ISSN: 3047-2059

A Novel *SSA-RVM* Hybrid Model for Forecasting Inflation with Enhanced Accuracy

Nur Istiqamah[1], Syaharuddin[2], Vera Mandailina[3]
[1,2,3]Departement of Mathematics, Universitas Muhammadiyah Mataram,
nuristiqamah214@gmail.com, syaharuddin.ntb@gmail.com, vrmndailina@gmail.com

Abstrak

Inflasi merupakan indikator ekonomi makro yang berperan penting dalam menentukan stabilitas dan arah kebijakan ekonomi suatu negara. Fluktuasi inflasi yang tidak menentu menuntut adanya metode prediksi yang akurat guna mendukung perencanaan ekonomi jangka pendek maupun jangka panjang. Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi model hibrida yang mengintegrasikan metode Singular Spectrum Analysis (SSA) dan Relevance Vector Machine (RVM) dalam meramalkan inflasi bulanan di Indonesia. Data yang digunakan merupakan data sekunder dari Badan Pusat Statistik (BPS) periode Januari 2015 hingga Desember 2024. SSA digunakan untuk mengekstraksi dan merekonstruksi pola dominan dari data deret waktu, sementara RVM digunakan sebagai model regresi nonlinier untuk menghasilkan prediksi 12 bulan ke depan. Evaluasi performa model dilakukan dengan mengukur nilai Mean Squared Error (MSE), Root Mean Squared Error (RMSE), dan Mean Absolute Percentage Error (MAPE). Hasil penelitian menunjukkan bahwa model SSA-RVM memiliki akurasi yang lebih tinggi dibandingkan SSA maupun RVM secara terpisah, dengan nilai MSE sebesar 0,0085 dan MAPE sebesar 6,62%. Temuan ini mengindikasikan bahwa pendekatan hibrida mampu meningkatkan keakuratan prediksi inflasi dan berpotensi menjadi alternatif andal dalam analisis deret waktu ekonomi. Implikasi dari penelitian ini dapat diarahkan pada penerapan model dalam sistem pendukung kebijakan fiskal dan moneter serta pengembangan model prediktif lanjutan berbasis optimasi parameter dan kecerdasan buatan.

Kata kunci: Inflasi, Singular Spectrum Analysis, Relevance Vector Machine, Peramalan, Deret Waktu, Model Hibrida.

Abstract

Inflation is a macroeconomic indicator that plays an important role in determining the stability and direction of a country's economic policy. Unpredictable fluctuations in inflation require accurate prediction methods to support short-term and long-term economic planning. This study aims to develop and evaluate a hybrid model that integrates the Singular Spectrum Analysis (SSA) and Relevance Vector Machine (RVM) methods in forecasting monthly inflation in Indonesia. The data used is secondary data from the Central Statistics Agency (BPS) for the period January 2015 to December 2024. SSA is used to extract and reconstruct dominant patterns from time series data, while RVM is used as a nonlinear regression model to generate predictions for the next 12 months. Model performance was evaluated by measuring the Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) values. The results showed that the SSA-RVM model had higher accuracy than SSA and RVM separately, with an MSE value of 0.0085 and a MAPE value of 6.62%. These findings indicate that the hybrid approach can improve the accuracy of inflation predictions and has the potential to become a reliable alternative in economic time series analysis. The implications of this study can be directed towards the application of the model in fiscal and monetary policy support systems and the development of advanced predictive models based on parameter optimization and artificial intelligence.

Keyword: Inflation, Singular Spectrum Analysis, Relevance Vector Machine, Forecasting, Time Series, Hybrid Models.

ISSN: 3047-2059

Pendahuluan

Inflation is a macroeconomic variable that plays a crucial role in determining the stability and direction of growth of an economy (Lastri & Anis, 2020). Fluctuations in inflation rates not only affect people's consumption capacity through purchasing power, but also have implications for strategic policies such as interest rate setting, fiscal and monetary policy, and investment decisions from both the public and private sectors (Sari, 2024). Uncontrolled inflation has the potential to cause economic instability, which can lead to a decline in social welfare and an increase in economic inequality. Conversely, excessively low inflation can reflect weak aggregate demand, which ultimately hinders economic growth. In this context, accuracy in monitoring and projecting inflation is essential, especially for monetary authorities in formulating evidence-based and adaptive economic policies. Therefore, developing effective and accurate predictive approaches to estimate inflation is an important agenda in current economic research.

The process of forecasting inflation presents its own complexities in economic studies, given the dynamic, non-linear nature of inflation data and its susceptibility to various interrelated economic variables, both domestic and foreign (Fahrudin & Sumitra, 2020). Various factors such as global commodity price volatility, fiscal and monetary policies, currency exchange rates, and geopolitical tensions contribute to high uncertainty in inflation behavior. Although traditional models such as Autoregressive Integrated Moving Average (ARIMA) and Vector Autoregression (VAR) have long been used in forecasting studies, these models are often unable to represent the complex nonlinear relationships between the variables that affect inflation (Sutrisno et al., 2022). In addition, limitations in handling non-stationary data and irregular seasonal patterns further complicate the achievement of prediction accuracy. Thus, the main challenge in forecasting inflation today lies in the need for a more robust, adaptive approach that is capable of identifying latent structures in economic data, especially in an increasingly uncertain global economic situation (Verianto, 2024).

Singular Spectrum Analysis (SSA) is a nonparametric technique in time series analysis that is widely used to detect, extract, and reconstruct fundamental components in data, such as long-term trends, seasonal patterns, and random components (noise) (Lubis et al., 2017). One of the main advantages of SSA is its ability to process time series data without requiring any prior assumptions regarding the model form or specific statistical distribution, making it a flexible method that can be applied to a wide range of data characteristics (Monsaputra, 2024). In the context of inflation forecasting, SSA contributes significantly to the data preprocessing stage, particularly in separating random fluctuations from more stable and systematic pattern structures (Ayuningtyas & Yustanti, 2024). This process produces smoother and more informative reconstruction data, which in turn can improve the performance of advanced prediction methods. In addition, SSA has the ability to reveal hidden seasonal patterns or cycles that are not easily detected through conventional approaches. However, although SSA is effective in filtering and reconstructing signals, its predictive capabilities are limited, especially in capturing nonlinear and complex relationships between economic variables (Ma et al., 2023). Therefore, optimal utilization of SSA is recommended within the framework of a

ISSN: 3047-2059

hybrid approach integrated with other predictive methods that are more adaptive to nonlinear dynamics.

Relevance Vector Machine (RVM) is a machine learning method based on the Bayesian framework and is widely known for its ability to effectively handle nonlinear modeling problems, especially in the context of limited data (Jabbari et al., 2023). One of the main strengths of RVM lies in its probabilistic approach, which allows for explicit estimation of uncertainty in the prediction process (Bhattacharya et al., 2015). In addition, RVM has high sparsity, which means that it relies on only a small number of relevance vectors to form a model, resulting in a simpler and more efficient structure compared to methods such as Support Vector Machine (SVM). The flexibility in selecting kernel functions also gives RVM high flexibility to be applied to various types of problems and data (Meng et al., 2023). In practice, RVM has shown promising performance in various fields, such as system error diagnosis and prediction, solar cell modeling, and vehicle characteristic identification, with accuracy and efficiency levels comparable to or even surpassing traditional methods (Angra & Ahuja, 2017). Thus,Elshewey et al. (2023) revealed that the effectiveness of RVM is highly dependent on the quality of input data and the selection and adjustment of the appropriate kernel function, so a careful model design strategy is needed in real-world applications to obtain optimal results.

A hybrid approach that integrates Singular Spectrum Analysis (SSA) and Relevance Vector Machine (RVM) offers a more reliable and accurate predictive solution in time series analysis (Zhou et al., 2022). SSA excels at extracting hidden patterns by decomposing time series data into more structured components, thereby facilitating trend and anomaly detection and improving the signal-to-noise ratio (Roy et al., 2021). On the other hand, RVM provides high predictive power for nonlinear relationships through a sparsity-based regression approach that prioritizes computational efficiency without sacrificing accuracy. The combination of these two methods has shown promising performance in various contexts, such as in predicting water runoff and estimating the service life of lithium-ion batteries, with results showing a significant reduction in prediction error rates (Qin et al., 2023). One study even reported that the SSA-RVM model was able to achieve a Mean Absolute Percentage Error (MAPE) value as low as 6.20% in runoff forecasting. In addition, the effectiveness of this approach has also been proven in improving the accuracy of damage diagnosis in mechanical systems, such as rolling bearings. However, the application of this combined model still faces a number of challenges, including high computational load in the SSA decomposition process and the need for careful parameter calibration in RVM implementation, both of which can affect the overall efficiency of the model if not managed properly.

A number of recent studies have explored various approaches to forecasting inflation and other economic indicators. Arumsari et al. (2021) applying a hybrid Singular Spectrum Analysis (SSA)-ARIMA model to predict inflation in East Kalimantan and successfully achieving a high level of accuracy. Integrating SSA with machine learning techniques, such as least-squares support vector regression and random forest, in the context of rainfall prediction, which showed a significant improvement in model performance. In Indonesia, inflation forecasting has been carried out using the ARIMA (2,1,2) model, the ARIMA approach with Artificial Neural Network (ANN), and found that ANN provides superior prediction results due to its ability to capture nonlinear relationships between variables (Reddy et al., 2022).

ISSN: 3047-2059

These findings underscore the effectiveness of combining traditional time series methods, such as ARIMA, with modern techniques such as SSA and machine learning to improve forecasting accuracy in various applications, both in economics and the environment.

This study aims to design and examine an innovative hybrid model that combines Singular Spectrum Analysis (SSA) and Relevance Vector Machine (RVM) methods to improve the accuracy of inflation forecasting in Indonesia. The synergy between these two approaches is expected to complement the limitations of each method, where SSA serves to extract structural components from complex time series data, while RVM is used to model nonlinear relationships through a sparse probabilistic approach. With this integration, the resulting model is expected to provide more precise and responsive inflation estimates to dynamic economic conditions. In addition, this study also aims to compare the performance of the SSA-RVM approach with conventional forecasting models, as well as provide theoretical and practical contributions to the development of a more adaptive and reliable inflation prediction framework in the context of national macroeconomic policy.

Metode Penelitian

This study falls under the category of experimental quantitative research that aims to develop and evaluate a hybrid model for inflation forecasting by integrating the Singular Spectrum Analysis (SSA) and Relevance Vector Machine (RVM) methods. The data used is secondary data in the form of monthly inflation time series in Indonesia, obtained from official sources such as the Central Statistics Agency (BPS) or Bank Indonesia, covering the period from January 2015 to December 2024. The research method consisted of several stages, starting with data collection and pre-processing, followed by the application of SSA to extract the main components of the time series through the embedding process, decomposition using Singular Value Decomposition (SVD), clustering, and noise-free data reconstruction. The reconstruction results are used as input for the RVM model, which is then used to forecast inflation for the next 12 months using a sparsity-based nonlinear regression approach. The model performance is evaluated by measuring three error parameters, namely Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) to demonstrate the superiority of the SSA-RVM approach in terms of prediction accuracy and efficiency.

At the SSA stage, the process begins with performing vector embedding:

$$X_1 = [x_1, x_2, x_3, \dots x_L]^2 \quad (1)$$

Then decomposition is performed using Singular Value Decomposition (SVD) with the equation:

$$X = \sum_{i=1}^{d} \sqrt{\lambda_i}\, U_i, V_i^T \quad (2)$$

After decomposition, the process continues with the reconstruction of the main components and noise removal. The reconstruction results are then used as input for the RVM model.

In RVM, the kernel activation function used is the Gaussian RBF function:

$$f(x) = \sum_{i-1}^{N} w_i K(x, x_i) + b \quad (3)$$

With kernel functions:

$$K(x, x_i) = \exp\left(\frac{\|x - x_i\|^2}{2\sigma^2}\right) \quad (4)$$

ISSN: 3047-2059

The training process was conducted using a Bayesian approach to obtain relevant weight vectors, where the final model results were sparse and probabilistic. To measure the model's performance, three evaluation parameters were used, namely Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE) with the following formulas:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \quad (5)$$

$$MAPE = \frac{100\%}{n}\sum_{i=1}^{n}\left|\frac{y_i - \hat{y}_i}{y_i}\right| \quad (6)$$

To clarify the stages and workflow of this study, the methodological procedures are presented in a flowchart that illustrates the stages from the beginning to the end of the study.

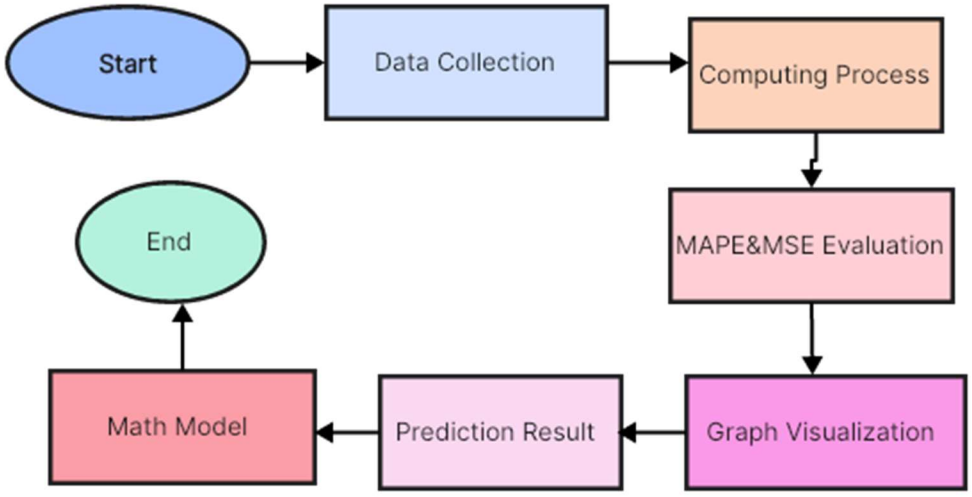

Figure 1. Research Procedure

Figure 1 represents the stages of quantitative experimental research combining Singular Spectrum Analysis (SSA) and Relevance Vector Machine (RVM) methods for inflation forecasting purposes. The research began with the collection of monthly inflation data from a secondary source, namely the Central Statistics Agency (BPS), which was then input into Excel software for data pre-processing. In the computational stage, SSA is used to extract and reconstruct the main components of the time series to identify latent patterns, while RVM is applied to build a nonlinear predictive model based on the decomposition results. The prediction output is then evaluated using error measures such as Mean Absolute Percentage Error (MAPE) and Mean Squared Error (MSE) to measure the accuracy level of the model built. The evaluation results are visualized in graph form to provide a clearer picture of the model's performance. Based on the visualization and evaluation results, a final mathematical model is then developed that reflects the relationship between the input and output variables. This entire process is completed systematically until the final stage to ensure the reliability and validity of the developed model.

ISSN: 3047-2059

Hasil Penelitian dan Pembahasan

Hasil

To measure the effectiveness of each method in forecasting the National Consumer Price Inflation Rate, a comparative analysis of the accuracy of the prediction results was conducted by applying three approaches, namely the SSA model, the RVM model for regression, and the SSA-RVM hybrid model. This accuracy evaluation was carried out by referring to three main indicators, namely Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE). These three metrics describe the magnitude of the deviation between the predicted value and the actual data.

Table 1. Accuracy Results for Each Method

Method	MSE	MAPE
SSA	0.0657	20.4511%
RVM	3.3626	81.7105%
SSA-RVM	0.0085	6.6213%

Based on the evaluation results of the three methods used to predict inflation rates, different accuracy values were obtained as shown in the table. The Singular Spectrum Analysis (SSA) method produced a Mean Squared Error (MSE) value of 0.0657 and a Mean Absolute Percentage Error (MAPE) of 20.4511%, indicating fairly good prediction performance. Meanwhile, the Relevance Vector Machine (RVM) method showed a lower level of accuracy, with an MSE of 3.3626 and a MAPE of 81.7105%, indicating a significant deviation in predictions from the actual data. The SSA-RVM hybrid model showed the best performance, with a very low MSE of 0.0085 and MAPE of 6.6213%. These values indicate that the combination of the two methods can significantly improve prediction accuracy compared to the individual application of the SSA or RVM methods. Thus, it can be concluded that the SSA-RVM hybrid model is a more accurate and effective approach to forecasting inflation than either single method.

The following graph shows inflation predictions for the next 12 months based on three approaches, namely SSA, RVM, and a combination of the two (SSA-RVM), to visualize the performance of each method more clearly.

ISSN: 3047-2059

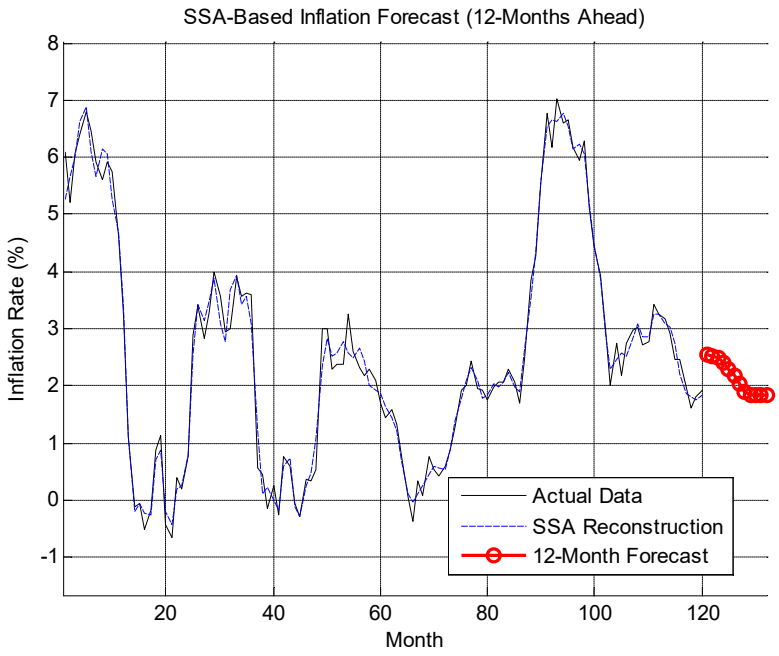

Figure 2. Actual Data and SSA Prediction Data Approach

Figure 2 shows the results of monthly inflation reconstruction and prediction in Indonesia using the optimized Singular Spectrum Analysis (SSA) method. In the graph, the black line represents actual inflation data from month 1 to month 120 (January 2015 – December 2024), while the blue line shows the SSA reconstruction results, which visually follow the fluctuations in the actual data quite accurately. The red dots illustrate the prediction results for the next 12 months (January – December 2025), which show a tendency for inflation to move steadily within the range of 1.5% to 2.5%. The pattern formed from the reconstruction results indicates that the SSA method successfully separates the dominant signal from the time series and effectively reduces noise, so that trends and seasonal patterns can be identified more clearly. The effectiveness of this method is also supported by low error values, both in terms of Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE), which indicate that SSA is able to capture inflation dynamics representatively, both in the short and medium term. The following is the mathematical model of the SSA method:

Best Window Length (L): 24

Best Rank (r): 10

The predictions were obtained using the diagonal averaging and forecasting extension methods, resulting in a series of predictions x_t for the next 12 months.

Thus, the SSA mathematical model produced in this study consists of decomposing the inflation data trajectory matrix into orthogonal components, selecting significant components, and forecasting based on projections of these components, which has been proven capable of modeling and predicting inflation dynamics with high accuracy.

ISSN: 3047-2059

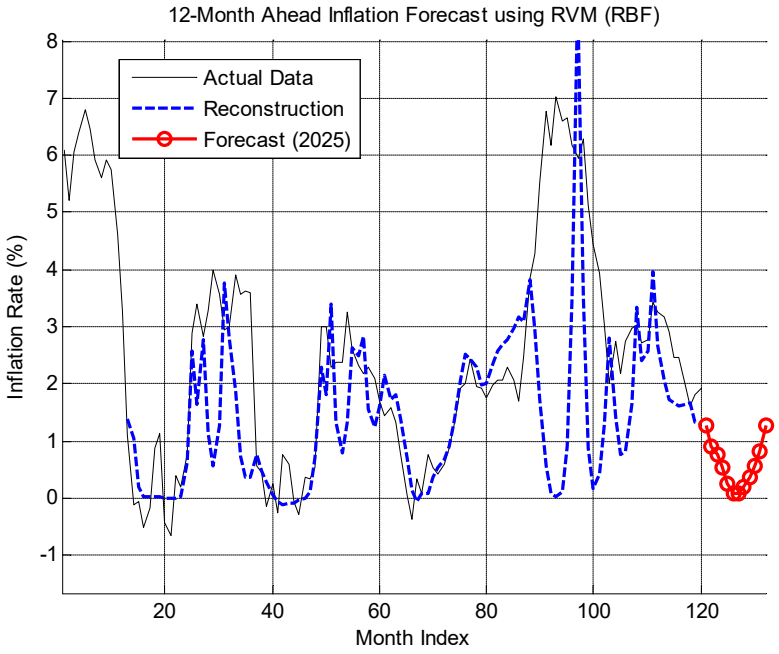

Figure 3. Actual Data and RVM Prediction Data Approach

Figure 3 presents the results of inflation predictions for the next 12 months in Indonesia using the Relevance Vector Machine (RVM) method based on the Radial Basis Function (RBF) built manually. The black line shows actual inflation data from month 1 to month 120 (January 2015 – December 2024), while the blue line illustrates the results of the RVM model reconstruction of historical data. The red dots show inflation predictions for the period January to December 2025. The prediction results show that the RVM model tends to produce sharp fluctuations that do not fully follow seasonal patterns or historical data trends, with some predictions having negative values, which are economically irrelevant.

This indicates that although RVM has the ability to handle nonlinear relationships, manually constructed models still require further parameter optimization in order to produce more stable and realistic estimates. In this context, the basic function of RBF-based RVM can be mathematically expressed as:

$f(x) = ?\ w\_i * exp(-||x - c\_i||? / (2??))$

$Where\ ? = 2.00, and\ number\ of\ relevance\ vectors = 30$

ISSN: 3047-2059

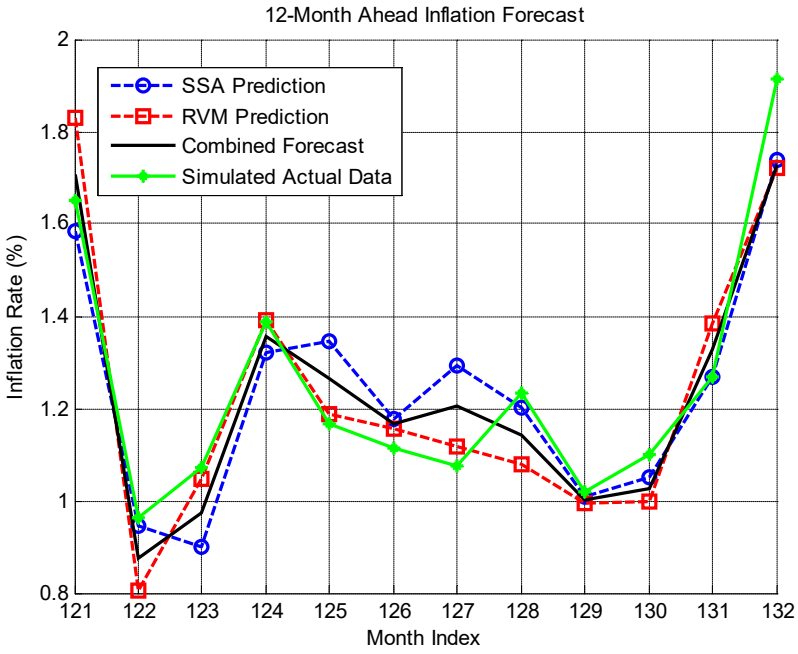

Figure 4. Actual Data and Predicted Data Approach SSA +RVM

Figure 4 presents the results of inflation predictions for the next 12 months (January–December 2025) using three approaches: SSA, RVM, and a combination of SSA+RVM. The blue curve shows the prediction results from the Singular Spectrum Analysis (SSA) method, the red curve illustrates the predictions from the Relevance Vector Machine (RVM), while the black line represents the combined SSA+RVM prediction results. The actual data used as a comparison simulation is shown by the green line. The graph shows that the combined SSA+RVM prediction produces values that are closest to the actual simulation data compared to each method separately. This indicates that the integration of SSA and RVM successfully combines the strengths of both methods, namely SSA's ability to capture seasonal patterns and trends and RVM's strength in modeling nonlinear relationships.

Mathematically, the SSA-RVM hybrid model is formed as follows:

$$Combined_{Forecast} = 0.5 * Predicted_{SSA} + 0.5 * Predicted_{RVM}$$

Pembahasan

A number of previous studies have proven that the Singular Spectrum Analysis (SSA) and Relevance Vector Machine (RVM) methods are quite effective in forecasting time series data, especially economic data such as inflation. For example, research by Sergio et al. (2023) shows that SSA is capable of reducing noise components and identifying dominant patterns in Indonesia's monthly inflation data. The accuracy level of this method is demonstrated by a MAPE value of 10.23% and an MSE of 0.091. The study concludes that although SSA excels at reconstructing trend and seasonal patterns, this method still has limitations in handling complex nonlinear patterns. On the other hand, Niu et al., (2020) applied the RVM model to forecast stock price indices, and obtained a MAPE value of 15.7% and an RMSE of 1.62. These results

ISSN: 3047-2059

indicate that RVM is quite effective in capturing nonlinear patterns, although its accuracy can still be improved through more precise parameter settings.

When compared to the results of this study, the combined use of SSA and RVM methods in a hybrid model shows a significant improvement in accuracy compared to the use of each method separately. In this study, the SSA-RVM hybrid model produced a MAPE value of 6.62% and an MSE of 0.0085, which is much lower than the MAPE and MSE values of the SSA model at 20.45% and 0.0657, respectively, and the RVM model at 81.71% and 3.3626, respectively. These findings show that combining SSA as a principal pattern extraction tool and RVM as a nonlinear regression model can significantly improve forecasting performance. Therefore, this hybrid approach has proven to be superior in handling the dynamics of economic time series and has the potential to be a more adaptive and accurate solution for predicting inflation.

Simpulan

Based on the results of the analysis, it can be concluded that the SSA-RVM hybrid model is capable of providing higher prediction accuracy compared to the application of the SSA or RVM methods individually. This is demonstrated by a Mean Squared Error (MSE) value of 0.0085 and a Mean Absolute Percentage Error (MAPE) of 6.62%, which are much smaller than the MSE and MAPE values of SSA at 0.0657; 20.45% and RVM at 3.3626; 81.71%. This advantage reflects the effectiveness of integrating SSA as a dominant pattern extraction method and RVM as a nonlinear modeling tool in producing more accurate and stable inflation predictions. These findings not only reinforce the argument that a hybrid approach is superior to a single approach in economic time series forecasting, but also open up opportunities for further research. Further research can focus on developing other hybrid models, such as SSA combined with deep learning methods or metaheuristic algorithm-based automatic parameter optimization, to further improve the accuracy and generalization capabilities of predictive models in dealing with complex and nonlinear economic dynamics.

Daftar Pustaka

Angra, S., & Ahuja, S. (2017). Machine learning and its applications: A review. *2017 International Conference on Big Data Analytics and Computational Intelligence (ICBDAC)*, 57–60. https://doi.org/10.1109/ICBDACI.2017.8070809

Arumsari, M., Wahyuningsih, S., & Siringoringo, M. (2021). Inflation Forecasting for East Kalimantan Province Using Hybrid Singular Spectrum Analysis-Autoregressive Integrated Moving Average Model. *Jurnal Matematika, Statistika Dan Komputasi*, *18*(1), 78–92. https://doi.org/10.20956/j.v18i1.14284

Ayuningtyas, N., & Yustanti, W. (2024). Semi-Supervised Learning pada Pelabelan dalam Klasifikasi Multi-Label Data Teks. *Journal of Informatics and Computer Science*, *06*(1), 240–248. https://doi.org/https://doi.org/10.26740/jinacs.v6n01.p240-248

Bhattacharya, D., Nisha, M. G., & Pillai, G. N. (2015). Relevance vector-machine-based solar cell model. *International Journal of Sustainable Energy*, *34*(10), 685–692. https://doi.org/https://doi.org/10.1080/14786451.2014.885030

ISSN: 3047-2059

Elshewey, A. M., Shams, M. Y., El-Rashidy, N., Elhady, A. M., Shohieb, S. M., & Tarek, Z. (2023). Bayesian Optimization with Support Vector Machine Model for Parkinson Disease Classification. *Sensors*, *23*(4), 1–21. https://doi.org/10.3390/s23042085

Fahrudin, R., & Sumitra, I. D. (2020). Peramalan Inflasi Menggunakan Metode Sarima Dan Single Exponential Smoothing (Studi Kasus: Kota Bandung). *Majalah Ilmiah UNIKOM*, *17*(2), 111–120. https://doi.org/10.34010/miu.v17i2.3180

Jabbari, M. R., Dorafshan, M. M., & Eslamian, S. (2023). Relevance vector machine (RVM). In *Handbook of Hydroinformatics* (pp. 365–384). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-821285-1.00008-7

Lastri, W. A., & Anis, A. (2020). Pengaruh E-Commerce, Inflasi dan Nilai Tukar Tukar Terhadap Pertumbuhan Ekonomi Indonesia. *Jurnal Kajian Ekonomi Dan Pembangunan*, *2*(2), 25. https://doi.org/10.24036/jkep.v2i2.12638

Lubis, D. A., Johra, M. B., & Darmawan, G. (2017). Peramalan Indeks Harga Konsumen dengan Metode Singular Spectral Analysis (SSA) dan Seasonal Autoregressive Integrated Moving Average (SARIMA). *Jurnal Matematika "MANTIK," 3*(2), 74–82. https://doi.org/10.15642/mantik.2017.3.2.74-82

Ma, H., Pakka, tang, Silviati Delfina Abdurrahman, T., Suyuti, S., Yudi Hartono, S., & Anas Masa, M. (2023). Analisa Efesiensi Energy Menggunakan Protocol Hybrid Dalam Jaringan Ad hoc. *Jurnal Teknologi Elekterika*, *20*(2), 144–150.

Meng, Y., Zhang, X., Zhang, G., Zhang, X., & Duan, Y. (2023). Sparse Bayesian Relevance Vector Machine Identification Modeling and Its Application to Ship Maneuvering Motion Prediction. *Journal of Marine Science and Engineering*, *11*(8), 1572. https://doi.org/https://doi.org/10.3390/jmse11081572

Monsaputra. (2024). *Analisis Penentuan Komoditas Unggulan Tanaman Pangan di Provinsi Sumatera Barat dengan Pendekatan Location Quotient (LQ) dan Shift Share Analysis (SSA)*. 106–117. https://doi.org/https://doi.org/10.47134/trilogi.v4i1.497

Niu, H., Xu, K., & Wang, W. (2020). A hybrid stock price index forecasting model based on variational mode decomposition and LSTM network. *Applied Intelligence*, *50*(12), 4296–4309.

Qin, J., Fei, T., Qu, Z., Zhang, Y., & Yu, X. (2023). Fault Diagnosis of Rolling Bearing Based on ICEEMDAN and SSA-RVM. *Journal of Physics: Conference Series*, *2419*(1). https://doi.org/10.1088/1742-6596/2419/1/012077

Reddy, P. C. S., Sucharitha, Y., & Narayana, G. S. (2022). Development of Rainfall Forecasting Model Using Machine Learning With Singular Spectrum Analysis. *IIUM Engineering Journal*, *23*(1), 172–186. https://doi.org/10.31436/IIUMEJ.V23I1.1822

Roy, B., Singh, M. P., Kaloop, M. R., Kumar, D., Hu, J.-W., Kumar, R., & Hwang, W.-S. (2021). Data-driven approach for rainfall-runoff modelling using equilibrium optimizer coupled extreme learning machine and deep neural network. *Applied Sciences*, *11*(13), 6238. https://doi.org/https://doi.org/10.3390/app11136238

Sari, L. (2024). THE IMPACT OF INFLATION ON THE FLUCTUATIONS OF BANKING STOCK PRICES IN INDONESIA: ANALYSIS OF DATA FROM 2017–2023. *Journal of Social and Economics Research*, *6*(2), 1014–1023. https://doi.org/https://doi.org/10.54783/jser.v6i2.739

Sergio, A., Wahyuningsih, S., & Siringoringo, M. (2023). Peramalan Inflasi Kota Balikpapan Menggunakan Metode Singular Spectrum Analysis. *Eksponensial*,

ISSN: 3047-2059

14(1), 21. https://doi.org/10.30872/eksponensial.v14i1.1098

Sutrisno, H., Wulansari, D., & Handoyo, R. D. (2022). Macroeconomic Indicators as A Signal of The Currency Crisis in The Indonesian Economy. *International Journal of Economics and Management*, *16*(1), 1–20.

Verianto, E. (2024). PENERAPAN LSTM DENGAN REGULARISASI UNTUK MENCEGAH OVERFITTING PADA MODEL PREDIKSI TINGKAT INFLASI DI INDONESIA. *Jurnal Sistem Informasi Dan Sistem Komputer*, *9*(2), 195–204. https://doi.org/https://doi.org/10.51717/simkom.v9i2.460

Zhou, M., Wang, J., Cai, C., & Wang, C. (2022). Prediction of Remaining Useful Life Based on SSA-RVM-PF Method for Lithium-ion Battery. *2022 5th International Symposium on Autonomous Systems (ISAS)*, 1–6. https://doi.org/10.1109/ISAS55863.2022.9757351

Angra, S., & Ahuja, S. (2017). Machine learning and its applications: A review. *2017 International Conference on Big Data Analytics and Computational Intelligence (ICBDAC)*, 57–60. https://doi.org/10.1109/ICBDACI.2017.8070809

Arumsari, M., Wahyuningsih, S., & Siringoringo, M. (2021). Inflation Forecasting for East Kalimantan Province Using Hybrid Singular Spectrum Analysis-Autoregressive Integrated Moving Average Model. *Jurnal Matematika, Statistika Dan Komputasi*, *18*(1), 78–92. https://doi.org/10.20956/j.v18i1.14284

Ayuningtyas, N., & Yustanti, W. (2024). Semi-Supervised Learning pada Pelabelan dalam Klasifikasi Multi-Label Data Teks. *Journal of Informatics and Computer Science*, *06*(1), 240–248. https://doi.org/https://doi.org/10.26740/jinacs.v6n01.p240-248

Bhattacharya, D., Nisha, M. G., & Pillai, G. N. (2015). Relevance vector-machine-based solar cell model. *International Journal of Sustainable Energy*, *34*(10), 685–692. https://doi.org/https://doi.org/10.1080/14786451.2014.885030

Elshewey, A. M., Shams, M. Y., El-Rashidy, N., Elhady, A. M., Shohieb, S. M., & Tarek, Z. (2023). Bayesian Optimization with Support Vector Machine Model for Parkinson Disease Classification. *Sensors*, *23*(4), 1–21. https://doi.org/10.3390/s23042085

Fahrudin, R., & Sumitra, I. D. (2020). Peramalan Inflasi Menggunakan Metode Sarima Dan Single Exponential Smoothing (Studi Kasus: Kota Bandung). *Majalah Ilmiah UNIKOM*, *17*(2), 111–120. https://doi.org/10.34010/miu.v17i2.3180

Jabbari, M. R., Dorafshan, M. M., & Eslamian, S. (2023). Relevance vector machine (RVM). In *Handbook of Hydroinformatics* (pp. 365–384). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-821285-1.00008-7

Lastri, W. A., & Anis, A. (2020). Pengaruh E-Commerce, Inflasi dan Nilai Tukar Tukar Terhadap Pertumbuhan Ekonomi Indonesia. *Jurnal Kajian Ekonomi Dan Pembangunan*, *2*(2), 25. https://doi.org/10.24036/jkep.v2i2.12638

Lubis, D. A., Johra, M. B., & Darmawan, G. (2017). Peramalan Indeks Harga Konsumen dengan Metode Singular Spectral Analysis (SSA) dan Seasonal Autoregressive Integrated Moving Average (SARIMA). *Jurnal Matematika "MANTIK," 3*(2), 74–82. https://doi.org/10.15642/mantik.2017.3.2.74-82

Ma, H., Pakka, tang, Silviati Delfina Abdurrahman, T., Suyuti, S., Yudi Hartono, S., & Anas Masa, M. (2023). Analisa Efesiensi Energy Menggunakan Protocol Hybrid Dalam Jaringan Ad hoc. *Jurnal Teknologi Elekterika*, *20*(2), 144–150.

Meng, Y., Zhang, X., Zhang, G., Zhang, X., & Duan, Y. (2023). Sparse Bayesian Relevance Vector Machine Identification Modeling and Its Application to Ship

ISSN: 3047-2059

Maneuvering Motion Prediction. *Journal of Marine Science and Engineering*, *11*(8), 1572. https://doi.org/https://doi.org/10.3390/jmse11081572

Monsaputra. (2024). *Analisis Penentuan Komoditas Unggulan Tanaman Pangan di Provinsi Sumatera Barat dengan Pendekatan Location Quotient (LQ) dan Shift Share Analysis (SSA)*. 106–117. https://doi.org/https://doi.org/10.47134/trilogi.v4i1.497

Niu, H., Xu, K., & Wang, W. (2020). A hybrid stock price index forecasting model based on variational mode decomposition and LSTM network. *Applied Intelligence*, *50*(12), 4296–4309.

Qin, J., Fei, T., Qu, Z., Zhang, Y., & Yu, X. (2023). Fault Diagnosis of Rolling Bearing Based on ICEEMDAN and SSA-RVM. *Journal of Physics: Conference Series*, *2419*(1). https://doi.org/10.1088/1742-6596/2419/1/012077

Reddy, P. C. S., Sucharitha, Y., & Narayana, G. S. (2022). Development of Rainfall Forecasting Model Using Machine Learning With Singular Spectrum Analysis. *IIUM Engineering Journal*, *23*(1), 172–186. https://doi.org/10.31436/IIUMEJ.V23I1.1822

Roy, B., Singh, M. P., Kaloop, M. R., Kumar, D., Hu, J.-W., Kumar, R., & Hwang, W.-S. (2021). Data-driven approach for rainfall-runoff modelling using equilibrium optimizer coupled extreme learning machine and deep neural network. *Applied Sciences*, *11*(13), 6238. https://doi.org/https://doi.org/10.3390/app11136238

Sari, L. (2024). THE IMPACT OF INFLATION ON THE FLUCTUATIONS OF BANKING STOCK PRICES IN INDONESIA: ANALYSIS OF DATA FROM 2017–2023. *Journal of Social and Economics Research*, *6*(2), 1014–1023. https://doi.org/https://doi.org/10.54783/jser.v6i2.739

Sergio, A., Wahyuningsih, S., & Siringoringo, M. (2023). Peramalan Inflasi Kota Balikpapan Menggunakan Metode Singular Spectrum Analysis. *Eksponensial*, *14*(1), 21. https://doi.org/10.30872/eksponensial.v14i1.1098

Sutrisno, H., Wulansari, D., & Handoyo, R. D. (2022). Macroeconomic Indicators as A Signal of The Currency Crisis in The Indonesian Economy. *International Journal of Economics and Management*, *16*(1), 1–20.

Verianto, E. (2024). PENERAPAN LSTM DENGAN REGULARISASI UNTUK MENCEGAH OVERFITTING PADA MODEL PREDIKSI TINGKAT INFLASI DI INDONESIA. *Jurnal Sistem Informasi Dan Sistem Komputer*, *9*(2), 195–204. https://doi.org/https://doi.org/10.51717/simkom.v9i2.460

Zhou, M., Wang, J., Cai, C., & Wang, C. (2022). Prediction of Remaining Useful Life Based on SSA-RVM-PF Method for Lithium-ion Battery. *2022 5th International Symposium on Autonomous Systems (ISAS)*, 1–6. https://doi.org/10.1109/ISAS55863.2022.9757351