Economica: Jurnal Ekomomi Islam
Vol 16, No 2 (2025): 387–411
DOI: 10.21580/economica.2025.16.2.28256

economica
Jurnal Ekonomi Islam

Arima Forecasting of Indonesia's Sovereign Sukuk as a Sustainable Financing Instrument

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Abstract

Sukuk development in Indonesia, along with SBSN (Surat Berharga Syariah Negara) sovereign securitization sukuk SBSN, sovereign securitization sukuk (SBSN), sustainable and diverse in-structure financing sukuk SBSN, is being balanced with the increasing usage of Sharia-compliant instruments for the financing of fiscal deficits and the management of sovereign debts, which continues to expand. An Autoregressive Integrated Moving Average (ARIMA) model is employed in this study, using monthly time series data for the period 2019 to 2024. Among the time series modeling techniques, ARIMA was chosen because explicit macroeconomic theories are not required for time series projection; thus, it is more suitable for modeling historical time series. The study has found that while the values of outstanding sukuk will no doubt increase, the uncertainty of longer-term forecasting will also increase. Forecasting in the present study lacks immediate quantification; however, the analyses provide a relevant and sustained policy framework for sovereign debt, and the analyses support the potentially strategic role of thematized instruments in fiscal management and for the sustainability of sukuk, in particular, focused sukuk, green sukuk, and retail sukuk. The research outlines strategic considerations for managing Shariah-compliant, long-term, and dynamic debt in Indonesia, thereby aligning financial innovation with national development interests.

Keywords: ARIMA Modeling; Fiscal Sustainability; Sharia Financing; Sovereign Sukuk; Sustainable Finance

Citation (APA):
Hartono, H. S., Nurrachmi, R., & Salleh, S. N. S. (2025). Arima Forecasting of Indonesia's Sovereign Sukuk as a Sustainable Financing Instrument. *Economica: Jurnal Ekomomi Islam*, 16(2), 387-411. https://doi.org/10.21580/economica.2025.16.2.28256

Submitted: 8 Aug 2025
Revised: 28 Oct 2025
Accepted: 5 Dec 2025
Published: 16 Dec 2025

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Introduction

Since 2008, sovereign sukuk have become a major financing instrument for the Indonesian government. They are used particularly for the State Budget (APBN) and certain strategic national projects. Following the first issuance of the Retail Sovereign Sukuk (SR-001), the government witnessed a significant increase in issuance volume and the number of investors. This significantly improved its capability to manage domestic sukuk (Kementerian Keuangan Republik Indonesia, 2022).

Figure 1. Indonesian Sovereign Sukuk 2008-2024

Source: (Otoritas Jasa Keuangan, 2023)

Figure 1 illustrates the annual growth trends for all Indonesian sovereign Sukuks issued and outstanding from 2008 to 2024. We note that among Indonesian Sukuks, the overall stock has grown substantially from IDR 4.96 trillion in 2008 to IDR 55.27 trillion in 2024. This growth underscores the importance of Sukuks in financing the public sector, while also clarifying their role in medium-term funding and what this could mean for fiscal space. Active financing from the government is reflected in the issuance measure, while outstanding stock refers to the Sukuk liabilities a government can carry at a given point in time. Both parameters showed a clear positive trend during the study period, strengthening the assumption of the importance of sovereign Sukuks in public financing in Indonesia relative to highly restricted budgetary or infrastructure financing. This imposition has several descriptors that collectively point to the lack of sustainability of sovereign financing, indicating an absence of systematic planning for medium-term debt.

The global economy is in a state of instability, and coupled with the adverse effects of climate change, has seen an upsurge in the global interest in Sharia-compliant sustainable finance, especially green sukuk. It is against this backdrop that sovereign sukuk plays an increasingly critical role in refining forecasting models for medium-term debt management and in positioning sustainable fiscal management more prominently. Green sukuk, as the World Bank and IDB (2021) report, has ample prospects to finance the construction of sustainable, climate-resilient infrastructure, while the assesses the Climate Bonds Initiative (2020) burgeoning global demand for sukuk financing for such projects.

Within the parameters of sustainable Shariah-compliant fiscal policy, outstanding sukuk trends and growth must be identified. The government's fiscal dynamism will be complemented by sukuk and financing forecasters, which will help build a more sophisticated financing framework. Yet, much remains to be desired in the context of literature forecasting the effects of sovereign sukuk in Indonesia. Empirical research of the recent past has shown that sukuk financing has quantifiable macroeconomic impacts, especially on the economic growth. The panel data analysis on ASEAN member states as done by Yusuf & Sumner (2015) illustrates that sukuk financing has a positive impact on GDP growth, a factor that supports its ability to raise long-term funds to develop. Additional evidence about the complementary nature of sukuk issuance is provided by the current cross-country studies that find the issuance of sukuk to be linked with positive long-run growth processes, particularly in the case of the emerging economy (Naz et al., 2025).

The ARIMA model, or Autoregressive Integrated Moving Average model, works well in this situation because it relies less on external variable forecasts and more on past data and trends. ARIMA is widely used for predicting data across various sectors, including, as Ediger & Akar (2007) demonstrate, predicting Turkey's primary energy demand, where ARIMA proved successful. Although ARIMA helps predict the data used in planning by identifying trends, irregularities, and seasonal fluctuations in time series data (Box et al., 2015; Brockwell et al., 2002), it does so in a more advanced way.

In this regard, predicting the remaining issuance of sovereign sukuk is integral to the sustainability of fiscal policy, as it helps policymakers anticipate, obviate, and balance debt and sukuk issuance with long-term sustainability targets. Yet, as far as

ARIMA is concerned, predicting outstanding Indonesian sovereign sukuk has received little research attention. Thus, this study aims to fill this particular gap by using an ARIMA algorithm to analyze outstanding sukuk data from 2019 to 2024 and to estimate data for 2029. The data provided in this study may assist in more adaptable, sustainable management of state debt in the future and in guiding Sharia fiscal policy to be more effective.

Literature Review

Conventional and Islamic Economic Approaches to Sovereign Sukuk

Defining sukuk sovereign sukuk, in particular, the evolution of the stock of debt, and sovereign debt management literature, including public finance medium-term fiscal frameworks, is also relevant. Sukuk is a Sharia-compliant financing tool that provides ownership of an asset or project, unlike bonds, which involve interest (*riba*). According to Accounting and Auditing Organization for Islamic Financial Institutions AAOIFI (2015), sukuk are certificates that represent shared ownership of tangible assets, rights, or project benefits. Investors receive returns through *Ijarah* (leasing), *Mudharabah* (profit-sharing), or *Wakalah* (agency). The regulatory standards in the international markets define sukuk as Sharia compliant securities that have a proportionate ownership of underlying assets or economic activities thus distinguishing them with conventional debt instruments (Islamic Financial Services Board, 2013).

Sukuk's asset-backed financing fundamentally bridges the gap between conventional economic analysis and Islamic public finance. However, unlike conventional bonds, where pricing, risk, and return are fundamentally driven by the interest rate and market supply and demand, sukuk's pricing structure is overdefined by the underlying assets or projects. This provides a stronger link between financial returns and economic activity, thereby reducing sukuk's risk relative to conventional sovereign debt (Godlewski et al., 2013). Thus, although it is possible, to a degree, to analyze sukuk's issuance and outstanding balances using conventional economic theory, the asset backing dictated by *Shari'ah* makes sukuk distinct in the context of sovereign debt management.

It is based on these differences that the key differences between sukuk and traditional bonds can be elaborated by looking at their structural features, risk, and consequences to economic wellbeing (Boukhatem, 2021; Ulfah, 2023). Although traditional bonds are mainly based on the creditworthiness of the issuer, sukuk are directly connected with actual economic actions and ownership of assets and thus provide a unique ethical finance solution (Ramadan et al., 2025). This organizational aspect radically refigures the relationship between the investor and the issuer as that of a creditor-debtor into a partnership/ownership approach (Wibowo, 2023) Compliance with Sharia principles that outlaw the use of interests and excessive speculation makes sukuk an alternative to conventional fixed-income securities and enables the financial returns to be more directly attached to the actual performance of the economy and ethical principles (Hakim, 2024; Izzaty, 2024). As a result, sukuk are not only differentiated by structure but can be differentiated in functions since their asset-backed nature can lead to productive investment, decreasing information asymmetries, and can result in improved outcomes of overall economic welfare (Boukhatem, 2021).

Traditional economics views outstanding sukuk through a financial-market supply-and-demand lens. Mishkin & Eakins (2018) describe a relationship between the investor demand and government supply of financial instruments (in this instance, sukuk). Outstanding sukuk refers to the volume of active sukuk liabilities that remain in the market at a particular point in time. Although sukuk are influenced by market factors such as yield and liquidity, as well as by investor demand and prevailing trading conditions, the volume of outstanding sukuk is largely determined by sovereign issuance and redemption policies.

From another standpoint, sovereign sukuk is part of Islamic Public Finance. It is a financing tool issued by a state, which is *Sharia*-compliant Iqbal & Mirakhor (2011) characterized sukuk as bonds that differ from conventional bonds, as conventional bonds are underwritten based on ownership of real assets and do not contain usury. Therefore, sukuk issuance as a financial product aims to improve just and equitable Sharia-compliant fiscal governance. Public financing activities, including the issuing of sovereign sukuk, can be guided by a moral framework of *Maqashid Sharia*. According to Dusuki & Bouheraoua (2011), *Maqashid Sharia* covers five objectives, which are the protection of (1) religion (*din*); (2) soul (*nafs*); (3) reason (*'aql*); (4) descendants (*nasl*); and (5) property (*mal*). These sovereign sukuk should be aimed at accomplishing the broader community welfare, development, equity, and social justice. Financial outcomes, it can be argued, cannot be the only metric of success for sovereign sukuk, as they may aid inclusive and sustainable development.

When considering sovereign sukuk, the *Maqasid al-Shariah* framework can be integrated with specific, measurable policy components, particularly when aligned with a use-of-proceeds strategy (Laldin & Furqani, 2013). It is also possible to achieve various *Maqasid* objectives, including environmental, social, and sustainable development, through the issuance of thematic sukuk, such as green sukuk and sukuk aligned with the Sustainable Development Goals (SDGs). Although this study refrains from directly assessing the outcomes of the *Maqasid*, the estimated outstanding value of sovereign sukuk serves as a pertinent metric for assessing the fiscal capacity of *Maqasid's* instruments. Empirical studies of green sukuk and SDG-linked sukuk have found them largely positive, as they tend to finance specific developmental goals via use-of-proceeds frameworks rather than simply adding to overall debt.

Statistical and Econometric Approaches in Sukuk Forecasting

To examine market behaviour and project performance, empirical studies of sukuk have employed a wide array of quantitative research methods, including the traditional econometric approach and the advanced machine learning solution (Çetin & Metlek, 2021). This fast-growing sukuk market has complicated the need to have strong forecasting frameworks that can support efficient risk management as well as informed decision-making in investment (Nurhanifah, 2024). However, a body of academic research has consistently shown that the Shariah-compliant and asset-backed character of sukuk creates unique risk and yield characteristics compared to traditional bonds and limits the ability to generally predict the behaviour of conventional predictive models (Sabu, 2024). Unlike conventional debt instruments that are largely determined by the creditworthiness of the issuers, sukuk have a structural connection to real-world economic operations and asset holdings, which introduce the difference in transmission among market variables and financial returns (Ramadan et al., 2025).

In turn, recent research highlights the urgency of specialised time-series and forecasting frameworks that have the capacity to reflect these structural attributes and their correlation with the rest of the market factors (Sabu, 2024).

Forecasting in time series has many techniques, but for non-stationary data, the most popular is the ARIMA (Autoregressive Integrated Moving Average) model, introduced by Box et al. (2015). Non-stationary time series data refers to time series data with unpredictable, unknown changes in the mean and variance. In time series forecasting, the most important components are the ARIMA components: the Autoregressive (AR) component, the Differencing (I) component, and the Moving Average (MA) component. These three components are then used to compute the time series, and their interaction ensures that past factors relevant to the series are always included in forecasting future values.

ARIMA model forecasting can support data-driven decision-making. According to Shmueli & Jr. (2017), forecasting using ARIMA in the public sector is a form of planning that aligns with the principles of structured implementation, which is based on a strong quantitative model, and the liberal school of thought in public sector economics. In this context, sukuk forecasting using the ARIMA model enables the fiscal authority to develop a financial plan that is more adaptable to economic circumstances. This paper will, instead of using market-efficiency arguments, use the Autoregressive Integrated Moving Average (ARIMA) model as a technology-oriented forecasting device to leverage time-series analyses and subsequent policy-oriented analyses. Forecasting with ARIMA models is particularly warranted when predicting policy-contingent stock variables, such as the remaining value of sovereign sukuk, and when past dynamics are instrumental in predicting medium-term fiscal plans.

There are a few studies that examine sukuk issuance and market volatility, but they focus mainly on flow variables and other market indicators (Aloui et al., 2015). This study is seeking to close that gap, such that in the case of the Indonesian market, the outstanding value of sovereign sukuk is treated as a stock variable. Sustaining the value of issued sukuk allows this study to contribute to the inter-temporal policy of debt and top in the fiscal space of the medium term, therefore extending the sukuk scholarship to the emergent sovereign debt stock and issuance-based sukuk research.

Methods

Data

The study employs a quantitative methodology, using a time-series analysis of 72 monthly data points on sovereign sukuk issued by Indonesia, covering the period from January 2019 to December 2019. Data were obtained from the Financial Services Authority (OJK) in Indonesia. There are both theoretical and practical reasons for using monthly data. The sample period captures the COVID-19 pandemic, potentially indicating a structural change in the government financing model. Such a change, however, is captured implicitly by the ARIMA model, thereby obviating the need for a structural breakpoint analysis (Box et al., 2015). The data were used as is, as the absence of a notable seasonal variation meant they were just as useful without seasonal adjustments.

In methodological terms, the use of monthly data strikes an optimal balance between the number of observations and the accuracy with which short-term movements are captured. A principle of time series analysis is that the greater the frequency of data capture, the greater the probability that a model will detect seasonality, cyclical movements, and turning points in trends (Box et al., 2015; Brockwell et al., 2002). Although the issuance and repayment of sovereign sukuk in Indonesia can be aligned with a monthly payment fiscal calendar, some processes, such as auctions for regular and retail sukuk and the issuance of green sukuk, tend to align with the fiscal month. Thus, prediction results tend to be more horizontal and align with the country's fiscal policy planning due to the use of monthly data.

Given the research's methodology and the practical application of the country's fiscal policy, a five-year forecasting horizon has been chosen. Within the State Financial Policy, the Government of Indonesia applies a Medium-Term Fiscal Policy (MTFF) spanning three to five years. Within such medium-term fiscal policy, the direction of fiscal policy, including strategies for financing the deficit and managing fiscal policy, is formulated. Thus, to comprehensively support the development of sustainable Sharia financing policies, Fiji's sukuk trading volume projections for the next five years would provide a relevant strategic input (Kementerian Keuangan Republik Indonesia, 2022).

To maintain model truth and balance it with model applicability in decision-making, a five-year frame was chosen. Time series predictions indicate that the longer the forecast period, the greater the uncertainty (Box et al., 2015). This means that five years is a good time frame for making predictions that are statistically reliable, while still providing a decent range for planning medium-term goals. Additionally, in five years, it would be possible to analyze a trend in sovereign sukuk as part of the sustainable financing agenda in the development of thematic sukuk, such as green sukuk and SDGs sukuk (OECD, 2020).

Model Specification and Forecasting Procedure

The study utilized one of the traditional yet highly effective methods for time series forecasting, the Autoregressive Integrated Moving Average (ARIMA) model, as developed by Box et al. (2015). This paper analyzes time-series forecasting using an ARIMA model for the outstanding value of sovereign sukuk, employing monthly data. The outstanding sukuk series captured high-frequency dynamics when analysed using monthly observations, even though the primary focus was on the non-seasonal trend. The model-building process comprises three primary components: identification, estimation, and diagnostic evaluation.

The first step in the stability test is to apply the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979). In the case of a non-stationary series, the difference is applied until the series becomes stationary. The series is usually logarithmically transformed for time-series analysis; however, in this case, the analyst chose to preserve the series at its original levels to maintain its simple interpretation in the context of fiscal planning. Following the achievement of stationarity within the data set, analysis of the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) graphs allows for the assignment of the p (autoregressive) and q (moving average) values, and the value of d (differencing) is attributed to the count of transformations necessary.

E-Views, a statistical software package, was used for model development and analysis, and parameter estimation was conducted using the Maximum Likelihood Estimation (MLE) method (Greene, 2018). A t-test was also conducted at the 5% significance level (P-value < 0.05). Among several considered criteria, the optimal model was selected based on the smallest Mean Squared Error (MSE), indicating the model's predictive accuracy, along with AIC and BIC, which indicate model efficiency. Furthermore, a residual diagnostic was performed to confirm that the residuals were white noise, with no autocorrelation (verified via autocorrelation and the Ljung-Box test), and to check for normality (verified via a histogram and Q-Q plots). When the residuals depicted a lack of randomness, the model structure was modified.

To comply with ARIMA modeling procedures, the first step is to test for stationarity using the Augmented Dickey-Fuller test, which will then determine the required order of differencing (Said & Dickey, 1984). Next, using the autocorrelation and partial autocorrelation diagnostics, the ARIMA specifications are formulated. Then, the full set of alternate ARIMA estimates is evaluated, and the model is chosen based on information loss, in this case using the Akaike Information Criterion and the Bayesian Information Criterion. Out-of-sample predictive performance is evaluated using a training window from January 2019 to December 2023 and a test window from January 2024 to December 2024. The two most common error metrics, Mean Absolute Percentage Error and Theil U, will be used to evaluate forecast accuracy. Predictions made using the ARIMA model will be evaluated against the benchmark and compared with a 'naive' model to provide a relative performance evaluation.

The forecasted outstanding value of sovereign sukuk and predictions up to 2029 (60 months into the future) will be based on the validated optimal model (Hyndman & Athanasopoulos, 2018). The predictions will be documented using point forecast(s) with the prediction set to a 95% confidence interval, i.e., the lower and upper bounds of the predictions. In addition, the results will be presented in a graph to facilitate better understanding and analysis of the future growth trend of sukuk for the purpose of Sharia-compliant risk management and fiscal policy planning.

Results and Discussion

Results

In time series analysis, stationarity is an important concept. A time series is said to be stationary if the mean and variance of the time series do not change with time, i.e., they remain constant, and the covariance is not time-dependent. If a time series is not stationary, then choosing a model is a futile exercise; it will produce incorrect estimates (spurious regression). The result of a spurious regression will yield a large value for the coefficient of determination (R2), suggesting a lack of a causal relationship or a statistically insignificant relationship between the dependent variable and the independent variables (Gujarati & Porter, 2009).

At the same time, the first option when working with a time series is to examine the model (Box et al., 2015). Stationarity is a key property of time series models, and failure to ensure it might lead to deficiencies in forecasts. One of the most popular methods for testing unit roots and, therefore, stationarity is the ADF (Augmented Dickey-Fuller) Test, named after its developers, Dickey and Fuller. To model time series data, the ADF test must be used to assess the presence of unit roots. If the data possess a unit root (i.e., are non-stationary), they must transform to achieve stationarity; this is accomplished through differencing.

The first stage of visual thinking is illustrated in Figure 2 and serves as the first step in the informal visual exploration of the pattern of stationarity before formal statistical testing. The vertical variable is the level of outstanding sovereign sukuk (measured in trillions of IDR), and the horizontal variable is time (monthly). The increasing trend in the graph's mean and the constant discrepancy in the variable's values around the mean indicate non-stationarity in the data. Thus, the mean and variance of the data can vary with time. The stationarity of the series needs to be confirmed using a unit root test, specifically the Augmented Dickey-Fuller (ADF) test. The test result serves as the basis for deciding whether a differencing process is needed before constructing an ARIMA model.

Figure 2. Plot of Outstanding Sukuk Before Unit Root Test

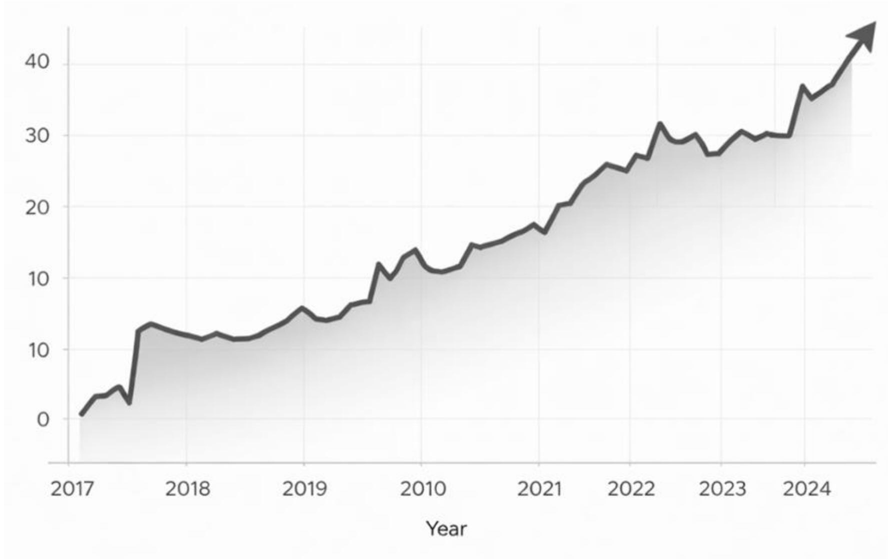


Table 1. SUKUK Data Stationarity Analysis Using Augmented Dickey-Fuller (ADF) Test.

Null Hypothesis: SUKUK has a unit root			
Exogenous: Constant			
Lag Length: 1 (Automatic - based on SIC, maxlag = 11)			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-0.047890	0.9503
Test critical values	1% Level	-3.527045	
	5% Level	-2.903566	
	10% Level	-2.589227	
MacKinnon (1996) one-sided p-values			

Table 1 shows the results of the Augmented Dickey-Fuller (ADF) test on the outstanding sovereign sukuk series. The test is done with an intercept, and the lag length is determined by the Akaike Information Criterion. The null hypothesis of a unit root cannot be rejected at the level series (ADF = -0.0479; p = 0.9503). After the first difference, the ADF value is significant (ADF = -11.4039; p < 0.01), which indicates that the series is stationary at first differences.

Table 2. SUKUK Data Stationarity Analysis After The First Differencing (1st Differentiation Level)

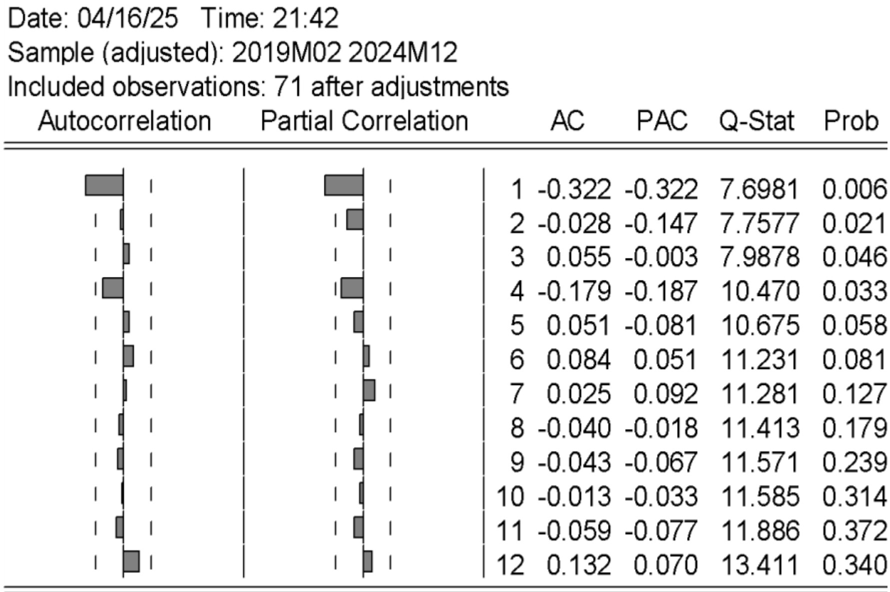
Null Hypothesis: D(SUKUK) has a unit root **Exogenous: Constant** **Lag Length: 0 (Automatic - based on SIC, maxlag = 11)**			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-11.40394	0.0001
Test critical values	1% Level	-3.527045	
	5% Level	-2.903566	
	10% Level	-2.589227	
MacKinnon (1996) one-sided p-values			

The analysis in Table 2 indicates that the data on sovereign sukuk satisfy the stationarity assumption, as indicated by the cumulative results of the unit root tests following the first differentiation. The vertical axis shows the first-differentiated outstanding sukuk volumes in IDR trillions, while the horizontal axis represents time in months. At the 5% significance level, the result of the unit root test indicates that the unit root test statistic is greater than the critical value, given that the unit root test statistic of -11.40394 is greater than -2.903566. Additionally, the p-value is less than 0.05 (p = 0.0001), confirming that the data are free of a unit root. Therefore, it can be concluded that the sovereign sukuk data are stationary in first differences (I(1)) and can be used in subsequent time-series modeling.

Simply put, a correlogram is a technique for analyzing the stationarity of time series data using autocorrelation, which is described using the notation of the autocorrelation function 0k and k(lag). To determine if the data is stationary or not, one has to compute the value of the autocorrelation function at every lag, or in other words, derive the autocorrelation function (ACF). So, one can draw a simple graph to estimate it regarding its stationarity.

Figure 3 shows the differentiated data plot. The values of the autocorrelation and partial autocorrelation that are out of the series are referred to as the correlogram. The ACF's significant limit for the autocorrelation coefficient used to examine time series data to determine whether a correlation pattern still exists is illustrated in the graph by a dotted line. Considering the results from both the ACF and PACF, no lag exceeds the significance threshold, indicating that the data have begun to satisfy the conditions for stationarity and that no pronounced pattern of autocorrelation is present. The similarity between the ACF and PACF suggests that differenced series can be modelled by an ARIMA specification. In this context, some of the candidate models, e.g., ARIMA (1,1,1) and ARIMA (1,1,0), may be considered for further evaluation.

Figure 3. Correlogram Output



Date: 04/16/25 Time: 21:42
Sample (adjusted): 2019M02 2024M12
Included observations: 71 after adjustments

	AC	PAC	Q-Stat	Prob
1	-0.322	-0.322	7.6981	0.006
2	-0.028	-0.147	7.7577	0.021
3	0.055	-0.003	7.9878	0.046
4	-0.179	-0.187	10.470	0.033
5	0.051	-0.081	10.675	0.058
6	0.084	0.051	11.231	0.081
7	0.025	0.092	11.281	0.127
8	-0.040	-0.018	11.413	0.179
9	-0.043	-0.067	11.571	0.239
10	-0.013	-0.033	11.585	0.314
11	-0.059	-0.077	11.886	0.372
12	0.132	0.070	13.411	0.340

The ARIMA estimation of the first-difference outstanding sukuk (D(SUKUK)) series for the period February 2019 to December 2024 yields an effective sample size of 71 (after first differencing from the initial 72 monthly observations). As reported in Table 3, the estimation results show that the F-statistic of 6.1477 ($p = 0.000934$) indicates that the model is statistically significant overall. The constant (C) and first-order autoregressive (AR(1)) terms are significant at the 1 percent level, with probabilities of 0.0000 and 0.0001, respectively. It indicates that the current outstanding sukuk shows the dominant changes from the previous period.

On the other hand, the first-order moving average (MA(1)) term is statistically insignificant, given its high standard error and probability of 0.9991. It indicates a failure to estimate the MA parameter due to either model misspecification or insufficient data to support the presence of the MA structure. The AR(1) component has a strong influence on this model, but it could be further optimized by either removing the MA(1) component or using a more appropriate ARIMA model.

Overall, as illustrated in Table 3, the ARIMA (1,1,1) model estimation of the first-differenced series of outstanding sukuk between February 2019 and December 2024 is statistically significant all around. The intercept as well as the AR(1) coefficient are both significant at the 1 percent level, thus, showing that changes in the outstanding sukuk are largely driven by the dynamics of outstanding sukuk that lag behind them. On the other hand, the MA(1) coefficient does not attain statistical significance with an extremely large standard error, indicating a poor identification of the moving-average component. Therefore, the data suggest that the ARIMA(1,1,1) specification might be over-parameterised and that a simpler (parsimonious) model, e.g. an ARIMA(1,1,0) one, is potentially capable of providing a more reliable and efficient fit to the observed data.

Table 3. ARIMA Model (1,1,1)

Dependent Variable: D(SUKUK)
Method: ARMA Maximum Likelihood (OPG – BHHH)
Date: 04/16/25 Time: 21:42
Sample: 2019M02 – 2024M12
Included Observations: 71
Note: Failure to improve objective (non-zero gradients) after 33 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.365235	0.028805	13.37411	0.0000
AR (1)	-0.583838	0.128831	-4.144851	0.0000
MA (1)	-1.000000	909.7925	-0.001099	0.9991
SIGMASQ	2.572371	52.04057	0.049530	0.9607
R-squared	-0.215852	Mean dependent var		0.450704
Adjusted R-squared	-0.180741	S.D. dependent var		1.824098
S.E. of regression	1.651014	Akaike info criterion		3.939113
Sum squared resid	182.6383	Schwarz criterion		4.085887
Log likelihood	-135.8833	Hannan-Quinn criter.		3.958065
F-statistic	14.47702	Durbin-Watson stat		2.056828
Prob (F-statistic)	0.000343			
Inverted AR Roots	0.54			
Inverted MA Roots	1.00			

The ARIMA model suggests that the most appropriate model for forecasting the changes (differenced) outstanding value of sovereign sukuk (D(SUKUK)) is ARIMA (1,1,0). The explanation for the differencing (d=1) is that the data is processed during the first differencing stage, which is presented to compute changes as opposed to the sukuk actual values (true values). In the first-order autoregressive (AR(1)) model, as shown in Table 4, the coefficient, -0.340476, is statistically significant at the 0.0000 level. He substantiates the existence of an influential relationship. The value worsened in previous periods, which has changed the present value. The 0.443738 constant value is also significant at the 5 percent significance level (p = 0.0142), which means the expected change in the value of (D(SUKUK)) is about 0.44. It implies that in the circumstances, there is no autoregressive effect. There was also no moving average (MA) component in this model (q=0), meaning it did not respond to past errors or shocks (value movements).

Table 4. Best ARIMA Model (1,1,0)

Dependent Variable: D(SUKUK)
Method: ARMA Maximum Likelihood (OPG – BHHH)
Date: 04/16/25 Time: 21:43
Sample: 2019M02 – 2024M12
Included Observations: 71
Convergence achieved after 31 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.443738	0.176288	2.517118	0.0142
AR (1)	-0.340476	0.078172	-4.737247	0.0000
SIGMASQ	2.919447	0.340752	8.554440	0.0000

R-squared	0.111424	Mean dependent var	0.460704
Adjusted R-squared	0.085289	S.D. dependent var	1.824098
S.E. of regression	1.744571	Akaike info criterion	3.939371
Sum squared resid	206.9612	Schwarz criterion	4.089657
Log likelihood	-138.7658	Hannan-Quinn criter.	4.031991
F-statistic	4.263459	Durbin-Watson stat	2.033300
Prob(F-statistic)	0.018014		
Inverted AR Roots	-0.34		

On the model's feasibility, the residuals are autocorrelated, as the value of Durbin-Watson equals 2.0335, and the AR-root 0.34 (which is less than 1). Therefore, the model is not nonstationary. Even though R-squared and Adjusted R-squared values are low at 0.111 and 0.085, respectively, this is the case with ARIMA models that are more forecasting-oriented than variance-explaining. Also, the F-statistic of 4.2635 and p-value of 0.0180 indicate that the overall model is significant. From all these metrics, it can be said that the ARIMA(1,1,0) model built with monthly data is applicable for short- and medium-term forecasting and, time-wise, for longer horizons, that is, the next 5 years or 60 months. When the data the model is based on are consistent and do not exhibit extreme structural changes, this model can still be used for long-term forecasting.

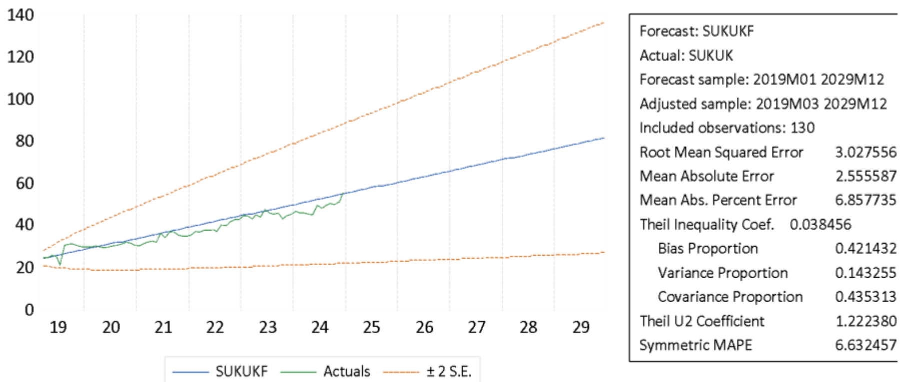
Figure 4. Ljung-Box Test on Residuals

Date: 04/16/25 Time: 21:43
Sample (adjusted): 2019M02 2024M12
Q-statistic probabilities adjusted for 1 ARMA term

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.059	-0.059	0.2556	
		2	-0.141	-0.145	1.7470	0.186
		3	-0.006	-0.025	1.7498	0.417
		4	-0.191	-0.218	4.5579	0.207
		5	0.027	-0.008	4.6136	0.329
		6	0.136	0.078	6.0931	0.297
		7	0.021	0.034	6.1291	0.409
		8	-0.053	-0.059	6.3644	0.498
		9	-0.069	-0.064	6.7624	0.562
		10	-0.050	-0.036	6.9748	0.640
		11	-0.023	-0.047	7.0191	0.724
		12	0.096	0.046	7.8272	0.729

The Ljung-Box test was performed considering the sample periods from February 2019 to December 2024. As in Figure 4. From the test description, the model is a set of residuals, i.e., the data captured, and correlations are computed to see whether any exist among the model's internal attributes. There is little or no autocorrelation at the 5% significance level, indicating no or little random residuals. This is to test the residuals that describe the model or structure, to determine whether the ARMA model sufficiently explains the data. The absence of autocorrelation in the model indicates that it has captured and described the data's essential underlying structure, and it is therefore ready to be applied for forecasting (Gujarati & Porter, 2009). After choosing the best ARIMA model based on model diagnostics and selection criteria, the next step is to use it for forecasting. Based on previously processed and analyzed data, the model should project future values. Figure 5 illustrates the extended duration of the SUKUKF from January 2025 to December 2029.

Figure 5. Indonesian Outstanding Sovereign Sukuk Forecasting Result



The results from the ARIMA approach for the outstanding sovereign sukuk indicate that the model can provide accurate forecasts and should be relied upon to analyze trends in the medium- and long-term. This model has a Mean Absolute Percentage Error (MAPE) of 6.86% and a Symmetric MAPE of 6.63%, both of which are considered good (Lewis, 1982). While the ARIMA model shows adequate in-sample performance, the model's Theil U2 is greater than 1; thus, its out-of-sample performance does not exceed that of the naive model. Consequently, the predictions must be treated as forecast-based for medium-term fiscal planning, rather than as precise point estimates. The gap between actual and forecast outcomes is still statistically reasonable, as evidenced by the RMSE of 3.03 and MAE of 2.56, which is not without value (Makridakis et al., 1998).

Furthermore, the Theil Inequality Coefficient of 0.038 indicates a good level of predictive efficiency, while the Theil U2 Coefficient of 1.22 indicates that the model performs worse than the naive forecasting approach. The U2 value, which is above 1, is the main reason the ARIMA model is retained despite its poor performance relative to a naive benchmark on the other point-forecast outcomes. Nonetheless, the model continues to provide useful insight for developing strategies for the government financing of Sukuk. The 42.1% imbalance indicates that further model development to reduce systematic errors (bias) between actual and predicted values is feasible. The time-varying proportion of covariance, which is moderately high (43.5%), indicates that the model has been highly effective in demonstrating the overall trend in Sukuk data (Pindyck et al., 1998). Theil's U2 is greater than one, which indicates that the ARIMA forecasts may not perform better than a naive benchmark for out-of-sample prediction. Considering the model's univariate nature and the controllable policy nature of the sovereign debt stock, this is understandable. Moreover, the R-Squared value is quite small, and one must tread carefully when interpreting it, since ARIMA models are built on differenced series and are evaluated not on standard fit measures but on their ability to capture the underlying temporal patterns. In this paper, the forecasting exercise is intended to provide examples of trends for medium-term debt management, rather than emphasizing short-term predictive accuracy.

Visually examining the projected Sukuk values shows they are consistent with the trends, and most points fall within the 95% confidence interval (2 standard errors). This indicates the model works well within the parameters of Sharia finance for budgeting and financial policy formulation. This also shows that forecasting tools are suitable for the Sukuk portfolio management, especially for the development of sustainable infrastructure. In the future, model improvement will be possible by including seasonal and other external macro factors, and/or by applying machine learning to enhance the accuracy and usefulness of the policy recommendations. The table 5 and Figure 6 for forecasting outcomes, along with the annual trillion-rupiah graphs with monthly breakdowns for 2025 to 2029, illustrate this phenomenon to some degree. Sovereign Sukuk Forecasting 2025 (in Trillion IDR).

Table 5. Indonesian Sovereign Sukuk Forecasting 2025-2029 (in Trillion IDR)

Month (Periode)	2025	2026	2027	2028	2029
January (M01)	55.19	60.52	65.84	71.17	76.49
February (M02)	55.64	60.96	66.29	71.61	76.94
March (M03)	56.08	61.41	66.73	72.05	77.38
April (M04)	56.52	61.85	67.17	72.50	77.82
May (M05)	56.97	62.29	67.62	72.94	78.27
June (M06)	57.41	62.73	68.06	73.39	78.71
July (M07)	57.86	63.18	68.50	73.83	79.60
August (M08)	58.30	63.62	68.95	74.27	80.04
September (M09)	58.74	64.07	69.39	74.72	80.49
October (M10)	59.19	64.51	69.84	75.16	80.49
November (M11)	59.63	64.95	70.28	75.60	80.93
December (M12)	60.07	65.40	70.72	76.05	81.37

Figure 6. Indonesian Sovereign Sukuk Forecasting 2025-2029

The predictions of the outstanding sovereign sukuk of Indonesia are shown in Table 5, based on the confirmed ARIMA(1,1,0) model. The outcomes show that the outstanding value is steadily growing up with the outstanding value to reach higher levels with the outstanding value projected to go up as far as IDR 55.19 trillion in January 2025 up to around IDR 81.37 trillion in December 2029. The smooth path depicts medium-term fiscal dynamics based on the past issuance patterns. Being a univariate model, the forecasts are expected to be treated as baseline trend forecasts, assuming that there are no significant structural shocks, and so form part of the reference to medium term sovereign debt planning.

Discussion

Trend Projection

The projected results indicate consistent growth in Indonesia's outstanding sovereign sukuk from 2025 to 2029. The outstanding amount is projected to grow from IDR 60.07 trillion in 2025 to IDR 81.37 trillion in 2029, with a Compound Average Annual Growth Rate (CAGR) of 7.9 percent. The estimates are based on the univariate ARIMA model, a time-series forecasting model commonly used for trend extension, assuming that past issuance and redemption patterns of the sukuk series will remain constant (Box et al., 2015; Hyndman & Athanasopoulos, 2018). Findings from such an analysis are typically treated as trend forecasts, ignoring other potential (and usually untracked) market-related or economic causal relationships, particularly in the case of sukuk series (Makridakis et al., 1998).

Debt Planning

In public finance, the potential increase in outstanding sukuk may inform medium-term sovereign debt planning. More outstanding sukuk means higher refinancing costs and budgetary constraints for long-term debt service. In this regard, sukuk are not merely Sharia-compliant financing instruments. They also become essential within public debt management frameworks, especially in times of fiscal stress (Naz et al., 2025). The COVID-19 crisis demonstrated that sukuk can be a flexible financing tool during periods of revenue collapse and increased spending. Thus, many governments, including Indonesia, employed sukuk to fund economic recovery initiatives (International Monetary Fund, 2021). Unlike sovereign loyalty or investor confidence, the results of the forecasts primarily relate to the need to integrate the volume of sukuk issuance with the prevailing debt sustainability and risk appetite.

Sustainability Relevance

Sustainable financing predictions must be taken with a grain of salt. While sovereign sukuk are often referenced for sustainability in policy discussions, univariate forecasts of outstanding sukuk stock should not be associated with sustainable outcomes (World Bank & Islamic Development Bank, 2021). There must be sustainability measurement criteria, and those criteria should be definable and measurable. This includes, but is not limited to, the measurement of thematic sukuk (green and SDG sukuk), the sectoral distribution of sukuk-financed projects, and the presence of ESG reports (OECD, 2021). In the context of SRI Sukuk, Malaysia exemplifies best how sustainability is served by a cohesive combination of frameworks and institutional structures rather than merely larger volumes of outstanding sukuk. In this regard, the projected volumes of outstanding Indonesian sukuk are expected to create fiscal space for sustainability-aligned instruments. Within sustainable financing, however, this will primarily be determined by the issuance mix, the sectors funded, and the ESG score, which will require additional research to support sustainability claims beyond total outstanding debt.

Conclusion

The current study describes the trends and forecasts for Government Sukuk (SBSN) trading in Indonesia. The model predicts that the outstanding sovereign sukuk value will reach IDR 81.37 trillion in 2029. Time series analysis shows the first data point is non-stationary due to long-term trends, but stationarity is achieved after the first differentiation. ADF tests and ACF and PACF analyses indicate ARIMA(1,1,0) as the best-fitting model. The state's economy exhibits positive SBSN growth as forecasted, but not beyond 2029. The forecast grows over time, as shown by the widening forecast interval, which considers macroeconomic processes and changing market conditions, and should be as introspective as possible. The results suggest that government sukuk can finance development and provide Sharia-compliant options, but management is needed to address medium- and long-term uncertainties. The ARIMA model is a primary tool. Still, more complex market conditions call for advanced forecasting techniques.

The Indonesian government is poised to enhance the country’s sukuk-based financing approach, which, given the uncertainty in medium- to long-term economic outlooks, is more flexible and better at forecasting key economic indicators. This can be accomplished via sukuk diversification, such as the incremental development of green and SDGs sukuk, as well as the expansion of retail sukuk to finance all tiers of sustainable development. In this regard, the expansion of the sukuk investors’ base, both domestically and internationally, is essential. In this regard, the government can enhance sukuk financing and sustainable development cash flow to investors via protective fiscal window(s) and green and SDGs sukuk financing, coupled with sukuk and sustainable development cash flow positive economic regulations, and active promotion of sharia-compliant sukuk to the international market.

The Monitoring and evaluation systems, from a Technology viewpoint, need to be reinforced periodically when it comes to forecasting models for sovereign sukuk. The development of sophisticated nonlinear models is highly encouraged, particularly Long Short-Term Memory (LSTM) models and Prophet, since they are more likely to succeed in forecasting complex and turbulent data as opposed to linear models. Research problems of such nature could also be used to address macroeconomic factors such as interest rate, inflation, and exchange rate to ascertain and evaluate the likely determinants of the sovereign`s dynamic behavior.

Poor Shariah financial literacy also needs to be addressed to foster greater participation and deepen the outreach of sovereign sukuk as a tangible investment option. It is also suggested that the relevant authorities, including the Government, use more digital means of educating people on Shariah finance, among other things. Last but not least, there is also the improvement of the use of sovereign sukuk as a priority. This should be addressed to the government to pursue and implement such initiatives in a more targeted manner, since they will have great value in the long run with respect to community welfare and the sustainability of the country's economy.

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