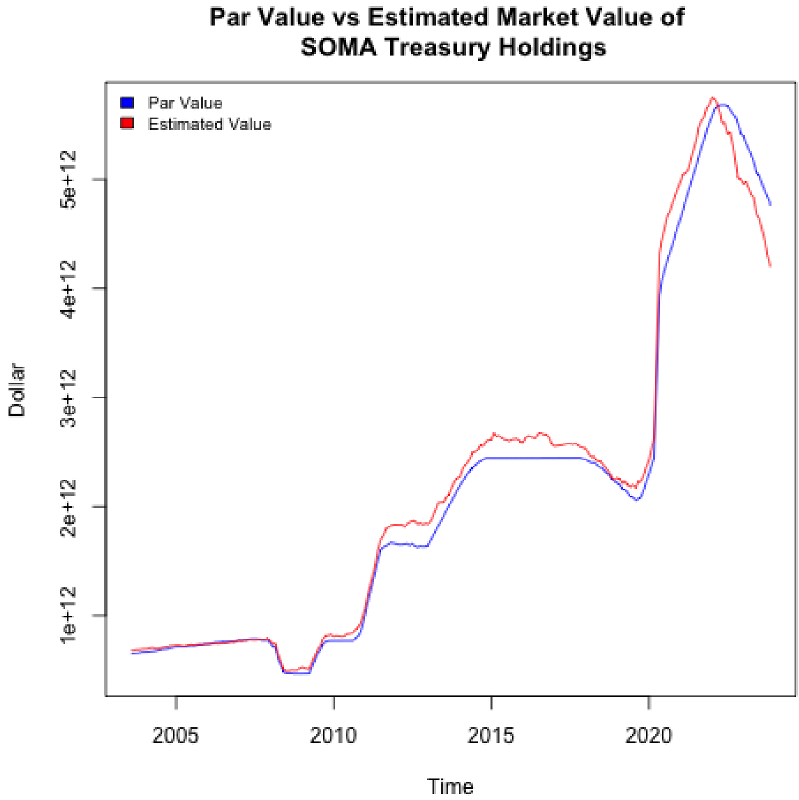

Figure 1: The par value compared to the estimated market value of Treasury Securities between July 30, 2003 and November 1, 2023.

R-squared of 0.96. While these two measurements indicate a good fit of our model, an analysis of the standard errors indicates a large variability in our estimated values. We attribute a majority of this dispersion to the year 2022. Excluding the year 2022, the standard errors are reduced by 35 percent. This indicates that our model explains a significant proportion of the variance in the reported values, but that there are deviations of individual data points. The mean absolute error (MAE), the mean squared error (MSE), and the root mean squared error (RMSE) also follows the same pattern.

3.2 Risk-Free Treasury Securities and Yield Dynamics

A distinct feature of Treasury securities is that they are not subject to the creditworthiness of the issuer because the issuance is supported by the U.S. Treasury Department. Consequently, these securities are commonly referred to as risk-free assets. This

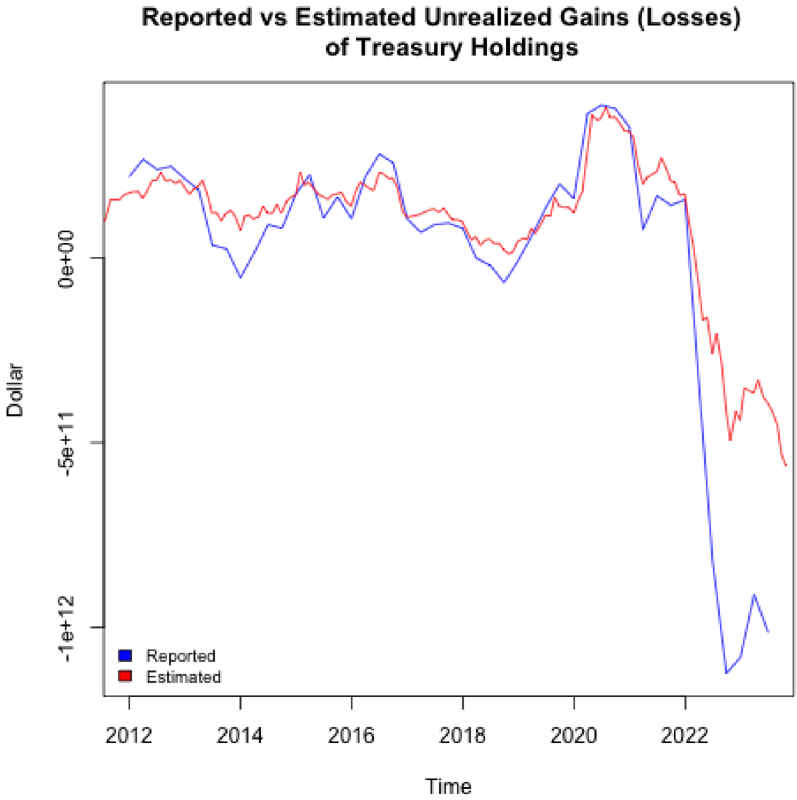

Figure 2: The reported versus the estimated unrealized gains or losses for the SOMA portfolio of Treasury Holdings between the 31 December, 2011 to the 30 June, 2023.

is rooted in the fact that the risk of default on Treasury securities can be mitigated through fiscal and monetary policies (Chen, 2022). Thus, the credit risk is not a relevant factor in determining the risk profile of the Fed's portfolio of Treasury securities.

Building on the concept of risk-free assets, the Expectations Theory assumes that the long-term interest rates is an average of the present and expected future short-term rates. This implies that in equilibrium, the required rate of return equals the expected rate of return (Tease, 1988). Thus, if investors are risk neutral, they are indifferent between investing in short-term securities and rolling them over versus investing in long-term security that they hold until maturity.

The recent monetary decision to increase the Fed's target rate, first announced on March 16, 2022 (Decision regarding monetary policy implementation, 2022) has driven volatility in short-term rates. Short-term rates tend to experience more frequent fluctuations than long-term rates (Neely, 2023). This is because the short-term rates are more sensitive to factors such as monetary policy decisions (Crump et al., 2018). Thus, Crump et al. (2018) suggest that the Expectations Theory falls short in explaining the behaviour of yields. Instead, they argue that the Term Premium accounts for the majority of the yield curve's response to macroeconomic shocks.

Moreover, Li and Wei (2018) illustrates that the Fed's announcement of large scale asset purchase programs and the total Treasury debt holds explanatory power for the yield curve. The authors argue that long-term interest rates deviate from expected future short-term rates, suggesting a disconnect between yields at different maturities. Gagnon, Raskin, Remache, and Sack (2011) also presented evidence for that Fed's asset purchases impacts the long-term rates. Thus, while Treasury securities in general are considered risk-free, there are still inherent risks associated with investing in them, particularly if not held until maturity.

3.3 Duration of Treasury Holdings

We previously mentioned that short-term rates are more sensitive to macroeconomic shocks. Conversely, the market price of long-term Treasury securities tend to fluctuate by a larger percentage than short-term securities because the duration effect is more pronounced (Crump et al., 2018). Macaulay duration estimates the number of years it takes for an investor to recover the initial investment, while modified duration is a measure of the expected price change in response to a 100 bps change in interest rates. Typically, bonds with longer maturities tend to have a higher duration because they carry a larger interest rate risk (Chen, 2022). Analyzing how the Treasury portfolio responds to a 100 bps increase in interest rates measures the perceived riskiness of an investment based on its sensitivity to interest rates changes.

Our findings indicate that Treasury securities with longer maturities and a greater exposure to interest rate fluctuations in general exhibit higher a duration, as illustrated in Table 1. Given that T-notes and T-bonds constitute the majority of the SOMA Treasury portfolio, the weighted average modified duration for the portfolio implies that a 100 bps increase in rates would result in a 4.37 percent unrealized loss on the

Table 1: Average Duration for Different Types of Treasury Securities

	Macaulay duration	Modified duration
T-bills	1.14	1.11
T-notes & T-bonds	5.13	5.07
TIPS	1.07	1.05
FRNs	3.10	3.08

portfolio.

We initiate a stress test to assess the potential gains or losses in the event of a 100 bps increase in interest rates (Figure 3). We observe a substantial decrease in the estimated values across all Treasury holdings, except for TIPS, demonstrating resilience to increase in interest owing to their inflationary protective properties. However, the adverse impact for the rest of the assets results in lower unrealized gains and amplified unrealized losses for the entire portfolio.

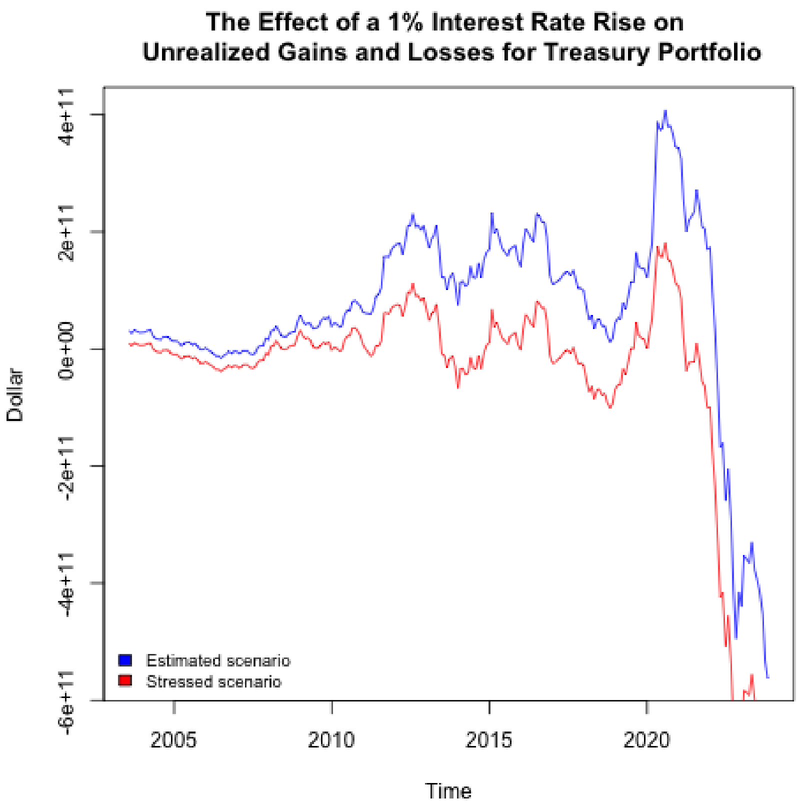

Figure 3: The impact of a 100 bps increase in interest on estimated unrealized gains or losses for Treasury Holdings between July 30, 2003 and November 1, 2023.

3.4 The Federal Reserve Banks Remittance to the U.S. Treasury

Section 7 of the Federal Reserve Act addresses the process of the Fed's remittance of net earnings to the U.S. Treasury, stipulating that after covering operating expenses, dividend payments, and maintaining surplus funds, any excess earnings of the Reserve Banks must be remitted to the U.S. Treasury. The practice of Fed's remittance of surplus earnings began in 2011 and serves several purposes. Firstly, it enforces responsible fiscal discipline, promoting transparency and accountability in the fiscal system. Secondly, remittance is a source of revenue for the U.S. government and the funds can be used to support expenditures, reducing the need for additional borrowing or heightened taxation. Lastly, the act of returning excess earnings to the U.S. Treasury serves to uphold public confidence in the Fed's role as a central bank, demonstrating commitment to act in the best interest of the United States of America.

However, if the net earnings of the Reserve Banks are insufficient to cover their operational costs and other obligations, a deferred asset is recorded on the Fed's balance sheet. In the long term, should the Fed's net earnings be insufficient, the central bank may find itself requiring capital injections from the Federal budget (Nordström & Vredin, 2022). This could affect the independence and credibility of monetary policy. According to the Board of Governors of the Federal Reserve System (2023), most Reserve Banks suspended their weekly remittance to the U.S. Treasury in 2022 and begun accumulating deferred assets. Since September 2022, the cumulative deferred asset has increased, reaching a negative value of $115 034 million on November 1, 2023. This implies that the Reserve Banks must reduce their deferred assets before they can resume their remittances to the U.S. Treasury (Anderson, Na, et al., 2022). Over the years, the remittance has ranged from a positive $4 667 million at its highest to a negative $115 034 million at its lowest. Only at four occasions prior to 2022 have there been a recording of a deferred asset on the Fed's balance sheet.

It is worth noting that a deferred asset does not impact the Fed's ability to conduct monetary policy or meet its financial obligations (Bonis et al., 2018). Nonetheless, it may have implications for the U.S. government and could potentially lead to additional borrowing or increased taxation (everything else held equal). Such scenario could influence public confidence in the Federal Reserve system and the Fed's commitment to operate in a financially responsible manner. Using our estimated unrealized gains or losses under a stressed scenario, a 100 bps increase in interest rates across our historical sample translates to an average potential tax increase of $316 for each American citizen (assuming that the estimated unrealized losses over our sample period would have been realized). In 2022 alone, the unrealized gains or losses under a stressed scenario renders a potential tax increase of $677 for each American citizen. This is equivalent to 19 percent of mandatory outlays for Social Security, or 46 percent of mandatory outlays for Student Loan Programs, or 30 percent of discretionary defense outlays, based on the Budget of the U.S. Government Fiscal Year 2022.

3.5 Interest Earned and Paid on the Market Value of Treasury Securities

The interest rate on reserves is one of the tools used by the Federal Reserve to influence short-term interest rates. However, it was set at zero percent before July 29, 2021. This means that banks were not earning interest on reserves held at the Fed during this period. Since then, the Fed regularly adjusts the interest on reserves to influence economic conditions.

Assessing the difference between interest earned and the interest paid on the estimated market value of the SOMA Treasury holdings, we observe that with beginning in June 29, 2022, the interest paid significantly exceeds the interest earned (Figure 4). We attribute this to the recent shift in yield environment relative to the size of the SOMA Treasury holdings. The most recent growth in the SOMA portfolio resulted from asset purchases initiated at the onset of the Covid-19 pandemic, as documented by Anderson, Marks, et al. (2022). In contrary to the earlier discussion on unrealized gains or losses, the difference in the Fed's interest income and expenses directly impacts its net income.

Clouse et al. (2013) concludes that in a scenario where the interest is rising considerable faster than expected, the taxpayers can still be better off with quantitative easing despite if the Fed incurrs losses. Nonetheless, there are plans to reduce the SOMA holdings, including Treasury securities, as communicated in Plans for reducing the size of the Federal Reserve's balance sheet (2022). Ennis and Kirk (2022) projects that the Fed's ultimate target of holding primarily Treasury securities is likely to take more than a few years to achieve and that the wind-down will be based on short-term macroeconomic considerations. However, the evolution of the SOMA holdings and interest-bearing liabilities depend on a range of outcomes for nominal GDP growth (Anderson, Marks, et al., 2022).

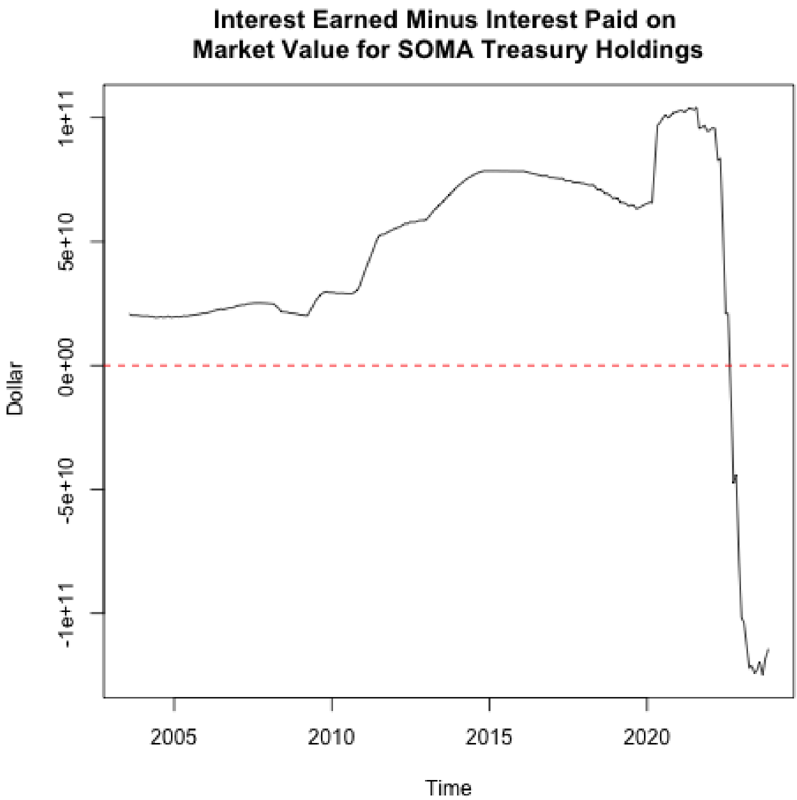

Figure 4: The monthly levels of interest earned minus the interest payed on the market value for SOMA Treasury Holdings between July 30, 2003 and November 1, 2023.

4 Discussion

Evaluating the effectiveness of our model in predicting unrealized gains or losses for SOMA Treasury holdings reveals that, while the model may not attain perfect predictions of market values, the observed deviations could arise from various factors. There is a strong linear relationship between our estimated and the reported values of unrealized gains or losses, indicating that our model explains a significant portion of the variability in the observed data. However, our model has limitations and penalises outliers. Additionally, factors such as macroeconomic conditions, monetary policy, and the broader dynamics of supply and demand for Treasuries, can impact the market prices of these assets (Crump et al., 2018). Drawing on insights from Li and Wei (2018), it is apparent that the duration of the Treasuries is subject to influences extending beyond conventional considerations.

Acknowledging that the duration of the SOMA Treasury portfolio is contingent upon the composition of the portfolio and the inherent characteristics of the securities it holds, our simulation for unrealized gains or losses under a stressed scenario, implying a 100 bps increase in interest rates, suggests a potential increase in tax of \$677 for each American citizen should our estimated unrealized losses have become realized in 2022. When interpreting the simulated results, the complexity of real-word fiscal scenarios requires consideration of factors influencing tax policies and governmental finances, in addition to potential hedging of the portfolio. For example, some tax rates are not flat but varies amongst different income groups, and a portion of U.S. citizens do not pay any taxes at all. Most importantly, unrealized losses represents declines in the value of assets that have not been sold, thus they do not result in direct tax liabilities. While unrealized losses do not immediately result in tax liabilities, the magnitude of potential losses highlights the interplay between financial decisions and legislative requirements, and their implications for the Fed, the U.S. government, and American citizens.

The accumulation of deferred assets on the Fed's balance sheet raises questions about the fiscal health of the Reserve Banks and their ability to continue their remittance to the U.S. Treasury in the future. Using our estimated market values, we observe a cumulative loss beginning on June 29, 2022. Additionally, a negative effect on the Fed's net earnings is observed on September 7, 2022, in the form of a deferred asset to the U.S. Treasury. Considering the potential long-term consequences of unrealized losses and their relation to actual losses could be a possible extension of this paper.

Conclusion

The composition of the SOMA Holdings of Domestic Treasury Securities, along with its financial risks, have implications for the funds transferred to the U.S. Treasury should any holdings be sold prior to maturity. We estimate that under a stressed scenario, implying a 100 bps increase in interest rates, the unrealized losses of the Treasury portfolio translates to an increase in tax of $677 for each American citizen in 2022, should the losses have been realized.

Furthermore, the interest earned and paid on the market value of Treasury securities have a direct impact on the Federal Reserve's net income, particularly in an environment with increasing interest rates. We observe that in mid-2022, the interest paid began to exceed the interest earned on our estimated market values for Treasury securities held by the Federal Reserve. We attribute these estimated losses to the recent shift in yield environment.

Adding other asset classes to our model could provide both explanatory value and insights into how actual losses stand in relation to unrealized losses, including studying the assets and liabilities of the Federal Reserve's balance sheet. The Federal Reserve's Treasury portfolio explains the Federal system from one lens, which in terms of improving the accuracy of our model, would be interesting to put into context by comparing with another national system.

Articles

Anderson, A., Marks, P., Na, D., Schlusche, B., & Senyuz, Z. (2022). *An analysis of the interest rate risk of the federal reserve's balance sheet, part 2: Projections under alternative interest rate paths*.

Anderson, A., Na, D., Schlusche, B., & Senyuz, Z. (2022). *An analysis of the interest rate risk of the federal reserve's balance sheet, part 1: Background and historical perspective*.

Bonis, B., Noonan, J., & Fiesthumel, L. (2018). *Soma's unrealized loss: What does it mean?* GMU Working Paper in Economics.

Chen, J. (2022). An overview of bond pricing models and duration of bonds, 2316–2320.

Crump, R. K., Eusepi, S., & Moench, E. (2018). The term structure of expectations and bond yields.

Ennis, H. M., & Kirk, K. (2022). *Projecting the evolution of the fed's balance sheet* (No. 15). Federal Reserve Bank of Richmond.

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2011). The financial market effects of the federal reserve's large-scale asset purchases. *International Journal of Central Banking*, *7*(1), 45–52.

Li, C., & Wei, M. (2018). Term structure modeling with supply factors and the federal reserve's large-scale asset purchase programs. *30th issue (March 2013) of the International Journal of Central Banking*.

Neely, C. J. (2023). *What is the probability of a recession? the message from yield spreads*. Federal Reserve Bank of St. Louis.

Nordström, A., & Vredin, A. (2022). *Does central bank equity matter for monetary policy?* Sveriges Riksbank.

Tease, W. J. (1988). The expectations theory of the term structure of interest rates in australia. *Economic Record*, *64*(2), 120–127.

Budgets

Biden, J. R. (2022, March). *Budget of the U.S. Government Fiscal Year 2022*.

Memorandums

Clouse, J., English, B., Faust, J., Ihrig, J., Huther, J., Klee, B., Leahy, M., Reifschneider, D., & Remache, J. (2013, March). *Fiscal implications of additional large-scale asset purchases for the federal government and the federal reserve* (Authorized for public release by the FOMC Secretariat on 6/12/2020.). Federal Reserve.

Press Releases

Board of Governors of the Federal Reserve System. (2023). *Federal reserve board announces reserve bank income and expense data and transfers to the treasury for 2022* [Press Release, January 13]. https://www.federalreserve.gov/newsevents/pressreleases/other20230113a.htm

Decision regarding monetary policy implementation [Implementation Note issued March 16, 2022]. (2022). https://www.federalreserve.gov/newsevents/pressreleases/monetary20220316a1.htm

Plans for reducing the size of the federal reserve's balance sheet [Press Release, 4 May]. (2022). https://www.federalreserve.gov/newsevents/pressreleases/monetary20220504b.htm

Reports

Board of Governors of the Federal Reserve System. (2012–2023). *Federal reserve banks combined quarterly financial report (unaudited).*

Appendix

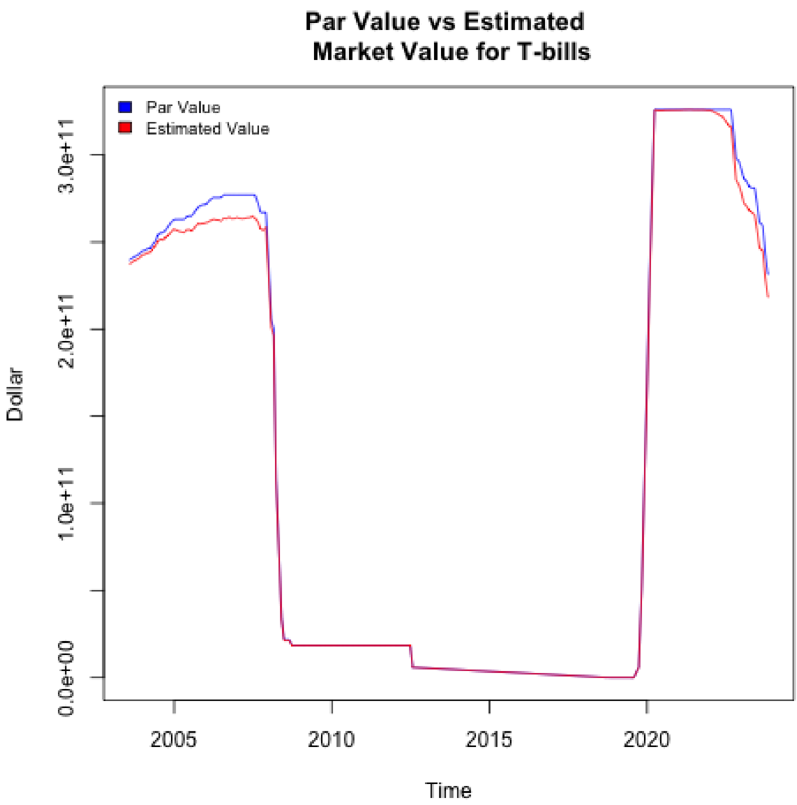

Figure 5: The par value compared to the estimated market value of T-bills between July 30, 2003 and November 1, 2023.

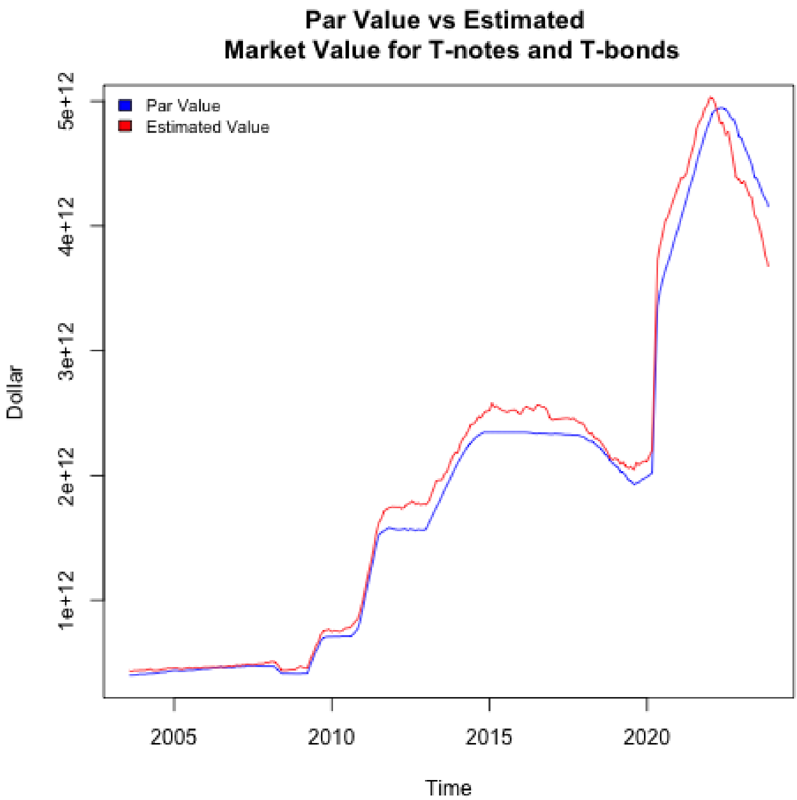

Figure 6: The par value compared to the estimated market value of T-notes and T-bonds between July 30, 2003 and November 1, 2023.

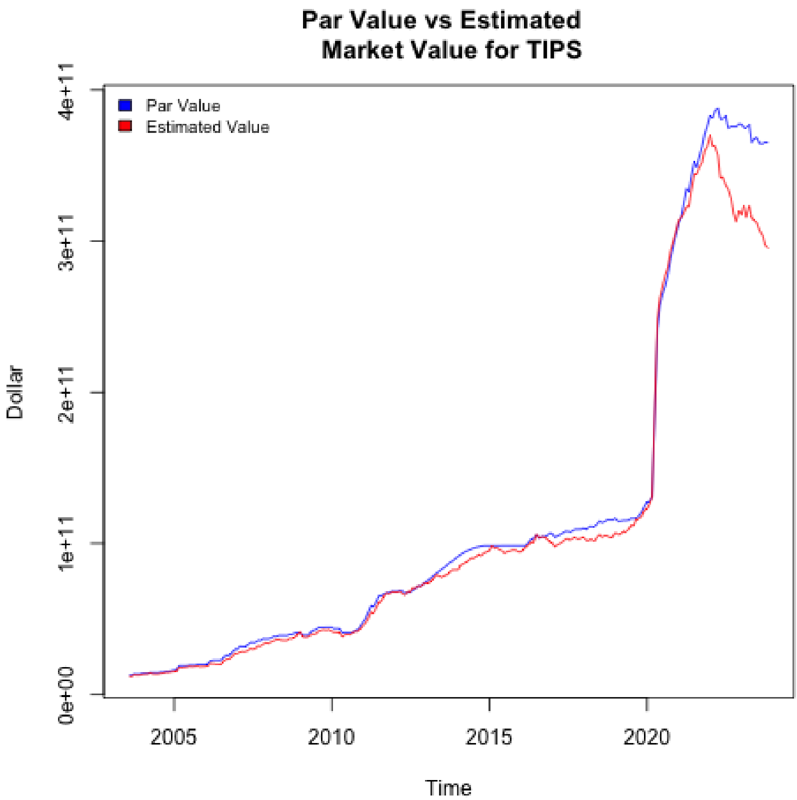

Figure 7: The par value compared to the estimated market value of TIPS between July 30, 2003 and November 1, 2023.

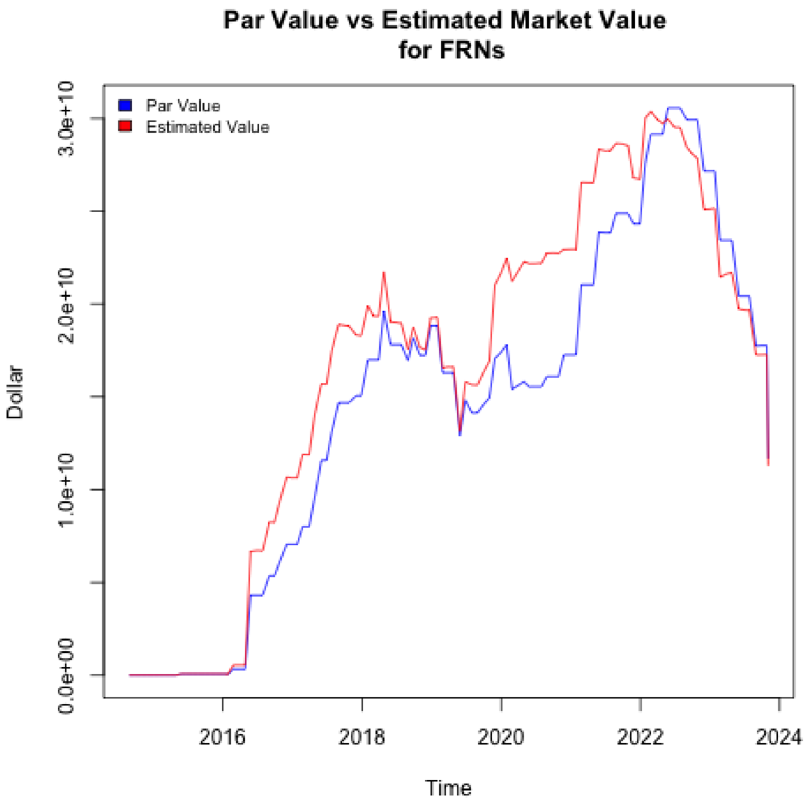

Figure 8: The par value compared to the estimated market value of FRNs between July 30, 2003 and November 1, 2023.

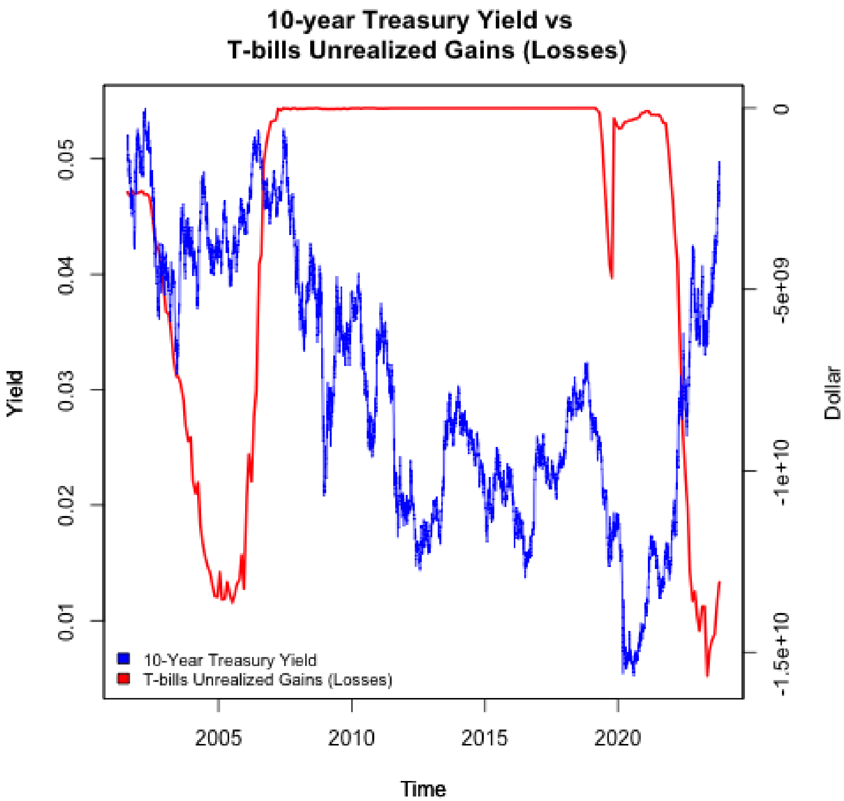

Figure 9: The interest rate spread between the 10-year Market Yield on U.S. Treasury Securities at constant maturity against the unrealized gains or losses of T-bills between July 30, 2003 and November 1, 2023.

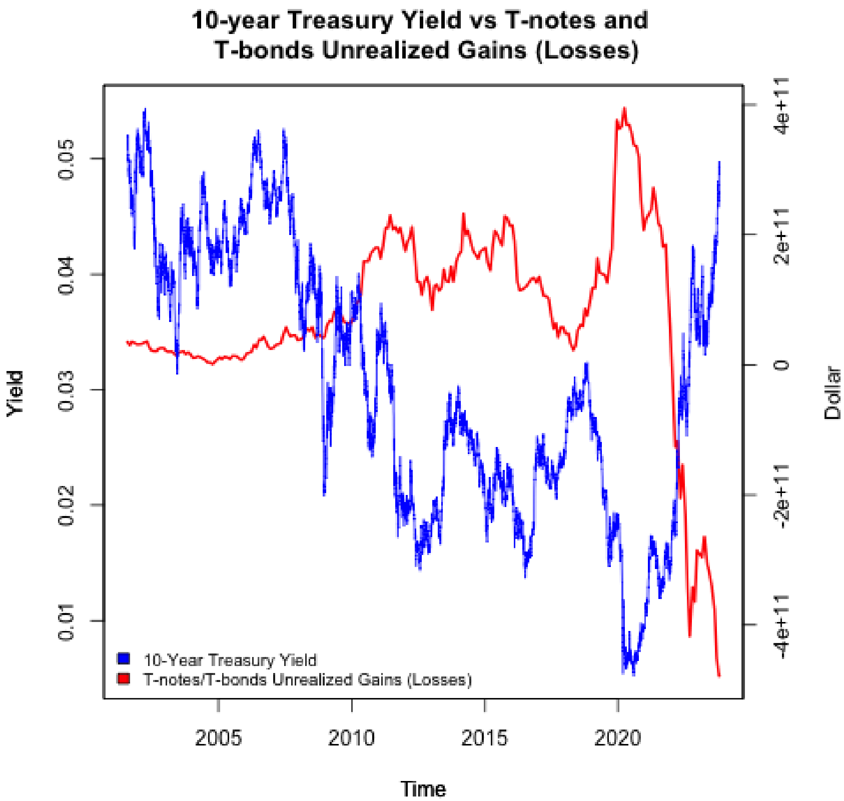

Figure 10: The interest rate spread between the 10-year Market Yield on U.S. Treasury Securities at constant maturity against the unrealized gains or losses of T-notes and T-bonds between July 30, 2003 and November 1, 2023.

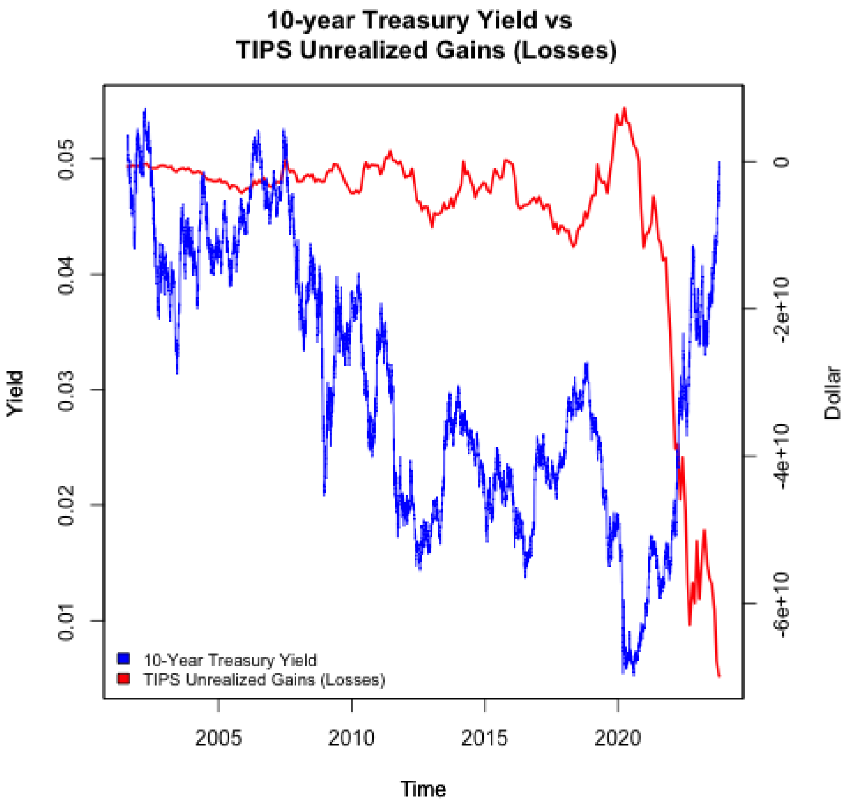

Figure 11: The interest rate spread between the 10-year Market Yield on U.S. Treasury Securities at constant maturity against the unrealized gains or losses of TIPS between July 30, 2003 and November 1, 2023.

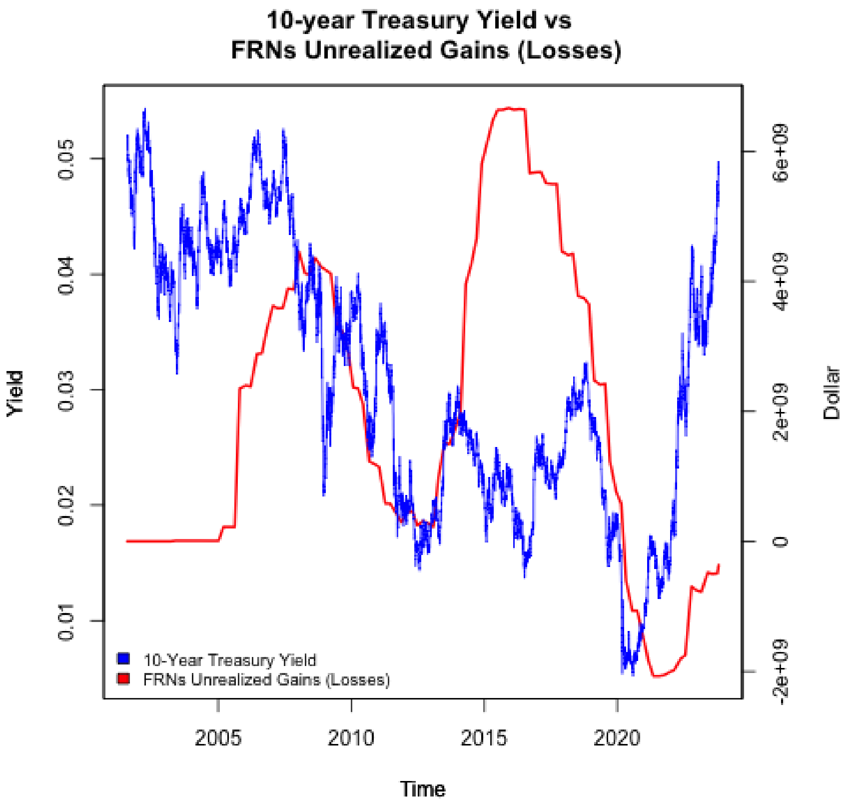

Figure 12: The interest rate spread between the 10-year Market Yield on U.S. Treasury Securities at constant maturity against the unrealized gains or losses of FRNs between July 30, 2003 and November 1, 2023.

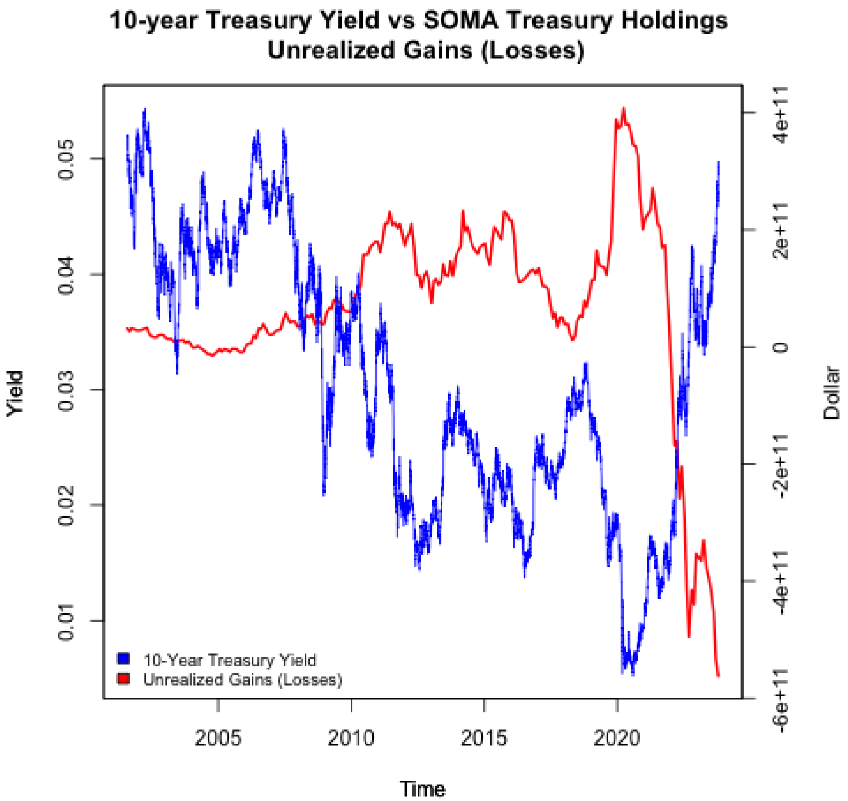

Figure 13: The interest rate spread between the 10-year Market Yield on U.S. Treasury Securities at constant maturity against the unrealized gains or losses of the SOMA Treasury Holdings between July 30, 2003 and November 1, 2023.

Table 2: Number of Treasury Securities and their Percentage Weights in the Fed's SOMA Portfolio

Security Type	Number	Percentage
T-bills	3881	5.70
FRNs	687	1.01
T-notes & T-bonds	55829	81.97
TIPS	7716	11.33

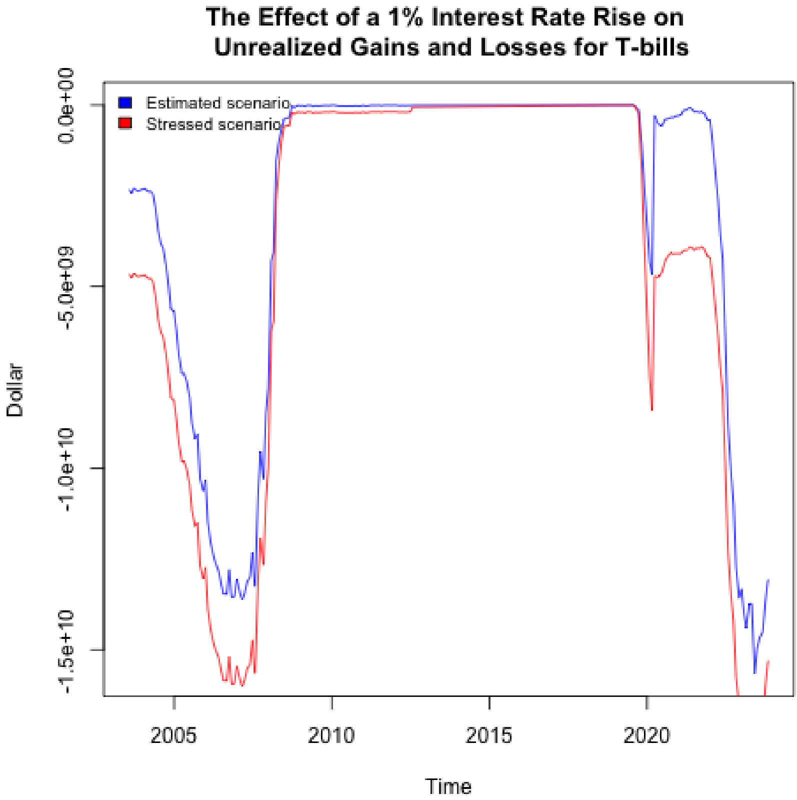

Figure 14: The impact of a 100 bps increase in interest on the estimated unrealized gains or losses for T-bills between July 30, 2003 and November 1, 2023.

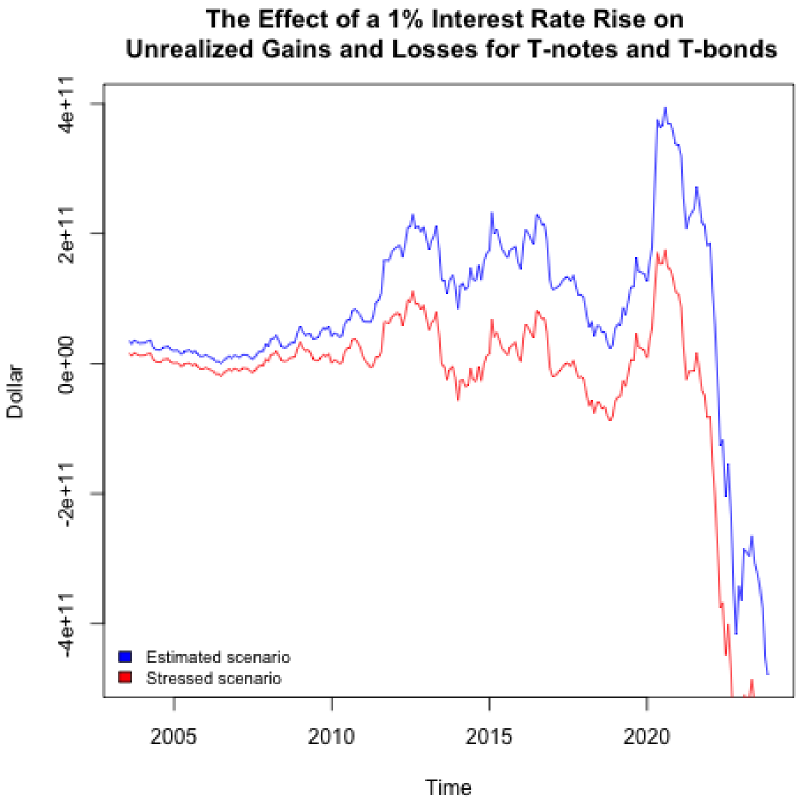

Figure 15: The impact of a 100 bps increase in interest on the estimated unrealized gains or losses for T-notes and T-bonds between July 30, 2003 and November 1, 2023.

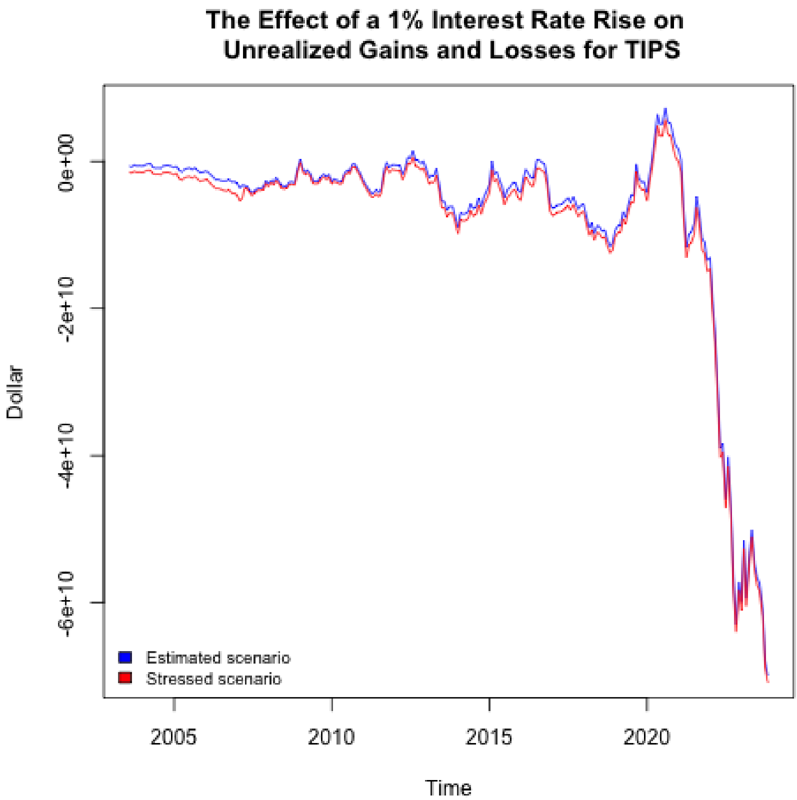

Figure 16: The impact of a 100 bps increase in interest on the estimated unrealized gains or losses for TIPS between July 30, 2003 and November 1, 2023.

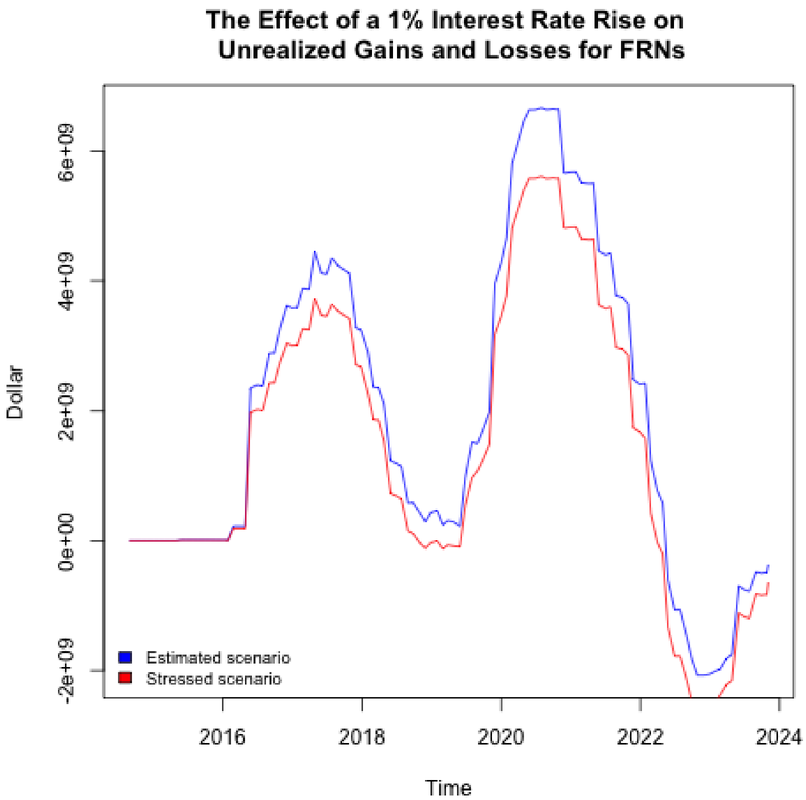

Figure 17: The impact of a 100 bps increase in interest on the estimated unrealized gains or losses for FRNs between July 30, 2003 and November 1, 2023.

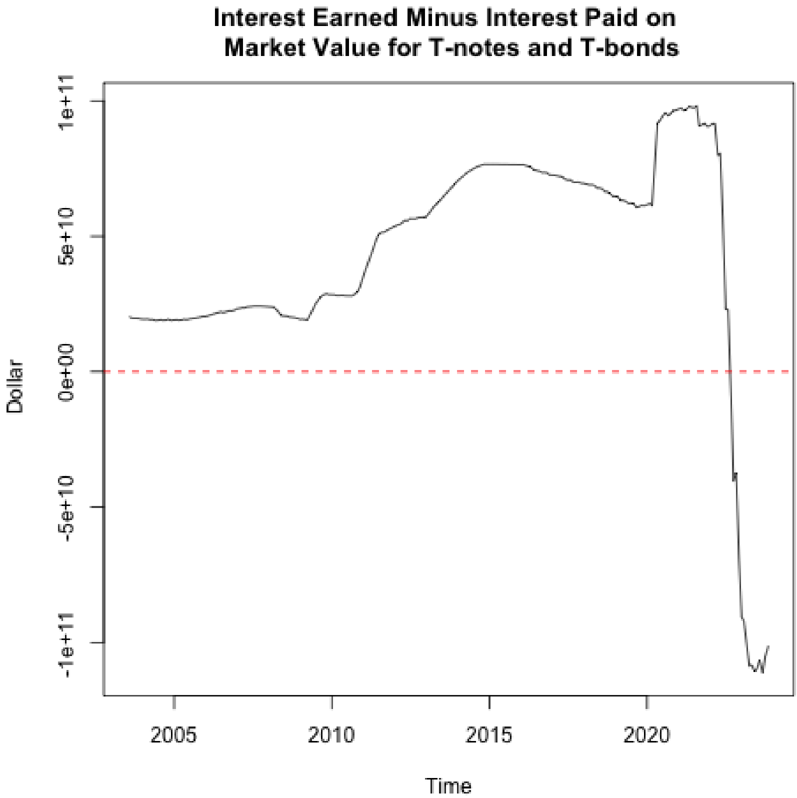

Figure 18: The monthly levels of interest earned minus the interest payments on market value for T-notes and T-bonds between July 30, 2003 and November 1, 2023.

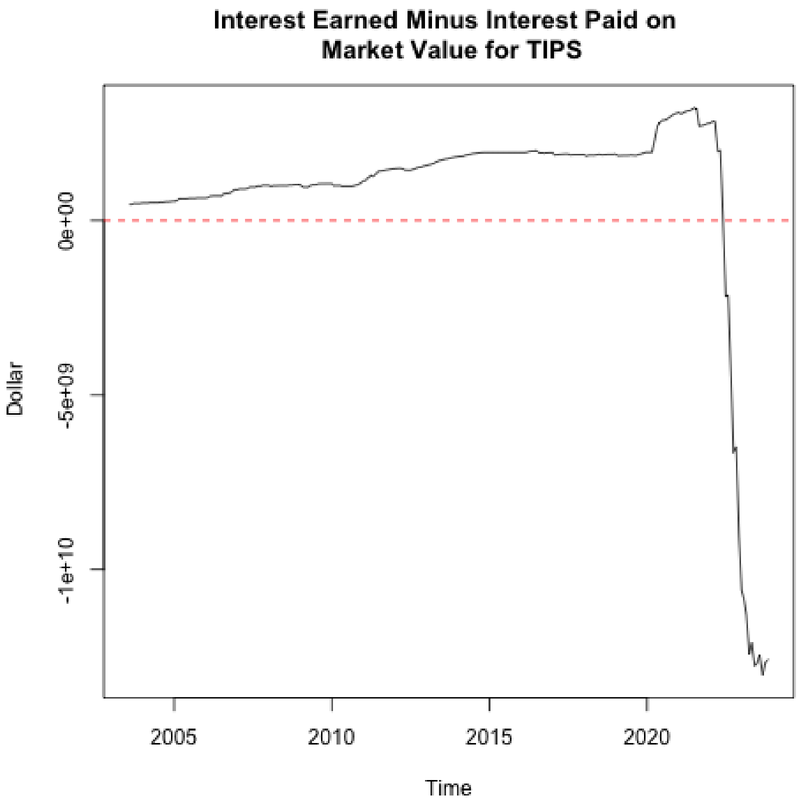

Figure 19: The monthly levels of interest earned minus the interest payments on market value for TIPS between July 30, 2003 and November 1, 2023.

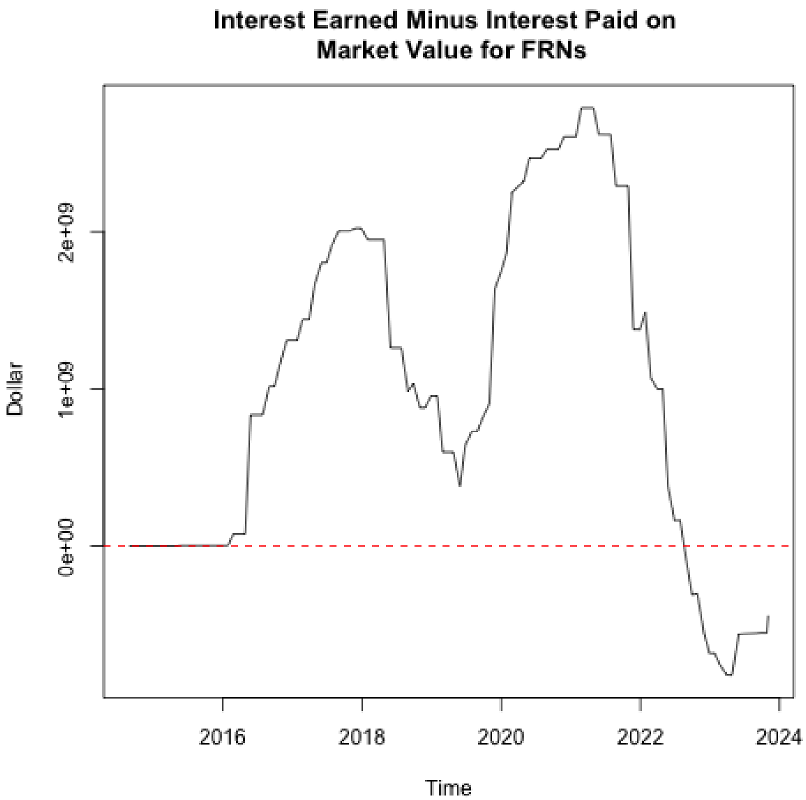

Figure 20: The monthly levels of interest earned minus the interest payments on market value for FRNs between August 27, 2014 and November 1, 2023.

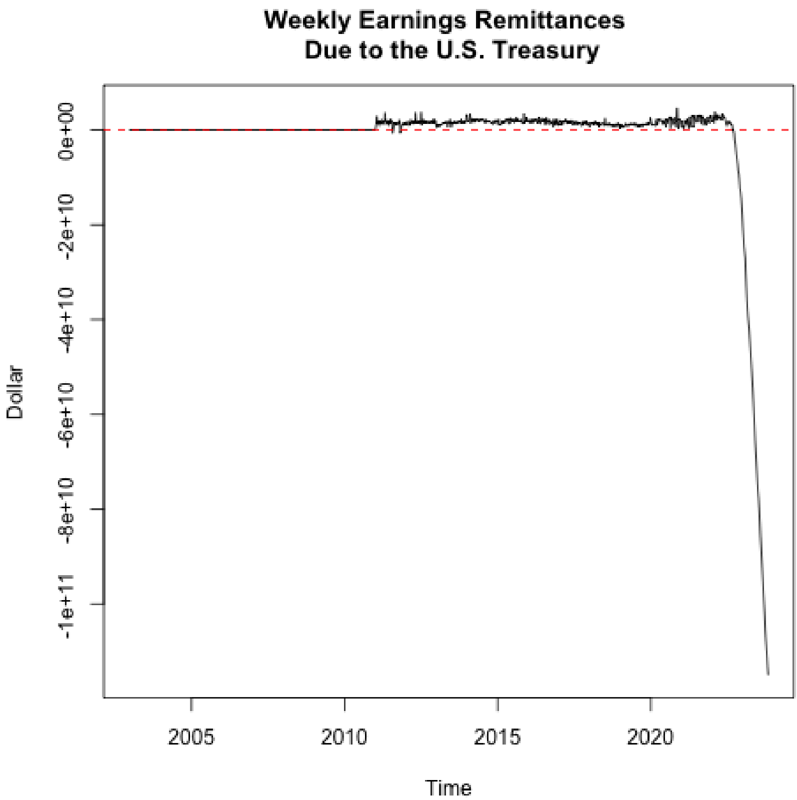

Figure 21: The remittance from the Federal Reserve Banks to the U.S. Treasury measured on a weekly basis between December 18, 2002 and November 1, 2023.