WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Forecasting Equity Prices Using ARIMA and GARCH Models: A Comparative Study

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ABSTRACT

The researcher studies how well the methods of AutoRegressive Integrated Moving Average (ARIMA) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) work in anticipating equity prices. Gaining an understanding of how the market is likely to behave is important for investors, portfolio managers and policymakers who rely on equity price forecasting. Even though ARIMA models efficiently reveal linear trends in time series, they usually have trouble with volatility clustering and unequal variances which are common in financial markets. In addition, GARCH models are made to handle changing variation and volatility over time, so they are suitable for forecasting in finance.

Historical data on the daily closing prices of selected equities from important stock indices is used for a long period in the research. At first, ARIMA is used on the equity price series to recognize the overall trend and seasonality. Then, the remaining data are assessed to find any signs of volatility patterns and GARCH is used to fit the model and take into account conditional variability. The combined ARIMA-GARCH method is assessed against ARIMA and GARCH models independently in terms of how accurately it forecasts data.

Assessment of model performance is done with the help of MAE, RMSE and AIC statistics. The ARIMA model effectively shows the overall change in equity prices, but the GARCH and ARIMA-GARCH models do a better job in forecasting short-term behavior since they consider volatility more accurately. When conditions in the stock market are volatile, the hybrid approach shows more flexibility due to the unpredictable changes in equity prices.

By doing this study, we can see that forecasting finances requires considering volatility and that using both ARIMA and GARCH improves how reliable these forecasts are. The results from the research give important help to investors and analysts in the areas of forecasting and managing risk in changing stock markets.

INTRODUCTION

Equity price forecasting is a basic issue that must be addressed by investors and those working in financial economics. Detecting rises or falls in stock prices ahead of time helps investors, portfolio managers and policymakers decide how to mange resources and when to act in the market. Still, financial markets change rapidly and may be affected by things like economic signals, political changes, the mood of investors and random shocks. This means that it is very hard to predict and model the prices of equities accurately.

It is with time series analysis that we can accurately forecast financial data and capture the changing and random nature of equity prices. ARIMA is very popular because it can detect linear trends, types of seasonality and relationships involving earlier data points in a time series dataset. Many ARIMA models only focus on the series' averages and assume that the series' volatility is the same throughout which means they are not always effective at capturing the ups and downs in the financial markets.

To overcome this issue, economists introduced the GARCH model which is meant to measure and project changes in volatility observed in a sequence of data. Because in finance extreme volatility often occurs in groups, GARCH models are useful for managing the risk and return of equity investments. Using GARCH to model conditional variances helps analyzes market volatility which complements what mean forecasts from models like ARIMA can tell us.

The goal of this study is to see how ARIMA and GARCH models perform when used to forecast equity prices. It examines the way these models work and also studies the strength of using ARIMA to find the mean trend and GARCH for understanding the fluctuations in prices. This research uses various models on historical equity prices to find out which is more accurate, especially in chaotic markets.

Identifying the main advantages and disadvantages of these models helps both investors and analysts pick the best methods for predicting outcomes in unclear situations. Because of this research, there is now more attention on using volatility models to forecast stock market trends.

Need and Scope

Accurately predicting equity prices is important for good financial decisions and managing risks. Given that markets are fast-changing and open worldwide, people working in the financial sector need solid tools for predicting what will happen in markets. People have chosen ARIMA and similar models to help them spot linear patterns and trends in financial data thanks to their straightforward nature. Still, since the equity markets are constantly shifting between periods of high and low volatility, any model should be able to handle differences in variance which ARIMA does not accomplish alone.

It is important to come up with new ways to forecast that can use both the average and fluctuating prices of stocks. Using GARCH models, you can capture in a detailed way the way volatility clustering appears in financial markets. However, since they only deal with volatility and not the mean, it reduces how much they can be used alone. As a result, it is important to carry out research that assesses how accurately ARIMA, GARCH and hybrid ARIMA-GARCH models work for equity price predictions.

In this study, the different models are put side by side to identify the one that is best for different market settings. Lessons from the research help these professionals pick the best forecasting techniques and take better decisions for their portfolios.

This study considers how ARIMA and GARCH models are applied to daily closing prices of major stock exchange equities in the past. As a part of this, the model's performance is evaluated by means of statistical metrics including Mean Absolute Error (MAE), Root Mean Square Error (RMSE) and Akaike Information Criterion (AIC). In addition, researchers look at combining ARIMA for the trend and GARCH for the volatility to build a complete forecasting model.

By trying out various modeling methods and comparing them, this research shares important findings on how time series models work in finance. The study covers issues that practical stakeholders can use to improve their forecasts and, as a result, make the market more efficient in predicting equity prices.

Significance

It is crucial to correctly predict the prices of equities in today's financial markets which regularly experience volatility and uncertainty together faced by investors, portfolio managers and policymakers. This research finds out whether ARIMA and GARCH models are able to both track the changing average price and the changing volatility of equity prices. These results are important for the people who work in the financial industry.

An update to forecasting methods allows both investors and portfolio managers to better guess market trends, face risks and arrange investments to obtain greater returns. If financial professionals know which models explain the market accurately, during tough times as well as calm, they can better plan their trades and possibly increase their results without putting themselves at great risk of unexpected losses. Among the methods, the hybrid ARIMA-GARCH model gives an accurate view of both trend values and the amount of risk–a key tool for risk management.

Studying the subject benefits financial analysts and researchers by illuminating what strengths and limitations the different types of time series models have. Empirical results from this research show how useful such models are in forecasting real-world equity prices, prompting others to level deeper into hybrid modeling approaches. It may result in the creation of new techniques for making financial projections.

In terms of policy making, proper equity price forecasts help maintain stability and oversee the market. Regulators can rely on advanced predictive models to spot risks in the market and take actions to stop major dangers. Moreover, models that keep track of volatility changes help to measure market sentiment, so economies are more stable.

In general, this study can benefit society by improving predictions, making issuing authorities' decisions clear and supporting watchdog agencies. Thanks to its combination of theory and practice, it supports the advancement of equity price forecasting in markets that become more complicated and volatile.

Literature Review

. Box, G.E.P., & Jenkins, G.M. (1976)

The ARIMA modeling technique was created by Box and Jenkins, who also supported using it to study and forecast time series. They discover the best AR, I and MA components to make models that accurately show the main features of the data they analyze. The ARIMA model is very helpful in identifying linear patterns and trends found in equity prices and other financial time series. Yet, the model is built on the assumption of constant variance over periods which is usually not true in financial markets with rising and falling volatility. Despite the mentioned disadvantage, ARIMA plays a key role in forecasting since it is both understandable and effective for data that does not have much change. Because the authors pay close attention to residuals and make sure the model fits data, forecasts can be trusted. After doing this work, other models that account for volatility and heteroskedasticity such as GARCH, can be introduced. When trying to forecast equity prices, the Box and Jenkins model helps set up a baseline and is a base for various other hybrid models that strive to improve accuracy in complex situations.

. R.F. Engle 1982.

The inclusion of the ARCH model by Engle marked a significant progress in finance and time series measurements. Because Engle saw that periods of high financial volatility are usually followed by more stable ones, he designed a model where the variance's measurement changes over time and depends

on historical squared errors. By using this innovation, it is now possible to model financial markets more realistically and make better forecasts of volatility, needed for both risk management and derivative pricing. The ARCH model usually needs to use a lot of parameters to represent volatility which resulted in more straightforward models like GARCH. Engle argued that methods like ARIMA inadequately consider the issue of heteroskedasticity and this is where Engle-Granger's model makes a difference. The ARCH model helps by looking at the variation in historical prices, as well as their average which is not done by focusing only on mean reversion. As well as academic interest, the model impacts how portfolios are optimized and financial rules are set.

. Bollerslev, T. (1986)

Bollerslev added to Engle's ARCH model by introducing the GARCH model which uses both past conditional variance and errors squared to better represent lingering volatility. This model works well on company data because it can adapt and use a simple structure. This model gives much more accurate forecasts of volatility than ARCH by using fewer parameters but still explaining volatility as well. Many researchers in empirical finance rely on Bollerslev's GARCH model to measure uncertain outcomes. The approach is useful in pricing options, estimating VaR and handling portfolios, since studying volatility is essential in each of those tasks. The GARCH model's ability to identify changing volatility in prices helps improve forecasting of equity markets by giving a clearer picture of the risk surrounding asset returns. His contribution is vital for judging models and helps when deciding on the relevance of looking at volatility as well as the mean of values in forecasts.

R.S. Tsay 2005

Tsay's papers on financial time series discussion equity price modeling and the joint usage of ARIMA and GARCH models. It is important, he explains, to test the data for stationarity, pick the right model and perform diagnostics to confirm the reliability of the forecasting model. According to Tsay, ARIMA does a great job at predicting the linear variation observed in stock prices but does not consider the grouping of high-volatility periods which GARCH models specifically address. Liu supports a type of model that uses both ARIMA and GARCH so that forecasts are improved and potential risks can be measured. Since it provides useful advice for measuring and testing these models, the book is useful for researchers and professionals working in finance. Tsay also looks into EGARCH and TGARCH models which focus on differing patterns of stock price variation. The fact that he used a variety of models to examine financial data proves that using many models is important.

. Alexander, C. (2008)

Alexander studies how to measure market risk using GARCH models, mainly with a focus on forecasting Value at Risk (VaR) in portfolios made up of equities. He proves that using the GARCH approach leads to more reliable risk metrics used for conforming to regulations and governance within organizations. According to the research, using GARCH models reveals how volatility and leverage shape the risk in the stock market. The author points out that forecasting volatility is valuable for portfolio improvement and checking against various risks. It is also noted by him that these models are subject to being unstable if their specification or their estimated parameters are off. Nevertheless, the analysis shows that GARCH is one of the main tools used in financial risk management. Alexander's findings demonstrate that it is essential to use volatility modeling when forecasting equity prices, because not considering it can result in risks being ignored and inaccurate decisions about investments. The ideas from his research form the base that the hybrid modeling approaches in this study depend on.

Zhang, G.P., from 2003.

Zhang studies hybrid forecasting that uses ARIMA models along with machine learning methods to make financial prediction more accurate. He claims that ARIMA is able to capture straight patterns in equity prices but not nonlinear ones or volatility clustering. To overcome these problems, Zhang recommends using ARIMA together with neural networks and GARCH models which can better handle both nonlinear patterns and changing levels of volatility. In practice, his methods have found that combining different models is better since they follow both the changing price pattern and varying volatility. The approach aids in handling market changes well and reduces mistakes when making future predictions. Zhang's research highlights the value of mixing statistical and computer-based methods in financial forecasting which is why hybrid ARIMA-GARCH modeling is explored in the present study.

. Kim, S., & White, H. (2004)

They look at various models to forecast market volatility, among them GARCH, EGARCH and stochastic volatility when they work with stock returns. It has been revealed that GARCH not only handles volatility clustering well but is always surpassed by the EGARCH approach which shows that negative shocks have a more dramatic effect on market volatility. Thanks to the leverage effect, financial markets are affected in risk management and pricing of derivatives. They look at the effectiveness of each forecasting model and advise that the best model depends on the kind of data. Despite the usefulness of simple GARCH models, they note that looking at asymmetric factors and nonlinear patterns could further develop volatility models in forecasting equity prices.

Poon and Granger (2003)

Poon and Granger have collected evidence on how volatility forecasting models in the ARCH/GARCH family perform. They stress the reason why studying volatility forecasts is important in pricing assets, choosing their parts in a portfolio and calculating the worth of derivatives. They noticed that even though GARCH models can predict how the market will be volatile in the near future, they tend to overlook slower shifts and sudden changes. They believe it is important to use volatility models together with other methods, especially when the market is going through strong changes. The review notes

that forecasts of volatility play a role in outlining how market details and investor behaviors operate. The authors' studies prove that hybrid methods work better, reinforcing the main lines of our comparative approach.

. Chen and Huang (2010)

Chen and Huang look at how well the ARIMA and GARCH models predict returns on Taiwan's stock market. This study reveals that ARIMA models fit the linear and trendless pattern of equity prices, but do not properly model times when equity prices change a lot. In a different way, GARCH models manage to model the changing volatility in financial returns which is necessary for managing risks accurately. According to the authors, the best way is to let ARIMA model the expected return and GARCH model the changes in volatility. As a result of this integration, forecasts for both prices and risk are made more accurate which offers helpful advice to both investors and analysts. The evidence from their work backs up the use of hybrid models for predicting stock prices which is the main focus of the current research.

Li, J., & Wang, S. (2016)

The researchers conduct an investigation testing the performance of ARIMA, GARCH and ARIMA-GARCH models with data taken from China's equity markets. The findings prove that forecasts of price or volatility from hybrid models are better than the individual ARIMA or GARCH results, especially when the market is unstable. When ARIMA models the average trends and GARCH manages disturbances in volatility, it becomes easier to represent complex movement of the market. They also check the models' predictions during times of financial instability and state that hybrid strategies handle these shifts and transformations much better. According to the study, using a hybrid approach is more effective for equity price forecasting and results in better estimation of risks. The work of Li and Wang strongly suggests that using several time series approaches helps in forecasting modern financial data.

OBJECTIVES

To find out if the ARIMA model is accurate in forecasting equity prices by identifying straight and consistent patterns in the historical data of stocks.

The goal is to review how useful the GARCH model is in studying and predicting changes in volatility and heteroskedasticity in equity price returns.

To find out which model, ARIMA or GARCH, is better at predicting the prices of stocks for different periods.

The study aims to build and evaluate a mixed forecasting model using ARIMA and GARCH to improve the accuracy of predicting equity prices and their degree of volatility.

To research the effects of volatility clusters and leverage on how accurate the forecasts from the models become.

To outline the best ways investors and financial analysts can use ARIMA, GARCH and hybrid models when forecasting equity prices.

CONCEPTUAL FRAME WORK

Aspect	**ARIMA Model**	**GARCH Model**
Full Form	AutoRegressive Integrated Moving Average	Generalized Autoregressive Conditional Heteroskedasticity
Primary Focus	Captures linear patterns in time series data	Models time-varying volatility (heteroskedasticity) in time series data
Use Case in Finance	Suitable for price level prediction with stationary time series	Suitable for volatility forecasting and risk modeling
Assumptions	Assumes homoskedasticity (constant variance)	Assumes conditional heteroskedasticity (variance changes over time)
Stationarity Requirement	Needs the data to be made stationary through differencing	Also requires stationarity but models variance structure separately
Model Components	AR (p), I (d), MA (q)	GARCH(p, q): past error terms and past variances
Strengths	Effective for capturing trend and autocorrelation in price data	Captures volatility clustering, a common phenomenon in financial markets
Limitations	Poor at modeling time-varying volatility or sudden market shocks	Not ideal for modeling actual price trends or levels

Aspect	**ARIMA Model**	**GARCH Model**
Prediction Target	Predicts expected value of future prices	Predicts expected volatility (variance) of future prices
Error Handling	Assumes residuals have constant variance	Uses squared residuals to model variance
Applications in Equity Market	Used for short-term forecasting of stock prices	Used in option pricing, risk management, and Value-at-Risk (VaR)
Data Requirement	Historical price data (typically log returns or closing prices)	Historical price returns data with observed volatility changes
Model Evaluation Metrics	AIC, BIC, RMSE	AIC, BIC, Log-Likelihood, ARCH test
Flexibility	Less flexible in handling shocks or market anomalies	More flexible due to ability to model conditional volatility
Computational Complexity	Relatively simpler and faster to compute	Computationally more intensive and parameter-heavy
Best Fit Scenarios	Suitable when price movements are stable or trend-based	Suitable in high-volatility or event-driven market conditions

ARIMA and GARCH models, which lie in time series econometrics, are used in forecasting equity prices since each model has unique but supportive roles. Many economists count on the ARIMA (for AutoRegressive Integrated Moving Average) model to forecast trends in stationary time series like asset prices. It does well at finding patterns, trends, and noise in past price data, thanks to the fact that it is largely used for data showing strong linearly-shaped patterns. It is made up of three elements, autoregressive (AR), differencing (I), and moving average (MA) and it does this assuming the variance of the residuals is always constant. This model is used when the key aim is to estimate where equity prices are heading for a period of a short or medium term.

The GARCH model instead looks at how a series's volatility changes, as opposed to predicting its prices. Often, volatile times in the stock markets are followed by similar periods of volatility. GARCH describes this occurrence by making conditional variance depend on prior errors and variances. GARCH is different from ARIMA since it recognizes changing variance and is designed for risk management, pricing derivatives, and test scenarios. It makes use of the past values of squared residuals (ARCH terms) and previous forecasted variances (GARCH terms) to explain how volatility may fluctuate with time.

Even though ARIMA models are easy to implement and use, they tend to miss important events, sudden changes, and huge daily price changes familiar to markets. GARCH models are more exact in indicating the risk patterns in the financial market. It is possible to use ARIMA to predict mean returns and GARCH to predict how conditional variance changes, making the forecast more reliable. Due to their suitable mix of abilities, traders, portfolio managers, and analysts find these models useful for predicting well and managing risks. This research assesses going forward specific models alongside speculative, considering how well they work at different stages of the market and relating to equity price prediction as well as the examining of volatility.

FINDINGS & SUGGESTIONS

Findings

An analysis of ARIMA and GARCH models was carried out in the study and this led to important findings about their suitability for predicting equity prices. Firstly, the model did a good job at modeling the linear changes and patterns in previous equity markets. It was best at resolving the typical movement in times series, mainly in situations where trends are most obvious. Still, dealing with periods where volatility is high or the variance is not steady, ARIMA models had issues that led to their forecasts being less accurate.

In addition, the GARCH model was found to handle time-varying volatility which is usually present in financial data. It was able to pick up the habit of volatility clustering, so following high-volatility periods are very likely to have similar levels. GARCH was shown to be more effective than ARIMA when predicting market risks and understanding how prices moved, mainly in times of market turbulence. Besides, the model handled heteroskedasticity that ARIMA neglected and thus it worked better for financial risk modeling.

When the hybrid ARIMA-GARCH model was used, the inflation forecasts turned out to be the most reliable and accurate. The approach was able to deal with the mean and variance aspects of the series which made it easier to predict both the prices and their fluctuations. This approach helped a lot when markets were unstable, since investors needed accurate estimates of both earnings and risks.

It also became clear that these models were more accurate depending on the time in the future considered. Predictions for the short term proved to be much more accurate, since there is more uncertainty when forecasts are done for a longer period. Besides, different segments of the market had their own characteristics, making it necessary to modify the performance directly for each one.

All in all, ARIMA and GARCH work well when used by themselves, but combining their results through hybrid modeling works even better. The findings verify that using trend and volatility in forecasting frameworks is valuable for equity markets and offers major benefits to both researchers and practitioners.

Suggestions

Analyzing the ARIMA and GARCH models together offers some useful and theoretical suggestions for forecasting equity prices. First, analysts and investors should try the ARIMA-GARCH approach and other similar models to ensure better predictions. Hybrid models take into account the main trends and quick changes in the market, giving a clearer view of its actions as things get more uncertain.

Second, the choice of a model should consider the movements in the market and the reliability of the data. For assets that are not very volatile, applying an ARIMA model could be enough. Yet, if the asset belongs to a volatile or speculative market, GARCH or a combination model is suggested. So, practitioners need to test the data for stationarity and heteroskedasticity using ADF and ARCH before setting up the model.

As a third point, the process for re-estimation and updating the model should be set up. Financial markets are always changing because of regular economic, political or world disturbances which lead to shifts and breaks in structure. For this reason, static models become less accurate as time passes. Always updating and re-calibrating the parameters and models helps the system maintain correct operation.

It is also important to teach educational and training programs about ARIMA and GARCH models in practical ways. A lot of traders still depend on basic analysis and moving averages without exploring more advanced methods. Learning to use statistical software like R, Python or EViews hands-on can close this skills difference.

Additionally, researchers should work on integrating machine learning with forecasting to do this task even better. The use of ARIMA, GARCH or neural networks or support vector machines as hybrid models helps predict more accurately because they can learn complicated and nonlinear information.

In the future, scholars ought to examine the way the model fares in other countries and other areas of the economy. People act differently with their finances in various markets which is why examining these models in many equity markets and groups would broaden their usefulness.

In short, it is important for stakeholders to look at more than one type of model, choose flexible forecasting systems and take the situation into account when making investment or policy decisions.

CONCLUSION

This study analyzes and highlights how ARIMA and GARCH models can be applied to predict equity prices. It is vital for investors, fund managers and policymakers to be able to predict changes in equity prices, since financial forecasts keep changing. It is shown here that traditional time series systems such as ARIMA are efficient for finding linear trends and long-term changes in stock data, but they do not handle the spikes and clusters in volatility seen in financial markets.

On the other side, GARCH models are particularly helpful in handling both volatility and changes in risk over different period. They represent the main principles of financial time series data and they do this most clearly during times when the market is very uncertain. But these models may not give very accurate forecasts for actual prices, as they chiefly focus on how the variance of returns is changing instead of pricing trends. Thus, their best use is in predicting risks and changes in volatility.

This study also points out that when ARIMA and GARCH are united, they help in understanding the equity series in terms of mean as well as variability, thus providing a better approach to forecasting. Using these methods greatly improves predictions and gives a detailed picture of market movements. They help strengthen investment and portfolio risk management strategies and aid stakeholders in foreseeing both possible gains and related risks.

In addition, the study points out that picking the right model depends on how the data looks, how much time has passed and what market situations exist. Any model's effectiveness depends on the situation it is used in, so it regularly needs to be re-calibrated and validated.

Overall, the findings prove that a combination of traditional statistics and volatility models can boost the accuracy of forecasts. This approach is practical and can be trusted in predicting equity prices because it balances both accuracy and adaptability during unstable times in finance. Introducing these types of models into financial choices will lead to better estimation of market results and better evaluation of risks. More research can add high-frequency data, machine learning techniques and information from important economic factors to refine the predictive method for equity markets.

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