Predicting Apple stock prices based on ARIMA

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Abstract. The volatility of the global financial market under the influence of the epidemic is a hot issue of concern to the whole society. Most tech company stocks have been affected to varying degrees, including Apple. However, Apple's future stock price trend under the influence of the epidemic has not yet been studied. Whether Apple stock is still worth buying has become a concern for many. Therefore, this article collects data on Apple's stock price from the time it went public until 2022. After cleaning and analyzing the data, an ARIMA model is established to analyze and predict Apple's stock. This paper will explore the relationship between the global financial market downturn and Apple's stock price volatility under the impact of the epidemic based on model results and data. According to the model's prediction of Apple's stock price, Apple's stock price will continue to increase in the next six months after June 2022. This article obtains the forecast data, and then combines the analysis of the impact events that have significantly fluctuated the price of Apple's stock in the past. It was found that although Apple's stock price will be affected by the big environment, its strong and unique product power will help it maintain a long-term increase in stock prices. Apple stock still has a high purchase value.

Keywords: Autoregressive moving average model; time series; Apple stock; coronavirus pandemic.

1. Introduction

Apple has been a high-profile tech company since its inception. Steve Jobs, founder of Apple, whose legendary personal experience is almost the history of "Apple" [1]. Jobs is also destined to become an important player in the history of scientific and technological development. With the release of Apple's first generation of smartphones, the world entered a new era of portable technology development. As the mobile Internet has grown and matured, more and more mobile apps have been completely developed and used on its foundation. The mobile Internet platform represented by smartphones is the primary method by which the mobile Internet will be a reality. [2]. As an Internet carrier that is more portable than computers, smartphones have accelerated the development of science and technology.

When Apple's iPhone was released in January 2007, the response was overwhelming. In two months, the search term "iPhone" generated more than a million searches on Google. When the iPhone finally launched in June 2007, customers queued for days for a chance to buy one, and more than 500,000 were sold in the first weekend. Since then, millions of iphones have been sold, arguably one of the most successful mobile phone products ever launched [3].

This also means that although Apple has been listed since 1980, the stock price has not changed significantly. It wasn't until the emergence of the US Internet bubble in 2000 that Apple stock had its first fluctuation. The Internet bubble economy in the United States, which broke out from 1995 to 2000, once again struck the capitalist world and had a serious impact on the economic development of the United States [4]. But like other Internet companies like Microsoft at the time, the trend returned to square one after a year.

Apple's stock began to rally and really happened in 2005, when Apple introduced the first generation of Ipod nano. The changes and breakthroughs in mobility, aesthetics and functions caused by it are important mobile technologies for human beings from car audio and walkman [5]. This also laid the foundation for Apple to later become the pioneer of mobile intelligent information devices.

Beginning in 2005, Apple introduced the original iPod, which was large. Sales in a year were more than 1 million units, and the stock price was more than $20 at the time. In September 2005, the first generation of iPod nano was launched, with sales of more than 10 million units, and the stock price

soared. Later, the sales of the second and third-generation iPod nano increased significantly. The launch of the new iMac in 2006 was also quite successful, which pushed up the stock price. By 2007, the iPhone was launched. At first, the sales volume was not large, and the stock price did not seem to have much impact. Later, the second generation was quite successful, and the stock price soared.

While Apple's stock price has risen rapidly, it has also encountered events where the stock price has fallen. The 2007-2009 The subprime mortgage crisis in the United States quickly spread around the world, causing turmoil in international financial market and threatening stable economic growth [6]. The U.S. subprime mortgage crisis has thus affected the entire U.S. stock market.

In 2011, Apple announced on October 5 that the company's former CEO Steve Jobs died at the age of 56. Apple's website posted the message: "Apple has lost a visionary and creative genius, and the world has lost an incredible person [7]." In 2012, iPhone 5 sales were not as good as iPhone 4, and the market was worried about Apple's future development. In 2015, Apple's product design lagged behind and market competitiveness declined. Sales shrank significantly.

Overall, Apple's stock is generally on an upward trend and has strong momentum. Buffett sees Apple as the best company in the world, said in an interview that he doesn't see Apple as a stock, but Berkshire's "third-largest business." It is extremely uncommon for Buffett to judge a business in this way, but he is not just talking, already heavy position to buy [8].

In recent years, the coronavirus pandemic has had a huge impact on the financial system, with the stock market being one of the main sources of risk in financial markets [9]. The emergence of the epidemic has led to the spread of investor panic, and in March 2020, the US S&P 500 index experienced four plunges, which caused the market trading circuit breaker, which had a very serious impact on the world financial markets [10]. Apple stock was also affected. In this case, does Apple still have potential for growth. Whether Apple stock is still worth buying becomes a question.

The exploration of these questions is useful to explore the reasons behind Apple's stock trends and Apple's rapid growth. This study is based on the data analysis of Apple stock over the past two decades. Trying to predict Apple's stock price trends over the next six months. This study will build an ARIMA model to analyze trends in Apple's stock data. Make a data prediction after completing the test.

2. Method

2.1 Data Sources

Kaggle is a data modeling and data analysis competition platform. Companies and researchers can publish data on it, and statisticians and data mining experts can compete to produce the best models. We can get all stock price data on Kaagle from its listing in 1980 to June 2022. From this, we have specific data on the price of Apple's shares.

2.2 Variables

When it comes to Apple stock data, we have a number of variables to choose from. For example, the data we collect has various indicators, such as the opening price. Closing. Highest price. Lowest price. Volume. Since the ARIMA model we use is a type of time series analysis, we first select the time variable in dates. Second, we take the daily closing price as Apple stock price data for analysis. The reason why the closing price is used is because the closing price is the equilibrium price reached by many parties after a day, which is more representative than the opening price, high price, and low price. The closing price reflects the final price in a certain period of time and reflects the wishes of people during that period. Relative to the highest, the lowest price is more reasonable. Also, even if you use the average price, that's for a time period. In practice, it is not possible to calculate the average price per hour and lesson. That closing price is the best representative. And the closing price is the last price of the day's trading, which can reflect the stock price trend on the time scale. It is generally believed that the closing price is the result of the day's game. At this point, we can clean the Apple stock data from Kaagle to get the two variables we need: the time, date and closing price.

2.3 Method

In this paper, the ARIMA model is selected in the analysis and model building process. ARIMA model, or differential integrated moving average autoregressive model, also known as integrated moving average autoregressive model, is one of the time series predictive analysis methods. The model is very convenient, requiring only endogenous variables instead of other exogenous variables. And time series forecasting belongs to the category of quantitative forecasting, where statistical principles and concepts are applied to the given historical data of variables to predict future values of the same variable. This type of model is generally suitable for stock price prediction, which is in line with the needs of this article for Apple's stock price prediction analysis. So far, we first obtained the time series of Apple's stock data through data sources and variable selection. Then the time series preprocessing is carried out, which includes two aspects of testing, stationarity test and white noise test. After completing these pre-processing, this paper can preliminarily obtain an ARIMA model for Apple's stock price prediction after model recognition, model grading and other steps. The last and most important step is to verify the resulting model, which is mainly to verify the fitting effect of the model. If the fitting effect is good, the model is successfully established.

3. Results and Discussion

Before modeling began, we collected nearly 20 years of stock price data from Kaggle about Apple. This article uses the ARIMA model to study and model the data. ARIMA model is a synthesis of autoregressive model, moving average model and difference model, also known as integrated moving average autoregressive model, is one of the methods of time series predictive analysis, the symbol is ARIMA(p,d,q). When the stationarity of the original data series is poor, it needs to be treated differently to make the original data more stable, where d represents the differential order.

The model was built with the assistance of SPSS's expert modelers, and after a comprehensive comparison, we chose to use the ARIMA (0,1,0) model to analyze and predict stock data. First, this article collects Apple's stock price data from Kaggle's official website and cleans the data with Python. Pick out the closing prices of stocks from 2012 to 2022 and plot the first-order difference over the past decade using SPSS software. As shown in the following figure 1.

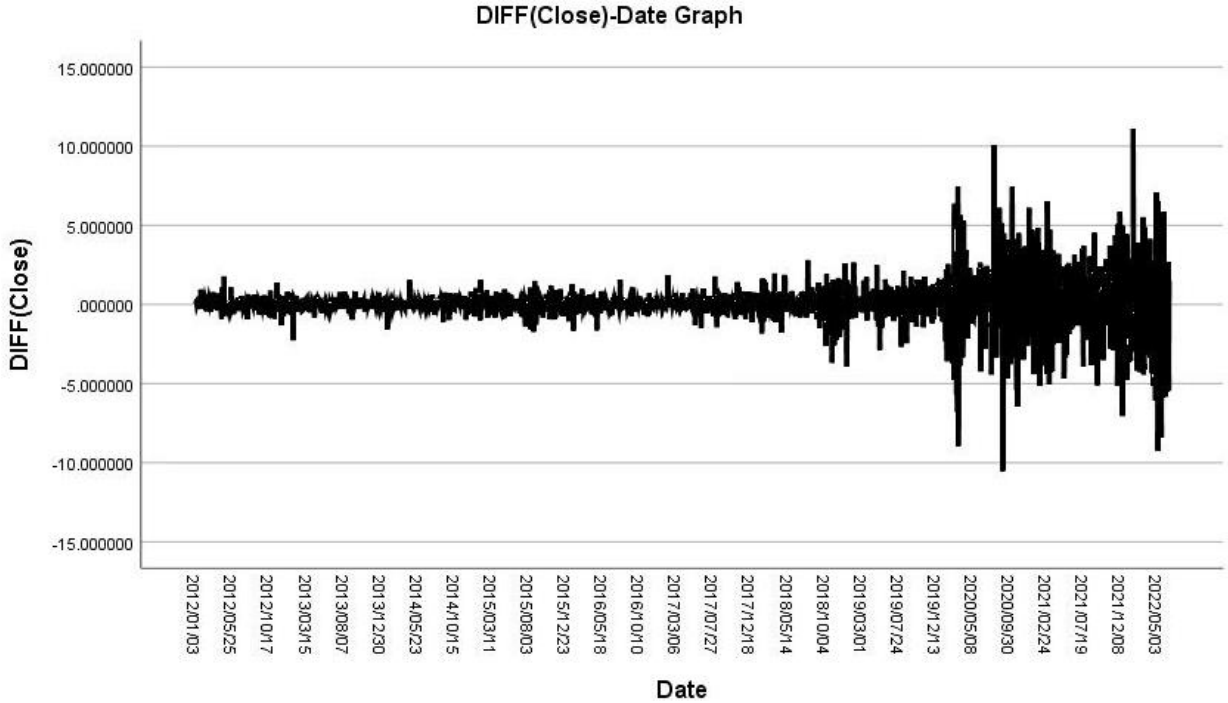

Figure 1. First-order difference plot

Since these variations and errors were found to be reasonable, this article continues to use the ARIMA model. The data from January 3, 2012 to January 2, 2020 were used as the training set. Taking the stock close value from January 2, 2020 to June 17, 2022 as the test set, by building an ARIMA (0,1,0) model. Compare the predicted result values with the test set data to draw a line chart, and the result plot is as follows in figure 2:

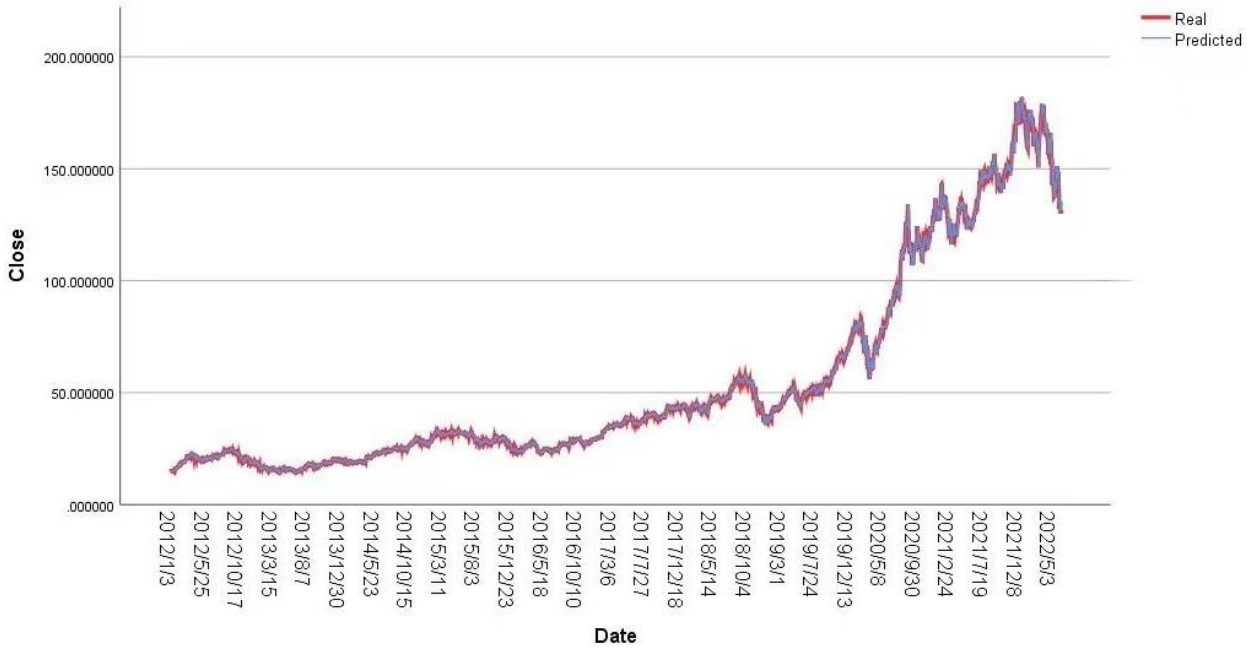

Figure 2. Interval plot of predicted values

At this point, we can initially find that the data change trend of the training set and the test set are similar. To make the comparison more intuitive and clearer, we calculate the average value by combining the upper and lower bounds of the predicted value interval. The average data is then used to build a line chart for comparison.

As shown in the following figure 3:

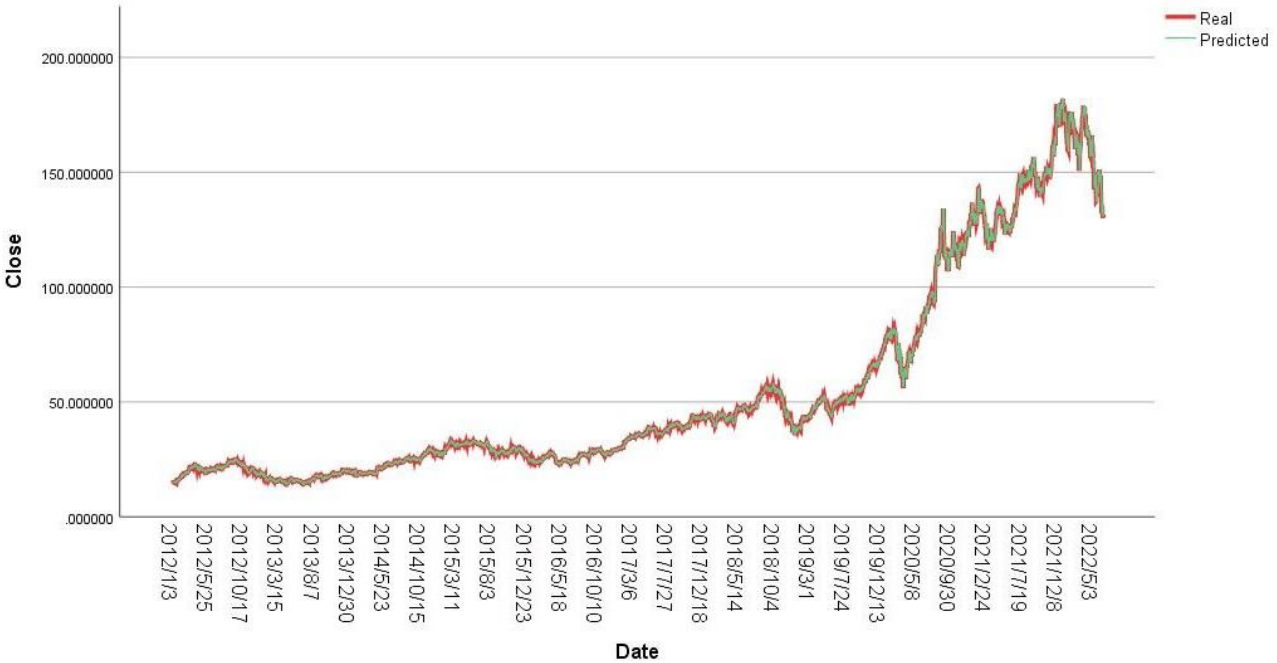

Figure 3. Comparison of predicted and actual values over a ten-year period

The red line represents the true value in the test set, and the green line represents the predicted value in the training set. Now, we can clearly see that the curves of change between the predicted and actual values are very similar.

For the sake of rigor, we also plotted the curves of the predicted and actual values over the past two years. Time and data are accurate to the month, and line charts from January 2020 to June 2022 are drawn for comparison in figure 4.

Figure 4. Comparison of predicted and actual values over a two-year period

We can see from the graph that although there are some differences between the predicted value and the actual value data, the overall change is still similar. After finding that the effect is good, solve the ARIMA (0,1,0) model to predict the value of Apple's stock in the next six months, and the results are as follows in figure 5:

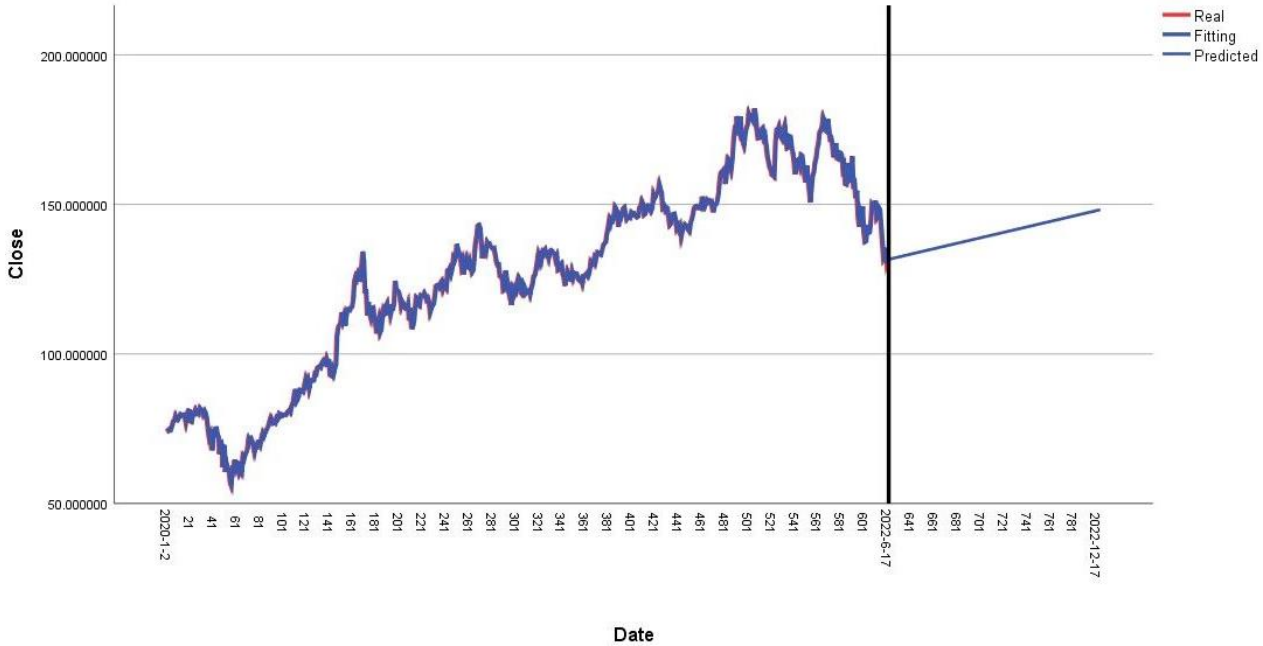

Figure 5. Future stock price forecast chart

The premise of using the ARIMA model for data analysis and prediction and ignoring some errors. By observing the image plotted by the predicted value, we can find that after June 2022, Apple's stock will have a relatively obvious price increase trend in the next six months.

Why is Apple's stock still rising? Today, after experiencing the first global ravages of COVID-19 in 2020. The global economy has slowed down or regressed to varying degrees, and the purchasing power of consumer groups has declined. Apple's stock price also fell. But after several years have passed, several generations of Apple products have changed. Apple's stock price is still on an overall upward trend. This situation is due to Apple's unique brand advantages and technical level.

One of the most important is Apple's independent development and design production capabilities. Apple, with its complete product manufacturing chain, strong user stickiness, comprehensive Apple's Eco-system, independent and excellent A series chips and M series CPUs, forms a moat of APPL stock value. Therefore, by observing Apple's stock data, this article finds that Apple's stock has not grown rapidly since its listing in 1980. But after the advent of its first portable electronic device, the Ipod, Apple's stock and market value began to rise wildly. The new era of portable electronic devices pioneered by Apple laid the foundation for it to become a tech giant.

In addition to technological strength and business sense ahead of the times, Apple's marketing strategy is also an important reason for its rapid development. The first is to cater to consumers and grasp the requirements of consumers for products. The second is the advertising of new items, which fosters a feeling of mystery, fills consumers with anticipation, and raises their brand recognition. It has succeeded in playing the dual role of brand and new product marketing. There is also penetration into related industries, Apple is also improving its product structure while launching different products, forming a variety of electronic products. Lastly, Apple's product pricing and distributors are also important. Apple's retail and online stores are distinctive in that they play a more supportive and educating function than a sales role. Among them, Apple has always adhered to the classic design. Such as Apple's shape design, especially the shape of the iPhone has become a classic. Apple uses its unique innovative ideas to create a unique and superior brand image and value proposition. Many brand loyalists and fans still choose to buy due to the impulse to try new things and the high demand for grade and taste.

Apple's restrictions on other developers and industry monopolistic behavior have also made it irreplaceable in today's electronic device market. Examine Apple's monopolistic actions in light of the App Store supply chain management. Apple has limited the interests of other developers. However, this action has allowed other software vendors to board the shuttle bus after Apple, rather than upending the industry food chain. The reason is simple, the App Store provides them with an efficient, popular platform that is also very profitable. The industry for mobile phone software has grown quickly and steadily as a result of relevant practitioners' high level of passion for software creation and increased investment in technology. This also once again improves user stickiness, and Apple has a better software experience than other brands.

In general, the above reasons allow Apple to maintain an absolutely strong competitiveness in the highly competitive mobile phone field and electronics market. Apple still has extremely strong vitality and development potential, and Apple's stock will also maintain an upward trend for a long time.

4. Conclusion

This article finds that Apple's stock price is on an upward trend in the next six months after June 2022. It shows that after a period of price fluctuations, Apple's stock will still show an overall upward trend. Therefore, Apple stock is a stock with vitality and growth potential. It is recommended that people who are interested in buying stocks can consider buying Apple shares under their own economic conditions, and hold them for a long time and wait for Apple shares to appreciate. For the high value preservation characteristics of Apple stocks, some researchers believe that this is the impact of Apple as the world's top technology company. These include Apple's history in smart

electronics, such as leading-edge smartphones and powerful chip designs. Apple's uniqueness makes its user audience extremely sticky, which guarantees Apple's new product sales and revenue every quarter. Therefore, Apple's steady development has led to a steady rise in its stock price. This article explores the future price trends of Apple shares to help people understand and discover the value of Apple shares. It is beneficial to shareholders and provides data and samples for studying Apple's development. The current study still has deficiencies in data accuracy and model construction data error. Data processing should be treated in greater detail in future studies. It is hoped that more company stock model analysis and prediction research will be carried out through a large number of samples to rationally analyze the global financial market. This is a way to avoid financial disasters or seize development opportunities.

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