Financial Economics Letters

Homepage: https://www.anserpress.org/journal/fel

# Nexus Between Asset Class Volatility and the Output ap in Nigeria: A Bayesian Var Approach

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## ABSTRACT

Excessive volatility in financial markets can disrupt economic activity, affect investor and consumer confidence, and potentially lead to financial crises in an economy. Due to this backdrop, this study examined the link between asset class volatility and the output gap in Nigeria. The asset classes were categorized into stock, crude, gold, and bitcoin. The study adopted the ARCH and Bayesian VAR approach and found that all share index has an initial negative impulse with output gap while other asset classes have a positive impulse on output gap. The outcome of this study revealed to both policymakers and economists the potential risks and vulnerabilities of asset class volatility in the economy. Based on this result, recommendations are made amongst which is the strengthening of the Nigerian stock market to help with the inflationary pressures this is because the Nigerian stock market hurt the output gap also, the government should prioritize investing in crude, gold, and bitcoin to push the actual output to full capacity, which brings about employment.

## KEYWORDS

Asset Classes, Output ap, ARCH, Bayesian VAR, Nigeria

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ISSN 2972-3426
doi: 10.58567/fel03010004


Received date 11 December 2023; Accepted date 5 January 2024; Available online date 19 January 2024; Version of Record 19 January 2024

## 1. Introduction

Asset class volatility can vary over time and is influenced by various factors specific to each asset class and region. Investors must consider their risk tolerance, diversify their portfolios, and stay informed about market conditions when investing in different asset classes across the world. This period of the 21st century has seen a rise in globalization in financial markets due to the gradual removal of trade barriers among countries, this has in turn brought about an easy flow of information on the stock market, oil prices, and currencies. Removal of trade barriers has also led to different shock transmissions ranging from climate change, COVID-19, gender equality, and technology. This uncertainty has brought about various distortions in the actual growth of most economies and placed them in different points of growth horizon which is not in line with their trend. Therefore, the output gap in the said economies is widening.

Output gap is majorly used to detect cyclical position in an economy such as the level of recession and progress. Billmeier (201 4) claimed that the output gap is a widely used indicator of the economy's cyclical position and degree of slack. A country's investment landscape can be influenced by regulatory changes and political factors. Sudden policy shifts, changes in government, or regulatory interventions can introduce additional volatility and uncertainty into the market. Volatility can impact market liquidity, making it harder to buy or sell assets at desired prices. Investors analyze the modes of the stock and share prices to make a profit. When there is a fall in the stock market, most investors search for a different asset class to invest in, they most times divert their money into gold and cryptocurrency. Asset class volatility can have implications for economic stability. That is excessive volatility in Asset class can disrupt economic activity, affect investor and consumer confidence, and potentially lead to financial crises. Notwithstanding, the question that remains to be answered is whether financial asset class volatility is responsible for the widening of the output gap in Nigeria.

Empirically, the studies on the link between asset class volatility and the output are vast and conflicting. Some of the studies include; Ogunmuyiwa (2010), Henry and Olabanji (2013), Chijindu and Ifunanya (2017), Olabisi et al. (2017), Heiberger (2018), Ebun, Olusuyi, and Michael (2018), Chinyere et al. (2019), Ezenduka and Joseph (2020), Chukwuka and Nzotta (2020), Akinmade, Adedoyin, and Bekun (2020) and Adigun and Okhankhuele (2021) investigated the relationship between stock and output in Nigeria. Nweze and Edame (2016), Ishmael, Terry, and Park (2017), Omitogun, Longe, and Muhammad (2018), Michael and Oyeyemi (2018), Olayongbo (2019), and Chigozie and Nyatanga (2020) researched on crude and output in Nigeria. Paul and Mmeyene-Abasi (2022) investigated the relationship between gold on output, while Ahmed 2021 looked at the nexus between bitcoin and output. It is worthy of note, that the existing literature on the subject matter which is based on different countries, data, and varied econometric approaches failed to provide conclusive results. Therefore, there is a need for increased empirical examination of the impact of asset class volatility on the output gap.

## 2. Literature Review

### *2.1. Conceptual Clarification*

#### 2.1.1. Output ap

Efstathiou (2019) sees the output gap as the discrepancy between real DP and an unobservable indicator of its potential. According to Majaski (2021), the output gap is referred to as the difference between an economy's actual and potential output. udmundsson, Mark iac, and Barkema (2020) asserted that the position of countries' business cycles is often gauged using output gaps. Due to the difficulties in calculating potential output, their value for real-time policymaking is contested. In the same vein, potential output is defined as the maximum number of products and services that an economy can produce at its peak efficiency, or when it is operating at capacity.

Potential output is frequently referred to as the economy's production capacity. The production gap can move in either a positive or negative direction, like how DP can increase or decrease. Both are not ideal. When actual output exceeds output at full capacity, there is a positive output gap. This occurs when demand is extremely high and workers labor beyond their most productive capabilities to meet that demand. When actual output is lower than what an economy could produce at maximum capacity, there is a negative output gap. A negative gap indicates that the economy has slacked because of low demand. An output gap indicates that an economy is operating inefficiently, either by using too many or too few of its resources.

In line with these different concepts of output gap, we can say that output gap is simply the difference between actual output and potential output in an economy. A positive output gap means that the actual is greater than the potential while the negative gap means that the potential is greater than the actual. None of these is better, because the positive output gap means that the economy is been overworked and the demand is higher than what is been produced, though we believe that demand creates its supply, therefore in the long run a new potential output would be created. A lower output gap means that the economy is operating below capacity due to low demand which means the growth rate would be significantly low.

The output gap would serve as a better objective than economic growth because of the estimation of the potential gap which the normal economic growth, doesn't possess. (Satti and Malik, 2017) believe that the five approaches of estimating output gap are the Hordrick-Prescott (HP) filter, production function, linear trend method, quadratic trend method, and structural VAR are typically used to de-trend, or remove the cyclical component of the actual output, to generate potential output. Pedro and Adesina-Uthman. (2022) made use of the HP filter to estimate the potential gap and output gap for the Nigerian economy.

### 2.1.2. Asset Classes

Yarovaya and Nasir (2021) were of the view that financial asset classes could be made up of bitcoin, gold, oil, and the dollar, in their work. Similarly, Bhuiyan, Husain, and Zhang. (2021) in their work, the causal relationship between bitcoin and conventional asset classes, classified asset classes as gold, currency, oil, commodity, and the S&P lobal 100. Pham and Nguyen (2021) in their study, asymmetric tail dependence between green bonds and other asset classes in US and European asset markets between 2014 October and 2021 February classified asset classes as treasury bonds, corporate bonds, energy markets, and stock markets while Mensi, et al (2022) in their study, pricing efficiency and asymmetric multi-fractality of major asset classes before and during Covid-19, were of the view that asset classes consist of S&P500, US Treasury bond, US dollar index, Bitcoin, and Brent oil. Furthermore, Aharon and Demir (2022), were of the view that asset classes are classified as gold, equities, currencies, bonds, and cryptocurrencies. Yousaf, Pham, and oodell (2023) classified asset classes as oil, gold, stocks, Bitcoin, fiat currencies, and bonds.

Based on the different classifications of Asset classes, it can be concluded that asset class is a grouping of comparable financial securities, which can be in different forms as hedging assets as well as offset risk. Thus, stock assets, which mirror the growth of an economy, and hedging assets which consist of crude oil, gold, and bitcoin, are the asset classes to be examined. The use of these asset classes in this study is because of the hedging characteristics that they have in common and the volatility that they portray in their trend.

We also used these asset classes because it has been backed up by kinds of literature, and since we are dealing with business cycles that concern boom and crisis, given that bitcoin and gold are both seen as safe havens during times of crisis, gold, and Bitcoin have drawn the most attention of all the asset classes (see, for example, Baur & McDermott, (2010); Reboredo (2013); Yousaf et al., (2021) (for gold); Shahzad, Bouri, et al., (2019); Bouri et al., (2020) (for Bitcoin). On the other hand, Antonakakis et al (2020) used asset classes, such as stock and oil prices, to investigate investment strategies and hedging effectiveness. Since we are dealing with the business cycle,

therefore we made use of asset classes such as bitcoin and gold. We also included hedging assets which include stock and oil prices.

## 2.2. Theoretical Literature

**The production function theory of output gap**

The production function approach, which is now used by the OECD (see iorno et al., 1995), the IMF (De Masi , 1997), and the CBO (1995), is one of the most popular techniques for estimating potential output among statistics organizations. Additionally, the European Union Economic Policy Committee advises using it. Its justification is to calculate potential output from the trend levels of structural factors like factor inputs and productivity. The components are properly weighted using technology.

The aggregate production function has the following shape, assuming for the sake of simplicity that technology has a Cobb-Douglas representation with constant returns to scale:

$$Y_{t=}TFP_t(L_tH_t)^{\sigma}(C_tK_t)^{1-\sigma}$$

Realized output (Yt) is defined by the production function method as the sum of actual factor inputs, typically labor and capital, and total factor productivity (TFPt). $\sigma$ is the output's labor-related elasticity, total hours worked are determined by multiplying employment ($L_t$) by the hours worked per person ($H_t$), and capital input is determined by the capital stock ($K_t$), which is obtained using the perpetual inventory approach and adjusted for capacity utilization ($C_t$), using values within range of the capital stock ($K_t$), which is obtained using the perpetual inventory approach and adjusted for capacity utilization (Ct), using values within a range, Equation (5) was modified to equation (6) in the production function theory;

$$\emptyset(L)\Delta pt = \emptyset(L)OG_t + \sum \boldsymbol{\delta_k}(\boldsymbol{L})\boldsymbol{x_{kt}} + \in_{\boldsymbol{\pi t}}$$

where θ(L) and δk(L), k = 1,…, K, are polynomials in the lag operator L, xt denotes a set of exogenous supply shocks and φ(L) is an autoregressive (AR) polynomial.

## 2.3. Empirical Review

The empirical literature is on the relationship between asset classes (stock, crude oil, gold, and Bitcoin) and output. This would be followed by the gap in the literature.

Scholars like Ogunmuyiwa (2010) used a proper econometric technique and time series data from 1984 to 2005 to examine the link as well as the pathway through which investor mood and liquidity impact growth. The result showed that both stock market liquidity and investor confidence ranger cause economic growth in Nigeria. Similarly, Henry and Olabanji (2013) looked at the connection between Nigeria's stock market performance and economic expansion. In analysis, they used the Co-integration method with bounds testing, often known as the Autoregressive Distributed Lag estimation method. Their result revealed that overall output in the Nigerian economy is less sensitive to the long-term changes in stock market capitalization and average dividend yield. This result was contrary to Ogunmuyiwa (2010), Chijindu and Ifunanya (2017), Olabisi et al. (2017), Akinmade, Adedoyin, and Bekun (2020) while Ebun, Olusuyi, and Michael (2018), Ezenduka and Joseph (2020), Chukwuka and Nzotta (2020) validate Ogunmuyiwa (2010).

By departing from earlier research works that frequently ignore the impact of the money supply on industrial output, Adigun and Okhankhuele (2021) examined the impact of the stock market and money supply on the level of industrial output in Nigeria. The Augmented Dickey-Fuller unit root test, co-integration test, and ARDL were used to explore the long-term correlation among the variables. The study concludes that differences in market capitalization, gross capital formation, stock trade, and broad money account for around 73 percent of the variation in industrial growth. This connotes that the industrial sector is influenced by variations in market capitalization, gross capital formation, stock trade, and broad money.

An empirical study was conducted by Nweze and Edame (2016) to look at oil revenue and economic growth in Nigeria from 1981 to 2014. Oil revenue and government spending, served as the explanatory variables while gross domestic product (DP) was used to proxy economic growth. Analytically, several cutting -edge econometric techniques were used throughout the empirical inquiry. These include the Augmented Dickey-Fuller Unit Root Test, the Johansen Cointegration Test, and the Error Correction Mechanism (ECM). The results show that the variables had a long-term relationship. The result revealed that all the variables had a significant impact on economic growth in Nigeria. The result further revealed that all the variables showed their predicted sign in the short run but showed a negative link with economic growth in the long run. Omitogun, Longe, and Muhammad (2018) analyze the connection between Nigeria's economic growth, revenue volatility, and oil prices. The study used secondary data that spans the years 1981 and 2016. The link between the variables over the long and short terms was examined using the auto-regressive distributed lag. The short-run outcome revealed that whereas the consumer price index and exchange rate have a negative relationship with economic growth, oil price, and oil revenue have a positive and significant relationship with economic growth. In the long run, oil revenue has a negative correlation with economic growth, but oil prices, the consumer price index, and exchange rates have positive correlations. Olayongbo (2019) investigates the effects of oil revenue on economic growth using the Bayesian time-varying parameter (TVP) model. The outcome offers fresh perspectives on Nigeria's "oil curse" phenomena. Thus, utilizing annual data from 1970 to 2015. The result showed that oil revenue export has favorably and considerably contributed to economic growth over the studied period. Chigozie and Nyatanga (2020) assessed how the rise in oil prices affected Nigeria's economic expansion. The need to comprehend the transmission mechanisms and channels via which abrupt fluctuations in oil prices affect economic output and to guide how to achieve output sustainability served as the impetus for this work. The new Hamilton Index was used in this study's Structural Vector Autoregressive (SVAR) framework to examine how macroeconomic variables react to abrupt fluctuations in oil prices. It has been shown that how these macroeconomic variables are transmitted to endogenous and exogenous shocks plays a critical role in determining how effective their influence on output growth will be. The study discovered that, compared to other types of oil price variation, negative oil price movements have the greatest impact on economic growth. Michael and Oyeyemi (2018) looked at how oil revenue impacted Nigeria's output growth from 1981 to 2014. They used the fully modified ordinary least-squared approach (FMOLS). Data for the years 1981 to 2014 were taken from the Statistical Bulletins of the Nigerian National Petroleum Corporation and the Central Bank of Nigeria. The study found that Nigeria's economic activities are not immediately impacted by oil money.

### *2.4. ap in Literature*

The empirical literature on the impact of asset classes on the output gap is mixed and contradictory. This is mostly because of the use of different data sets, methodologies, and asset class measurement issues. Also, to the best of our knowledge, all the studies focused on asset classes and output, and none focused on asset classes and output gaps. The output gap is better than output/growth. It is a more accurate indicator of the health of an economy than just measuring growth which only looks at the change in output over time. In this regard, this study chooses to

provide an answer to the following research question; what is the impact of asset class volatility on the output gap in Nigeria? This question begs for an empirical investigation.

The Bayesian graph diagnostic technique would be used to assess the robustness of the Bayesian var methodology. The data used in this analysis are mostly recent data that ranges from January 2010 to December 2020, which previous pieces of literature on asset classes had failed to cover. Also, the findings of the study would advise policymakers on what asset class to invest in during different business cycles.

## 3. Method of Analysis

To estimate the relationship between asset class volatility and the output gap in Nigeria, the study adopted the eneralized Autoregressive Condition Heteroscedastic (ARCH) approach and the Vector Autoregression (VAR) approach.

### *3.1. eneralized Autoregressive Condition Heteroscedastic (ARCH) Approach*

To model volatility, this study employed Autoregressive Conditional Heteroscedastic (ARCH) developed Engle (1982) which is further extended by Bollerslev (1986) to eneralized Autoregressive Condition Heteroscedastic (ARCH) model. It is commonly used in fin ance and econometrics to model and forecast volatility in time series data. The ARCH model allows for more flexibility in capturing the dynamics of volatility compared to the ARCH model. It can capture volatility clustering, leverage effects (asymmetric response to positive and negative shocks), and long-term persistence in volatility.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, u_{t-i}^2 + \sum_{i=1}^{p} \beta_i \, \sigma_{t-i}^2 \qquad (12)$$

All parameters in the variance equation (question 12) must be positive and $(\alpha + \beta)$ are expected to be less than one but it is close to 1. If the sum of the coefficients equals 1 it is called an Integrated ARCH (IARCH) process.

### *3.2. Vector Autoregressive (VAR) Approach*

Vector Autoregressive (VAR) models are generally recognized for their ability to predict and describe dependence among variables. VAR models are commonly used for forecasting. Here we show how to compute Bayesian dynamic forecasts after fitting a Bayesian VAR model. In Bayesian VAR models, dynamic forecast refers to the process of making predictions about future values of variables based on the estimated model parameters. It takes into account the interdependencies and interactions among the variables to generate forecasts that capture the dynamic nature of the system. The Bayesian VAR analysis allows for the estimation of how variables respond to a specific shock over time, considering uncertainty and priori knowledge.

The usefulness of VAR models for applied macroeconomics and policy analysis has widely increased since Sim's (1981) work. Some of the scholars that used the VAR models include; Christiano, Eichenbaum, and Evans (1998); Canova, (2005), and Lutkepohl, (2012) etc.

This study employed the Bayesian VAR, which is an extension of the VAR model. The VAR (P) process is estimated as:

$$Y_t = A_i y_{t-i} + e_t \qquad (1)$$

Where $A_i$ is the (N*N) matrix of coefficients, for i= 1, 2… p and, $e_t$ represents (N*1) unobservable vector white

noise processes with E ($e_t$)=0. $Y_t$ is (N*1) vector of endogenous variables in the model.

The popularity of the Bayesian VAR approach to econometric modeling continues to expand, and many macroeconomists contend that it often offers significant advantages over the traditional (frequentist) approach. Schorfheidede and Negro (2011), Fernández-Villaverde, uerrón -Quintana, and Rubio-Ramrez (2010), as well as Koop and Korobilis (2010), among others, provide support for this viewpoint. It is argued that these techniques may be better able to handle problems with identification, various data sources, misspecification, parameter uncertainty, and many computational challenges.

The Bayesian model of asset classes shock could be estimated using a specific aussian prior for the parameter of the VAR model as proposed by Litterman (1986), which is often called Minnesota prior or the Litterman prior. To model the asset classes' shocks, Bayesian impulse response analysis is used. This is a powerful tool for examining the dynamic effects of shocks in a Bayesian framework. It allows for the estimation of how variables respond to a specific shock over time, considering uncertainty and priori knowledge.

Therefore, our Bayesian VAR (6) model, with a lag 1 based can then be estimated with all the coefficients evaluated at their priori mean.

$$og_t = 0 + 1.og_{t-1} + 0.asir_{t-1} + 0.cruder_{t-1} + 0.goldr_{t-1} + 0.bitcoinr_{t-1} + u_{1t} \quad (4)$$
$$(\infty) \quad (\boldsymbol{\lambda}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{asir}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{cruder}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{goldr}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{bitcoinr})$$

$$asir_t = 0 + 1.asir_{t-1} + 0.og_{t-1} + 0.cruder_{t-1} + 0.goldr_{t-1} + 0.bitcoinr_{t-1} + u_{1t} \quad (5)$$
$$(\infty) \quad (\boldsymbol{\lambda}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{og}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{cruder}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{goldr}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{bitcoinr})$$

$$cruder_t = 0 + 1.cruder_{t-1} + 0.og_{t-1} + 0.asir_{t-1} + 0.goldr_{t-1} + 0.bitcoinr_{t-1} + u_{1t} \quad (6)$$
$$(\infty) \quad (\boldsymbol{\lambda}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{og}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{asir}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{goldr}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{bitcoinr})$$

$$goldr_t = 0 + 1.goldr_{t-1} + 0.og_{t-1} + 0.cruder_{t-1} + 0.asir_{t-1} + 0.bitcoinr_{t-1} + u_{1t} \quad (7)$$
$$(\infty) \quad (\boldsymbol{\lambda}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{og}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{cruder}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{asir}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{bitcoinr})$$

$$bitcoinr_t = 0 + 1.bitcoinr_{t-1} + 0.og_{t-1} + 0.cruder_{t-1} + 0.asir_{t-1} + 0.goldr_{t-1} + u_{1t} \quad (8)$$
$$(\infty) \quad (\boldsymbol{\lambda}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{og}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{cruder}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{asir}) \quad (\boldsymbol{\lambda}\theta\sigma_1/\sigma_{goldr})$$

The figures in parenthesis here represent the previous standard deviations. For the dependent variables, each of the two equations specifies a random walk prior mean. The nonzero prior standard deviations show the lack of confidence in the model's applicability. Due to the assumption that more recent delays are more likely to have values other than zero, the standard deviations decrease as lag duration increases. To account for our lack of knowledge on the precise values of these parameters, the standard deviations for the intercept terms are set to infinity.

### *3.3. Sources and Description of Data*

The data for this study were sourced from the Central Bank of Nigeria's (CBN) statistical bulletin (various issues), Bloomberg and Auronum. The study covered daily data ranging from January 2010 to December 2022. This selection of the study time period covers the most recent period of global shocks that affects asset classes. The lists of variables for which data were gathered for the study are shown in Table 1. It explains the various variables and sources used in the estimation of asset class volatility and output gap in Nigeria.

**Table 1**. Data and variable description.

| Variable | Description | Source |
|---|---|---|
| Og | Output gap, calculated as the difference between actual and potential growth | CBN |
| Asir | All share index returns | Bloomberg |
| Cruder | Brent crude oil returns | Bloomberg |
| Goldr | Gold prices in USD returns | Auronum |
| Bitcoinr | Bitcoin prices in USD returns | Bloomberg |

Source: Authors computation

## 4. Results and Interpretation

### *4.1. Descriptive statistics*

**Table 2.** Descriptive Statistics

| *Variables* | *og* | *asir* | *cruder* | *goldr* | *bitcoinr* |
|---|---|---|---|---|---|
| Mean | -.0000163 | .0000879 | .0005345 | .000093 | .0039876 |
| Median | -1855.568 | .0000591 | .0003177 | .0000781 | .00201 |
| Maximum | 24112.13 | .0038737 | .0100867 | .0005412 | .083462 |
| Minimum | -18352.25 | 0 | 0 | 0 | 0 |
| Standard dev. | 10333.15 | .0001222 | .0008456 | .000054 | .0065532 |
| Observation | 3,391 | 3,391 | 3,391 | 3,391 | 3,391 |

**Source:** Authors Computation using Stata

The descriptive statistics presented in Table 2, show that *bitcoinr* has the highest mean value among the variables, followed by cruder. The table also showed that bitcoinr has the highest median value of .00201, followed by cruder with a median value of .0003177 and *Og* with the least median value of -1855.568. The variable with the highest maximum value is *Og* with a value of 24112.13, followed by *bitcoinr*, and the variable with the least maximum value is *goldr* with a value of .0005412. The variables with the minimum value are *asir, cruder, goldr* and *bitcoinr* with a value of 0. The standard deviation of *goldr* is less than the mean while the other variables in the model have higher standard deviations compared to their mean. This means that the time series in the model are more dispersed. This is because of their volatile nature except *goldr* which showed to be less dispersed.

### *4.2. Unit Root Test*

**Table 3**. The Augmented Dickey Fuller Unit Root Test

| Variable | level | | | first difference | | |
|---|---|---|---|---|---|---|
| | C | trend | drift | C | trend | drift |
| *og* | -5.082*** | -5.081 *** | -5.082*** | | | |
| *asir* | -14.991*** | -14.996*** | -14.991** | | | |
| *cruder* | -4.375*** | -4.600*** | 2.345 | | | |
| *goldr* | -5.755*** | -5.940*** | -5.755 *** | | | |
| *bitcoinr* | -6.622*** | -6.952*** | -6.622*** | | | |

*Note: * represents 10 percent significance, ** represents 5 percent significance, while *** represents 1 percent significance.*

**Source:** Authors Computation (2023).

From Table 3, it shows that all the variables in the model are stationary at level at 1 percent level of significance.

### *4.3. The ARCH Test*

The ARCH test is a statistical test used to determine if there is autoregressive conditional heteroscedasticity in a time series. It is majorly used to test for volatility in series.

**Table 4.** ARCH Test

| ***Variables*** | ***Arch (1)Lm stat*** | ***P*** |
|---|---|---|
| asir | 59.74 | 0.00 |
| cruder | 252.14 | 0.00 |
| goldr | 24.07 | 0.00 |
| bitcoinr | 237.39 | 0.00 |

**Source:** Authors' Computation (2023)

The result of the ARCH test in Table 4 shows that the asset classes have an ARCH effect on their residuals. This means the volatility among the variables are not constant over time, but instead exhibits patterns or clusters of high and low volatility. Therefore, the residual terms are modeled using ARCH (1,1) approach. ARCH is a statistical test used to analyze volatility in financial markets.

### *4.4. ARCH Volatility Test*

ARCH is a statistical test used to analyze volatility.

**Table 5.** ARCH Test statistics

| ***Variables*** | ***asir*** | | ***cruder*** | ***goldr*** |
|---|---|---|---|---|
| ***bitcoinr*** | | | | |
| Past (-1) | 0.23*** | -0.01 | -0.01 | 0.02 |
| Residual | 0.20*** | 0.10*** | 0.15*** | 0.11*** |
| GARCH | 0.69*** | 0.89*** | 0.60*** | 0.89*** |

*Note: * represents 10 percent significance, ** represents 5 percent significance, while *** represents 1 percent significance.*

**Source:** Authors Computation (2023).

From Table 5, it shows that the volatility of *asir* is affected by its past, but *cruder, goldr*, and *bitcoinr* are not affected by their past. The addition of the residual and ARCH show that the estimates of *asir* and *goldr* are less than one. This means that the volatility of *asir* and *goldr* are persistent throughout the series. Same goes to *cruder*, and *bitcoinr*, they all show not to have persistent volatility through their series. This is because the residual and ARCH of *cruder*, and *bitcoinr* is approximately one.

### *4.5. The Bayesian VAR Model Test*

To assess the performance and validity of the Bayesian model, the Bayesian raph Diagnostic technique is used. This diagnostic help in evaluating the model fit.

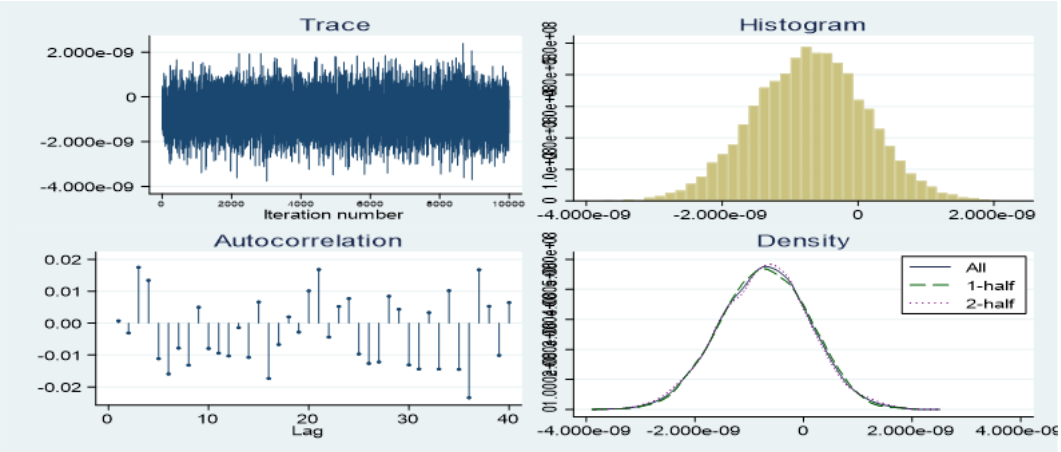


**Figure 1**. All share index and Output gap

Figure 1 shows the validity of the Markov Chain Monte Carlo (MCMC), this is seen by the trace statistics, which clustered around a value with less trend, and there is the presence of less autocorrelation in the graph. This means that the nexus of all share index (*asir* ) and output gap (og) in Nigeria can be investigated empirically.

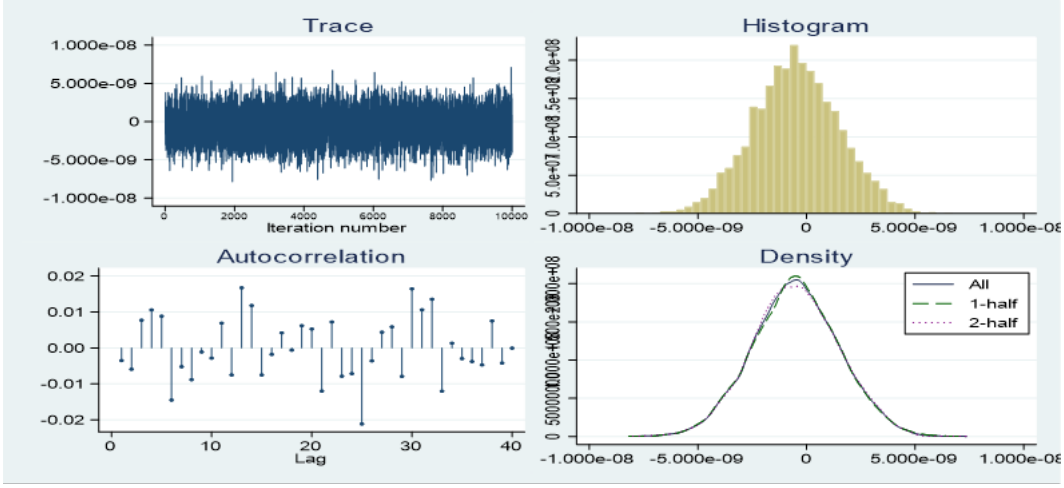


**Figure 2**. Crude and Output gap

Figure 2 also shows that the priori of crude oil (*cruder*) and output gap (*og*) also satisfy the MCMC criteria, because the trace statistics show to be clustered around a particular number and it reveals to have few autocorrelations. The result from the figure shows that the crude oil and output gap can be investigated empirically.

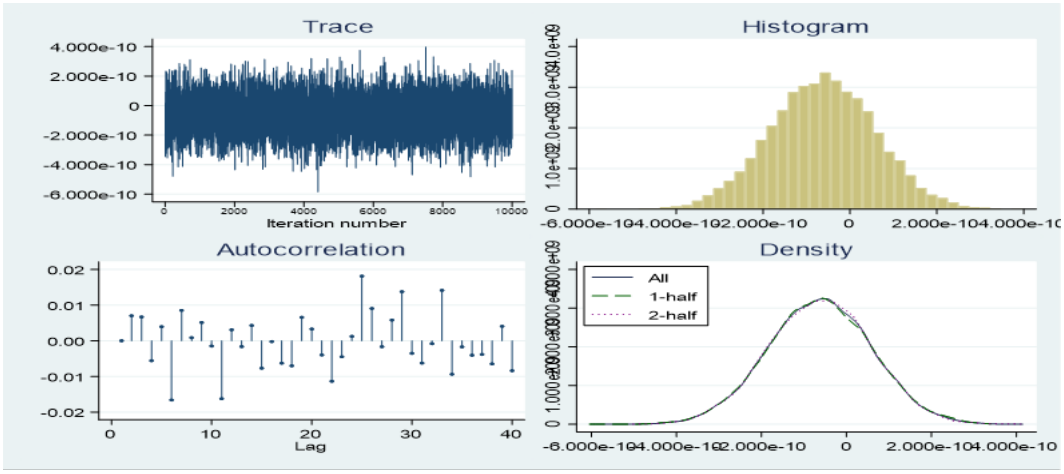


**Figure 3.** Gold and Output gap

Figure 3 also shows that the priori of gold (*goldr*) and output gap (og) satisfy the MCMC criteria, and it reveals to have few autocorrelations, which makes it suitable to investigate the impact of gold on output gap empirically.

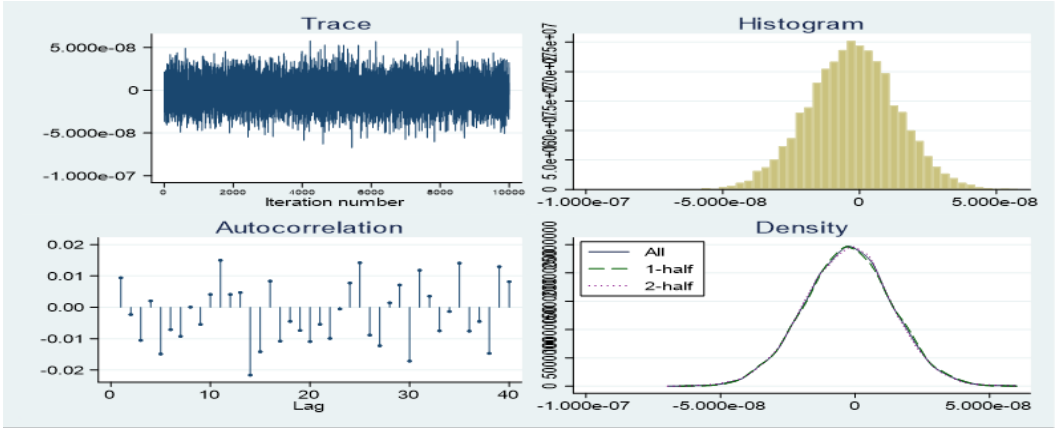


**Figure 4.** Bitcoin and Output gap

As shown in Figures 1, 2 and 3, Figure 4 depicts the priori of bitcoin (*bitcoinr)* and output gap (*og*) which also satisfy the MCMC criteria, because the trace statistics also show to be clustered around a particular number and it also shows to have few autocorrelations. The result reveals that the impact of bitcoin on output gap can be investigated empirically.

### *4.6. Bayesian VAR Model Impulse Response Analysis*

Bayesian impulse response analysis is a powerful tool for examining the dynamic effects of shocks in a Bayesian framework. It allows for the estimation of how variables respond to a specific shock over time, considering uncertainty and priori knowledge.

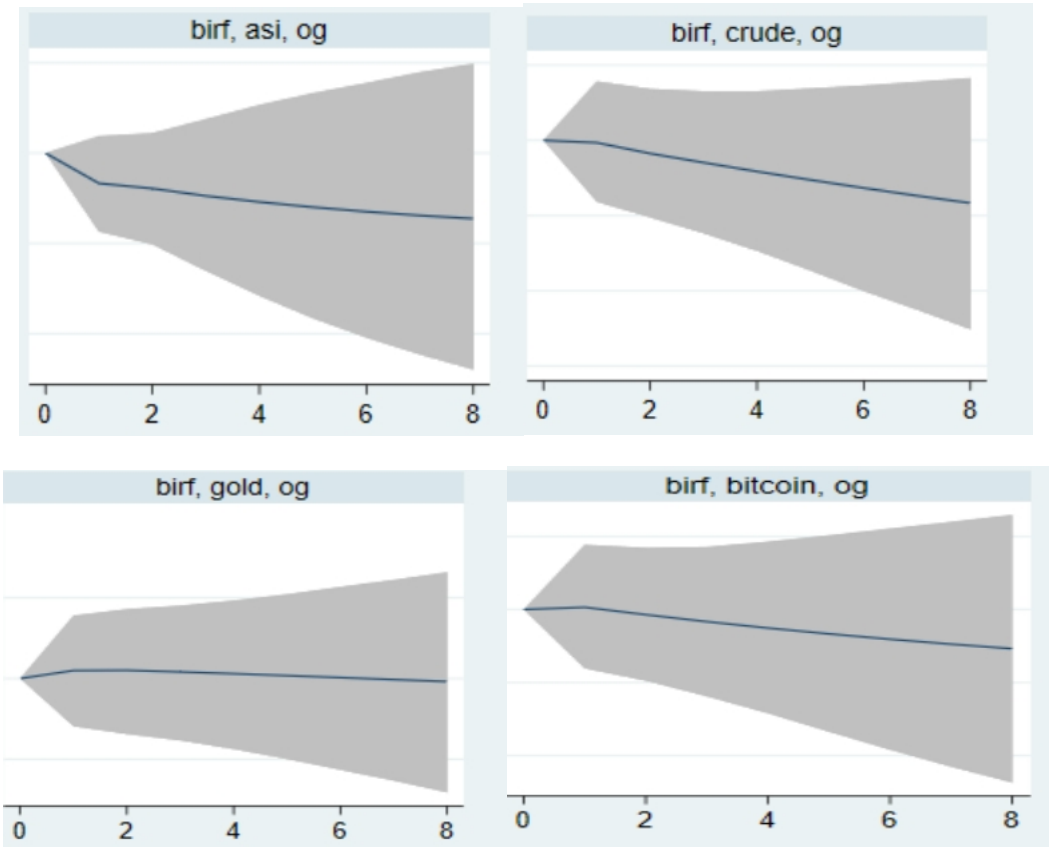


**Figure 5.** Impulse response of Asset classes and output gap.

From Figure 5, it shows that at average, all share index (*asir)* tends to reduce output gap (*og)* more when compared to crude oil (*cruder), gold (goldr)* and bitcoin (*bitcoinr)*. This can be seen in the initial response of output gap (*og)* from the initial impulse of all share index (*asir)* which is negative while the initial response of output (*og)* from the initial impulse of crude (*cruder*), gold (*goldr)* and bitcoin (*bitcoinr*) is positive. This means that when there is a business cycle in the economy, investing in either crude, gold and bitcoin would cause the actual output to be more than full capacity output or potential output. This means that asset classes would increase demand, and to meet this demand, factories and households would operate far above their efficient capacity. Also, investing in stocks (all share index (*asir*)) during a business cycle would cause an initial negative output (*og)*, which means actual output would be less than what an economy could produce at full capacity. This would bring about a less demand.

Summarily, the result revealed that stocks (*asir*) had an initial negative impact on output gap, and a reduction in output gap means that the difference between the actual and potential growth has reduced, thereby reducing the

growth level in an economy which would reduce the level of economic activity, thus reducing inflation. Knowing the fact that stock market *(asi*) tells a lot about the health of an economy, therefore a strong stock market in Nigeria would enhance overall economic sentiment. If the Nigerian stock market is improved, stocks (*asi*) would help in managing inflationary pressures, this means investing on stocks (*asi)* might reduce the growth of the economy during inflation, and hence reducing inflationary pressures. This is as a result of the impulse-response of the BVAR which brings about an initial decline of output gap (*og)*. Also, the result of the impulse-response function revealed that crude oil (*cruder),* gold *(goldr)* and bitcoin (*bitcoinr)* increases output (*og*), which brings about an improvement in employment. For example, the mining and extraction of crude oil (*cruder*) and gold (*goldr)* create jobs in those industries. Additionally, the growing of bitcoin has led to emergencies of new job roles for digital asset managers. Therefore, to increase demand in Nigeria, crude oil (*cruder*), gold (*goldr*) and bitcoin (*bitcoinr*) would be the ideal asset classes to invest in, in order to boost employment, especially in the short run while to reduce inflation, stocks (all share index (*asir*)) are the best asset class to invest in.

### *4.7. Bayesian VAR Model Variance Decomposition*

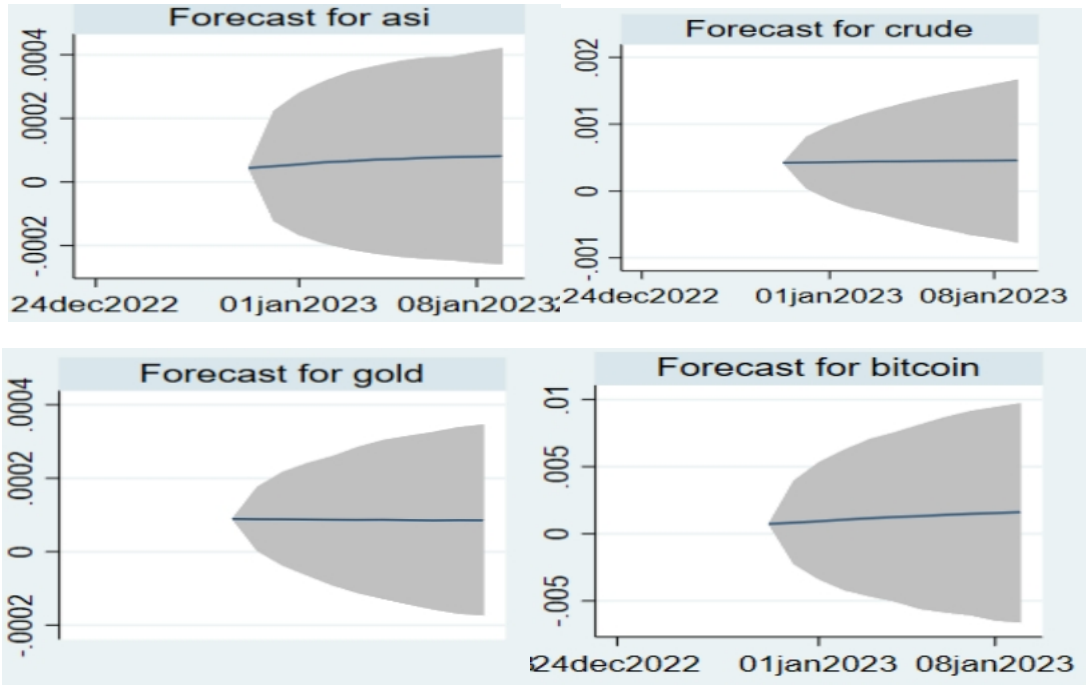


**Figure 6.** Variance Decomposition

Figure 6 shows that stocks (all share index (*asir)*) in the long run would increase slightly when compared to other asset classes. This shows that *asir* has more potentials of increasing in the long run than other assets, though slightly. At the average, all asset classes showed to be increasing in the long run.

## 5. Concluding Remarks

The study made use of asset classes comprising of stocks (*all share index)*, crude oil, gold and bitcoin. The ARCH and ARCH, descriptive statistics and unit root were the pre -estimation test carried out. The ARCH and ARCH models were used to estimate the volatility. The Bayesian VAR (BVAR) was then estimated from the volatility series generated from the ARCH model. The unit root test result showed that all the series were stationary at level. The post-estimation test of the BVARS showed that the model was stable. The impulse-response of the BVAR showed

that stocks (*asir*) has an initial decrease of output gap (*og)*, while other asset classes showed an initial increase. Therefore, empirically, stocks (*asir)* have an initial negative relationship with output gap while other asset classes have an initial positive relationship with output gap, hence stocks (*asir*) would be better off to invest in during period of inflation and other asset classes in the model would be better off to improve employment in Nigeria. The variance decomposition result showed that all asset classes would increase in the long run but stocks (*asir*) would increase more slightly compared to other asset classes. Based on the findings, the study recommends for an effective and viable stock market in Nigeria as it will enhance overall economic performance. If the Nigerian stock market is improved, it will help in managing inflationary pressures. Also, there is a need for the government to prioritize investing in crude oil, gold and bitcoin in order to push the actual output to full capacity, as it will bring about employment.

## Funding Statement

This work received no external funding.

## Acknowledgments

Acknowledgments to anonymous referees' comments and editor's effort.

## Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

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