The Impact of the Federal Reserve Raises the Interest Rates on the US Stock Market Index: The Dynamic Perspective

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Abstract: In order to battle growing inflation, the Federal Reserve raised interest rates in March 2022 for the first time since 2018. This action signals the conclusion of the Federal Reserve's accommodative monetary policy adopted during the pandemic, coinciding with significant inflationary trends in the United States. One of the main focuses that this may bring is the effect on stock price. This article will use past data on NASDAQ stock prices to forecast future trends and will discuss the analysis. At the end, the research finds that Fed's policy has let NASDAQ index decrease than expected trends in a long-term perspective. This suggests that the Fed's policy may have a more pronounced impact on long-term trends rather than short-term fluctuations. It also implies that investors should adopt a strategic, long-term approach to their investments, rather than reacting to short-term market noise. Investors may also consider implementing risk management strategies, including stop-loss orders and options contracts, to protect against sudden market downturns that may result from interest rate hikes.

Keywords: Federal Reserve, interest rates hikes, NASDAQ Index, forecast future trends

1. Introduction

After a new rate raise meeting in March 2022, the Federal Reserve decided to make its first interest rate hike since 2018 [1] as a response to the growing inflationary pressures in the US. With this move, the Federal Reserve's pandemic-era policy of keeping interest rates low to support the economy has come to an end. The Federal Reserve increased the policy rate in a series of steps, beginning with a 25-basis point hike in March 2022. This was followed by a 50-basis point increase in May, and subsequent 75 basis point hikes in June, July, September, and November. This rapid succession of rate increases was the fastest since the 1990s [2]. Fast forward to July 26th this year, the Federal Reserve raised its standard rate for lending for the 11th time since its first increase in March 2022. It rose this time by a quarter point, reaching its highest mark in the previous 22 years. According to estimates, there may be one more rate increase this year to combat inflation. Jerome Powell, the chair of the Fed, stressed after this decision that it is still possible to conduct another rate hike; this would occur if the economy was to strengthen and maintain pressure on prices to rise. According to Powell, stronger growth on the margins might eventually result in greater inflation, which would call for an appropriate monetary policy response. In addition, he noted that core inflation stays fairly elevated [3]. Stocks ended the day had a varied performance after his speech: the Dow continued its streak of

gains for the 13th consecutive day, the S&P 500 remained stable with no significant change, and the Nasdaq Composite fell marginally [3].

As mentioned, the rate increased in order to combat inflation. But how? Here is the logic: When interest rates go up, debt management becomes more expensive and causes individuals to borrow less money. To elaborate further, borrowing plays a significant role in generating new money. Therefore, higher interest rates should theoretically reduce money creation and the supply of money may go down. Companies and individuals spend less as liquidity tightens, making the economy slow down. As this growth declines, inflation falls along [4].

In this research paper, the main focus is on how this increase in interest rate by the Fed might impact the Nasdaq 100 Index. This article will mainly concentrate on what happened to the Nasdaq index after the first incline of the interest rate by the Fed, and will discuss changes from different views: short-term (daily), short-medium-term (weekly), and medium-term (monthly). The main structure of this article will be organized in this way: the research design part will introduce some pre-examination setup work and the model along with the formulas this research will be using. The result and analysis section will show the running results from the models and analyze the results. The discussion part will analyze more deeply; compare how the result is related to existing papers, how to understand this paper, etc. And finally, there will be a conclusion to cover the whole research. Readers may explore more details from the reference page at the end.

2. Literature Review

2.1. The Economic Consequences Associated with Fed rate Hikes (Consumption, Savings, Capital flows, Exchange rates, etc

The rise in the prime rate typically leads to an increase in money market rates. Theoretically, this should encourage individuals and businesses to save more since there's potential to earn greater returns on savings. On the other hand, consumption power goes down. This is because as interest rates increase, borrowing money becomes more expensive. Rising interest rates lead to a reduction in borrowing and subsequently lower spending, following a relatively consistent demand curve for loans. [5] This would raise the cost of purchasing certain products and services, such as properties and automobiles. The demand for goods and services would decrease as a result of consumers spending less. When demand for goods and services falls, firms reduce production, laying off workers which would increase unemployment. An increase in interest rates therefore eventually slows down the economy. But it is one strategy to against inflation, because prices of goods and services would decrease along with the decrease of the demand of those. This would reduce inflation.

Switching views to the capital markets, based on the traditional interest rate parity theory, when interest rates vary between two countries, capital tends to move from the country with lower interest rates to the one with higher rates in pursuit of greater returns. Consequently, fluctuations in interest rates directly impact the dynamics of the capital market. In this scenario, higher interest rates can encourage capital inflows into the US, boosting the country's financial industry [6]. Shifts in the U.S. real interest rate have a notable effect on the U.S. real exchange rate [7]. A rise in domestic interest rates will result in an increase in the home currency's foreign exchange rate [8]. This is because theoretically, this increased the attractiveness of the US dollar to international investors. Consequently, investors worldwide engaged in selling off other currencies in favor of obtaining US dollars, bolstering the dollar's strength and depreciating other currencies.

2.2. The Potential Impact of Interest Rate Hikes on the Stock Market

Turning attention to the stock market, interest rates wield a substantial influence on its performance. Increasing rates results in a stronger valuation of the US dollar. This action heightened investment

risk and expenses for investors, dampening their eagerness to invest. Therefore, the stock market may experience a notable downturn. The upsurge in interest rates also triggered various ripple effects, including the strengthening of the U.S. dollar, the outflow of capital, and a shift in investments from the stock market to more stable alternatives like the bond market [9]. To be more specific, when interest rates rise, capital tends to flee the stock market, resulting in lower stock prices. This is because rising interest rates make bonds more alluring to investors while raising the cost of borrowing for businesses [6].

2.3.   Review of the Literature

The decision of the Federal Reserve to raise interest rates have multifaceted economic consequences. Such rate hikes often encourage savings and debt reduction due to the prospect of higher returns on savings and increased borrowing costs. Consequently, consumer spending tends to decline as the cost of borrowing for major purchases rises. All these would potentially slowing down the economy and leading to unemployment, at the same time be a good tool to combat inflation since prices goes down when demand decreases. Additionally, increased interest rates attract foreign investment, strengthening the domestic currency. Overall, people tend to spend less and save more, thereby mitigating inflationary pressures. In the stock market, alternatively, rising interest rates can negatively affect businesses by increasing borrowing costs, potentially impacting stock performance. Conversely, they can make safer assets more appealing, potentially diminishing the attractiveness of risky stocks. Bond prices tend to move inversely with interest rates, causing them to decline as rates rise, which can have significant implications for bond investors.

3.   Research Design

3.1.   Data Source

In the course of this research, the primary data repository employed was Yahoo Finance. This platform was selected due to its easy accessibility, user-friendly interface, and comprehensive data coverage. The dataset encompassed daily, weekly, and monthly NASDAQ rates, ensuring a holistic perspective of the market trends across varying timeframes. In order to ensure the accuracy of the acquired data, same data was also researched from cn.investing.com [10]. Notably, this cross-validation substantiated the consistency and integrity of the data procured from Yahoo Finance [11].

The methodology entailed constructing a time series of closed rates, thus facilitating an astute temporal and categorical analysis of trends. The time ranged from January 4, 2010, to August 6, 2023. Within this timeframe, a critical date, March 16, 2022, was designated as t0. This date holds significance as it marks the Federal Reserve's inaugural interest rate hike in 2022. By comparing the periods before and after this significant turning point, a more nuanced evaluation of divergences become possible, enhancing the study's evaluative conclusions.

3.2.   Weak Stationarity Test

Before starting the actual examination, the first step is doing a unit root test. This test's purpose is to determine whether a given time series has a unit root.

Table 1: Weak stationarity test

	t	p
Daily		
Raw	-3.420	0.0488
1st order difference	-40.907	0.0000
Weekly		
Raw	-3.166	0.0914
1st order difference	-18.496	0.0000
Monthly		
Raw	-2.775	0.2062
1st order difference	-10.242	0.0000
2nd order difference	-15.234	0.0000

In table 1, t represents Test Statistics, and p means MacKinnon approximate. It is obvious to see that all p-values and different levels are less than 0.1. This means that the models are very stable because there's enough evidence to reject that the variables have a unit root. This means that the model built on the data is feasible and the data is stationary.

One thing to note is that the monthly sequence should use second-order differencing; this is because based on the first-order difference, it is difficult to determine the model orders, p and q.

3.3. ARIMA Model Settings

$$Return_t = \phi_0 + \sum_{i=1}^{p} \phi_i Return_{t-i} + a_t - \sum_{i=1}^{q} \theta_i \alpha_{t-i} \tag{1}$$

The purpose of using ARMA is because this paper can simultaneously predict the future using past realized values and past perturbations. The AR(p) is represented by the component $\phi_0 + \sum_{i=1}^{p} \phi_i x_{t-i}$ whereas the rest of the equation represents MA(q). AR(p) estimates future value applying past NASDAQ stock returns from Jan 2010 to Aug 2022, and MA(q) forecasts using an error term.

The fundamental objective of employing autoregressive integrated moving average (ARIMA) models is to predict upcoming values by analyzing historical data. ARIMA utilizes lagged moving averages to smooth time series data. The logarithmic price series is not stationary, therefore it is necessary to do differencing in order to obtain the logarithmic return which is stationary series.

4. Results and Analysis

4.1. ARMA Specification

Regarding the order of the stock return in logarithm, PACF and ACF can be helpful in deriving the lag orders for AR(p) and MA(q) using the ARIMA times series model. As this paper is using MLE, the parts beyond 10 MLE the equations are iterated and may get stuck counting at very high orders, therefore only the parts before 10 would be observed. Another thing to note is that this model only captures the potential future trend instead of an accurate forecast.
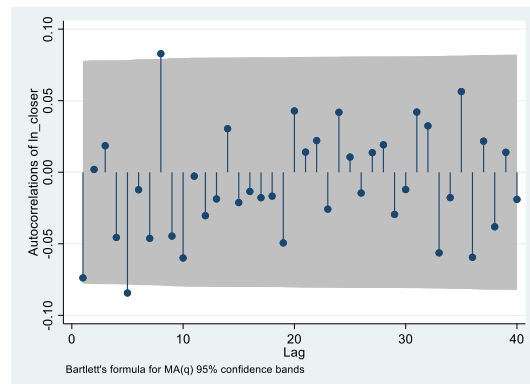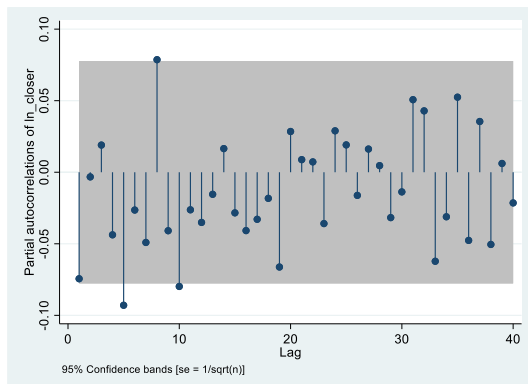
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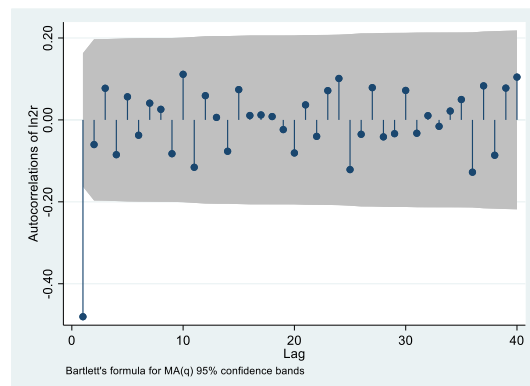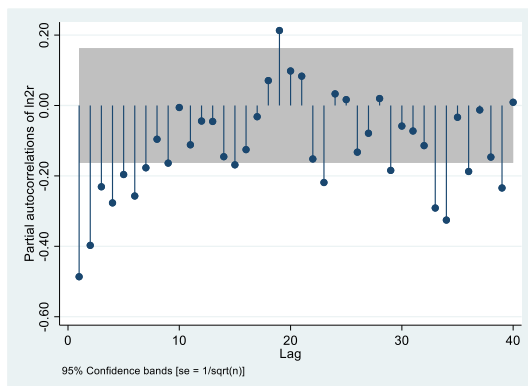Daily
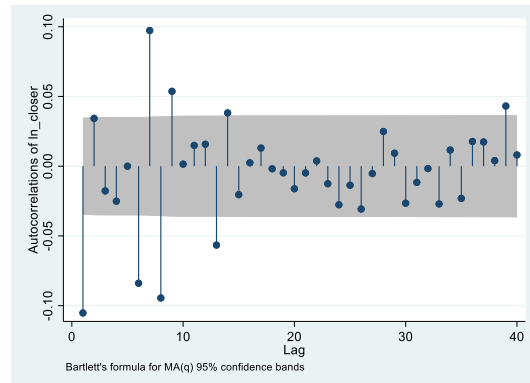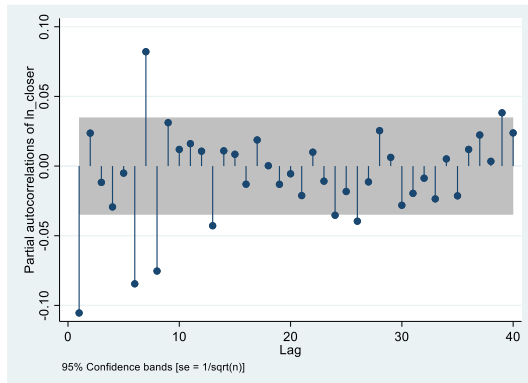
Weekly

Monthly

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

Shown in Figure 1, Y-axis represents the dependent variable; The partial autocorrelation function (PACF) and autocorrelation function (ACF) of the logarithmic returns at various time horizons for Nasdaq's stock; and X-axis represents the time lag order. The region enclosed between $y = \pm 2$ standard errors corresponds to the 95% confidence interval applicable to AR(p) and MA(q). If an order is beyond the critical value, it infers that this order is significant, which is helpful to form the model prediction.

For (p, d, q), each represents a meaning. To illustrate, p signifies the autoregressive (AR) order, signifying the quantity of previous terms of the dependent variable included in the model. It signifies

how many past values of the variable are considered in predicting its current value. Moreover, d denotes the differencing order, indicating how many times the data has been differenced to attain stationarity. Differencing is often necessary to make a time series stationary by removing trends and seasonality. Lastly, q stands for the moving average (MA) order, indicating the number of lagged forecast errors (residuals) that are included in the model. It signifies the influence of past forecast errors on the current value.

In this figure, for the Daily data, the first part beyond the critical values is 8 for PACF, and 9 for ACF, meaning that AR(p) and MA(q) have order 1 and the value of p is 8 while q is 9.

For Weekly data, the first part beyond the critical values is 10 for PACF, and 8 for ACF, meaning that AR(p) and MA(q) have order 1 and the value of p is 10 while q is 8.

For monthly data, the first part beyond the critical values is…the first part beyond the critical values is 7 for PACF, and 1 for ACF, meaning that AR(p) and MA(q) have order 2 and the value of p is 7 while q is 1.

4.2. Residual test

The Portmanteau Q statistic is employed to evaluate the overall goodness-of-fit of an ARIMA model. The Q statistic determines if the residuals exhibit significant autocorrelation. In the context of time series modeling, the lower the Q statistic, the better the model is at explaining the underlying patterns in the data.

Table 2: Residual test

Model	Portmanteau (Q) statistic	Prob > chi2
Daily-ARIMA(8,1,9)	48.3403	0.1716
Weekly-ARIMA(10,1,8)	20. 1732	0.9962
Monthly-ARIMA(7,2,1)	55.9920	0.0479

This refers to the probability associated with the chi-squared statistic in hypothesis testing. In the context of the Portmanteau Q statistic, "prob > chi2" indicates the p-value associated with the calculated Q statistic. A low p-value indicates that the residuals do not exhibit randomness and that the underlying patterns in the data might not be sufficiently captured by the model. On the other hand, a high p-value suggests that the residuals are behaving randomly, indicating a better fit of the model.

Residual test is shown in Table 2. In the case of the daily model, the Portmanteau Q statistic registers at 48.3403, with a corresponding p-value of 0.1716. For the weekly model, the Portmanteau Q statistic stands at 20.1732, and gives a p-value of 0.9962. Lastly, in the monthly model, the Portmanteau Q statistic is 55.9920, while the p-value is 0.0479. Here, the p-value of daily and weekly are greater than 0.1, while the monthly p-value is less than 0.1. This is because when a financial model is doing a long-term prediction, its goodness of fit may be poor. But again the point of this model is to estimate the future trends instead of doing a accurate prediction, so this issue will be temporarily ignored.

4.3. Forecast

Fitted values, also known as predicted values, or forecasted values, are the values that the ARIMA model generates based on its parameters and historical data. These values are the model's best estimates of what the actual values should be for each time period in the dataset (see Figure 2, 3 and 4). Actual values, also referred to as observed values or real values, are the actual data points that have been recorded or collected over time. These values represent the true behavior of the

phenomenon being studied. The average treatment effect (ATE) is 6.82% for daily data, -8.88% for weekly data, and -24.71% for monthly data.

Figure 2: Actual value and fitted value, daily
Photo credit: Original

Shown from this running result, there is some difference between daily, weekly, and monthly data. For daily data, the actual value is higher than the fitted value. There could be several possible reasons, and here are two of the main ones. 1) This hike in interest rate isn't big enough to really have some obvious effect; 2) there might be some lag time for the price to react with the policy, which is called impact lag. Changes in interest rates influence economic activity through six primary channels: inter-temporal substitution, the impact of induced exchange rate variations on the tradeable sector, effects of interest rates on other asset values, effects of cash flow on liquidity-constrained borrowers, effects of credit supply, and the direct impact of monetary policy changes on growth forecasts. These channels, as well as their interactions, collectively contribute to the time delays associated with monetary policy [12].

While daily price has a higher frequency, it is also harder to observe a sudden difference. The second explanation is more acceptable after observations from longer horizons weekly and monthly. For weekly data, starting from early April, the actual value is under the fitted value. This difference is more obvious from monthly data. This infer that the Federal Reserve raising interest rates has a negative effect on the NASDAQ rate in longer term.
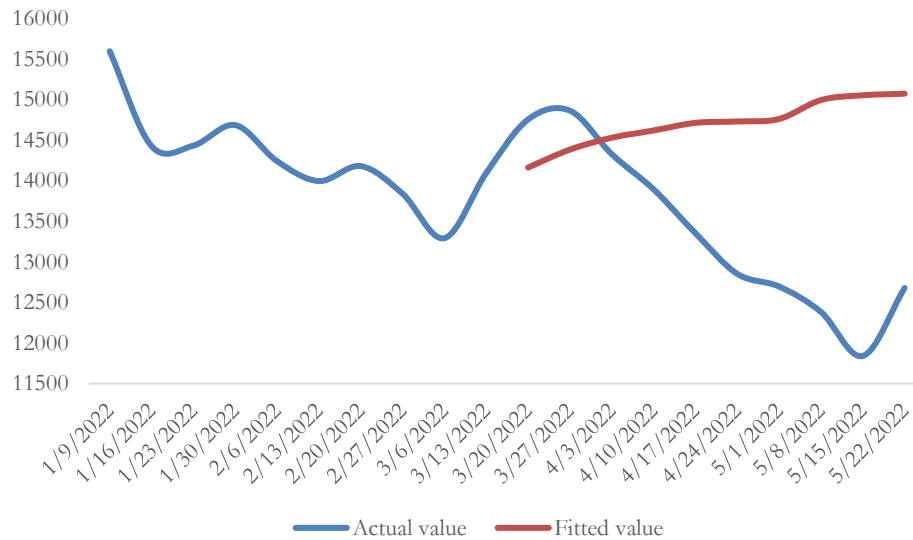
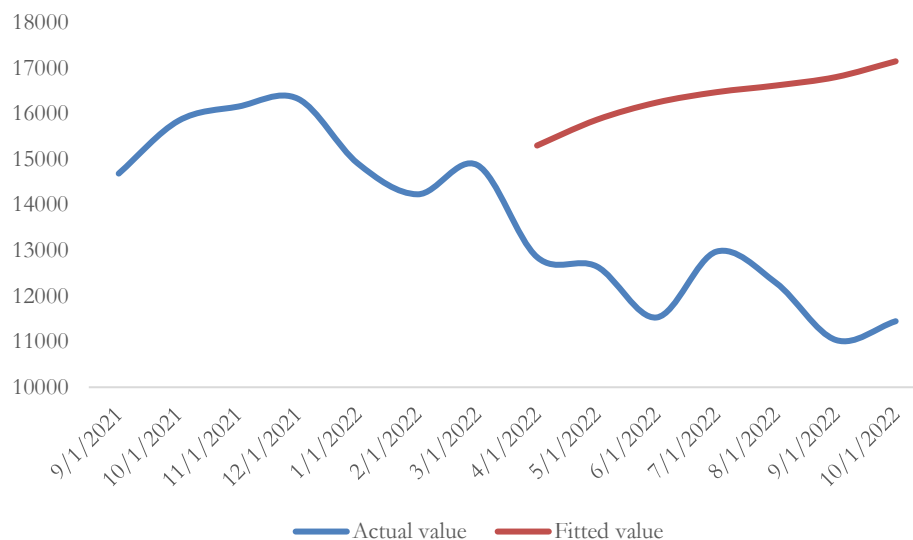Figure 3: Actual value and fitted value, weekly
Photo credit: Original

Figure 4: Actual value and fitted value, monthly
Photo credit: Original

5.   Discussion

In comparing and contrasting this research article with the existing analysis, several key points emerge. Both the literature review and this study acknowledge that Federal Reserve interest rate hikes have multifaceted impacts on the economy and financial markets. They both recognize that these hikes can potentially lead to a decrease in stock prices. However, one difference noticed is that most of the existing studies offer a broader perspective on the economic consequences (including effects on consumption, savings, capital flows, and exchange rate) as well as a general imply on how the

stock would change, while this paper focuses specifically on the NASDAQ Index's response to the rate increase.

The research implications of this article underscore the importance of understanding the time lag associated with interest rate policy changes. The study finds that the impact on the NASDAQ Index is not immediately apparent from daily view but becomes more pronounced in the short-medium and medium-term perspectives (which is weekly and monthly views). This suggests that policymakers should consider the delayed effects of their decisions and exercise caution in interpreting short-term market reactions. This impact lag issue also suggests policymakers to monitor and evaluate policy impacts over extended periods, while also noticing that the longer term predictions in this paper may not be very accurate as ARIMA model is not the best tool to estimate future trends over extended periods. Moreover, policymakers may also consider broader economic and market dynamics beyond interest rates. Investors may also refer to the research analysis. The knowledge of delated effects on stock prices caused by interest rate hikes may inform investment strategies, encouraging investors to adopt a longer-term perspective and consider more options like investment portfolio. Additionally, external events can also influence stock markets since stock prices are sensitive. Therefore, investors are suggested to remain vigilant and consider various factors when making investment decisions.

6. Conclusion

Federal Reserve's decision on March 2022 to increase the interest rate and action to keep rising this rate has been an important issue to reflect on. The objective of this study is to learn what are the impacts on the NASDAQ Index due to this increase of the interest rate by the Federal Reserve. As this increase technically started in March 2022, this study compares the NASDAQ closed stock price with respect to pre-period and post-period separately. The outcome has shown that in the short term which is from the daily perspective, the impact of the increased rate isn't apparent, indicating that there might be some delay for the policy to go into effect. In the short-medium term which is from the weekly perspective, the impact has shown a little starting the first week of April as the actual value gradually gets lower than the fitted value. The effect of the policy starts to be revealed and gets more obvious in the medium-term perspective (monthly). In a nutshell, the hikes in interest rate has let the stock price on NASDAQ decrease than the expected value.

There is also some limitations that need to be considered. First, ARIMA model isn't suitable for a long term prediction. ARIMA models mainly rely on the past observations (lags) to make predictions. The number of lags included in the model is determined by the order of the AR and MA components. Therefore, the predictive power of the model may diminish as the forecast horizon extends further to the future. It also introduces a high degree of uncertainty because the model assumes the past patterns will continue indefinitely, which might not be the real case situation.

It is a fact that stock market is very sensitive and may be impact by any events. Another limitation thereby reveals: the research in this paper is constructed based on a counterfactual framework, and this modeling approach heavily relies on the exclusionary assumption – the paper assumes that the stock markets are not affected by significant events other than time trends, except for the policy shock discussed in the paper.

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