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AUTOREGRESSIVE INTEGRATED MOVING AVERAGE MODEL FOR EVALUATION OF THE IMPACT OF INSURANCE SCHEMES ON MANUFACTURURING INDUSTRIES IN NIGERIA

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Abstract: The study focus on impact of insurance business for manufacturing industries in Nigeria using a 41 years' data from 1981 to 2022 extracted from the CBN Statistical Bulletin, (2022). The Augmented Dickey-fuller (ADF), unit root was used to examine the stationarity of the data and the Box-Jenkins ARIMA time series methodology was used for analysis and for making future forecasts. The data showed an upward trend in the series and the result of the Augmented Dickey-Fuller (ADF) unit root test on insurance data, indicating non-stationarity in the time series. The test results show insufficient evidence to reject the null hypothesis of a unit root, suggesting nonstationarity while ARIMA (1,1,1) being selected based on criteria such as the Akaike, Schwarz, and Hannan-Quinn criteria. Conclusively, ARIMA (1,1,1) was the best fit model to forecast the insurance business in Nigeria. Likewise, from the result of the forecasts for insurance business in manufacturing industries in Nigeria from 2023 to 2027. The forecast suggests a steady increase in insurance business over the forecasted period. It was recommended that the Insurance companies should employs techniques such as data differencing to investigate underlying factors contributing to non-stationarity could enhance the robustness of the analysis. Government should consider implementing interventions and initiatives aimed at fostering growth and sustainability in the insurance sector.

Keywords: Stationarity, ARIMA, Insurance, Akaike Information criteria, Augumented Dickey-Fuller

1.0 Introduction

The manufacturing sector is a critical component of Nigeria's economy, contributing significantly to employment and gross domestic product (Onodje, & Farayibi, 2020.). Usman (2024) highlighted that the sector faces numerous challenges, including financial risks that can impede growth and sustainability. Insurance schemes are designed to mitigate these risks, yet their effectiveness in influencing manufacturing performance remains underexplored (Inyang, Orji., Okparaka, & Okeke,n.d). Udokang,and Olafuyi,(2023).opined that the challenges in manufacturing industries stem from a combination of regulatory issues, infrastructural inadequacies, low insurance penetration and a general lack of trust in insurance providers. Regulatory demands on insurance in Nigeria significantly impact insurers' business processes, with strict compliance requirements often diverting resources away from core activities (Inyang, & Okonkwo,2021; Shoyemi,2024). Soetan, and Magahi, (2024) pointed out that the National Insurance Commission (NAICOM) has implemented policies that require higher paid-up capital for insurance companies, which can strain smaller firms and limit their ability to innovate or expand their services. Insurance penetration rate in Nigeria is relatively lower than the African average estimated penetration. This low penetration reflects a lack of awareness and understanding of insurance products among manufacturers, leading to inadequate coverage against risks such as equipment breakdown, product recalls, and theft during transit (Nwaizugbo, & Danjuma,2022). The Nigerian insurance market suffers from a lack of product diversity, which restricts its ability to cater for the specific needs of manufacturers (Owuna, Henry, & Odonye,n.d., Horvey, Odei-Mensah, & Liebenberg, 2024). Dawodu,Omotosho., Akindote,.,Adegbite and Ewuga,(2023) asserted that many accesible insurance products in nigeria do not adequately address emerging risks associated with modern manufacturing processes such as cyber threats and environmental liabilities.Inadequate infrastructure is another critical challenge facing the Nigerian insurance industry(Ohonba, & Ogbeide,2023).

In attempt to evaluating the impact of insurance schemes on manufacturing industries, the Autoregressive Integrated Moving Average (ARIMA) model could serve as an essential framework due to its capability in assessing fluctuations in insurance premiums and measure its influence on manufacturing output and economic performance. The ARIMA model is a widely utilized statistical method for analyzing and forecasting time series data (Dimri, Ahmad, & Sharif,2020). ARIMA combines essential features such autoregression, differencing, and moving averages to model non-stationary data effectively (Arumugam, & Natarajan,2023; Singh, Parmar, Kumar, & Makkhan, 2020). ARIMA models are particularly advantageous in situations where they have been used to forecast production indicators by accounting for trends and seasonal variations. Fatima and Rahimi (2024) stated that the ability of ARIMA model to handle complex time series data makes it suitable for evaluating the interdependencies between insurance schemes and manufacturing output. The focus of this work is to explore the potential of ARIMA models to examine the impact of insurance on manufacturing industries and make a forecast based on the most appropriate ARIMA model.

2.0 **Methodology**

This data for this study is secondary data covering a period of 41 years i.e. 1981 – 2022 obtained from the statistical record of the world bank. The ARIMA model was adopted for the analysis to explore the features of the mode in handling the data. Autoregression component models the relationship between an observation and a number of lagged observations. Integrated component works on differencing to attain stationarity and moving Average component models the relationship between an observation and a residual error from a moving average model applied to lagged observations.

A more General model is a mixture of the AR (p) and MA (q) models and is called autoregressive moving-average model, ARMA (p, q) model.
Where AR(p) is of the type

$$X_t = c + \sum_{i=1}^{p} \Theta_i X_{t-1} + \epsilon_t$$

And MA(p) is

$$X_t = \epsilon_t + \sum_{i=1}^{p} \varphi_i \epsilon_{t-1}$$

Combining the two models, we have *ARMA*(*p*,*q*) where *p* is the order of the AR and *q* is the MA part. For ARMA to function very well the roots of *AR*(*p*) should be stationary and the *MA*(*q*) roots should be invertible. The *ARIMA* (*p*,*q*) is given as:

$$X_t = \epsilon_t + \sum_{i=1}^{p} \varphi_i \epsilon_{t-1} + \sum_{i=1}^{q} \Theta_i \epsilon_{t-}$$

The *ARMA*(p,q) model above can be expressed as

$$(1-\boldsymbol{\varphi}_1 B - \boldsymbol{\varphi}_2 B^2 - \dots - \boldsymbol{\varphi}_P B^P)\, y_t = \Theta_0 + (1 + \Theta_1 B + \Theta_1 B^2 + \dots + \Theta_p B^p)\epsilon_t$$

Where B is the backward shift operation that is

$B_k Y_t = Y_{t-k}$ for k +ve integer

$$\varnothing(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \ldots - \varphi_P B^P$$

3.0 Results and Discussion

The descriptive statistics provides some information about the data.The average provides a general idea of the overall level of insurance activity during this period of the insurance business over the sampled years is approximately with a mean of 164.48.The the peak of the insurance activity is attained 647.15 with a median lower than the mean.

Table 1 presents the results of the Augmented Dickey-Fuller (ADF) unit root test on the variable INSURANCE indicate that the null hypothesis, which states that the series has a unit root (and is thus non-stationary), cannot be rejected. It is evident that the exists a unit root in the dataset.The ADF test statistic of 2.669739 is significantly higher than all critical values at the 1%, 5%, and 10% levels, indicating that it does not fall into the rejection region for any of these significance levels. Typically, if the test statistic is more negative than the critical value, one would reject the null hypothesis of a unit root, suggesting stationarity in the series.The p-value of 1.0000 is extremely high, far exceeding common significance levels (e.g., 0.01, 0.05, or 0.10). This reinforces the conclusion that there is insufficient evidence to reject the null hypothesis. Since both the ADF test statistic and the p-value indicate that we fail to reject the null hypothesis, we conclude that the series _INSURANCE is likely non-stationary and possesses a unit root. This suggests the need for differencing or other transformations to achieve stationarity before further modeling can be performed.

Table1: Augmented Dickey-Fuller unit root test on INSURANCE

Null Hypothesis: _INSURANCE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.669739	1.0000
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(_INSURANCE)
Method: Least Squares
Date: 03/03/24 Time: 07:35
Sample (adjusted): 1982 2022
Included observations: 41 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
_INSURANCE(-1)	0.058318	0.021844	2.669739	0.0110
C	6.806430	5.377378	1.265753	0.2131

R-squared	0.154518	Mean dependent var	15.71226
Adjusted R-squared	0.132838	S.D. dependent var	29.00079
S.E. of regression	27.00597	Akaike info criterion	9.477544
Sum squared resid	28443.57	Schwarz criterion	9.561132
Log likelihood	-192.2896	Hannan-Quinn criter.	9.507982
F-statistic	7.127507	Durbin-Watson stat	1.690334
Prob(F-statistic)	0.011009		

The regression output shows an R-squared value of approximately 0.1545, indicating that only about 15% of the variance in the differenced variable can be explained by its lagged values and constant term. The Durbin-Watson statistic of 1.690334 suggests some degree of autocorrelation in the residuals. In summary, the ADF test results suggest that _INSURANCE is non-stationary due to a unit root, necessitating further steps to stabilize the series for effective time series analysis

Table 2: Result for model Identification ARIMA (p,d,q)

The result in table 2 shows the test of various ARIMA models to determine the best ARIMA model to use for the data using the selected criterons, Akaike criterion, Schwarz criterion and Hannah-quinn criterion. It is seen that ARIMA (1,1,1) since it has the least value from all the models with respect to all the criterions used

	Model	Akaike Criterion	Schwarz-Criterion	Hannah-Quinn
1	ARIMA (1,1,0)	5.099465	5.239585	5.144291
2	**ARIMA (1,1,1)**	**5.012442**	**5.199268**	**5.072209**
3	ARIMA (1,0,2)	5.025543	5.212369	5.08531
4	ARIMA (0,1,3)	5.156655	5.343482	5.216423
5	ARIMA (2,1,2)	5.458505	5.645332	5.518273

It can be deduced that ARIMA (1,1,1) is the appropriate model for the analysis. The estimates of the parameter presented in table 3 are computed to adequately model the scenario based on the transformed data.

Table 3: estimated parameter of ARIMA (1,1,1)

	Coefficient	Standard error	Z-test	p-value
Constant	0.821493	0.170545	4.816863	0.0001
theta-1	-0.2218	0.305571	-0.72585	0.4744
theta-2	-0.6645	0.270296	-2.45841	0.0209

The final ARIMA model for the data is represented as;

The selected ARIMA model equation is given thus;

$$Y_t = c + \emptyset_1 y_{t-1} + \emptyset_1 e_{t-1} + \emptyset_2 y_{t-2}$$

$$Y_t = 0.821493 + -0.6645 e_{t-1} - 0.2218 y_{t-2}$$

This model is used to predict for the years 2023 to 2027 as shown in table 4. The estimated value of 786.17998 for 2023 rise to 786.23943 and 786.29277 in 2024 and 2025 which also rise to 786.34063 and attain 786.38358.

Table 4:

Year	2023	2024	2025	2026	2026
Forecast	786.17998	786.17998	786.17998	786.17998	786.17998

4.0 **Conclusion**

The result of the analysis on the impact of insurance on manufacturing industries revealed non-stationary case in the data based on the ADF unit root test which required differencing to achieve stationary data for reliable forecast. ARIMA (1,1,1) gives the most appropriate model on the basis of the model performance indicators. The ARIMA (1,1,1) model was used to predict for 5 years. The prediction revealed a steady growth in the values over the year which indicate a relatively low impact of insurance scheme on manufacturing industries. Further studies can be carried out to gain adequate understanding with goal of improving the impact of insurance on manufacturing industries and other sectors.

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