1. **Abstract**

This research critically examines and forecasts GDP growth using a combination of ARIMA models and Ordinary Least Squares (OLS) regression. GDP growth, a crucial economic indicator representing year-on-year economic performance, is analysed over a historical dataset spanning 69 years. The study evaluates the appropriateness of ARIMA models with varying configurations, including ARIMA(0,1,1), ARIMA(1,2,1), and ARIMA(2,1,1), as well as an OLS regression model incorporating a time trend. Stationarity tests such as the Augmented Dickey-Fuller (ADF) and KPSS tests are employed to verify the suitability of the data for time-series analysis. Model performance is evaluated using standard metrics like AIC, BIC, RMSE, and MAE, alongside diagnostic checks for autocorrelation and heteroskedasticity.

1. **Methodology**

**1) Data Preparation**

* The GDP growth dataset, spanning 69 years, was transformed into a time-series format, enabling temporal analysis and forecasting.
* Stationarity of the dataset was evaluated using the Augmented Dickey-Fuller (ADF) and KPSS tests. While the ADF test indicated stationarity after first differencing, the KPSS test further reinforced the need to maintain the dataset at the first differencing level.

**2) Model Development**

* **ARIMA Models:** 
  + Three configurations were examined: ARIMA(0,1,1), ARIMA(1,2,1), and ARIMA(2,1,1).
  + ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function) plots guided model selection, ensuring the correct identification of autoregressive and moving average terms.
  + Five-year forecasts were generated for each ARIMA model, with model diagnostics evaluated for accuracy and residual quality.
* **OLS Regression:** 
  + A time-trend model was developed to capture linear growth patterns in GDP growth rates.
  + Diagnostic tests, including the Breusch-Pagan test for heteroskedasticity and the Durbin-Watson test for autocorrelation, were performed to validate model assumptions.

**3) Model Evaluation**

* **Key Metrics:** 
  + Model Fit: AIC and BIC values were used to assess model fit, with lower values indicating better balance between accuracy and complexity.
  + Forecast Accuracy: RMSE, MAE, and MAPE were calculated to evaluate the accuracy of each model's forecasts.
  + Residual Diagnostics: Tests for heteroskedasticity and autocorrelation were conducted, with the Ljung-Box test applied to ARIMA residuals and the Durbin-Watson statistic calculated for OLS residuals.

**4) Forecast Validation**

* Forecasts from all models were compared to assess predictive reliability and accuracy. Confidence intervals for each forecast were analyzed, with narrower intervals indicating greater certainty in predictions.
* ARIMA(2,1,1) and OLS regression emerged as the most accurate models, with ARIMA(2,1,1) capturing both autoregressive and moving averagepatterns effectively, **a**nd **OLS providing robust linear growth trends.**

1. **Results**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Model | ME | RMSE | MAE | AIC | BIC | Forecast 2024 (Point) | Range (95% CI) | Autocor  P value |
| ARIMA(0,1,1) | 0.46 | 2.79 | |  | | --- | | 2.17 |  |  | | --- | |  | | |  | | --- | | 339.14 |  |  | | --- | |  | | 343.58 | |  | | --- | | 6.36 |  |  | | --- | |  | | [0.73, 12.00] | 0.1047 |
| ARIMA(1,2,1) | 0.15 | |  | | --- | | 3.43 |  |  | | --- | |  | | 2.52 | |  | | --- | | 368.61 |  |  | | --- | |  | | |  | | --- | | 375.22 |  |  | | --- | |  | | 4.98 | [-6.61, 16.57] | 0.006366 |
| ARIMA(2,1,1) | 0.15 | 2.71 | 2.14 | 339.81 | 348.69 | |  | | --- | | 6.56 |  |  | | --- | |  | | [0.98, 12.15] | 0.0246 |
| OLS |  | 2.68 |  | 335.75 | 342.46 | 7.31 |  | dw = 2.3 |

The table highlights the performance and diagnostic metrics of different models for forecasting GDP growth. Among the ARIMA models, ARIMA(2,1,1) emerges as the most reliable, with the lowest RMSE (2.71) and MAE (2.14), along with competitive AIC and BIC values, indicating a good balance of accuracy and model fit. In contrast, ARIMA(1,2,1) performs poorly, with the highest AIC (368.61) and BIC (375.22), significant autocorrelation in residuals (Ljung-Box p-value = 0.006366), and overly broad forecast confidence intervals, reflecting high uncertainty. The OLS model also performs well, with a Durbin-Watson statistic of 2.3, indicating no autocorrelation and consistent forecasts.

ARIMA(1,2,1)'s poor performance stems from conceptual and statistical flaws. The second differencing applied in this model is unnecessary and distorts trends, as GDP growth is already a first-differenced metric. This over-differencing leads to significant residual autocorrelation and inflated uncertainty in forecasts. In contrast, ARIMA(2,1,1) and OLS capture trends more effectively, providing accurate and reliable predictions. The findings demonstrate that ARIMA(1,2,1), as suggested in the original research, is unsuitable for forecasting GDP growth, while ARIMA(2,1,1) and OLS are the most accurate models.