

Monetary Policy Uncertainty and Changes in US Stock Market: Evidence from USD and Stock Index

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Abstract. According to the U.S. monetary policy keep changing these years, these changes may cause some effect on the U.S. stock market, investors are looking for a investigation on these changes. As the biggest stock market in the world, the U.S. stock market is a large system that may entail many statistics to find out whether monetary uncertainty does change the stock market in stock index. In this paper, two of well-known stock markets are chosen and daily stock data from June 1, 2021 to September 14, 2022 is extracted as well as USD index through that period. The VAR model was applied in the study to evaluate the link between variables, and the ARMA-GARCH model was used to determine and analyze both earning ability and stock volatility throughout the monetary uncertainty. Interestingly, two large stock markets have different response to the USD index. The study forecasts the possible future of the stock market fluctuation and provides managerial and investment recommendations to its stakeholders.

Keywords: NASDAQ; USD Index; S&P 500; monetary policy uncertainty.

1. Introduction

According to the literature review, many of researches shows there is a relationship between monetary policy uncertainty and the stock market. This paper use VAR model and ARMA-GARCH model to test these statistics and find out that how does USD index effect NASDAQ and S&P 500.

Rates were increased by the Federal Reserve several times in a short time period intended to temper the domestic inflation. This action caused the dollar appreciation then intrigue global capital flows. Stock markets often see greater volatility when there is civil unrest or political unrest because significant political events might signal a shift in politics that could affect the market's value. When imagining future business health and investment outlooks, stock market volatility is crucial for policymakers and portfolio managers. Based on this, the authors of the research anticipate that investors may get uneasy about potential consequences on the stock market if present monetary policies aren't changed or if agreed-upon adjustments are made too quickly.

Few research has previously assessed how monetary policy uncertainty (MPU) affects stock markets. According to BS Bernanke and KN Kuttner, changes in monetary policy should be reflected in the stock markets since they affect individual portfolios owing to the "wealth effect" [1].

Additionally, the spillover effects of the 2007 and 2008 worldwide financial crisis pushed the policy perspective on international risk transmission. Since risk spillovers have an effect on stock value, investors should tremendously benefit from knowing the mechanics of how concern about U.S. monetary policy travels worldwide. Given the impact of U.S. interest rate policy uncertainty on international capital movements and outside finance, the study is justified in light of the fact that many decision-makers frequently cite uncertainty related to choices made by the US government as the justification for arbitrary policy and updating economic projections [2]. Several noteworthy studies have looked at the unpredictability of U.S. interest rate policy from a local or ternational perspective [3]. The Gulf Cooperation Council (GCC) stock markets are the only ones included in Algahtani.'s research on the impact of the U.S. policy uncertainty shock, therefore the results may not generalize to other significant equity markets like the developed and emerging equities markets. Instead of focusing on the spillover to other equity markets, Paule-Vianez investigate how MPU impacts the equities market [4]. According to the Lakdawala study, both developed and developing nations' equities markets are impacted by US policy uncertainty [5]. Notwithstanding, the research

uses an analytical method that overlooks key characteristics of the relevant economies. Determining how the uncertainty around U.S. interest rate spreads to global equities markets requires that this paper uses a methodology that simultaneously takes into consideration the unique characteristics of each country so as domestic and international trade and financial ties between them.

The implications of unanticipated changes in the volatility of policy innovations or unexpected second-moment shocks have only recently gotten the attention they deserve in terms of their effects on economic policy uncertainty. For instance, Baker found that policy uncertainty shocks predict losses in investment, output, and employment when they created a measure of the unpredictability of economic policy based on the frequency of media coverage [6]. When analyzing monetary policy uncertainty, Mumtaz and Zanetti, Creal and Wu, Fernandez-Villaverde, and Mumtaz and Surico, as well as Born and Pfeifer, also obtained similar results [7-11]. However, these papers focus on the US economy and disregard the global influence of US policy uncertainty shocks.

General uncertainty shocks and their consequences on the real economy are a topic covered in a related but still developing field of study. For instance, uncertainty may play a role in driving business cycles, according to Bloom, who also stress the need to model recessions as negative first-moment and positive second-moment shocks. They also underline the powerful countercyclical effects of uncertainty, both globally and within individual industries [12]. In a multi-country model with realized equity price volatility, Cesa-Bianchi find that the financial common factor considerably lowers country-specific GDP growth [13]. The growing level of financial uncertainty across mature and developing small open economies has negative impacts on output, but more varied effects on nominal variables, according to Bonciani and Ricci [14]. Empirical evidence of the worldwide transmission of volatility shocks by Mumtaz and Theodoridis shows that a 1% relative trend reduction in the UK's GDP results from a shock's volatility increasing by one standard deviation with respect to the US real GDP [15]. In their study of the macroeconomic impact of international turbulence frightens in G7 nations, Cuaresma demonstrate that these shocks have detrimental effects on all economies and variables taken into account, resulting in sharp drops in output, prices, exports, interest rates, and equity prices [16]. But unlike these other researchers, this paper is interested in monetary policy risks that influence economic fluctuations both domestically and internationally. Importantly, uncertainty shocks in policies can have significant effects on the global economy, particularly on currency rates, interest rates, and capital flows, as noted by Chinn, but the mechanisms of cross-border spillovers are still poorly unexplored [17].

Tillmann evaluates the effect of unclear monetary policy on interest rate term structure using three different metrics [18]. One of them is Husted's MPU measure, the second is the Survey of Professional Forecasters' interquartile range for 12-month-ahead projections about 3-month Treasury bills, and the third is a discrepancy in Consensus Economics' 12-month-ahead ojections about 10-year yields that Istrefi and Mouabbi introduced [19]. According to Tillmann, who agrees with De Pooter, how unpredictable monetary policy is currently affects how the term structure of interest rate responds to monetary policy shocks. In a representative agent endowment economy, for the link between the premium, fluctuating interest rates, and the relationship between bond rates and consumption, Bundick provides a model [20]. Additionally, Husted demonstrate that aftershocks that raise the MPU index, inflation and output in the United States fall, while financial conditions tighten. The aim of this research is to show how the S&P 500 and NASDAQ stock markets, in particular, are affected by monetary policy uncertainty.

According to these literature reviews, the U.S. monetary policy uncertainty is a question need to be figure out. Compounding the COVID-19 these years, the financial environment is getting worse than before. And the worldwide keeping inflation these years makes this situation even worse. This paper is aim to find out under these acerbic challenges, how does the monetary policy effect the NASDAQ index and S&P 500 index. Does it have a correlation with these two stock markets or any effect on these markets?

The rest parts of this paper are arranged as follows: Part 2 is research design, including data sources, ADF test and model specification; Part 3 introduces empirical results and analysis including VAR

order selection, Impulse response, ARMA specification, ARMA-GARCH estimation results and variance equation; Part 4 is the conclusion of this paper.

2. Research Design

2.1. Data Source

Data of USD index, SP500 index and NASDAQ index in this paper are derived from the Wind application. This is one of the most popular financial applications around the world. Forming all historical data of these index, this paper chooses the index from June 1, 2021 through September 14, 2022.

2.2. Unit Root Test

A unit root test (process) is used to ascertain if a time series is stationary. The priority of quantificational time series analysis is based on the premise that the time series is stationary. As a result, the stationarity condition of the data must be examined before the research is conducted. If any series is not stationary, this study must investigate potential solutions to enhance the outcomes. During the Unit Root Test, it is usually assumed that the time series x_t can be written as:

$$x_t = c_t + \beta x_{t-1} + \sum_{i=1}^{p-1} \phi \Delta x_{t-i} + e_t \quad (1)$$

The test's null hypothesis is that the coefficient is greater than one, indicating that the series is stationary and does not possess a unit root. The series is stationary if the coefficient is smaller than one, which is the alternative hypothesis. The test results for both the processed series and the raw data are shown in Table 1.

Table 1. ADF test.

Variables	t-statistic	p-value
	Index	
Nasdaq	-2.599	0.2805
S&P 500	-2.494	0.3312
USD index	-2.297	0.4358
	Yield	
Nasdaq	-12.600	0.0000***
S&P 500	-12.556	0.0000***
USD index	-13.866	0.0000***

Testing whether the data are stationary is the first step before proceeding. Based on the ADF test conducted in Stata, the P-values in Table 1 for index of NASDAQ, S&P 500 and USD are not equal to 0, so it is unstable, but the P-values for yield of all these three variables are all equal to 0, that means the statistics is stable which is considered statistically significant. Due to these findings, evidence is enough to reject that the variable has a unit root. In other words, the model built on the data is feasible and the data are stationary.

2.3. Vector Autoregression (VAR) Model

Before Sim's well-known contribution to the use of the VAR model, research on linear stochastic difference equations and the autoregressive nature employed in Tinbergen's model were conducted. The issue of building a model based on rigorous economic theory can be avoided by using the VAR model to capture the relationship between numerous variables. The concept that there is a strong correlation between stock index and monetary policy uncertainty is not well supported by the available data, despite several analysis suggesting that U.S. stock market volatility was caused by monetary policy uncertainty. In this context, the VAR model was chosen, and there are three separate

time series variables, denoted by $x_{t,1}, x_{t,2}, x_{t,3}$, resulting in a triadiate VAR (p) model. This paper used USD yield, NASDAQ yield and S&P 500 yield to make up the VAR model.

$$x_{t,1} = \alpha_1 + \phi_{11}x_{t-1,1} + \dots + \phi_{1p}x_{t-p,1} + \beta_{11}x_{t-1,2} + \dots \beta_{1p} + \delta_{11}x_{t-1,3} + \dots + \delta_{1p}x_{t-p,3} + e_{1t} \tag{2}$$

$$x_{t,2} = \alpha_2 + \phi_{21}x_{t-1,1} + \dots + \phi_{2p}x_{t-p,1} + \beta_{21}x_{t-1,2} + \dots \beta_{2p}x_{t-p,2} + \delta_{21}x_{t-1,3} + \dots + \delta_{2p}x_{t-p,3} + e_{2t} \tag{3}$$

$$x_{t,3} = \alpha_3 + \phi_{31}x_{t-1,1} + \dots + \phi_{3p}x_{t-p,1} + \beta_{31}x_{t-1,2} + \dots \beta_{3p}x_{t-p,2} + \delta_{31}x_{t-1,3} + \dots + \delta_{3p}x_{t-p,3} + e_{3t} \tag{4}$$

2.4. ARMA-GARCH Model

$$y_t = \phi_0 + \sum_{i=1}^q \phi_i y_{t-i} + \alpha_i - \sum_{i=1}^q \phi_i \alpha_{i-1} \tag{5}$$

The general expression of the ARMA model is displayed in equation above. The AR (p) is presented by the component $\phi_0 + \sum_{i=1}^p \phi_i y_{t-i}$, whereas the rest of the equation is MA (q). AR (p) estimates future value applying past stock returns from June 2021 to September 2022, whilst MA (q) forecasts using an error term.

Then comes another section GARCH. GARCH is derived from ARCH fundamentally, and both treat volatility as a variance to be modelled. In this paper, GARCH (1, 1) was taken into account, where the first 1 denotes one autoregressive lag and the second 1 denotes one moving average lag. The reasons for selecting GARCH (1, 1) are as follows: it has fewer parameters than ARCH (p); it fits many time series well, it is sufficient to identify the volatility clustering in the data, and it only requires one lag for analysis. As a result, the model GARCH (1, 1) was picked.

$$\sigma_t^2 = \alpha_{0,1} + \alpha_1 \varepsilon_{t-1}^2 + \beta_t m_t + \gamma_1 \sigma_{t-1}^2 \tag{6}$$

In the equation above, term $\alpha_1 \varepsilon_{t-1}^2$ is ARCH part and $\gamma_1 \sigma_{t-1}^2$ represents GARCH part, and the additional term $\beta_t m_t$ other than the generalized formula represents daily new confirmed cases that acted as an extra explanatory variable in the model.

3. Empirical Results and Analysis

3.1. VAR Order Selection

This section of the study applies our Vector Autoregression algorithm to three stationary series: the yield rate of the NASDAQ, S&P 500, and USD. To begin with, several Stata VARSOC selection-order criteria are utilized to determine the appropriate order p for this VAR (p) model. Table 2 displays the outcome and shows that a VAR with 10 orders can be considered.

Table 2. VAR model identification.

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	3415.52				6.3e-14	-21.8751	-21.8607	-21.8391*
1	3433.02	35.007*	9	0.000	6.0e-14	-21.9296*	-21.8721*	-21.7857
2	3436.15	6.2522	9	0.714	6.2e-14	-21.892	-21.7913	-21.6401
3	3442.18	12.057	9	0.210	6.4e-14	-21.8729	-21.7291	-21.513
4	3447.33	10.295	9	0.327	6.5e-14	-21.8482	-21.6612	-21.3804
5	3452.19	9.7192	9	0.374	6.7e-14	-21.8217	-21.5916	-21.2495
6	3455.9	7.4224	9	0.593	6.9e-14	-21.7878	-21.5145	-21.104
7	3463.7	15.614	9	0.075	7.0e-14	-21.7802	-21.4637	-20.9884
8	3467.4	7.4028	9	0.595	7.2e-14	-21.7462	-21.3866	-20.8464
9	3473.18	11.557	9	0.239	7.4e-14	-21.7255	-21.3228	-20.7178
10	3480.93	15.483	9	0.078	7.4e-14	-21.7175	-21.2716	-20.6018
11	3487.96	14.075	9	0.120	7.5e-14	-21.7049	-21.2158	-20.4812
12	3494.44	12.956	9	0.165	7.7e-14	-21.6887	-21.1565	-20.3571

It is critical to determine whether the VAR model is stationary after specifying the order of the model. The impulse-response function will not converge to zero if the VAR model is non-stationary, showing that everyday fresh examples have long-lasting effects on the return on the Twitter stock. After that, the unit root test was run and a unit circle was drawn using the model's roots to determine its applicability. Inferring that there is no need to reevaluate the lag order and that triradiate VAR (10) is a stable model, all the roots are obviously within the circle in Figure 1.

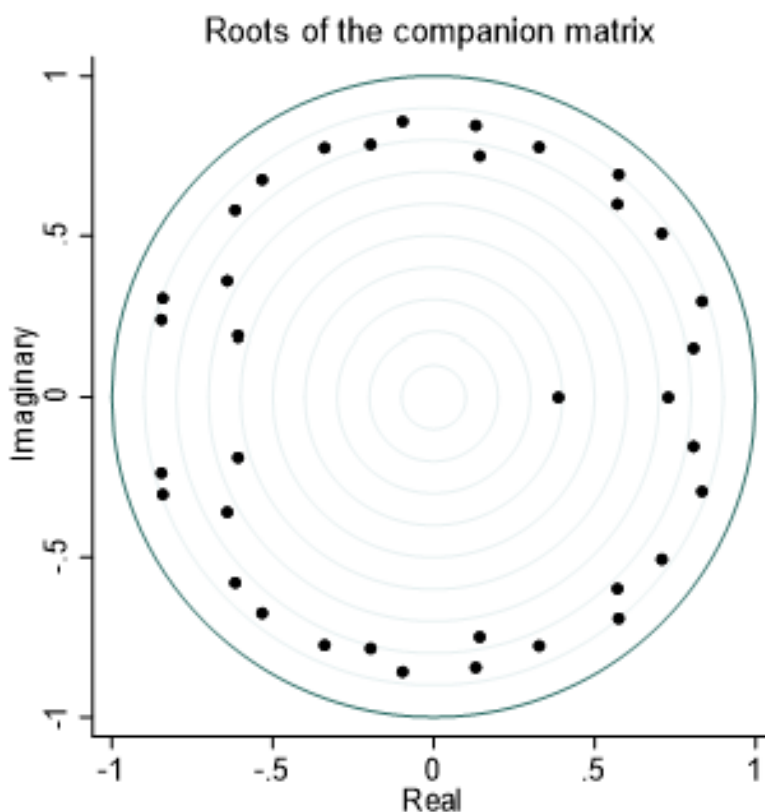


Figure 1. VAR stability.

Photo credit: Original

3.2. Impulse Response

In this paper, investigation on how NASDAQ, S&P 500 and the USD index respond to new case impulses in the U.S. was done. Previous research found that a high level of policy uncertainty had a detrimental impact on stock market performance because investors or market participants were pessimistic about the expected discount rate, resulting in a reduction in stock price.

In order to control the domestic inflation rate, several rounds of interest rate hikes by the Federal Reserve in a short period of time have resulted in the strengthening of the US dollar. The strengthening of the US dollar will cause capital flows, and the international capital market and international hot money will increase their holdings of the US dollar due to profit-seeking factors. These financial effects of this activity are possible: First, the growth in the number of US dollars held by foreign capital might result in a significant inflow of US dollars into the US bond or stock markets. This behavior means that there is a net inflow of capital in the United States. On the contrary, there will be a net capital outflow in other countries. The possible consequence of this behavior is that these funds flow into the U.S. stock market or bond market from foreign financial markets, increasing the price or yield in the U.S. stock market and lowering the price or yield in the foreign stock market;

Second, the appreciation of the U.S. dollar means that the currency value of the U.S. dollar will increase, which will definitely promote the exports of foreign companies and increase the imports of domestic import-dependent companies in the United States. But the impact of these two effects on the stock market is uncertain;

Third, raising interest rates means rising interest rates. As a tightening monetary policy, an inevitable result is an increase in savings and a decrease in consumption. The direct result of this channel is a downturn in the U.S. stock market.

To sum up, it cannot be directly inferred from the theoretical analysis which of the above effects is dominant. From the impulse response graph (Figure 2), the dollar appreciation has a detrimental effect on the American stock market. Specifically, when the dollar logarithmic yield increased by 1 unit in the period of $t=0$, the largest negative effect occurred in the current period, and the impact on the NASDAQ yield was slightly lower than 0.4%. The second highest value occurred in the period of $t=2$. Slightly more than 0.1%. The negative effect that had the greatest impact on the S&P 500 also appeared in the current period, with a value slightly higher than 0.3%. Although both showed a small number of positive effects, the numerical values were small, showing negative effects overall. This article argues that this result can partially explain the downturn in the U.S. stock market from 2022.

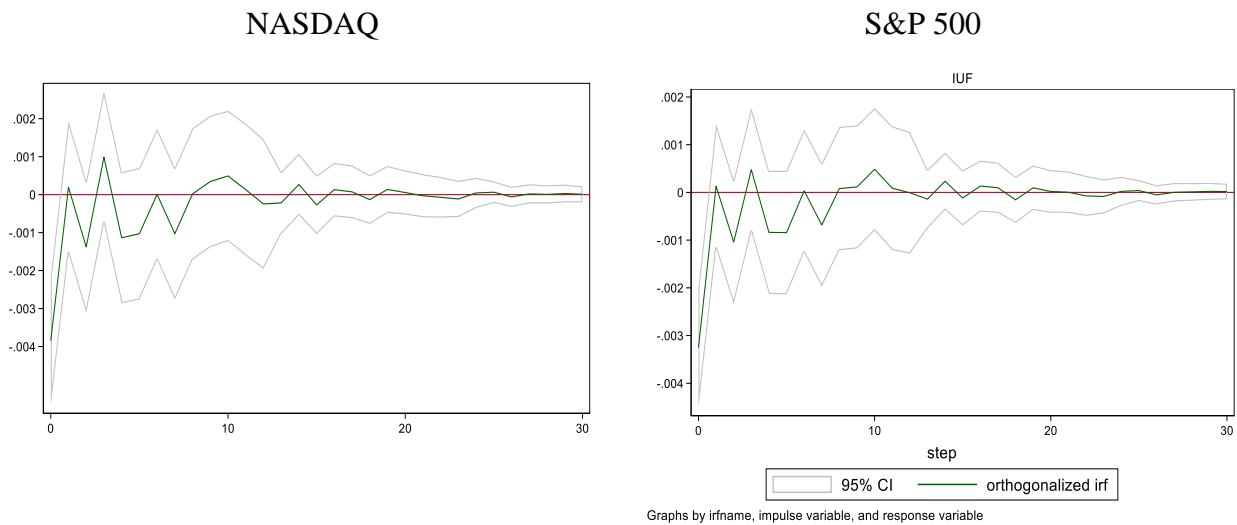
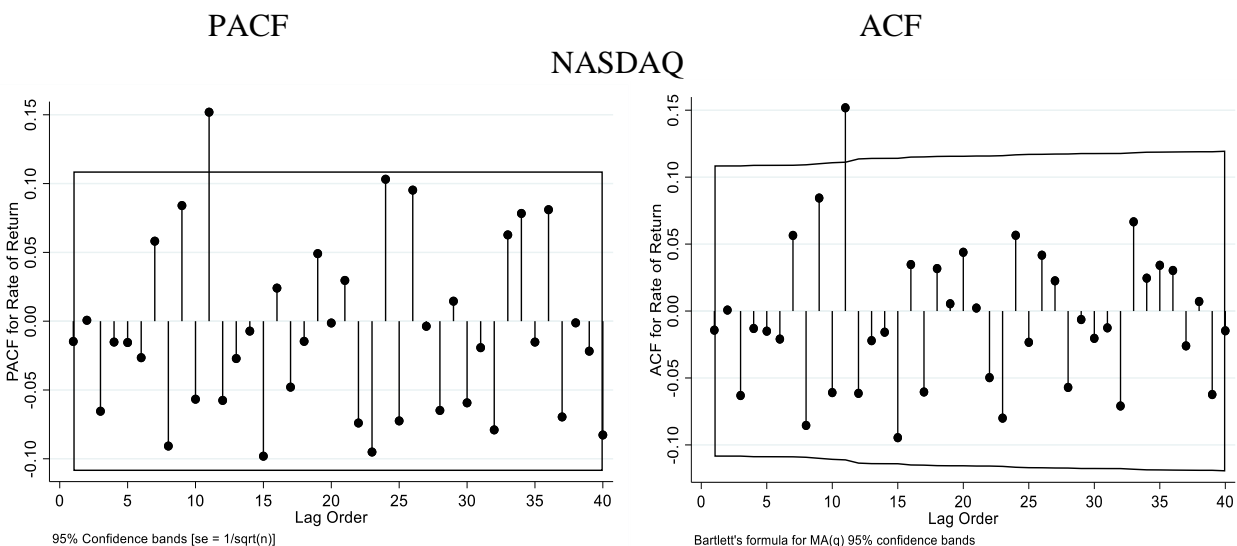


Figure 2. Impulse and response.

Photo credit: Original

3.3. ARMA Specification

Regarding to the order of the stock return in logarithm, PACF and ACF can be helpful to derive the lag orders for AR (p) and MA (q). In the Figure 3, the first part beyond the critical values is 11 for both PACF and ACF plots, demonstrating that AR (p) and MA (q) both have order 11 and value of p and q are equal to 11.



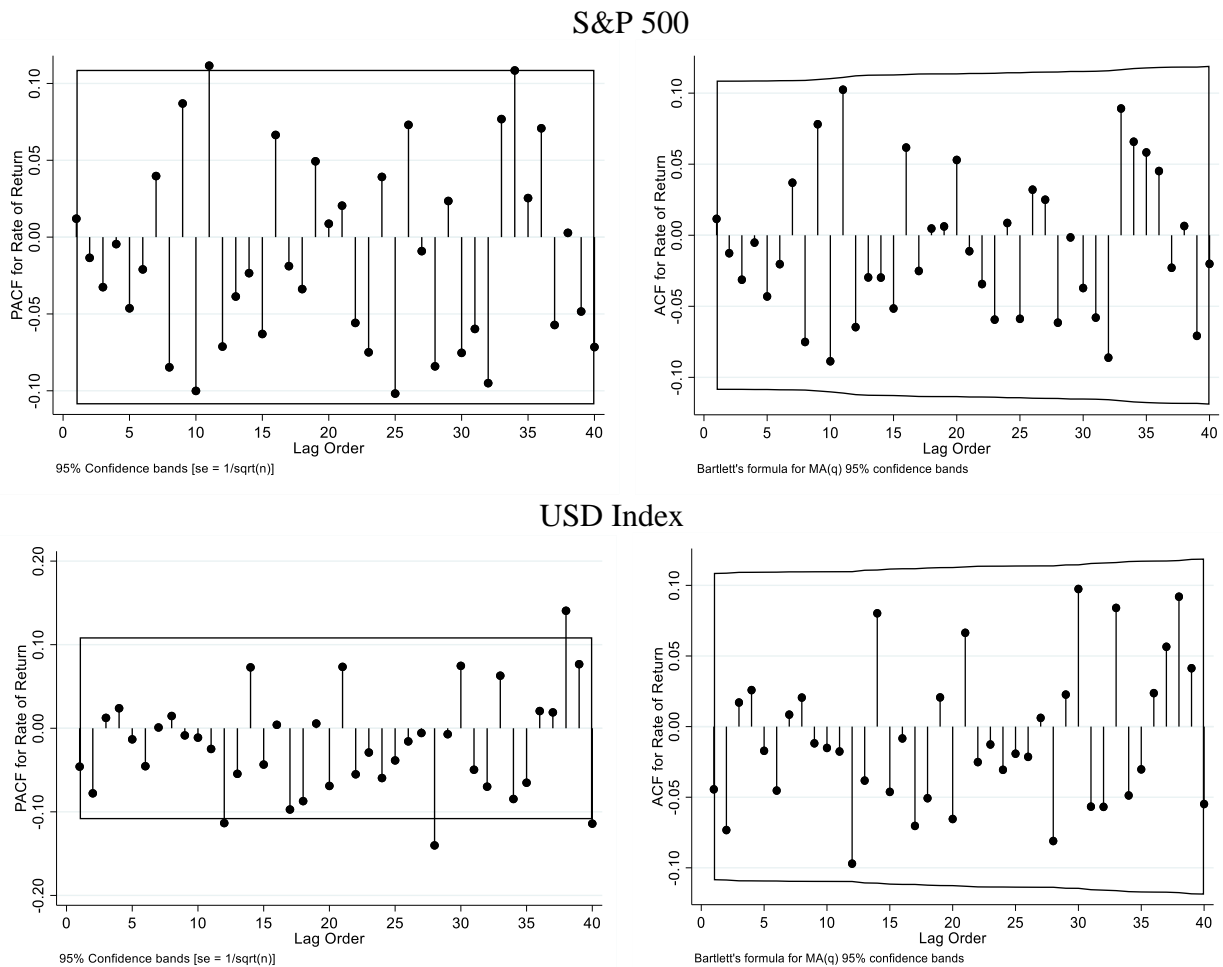


Figure 3. PACF and ACF.
 Photo credit: Original

3.4. ARMA-GARCH Estimation Results and Variance Equation

In this part, the GARCH model in this paper is used to calculate the volatility of the US dollar index, and puts the volatility into the variance equation with the S&P 500 and NASDAQ volatility as the dependent variables, and examines the effect of the volatility of the US dollar a measure of volatility of the US stock market. Impact.

From the estimation in Table 3, that the ARCH and GARCH terms of the two-column models are significant, indicating that the returns of the S&P 500 and NASDAQ have significant conditional heteroscedasticity, which can be used for GARCH modeling.

Judging from the estimated results of external explanatory variables, the volatility of the US dollar (for the convenience of coefficient interpretation, this paper expands the volatility by 10,000 times) increases by 1 unit, the volatility of the S&P 500 increases by 6.0675 units, and the coefficient is at the level of 1%. The NASDAQ volatility, however, is not much impacted by the volatility of the US dollar. The possible reason is that the NASDAQ market has a larger volume and stronger risk resistance.

Table 3. ARMA-GARCHX estimation results.

Variables	(1) SP500			(2) NASDAQ		
	Coef.	Std. err	p> Z	Coef.	Std. err	p> Z
Mean equation						
AR, L11	.7172	.3630	0.048	-.0189	.3672	0.959
MA, L11	-.6531	.3893	0.093	.1571	.3621	0.664
Constant	.0003	.0007	0.646	.0004	.0008	0.620
Variance equation						
USD, sigma-sq	6.0675	2.1799	0.005	5.2275	5.2847	0.323
GARCH (1, 1)						
ARCH, L1	.1499	.0591	0.011	.1526	.0679	0.025
GARCH, L1	.8020	.0774	0.000	.8441	.0759	0.000
Constant	-12.8631	.5886	0.000	-13.3097	1.0838	0.000

4. Conclusion

U.S. monetary policy kept changing these years and many wondering how this has an effect on stock market in U.S. This paper is meant to find out how the U.S. monetary policy effects the U.S. stock market. Used the NASDAQ, S&P 500, and the USD index to find out the relationship between theses index and monetary policy.

This paper went through the USD index through June 1, 2021 to September 14, 2022 to determine the potential relationship between the monetary policy and the stock market in U.S.

This paper use Stata application to set up number of data and calculated the ARMA-GARCHX result of this question, it can be seen that the ARCH and GARCH terms of the two-column models are significant, indicating that the returns of the S&P 500 and NASDAQ have significant conditional heteroscedasticity, which can be used for GARCH modeling. The volatility of the US dollar has a conspicuous effect on S&P 500, but no magnificent effect on NASDAQ. The possible reason for this conclusion is NASDAQ has a much bigger market so it has a better anti-risk capability.

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