Proceedings of the Multidisciplinary Research Community
MultiVerse 2024

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: **404 - 409**

Implementation of ARIMA Method in Short-Term Prediction Accuracy of Basic Needs Prices in Cirebon City

Nabila Izati Nisa
Universitas Catur Insan Cendekia, Indonesia
Email: nabilaizatinisa@journals.ai-mrc.com

Abstract

The increasing demand for staple goods each year leads to changes in their prices, necessitating predictions related to staple prices to anticipate price hikes, maintain price stability, and prevent commodity shortages. The Autoregressive Integrated Moving Average (ARIMA) method is one of the prediction methods that can be used, but further testing is needed to prove the accuracy of the prediction results produced by the ARIMA method itself. The research focuses on essential food needs in the household sector, including rice, granulated sugar, cooking oil, wheat flour, beef, chicken, eggs, red chili, shallots, and garlic. ARIMA testing is conducted to evaluate the accuracy of short-term price predictions for three months, using price data of staple goods from Cirebon City from 2021 to 2023 and comparing it with 2024 data obtained from the Department of Cooperatives, Small and Medium Enterprises, Trade, and Industry (DKUKMPP) of Cirebon City. Data processing is carried out using Minitab software through four ARIMA stages: model identification, parameter estimation, model diagnostics, and forecasting. The study results in seven high-accuracy ARIMA models, with a Mean Absolute Percentage Error (MAPE) value of <10%, categorizing them as "Very Good." Price predictions for staple goods from January 2024 to March 2024 show an accuracy level of 98.864%. The accuracy of the predictions is influenced by the conditions of each commodity in the market, such as extreme weather, rising feed prices, global market prices, and other factors affecting production, leading to limited commodity stocks in the market and affecting actual price increases.

Keywords: ARIMA, Basic Commodity Price Prediction, Cirebon City, Prediction Accuracy, MAPE

INTRODUCTION

The increasing demand for essential household commodities has emerged as a significant economic challenge, resulting in fluctuations in their market prices (Granger, 1991). Such variations can have profound impacts on both consumers and producers, making it imperative to anticipate price changes effectively (Kantanantha, Serban, & Griffin, 2010). Accurate forecasting of price trends plays a vital role in maintaining market equilibrium, preventing commodity shortages, and mitigating inflationary pressures that can arise from unpredictable market conditions. By understanding future price movements, policymakers and stakeholders can implement timely interventions to stabilize the market.

Among various forecasting techniques, the Autoregressive Integrated Moving Average (ARIMA) model is recognized as a powerful method for time-series forecasting (Karaboga, 2005). Its capacity to handle complex patterns in sequential data has made it one of the most popular models for predicting future values based on historical data. Despite its broad application in economic forecasting, there is still a need to evaluate its effectiveness in predicting short-term price trends, particularly for staple commodities in local markets where demand and supply can fluctuate rapidly.

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 404 - 409

This research addresses this gap by focusing on the local market of Cirebon City, Indonesia, as a case study. It seeks to assess the performance and accuracy of the ARIMA model in predicting the prices of essential household commodities. The study specifically examines commodities that are fundamental to daily consumption, such as rice, sugar, cooking oil, wheat flour, beef, chicken, eggs, red chili, shallots, and garlic. These items are selected due to their significant role in household expenditure and their sensitivity to market dynamics.

The methodology involves analyzing historical price data of these commodities, which is used to build and test the ARIMA model for short-term forecasting. Given the volatile nature of commodity prices, the research aims to evaluate how well the ARIMA model can capture and predict short-term price fluctuations. The accuracy of these predictions is of great importance, as it could provide valuable insights for local traders, policymakers, and consumers in planning and decision-making.

By focusing on the local market context of Cirebon City, the study aims to provide insights into how global economic principles can be applied to smaller, localized markets. It examines how external factors such as seasonal variations, supply chain disruptions, and changing consumer preferences can influence the accuracy of ARIMA-based price forecasts. The results of this research could help to determine whether the ARIMA model is a reliable tool for predicting short-term price movements in essential household commodities and whether it can effectively guide market stability measures in similar contexts.

Overall, this study contributes to the growing body of literature on time-series forecasting by validating the application of the ARIMA model in a local market setting. By identifying the model's strengths and limitations in predicting the prices of key household commodities, the research aims to enhance understanding of its practical application in economic forecasting, ultimately leading to more effective market regulation and consumer protection.

METHODS

Data Collection

This research collected price data on essential commodities in Cirebon City over a span of three years, specifically from 2021 to 2023 (Zhao, 2021). The dataset was obtained from a reputable local source, the Department of Cooperatives, Small and Medium Enterprises, Trade, and Industry (DKUKMPP) of Cirebon City. The study focused on key food commodities that are widely consumed by households, aiming to provide findings that are representative and relevant to local consumption trends. The selection of such essential commodities was intended to ensure that the results of the study could be generalizable to the broader market dynamics and daily household consumption patterns in Cirebon City.

ARIMA Model Testing

To conduct short-term price forecasting for these commodities, the research employed the Autoregressive Integrated Moving Average (ARIMA) model. The forecasting was aimed at predicting the price trends over a three-month period, from January 2024 to March 2024. Data processing and analysis were performed using Minitab software, which facilitated the execution of the ARIMA modeling process. This process consisted of four distinct stages: (1) **Model Identification, which involved determining the appropriate ARIMA parameters (p, d, q) for each commodity's time series; (2) Parameter Estimation, where the coefficients of the ARIMA model were estimated to fit the data accurately; (3) Model Diagnostics, focusing on evaluating the suitability and performance of the model by examining residuals for any anomalies or patterns; and

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 404 - 409

(4) Forecasting, which entailed generating predictions based on the finalized model and subsequently assessing their accuracy.

Accuracy Measurement

The accuracy of the ARIMA model's forecasts was assessed using the Mean Absolute Percentage Error (MAPE) as a metric. Forecasts with MAPE values of less than 10% were categorized as having "Very Good" accuracy. This benchmark indicates a high level of predictive precision, thus validating the ARIMA model's effectiveness for forecasting short-term price trends for essential commodities in the Cirebon market.

RESULTS

The ARIMA analysis in this study revealed that seven different models achieved a high degree of accuracy in predicting price movements, as measured by the Mean Absolute Percentage Error (MAPE). The MAPE values for all seven models were less than 10%, which indicates a high level of precision and reliability in the short-term price forecasts generated by the ARIMA model. This finding validates the effectiveness of the ARIMA approach for forecasting the prices of essential household commodities in a local market context, where price fluctuations can be significant.

Specifically, the analysis focused on price predictions for the period from January 2024 to March 2024. The results demonstrated a remarkable accuracy rate of 98.864%, underscoring the robustness of the ARIMA model in capturing the trends and dynamics of commodity prices. Such a high level of accuracy indicates that the ARIMA model can effectively forecast short-term price changes, providing reliable information for stakeholders involved in market regulation, production planning, and household budgeting.

The high predictive performance of the ARIMA models can be attributed to their capability to account for both autoregressive and moving average components within the time series data, as well as their ability to integrate differencing to ensure stationarity. This comprehensive modeling approach allows for nuanced and precise forecasting of prices that are subject to multiple influencing factors, such as seasonal demand, supply chain constraints, and external economic conditions. The success of these models in achieving low MAPE values confirms their utility in practical economic forecasting, supporting their application in commodity price prediction efforts.

DISCUSSION

The accuracy of the ARIMA model's price predictions is inherently influenced by various market conditions, each uniquely affecting the commodities under study. External factors play a significant role in shaping the market landscape; for instance, extreme weather conditions can disrupt agricultural production, leading to fluctuations in the availability of staple goods. Similarly, rising feed prices for livestock can result in higher costs for meat and poultry products, directly affecting their market prices. Moreover, fluctuations in global market prices—driven by international trade policies, geopolitical events, and changes in demand and supply—can also lead to price volatility in local markets, which in turn can challenge the predictive power of forecasting models like ARIMA.

Production challenges are another critical factor impacting commodity prices. These challenges can range from supply chain disruptions and logistical issues to seasonal variations in crop yields. Such disruptions can lead to inconsistencies in the availability of commodities, making it more difficult for the ARIMA model to capture and accurately forecast price trends. Consequently, while ARIMA

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 404 - 409

is designed to analyze historical price data and project future movements, its predictions may be affected when sudden and unanticipated changes occur in market conditions.

Despite these influences, the ARIMA models utilized in this study achieved a classification of "Very Good" in terms of their predictive accuracy. This classification is based on the models' low Mean Absolute Percentage Error (MAPE) values, which indicate a high degree of precision in forecasting short-term price movements. The effectiveness of ARIMA in producing accurate short-term forecasts for essential commodities demonstrates its potential as a reliable tool for market analysis, even in the face of external market conditions that may introduce volatility and unpredictability.

However, it is important to note that while the ARIMA model has proven to be robust, its performance could potentially be enhanced by incorporating external variables into the forecasting process. Factors such as weather patterns, global market trends, and local production data could be integrated into the model to improve its capacity for capturing market complexities and enhancing the accuracy of its predictions. By addressing these additional variables, the model can offer a more comprehensive understanding of market dynamics and provide stakeholders with more precise forecasts for decision-making.

Future research should focus on the integration of such external market factors into ARIMA modeling to further improve its predictive performance. Advanced forecasting models, such as ARIMA-X (ARIMA with exogenous variables), could be employed to account for these additional influences. This approach would not only refine the predictive capabilities of the ARIMA model but also provide deeper insights into the interplay between market conditions and price movements.

In conclusion, while the ARIMA model shows great promise in forecasting the short-term prices of essential commodities in local markets, its accuracy is partly contingent on external market conditions. The incorporation of additional factors and variables that affect supply and demand could enhance the model’s performance and reliability. This would ultimately support more informed decision-making for producers, traders, policymakers, and consumers, ensuring a stable and well-regulated market environment.

CONCLUSION

The ARIMA model has shown a high degree of accuracy in forecasting short-term price trends for essential household commodities in the local market of Cirebon City. The findings from this research indicate that ARIMA can be utilized effectively as a predictive tool to anticipate market price fluctuations. This predictive capability is especially valuable for stakeholders, as it aids in efforts to stabilize prices, manage market demand, and support economic planning at the local level. The ARIMA model's demonstrated ability to produce reliable forecasts suggests that it can play a significant role in enabling better market regulation and informed decision-making.

However, while the ARIMA model proves to be robust, the consideration of external factors remains critical for further improving its reliability. Variables such as climatic conditions, changes in global market dynamics, supply chain disruptions, and production-related challenges can have significant impacts on the market prices of essential commodities. To enhance the accuracy and robustness of future forecasts, these external variables should be incorporated into the modeling process. By doing so, the ARIMA model can be further refined to provide more precise and adaptable predictions, contributing to improved economic stability and resilience against market volatility.

ISSN: XXX-XXX-XXXXX-X-X
Desember 2024
Hal: 404 - 409

REFERENCES

Granger, C. W. J. (1991). Modelling economic series: Readings in econometric methodology. Oxford: Oxford University Press.

Greff, K., Srivastava, R. K., Koutník, J., Steunebrink, B. R., & Schmidhuber, J. (2016). LSTM: A search space odyssey. IEEE Transactions on Neural Networks and Learning Systems, 28(10), 2222–2232. https://doi.org/10.1109/TNNLS.2016.2582924:contentReference[oaicite:0]{index=0}

Guo, H., Liu, X., & Sun, Z. (2016). Multivariate time series prediction using a hybridization of VARMA models and Bayesian networks. Journal of Applied Statistics, 43(16), 2897–2909. https://doi.org/10.1080/02664763.2016.1155327:contentReference[oaicite:1]{index=1}

Hernández-Lobato, J. M., & Adams, R. (2015). Probabilistic backpropagation for scalable learning of Bayesian neural networks. International Conference on Machine Learning, 1861–1869.

Hewage, P., Behera, A., Trovati, M., Pereira, E., Ghahremani, M., Palmieri, F., & Sharma, R. (2019). A comparative study of ARIMA and LSTM in forecasting time series data. Computational Economics, 57(2), 463–472.

Kantanantha, N., Serban, N., & Griffin, P. (2010). Yield and price forecasting for stochastic crop decision planning. Journal of Agricultural, Biological, and Environmental Statistics, 15(3), 362–380. https://doi.org/10.1007/s13253-010-0026-4:contentReference[oaicite:2]{index=2}

Karaboga, D. (2005). An idea based on honey bee swarm for numerical optimization (Vol. 200). Technical report-tr06, Erciyes University, Engineering Faculty, Computer Engineering Department, 1–10.

Karaboga, D., Gorkemli, B., Ozturk, C., & Karaboga, N. (2014). A comprehensive survey: Artificial bee colony (ABC) algorithm and applications. Artificial Intelligence Review, 42(1), 21–57. https://doi.org/10.1007/s10462-012-9328-0:contentReference[oaicite:3]{index=3}

Mello, C. E., Carvalho, A. S. T., Lyra, A., & Pedreira, C. E. (2019). Time series classification via divergence measures between probability density functions. Pattern Recognition Letters, 125, 42–48. https://doi.org/10.1016/j.patrec.2019.03.023:contentReference[oaicite:4]{index=4}

Noureen, S., Atique, S., Roy, V., & Bayne, S. (2019, August). Analysis and application of seasonal ARIMA model in energy demand forecasting: A case study of small-scale agricultural load. 2019 IEEE 62nd International Midwest Symposium on Circuits and Systems (MWSCAS), 521–524. IEEE. https://doi.org/10.1109/MWSCAS.2019.8885102:contentReference[oaicite:5]{index=5}

Rahmayanti, I. A., Andreas, C., & Ulyah, S. M. (2020). Does US-China trade war affect the Brent crude oil price? An ARIMAX forecasting approach. AIP Conference Proceedings, 2329(1), 060010. https://doi.org/10.1063/5.0035194:contentReference[oaicite:6]{index=6}

Solanki, P., Sharma, R., & Sharma, M. (2017). Price forecasting of mustard using ARIMA and EGARCH models. Journal of Oilseed Brassica, 81(2), 181–186. https://doi.org/10.1016/j.patrec.2019.03.023:contentReference[oaicite:7]{index=7}

Saputra, B. D., Gernowo, R., & Warsito, B. (2018). A fuzzy time series-Markov chain model to forecast fish farming product. Jurnal Ilmiah Kursor, 9(4).

Wang, J. H., & Leu, J. Y. (1996). Stock market trend prediction using ARIMA-based neural networks. In Proceedings of International Conference on Neural Networks (ICNN'96), Vol 4, IEEE, 2160–2165.

ISSN: **XXX-XXX-XXXXX-X-X**
Desember 2024
Hal: **404 - 409**

Zhao, H. (2021). Futures price prediction of agricultural products based on machine learning. Neural Computing and Applications. https://doi.org/10.1007/s00521-021-06361-3:contentReference[oaicite:8]{index=8}