Time-Varying Model for Non-Oil Export Volatility in Nigeria

Olushina Olawale Awe[1*], Opeyemi Aromolaran[2], Abosede Adedayo Adepoju[3]

[1]Department of Mathematical Sciences, Anchor University, Lagos, Nigeria.
[2]Department of Economic Sciences, North-West University, South Africa.
[3]Department of Statistics, University of Ibadan, Nigeria.
[*]Corresponding Author: oawe@aul.edu.ng

ABSTRACT

The study of export volatility is important because it plays important roles in the growth of an economy. Most previous studies on export had concentrated on investigating its dynamics with classical econometric models which have static parameters that are incapable of capturing its associated time-varying dynamics and volatility. This paper proposes a Bayesian time-varying parameter dynamic linear model to investigate major non-oil export predictors in the Nigerian economy. The Kalman filter and Markov chain Monte Carlo (MCMC) algorithm are used to perform posterior Bayesian inference on time-varying parameters which implicitly describes the fluctuating relationships between the key drivers of export in an economy. In particular, we investigate the predictive performance of relevant macroeconomic variables on non-oil export using a Bayesian time-varying parameter model. Empirical results show that Gross Domestic Product (GDP) and Lending Rate predict the level of fluctuation in non-oil export in Nigeria for the period under consideration. Some policy implications and change point analyses of these results are also discussed.

1.   Introduction

It is unequivocally indisputable that the export activities of a nation play important role in the macroeconomic performance of its economy and ceteris paribus, have the tendency of improving the gross domestic product (GDP) and general welfare of the people. This assertion has been corroborated in literature by Adenugba and Dipo (2013) as well as Sheridan (2014) who are of the view that export stimulates

economic growth and promotes the economy. The gradual progression in export trade as posited by Kandiero et al (2009) is a key factor influencing the performance of economic growth globally. Nigerian economic revenues have consistently come from two major sources: oil and non-oil export. The former has historically been the most significant contributor to budget finance of the nation since inception. Hence, Nigeria is an economy that is mostly dependent on crude-oil and with the recent dwindling in the price of crude oil as a result of the COVID-19 pandemic, the country needs to implement more policies that would diversify the economy but concentrates more on its non-oil revenues. It therefore becomes imperative to embark on non-oil export in the Nigerian economy given the variation in resource endowments. This is in line with the Sustainable Development Goal 12 (SDG-12) which advocates for sustainable consumption and production patterns in an economy.

Export fluctuations, on the average act as a hindrance to the stability and growth of many African countries where the volumes of imports are mostly more than the exports (Awe et al., 2018). Following the shortcomings of the economy, the federal government of Nigeria implemented an International Monetary Fund Policy of Structural Adjustment Program (SAP) in 1986 which was intended to motivate a private sector led economy. The key focus of the structural Adjustment Programme (SAP) was to re-organize the economy from inward-looking import substitution to that of outward looking export promotion approach with exchange rate as the policy variable (Williamson, 1995). A number of policies were pursed during the SAP regime in order to enhance the export of manufactured goods such as incentives and investment in research and development. However, the incentives and strategies adopted did not yield any significant appreciable effect on export. Weak manufacturing, for both export and domestic market implies weak capacity utilization for the economy with business closing down and widespread unemployment in the economy. The cost of investment activities within the economy and the poor availability of infrastructures coupled with preference for foreign products by the citizens further deteriorates manufacturing activities. Sadly, quite a number of manufacturing firms have to run on diesel due to the poor reliability of electricity supply being generated. This is of course a diversion of fund which could have been invested in manufacturing in order to improve the quality and competitiveness of Nigeria's non-oil export in the world market.

It is against this backdrop that this study considers a number of key macroeconomic variables which could have a strong time-varying effect on non-oil export in Nigeria as a contribution to the body of knowledge and to provide policy directives to the government. The factors considered include: movement in exchange rate, the consumer price index proxied by inflation rate, government capital expenditure on infrastructure and lending rate. The analysis was done with respect to United States

of America, being the largest trade partner of Nigeria. The main objective of this paper is to investigate the time-varying pattern of fluctuation of export with respect to certain key economic indicators by using a proposed Bayesian dynamic modeling framework.

2.   Literature Review

2.1   Theoretical Review

Econometric analysis usually begins with a statement of a theoretical proposition (Greene, 2003). In this section, we briefly review two neoclassical trade theories that are relevant to this study:

(a)The Theory of Comparative and Absolute Cost Advantage

Absolute and comparative cost advantage are widely known theories of international trade. Ruffin (2005, p.714) states that describes the absolute advantage theory of trade *as being "necessary for a country to have a productivity advantage over other countries in order to profitably export"* However, Smith (1776) opines that a country participates in international trade in commodities characterized by an absolute cost advantage. Conversely, Ricardo (Vol. 1, p.133) relays that "the same rule which regulates the relative value of commodities in one country does not regulate the relative value of the commodities exchanged between two or more countries." Comparative advantage therefore, in the idea of Ricardo requires that a country can embark on the importation of some units of a commodity despite that it could be produced domestically at lower real costs compared to the country that exports it.

Although several issues may surround this trade theory, it gives some level of insight as regards why the countries of the world should embark on international trade which have the prospect of stimulating an economy as well as promoting growth and development.

(b) Hecksher Ohlin Theory

This theory states that a country should concentrate on the production and exportation of commodity that requires a higher factor intensity of the resources that is generously available and cheap while the ones that are relatively scarce and of high cost should be imported. The Heckscher-Ohlin theory is premised on variation in relative factor prices and therefore attempts to investigate the underlying basis for countries to be characterized by different factor prices. The model assumes: (i) free mobility of commodities among countries (ii) that the technology employed in the

production process is uniform (iii) there is no restriction to domestic mobility of factors of production (Subasat, 2003).

2.2   Empirical Review

A number of studies have been done on the determinants of the volume of export in the literature. For instance, Funke and Holly (1992) opine that the majority of the previous approaches on modeling export determinants have emphasized on demand factors which make such models rather unsuccessful in explaining long-run trends in export performance. Their study considered both supply side and demand side factors using quarterly data over the period 1961.1 to 1987.4. The findings of the study suggest that supply side factors are much more important in explaining export performance than demand side factors.

A study by Lipuma et al. (2013) reveal the relevance of institutions to export performance on the basis that there will be a superior export performance if there exists a high quality of institutions. Chen et al (2016) work on the synthesis and the examination of recent research in respect of the determinants of export performance. They reviewed 124 papers published between the period 2006 and 2014 through the technique of vote-counting with the goal of examining export performance determinants. The authors find the evidence of a significant progress during the period under consideration. The interaction and indirect relationships were also put into consideration. Nevertheless, the authors held the view that the non-existence of synthetic theoretical basis, inconsistency in the results of empirical test as well as inadequacy in the research framework alongside statistical methodologies constrained the research of export performance.

Usman (2010) examines non-oil export determinants and economic growth covering the period 1988-2008 using multi-linear regression and finds a direct relationship between GDP and Non –oil export, exchange rate and consumer price index. He recommends the need for the diversification of the sources of export in order to stimulate and promote economic growth considering that non-oil exports have a direct effect on economic growth over the study period.

Ezike and Ogege (2012) analyzed the nexus between Nigeria foreign trade policy and the impact it has on non-oil export in Nigeria using correlation and least squares techniques and find an inverse relationship between trade policies and non-oil export. The result reveals that non-oil export exerts a direct impact on economic growth and the exchange rate is positive and significant at 5% level of significance. Diversification of the export base, according to them has the prospect of the attainment of economic growth.

Aladejare and Saidi (2014) considered the determinants of non-oil export and economic growth in Nigeria using the bound test approach to examine the long and short run effects of the non-oil export and its determinants. Results show significant effect of non-oil export on economic growth in the short run and the long run.

The work of Imoughele and Ismaila (2015) examine the impact of exchange rate on non-oil export using time series data obtained from Central Bank of Nigeria for a period of 27 years. They used Augmented Dickey-Fuller (ADF) test for the unit root test and Johansen's co-integration test to establish short and long run relationships between non-oil exports and some independent variables. The result shows three co-integrating equations which establish the existence of long run relationship among the variables.

Vincent (2017) investigates whether Nigeria's non-oil exports are effective in diversifying the productive base of the Nigerian Economy from Crude oil as the major source of foreign exchange using annual data between 1980 to 2016. The study adopts the Phillip Perron (PP) and the Engel Granger Model (EGM) for co-integration and finds that a strong evidence of co-integrating relationship of non-oil exports in influencing rate of change in the level of economic growth.

Awe et al. (2018) examines the time series properties of co-integration and causal relationship between oil (non-agricultural) and non-oil (agricultural) import and export in Nigeria using Granger causality and Johansen and Juselius's co-integration methods to investigate causal relationships among Naira-US dollars' exchange rate (USD), Naira-Pounds exchange rates (GBP), Oil Import (OI), Non-Oil import (NO), Oil Export (OE) and Non-Oil export (NE). The result reveals the existence of long run equilibrium between exchange rates, oil import and export, and non-oil import (agriculture) and export.

Employing a disaggregated analysis approach, Uzonwanne (2020) examines the role of non-oil exports in boosting the economy of Nigeria using selected independent variables (non-oil commodities) like hides and skins, vegetables, rubber and plastic, textiles exports by employing quarterly time series data from 2010-2017. The ARDL result shows that hides and skins, plastic and rubber and textile export all have positive and significant effect on the real GDP of the economy. The study also finds that there is bi-directional flow of causality between real GDP and non-oil export items.

It is essential to note that none of the earlier studies consider models that are capable of capturing the time-varying dynamics and fluctuations associated with export determinants over time. Therefore, this paper examines the role of exchange rate, GDP, lending rate, consumer price index and capital expenditure in predicting non-oil export using a time-varying parameter Bayesian dynamic model. The

Kalman filter and Markov chain Monte Carlo (MCMC) algorithms are used to perform posterior Bayesian inference on time-varying parameters which implicitly describes the fluctuating relationships between the key drivers of non-oil export in the Nigerian economy.

3.   Methodology

3.1 Model Specification

We propose the Bayesian dynamic linear regression model of West and Harrison (1997) to assess the dynamic relationships between export and some key economic indicators of the Nigerian economy. The model specification takes the following form:

$$y_t = X_t\theta_t + v_t \quad v_t \sim N(0, V) \tag{1}$$

$$\theta_t = G_t\theta_{t-1} + \omega_t \quad \omega_t \sim N_\rho(0, W_t) \tag{2}$$

Equation (1) is referred to as the observation equation and equation (2) is the evolution equation. $G_t \ and \ X_t$ are known matrices of order p*p and k*p respectively that determine how the observation and state equations evolve in time (Awe and Adepoju, 2018). We assume that all $v_t's$ are independent from the $\omega_t's$. Since each parameter at time t only depends on results from time t-1, the state parameters are time-varying and constitute a Markov chain.

In the Equation (1), the response y_t is the annual non-oil export of Nigeria from 1960 to 2009. The matrix X consists of economic indicators measured concurrently with export and includes a column of 1's representing a dynamic intercept term. θ_t are time varying regression coefficients which describes the relationship between the regressors and the response at each time t. In the export model specification, we consider key macroeconomic variables that can potentially play meaningful roles in the determination of exports in African countries. It is assumed that the regression parameters in the model follow a Markov dependence structure, which permits the macroeconomic variables to evolve differently over time.

In the model estimation, the probability distribution of update is proportional to the product of the time series measurement likelihood and the predicted state:

$$\rho(\theta_t/y1:t) = \frac{\rho(y_t/\theta_t)\rho(\theta_t/y1:t-1)}{\rho(y_t/y1:t-1)} \tag{3}$$
$$\propto \rho(y_t/y1/\theta_t)\rho(\theta_t/y1:t-1)$$

Where the denominator $\rho(y_t/y1:t-1)$ is constant relative to θ_t and thereby ignored. The posterior was used to update the prior recursively until convergence is achieved.

The Gibbs sampler was run for M = 12,000 iterations with a burn-in period of 2,000. Predictive performance of the variables in the various models estimated was assessed using one-step-ahead Mean Squared Prediction Error (MSPE). Here, the MSPE was used to measure the expected squared distance between what a predictor predicts for a specific value and what the true value is. The variable with the lowest MSPE indicates a stronger predictive power with respect to the response variable and is chosen as the best model. The Geweke convergence diagnostic (GCD) statistic was computed for each model.

4.   Empirical Analysis

This section involves the data presentation and econometric analysis involving the predictors of Nigerian non-oil export data using the proposed model and method outlined in section 3 above. Such analyses become relevant considering the need for the Nigerian government to diversify into non-oil exports.

4.1 Data

The data used in this research are Nigerian economic indicators sourced from the Central Bank of Nigeria (www.cbn.org). The data includes Fifty (50) year's annual time-series data on Nigerian Non-Oil Export, GDP, Capital Expenditure, Consumer Price Index, Exchange Rate and Lending Rate of the pre-global recession period (1960-2009). GDP and non-oil export data were logged before analysis.

4.2 Empirical Results

 First, we examined the predictive effect of each macroeconomic variable on non-oil-export. It was discovered that lending rate performed better than other variables in the study in terms of predictive

performance, as a result of the low value of MSPE. However, we find that GDP performed better in predicting oil-export when combined with lending rate. In the tables showing the various model results (Tables 1 and 2) lower values of MSPE indicate a better predictive performance, while higher values indicate a lower predictive performance of the variables.

Table 1: Dynamic Linear Regression of Non-Oil Export on Various Economic Variables

Model	Regressor	MSPE	GCD
1	GDP	0.003	0.996

2	CE	0.004	1.040
3	CPI	0.003	1.017
4	EXRT	0.009	0.916
5	LR	0.002	1.366

GDP –Gross Domestic Product, CE- Capital Expenditure, CPI – Consumer Price Index, EXRT- Exchange Rate and LR- Lending Rate
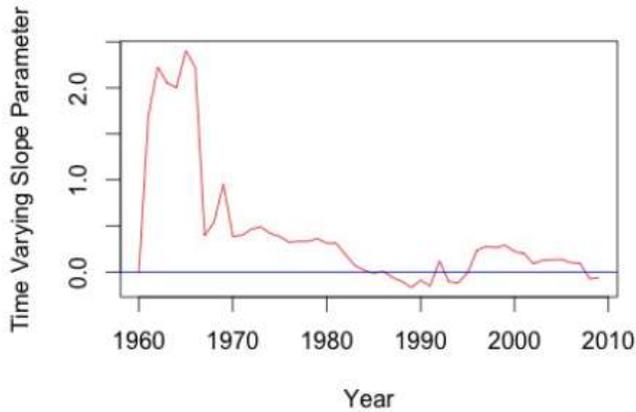

Figure 1: Dynamic Regression of Non-Oil Export vs GDP

Figure 1 depicts that Non-Oil Export and GDP exhibit a strong relationship in the early 1960s but declined in the late 1960s.
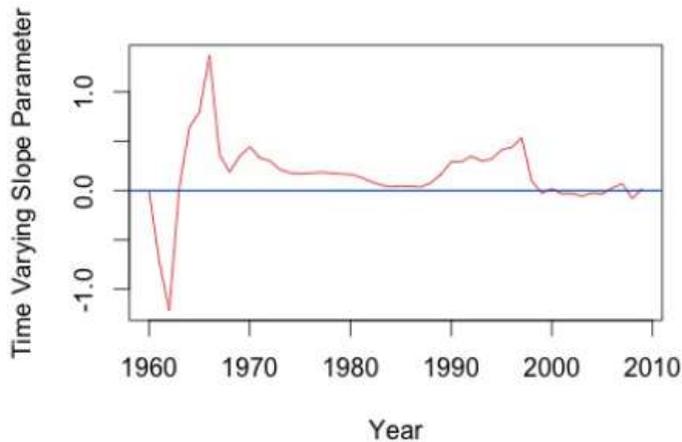

Figure 2: Dynamic Regression of Non-Oil Export vs Capital Expenditure

Figure 2 depicts that Non-oil export and capital expenditure were strongly correlated around mid- 1960s. Thereafter, it followed a downward trend.
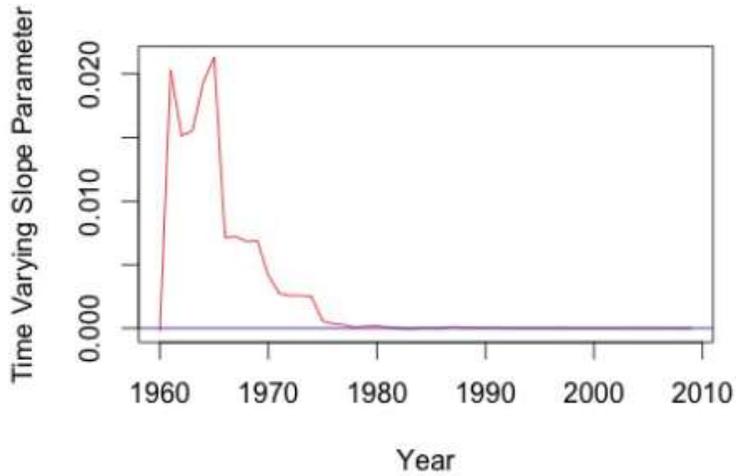
Figure 3: Dynamic Regression of Non-Oil Export Vs Consumer Price Index

Figure 3 depicts that Non-Oil export and Consumer Price Index were characterized by a swift upward relationship in the early 1960s and a swift downward trend in the late 1960s.
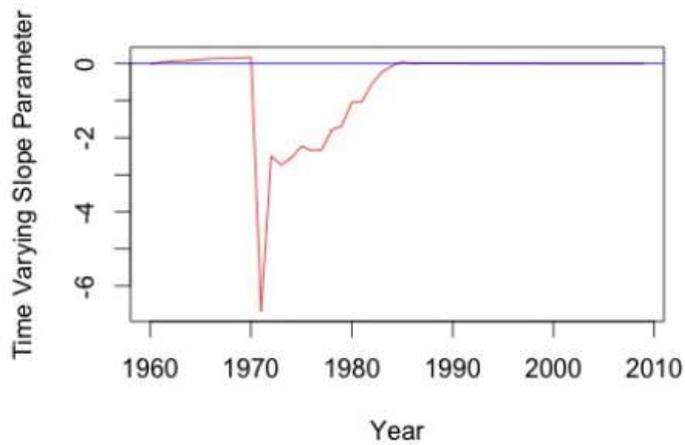

Figure 4: Dynamic Regression of Non-Oil Export vs Exchange Rate

Figure 4 shows that the relationship between Non-Oil Export and Exchange Rate was mostly negative till around mid-1980s.
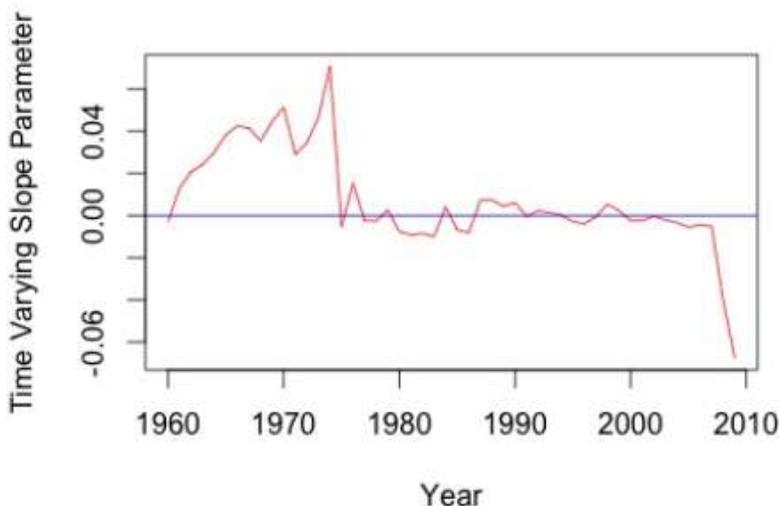
Figure 5: Dynamic Regression of Non-Oil Export Vs Lending Rate

Figure 5 depicts that the relationship between Non-Oil Export and Lending Rate was highly erratic over the study period.

Table 2: Dynamic Linear Model of Non-Oil Export on Various Predictors

Model	Regressor	MSPE	GCD
1	LR +GDP	0.003	1.001
2	LR +CE	0.006	1.086
3	LR +CPI	0.004	0.058
4	LR + EXRT	0.007	0.966

4.3 Discussion of Results

There are quite a number of interesting results from this study. Table 1 shows the dynamic regression of Non- Oil export on its various predictors. Lending rate exhibits the minimum MSPE of 0.002 on non-oil export. This result agrees with investment theory which requires that investment and interest rates are inversely related. The lending rate is the cost of capital and as it reduces, it encourages more investment activities either for domestic or export.

For instance, Bader and Malawi (2010) examine the impact interest rate exerts on investment for Jordan using co-integration technique for a period of 1990-2005 and establish that real interest rate exerts a negative influence on investment. It is therefore very pertinent for the monetary authority in Nigeria to effectively set its

monetary policy rate towards ensuring stability of the lending rate in order to stimulate non-oil export business in Nigeria.

In Table 2, with non-oil export as the regress and, lending rate and GDP predict non-oil export better than the other combinations of predictors. This agrees with principle that a lower lending rate made accessible to aliens will stimulate foreign GDP, thus stimulating non-oil export.

Non-oil exports are mostly cash crops such as cocoa, timber, coffee, cotton etc., Figure 1 shows that the relationship between non-oil export and GDP was very high in the 60s when agriculture played a significant role in the economy of Nigeria. Sadly, the relationship consistently became poor thereafter suggesting that a decline in foreign GDP reduces non-oil export. Capital expenditure and non–oil export did not fare well over the study period which can be attributed to inadequate infrastructure in the supposed largest economy in Africa.

Figure 3 shows that in 1960s, consumer price index and non-oil export give a high positive time-varying correlation, suggesting that an increase in non-oil export will boost domestic income with its aftermath effect on aggregate demand as well as the price level. Unfortunately, the relationship became poor and eventually neutralized beyond the mid-1960s. Figure 4 shows an unstable relationship between the time-varying parameter estimates of non-oil export and the exchange rate. In Figure 5, non-oil export and lending rate display erratic pattern over the study period, which implies the lending rate will influence the availability of capital for non-oil export activities. Its stability is therefore indispensable.

The proposed dynamic model also addresses reverse causality, as the lending rate affects exports, exports also affect lending rate. All of the Geweke Z statistics are below the 1.96 threshold, indicating a failure to reject the null hypothesis of stationary means in each time series. In the results, if the null hypothesis of the convergence to the posterior distribution is not rejected for the parameters at the 5% significance level, it indicates an efficient sampling for the parameters.

5. Conclusions and Recommendations

The paper proposed and estimated a time-varying parameter dynamic regression model with application to econometric modelling of the determinants of non-oil export in Nigeria. The roles of exchange rate, GDP, lending rate, consumer price index as well as capital expenditure are considered in predicting non-oil export. Lending rate proves to be a better predictor when compared with other economic variables in the study.

It is therefore pertinent for the monetary authorities in Nigeria to maintain the stability in the value of lending rate. Lending rate combined with GDP gives a minimum mean square predictive error of 0.003. Investment in non-oil activities, most especially agriculture and manufacturing should be encouraged. The economy will eventually improve as government's expenditure on social overhead capital expands thus creating an enabling environment for investment activities with its resultant effects on employment generation as well as higher standard of living for the citizens of Nigeria after the pandemic.

Acknowledgement

References

1. Adenugba, A. A. and Dipo, S.O. (2013). Non-Oil exports in the economic growth of Nigeria: A study of Agricultural and Mineral Resources. *Journal of Educational and Social Research,* 3(2), 403-418.
2. Aladejare, S. A. and Saidi, A. (2014). Determinants of non-oil export and economic growth in Nigeria: An application of the bound test approach. *Journal for the Advancement of Developing Economies.* 3(1), 68-81.
3. Awe, O.O. and Adepoju, A. A. (2018). Modified recursive Bayesian algorithm for estimating time-varying parameters in dynamic linear models. *Statistics in Transition-New Series,* 19(2), 239-258.
4. Awe, O. O., Akinlana, D. M., Yaya, O.S. and Aromolaran, O. (2018). Time series analysis of the behaviour of import and export of agricultural and non-agricultural goods in West Africa: A case study of Nigeria. *Agris On-line Journal of Economics and Informatics,* 10(2), 15-22.
5. Bader, M. and Malawi, A. I. (2010). The impact of interest rate on investment in Jordan: a cointegration analysis. *Economics and Administration*, 24(1), 199-209.
6. Chen, J. and Carlos, M. P. (2016). The determinants of export performance: a review of the literature 2006-2014. *International Marketing Review.* 33(5), 626-670.
7. Ezike, J. E. and Ogege, S. (2012). Nigerian foreign trade policy: Its impact on non-oil exports. *Journal of Economics and International Finance.* 4(8), 192-200.

8. Funke, M. and Holly, S. (1992). The determinants of West German exports of manufactures: An integrated demand and supply approach. *WeltwirtschaftlichesArchiv*, 128(3), 498-512.

9. Greene, W. H. (2003). *Econometric analysis*. Pearson Education India, 2003.

10. Imoughele, L. E. and Ismaila, M. (2015). The impact of exchange rate on Nigeria non-oil exports. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 5(1), 190-198.

11. Kandiero, T., Kamara, A. and Ndikumana, L. (2009). Commodities, export subsidies, and African trade during the slump. Policy Brief on Financial Crises. No.5/2009. Retrieved from www.afdb.org on 6/8/2010.

12. Lipuma, J. A., Newbert, S. L. and Doh, J. P. (2013). The effect of institutional quality on firm export performance in emerging economies: a contingency model of firm age and size. *Small Business Economics*, 40(4), 817-841.

13. Ricardo, D. (2004). The Works and Correspondence of David Ricardo. (P. Sraffa, Ed.) Indianapolis: Liberty Fund, Inc.

14. Ruffin, R. J. (2005). Debunking a Myth: Torrens on Comparative Advantage. *History of Political Economy*, 37 (4), 711-722.

15. Sheridan, B. J. (2014). Manufacturing exports and growth: When is a developing country ready to transition from primary exports to manufacturing exports?. *Journal of Macroeconomics.* 42, 1–13.

16. Smith, A. (1937). The wealth of nations [1776].

17. Subasat, T. (2003). What does the Heckscher-Ohlin Model contribute to international Trade Theory? A critical assessment. *Review of Radical Political Economics/Spring 2003.*

18. Usman, (2010). Non-oil Export Determinants and Economic growth in Nigeria (19852008): *European Journal of Business and Management Sciences,* 3(3), 124 of 10.

19. Uzonwann, M. C. (2020). Non-oil export and economic growth in Nigeria: A disaggregated analysis. *Turkish Economic Review*, 7(1), 1-15.

20. Vincent, K. (2017). An analysis of the impact of non-oil exports and economic growth in Nigeria from 1980–2016. *International Journal of Innovative Research in Social Sciences & Strategic Management Techniques*, 4(2), 83-94.

21. West, M. and Harrison, P.J. (1997). *Bayesian Forecasting and Dynamic Models*. Springer-Verlag.

22. Williamson, J. (1995). Exchange rate policy and development strategy. AERC Plenary Session, *Journal of African Economies,* 6(3), Nairobi.