

# What a Federal Reserve Hikes Interest Rates Effect Bond Price and the Enlightenment to Investors

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**Abstract.** In recent years, the Federal Reserve's series of interest rate hikes have wielded a profound influence over the intricate workings of financial markets. This article offers a succinct yet comprehensive analysis, beginning with a succinct summary of the repercussions of the increase in the Federal Reserve's interest rates affects both stock market liquidity and the bond market. This paper constructs a ARIMA model to estimate the data which not effected by Federal reserve interest rate hikes. The constructed ARIMA model not only elucidates the direct impact of these monetary policy adjustments on bond prices but also encapsulates the temporal dynamics at play. Through a meticulous examination of various time intervals, the model captures the distinct nuances of monetary policy's influence, reflecting its inherent lag and the intricate interplay with market responses. They extend to investors and policymakers, offering a practical guide for optimizing investment portfolios and shaping effective monetary strategies. As investors navigate the ever-fluctuating financial landscape, a nuanced understanding of the temporal dynamics can aid in crafting informed investment decisions. Policymakers, too, stand to benefit from these insights, as they can harness the model's revelations to formulate timely and precise monetary policies that align with the intricate pulse of the market.

**Keywords:** federal Reserve; Bond market; financial market.

## 1. Introduction

Against the backdrop of escalating inflation, stemming from the far-reaching effects of the global pandemic, the Federal Reserve initiated a series of interest rate hikes since March 2022. This policy shift centers around elevating the federal funds rate, a pivotal lever in the Federal Reserve's toolkit for influencing borrowing costs. The process of adjusting interest rates, often referred to as "tightening" or "easing" monetary policy, wields substantial influence across an array of financial instruments, with the bond market assuming a prominent role within this intricate interplay. The bond market, having served as a haven, confronts the potential of undergoing shifts in investor sentiment as interest rate decisions come into focus.

Drawing insights from a synthesis of existing literature and pertinent data, this paper aims to illuminate the anticipated implications of the Increase in interest rates by the Federal Reserve and its impact on bond prices. Considering the inverse correlation between bond prices and prevailing interest rates, the prospect of rising rates has the potential to render newly issued bonds more attractive due to elevated yields. These price fluctuations resonate beyond the bond market, rippling across the broader financial landscape, potentially affecting investor behaviors and portfolio allocations.

The subsequent segments of this paper are structured as follows: Section 2 presents a comprehensive review of the pertinent literature. The establishment of ARIMA model is in Section 3. Following that, there is a discussion on the study's focus, objective, and advice. Ultimately, Section 5 reiterates the conclusion briefly.

## 2. Literature review

The Federal Reserve's interest aims to raising the federal funds rate, which an important measure is taken to address inflation and promote economic development [1]. Raising interest rates is a tightening monetary policy.

Following the Federal Reserve's decision to increase interest rates, the stock market experienced significant changes. Interest rates are an important factor to reflect the changes in stock returns (Samarakoon et al) [2]. An asymmetric relationship exists between changes in interest rates and stock prices, with monetary tightening leading to decreases in stock prices (Ajaz et al.) [3]. Bernanke & Kuttner's study additionally suggests that stock prices have influenced by monetary policy by shaping anticipated excess returns. [4].

The foreign exchange market has also shown greater volatility due to the Federal Reserve's interest rate actions. OGAWA et al. argue that the US interest rate hike may reduce the portfolio flow (including equity and debt flows) of most emerging market countries and significantly worsen their domestic stock prices [5]. Meanwhile, emerging market economies have significantly higher capital flows than developed market economies due to the Federal Reserve's interest rate hike. [6] In addition, different types of capital flows will cause different outcomes. Bank flows have the deepest response to monetary policy, while foreign direct investment flows have the smallest response (Villamizar et al) [7].

Federal Reserve's interest rate hike has effect on the bond market are rooted in fundamental bond valuation principles, posits that rising interest rates diminish the attractiveness of existing bonds, thereby leading to price declines. Demary's research provides empirical evidence substantiating this correlation, highlighting the consequential impact of yield differentials on market dynamics [8]. In addition, the research by Marfatia expands this discourse by underscoring the role of bond duration and maturity in accentuating the bond market's reaction to rate fluctuations [9].

The Federal Reserve's interest rate hike affects various aspects of the financial market, it's very important for investors to decide the portfolios in financial market. Investors prefer to choose bond when Federal Reserve's interest rate hikes, since monetary policy has yielded more positive effects on the bond market in contrast to the stock market (Liu et al) [10]. Lozano& Damyanova also mention that the interest rate hike has increased the attractiveness of European bank stocks [11]. Therefore, Due pointed out that updating portfolio allocation is usually a good idea to ensure asset protection [12].

In conclusion, the references provide valuable insights into the wide-ranging effects of Federal Reserve interest rate hikes on financial markets. They illuminate the connections between interest rates and stock returns, highlight the bond market's sensitivity, and underscore the impact on capital flows. These contributions deepen our understanding of how monetary policy adjustments influence various market sectors and guide investor strategies.

### **3. Research Design**

#### **3.1. Data Source**

The primary data source and data basis for this paper is from 'investing', a search engine, which offer historical pricing information for U.S. 10-Year T-Note futures that can relatively reflect the bond price. The data includes closing prices recorded on a daily, weekly, and monthly basis, covering the period from 2010 to the current date. Additionally, the paper incorporates the timing of the first Federal Reserve interest rate hike in 2022, marked as T0, discussing the impact between Federal Reserve interest rate rising and the price changing in bond price.

#### **3.2. Weak Stationarity Test**

ADF test indicates a unit root test to verify the model constructed is smooth or not, where the null hypothesis is that the model is not smooth. After putting the date into Stata and performing the ADF test, we can conclude from Table 1 that the p-value for 3 durations of original series is all bigger than 0.1, so we could accept the null hypothesis that the model is unsmooth. Consequently, we should difference the original return sequence to let the model stable. After differencing it, the Table 1 illustrates that the p-value for the series after differencing is all 0, so we can reject the original hypothesis and use it to build the model.

**Table 1.** Weak stationarity test.

	t	p
Daily		
Raw	-2.367	0.3972
1st order difference	-41.561	0.0000
Weekly		
Raw	-2.177	0.5029
1st order difference	-17.474	0.0000
2nd order difference	-31.022	0.0000
Monthly		
Raw	-2.406	0.3767
1st order difference	-8.641	0.0000
2nd order difference	-16.401	0.0000

### 3.3. ARIMA model

From equation (1) above, AR (p) refers to  $\phi_0 + \sum_{i=1}^p \phi_i x_{t-i}$ , which uses the historical data to forecast the future.  $\alpha_i - \sum_{i=1}^q \phi_i a_{t-1}$  Represents the MA (q) model, predicting the future through past disturbances. The ARMA (p, q) model constitutes the fusion of the AR (p) and MA (q) components.

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + \alpha_i - \sum_{i=1}^q \phi_i a_{t-1} \tag{1}$$

When faced with non-stationary data, models like AR (p), MA (q), and ARMA (p, q) often begin with an initial step: implementing an ARIMA model. For non-seasonal data, it's shown in the equation (2), the ARIMA (p, q, d), where 'p' represents AR order, 'd' signifies differencing, and 'q' stands for MA order. This approach transforms data into a stationary form, enhancing subsequent time-series modeling accuracy.

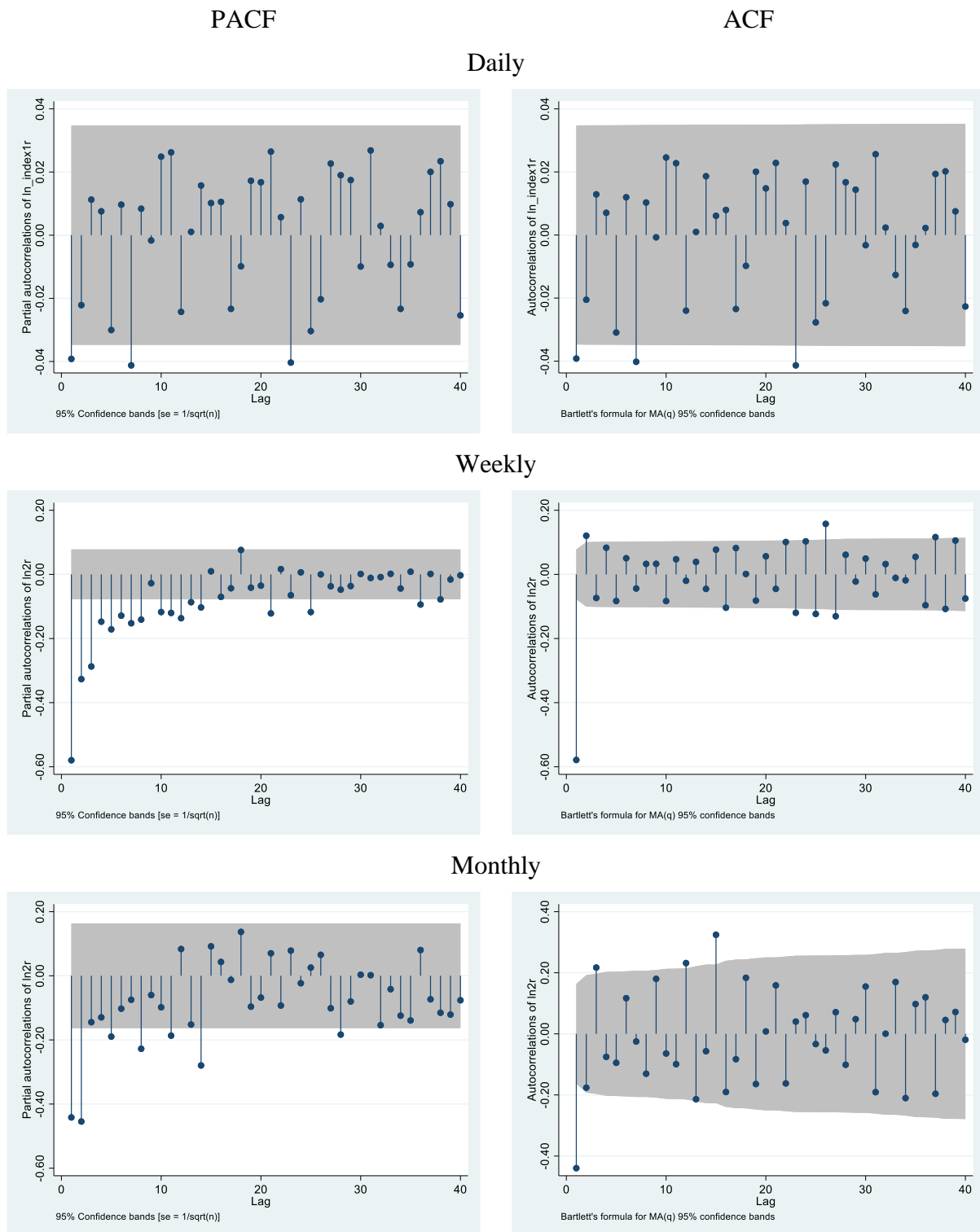
$$\left(1 - \sum_{i=1}^p \phi_i L^i\right) (1 - L)^d X^t = \left(1 + \sum_{i=1}^q \theta_i L^i\right) \varepsilon^t \tag{2}$$

This paper establishes a hypothetical sequence for the experimental group where the Federal Reserve doesn't raise interest rates. This sequence uses employs pre-interest rate hike data from the Federal Reserve, as this data remains unaffected by the perturbations induced by interest rate adjustments. Daily, weekly, and monthly ARIMA models are constructed for comparison with the actual control group. Leveraging this premise, the study adopts a counterfactual framework to construct a model that enables the prediction of a control group untainted by the impacts of Federal Reserve interest rate hikes. By employing T0 as the point of reference, this methodology enables a thorough evaluation of the impacts of Federal Reserve interest rate increases on bond prices.

## 4. Empirical Results and Analysis

### 4.1. ARIMA Specification

In the context of analyzing the logarithmic stock return order, the PACF and ACF can provide valuable insights for determining the lag orders of the AR (p) and MA (q) models, the outcomes of which are displayed below.



**Figure 1.** ARMA (p, q) identification.  
 Photo credit: Original

As shown in Figure 1, the initial segment surpassing the critical thresholds corresponds to a lag of 7 in both the PACF and ACF plots for daily model. This suggests that both the AR (p) and MA (q) processes exhibit an order of 7 for daily returns, implying that the values of p and q are both equal to 7.

When this paper sorts the data after the first difference in periodicity, the fixed orders fall within the x-axis. Therefore, this paper uses the data from the second difference for modeling. From the two images in the second row of Figure 1, as models are usually taking the maximum number of

significant periods within 10, it can be deduced that the AR order (p) is 8, while the MA order (q) is 2.

Subsequently, the paper necessitates arranging the monthly logarithmic returns based on the predetermined sequence outcomes presented in the third row of Figure 1, the most significant in this model is 8 and 1, respectively. Hence, the AR orders are 8, and the MA orders are 2.

**4.2. Residual test**

For enhancing prediction accuracy, this study employs a residual test to ascertain if the residual value of modeling outcomes conforms to a white noise pattern. This original hypothesis assume that the sequence is uncorrelated.

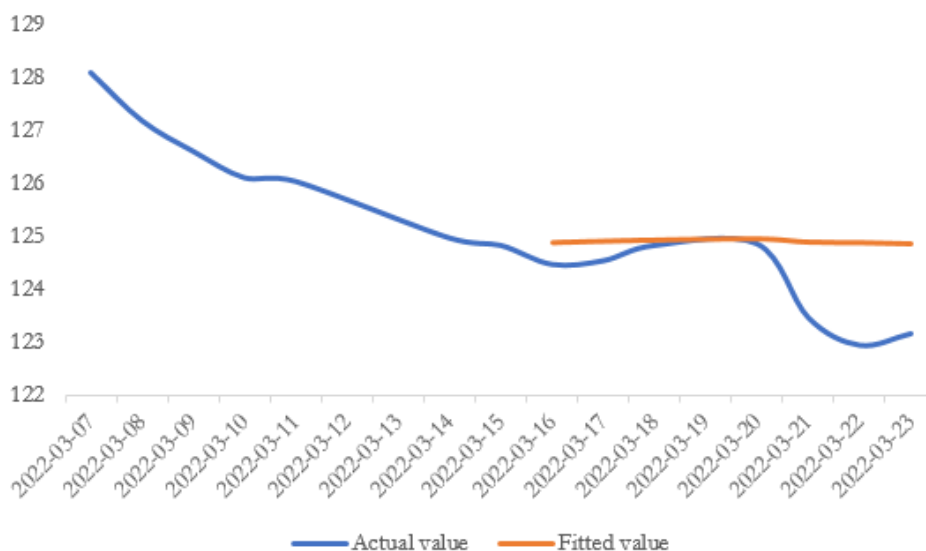
**Table 2.** Residual test.

Model	Portmanteau (Q) statistic	Prob > chi2
Daily-ARIMA(7,1,7)	42.6104	0.3594
Weekly-ARIMA(8,2,2)	49.7499	0.1388
Monthly-ARIMA(8,2,1)	35.0834	0.6907

From the results of Table 2, the three models cannot reject the original assumption that there is no significant correlation between residual values. Therefore, these three models are significant and can be used for analysis and discussion.

**4.3. Estimation Results and Analysis**

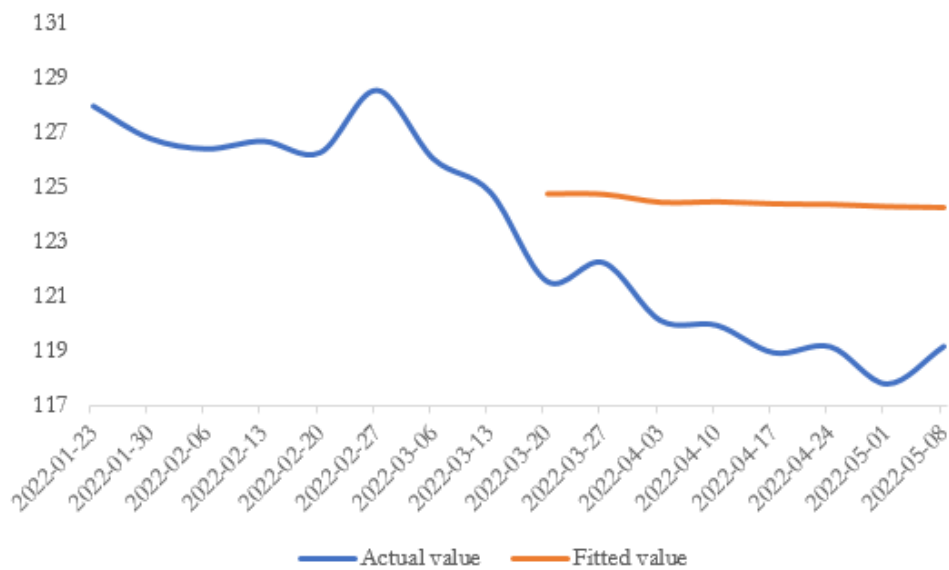
After estimating the model, this paper has the graph of Figure 2, 3 & 4.



**Figure 2.** Actual value and fitted value, daily.

Photo credit: Original

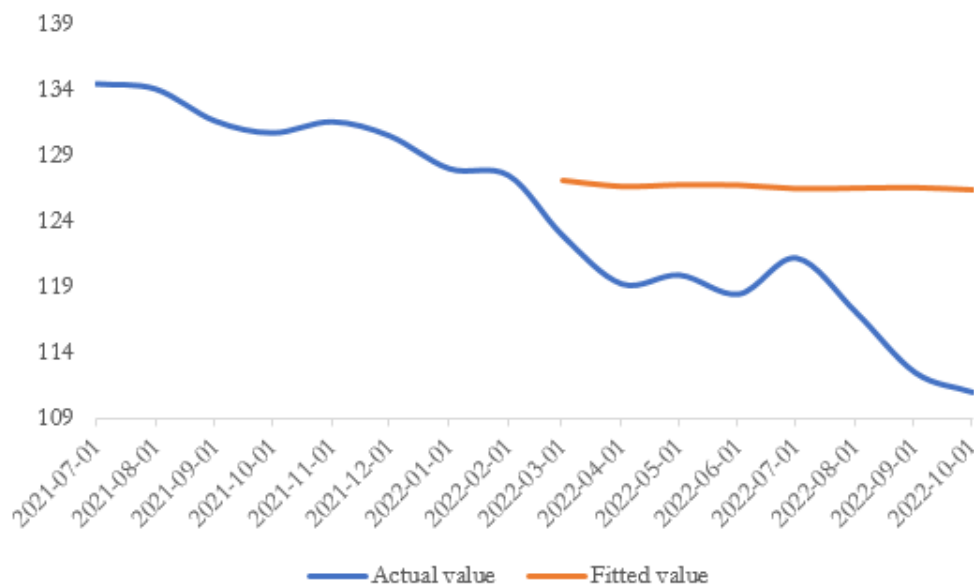
Through a rigorous comparative analysis of the experimental group and control group depicted in Figure 2, discernible is a gradual descent in futures prices post the identified point t0, albeit the pronouncedness of the trajectory lacks prominence. Moreover, Figure 3 markedly highlights a substantial disjunction between actual values and fitted values within the short-term. Following the initial interest rate hike on March 16th, futures prices have a downward trend. The second interest rate hike on May 4th yielded a disparate outcome, the price of futures is going upward. This intriguing pattern underscores the non-immediate nature of the response to Federal Reserve interest rate hikes, challenging the promptness premise postulated in the conclusion drawn from Figure 2, and rendering the ultra-short-term impact perceptibly modest. This conclusion mirrors the time delay inherent in monetary policy, and the duration of this time lag also exerts distinct levels of influence on the stability of the economy. [13].



**Figure 3.** Actual value and fitted value, weekly.

Photo credit: Original

The insights gleaned from Figure 4 are noteworthy, accentuating an accentuated dissonance between actual and fitted values post-July, as compared to the preceding period. This discrepancy likely stems from the Federal Reserve's pivotal decision to augment interest rates by a substantial 75 basis points in June – a pronounced adjustment that is, arguably, the most impactful since March. While the visual aid of three images inherently imposes limitations on the comprehensive assessment of data amplitude and disparities, Excel's computation of average differences provides a more quantitative dimension, as illustrated in Table 3.



**Figure 4.** Actual value and fitted value, monthly.

Photo credit: Original

Upon meticulous examination of the tabulated data, it becomes discernible that the responsiveness of futures prices to interest rate hikes evinces incongruities across daily, weekly, and monthly temporal scales. This paper concludes that the endeavors of the Federal Reserve to raise interest rates distinctly correlate with a subsequent reduction in bond prices, but the bond market's response to the Fed's rate hike is complex and multifaceted.

**Table 3.** Actual and fitted value.

Panel A: Daily-ARIMA (7,1,7)			
	Actual value	Fitted value	Difference
2022-03-07	128.08		
2022-03-08	127.17		
2022-03-09	126.59		
2022-03-10	126.09		
2022-03-11	126.02		
2022-03-14	124.95		
2022-03-15	124.81		
2022-03-16	124.45	124.88609	-0.43609
2022-03-17	124.52	124.91335	-0.39335
2022-03-18	124.81	124.93456	-0.12456
2022-03-20	124.84	124.95842	-0.11842
2022-03-21	123.44	124.89562	-1.45562
2022-03-22	122.92	124.88588	-1.96588
2022-03-23	123.14	124.86362	-1.72362
Panel B: Weekly-ARIMA (8,2,2)			
	Actual value	Fitted value	Difference
2022-01-23	127.95		
2022-01-30	126.77		
2022-02-06	126.39		
2022-02-13	126.67		
2022-02-20	126.25		
2022-02-27	128.53		
2022-03-06	126.02		
2022-03-13	124.81		
2022-03-20	121.55	124.72657	-3.17657
2022-03-27	122.23	124.70895	-2.47895
2022-04-03	120.12	124.44132	-4.32132
2022-04-10	119.94	124.45831	-4.51831
2022-04-17	118.94	124.39045	-5.45045
2022-04-24	119.16	124.36978	-5.20978
2022-05-01	117.8	124.29902	-6.49902
2022-05-08	119.17	124.26575	-5.09575
Panel C: Monthly-ARIMA (8,2,1)			
	Actual value	Fitted value	Difference
2021-07-01	134.45		
2021-08-01	134.05		
2021-09-01	131.61		
2021-10-01	130.7		
2021-11-01	131.55		
2021-12-01	130.47		
2022-01-01	127.97		
2022-02-01	127.45		
2022-03-01	122.88	127.08575	-4.20575
2022-04-01	119.16	126.62929	-7.46929
2022-05-01	119.84	126.74872	-6.90872
2022-06-01	118.39	126.72295	-8.33295
2022-07-01	121.14	126.45986	-5.31986
2022-08-01	117	126.49609	-9.49609
2022-09-01	112.38	126.53637	-14.1564
2022-10-01	110.88	126.37073	-15.4907

## 5. Discussion

In comparison with existing literature, this paper conclusion aligns with prevailing research that Federal Reserve interest rate hikes indeed induce a decline in bond prices. This consensus highlights the consistency in understanding the immediate impact of interest rate adjustments on financial markets. However, what sets this study apart is its nuanced exploration of temporal dynamics in the bond market's response. Unlike some earlier research that predominantly focuses on short-term outcomes, this study delves into daily, weekly, and monthly trends, revealing variations in bond price adjustments. This temporal granularity adds depth to the understanding of market reactions to Federal Reserve actions.

This study offers profound insights that extend beyond the conventional understanding of the Federal Reserve's impact on bond prices. The identification of diverse temporal reactions underscores the importance of considering time frames when assessing market responses to policy decisions. Furthermore, this research highlights the intricate nature of the bond market, necessitating a comprehensive approach in gauging the effects of interest rate hikes. The nuanced findings underscore the complexity of financial markets and the need for a holistic perspective in policy analysis and investment strategies.

For policymakers, this paper stress the importance of considering time lags in market reactions. The non-immediate response of the bond market to interest rate hikes suggests that policy adjustments may take time to permeate through financial markets. Understanding the diverse temporal patterns can aid in more precise policy decision-making. Additionally, this paper underscores the necessity of a balanced approach that considers various temporal horizons for effective policy communication and market stability.

Investors can leverage the findings of this paper to fine-tune their strategies. Short-term investors may recognize the potential for delayed market reactions to interest rate hikes and adjust their trading frequency accordingly. Long-term investors might find value in assessing the market's cumulative response across various temporal intervals to make informed portfolio decisions.

In conclusion, this study's unique contribution lies in its exploration of the temporal dimension of the bond market's response to Federal Reserve interest rate hikes. While consistent with previous research in affirming the link between interest rate hikes and bond price declines, this study's focus on temporal granularity uncovers variations in market reactions. The implications extend to policymakers seeking precise timing in policy adjustments and investors seeking to optimize strategies across different time horizons.

## 6. Conclusion

This study delves into the intricate relationship between Federal Reserve interest rate hikes and bond prices, unveiling a multifaceted landscape where temporal dynamics play a pivotal role. The empirical analysis, augmented by ARIMA models, substantiates the core assertion that Federal Reserve interest rate hikes indeed correlate with a discernible decrease in bond prices.

The empirical evidence showcases that the bond market's response to interest rate hikes is not uniform across daily, weekly, and monthly time intervals. The analysis unveils that the impact of rate adjustments on bond prices exhibits nuances that are influenced by the temporal proximity to the Federal Reserve's decisions. This nuanced temporal perspective provides valuable insights into the evolving dynamics of financial markets and the intricate interplay between monetary policy shifts and market behaviors.

The findings offer multifaceted implications for policymakers, investors, and market participants. Acknowledging the temporal variations in market reactions, policymakers can refine the timing of policy adjustments, considering the lagged response of the bond market. Investors, equipped with a deeper understanding of temporal patterns, can devise more informed strategies that navigate the varying market responses to interest rate changes.

While this study contributes valuable insights, several limitations warrant consideration. Relying on historical data may overlook real-time complexities. Focusing on the bond market alone might neglect broader financial interactions. Additionally, the linear nature of ARIMA models might not capture all dynamics. External variables, like geopolitical events, were omitted, impacting the results' comprehensive applicability. These limitations underscore opportunities for future research. Incorporating real-time data and advanced methodologies, such as machine learning, could refine predictions. Expanding the analysis to include various financial instruments and considering multifaceted external factors would yield a more nuanced understanding of the intricate relationship between Federal Reserve interest rate hikes and financial markets.

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