WEST AFRICAN INSTITUTE FOR FINANCIAL AND ECONOMIC MANAGEMENT (WAIFEM)

WEST AFRICAN FINANCIAL AND ECONOMIC REVIEW

Volume 20 ■ December 2020 ■ Number 2

ISSN 0263-0699

West African Institute for Financial and Economic Management

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The Institute is grateful to the **African Capacity Building Foundation (ACBF)** for the financial support toward the publication of this journal.

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Published in Lagos, Nigeria by
West African Institute for Financial and Economic Management (WAIFEM),
Central Bank of Nigeria Learning Center, Navy Town Road, Satellite Town,
PMB 2001, Lagos, Nigeria.

ISSN 0263-0699

Printed by
Kas Arts Service Ltd.
08056124959

EFFECTS OF FOREIGN DIRECT INVESTMENT AND DOMESTIC INVESTMENT ON NON-OIL INDUSTRIAL PRODUCTION IN NIGERIA

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Abstract

This study examines the effects of Foreign Direct Investment (FDI) and Domestic Investment (DI) on non-oil industrial production (comprising manufacturing and solid minerals) in Nigeria, using annual time series data spanning the period from 1981 to 2018. The ARDL approach to co-integration and error correction modeling was adopted for the analysis. The empirical evidence indicates that FDI positively and significantly affects non-oil industrial production in the short run and in the long run in the country. The short run and long run effects of DI on non-oil industrial production are found to be statistically insignificant. Financial development positively and significantly affects non-oil industrial production in the short-run and in the long-run. Further evidence is that inflation adversely affects non-oil industrial production in the short-run, but the effect is not significant in the long-run; and exchange rate positively and significantly affects non-oil industrial production in the long run. Based on the evidence, the study recommends that Nigeria's government should intensify efforts to enhance the attractiveness of the nation's non-oil industrial sectors to FDI in order to boost output therefrom. There is also need to develop the nation's financial system to enhance its capacity to provide credit to the nation's non-oil industry. The monetary authority should wield its various instruments to bring inflation under control. Trade liberalization should be cautiously implemented. In particular, there should be restrictions on selected categories of imports (especially consumption goods) to protect domestic (infant) non-oil industries. The monetary authority should occasionally intervene in the foreign exchange market to prevent over-valuation of the domestic currency (the Naira) thereby avoiding influx of excess (foreign consumer goods) to the economy.

Keywords: FDI, Domestic Investment, Financial Development, Trade Openness, Inflation, Exchange Rate, Non-oil Industrial Production.

JEL Classification Codes: B17, F21, D23, E22, E51, F31, H55, O15, L60, L70

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1.0 INTRODUCTION

The industrial sector constitutes the engine of growth of modern economies. Industrial development sets the pace for industrialization which is a key requirement for rapid and sustainable economic growth and development. Countries with highly developed industrial sectors are characterized by high per capita income, low poverty rates, low income and consumption inequalities, low unemployment rates, trade competitiveness, high and stable growth rates, etc. It can be argued that the level of development of less developed countries is due to the poor or moribund state of their industrial sector. This is reflected in low volume and value of industrial outputs which are quite uncompetitive in local and foreign markets, high unemployment rates, low wages, high poverty rates, low per capita income, etc. Thus the need to deliberately embark on industrialization drive by Less Developed Countries (LDCs) cannot be overemphasized.

Nigeria is a lower middle income country, according to recent World Bank countries classifications based on Gross National Income-per-capita (World Bank, 2019). The country's real sector has five activity sectors, namely, agriculture, industry, trade (commerce), construction and services sectors which are responsible for the production (and distribution) of the country's output of goods and services (Oduyemi, 2013; CBN, 2018). The sectors contributing majorly to the nation's Gross Domestic Product (GDP) are services, industry and agriculture. Over the years since 1981, the services sector has been the largest contributor to the GDP, followed by the industrial and the agricultural sectors. Table 1 shows the trends in the contributions of each sector to the GDP.

Table 1. Average Sectoral Contributions to GDP (%), 1981-2018

Activity Sectors	**Periods**								**Average 1981-2018**
	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016-2018	
Agriculture	15.00	20.64	23.38	27.15	30.47	25.61	21.29	21.23	23.20
Industry	**24.92**	**27.45**	**30.25**	**27.44**	**22.21**	**20.34**	**21.43**	**17.56**	**24.29**
Construction	5.43	3.49	2.54	1.90	1.82	2.49	3.34	4.01	3.08
Trade	9.45	12.38	15.60	17.59	14.94	17.59	17.36	18.83	15.25
Services	45.50	36.04	28.22	25.91	30.56	33.96	36.58	38.37	34.18

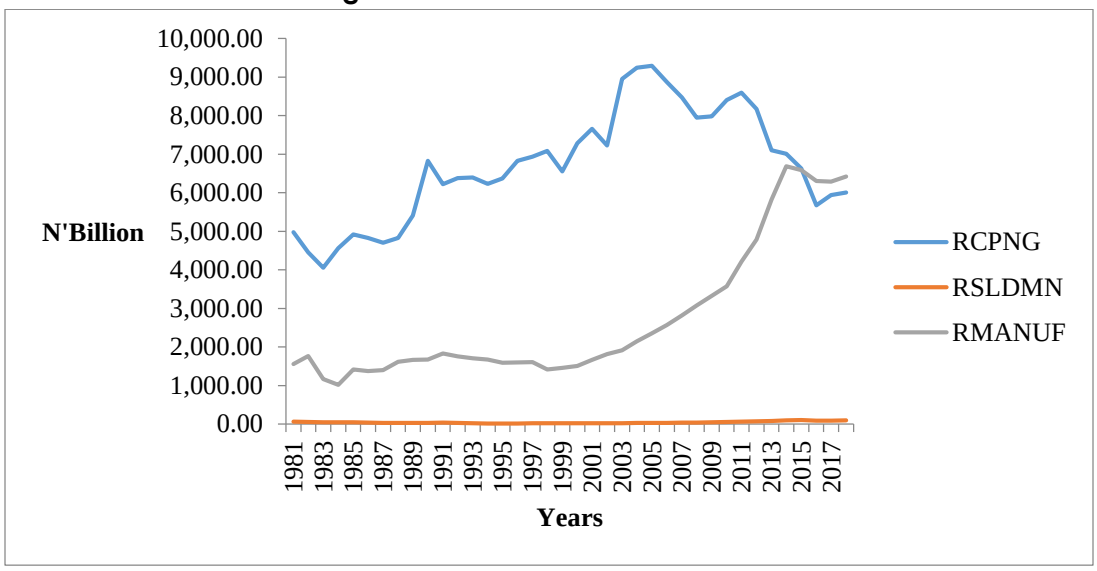
Source: Authors' calculations using data from CBN Statistical Bulletin (2018).

Nigeria's industrial sector comprises the crude oil and natural gas subsector and the other subsectors including solid minerals and manufacturing which are grouped as the non-oil industrial sector in this study. The sector is dominated by the crude oil and

natural gas subsector which is also the main driver of the nation's economy, accounting for an average of about 10% of the GDP, over 90% of total export earnings and about 65% of total government revenue as at 2018 (CBN, 2018; OPEC, 2018; EITI, 2020).

Nigeria has an abundance of solid mineral resources such as coal, iron ore, limestone, gold, silver, diamond, and zinc(Ministry of Mines and Steel, 2017), which however are largely under-exploited. In spite of efforts by the government to resuscitate the manufacturing sector through the implementations of various programs and policies, the growth of the sector has been unimpressive owing to unfavorable ambience created by weak infrastructure (including energy, road infrastructure, and railways) and other economic, political and socio-cultural factors contributing to raising the cost of doing business and adversely affecting investment decisions therein. Figure 1 shows the trends in the real values of outputs of the various activity sectors of the industrial sector in Nigeria.

Figure 1: Trends in Real Values of Outputs of Crude Petroleum and Natural Gas, Solid Minerals and Manufacturing Sectors.



Note:

RCPNG = Real value of crude petroleum and natural gas activity sector output

RSLDMN = Real value of solid minerals activity sector output

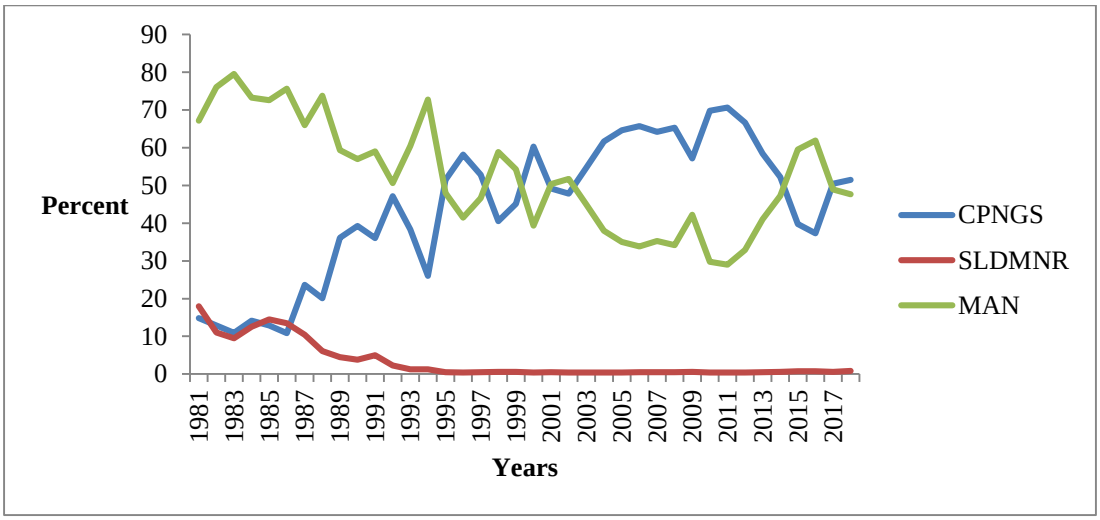
RMANUF = Real value of manufacturing activity sector output

Source: Data from the CBN Statistical Bulletin, 2018.

Under-exploitation of the abundant solid minerals found in various parts of the country is reflected in the low level of output of the sector (Figure 1). It can be seen from Figure 1 that the crude petrol sector dominates the industrial sector as the real value of its output significantly exceeded that of the manufacturing sector in most of the period, except during the period from 2015-2018, owing to the collapse of global crude oil prices.

The bane of the manufacturing sector in Nigeria has been attributed to the prominence of the crude petroleum and natural gas sector (Edo, 2013). This is hardly contentious considering that the (nominal) shares of crude petroleum and natural gas sector in total industry output and that of the manufacturing sector have always tended to move in opposite directions over the years since 1981. The share of solid mineral output in total industry output has been evidently very low compared to those of other activity sectors of the industrial sector. These are shown in Figure 2.

Figure 2: Shares of Crude Petroleum and Natural Gas, Manufacturing and Solid Mineral in Total Industry Output



Note:

CPNGS = Market/nominal value of output of crude petroleum and natural gas sector as a percentage of total nominal value of industry output.

SLDMNR = Market/nominal value of output of solid mineral sector as a percentage of total nominal value of industry output.

MAN = Market/nominal value of output of manufacturing sector as a percentage of total nominal value of industry output.

Source: Data from the CBN Statistical Bulletin, 2018

This suggests a stylized fact that a boom in the crude oil sector has been associated with a squeeze in the manufacturing sector over time.

Industrial sector output and its growth are affected by numerous factors. These include the level of technological advancement or sophistication, skill of the labor force, electricity consumption, public and private consumption expenditure, financial development, exchange rate, and aggregate investment (Barişik & Yayar, 2012; Yeo & Grant, 2017). Investment has been defined as monetary outlays on real assets such as plants and machinery, inventory, building, etc. that contribute to the production of goods or provision of services (Weiss & Clara, 2016). It could be foreign or domestic investment. Foreign ownership of such productive assets or large/controlling stake in it in a host country is referred to as foreign direct investment (FDI). On the other hand, ownership of productive assets or holding of controlling stake by government and nationals (including those resident abroad) of a country is referred to as domestic investment.

The bulk of FDI that flows into Nigeria's economy is in the crude petroleum and natural gas sector (UNCTAD, 2009), and this may have contributed to the large share of the sector's output in total industry output in the country. Relatively lower amounts of FDI flow into the non-oil industrial sector in spite of programs and policies implemented to attract FDI, including the National Investment Promotion Act of 1995 which opened up all sectors of the economy to foreign investors (UNCTAD, 2009; Babatunde, *et al*., 2013). The consequence has been that the value of manufacturing sector output is still far below that of the crude petroleum and gas sector, and FDI inflow to the non-oil industrial sector seems to have been substituting (or displacing) instead of complementing domestic investment therein (Nwanna, 1986; Jude, 2018). The inability of most of the non-oil activity sectors of the country's industrial sector to attract significant FDI could be a pointer to the need to encourage domestic investment in those sectors (Weiss & Clara, 2016).

Most of the previous studies on Nigeria examined the effect of FDI on industrial output and quite a few examined the effect of FDI on manufacturing sector performance (Orji *et al*., 2015; Ekienabor, 2016; Agbarakwe, 2019). This study contributes to the literature by investigating the effect of FDI and domestic investment on non-oil industrial production (comprising manufacturing and solid minerals). To our knowledge based on our search of the literature, this has not been previously researched. The current study, therefore, goes beyond just the manufacturing sector to incorporate the solid mineral sector as this also has the potential to enhance industrial growth if properly harnessed. Thus, the objectives of the study are to examine the effects of FDI

and domestic investment on non-oil industrial production. The focus on non-oil industrial production is informed by the fact that crude-oil is a primary commodity which cannot be indefinitely relied upon for sustainable economic growth and development, hence the need to examine the factors affecting non-oil industrial sectors' production with a view to optimizing the potentials of the non-oil activity sectors to contribute to the growth of the nation's economy in the long run.

2.0 LITERATURE REVIEW

Neoclassical and endogenous growth theories predict a positive relationship between investment and output growth. Investment plays a significant role in promoting economic growth and ensuring sustainable development (UNCTAD, 2010). The key channel through which investment affects output growth is its effect on productive activities, which take place in the real sectors of the economy. The major growth-driving sector of modern economies is the industrial sector. Investment in the industrial sector will therefore translate into enhanced industrial output and sustainable growth and development.

Gross investment in an economy comprises domestic and foreign investment. All things being equal, FDI is expected to contribute to the stock of capital in an economy, if it does not crowd out domestic investment (Agosin & Mayer, 2000). The dual-gap theory postulated by Chenery and Strout (1966) explains the importance of foreign assistance in LDCs. The theory identifies two gaps in LDCs, namely the investment gap arising from domestic savings falling short of desired investment and the foreign exchange gap, arising from insufficient foreign exchange to facilitate international trade. Foreign assistance in terms of inflow of foreign capital or foreign direct investment is required to fill the investment gap.

The channels or mechanisms through which FDI affects output include technology transfer, skill transfer, direct production, etc. These translate into enhanced production or output, given favorable investment ambience including government programs and policies on investment.

The effect of FDI in manufacturing sector on the growth of the sector in Nigeria during the 1970-2011 period was examined in Anowor *et al.* (2013) using the Engle-Granger two-step approach to co-integration and error correction analysis. The empirical evidence indicated that the short run effect of FDI on manufacturing sector output was negative, but not statistically significant. The short run effects of other variables which served as control variables in the model including exchange rate, trade

openness and investment were also not significant. The high coefficient of determination of over 95% reported in spite of the fact that none of the explanatory variable was significant points to the problem of multicolinearity, which renders the results and the conclusion of the study unreliable as the variances of the estimated parameters would have been inflated. Moreover there is also the problem of inconclusiveness as the associated long run model was not presented. What was presented instead was an estimated GDP equation.

The study by Nwosa (2015) employed the OLS technique to examine the effect of capital inflows (FDI and foreign aid) and other policy variables on sectoral output in Nigeria during the period from 1970 to 2014. The sectors were split into six namely agriculture, building and construction, extractive, manufacturing, retail and wholesale. (*The study differs from this current study in that it lumps oil and gas and solid mineral sector together as extractive sector*). The study found *inter alia* that the effects of FDI and foreign aid on manufacturing sector output were not statistically significant. The effect of FDI on extractive sector output was positive and statistically significant, while that of foreign aid failed the test of statistical significance at the conventional levels. However, careful consideration of the results presented revealed that the variables were integrated of order 1 or 2, raising questions on the appropriateness of the methodology of the study.

Ibi *et al.* (2015) examined the effects of capital market, domestic investment and other macroeconomic factors on industrial development in Nigeria during the period of 1980 to 2012 using error correcting modeling. The study found that gross domestic investment negatively and significantly affected industrial output in the country in the short run. The short run industrial output effect of capital market (market capitalization and number of deals) was observed to be positive and significant. Exchange rate was found to be negatively and significantly related to industrial output in the short run in the country. The long run results were however not reported.

Orji *et al*. (2015) employed the OLS estimation technique to examine the effect of FDI on manufacturing sector output in Nigeria during the period from 1970 to 2010. The study found that FDI adversely affected manufacturing output in the country. The effects of private sector credit and exchange rate on manufacturing sector output were also found to be negative and significant, while that of savings was found to be positive and significant. The researchers suggested that the adverse effect of FDI on manufacturing sector could be reversed if the FDI were channeled into critical sector of the economy. In a similar study, Orji *et al.* (2018) also employed OLS technique to investigate the effect of FDI, exchange rate, government expenditure, imports and

credit to the private sector on manufacturing sector output during the period from 1981-2016. The study found that all the variables significantly affected manufacturing sector output. However, contrary to the observed adverse effect of FDI in the previous study, it was found that FDI positively affected manufacturing sector output. Government expenditure, imports and exchange rate also affected manufacturing sector output positively, but credit to private sector negatively affected it. Failure of both studies to test for unit root and provide a justification for the use of OLS renders the results and their conclusions unreliable.

Ekienabor *et al*. (2016) also employed the OLS estimator to estimate a linear regression model to investigate the effect of FDI inflows to the manufacturing sector on the sector's output in Nigeria during the 1981-2012 period. The study found that FDI in the sector positively and significantly affected its output. It was also found that exchange rate positively and significantly affected manufacturing sector output in the country. The effect of interest rate was not statistically significant. As in the studies by Orji *et al.* (2015, 2018), this study fails to report the unit root test and provide a justification for use of OLS. These also render the findings and the conclusion of the study unreliable.

Adegboye, *et al*. (2016) examined the effect of FDI on industrial sector performance (measured by industrial value added as a percentage of GDP) in a sample of 43 African countries during the period from 1996 to 2015. The pooled OLS and fixed effects models were estimated for the analysis. The study found that FDI positively and significantly affected industrial sector performance. Gross domestic savings, technology and real GDP were also found to positively affect industrial performance in the countries. Gross capital formation (domestic investment), domestic credit to private sector and employment to population ratio were however found to be counter-productive as they adversely affected industrial sector performance.

Obi-Nwosu *et al*. (2019) estimated a linear regression model using the OLS estimator to investigate the effect of FDI on manufacturing capacity utilization in Nigeria during the period from 1984 to 2017. The study found that FDI positively and significantly affected capacity utilization. It also found positive and significant effect of exchange rate on manufacturing capacity utilization. The effect of inflation was found to be positive, but not statistically significant. Considering that the unit root tests indicated that the variables of the study were integrated of order 1, and the co-integration test indicated the variables were co-integrated, the use of OLS estimator renders the results and conclusion of the study of the study unreliable.

The study by Offum and Ihuoma (2018) on the relationship among domestic investment, capital market, industrial performance and other economic factors in Nigeria during the 1985-2015 period found no causal relationship between domestic investment and industrial performance. It, however, found unidirectional causality running from ratios of market capitalization and value of shares traded to GDP, to industrial performance in the country.

Nwosa (2018) examined the effect of FDI on industrial production in Nigeria during the 1970-2016 period, using error correction modeling. The study found that FDI negatively affected industrial output in the country in the short run. Labour force was found to positively affect industrial production in the short run. The short run effects of other variables including inflation capital stock and financial development were found to be statistically not significant. However, the study did not report the long run effects of these variables on industrial production. This renders the study inconclusive.

Djulius, *et al*. (2019) investigated the effects of FDI and domestic investment on manufacturing value-added of manufacturing firms in 10 industries of Indonesia during the 2010-2015 period. The study explored OLS-estimations of fixed and random effect models. The study found that for the entire sample, FDI and domestic investment positively and significantly affected manufacturing sector value-added. However, evidence from estimation involving different groups (capital intensive industries and labor intensive industries) showed that only the effect of domestic investment was significant in capital intensive industries, and only the effect of FDI was significant in labor intensive industries.

3.0 METHODOLOGY

3.1 Theoretical Framework, Model and Estimation Technique

In this section, a model is derived to examine the effect of FDI and domestic investment on non-oil industrial production in Nigeria. The Solow (1956) model which is presumed to provide the framework for comprehending the determinants of economic wellbeing (Mankiw, 1992) provides the theoretical framework for this study. The model relates output to factor inputs such as technology (A), capital (K) and labor (L). The relation is expressed as:

$$Y = f(A, K, L) \qquad [1]$$

According to Baldwin & Forslid (2000), investment is the heart of output growth model. Total investment in an economy comprises domestic and foreign investments (Agosin and Mayer (2000). Chenery and Strout (1966) considered foreign investment as a separate factor of production. Hence,

$$K = K_f + K_d \quad [2]$$

Substituting equation [2] into equation [1] yields:

$$Y = f(A, K_f, K_d, L) \quad [3]$$

Equation [3] relates output to level of technology, foreign investment, domestic investment and labor force. In empirical applications, the basic Solow model is augmented to incorporate other policy variables that are to likely affect output (Mankiw, 1992). In view of this, to achieve the objective of our study, equation [3] is augmented by incorporating variables identified by growth theories and justified in the literature as determinants of industrial output. Thus, the model estimated for our investigation is specified as:

$$NOILINDQ = f(FDI, DINV, FINDEV, TOPEN, INFL, EXRT) \quad [4]$$

Where NOILINDQ = Real value of non-oil industrial output from manufacturing and solid mineral industries; FDI = Net foreign direct Investment inflows; DINV = Domestic investment, measured by gross capital formation (CBN, 2012; World Bank, 2020); FINDEV = Financial development measured by credit to the private sector as a percentage of GDP; TOPN = Trade openness measured by total trade (export plus import) as percentage of GDP; INFL = inflation measured by annual percentage change in the consumer price index; EXRT = Nominal (₦/$) exchange rate.

The ARDL approach to co-integration and error correction modeling developed by Peraran *et al*. (2001) was adopted for the analysis. It was adopted because of its flexibility. It can be applied in cases of small finite sample size, mixed order of integration of variable data series (including fractionally integrated series) as far as none is integrated of order 2, I(2), and it is designed to correct the problem of autocorrelation and endogeneity of regressors (often found with co-integrated regressors) to yield consistent and efficient long run estimates with valid t-statistics (Harris and Sollis, 2003). In this approach, an unrestricted error correction model (UECM) version of the ARDL model is specified and estimated using the OLS estimator. The model is specified as:

$$\Delta \mathrm{Ln}(\mathrm{NOILINDQ})_t = \beta_0 + \sum_{j=1}^{p}(\lambda_{1j}\Delta \mathrm{LnNOILINDQ}_{t-j}) + \sum_{j=0}^{p}(\lambda_{2j}\Delta \mathrm{LnFDI}_{t-j}) + \sum_{j=0}^{p}(\lambda_{3j}\Delta \mathrm{LnDINV}_{t-j}) + \sum_{j=0}^{P}(\lambda_{4j}\Delta \mathrm{FINDEV}_{t-j}) + \sum_{j=0}^{P}(\lambda_{5j}\Delta \mathrm{TOPEN}_{t-j}) + \sum_{j=0}^{P}(\lambda_{5j}\Delta \mathrm{INFL}_{t-j}) + \sum_{j=0}^{P}(\lambda_{6j}\Delta \mathrm{LnEXRT}_{t-j}) + \gamma_1 \mathrm{LnFDI}_{t-1} + \gamma_2 \mathrm{LnDINV}_{t-1} + \gamma_3 \mathrm{FINDEV}_{t-1} + \gamma_4 \mathrm{TOPEN}_{t-1} + \gamma_5 \mathrm{INFL}_{t-1} + \gamma_6 \mathrm{LnEXRT}_{t-1} + \xi_t \quad [5]$$

The variables are as defined previously. Ln stands for natural logarithm. Parameters γ_1 to γ_5 correspond to the long run relationship, while the parameters $\lambda_{1j} \ldots \lambda_{6j}$ correspond to the short run relationships. Δ is the first difference operator, ξ is the error term, j is the optimal lag order of the ARDL and it is to be empirically determined. Following the estimation of the model is the test of the joint significance of the regressors using the computed Wald's F test. The null hypothesis of "no co-integration" ($\gamma_1 = \gamma_2 = \gamma_3 = \ldots \gamma_6 = 0$) is tested against the alternative hypothesis of co-integration ($(\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \ldots \lambda_8 \neq 0)$. Pesaran *et al*. (2001) have computed two sets of asymptotic critical values for the F-statistic at different levels of statistical significance (1%-10%). One is the lower bound critical values which assume the variables are I(0), and the other is the upper bound critical value which assumes the variables are I(1). The null hypothesis of no co-integration is rejected if the computed F-statistic is greater than the upper bound critical value at the chosen level of significance. The null hypothesis is accepted if the F-statistic is less than the lower bound critical value, implying the variables are not co-integrated. The test is inconclusive if the computed F-statistic is between the lower and upper bound critical values.

The error correction model is derived from the UECM-ARDL model (equation 5) as:

$$\Delta \mathrm{LnNOILINDQ}_t = \beta_0 + \sum_{j=1}^{p}(\beta_{1j}\Delta \mathrm{LnNOILINDQ}_{t-j}) + \sum_{j=0}^{p}(\beta_{2j}\Delta \mathrm{LnFDI}_{t-j}) + \sum_{j=0}^{p}(\beta_{3j}\Delta \mathrm{LnDINV}_{t-j}) + \sum_{j=0}^{P}(\beta_{4j}\Delta \mathrm{FINDEV}_{t-j}) + \sum_{j=0}^{P}(\beta_{5j}\Delta \mathrm{TOPEN}_{t-j}) + \sum_{j=0}^{P}(\beta_{6j}\Delta \mathrm{INF}_{t-j}) + \sum_{j=0}^{P}(\beta_{7j}\Delta \mathrm{LnEXRT}_{t-j}) + \varphi \mathrm{ECT}_{t-1} + \varepsilon_t \quad [6]$$

The βs are estimates of the respective short run effects of the explanatory variables on the dependent variable. ECT is the error correction term which *inter alia* measures the speed of adjustment to equilibrium in the event of short run deviation from the long run (equilibrium) relationship. To play the role of error correction, its coefficient (φ) is expected to be negatively signed and statistically significant. The negative and significant coefficient is a further indication of co-integration of the variables. **ε** is the error term.

The long run (static) equation is derived from the ARDL model as:

$$LnNOILINDQ_t = \Gamma_0 + \Gamma_1 LnFDI_t + \Gamma_2 LnDINV_t + \Gamma_3 FINDEV_t + \Gamma_4 TOPEN_t + \Gamma_5 INFL_t + \Gamma_6 LnEXRT_t + \mu_t \quad [7]$$

The Γs measure the long run effects of the explanatory variables on the dependent variable. μ is the error term.

The *a priori* expectations are: $\Gamma_1 < 0$, $\Gamma_2 > 0$, $\Gamma_3 > 0$, $\Gamma_4 > 0$, $a_5 < 0$, $\Gamma_5 > 0$.
Growth theories predict positive effects of FDI, domestic investment, financial development, trade openness and exchange rate on industrial output which is strongly linked to economic growth. Inflow of FDI (a channel through which foreign technology and skills flow into a country), increase in domestic investment, development of the financial system (which enhances firms' access to capital for investment finance), openness of the economy to the global market (which enhances access to foreign technology and other production inputs which are not locally available through importation) and increase in the exchange rate (which is used as a tool to curb importation and encourage demand for locally made goods as imports become more expensive in the domestic market, depending on the elasticity of demand for imports, going by the Marshall-Lerner condition) are predicted to affect non-oil industrial production positively.

Estimation of the models was preceded by testing the variables for unit root. For this, the augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests were performed.

3.2 Data and Sources

Annual time series data covering the period from 1981 to 2018 were used for the analysis. The data were obtained from different sources. Data on real non-oil industrial sector output (solid minerals and manufacturing) and financial development were obtained from the CBN Statistical Bulletin (2018), while data on real domestic

investment, net FDI, trade openness, exchange rate and inflation were obtained from the World Bank's World Development Indicators (2018).

4.0 RESULTS AND DISCUSSION

4.1 Unit Root and Co-integration Tests

A summary of the unit root test results for the variables of the study is presented in Table 2. The ADF test results indicate that all the variables are stationary at first difference [I(1)], except INFL which is found to be stationary at level [I(0)]. The PP test indicates that all the variables are stationary at first difference. However, there is the possibility for a linear combination of the variables to be stationary at level, signifying long-run convergence. This was tested using the ARDL (Bounds) test for co-integration which is suitable for I(1) and I(0) variables. The result of the test is presented in Table 3. The null hypothesis of no co-integration is rejected even at the 2.5% significance level as the estimated F-statistic is greater than the upper bound critical value. Thus, it can be inferred from the result that the variables are co-integrated.

Table 2: Unit Root Test Results

ADF Test							
Variables	**Levels**			**1st Difference**			**I(d)**
	ADF Stat	Critical Value (5%)	Inference	ADF Stat	Critical Value (5%)	Inference	
Ln(NOILINDQ)	-2.38	-3.54	NS	-5.66	-3.54	S	1
Ln(FDI)	-3.10	-3.54	NS	-9.82	-3.54	S	1
Ln(DINV)	-0.60	-2.95	NS	-4.00	-2.95	S	1
FINDEV	-1.87	-3.54	NS	-4.81	-3.54	S	1
TOPEN	-2.33	-3.54	NS	-4.58	-3.58	S	1
INFL	-3.97	-3.54	S	-	-	-	0
Ln(EXRT)	-1.41	-3.54	NS	-5.48	-3.54	S	1
PP Test							
Variables	**Levels**			**1st Difference**			**I(d)**
	PP Stat	Critical Value (5%)	Inference	PP Stat	Critical Value (5%)	Inference	
Ln(NOILINDQ)	-1.82	-3.54	NS	-5.68	-3.54	S	1
Ln(FDI)	-3.21	-3.54	NS	-9.83	-3.54	S	1
Ln(DINV)	-1.10	-2.94	NS	-4.76	-2.95	S	1
FINDEV	-1.92	-3.54	NS	-4.71	-3.54	S	1
TOPEN	-2.25	-3.54	NS	-11.27	-3.54	S	1

INFL	-2.82	-3.54	NS	-10.33	-3.54	S	1
Ln(EXRT)	-1.46	-3.54	NS	-5.32	-3.54	S	1

NS = Non-stationary; S = Stationary; I(d) = Order of integration

Source: Authors' estimations using EVIEWS 9

Table 3: ARDL Bounds Test

Sample: 1983 2018				
Included observations: 36				
Null Hypothesis: No long-run relationships exist				
Test Statistic	Value	k		
F-statistic	4.11	6		
Critical Value Bounds				
Significance	Lower Bound	Upper Bound		
10%	2.12	3.23		
5%	2.45	3.61		
2.5%	2.75	3.99		

k = Number of explanatory variables

Source: Authors' estimations using EVIEWS 9

4.2 Model Estimations

Considering that the variables are co-integrated, the short-run and long models were estimated. The results are presented in Table 4 and Table 5 respectively. The coefficient of determination (R^2) implies that the model has a good fit as over 66% of the systematic variation in the dependent variable is explained by the model. The F-statistic passes the test of statistical significance at the 1% level, implying that the explanatory variables are jointly significant in explaining the dependent variable. The Durbin-Watson (D.W.) statistic indicates absence of the problem of autocorrelation.

The contemporaneous short run effect of FDI on non-oil industrial output is positive and statistically significant at the 5% level. The positive sign on the coefficient conforms to *a priori* expectation. The coefficient implies that 1% rise in net inflow of FDI into the country is associated with 0.07% rise in non-oil industrial output. Thus FDI inflow is a significant determinant of non-oil industrial output in the country. The lagged effect of FDI on non-oil industrial output is not significant. Domestic investment also positively affects industrial output, conforming to *a priori* expectation, but the effect is not statistically significant. This shows that the domestic investment is not a key determinant of industrial production in the country. This could be attributed to several factors

including the level of domestic investment in the sector, poor technology resulting in low efficiency and low production effectiveness, and the inability of domestic investors (producers) to absorb or copy foreign technology in their production activities, and so on. These results reveal that foreign direct investment has been a major driver of the country's non-oil industrial sector production.

The contemporaneous effect of financial development on non-oil industrial production is positive and significant at the 10% level. This conforms to *a priori* expectation. Thus the development of the financial system is a requirement for the growth of the nation's non-oil industrial sector. However, its short run lagged effect is negative and significant at the 1% level suggesting that excess credit in the economy could have adverse lagged effect on non-oil industrial output through its effect on inflation in the short run. The negative lagged effect of financial development corroborates evidence from Orji, *et al*. (2015) which also found that financial sector credit adversely affects manufacturing sector output.

The short run effect of trade openness on non-oil industrial output is negative and significant at the 1% level. This implies that openness of the nation's economy to the global market adversely affects its non-oil industrial sector output. A unit rise in the trade-GDP ratio is associated with 0.6% decrease in real value of non-oil industrial sector production in the country. This may be attributed to the fact that unrestricted openness paves way for high volume of imports from highly industrialized countries and exposes the nation's industrial sector to global competition, adversely affecting demand for locally produced goods, and this has been detrimental to local industrial production. Moreover, the low competitiveness of home made goods reflected in the nation's low economic complexity index as computed by the Observatory of Economic Complexity (OEC, 2020) adversely affects the export potentials of the local non-oil industry. This stifles the incentive to produce. This result corroborates evidence from Okoye, *et al*. (2016) and Ebenyi, *et al*. (2017) which also found that trade openness adversely affects industrial output and manufacturing sector value-addition respectively in the short run in Nigeria.

The contemporaneous effect of inflation on non-oil industrial output in Nigeria is not statistically significant. However, its lagged effect is negative and significant at the 5% level, suggesting that inflation adversely affects industrial production in the short run with a lag. The short-run effect of nominal (₦/$) exchange rate on non-oil industrial production in the country is statistically not significant. This corroborates evidence from Adamu and Dogan (2017) which also found non-significant effect of nominal effective exchange rate on industrial production in the country.

The error correction coefficient is negatively signed as expected. It also passes the test of statistical significance at the 1% level. Thus it will rightly play the role of error correction in the model, reconciling short run dynamics with equilibrium relationships. Its coefficient however indicates that the speed of adjustment to equilibrium is low as only about 39.2% of short run deviations from equilibrium are adjusted annually to restore equilibrium in the system.

Table 4: Error Correction Model

Dependent Variable: Δ(Ln(NOILINDQ)) Selected Model: ARDL(1, 2, 1, 2, 0, 2, 0)			
Sample: 1981 2018			
Included observations: 36			
Variable	Coefficient	t-Statistic	Prob.
ΔLn(FDI)	0.0679	2.0692	0.05
ΔLn(FDI(-1))	-0.0511	-1.6261	0.12
ΔLn(DINV)	0.0336	0.3170	0.75
Δ(FINDEV)	0.0179	1.9218	0.07
Δ(FINDEV(-1))	-0.0385	-3.8094	0.00
Δ(TOPEN)	-0.0065	-2.7904	0.01
Δ(INFL)	0.0003	0.2040	0.84
Δ(INFL(-1))	-0.0031	-2.2626	0.03
ΔLOG(EXRT)	0.0358	1.4699	0.16
ECT(-1)	-0.3923	-3.0965	0.01

R^2 = 0.66; Adj. R^2 = 0.44; F-stat = 2.94, p = 0.01; D. W. Stat = 1.86.
Source: Authors' estimations using EVIEWS 9.

The long run effects of FDI, domestic investment and other explanatory variables on non-oil industrial production were estimated, and the results are presented in Table 5. As in the short run, FDI also positively affects non-oil industrial production in the long run. The effect is significant at the 5% level. A 1% rise in net FDI inflows is associated with 0.29% rise in non-oil industrial production. Comparing this with the short run effect, we find that the effect of FDI on non-oil industrial production is larger in the long run than in the short run. The observed positive effects of FDI on non-oil industrial output corroborates evidence from the studies by Bitzer and Görg (2005), Qiong and Minyu (2013) and Adegboye *et al*. (2016) which also found that FDI positively affects industrial output in OECD countries, China and Nigeria respectively.

The long run effect of domestic investment on non-oil industrial production is not statistically significant, as in the short run. The positive role of financial development in non-oil industrial growth is further underscored by the positive and highly significant long run effect of financial development on non-oil industrial output in the country. The effect is larger in the long-run than in the short-run. This buttresses evidence from Aminu *et al*. (2019) which also found that financial development contributes positively and significantly to the growth of the manufacturing sector.

As in the short run, trade openness negatively affects non-oil industrial production in the long run, and the effect is highly significant at the 1% level. Thus, if the current composition and trend in the nation's international trade should persist, development of domestic infant industries will be suppressed, and trade openness will adversely affect non-oil industrial production in the country in the long run. The long run effect of inflation on non-oil industrial output is also negative, but not statistically significant. This is in agreement with evidence from Adamu and Dogan (2017) which also found negative, non-significant long run effect of inflation on industrial production in Nigeria. The non-significance of the inflation may be due to the fact that in the long run, foreign firms operating in the country may have to import their productive factors (inputs) and these are not necessarily affected by domestic inflation.

The effect of exchange rate on non-oil industrial production is positive, but significant only at the 10% level. This suggests that depreciation of the domestic currency (increase in the nominal exchange rate) may have helped to protect domestic (infant) industries through its effect on imports as it discourages demand for imports whose domestic prices get inflated, and encourages exports whose prices in foreign markets are lowered, depending on the elasticity of demand of the exportable goods. This finding is in agreement with evidence from Musa and Jibrin (2018) which found that industrial output responds positively to shock in exchange rate and Segun and Adebayo (2018) which found positive and significant effect of exchange rate on industrial output in the country.

Table 5: Long Run Coefficients

Dependent Variable: Ln(NOILINDQ)			
Variable	Coefficient	t-Statistic	Prob.
Ln(FDI)	0.2925	2.0712	0.05
Ln(DINV)	-0.6294	-1.6173	0.12
FINDEV	0.1174	3.6301	0.00

TOPEN	-0.0165	-3.3644	0.00
INFL	-0.0007	-0.1796	0.86
LOG(EXRT)	0.0913	1.9626	0.06
C	15.6979	2.2883	0.03

Source: Authors' Estimation using EVIEWS 9.

4.3 Diagnostics

Diagnostics tests involving the tests for residual normality, serial correlation, heteroskedasticity and regression equation specification error were performed to ascertain the reliability of the estimated model. The results are summarized in Table 6. The test for normality of the residual indicates that the residuals of the model are normally distributed. This is indicated by the p-value of the Jarque-Bera statistic which is greater than 0.05 ($p > 0.05$), thus accepting the hypothesis of residual normality. The Breusch-Godfrey LM test indicates absence of serial correlation as the F-statistic (with $p = 0.106 > 0.05$) fails to reject the null hypothesis of absence of serial correlation. The Breusch-Pagan-Godfrey tests indicates absence of heteroskedasticity as the F-statistics (with $p = 0.521 > 0.05$) fails to reject the null hypothesis of heteroskedasticity. The Ramsey TEST fails to reject the null hypothesis of no error in the specification of the regression equation. In view of these, the estimation results can be accepted and relied upon with a high degree of confidence.

Table 6: Diagnostic Tests

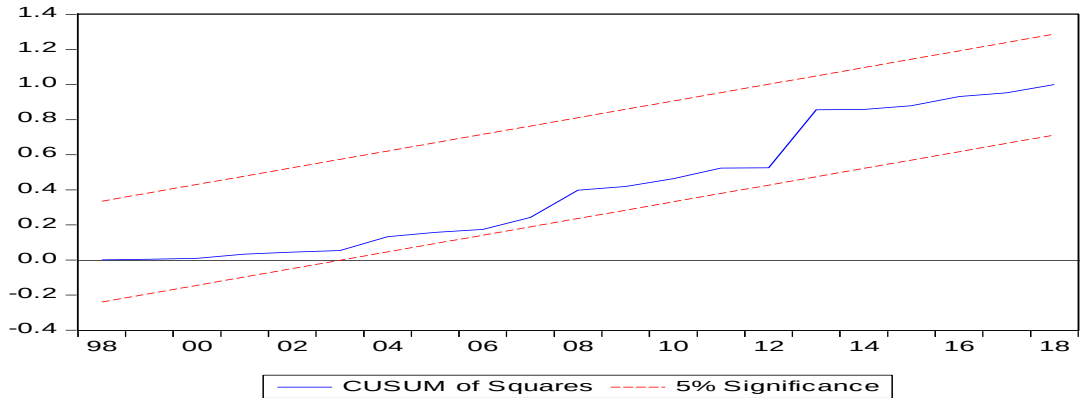
Test	F-stat	p-value	Jarque-Bera stat	p-value
Normality test	-	-	1.919	0.383
Serial Correlation LM Test (Breusch-Godfrey)	2.527	0.106	-	-
Heteroskedasticity Test (Breusch-Pagan-Godfrey)	0.959	0.521	-	-
Functional Form (Ramsey RESET Test).	1.264	0.274	-	-

Source: Authors' estimations using EVIEWS 9.

4.4 Stability Test

The study relies on the plot of cumulative sum of squared residuals (CUSUMSQ) which is an approach to testing the structural stability of regression proposed by Brown, et al (1975), to test the stability of the estimated ARDL model. The result is presented in Figure 3. The CUSUMSQ plot lies between the 5% significance bounds. On this basis, we can reasonably infer that the model is stable and can be deployed for policy purposes.

Figure 3: CUSUMSQ



5.0 CONCLUSION AND RECOMMENDATIONS

This paper has investigated the effects of FDI and domestic investment on non-oil industrial production in Nigeria, using the ARDL modeling approach to co-integration and error correction analysis. The study found that FDI positively and significantly affects non-oil industrial output in the short-run and long-run. The short-run and long-run effects of domestic investment on non-oil industrial output were found to be not statistically significant. Thus, FDI is a major determinant of Nigeria's non-oil industrial output. This can be attributed to the technology and skill transfer spillover effects of FDI which enhance productivity of factors of production to expand industrial output. The non-significant effect of domestic investment may be attributed to poor technique of production, unfavorable investment climate and other macroeconomic factors adversely affecting their productive efficiency. Financial development positively and significantly affects non-oil industrial output in the short-run and in the long run. Exchange rate depreciation also positively and significantly affects non-oil industrial production in the long run in the country. It was also found that non-oil industrial output is adversely affected by inflation.

Based on the empirical evidence, it is recommended that the government intensify effort to enhance the attractiveness of the nation's non-oil industrial sectors (including manufacturing and solid minerals sectors) to FDI in order to boost output therefrom. There is also need to develop the nation's financial system to enhance their ability to provide credit to the nation's non-oil industry. The monetary authority should wield its various instruments to bring inflation under control. Trade liberalization should be cautiously implemented. In particular, there should be restrictions on selected categories of imports (especially consumption goods) to protect domestic (infant) non-oil industries. The monetary authority should occasionally interfere in the foreign

exchange market to prevent over-valuation of the domestic currency (the naira) thereby avoiding influx of excess (foreign consumer goods) to the economy.

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Appendix

Table A1: Composition of Nigeria's Non-Oil Industrial Sector

Nigeria's Non-Oil Industry
(a) Solid Minerals
Coal Mining
Metal Ores
Quarrying & Other Mining
(b) Manufacturing
Oil Refining
Cement
Food, Beverage and Tobacco
Textile, Apparel and Footwear
Wood and Wood Products
Pulp, Paper and Paper Products
Chemical and Pharmaceutical Products
Non-Metallic Products
Plastic and Rubber products
Electrical and Electronics
Basic metal , Iron and Steel
Motor vehicles & assembly
Other Manufacturing

Source: CBN Statistical Bulletin, 2018.

EXTERNAL DEBT, FOREIGN DIRECT INVESTMENT AND GROWTH: NEW EVIDENCE FOR AFRICAN COUNTRIES

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Abstract

This study investigates the impact of external debt and FDI inflows on economic growth in 29 selected Africa countries for the period spanning from 1990 to 2017. Panel Fully Modified Ordinary Least Squares(FMOLS) estimation technique was employed and it was found that external debt and FDI inflows positively and significantly impact economic growth. However, foreign aid exerts negative and significant influence on economic growth. Robustness check was conducted using the Panel Dynamic Ordinary Least Squares (DOLS). The robustness check estimates was not significantly different from the estimates of the benchmark analysis. Arising from the aforementioned estimation results, this study recommends that African countries should source for fund through external borrowing taking into account the international debt thresholds, and implement policies and programmes that will attract more FDI into the Africa continent in order to enhance economic growth.

Keywords: *External debt, Foreign Direct Investment, Economic growth, Dynamic panel estimator, Developing countries*

JEL: *F34, F21, F43, C33, O55*

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1.0 INTRODUCTION

The attainment of econonomic growth requires a high level of investment which could be derived from internal sources such as domestic savings and external sources such as external debt and Foreign Direct Investment (FDI)). In most developing countries, economic growth is driven by external fund due to low domestic savings (Moon and Dixon, 1993).

Though most studies such as McGillivray, De Haas (2007); Salisu and Ogwumike (2010) and World Bank (2017) revealed that there has been a relatively sustained increase in economic growth of most of countries in Africa particularly since the mid-1990s. FDI inflows to Africa fell between 2008 and in 2009 (declining from US$72 billion to US$59 billion) - due mainly to the economic and financial crisis (IMF, 2011). However, an increase of about 3.6 percent was recorded in 2013 - an increase of about $57 billion from $55 billion in 2012 (UNCTAD, 2015). Data from UNCTAD (2015) further revealed that though a decline was recorded in most Northern Africa countries, the inflow of FDI to Africa was relatively stable at about $54 billion in 2014. In recent times, FDI inflow to Africa show that the continent has been part of the worldwide increasing trend over the years. The upward trend in FDI inflows to Africa made it to rank amongst the largest recipients of external capital inflows (World Bank, 2017). External debts of Africa may appear manageable, however, the rapid growth in some countries within the continent is of concern (UNCTAD, 2016). IMF(2018) stated that Africa's external debt outstanding (as a percentage of GDP) rose steadily from about 22.3 percent to 32.7 percent between 2012 and 2017. Similarly, debt service (as a percentage of exports) also rose gradually from 12.4 percent to 24.1 percent between the period 2012 and 2017 respectively.

Reports such as World Economic Situation and Prospects (2018) revealed that Africa's contribution to world output has been fluctuating over the years. The report specifically showed that Africa's contribution to world output in annual percentage change was about 3.1, 1.7, 3.0, 3.5, 3.7, -0.2 and -0.3 percents for year 2015, 2016, 2017, 2018, 2019, 2017 and 2018 respectively. However, the impact of external debt and FDI inflows on economic growth have been a subject of empirical debate owing to mixed findings by Pattillo, Helen and Luca (2004), Kasidi and Said (2013), Tanna and De Vita (2018); Djulius (2018), Chorn and Siek (2017). Also, there exist scanty studies with spread representation of up to twenty-nine (29) Africa countries in investigation of the impact external debt and FDI inflows have on economic growth. In addition, this research work incorporate foriegn aid receipt and personal remittances as yard stick to further reveal new evidence. This is premised on the fact that the inflows of foreign aid and remittances recorded huge increase in the last two decades and as such made both

inflows to also compete for the largest sources of external capital inflows to Africa (World Bank 2017; OECD 2014).

2.0 BRIEF EMPIRICAL LITERATURE

2.1. External Debt and Growth

A major challenge in most developing countries, particularly those in Africa, is widening savings and investment gap resulting in the accummulation of huge external debt. However, Pattillo, Poison and Ricci (2002) opined that a given level of external debt could impact on growth positively but beyond a certain threshold external debt becomes inimical to growth. Tanna and De Vita (2018) examined the role of external debt in FDI-growth nexus. Annual 5-year averaged data for 39 developing countries was employed for the period 1984 to 2010 and it was found that FDI-induced growth is dependent on the constraint of external debt.

The impact of external debt on growth of Tanzania for the period 1990-2010 was examined by Kasidi and Said (2013). The study employed time series data in its analysis and found that external debt and debt service significantly impact on GDP growth. However, total external debt stock was found to exhibit positive effect on growth while debt service exhibited negative effect on growth. Similarly, Atique and Malik (2012) investigated the impact domestic and external debts have on growth of Pakistan for the period 1980-2010. Ordinary Least Square (OLS) and co-integration etimation techniques were employed and it was found that a significant inverse relationship exist between domestic debt and economic growth on one hand, and external debt and economic growth on the other hand. Pattillo, Helen and Luca (2004) examined the channels through which external debt affects growth. The presence of non linearities in the effect of debt on the different sources of growth was also taken into consideration in a study of 61 developing countries for the period 1996-1998. It was found that huge external debt negatively impact on growth through its negative effect on physical capital accumulation and total factor productive growth. Edo, Osadolor and Dading (2020) examined the impact of external debt and export has on economic growth of Sub Saharan African countries, using ARDL panel model estimation techniques. It was found that external debt and export positive and insignificantly impact on economic growth in the short run. The impact however turns negative in the long run, with export exerting a more significant adverse impact than external debt. However, there is long-run convergence among the variables. Amooteng and Amoako (1996) examined the nexus between external debt and growth in 35 African countries. Granger causality test was employed and it was found that a unidirectional relationship exist from economic growth to debt servicing.

Sulaiman and Azeez (2012) examined the impact external debt has on growth in Nigeria for the period 1970-2010. OLS estimation technique was employed and it was found that external debt exhibit a positive impact on growth in Nigeria.

2.2. Foreign Direct Investment and Economic Growth

The importance of FDI inflow to an economy is premised on the fact that FDI contributes towards growth in output, technology flows, knowledge and innovation (Anyanwu, 2012). Djulius (2018) in comparative terms investigated the impact FDI, external loans and domestic savings have on economic growth of Indonesia. Error correction mechanism was employed and it was found that the three variables significantly affect economic growth in the short run. However, in the long run, it was only domestic savings that was found to exhibit positive and significant impact on growth. Phimmavong (2017) investigated the effect foreign capital inflows has on growth in six ASEAN countries (Indonesia, Lao PDR, Malaysia, Philippines, Singapore and Thailand) for the period 2000-2015. Fixed effect model was adopted and it was found that FDI positively and significantly affect economic growth.

Chorn and Siek (2017) investigate the relative impact of FDI and foreign aid on growth for 77 developing countries covering the period 1997 to 2012. OLS with time and country fixed effect estimator was employed and it was found that both forms of foreign capital positively and significantly impacted on economic growth with that of FDI exhibiting a larger impact. Rehman and Ahmad (2016) employed pooled mean group estimation technique in the investigation of the effect foreign capital inflows has on economic growth in 21 developing countries covering the period 1990 to 2013. It was found that debt and foreign aid negatively affect growth. However, it was also found that the long run growth was enhanced by FDI and remittances inflows.

Chugbu, Uba and Chigbu (2015) investigated the effect foreign capital (FDI, foreign portfolio investment, workers remittances, external debt and foreign aid) has on growth in Nigeria, India and Ghana for the period 1986 to 2012. OLS and causality analysis were employed and it was found inter alia, that in Ghana, apart from foreign aid, other forms of foreign capital inflows positively and significantly affect economic growth. In India, only workers remittances positively and significantly affected growth, while in Nigeria, FDI, FPI, workers remittances and external debt positively and significantly affected growth. The growth effect of foreign aid was negative, though statistically insignificant. The effect of Asia's FDI and trade on Africa's growth with focus on 13 West African countries for the period 1980 to 2015 was investigated by Modou and Liu (2017). Panel Weighted FMOLS estimation technique was employed and it was found that FDI inflows from Asia and Asia's trade impacted positively and significantly

on economic growth in these countries. This implies that increased investment from Asia and trade between Asia and West Africa is beneficial to the West African sub-region.

2.3. Summary of Empirical Review

The empirical review shows that while there exist studies that affrim that external debt and FDI have positive and significant impact on economic growth, others stated otherwise. Also a cursory look at the empirical literature shows that few of the studies were based on Africa countries and of the studies that focus on Africa, fewer countries where employed to represent the continent. This may cast doubt on the reliability of the findings emanating thereof, thus creating a gap in the literature. This study intends to fill this gap in the literature.

3.0 THEORETICAL FRAMEWORK, MODEL SPECIFICATION AND METHODOLOGY

3.1. The Theory

Dependence Theory traced to the 1970s and 1980s holds that at best, external capital such as external debt and FDI exhibit positive influence on economic growth in the short-run and that in the long-run, their effect on growth is negative. The argument here is that recipient country will tend to depend heavily on them for long term developmental purposes and in the event of falling below expectation, the growth process becomes adversely affected. Lopez-Mejia (1999) held that external capital often results in increased aggregate demand and macroeconomic instability in the recipient economy with negative impact on growth in the long-run. This position was also upheld by Edo (2007) when attention was drawn to the fact that the huge volume of external capital to most Asian countries in the 1990s led to growth inhibiting situations such as financial crisis and poor returns on investment.

Developmental Theory is one of the earliest theories that explained the relationship between external capital and growth. The theory which evolved in the 1950s and 1960s posits that the inflows of external capital enhance economic growth. External capital had been identified as a vital means of supply of funds for domestic investment (Fosu and Magnus, 2006). This is because the additional resource helps to close existing savings and investment gaps in the domestic economy. The theory posited further that less developed countries could attain growth through external capital, adoption of western values among others (So, 1990).

Endogenous Growth Theory emerged in the 1980s. It was basically an attempt to bring to the fore technical progress and a sustained productivity growth in the equilibrium

framework of the Neoclassical Growth Model (Ogujiuba and Adeniyi, 2005). The Endogenous Growth Theory holds that growth emanates from endogenous factors and not exogenous factors as held by the Neoclassical and Harrod-Domar Growth models. The model main contributors, Romer (1986) and Lucas (1988) were of the view that growth is as a result of 'learning by doing' which occurs between physical and human capital (Mallick and Moore, 2006; see Ogundipe, Ojeaga and Ogundipe 2014). This was illustrated by Lucas (1988) when he held that investing in education leads to the production of human capital with the requisite critical skills needed for production activities.

3.2 Data Issues and Preliminary Analysis

To ensure a good representation, twenty nine (29) countries spread across Africa are employed. They include ; three (3) Central Africa countries (Gabon, Cameroun, Congo Republic), six (6) East Africa countries (Kenyan, Madagascar, Mauritius, Rwanda, Sudan, Tanzania) and four (4) South Africa countries (Botswana, Malawi, Mozambique, South Africa). Others are ; thirteen (13) West Africa countries (Benin, Burkina Faso, Cabo Verde, Cote d Ivoire, Ghana, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, Guinea, Guinea Bissau) and three (3) North Africa countries (Algeria, Egypt, Morroco). The choice of these countries and the period spanning 1990 to 2017 (28 years) was informed by the need to have a wider coverage that approximate countries in Africa. The analysis of the data sourced from World Bank and World Development Indicator (2018) include; descriptive statistics and correlation matrix (to determine the pattern of catergoristion of the relationship that exist amongst the variables), test of unit root, long run convergence test, panel FMOLS and robustness analysis with panel DOLS.

3.3. Model Specification and Estimation Technique

Endogenous Growth Model forms the basis for this study. In its basic form output (Y) is expressed as a function of Capital (K) and Labour (L) with a provision for elasticities of output, α and β, with respect to capital and labour respectively while total factor productivity is represented by A. This can be algebraically expressed as;

$$Y = AK^{\alpha} L^{\beta} \quad (1)$$

In empirical studies, the Endogenous Growth Theory takes into consideration variables such as FDI, debt, trade openness, and human capital development (Mallick 2008; Ogundipe, Ojeaga and Ogundipe, 2014). This means that other variables can enter into the growth function as input through total factor productivity (A).

If we assume that firms uses same level of capital and labour and thereafter divide through by labour (L), the growth function can be expressed in per capita terms as shown below;

$y = Ak^{\alpha}$ (2)

Total physical capital stock (k) comprises domestic and external capital such as debt, FDI, remittances and foreign aid (Fosu,1996; Agosin and Meyer, 2000). If external sources of capital is represented by F_k, then F_k can be expressed as:

F_k = [EXT, FDI, FAID, REM] (3)

Substituting this into equation (2) result in equation (4) which is dynamically expressed as :

$$Log(PCGDP)_{it} = \beta_{1i} + \beta 2ilog(PCGDP)it_{-1} + \beta 3ilog(EXT)it + \beta 4ilog(FDI)it + \beta 5ilog(FAID)it + \beta 6ilog(REM)it + \varepsilon_{it} \quad (4)$$

Where;

PCGDP = y (Per capita GDP); EXT= external debt stock ; FDI = FDI net inflows; FAID = foriegn aid received; REM = personal remittances receieved; ε = error term.The natural logarithms of the varaibles were taken to avoid discrepancies among the configuration of the data.The a priori signs of the variables are indeterminate; they could take either be positive or negative.

This study employ panel least squares estimation techniques. These include; panel Fully Modified Ordinary Least Square (FMOLS) techniques and panel Dynamic Ordinary Least Square (DOLS).

FMOLS estimator technique performs better compared to other methods such as OLS for estimating cointegrating relations (Hansen and Phillips, 1990; and Hargreaves, 1994). However, the main technique employed for this study is FMOLS while the panel DOLS serve as robustness check. The choice of DOLS as a tool for robustness check stem from the fact that it estimate cointegrating relations directly by taking into account endogeneity and serial correlation. DOLS helps to obtain co-integrating vectors involving deterministic components. It also accommodates different orders of integration and correct for simultaneity among variables (Stock and Watson, 1993).

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4.0 EMPIRICAL RESULTS

Table 1: Descriptive Statistics

Variables	*Observation*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
per capita GDP	812	1536.03	1946.169	120.6293	10716.2
external debt stock	812	9.83E+09	1.72E+10	1.34E+08	1.76E+11
foreign direct investment net inflows	812	7.16E+08	1.49E+09	-5.38E+08	1.16E+10
aid received	812	9.53562	10.41918	-0.188791	94.94603
personal remittances received	812	9.83E+08	3.18E+09	27072.38	2.37E+10

Authors' Compilation.

Table 1 reports the characteristics within the series. From the Table, average per capita GDP is over 1536 for the period. It is unstable due to the high standard deviation value of over 1946. With respect to external debt stock, FDI net inflow, foreign aid received and personal reittances received, the mean values ranges between 7.16 and 9.83 with also low standard deviation values that hovers 1.49 and 10.41. This indicates that the density function of the series are non-normally distributed.

Table 2: Pairwise Correlation Matrix

Variables	*per capita GDP*	*external debt stock*	*foreign direct investment net inflows*	*personal remittances received*	*aid received*
per capita GDP	1.00	0.30	0.25	0.11	-0.43
external debt stock	0.30	1.00	0.53	0.34	-0.31
foreign direct investment net inflows	0.25	0.53	1.00	0.64	-0.28
personal remittances received	0.11	0.34	0.64	1.00	-0.22
aid received	-0.43	-0.31	-0.28	-0.22	1.00

Source: Authors' Computation

The matrix of coefficients of correlation between variables in the model is presented in Table 2. It can be observed that the variables such as external debt stock, FDI net inflows and personal remittances received were positively related to per capital GDP while foreign aid received exhibited a negative relationship with per capita GDP. Similar conclusion can also be held for external debt stock, FDI net inflows and personal remittances received with respect to their relationship with each of the variables. However, all the variables (per capital GDP, external debt stock, foreign direct investment net inflows and personal remittances received) were negatively related to foreign aid received. (see Table 2 for details).

Table 3: Stationarity and Co integration Tests

	Unit root test test					*Pedroni residual co integration test*			
	Homogeneous		*Heterogeneous*				*within dimension*		*between dimension*
Variables	*Llc*	*Brt*	*Ips*	*adf*	*pp*		*Unweighted*	*weighted*	
Pcgdp	*-0.86*	*2.65*	*1.08*	*39.85*	*43.28*	*Panel v-Statistic*	*-1.53*	*-2.36*	
Edt	*9.11*	*10.34*	*9.19*	*12.61*	*14.53*	*Panel rho-Statistic*	*3.07*	*2.12*	
Fdi	*-2.97**	*-3.47**	*-5.13**	*132.19**	*134.83**	*Panel PP-Statistic*	*-0.47*	*-3.34**	
Aid	*-6.79**	*-4.52**	*-7.34**	*151.79**	*223.72**	*Panel ADF-Statistic*	*-0.70*	*-1.78***	
Prt	*-0.74*	*2.01*	*0.96*	*47.78*	*48.07*				
Dpcgdp	*-17.81**	*-6.88**	*-15.89**	*320.69**	*350.37**	*Group rho-Statistic*			*3.95*
Dedt	*-13.14**	*-7.93**	*-12.95**	*253.31**	*251.06**	*Group PP-Statistic*			*-3.33**
Dfdi	*-24.48**	*-15.63**	*-26.69**	*569.82**	*1941.66**	*Group ADF-Statistic*			*-1.50****
Daid	*-26.51**	*-21.28**	*-27.66**	*578.61**	*1541.90**				
Dprt	*-19.85**	*-9.59**	*-20.72**	*424.17**	*1162.52**				

Source:Authors' Computation. *llc= levin, lin &Chu t*, brt=breitung t-stat, ips=im,pesaran and shin, adf=adf-fisher chi-square and pp=pp-fisher chi-square. */**/*** = 1%/5%/10%*

The stationarity was determine by means of homogenous and heterogenous unit root tests. From Table 3, It can be observed that the variables were all non-stationary at level rather attained stationarity at their first differences at 1 percent significant level. This provides the basis for the determination of a long run covergence among the variables.

Similarly, Table 3 also presents the result of the long run covergence of the variables. This is shown by the within and between dimension Pedroni residual co integration test. The results of both test revealed that the null hypothesis of no cointegration of the series should be rejected. This is because the results passed the significant test at 1, 5 and 10 percent level.

Table 4: External Debt, Foreign Direct Investment and Economic Growth in Africa

Variables	*Baseline Estimation (GDP per capita as dependent variable)*		*Robustness Check (GDP per capita as dependent variable)*	
	Panel FMOLS		***Panel DOLS***	
	Coefficients	*t-statistics*	*Coefficients*	*t-statistics*
log of external debt stock	*0.079**	*2.196*	*0.031*	*0.557*
log of foreign direct investment net inflows	*0.148**	*11.587*	*0.173**	*6.629*
log of aid received	*-0.169**	*-5.035*	*-0.092*	*-1.395*
log of personal remittances received	*0.092**	*5.874*	*0.128**	*4.948*
R- squared	*0.913*		*0.972*	
adjusted R-squared	*0.909*		*0.929*	
long range variance	*0.202*		*0.055*	

Source: Authors' computation using the dataset from WDI, and the Eviews
* = 1 percent significance level

Table 4 shows the result of Panel Fully Modified Ordinary Least Squares(FMOLS) and the Panel Dynamic Ordinary Least Square(DOLS), the former is the main estimation technique while the latter serves as a robustness check. The Panel FMOLS estimates revealed that external debt stock, foreign direct investment, aid inflows and personal remittances significantly affect economic growth in Africa. However, foreign aid inflows exerts negative influence on economic growth in the region unlike the positive influences shown by the other variables. In terms of magnitude, aid received adversely impacts economic growth with about 16.9 percent while external debt stock, foreign direct investment and personal remittances stimaulate economic growth with about 7.9%, 14.8% and 9.2% respectively, and the result reflects the overwhelming contribution of FDI to the economic growth experiences of Africa. The coefficient of determination revealed that the explanatory variables have high forecasting ability, and that the explanatory varaibles explain about 91 percent of the systematic variation in economic growth in Africa within the period under study. In terms of robustness check, the panel DOLS estimates were not significantly different from those of the FMOLS in terms of sizes, however, external debt stock and foreign aid does not exert significant influence on economic growth.

5.0 IMPLICATIONS AND RECOMMENDATIONS

The implication of the findings is that though external debt stock in most africa countries is on the increase and as such has raised some concern, however, its positive impact on growth shows that the external debt spurs economic growth in Africa. This is in tune with similar findings such as Kasidi and Said (2013); Sulaiman and Azeez (2012). Also the positve impact of FDI on growth shows that the inflows help to complement domestic resources and economic growth enhancement in Africa also in line with findings by Modou and Liu (2017); Chorn and Siek (2017).

It can then be recommended that in the quest for the attainment of economic growth, Africa countries should continually indulge in moderate external borrowing with the assumption that debt will be employed productively. Also, there should be sustained effort by Africa countries to aim at attracting and retaining FDI inflows to the continent since it has a positive impact on growth. This could be attained through the implementation of relevant policies and programmes.

6.0 CONCLUSION

Analysis of the impact that external debt and FDI have on growth in Africa was undertaken using 29 countries covering the period 1990 to 2017. A model was drawn base on the Endogeneous Growth Model to capture relevant variables employed. Descriptive and correlation analysis were carried out to show the properties of the data set. This was followed by the test of stationarity (unit root test). The homogenous and heterogenous unit root result indicated that variables were all non-stationary at level rather, they all attained stationarity at their first differences. This was followed by test of long run cointegration and the results from the between and within dimension statistics show that the variables are cointegrated.

The panel FMOLS techniques employed show that the key variables impact economic growth positively(except for foreign aid) and significantly with a high coefficient of determination, adjusted coefficient of determination. The robustness check carried out using panel DOLS shows similar results as those of the bench mark estimation though it has little changes in terms of the level of significance. In the light of the empirical findings, policy implications and recommendations were proffered.

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Appendix

Table 1: Residual Cross-Section Dependence Test

Null hypothesis: No cross-section dependence (correlation) in residuals

Test	*Statistic*	*degree of freedom*	*Probabilty*
Breusch-Pagan LM	3359.69*	406	0.00
Pesaran scaled LM	103.65*		0.00
Pesaran CD	34.60*		0.00

Source: Authors' Computation. */**/*** = *1%/5%/10%*

CURRENCY SUBSTITUTION AND AGGREGATE CONSUMPTION EXPENDITURES: EVIDENCE FROM WAMZ COUNTRIES

Lionel Effiom*[1] and Kenneth Onye[1]

Abstract

Existing literature on currency substitution mainly concentrate on investigating the determinants and persistence of the phenomenon, neglecting largely its impact on other macroeconomic variables. With the envisaged ECOWAS-wide monetary union and the *eco* as the proposed single currency, this paper sought to investigate the effect of currency substitution on aggregate consumption expenditures of selected countries in the West African Monetary Zone (WAMZ). The study relies on the Fixed Effect estimation framework for a balanced panel of 4 selected WAMZ countries (Ghana, Guinea, Liberia, and Nigeria) for which data were consistently available and covered the period 2000-2018. The key findings were as follows: (i) Currency substitution exerted a depressing effect on gross consumption expenditure; (ii) Foreign and domestic interest rates, inflation, as well as exchange rate equally impacted negatively on gross consumption expenditure; and (iii) Aggregate spending was however found to be an increasing function of real GDP. Our findings were robust to the alternative measure of gross consumption expenditure introduced in the fixed effect model specification. The paper re-echoed the need for member countries to grow the real sector of the economy so as to stabilize exchange rate and regain agents' confidence in the domestic currency.

Keywords: Currency Substitution; Aggregate Consumption Expenditure; WAMZ Countries

JEL Classification Code: F20

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1.0 INTRODUCTION

An economy is said to experience currency substitution when residents and agents generally prefer the use of a foreign currency to the local currency in their daily domestic transactions. In most instances, the foreign currency is used concurrently with the domestic currency. It is an economic state of affairs sparked mainly by domestic agents' exhibition of a lack of confidence in the ability of the local currency to fulfil one or more of its basic functions. The underlying economic cause for this preference is akin to conditions that give rise to capital flight. With surging and spiralling inflation, the capacity of the domestic currency to effectively fulfil its unit of account, means of exchange and more importantly, store of value functions are greatly compromised. These circumstances create a gradual shift and displacement of the local currency with a perceived stable and convertible currency, which on the most part is interest-bearing. Thus within the same commodity space, the local and the foreign currency compete for social and economic acceptance. In most cases, this interest-bearing, stable and convertible currency is the ubiquitous United States dollar, the phenomenon is usually termed in the literature as dollarization (Fiege & Dean 2002; Calvo & Rodriguez, 1977).

Although every currency plays the store of value, medium of exchange, unit of account, and standard for deferred payment functions of money, the preference of foreign currency by agents is basically linked to its role as a store of value. As observed by Sawada and Yotopoulus (2002), currencies have an ordinal preference ranking, which becomes relevant when agents use a currency for asset-holding purposes. In a liberal financial regime, agents manifest or execute this ranking by transiting to a higher-ranking monetary asset at either small or zero transaction costs. These congenial conditions, which enhance agents' ability to hold any currency of their choice for asset purposes, ensure that they hold the best currency available. This best currency is usually the one held by the Central Bank as the reserve currency. Thus, a systematic process of currency substitution is engendered by the existence of a liberal financial or currency regime.

Many developing countries have been plagued by the phenomenon of currency substiution for a long time now (See for instance studies by Effiom & Ubi, 2010; Adom, Sharma & Morshed, 2006; Aziakpono and Babatope-Obasa, 2004; Bawa, Omotosho & Doguwa, 2015; Bonga & Dhoro, 2015). Besides the general documentary evidence of the prevalence and persistence of this phenomenon in developing countries ravaged by currency crises and macroeconomic instability, no studies have been conducted on its effect on other significant macroeconomic variables in developing countries. Generally, a substantial part of the currency substitution literature devotes attention to

investigating its determinants, dynamism and trends. For instance, studies by El-Erian (1988) for Yemen and Egypt; Ramirez-Rojas (1985) for Latin American countries of Uruguay, Mexico and Argentina; Boamah, Guy, Grosvenor & Lescott (2012) for the Caribbean countries of Barbados, Trinidad and Tobago, Jamaica, and Guyana, as well as Elkhafif (2002) for South Africa and Egypt. However, beyond identifying its effects on the general economy, the literature is considerably silent on its impact on private consumption expenditure. Thus, the objective of this paper is to extend the literature by specifically investigating dollarisation's impact on consumption expenditures.

Our interest in the impact of dollarisation on consumption expenditures has solid theoretical basis as well as huge implications for policy. Firstly, there is the need to ascertain what happens to consumption and other associated macroeconomic variables, when agents gradually shift their currency portfolio preferences in favour of a foreign currency. Secondly, besides the established fact that currency substitution may weaken monetary policy autonomy, it increases vulnerability to economic shocks, and significantly deteriorates the Balance of Payments account (Boamah *et al*.,2012; Komarec, & Melecky,2003). Thus, the research question that arises is: would the altering of the money demand function away from the domestic currency (Elkhafif, 2002; Arize, 1991; El-Erian, 1988; Fasano-Filho,1986), also lead to decreased domestic consumption spending? Or Put differently, to what extent is rising currency substitution associated with a proportional increase in domestic consumption? An answer to this question has implications for policy, as it could be argued that currency substitution should be tolerated if aggregate demand is stimulated. This is an empirical question which has so far not been addressed by previous studies on currency substitution and this paper seeks to fill this dearth in the literature.

We, therefore, investigate the effect of currency substitution on aggregate consumption expenditure in four West African Monetary Zone countries, namely, Ghana, Guinea, Liberia, and Nigeria. Our choice of these countries is based on the availability of data, particularly as regards currency substitution index (CSi). Within the context of the envisaged ECOWAS-wide monetary union, this study is relevant as it provides some insights into the prevalence and impact of dollarization on aggregate consumption expenditure in the region. In addition, this study stimulates thinking and policy focus as to the potential opportunity cost implications of residents abandoning an apparently entrenched preference for a foreign currency over the proposed eco.

The rest of the paper proceeds in the following structure. Section 2 reviews extant literature on currency substitution, evaluating both the theoretical and empirical issues

as well as economic performance in the ECOWAS region, particularly our selected WAMZ countries. While section 3 presents the methodology, describing the data sources and measurements, section 4 presents and discusses the results. The paper ends with summary and conclusion in section 5.

2.0 LITERATURE REVIEW

2.1 Conceptual Considerations

It has become important (given the lack of consensus in the literature) to properly clarify what is meant by currency substitution. There are two broad applications of the concept. First, currency substitution exists whenever a foreign currency is used concurrently with domestic money in transactions not related to international trade. Second, it indicates a situation where a change in the relative cost of holding a currency results in a change in the ratio of local to foreign money holdings demanded. It is a substitution between two monies where the quantity of foreign currency holdings varies in response to domestic economic conditions. In the wake of the Latin American financial crises wherein many countries in the region experienced inflationary trends leading to the phenomenon, the term dollarisation found its way into the literature, because agents used the dollar as a hedge against these unpleasant domestic economic conditions. It must be emphasized that the foreign currency contemplated here is that of a key trading partner or a significant industrial power, with a pedigree of monetary policy soundness and currency stability.

However, as Cuddington (1983) later argued, the use of the term dollarisation ignited a measure of confusion as to the exact nature of the phenomenon. He thus distinguished between the term asset substitution and currency substitution. Asset substitution relates to capital mobility and is influenced by interest rates differentials between foreign and domestic assets. Thus a major consideration for agents in asset substitution is the growth or improvement in their stock of wealth represented by their portfolio of assets. However, currency substitution is concerned mainly with currency or money in its function as a medium of exchange. There will be an ordinal preference of agents for the foreign money if the liquidity services derived from its use are cheaper relative to the domestic currency. Confirming this conceptual difference, Calvo and Vegh (1993) found that asset substitution depended mainly on differences in return rates between two monetary assets, while currency substitution was determined primarily by inflation rate differences.

Despite the settled differences in these two concepts, the term dollarisation has come to conventionally denote either currency substitution or asset substitution. This is due

largely to the liberalisation of most economies in response to the McKinnon (1973) and Shaw (1973) financial liberalisation hypothesis and more significantly, to the revolution witnessed in financial innovation instruments. This liberalisation of the financial system has permitted capital flows in and out of economies at a minimal cost. This then enables agents to switch between two currencies within the same domain in response to either store of value, unit of account or medium of exchange variations. In essence, the liberalization of the global financial system as a component of the overall globalisation trend has conflated the trio of domestic transactions, foreign trade transactions, and portfolio diversification. Thus, in the ensuing empirical literature, the terms dollarization and currency substitution are used interchangeably.

2.2 Theoretical Issues

The process of dollarization or currency substitution can be explained within the framework of Money Demand Theory and the Portfolio Balance Theory. With regards to the former, the foundational pivot of money demand models is the twin roles money plays as a medium of exchange and as a store of value. This confers on agents the attitude to hold a proportion of their wealth either in cash or in the form of other financial assets. Thus, changes in money demand is then analysed with respect to the scale variable (income) and the trade-off or substitution effect of holding it, represented by the interest rate. Substitution effect denotes the relative preference of agents to hold money in the form of assets instead of in cash. In modelling the money demand theory, we express real money demand as a function of interest rate and income thus:

$$m/p = f(y,r)$$

where, *p* represents the price level, *m* is demand for money, *y* is income, and *r* is real rate of interest. As explained above, while real money demand is an increasing function of income (*y*), it is however a decreasing function of interest rate (*r*). Specifically, the dollarization hypothesis postulates that, the demand for domestic currency by agents is influenced by the expected depreciation rate, domestic interest rate and the income level (Doguwa, 2014; Yinusa and Akinlo, 2008).

On the other hand, the portfolio theory of Markowitz (1952) stipulates that given certain conditions, expected returns on a portfolio can be maximised by carefully selecting the shares of each asset in the portfolio. The message inherent in the Portfolio Balance Model (PBM) is that diversification pays, because agents are afforded the space of investing with the objective of choosing a bunch or portfolio of assets which collectively has lower risk compared to any individual asset in the portfolio. Technically speaking, the overall variance of the expected return on the portfolio can be

minimised with a shrewd combination of different assets, which have perfectly uncorrelated returns. Thus the PBM specifies expected return on assets as a normally distributed function, with portfolio and individual asset risk as the standard deviation of return, and the portfolio itself as a weighted aggregate of return on asset. Its underlying assumptions are rationality and risk averseness of investors, efficient markets, profit maximisation motives of agents, absence of taxes and transaction cost, among others.

The empirical literature on currency substitution however owes much to Cuddington (1983) who adapted the Portfolio Balance Model and applied it to domestic agents, who allocate wealth between diverse types of assets and money concurrently, especially in a free currency regime. Agents are at liberty, under the capital mobility assumption, to hold both domestic and foreign money as well as their respective bonds and other financial assets. In effect, the proportion of each asset in the portfolio is a function of real income and the expected return on total portfolio assets. The next section reviews the empirical application of this theory to specific contexts.

2.3 Empirical Review

The taxonomy of the currency substitution literature is executed in this paper alongside those which explore the determinants of currency substitution, its presence in an economy, its persistence and magnitude as well as its consequences on the money demand function. We review the literature along these themes, seriatim.

Several drivers of currency substitution have been identified in the literature, namely, macroeconomic instability (due primarily to inflation and exchange rate volatility), interest rate differential between the foreign and domestic currency, expectations of currency devaluation, as well as domestic political uncertainties and instabilities. These factors have been empirically evaluated by scholars. For instance, Fasano-Filho (1986) documented that the prevalence of currency substitution in Argentina in the peak of her financial crises was fueled by the expectations of adjustments of her nominal exchange rates to correct for her precarious Balance of Payments (BOP) positions. Additionally, the low value of the *peso* relative to the dollar discouraged holdings of the former in preference to the dollar. In a similar study for Egypt and Yemen, El-Erian (1988) noted that currency substitution in Egypt correlated positively with increased expectations of depreciation in the exchange rate of the domestic currency as well as rising political instability. However, Yemen's dollarization was associated with agents' anticipation of rising yields on foreign currency due to the depreciation of the exchange rate. For the Kyrgyz Republic, Mongardini and Mueller (2000) found among other things that currency substitution was significantly influenced by differentials in interest rates and exchange rate depreciation.

A study by Boamah *et al.* (2012) indicated that, currency substitution was considerably influenced by exchange shocks for Barbados, Trinidad and Tobago, and Jamaica; while Komarek and Melecky (2003) showed that for the Czech Republic, currency substitution was associated with the absence of restrictions of inflow of capital, sudden trade liberalization and the early adoption of financial innovations. For Nigeria, Doguwa (2014) found that the phenomenon was influenced by expectations of devaluation of the naira, the widening spread between the parallel and official exchange rates, as well as exchange rate risks. These sentiments of the causes of dollarisation in the Nigerian economy was also shared by Adeniji (2013), Akinlo (2003) and Yinusa & Akinlo (2008). In particular, the latter concluded that Nigeria experienced moderate dollarization within the period 1986 – 2005, and that the phenomenon was largely influenced by the volatility in the real unofficial market exchange rate.

The presence of currency substitution in an economy might not necessarily imply its persistence or hysteresis, which merits its own empirical investigation altogether. On this score, Mongardini and Mueller (2000) examined the presence and persistence of currency substitution in the Kyrgyz Republic. Deploying the Autoregressive Distributed Lag (ARDL) methodology with a ratchet effect variable, the study found that though currency substitution was widespread and persistent and was not irreversible. This implies that with proper and timely implementation of monetary policy, decisions of the private sector regarding their currency and wealth portfolio can still be manipulated to ensure a redirection of portfolio holdings in favour of the local currency or domestic-denominated assets.

Similarly, Us (2003) investigated the persistence of currency substitution in the Turkish economy. The study specified an empirical model with a ratchet effect variable which sought to determine if the economy had reached a point of irreversibility of currency substitution, in which case monetary policy would be ineffective. Employing an ARDL framework, the study found that for the 1990 – 1993 period, currency substitution was not as persistent enough as to lead to irreversibility, but was nonetheless irreversible and persistent during the 1995 to 1999 period. Similarly, Bawa et al (2015) estimated an empirical model with a ratchet variable using Bounds Tests Cointegration technique and found the persistence of currency substitution in Nigeria, with negative effects on the stability of the demand for money function. A similar conclusion was drawn for Bulgaria where Valev (2010) used survey data to trace the origins of hysteresis. The study found that the persistence of currency substitution was due to the effect of network externalities, where agents perceived that since foreign money was in wide use, there was no incentive to switch to the local currency even when local macroeconomic conditions have improved.

With regards to the money demand function, the literature indicates that with high and persistent currency substitution, the domestic money demand function becomes volatile (Sharma et al., 2004) and shrinks away from the local currency in favour of the foreign currency, now used as a hedge to protect the wealth of agents against the depreciating value of the local currency. This has been the experience with the Ukrainian economy, where Volkov (2000) submitted that the money demand function was biased in favour of foreign money due largely to exchange rate differentials between foreign and domestic money. Other studies that sought to ascertain the existence of currency substitution using the money demand function were Darrat et al. (1996) for Japan, Sharma et al. (2004) for Asian countries, and Rodriguez and Turner (2003) for Mexico. In a study of the money demand function for five European Union countries, Yildirim (2003) asserted that the money demand function at the EU-wide level appeared stable suggesting the potential effectiveness of monetary policy.

The stability of the money demand function in the presence of currency substitution in selected African countries was the subject of inquiry by Adom, et al (2006). The eight countries used in the study were attached with either the US dollar or CFA franc as anchor currencies. When the CFA franc was used as the anchor currency, the study revealed the prevalence of currency substitution in Nigeria and Ghana. However, with the dollar in use, there was no currency substitution in Ghana though still prevalent in Nigeria. A similar study was conducted for the Latin American countries of Mexico, Brazil, and Argentina. Prock *et al.* (2003) used an Error Correction Model and found that currency substitution prevailed in the three countries, though less prominent in Mexico than in Argentina and Brazil. In a related study on Zimbabwe, Bonga and Dhoro (2015) concluded that exchange rate risk and changes in inflation rates were the most significant incentives for currency substitution and therefore changes in the money demand function.

Qualitative or survey data have also been employed in empirical studies to investigate the existence of dollarisation. One of such is Kessy (2011) which combined the error correction technique and survey data of some firms in Tanzania to ascertain the extent to which the dollar was used for the purpose of unit of account. The survey findings indicated the gradual displacement of the local currency by the US dollar as a unit of account, mostly in the education and real estate sectors. Equally revealing was the fact of huge dollarisation in the retail sector, especially those involved in imported products like automobiles and computers. Similarly, Kabote et al. (2014) using cross-sectional data, explored the impact of dollarization on human resources in the Zimbabwean hospitality industry. They found that dollarization positively influenced the

performance of the industry, evidenced in positive socio-economic change and happiness amongst industry employees.

It is evident from the above empirical review that studies are devoted more to the implications of dollarization on financial sector variables of either money demand, or its hysteresis or persistence. There is virtually no study on the effects of dollarization on the real sector, particularly on either consumption or investment.

2.4 Overview of Economic Performance in the WAMZ

Structurally, ECOWAS comprises of 15 countries, with two major monetary alliances, namely, the West African Economic and Monetary Union (WAEMU), and the West African Monetary Zone (WAMZ). The Community is linguistically characterised by three blocs of English, Portuguese and French-speaking countries. While the WAEMU consists of the French-speaking states, united monetarily and fiscally by a single currency (the CFA, franc) tied to the French currency, the WAMZ has but a recent history. Established in 2000 to further accelerate the pace of monetary union for the entire Community, the WAMZ is made up of the following Anglophone countries: The Gambia, Ghana, Nigeria, Liberia, Sierra Leone, and Cape Verde. With the WAEMU well established since 1994, coupled with the disparate and contrasting monetary and fiscal landscape of the non-WAEMU countries, the WAMZ was specifically set up as a second monetary zone to aid in the establishment of a single monetary union for the whole Community. The mechanism to facilitate and achieve these objectives is the West African Monetary Institute (WAMI), established also in 2000. So far, ECOWAS is yet to achieve its dream of a monetary union with the *eco* as its currency. Deadlines have been established in the past with setback dogging each, mainly based on the inability of member states to meet the convergence criteria enshrined in the various protocols of the envisaged monetary union. The economic performance in the sub-region is symptomatic of that in most of sub-Saharan Africa. A summary of stylised facts of key macroeconomic indicators shows that real GDP growth was 6.2 percent in 2011, declining sharply to 2.8 percent in 2015 (IMF, 2018). With the collapse of commodity prices from 2016, all the economies of the WAMZ plunged into recession, posting GDP growth that was much lower than that of the Community. However, for the WAEMU countries, growth in real GDP has grown by over 6 percent yearly since 2012, exceeding the average growth rate in sub-Saharan Africa as well as other developing countries (IMF, 2018). It must be noted that the economic fundamentals of the ECOWAS vary proportionally with variations in mineral or commodity prices of member countries. Its economies are also dissimilar across many dimensions of development.

The estimated growth in real GDP for ECOWAS was 3.3 percent, an increase from 2.7 percent in 2017. The growth rate of ECOWAS between 2014 and 2017 was higher than that of Southern and Central Africa, though it lagged behind the growth of the entire continent (IMF, 2018). This lack-lustre performance, as indicated earlier reflects the tumbling of commodity prices, especially oil production which had impact on the Community's largest economy, Nigeria. While other economies within the sub-region may have recorded high growth rates, the economic contraction in Nigeria had an overwhelming net negative impact on the region's overall average growth rate. Table 1 shows comparative growth rates for the WAMZ and WAEMU countries.

Table 1: GDP Growth rate in WAMZ (2000-2018)

Country	2000-2004	05	06	07	08	09	10	11	12	13	14	15	16	17	2018
BEN	4.7	1.7	3.9	6.0	4.9	2.3	2.1	3.0	4.8	7.2	6.4	2.1	4.0	5.6	6.1
BFA	5.0	8.7	6.3	5.7	7.3	3.0	5.4	6.6	6.5	5.8	4.3	3.9	5.9	6.7	5.8
CIV	-0.7	1.7	1.5	1.8	2.5	3.3	2.0	-4.4	10.7	8.9	8.8	8.8	8.3	7.8	7.4
GNB	2.0	4.3	2.3	3.3	3.2	3.4	4.6	8.1	-1.7	3.3	1.0	6.1	6.3	5.9	4.5
MLI	5.8	6.5	4.7	3.5	4.8	4.7	5.4	3.2	-0.8	2.3	7.0	6.0	5.8	5.3	5.1
NER	2.8	4.5	5.8	3.1	9.6	-0.7	8.4	2.3	11.8	5.3	7.5	4.3	4.9	4.9	5.3
SEN	4.2	5.6	2.5	4.9	3.7	2.4	4.2	1.8	4.4	3.5	4.1	6.5	6.7	6.8	6.9
TGO	0.7	1.2	4.1	2.3	2.2	3.5	4.0	4.9	4.8	4.0	5.9	5.4	5.4	5.6	4.8
WAEMU	3.1	4.3	3.9	3.8	4.8	2.7	4.5	3.2	5.1	5.0	**5.6**	**5.4**	**5.9**	**6.1**	**5.7**
No..WAEMU	0	1	0	0	2	0	0	0	0	1	**1**	**1**	**1**	**1**	**1**
GHA	4.6	5.9	6.4	4.3	9.1	4.8	7.9	14.0	9.3	7.3	4.0	3.8	3.7	8.5	6.3
GMB	4.4	-0.9	1.1	3.6	5.7	6.4	6.5	-4.3	5.6	4.8	0.9	4.3	2.2	3.5	5.4
GIN	3.0	3.0	1.2	6.8	4.1	-1.1	4.8	5.6	5.9	3.9	3.7	3.8	10.5	8.2	4.8
LBR	1.6	5.3	8.0	9.5	7.1	5.3	6.1	8.2	8.0	8.7	0.7	0.0	-1.6	2.5	2.9
NGA	11.5	3.4	8.2	6.8	6.3	6.9	7.8	4.9	4.3	5.4	6.3	2.7	-1.6	0.8	1.9
SLE	8.5	4.5	4.2	8.1	5.4	3.2	5.3	6.3	15.2	20.7	4.6	-20.6	6.1	4.2	3.7
WAMZ	5.6	3.5	**4.9**	**6.5**	**6.3**	**4.3**	**6.4**	**5.8**	**8.0**	**8.5**	3.4	-1.0	3.2	4.6	4.2
N0.WAMZ	2	0	**2**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	0	0	1	1	0

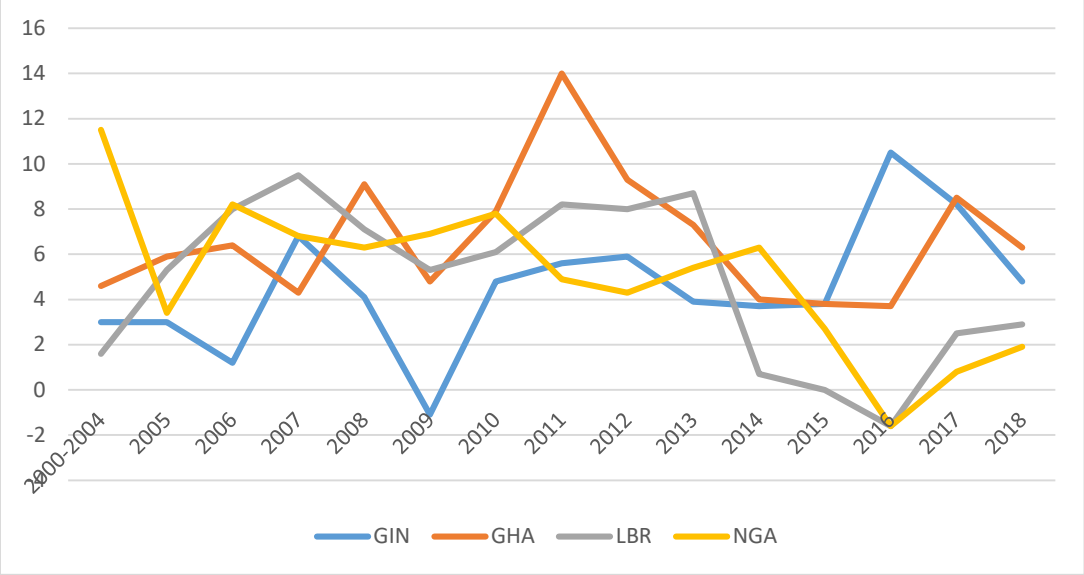
Source: World Bank's WDI (2019): note: WDI growth is measured as the *annual percentage* growth rate of GDP at market prices based on constant local currency (aggregates are based on constant 2010 U.S. dollars). Only the 2018 growth rate data is based on IMF's WEO estimates which are used because the WDI data stops at 2017.

GDP growth rate in the WAMZ area consistently surpassed those of the WAEMU area in the period preceding the year 2014, that is between 2006 and 2013. And this was led mainly by the growth rate in Liberia, Nigeria and Sierra Leone. More recently, the

WAMZ region has witnessed rather unimpressive growth performances as the growth rate for the zone dipped to -1.0% (led mainly by the slowdowns in Sierra Leone) and 3.2 % in 2015 and 2016 respectively from an average of 8.0% and 8.5% in 2012 and 2013 respectively. As of 2018 and 2017, the WAMZ growth rate stood at 4.2% and 4.6% respectively compared to the higher GDP growth rate of 6.1% and 5.7% over the same periods in the WAEMU area. However, in terms of the real growth rate, the IMF (2018) notes that the growth rate of the WAEMU has grown over 6% yearly, well exceeding the mean growth rate in sub-Saharan Africa. This might vaguely underline the need for a speedy integration of the entire sub-region into the proposed monetary union as obtainable in the WAEMU.

Taking the country-specific experiences of WAMZ economies into account, it is evident that the Member States have performed poorly over the preceding half-decade. This has generally been attributed to the lingering effect of declining commodity prices. The real GDP growth rate moderated in The Gambia to 2.2 % in 2016, from 4.3% in 2015 and 4.8%in 2013. According to Onye and Umoh (2020), this had resulted from adverse weather conditions, the decline in foreign exchange reserves resulting from fall in export, and the uncertainty that surrounded the 2016 general election in The Gambia (see WAMI Annual Report 2015, 2016). Similarly, the growth rate was sluggish in Ghana over the period 2014-2016 except in 2017 and 2018, when growth in Ghana surpassed those in all other WAMZ economies. This is mainly on account of an increase in the production of gold, oil and gas in the recent history of Ghana. Over the past four years, Nigeria's growth rate has been unimpressive as the economy witnessed a persistent decline in growth, from 6.3% in 2015 to a negative growth rate of -1.6% in 2016 when the country plunged into recession. Nigeria's 2016 economic recession was orchestrated by plummeting price of crude oil (the major source of foreign exchange), which resulted in a drastic drain of the country's foreign exchange reserve. Modest recoveries have been made with Nigeria posting a growth rate of 0.8% and 1.9% in 2017 and 2018 respectively (Onye and Umoh 2020). Remarkably, from Figure 1, Ghana recorded the highest real GDP growth rate of 14 % over the period, while Guinea maintained a clear lead over the other three countries from 2015 to 2017.

Figure 1: Growth Rate Trends for Guinea, Ghana, Liberia, and Nigeria



The Inflation rate for the ECOWAS in 2011 was 11.2 percent, but fell marginally to a single digit of 8.9 percent in 2015 (Ekpo, 2020). This stability was short-lived as inflation rose sharply to 15.5 percent in 2016, but fell slightly to 13.6 in 2017 (Ekpo, 2020; WAMZ, 2017). Table 2 highlights inflation trends in the WAMZ countries.

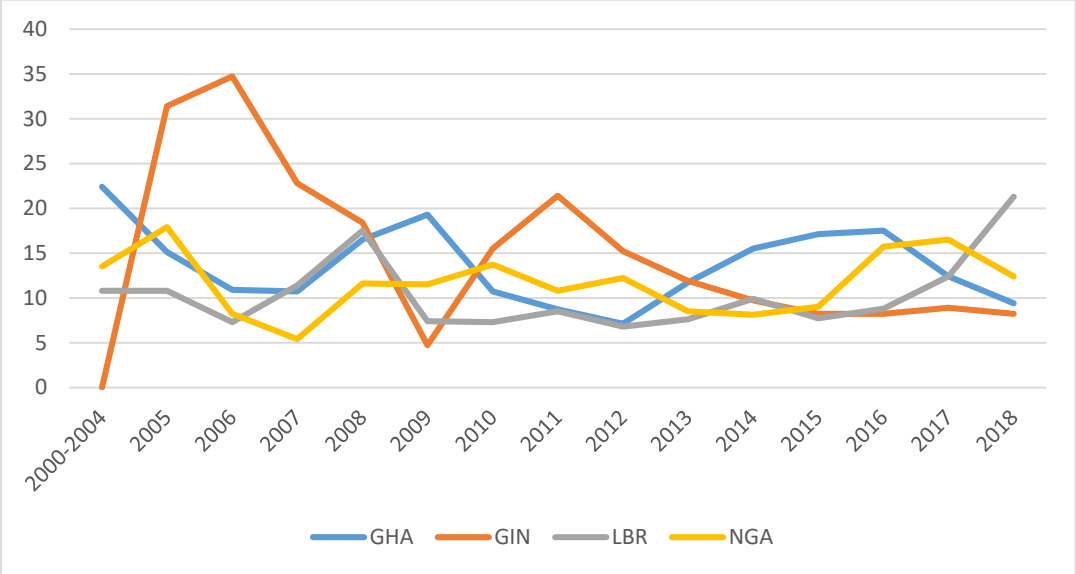
Table 2: Inflation, consumer prices (annual %), 2000-2018

Country Code	2000-2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GMB	9.0	4.8	2.1	5.4	4.4	4.6	5.0	4.8	4.3	5.7	5.9	6.8	7.2	8	6.2
GHA	22.4	15.1	10.9	10.7	16.5	19.3	10.7	8.7	7.1	11.7	15.5	17.1	17.5	12.4	9.4
GIN	..	31.4	34.7	22.8	18.4	4.7	15.5	21.4	15.2	11.9	9.7	8.2	8.2	8.9	8.2
LBR	10.8	10.8	7.3	11.4	17.5	7.4	7.3	8.5	6.8	7.6	9.9	7.7	8.8	12.4	21.3
NGA	13.5	17.9	8.2	5.4	11.6	11.5	13.7	10.8	12.2	8.5	8.1	9.0	15.7	16.5	12.4
SLE	..	..	..	11.6	8.2	7.5	7.2	6.8	6.6	5.5	4.6	6.7	10.9	18.2	15.6
WAMZ	**12.2**	**16.0**	**12.6**	**11.2**	**12.8**	**9.2**	**9.9**	**10.2**	**8.7**	**8.5**	**9.0**	**9.3**	**11.4**	**13.7**	**12.2**
N0. of CO	**Na**	**1**	**3**	**2**	**2**	**4**	**3**	**4**	**4**	**4**	**5**	**5**	**3**	**2**	**3**

Source: World Bank's WDI (2019).Note: (i) All data are obtained from WDI except the 2018 Inflation data which is retrieved from IMF's WEO database because WDI has data only up to 2017; (ii) The WDI and WEO Inflation data used here is measured as annual percentage changes of *average consumer prices* (year-on-year changes). It is not based on 'averages for the year' or 'end-of-period' data (which are also reported in the WEO database). Liberia was on 'observer status' between 2000 and 2009.

Arguably, the rising rate of inflation in WAMZ countries significantly impacts on that of the entire Community. This, in turn, can be explained partly by the surging expansionary fiscal policy in member states coupled with supply-side constraints. Equally responsible is the fact that between 2008 and 2018, there has been a continuous depreciation of all the region's currency in real terms (AfDB, 2019). Expectedly, these have debilitating effects on investment and long-term growth. Figure 2 extracts inflation data for the four countries of our study, showing that between the year 2000 and 2004, the average inflation rate of Guinea, which was the lowest of the four countries, skyrocketed strangely to 31.4% in 2005. While Liberia's inflation rate remained single digit from 2009 to 2016, it ended up exceeding other countries (21.3%) in 2018. However, Ghana and Nigeria seem to exhibit a common trajectory of double digit inflation for the most part.

Figure 2: Inflation Trends for Ghana, Guinea, Liberia, and Nigeria



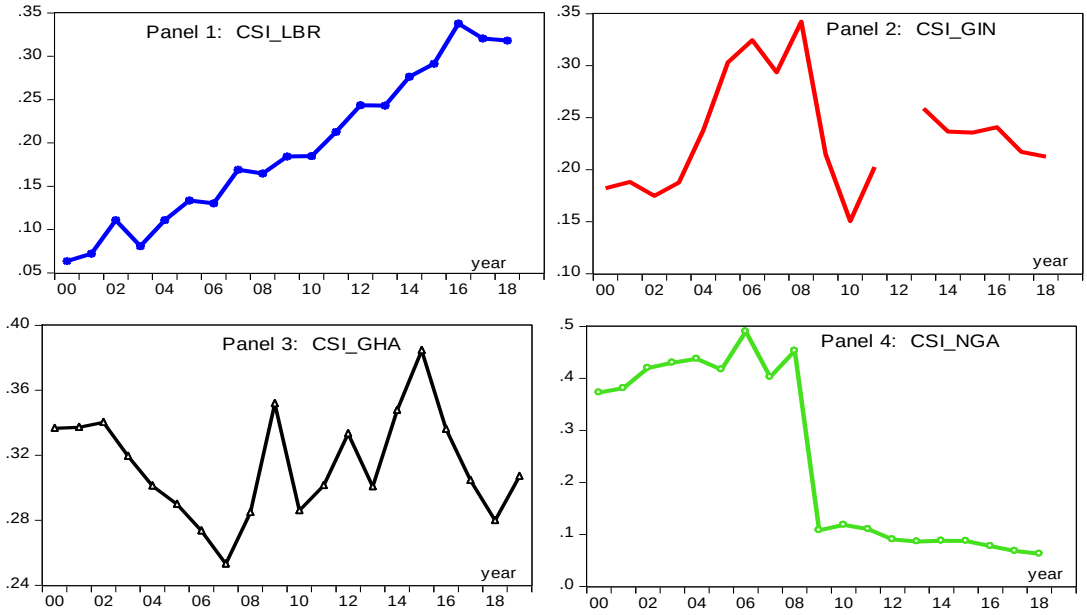
Interesting trends are also noticeable in other key macroeconomic indicators for the four countries. It can be observed from Table 3 that Guinea's real exchange rate to the dollar exceeds that of the other three countries, while Liberia records the highest gross national expenditure. There is relatively low prevalence of currency substitution, as none recorded an index exceeding 0.5. Figure 3 depicts the relative Currency Substitution Index (CSI) for the four economies, showing that the rate of dollarisation in Nigeria was the highest from 2000 to 2008, plunging dramatically below the other three countries from 2009 to 2018.

Table 3: Trends in key study variables for the Selected Countries

YEAR	REAL EXCHANGE RATE				GROSS NATIONAL EXPENDITURE				CURRENCY SUBSTITUTION INDEX			
	GUINEA	GHN	LIB	NGA	GUINEA	GHN	LIB	NGA	GUINEA	GHN	LIB	NGA
2008	4601.69	103.85	63.21	99.58	120.90	119.46	210.34	89.46	0.34	**0.28**	0.16	0.45
2009	4801.08	94.83	68.29	92.66	124.78	113.01	179.68	98.80	0.21	**0.35**	0.18	0.11
2010	5726.07	100.00	71.40	100.00	112.86	113.78	173.50	93.57	0.15	**0.29**	0.18	0.12
2011	6658.03	95.21	72.23	100.52	120.75	112.42	172.65	92.12	0.20	**0.30**	0.21	0.11
2012	6985.83	86.47	73.51	110.52	120.40	112.45	156.34	83.01		**0.33**	0.24	0.09
2013	6907.88	86.25	77.52	117.41	127.49	110.00	161.83	96.08	0.26	**0.30**	0.24	0.09
2014	7014.12	66.38	83.89	124.50	123.39	109.33	180.10	95.23	0.24	**0.35**	0.28	0.09
2015	7485.52	64.67	86.19	119.05	129.45	109.57	187.08	101.22	0.24	**0.38**	0.29	0.09
2016	8967.93	74.23	94.43	110.18	153.10	103.64	178.84	102.29	0.24	**0.34**	0.34	0.08
2017	9088.32	73.63	112.71	100.82	111.52	100.52	174.42	100.00	0.22	**0.30**	0.32	0.07
2018	9011.13	73.79	144.06	109.11	114.99	95.87	168.34	101.99	0.21	**0.28**	0.32	0.06
2019	9183.88	72.03	186.43	122.69	-	-	-	-	-	-	-	-

Source: International Financial Statistics (2020)

Fig 3: Evolution of Currency Substitution in Selected WAMZ countries (2000-2019)



Source: IMF's International Financial Statistics (2020); BoG Monetary Survey (2020); CBN Bulletin (2019)

As Figure 3 clearly shows, currency substitution rose consistently in Liberia over the entire review period 2000-2019. This can be attributed to the high level of dollarization of the Liberian economy. From Panel 2 and 4, the level of currency substitution in Guinea and Nigeria declined in 2007/2008 following the global financial crisis. A possible explanation of this could be that the stock markets in both countries were adversely affected by the crises. For instance, Njiforti (2015) for instance notes that despite the official downplaying of the impact of the crises on the Nigerian economy, the latter's stock market contracted coupled with the plunging of the price of crude oil as well as a significant decline in money supply and credit to the private sector. All this may have impacted negatively on the availability and flow of foreign currency holdings in the economy. Economic contractions in sub-Saharan Africa, due largely to the tumbling of commodity prices in the wake of the recession means that Guinea would also not be immuned (AfDB, 2009). Currency substitution in Ghana (Panel 3) has been variegated over the period 2000-2019. With a currency substitution index of about 0.34 in 2000, Ghana recorded a low in currency substitution of 0.26 just before the global financial crisis 2006/2007 and a peak in currency substitution of 0.38 in 2015/16.

3.0 METHODOLOGY

3.1 Model Specification

Following the review of both theoretical and empirical literature above, the study's model specification is theoretically underpinned by the Portfolio Balance Model (PBM). The PBM explains that domestic agents hold in their asset portfolio four different kinds of assets; domestic money, foreign money, domestic bond, and foreign bond. It informs that agents can switch among these assets unrestrictedly and simultaneously, with the exchange rate performing an equilibrating role in the event of a change in risks or returns on any of the assets. Thus, our model is specified to investigate the effect on consumption expenditure of agents' preference of the foreign currency over the local currency. In particular, aggregate consumption expenditure is modelled to functionally depend on currency substitution, domestic interest rates, exchange rate, foreign interest rate, and other control or explanatory variables suggested by the literature such as inflation, and real GDP.

In this regard, our objective and modelling strategy depart from traditional studies on currency substitution that have largely focused on the macroeconomic determinants of the dollarization phenomenon. A common aspect of the latter type of modelling strategy is to capture the so-called ratchet or hysteresis effect of past currency substitution (CS_{-1}) on contemporaneous currency substitution (CS) – often using the

peak historical value of currency substitution and/or (sometimes) using peak historical value of exchange rate – that is, the maximum value of depreciation of the local currency or maximum value of exchange rate differentials (see e.g., Mueller 1994; Mongardini and Mueller 1999:15). Many of such studies also endeavour to address the issue of asymmetric effect of exchange rate on currency substitution[2]. As the main objective of the study is to investigate the underlying dynamic impact of currency substitution on aggregate consumption expenditure, we model the later as a function of Currency Substitution Index (CSI) and other hypothesized determinants of consumption expenditure. These include economic growth rate, inflation rate, domestic interest rate, foreign interest rate, and exchange rate or its differential.

The estimable empirical model we specify is the Fixed Effect (FE) panel data model. We rely on a balanced panel of 4 selected WAMZ countries (Ghana, Guinea, Liberia, and Nigeria) for which data are consistently available and covers the period of 2000-2018. Our baseline Fixed Effect Model is close in spirit to those of Adom, Sharma, and Morshed, (2006), as well as Bonga and Dhoro, (2015). Nonetheless, our research differs from theirs in at least two major ways. First, rather than express currency substitution index as a function of a set of macroeconomic variables, we incorporate the former as a major argument in the aggregate consumption function. The motivations for this is to enable us capture (separately) the macroeconomic impact of the dollarization phenomenon in the West African Monetary Zone countries. Second, we go beyond this and endeavor to capture a measure of foreign or global interest rate regime (measured by US real interest rate).

Our base-line fixed effect (FE) model is presented with clarity by first considering its general specification as follows (see e.g Onye and Umoh, 2020):

$$Y_{it} = \alpha_i + \beta_1 X_{it} + \mu_{it} \qquad 1$$

Where:

Y_{it} represents the dependent variable, with i and t being the entity/country and time subscripts respectively. X_{it} is a vector of independent variables (IVs) while α_i (i =1 ….n) is the unknown intercept for each entity (n entity–specific intercepts); μ_i is the error term; β_i is the coefficients of a vector of independent variables which captures each

[2] Ratchet or hysteresis effect simple refers to the persistent effect of past value of a variable (e.g., currency substitution behaviour) on contemporaneous value of the variable (Mongardini and Mueller, 1999; Mueller 1994, Samreth 2011; Samreth and Sok, 2018:11). For studies on stock or bond markets, such persistency is referred to as leverage effect. As in Shin et al (2014), Bahmani-Oskooee and Bahmani (2015), Bahmani-Oskooee, et. al (2016, 2017), the decomposition of exchange rate growth rate into the positive and negative components (to capture its asymmetric effect on currency substitution) follows the partial sum approach.

country's specific characteristics. Given the general specification of the FE model, our baseline (estimable) equation is expressed as equation 2, thus:

$$\ln GCE_{i,t} = \beta_o + \beta_1 \mathrm{CSi}_{i,t} + \beta_2 Domi_{i,t} + \beta_3 Foreigni_{i,t} + \beta_4 GDPG_{i,t} + \beta_5 EXR_{i,t} + \beta_5 INF_{i,t} + \mu_i \quad \ldots\ldots \quad (2)$$

Where: lnGCE is log of aggregate national expenditure; CSI represents currency substitution index (FCD/M2); INF is the CPI-based inflation rate; Domi is the domestic real interest rate; Foreigni stands for the foreign interest rate measured as US real interest rate; EXR is the official bilateral exchange rate (LCU/ US$); and GDPG is the real GDP growth rate. On a priori grounds, we expect the estimated coefficients of all the predictor variables to be negatively correlated with gross consumption expenditure, except the coefficient of real GDP growth rate which is expected to have a positive sign.

3.2. Data: Measuring the Degree of Currency Substitution and other Macro variables

Currency Substitution Index (CSI): The traditional measures of currency substitution have tended to omit foreign currency-denominated bills and coins circulating within an economy in the CS index used in most studies. First, this is mainly on account of the dearth of data on the stock of foreign cash in circulation within a particular country. While this caveat also applies to this study, the poor level of financial intermediation in developing economies like the WAMZ countries warrants at least an attempt to capture the cash economy. Second, the IMF's International Financial Statistics (Monetary Survey) do not provide separate data on Foreign Currency Deposit (FCD) with the banking institution, and time/saving deposit. Instead the IMF lumps these important measures into a single data set. Following the IMF's approach, many Central Bank of Ghana including most WAMZ countries like Nigeria, Guinea and Liberia have followed the same practice of lumping these measures in their monetary survey dataset. The central bank of Ghana is an exception and appears to have made an impressive effort in this regard, as the Bank of Ghana (BoG) is found to appropriately isolate Foreign Currency Deposits (FCD) from the time and saving deposits. Against this background, our proxy for currency substitution is foreign Currency Deposit (plus time and saving deposit) as a ratio of broad money supply (M2). Our measure is equivalent to FCD/money deposit – or at least closely mimics it given our choice of M2 as the denominator. This is because both the numerator and denominator (M2) in our measure contain savings and time deposit which cancel out when we take the ratios (see e.g., Olayungbo & Ajunwon, 2015;Yinusa, 2009; Viseth, 2001; Samreth 2011; Shin et al.,2014; Bahmani-Oskooee and Bahmani , 2016: Samreth and Sok, 2018).

Broad Money Supply (M2): Broad money (IFS line 35L..ZK) is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveller's checks; and other securities such as certificates of deposit and commercial paper. The data is retrieved from the World Banks' World Development Indicators.

Domestic Interest Rate: This is measured as real interest Rate (%).
Gross National Expenditure (current US$): Gross national expenditure (formerly domestic absorption) is measured as the sum of household final consumption expenditure (formerly private consumption), general government final consumption expenditure (formerly general government consumption), and gross capital formation (formerly gross domestic investment). Given the focus of the current study which is on the impact of currency substitution on aggregate consumption expenditure, the use of GNE is obviously preferred given that household final consumption expenditure ignore expenditure by the general government as well as domestic investment expenditures. We check the robustness of our result to alternative definition of gross national expenditure (GNE in % GDP).

Exchange Rate: As Guinea and Liberia have little or no data on real effective exchange rate, we rely on official exchange rate (LCU per US$, period average).

Foreign Interest rate: This is measured as U.S real interest rate (%). Two reasons account for its usage here. First, it reflects the cost of holding money or an alternative to wealth allocation compared to money holdings; and secondly, it is a pointer to the intentions (monetary policy) of the monetary authorities within the period under study (Olayungbo & Ajunwon, 2015). Overall, data on the variables are retrieved from the CBN Statistical Bulletin (2018), Bank of Ghana (BoG) Statistical Bulletin (2019), World Development Indicators (2020) and the IMF's International Financial Statistics (2020).

4.0 RESULTS AND DISCUSSIONS

In order to test the appropriateness of our regression model, we first implement the Hausman Specification test which helps us in deciding whether to use the random effect model or fixed-effect model for the study. Table 4 reports the Hausman's specification result. The null hypothesis for the Hausman's test assumes that the difference in the coefficients is not systematic.

Table 4: Haussmann Specification Test: Fixed Effect versus Random Effect

	Sample: Panel of 4 WAMZ Countries (GIN, GHA, LBR, NGA)	
	Dep Var: GCE (Gross national Expenditure in % GDP)	Dep Var: lnGCEl (log of level Gross National Expenditure)
Regressor	(b-B)	(b-B)
CSi	-0.46	-0.76
DOMi	9.8	12
Foreigni	-11.3	-3.54
INF	-0.08	-0.11
GDPG	0.033	4.32
EXR	-0.1856	-0.03
chi2(1)	**17.74**	**7.65**
Prob_chi2	0.001	0.035

Note: b-B stands for Coefficient Difference, i.e., Fixed -Random; H0: Difference in Coefficient is not systematic; Decision; if *Prob_chi2 is < 0.05, then FE is appropriate.*

The decision rule is that if *P* > 0.05, it indicates that the random effect model is more appropriate. The Probability value of 0.001 and 0.035 for the respective cases where the dependent variables are gross national expenditure, GCE (in percent of GDP) and log of level national expenditure (lnGCEL) indicate that the Fixed Effect model is the more appropriate specifications.

Thus, the results we present is that of the Fixed Effect model. Table 5 shows the results of the Fixed Effect panel data regression estimated for the 4 WAMZ Countries in our sample – namely, Ghana, Guinea, Liberia and Nigeria.

Table 5: Fixed Effect Result for the Panel of Selected WAMZ Economies

	Sample: Panel 4 WAMZ Countries (GIN, GHA, LBR, NGA)	
C1	Dep Var: GCE (GCE in % GDP) (C2)	Dep Var: lnGCEl (log of Gross National Expenditure, Curr. $US) (C3)
Regressor	**C2**	**C3**
CSi	**-10.5**	***-7.25***
	(0.005)**	**(0.027)****
DOMi	**-0.19**	**-0.1.**

	(0.13)	**(0.013)**
Foreigni	**-5.9**	**-3.8**
	(0.007)**	**(0.08)****
INF_{-1}	**-0.03**	**-0.19**
	(0.09)	**(0.42)**
GDPG	**2.1**	***3.81***
	(0.001)**	**(0.02)****
EXR	**-0.30**	***-0.27***
	(0.02)**	***(0.01)*****
Intercept	**12.1**	**-90.1**
	(0.58)	**(0.4)**
corr(u_i, Xb)	**-0.32**	**-0.34**
F value	**2.47**	**6.1**
Prob > F	**0.02**	**0.00012**

Note: values in bracket are the prob. of t values, P> | t | ; Significant coefficient are bold-italicized and their corresponding probability value flagged with ** and * for the 5% and 10% significance levels, respectively. *corr(u_i, Xb) of < -0.5 suggest that, overall, the error term is negatively correlated with the regressors in the Fixed effect model.*

The first column reports the list of regressors included in the baseline model (equation 2). Columns C2 and C3 report the results for the different measures of the dependent variable. While C3 shows the results of the log of GCE (current $US) as the dependent variable, C2 reports the results of the GCE (%GDP) as the dependent variable. Our choice of two different measures of the dependent variable is to check the sensitivity and robustness of our baseline results to different measures of the variable. Since GDP growth rate appears as a dependent variable in the model that measures GCE in percentage of GDP, there is bound to be problem of multi-collinearity in the estimation equation for the result reported in C2. We account for this by including the robustness check via the stata option 'robust' in the fixed effect estimation. This returns the robust standard error of the equation and corrects for potential multi-collinearity.

Beginning with C2, it is found that currency substitution has a negative effect on aggregate national expenditure and the effect turns out to be highly statistically significant with a probability value of 0.005. With the CSI coefficient of -10.5, a unit increase in currency substitution could lead to a decline in gross national expenditure as a percentage of GDP by about 10.5 unit. We found the effect of domestic interest rate on consumption expenditure to be negative as expected - although the effect turns out to be statistically insignificant. Foreign interest rate is also found to negatively

impact consumption expenditure in the domestic economies of the WAMZ countries. A possible explanation to this is that with increase in foreign interest rate, agents are likely to hold their asset in hard currency or invest in high interest-yielding foreign assets that could lead to a decline in domestic investment and aggregate national consumption expenditure. This finding is corroborated by di Giovanni and Shambaugh (2008) who found that spikes in foreign interest rates exert a contractionary effect on growth of real GDP of the domestic economy. It must be emphasised that though in the instant case, aggregate consumption expenditure is the dependent variable, the conclusion is still relevant because a contraction in aggregate expenditure bears directly on aggregate output.

The result also shows that increase in domestic inflation rate leads to decline in consumption expenditure since inflation is a burden on current money balances. This is not too surprising as rising inflation is likely to create uncertainties about the business climate which could decrease private and public consumption expenditures and thereby decelerating investment. As these are critical components of the aggregate consumption expenditure, the latter is likely to decrease with a rise in inflation. We found increase in GDP growth rate to lead to increase in consumption expenditure. This is expected because as investment, private consumption and public consumption expenditures are critical component of GDP, the latter is expected to reinforce contemporaneous gross consumption expenditure.

An evaluation of the results of exchange rate, which is the most important hypothesized variable (aside inflation) through which the dollarization phenomenon could impact consumption expenditure (Samreth and Sok, 2018; Mueller 1994) indicate that an increase in exchange rate (depreciation of the domestic currency of WAMZ countries) leads to decline in aggregate expenditure for countries in the region. We also found the negative effect of local currency depreciation (increase in exchange rate) on aggregate expenditure to be statistically significant with a probability value of 0.02. More precisely, a 10 unit increase in exchange rate would lead to a 3 units decrease in aggregate expenditure for the WAMZ countries. A possible explanation of this is that an increase in local currency exchange rate (depreciation of local currency) would imply that agents (household and business firms) have the incentive to substitute the foreign currency (mainly dollars) for the local currency, i.e., hold their assets in form of foreign currency. This will lead to decline in private consumption spending and decline in domestic investment expenditure - with the result that aggregate national expenditure (our dependent variable) declines.

Turning to Coulmn 3 of the result, we found that our Fixed Effect model specification is robust to the alternative measures of aggregate national expenditure. The result in column 3 closely mimics that of C2 except that in the former, the effect of domestic interest rate turns out to be statistically significant with a probability value of 0.013. We found no evidence of sign reversal of any of the explanatory variables. Currency Substitution Index continues to maintain its negative and significant effect on aggregate expenditure, although the size of the coefficient declined (in absolute terms) from 10.5 to 7.25. Similarly, foreign interest rate maintained its negative impact and statistical significance, albeit with a decline in the magnitude of the coefficient in absolute terms from 5.9 to 3.8. For both specification, the inflation rate remains statistically insignificant but with a marginal increase in the size of its coefficient (in absolute terms) from 0.03 to 0.19. GDP growth rate, on the other hand, remains significant for both specifications. The size of the coefficient increased from 2.1 (C2) to 3.81 (in C3). Similar to that of Currency Substitution Index, the effect of exchange rate remains significant with different sizes of the coefficients.

5.0 SUMMARY AND CONCLUSION

In this paper, we investigate the dollarisation experience of four selected WAMZ countries – Ghana, Guinea, Liberia, and Nigeria for which we found consistent data. In particular, we focus on the effect of dollarization on aggregate consumption expenditures. Our findings indicate that currency substitution has a depressing effect on gross consumption expenditure. Foreign and domestic interest rates, inflation, as well as exchange rate equally impacted negatively on gross consumption expenditure. Aggregate consumption spending was however found to be an increasing function of real GDP. Our results were robust to the alternative measure of gross consumption expenditure introduced in the fixed effect model specification. Specifically, we observed that this alternative measure showed no significant departure from the original measure of the dependent variable.

Important policy issues undergird the results of our study. First, the study redirects policy focus away from monetary factors to real variables within the currency substitution research context. It gives a fresh perspective to the fact that dollarisation might affect real variables much as they influence monetary factors (e.g. the money demand function). With the envisaged introduction of the *eco* as the regional currency for the entire ECOWAS in the proposed monetary union, each member country within the WAMZ must ensure the stability of their exchange rate, for as the study indicates, domestic currency depreciation is one of the significant variable inducing agents' preference of the foreign currency over the domestic currency, with consequential effect on aggregate consumption spending. Interestingly, the secondary

convergence criteria for the WAMZ countries list exchange rate stability as a criterion to be met by each member country. Specifically, the criteria provide that depreciation of the nominal exchange rate should not exceed 10 percent, coupled with a public debt-to-GDP ratio of not more than 70 percent.

Containing exchange rate volatility within the WAMZ might induce a strong positive multiplier effect on other equally important factors influencing aggregate consumption expenditure. These include inflation and domestic interest rates. Foreign interest rates are attractive to residents and agents only in relation to that of the domestic economy. With policies targeted at improving domestic production of imported commodities, there would be a gradual shift by agents away from foreign currency to the domestic. Consequently, aggregate consumption expenditure (including its individual components) would experience an upward shift; investment would increase, leading to an overall rise in the real GDP. A corollary of the foregoing policy issue is the fact that there is considerable opportunity cost, besides the ones already identified in the literature, of tolerating persistent dollarisation – aggregate consumption spending would be dampened, leading to a falling output in the long run. Theoretically, this might work through the investment channel.

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EXPORT TRANSACTION COSTS AND EXPORT PERFORMANCE IN ECOWAS COUNTRIES: A MULTI-VARIANT PANEL DATA APPROACH

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Abstract

The quest to achieve increased regional trade and economic integration through export facilitation cannot materialize under a high transaction cost regime, as it constitutes a major trade deterrent. In this paper, we investigate the impact of export trade transaction costs and a battery of other explanatory variables on export performance in the ECOWAS sub-region. Several panel data estimation techniques and data that covered the 2006-2018 sample period were used. The empirical findings show that high export transaction cost has a significantly negative effect on export performance, implying that lower trade transaction costs, engendered by trade simplification, harmonization, modernization and transparency tend to facilitate exports. We found also evidence that real output (productive) capacity, gross capital formation and financial development positively and significantly determine export performance in the sub-region. Exchange rate has a positive and moderate impact on export performance, owing to the sub-region's dependence on the export of largely undiversified primary commodities, with weak elasticity of demand. The impact of foreign direct investment on export performance is positive but weak, given that foreign investors tend to concentrate their investments in few, mainly extractive sectors with high economic returns. The implications of these empirical findings for policy were discussed.

JEL Classification: F1, F14.
Keywords: Export trade transaction costs, Export performance, ECOWAS, Panel Data.

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1.0 INTRODUCTION

Regional trade facilitation, hinged on promoting export of goods and services among ECOWAS member countries is largely based on simplification and harmonization of trade processes that lower trades transaction costs of trade. It is in this regard that the effect of export trade transaction costs on trade expansion is currently receiving the deserved attention in academic circles and policy discourse. Conventional trade theories had postulated that the removal of obstructions to free flow of trade would enhance trade and rapid economic growth of member countries through efficient and optimal allocation of resources (Edwards, 1998). The elimination of export distortions through the simplification of export trade procedures is mainly aimed at lowering transaction cost of exports to encourage the orientation of trade towards exporting sectors. Thus, high trade transaction costs tend to cause substantial distortions in the efficient allocation of resources towards exporting sector, the effect of which is a decline in output and export (Bloch & Tang, 2004). Increased trade facilitated by lower transaction costs would not only induce export, it can also boost productivity through the channels of technology, increased economies of scale, and the competitive influence of interaction with foreign firms in markets at home and abroad (Jack, Meissner & Novy, 2008).

Rapid expansion in export will not materialize until significant trade reforms are carried out to reduce export transaction cost. Facilitating trade through low trade transaction cost constitutes the recent focus of the World Bank and other Multilateral Trade Organizations such as the World Trade Organization (WTO). In the same vein, facilitating trade through the reduction of intra-ECOWAS trade-related costs constitutes the crux of various trade reforms and ECOWAS Trade. Trade expansion (export growth) contributed significantly to the high levels of economic growth recorded by the East Asian economies.

The success of the high-performing Asian economies (Hong Kong, Korea, Singapore and Taiwan) in the past three decades provides a strong argument for export-led growth. The spectacular export performance recorded by these economies improved their standard of living comparable to those of the rich industrialized countries. There appears to be a consensus that the success achieved by these economies is largely due to their unusual export performance of manufactured goods, which caused low export transaction costs. Spectacular export performance not only allowed the high-performing Asian economies to reap economies of scale from expanding market size, it also gave them an ability to move to a new and higher production function typical of OECD countries (Block & Tang, 2004).

Overall, export performance, as reflected in annual growth rates of export, has on the average, been rather weak in ECOWAS countries during the past decades. The weak export performance may not be unrelated to the high and destabilizing export transaction costs, arising from poor trade reforms. The low level of and rate of export in ECOWAS countries is a reflection of the failure to actualize the objectives of fully functioning customs and market union, which are impetus to trade and economic integration. Available evidence points to the fact that, the low volume of exports among ECOWAS countries contrast sharply with the heavy volume in Asian countries and the OECD countries (Ozekhome, 2015). The region's export rose from USD 20 billion in 1999 to USD 100 billion in 2009, and between 2010 and 2017, export rose by 5.2 percent. This is abysmally low, when compared with that of the East-Asian countries, which recorded an average export growth of 125.3 per cent and 272.2 per cent within the two sub-periods respectively (World Bank, 2016). Intra-regional export vacillated between 8.4 and 14.2 per cent during the same period while imports fluctuated between 11.5 and 19.9 per cent. Intra-ECOWAS export was 0.1 per cent in 1999 and 0.3 per cent in 2015 (World Bank, 2017). The diminishing trend in export trade is attributed to high trade transaction costs, a key factor in trade facilitation, weak trade infrastructure, poor trade implementation policies and other trade-inhibiting factors (World Bank, 2015).

To the best of our knowledge, the nexus between export transaction costs (which is a major trade facilitation variable) and trade performance in the ECOWAS sub-region appears, thus far, not to have received the attention of researchers, especially when viewed against the backdrop that the push towards trade and economic integration cannot be realized without strong trade export performance. In view of this, our study seek to contribute to the literature by adducing empirical evidence that could inform policies to enhance economic integration through export facilitation. In this regard, the paper addresses issues of policy relevance to the sub-region, in light of recent policy discussions to create the enabling environment that would promote trade integration in the ECOWAS sub-region. In doing this, the rest of the paper, following this introductory section, is organized as follows:

Section 2 presents the stylized facts on export trade facilitation (i.e. documents to export and cost to export) in ECOWAS. Section 3 provides a review of the literature, which considers key theoretical, empirical and policy issues associated with trade costs and export. Section 4 contains the methodology, model specification and data. Section 5 presents the empirical results and analysis, while Section 6 draws the evidence-based policy implications and conclusion.

2.0 STYLIZED FACTS ON EXPORT TRADE FACILITATION IN ECOWAS

According to the World Bank, the literature on trade facilitation in ECOWAS can be discussed within four critical evolutionary periods; 2006, 2008, 2010 and 2012 respectively. The available data on trade facilitation from the World Bank (2015) shows that Republic of Niger recorded the highest time to export (in days) at 59 days in 2006, 2008, 2010 and 2012 among ECOWAS countries, as well as other regions of the world (see Table 1 in appendix) . Besides, this exceeded the world average, thus, making her the least performer in the region and in the world. Burkina Faso, on the other hand recorded the highest number of documents to export in the ECOWAS and other regions. Senegal required 11 documents to export in 2006 whilst Guinea-Bissau required 10 both in 2010 and 2012, with a cost to export that was lower than the sub-regional average. Nigeria required 9 documents to export in 2006, 2008, 2010 and 2012 respectively (Table 1 in Appendix). In terms of cost to export, it is also seen that Niger had the highest throughout the period, thereby making her the least performer in the region. On the other hand, Nigeria required 9 documents to export in 2006, which equaled the sub-regional average while the corresponding values for 2008, 2010 and 2012 exceeded the sub-regional average, indicating poor performance (see Table 1 in appendix).

On the contrary, the best performer in ECOWAS for the periods in terms of documents to export and cost to export is Ghana. This is closely followed by Senegal in terms of documents to export and time to export, except in 2006 when her number of documents to export was jointly highest alongside Burkina Faso. Togo also has impressive performance. The performances of these countries exceeded that of the average in the periods. Overall export cost in 5 of the 15 ECOWAS countries exceeded the world's average in 2006, 2008 and 2010 respectively. On the other hand, in 2012, export cost in 4 out of the 15 ECOWAS countries exceeded the world's average, while the time necessary to export (time to export) exceeded the corresponding world's average in as many as 10 ECOWAS countries in 2010 and 2012 respectively. In the same vein, documents required to export in 10 ECOWAS countries exceeded the world average in 2008 and in 9 of the 15 ECOWAS countries in 2010 and 2012 (World Bank, 2015) (see Table 1 in appendix).

In terms of cost, exporting activities are unduly disadvantaged in Sub-Saharan African countries (which include ECOWAS), where export of one standard container takes on the average 31 days and costs USD 2,100 in 2012. This compares to 19 days and USD 839 in East Asia and Pacific, and 11 days and USD 1,053 in OECD High income countries in the same period. For instance, between 2006 and 2012, export cost increased by 21.1% in nominal terms, rising to 22.5 percent in 2017 (World Bank, 2017). In 2006, global

average export cost was USD 1,225 but surged sharply to USD 1,484 in 2012 and USD 1462 in 2017. A similar upward trend occurred in Sub-Saharan Africa and ECOWAS sub-region (see Table 1 in appendix). The number of documents to export and time to export have slightly declined in both the ECOWAS sub-region and the world. However, Sub-Saharan Africa and West Africa still have the highest cost to export, thus hampering export growth and consequently, an impeding the efforts of regional trade integration. In addition to the foregoing, Custom procedures in ECOWAS have been most complex, multifarious and burdensome, translating to high trade transaction costs. This explains the low volume of export trade in the region, a factor that that is responsible for the sub-region's low export performance in the world trade matrix (UNCTAD, 2015; World Bank, 2015). These unimpressive indicators of trade facilitation underscores the need for an empirical investigation of the effect of exports transaction costs- being a major trade facilitation variable on export performance in the sub-region.

In a bid to facilitate greater trade through the reduction of number of documents to exports and cost to export, some policy responses and initiatives have been adopted and implemented by governments and institutions of the sub-region. For instance, the Common External Tariff (CET) and ECOWAS Trade Liberalization Scheme (ETLS) were launched in 2015, which aimed at creating unimpeded and unhindered export trade in the sub-regional market through the reduction of cost of trade. Put differently, the measures were aimed at simplifying trade processes and procedures by addressing border post surveillance and inspection duplication, in order to reduced documents to trade and transaction cost of trade. In the same year, agreement among ECOWAS and the United Nation Industrial Development Organization (UNIDO), the World Bank and the German Development Corporation led to the establishment of €40 million regional programme designed to support trade and integration. The programme also aims at fast-tracking customs union program, developing and harmonizing regional trade policies, collecting data on trade and efficiently issuing trade information across the region. Export trade, in this direction will be promoted through simplification, harmonization, modernization and enhanced transparency in customs procedures, in addition to other processes connected to exports.

Critical steps and initiatives have also been taken to reduce intra-ECOWAS trade-related costs. Prominent efforts in this regard is the Lagos-Dakar regional infrastructural development programme. The Abidjan-Lagos Transport Facilitation Scheme, which aims at reducing trade transaction costs among member countries (Amoakor-Tuffour et al., 2016). Other measures taken thus far, include, institutional reforms to strengthen the weak political and security environment of member ECOWAS states through

democratic reforms and the consequent entrenchment of democracy in most ECOWAS countries. Adherence to trade protocols and treaties through enforcement proceedings, joint multilateral surveillance and boarder patrol, deployment of non-intrusive equipment such as scanners and electronic connectivity to reduce cost of doing business and trade have also been emphasized. These policy responses, measures and initiatives are all favourably disposed to greater regional trade openness, particular export orientation, promotion, and increased regional integration (Ozekhome, 2019).

3.0 LITERATURE REVIEW

3.1. Brief Theoretical Literature

Export promotion (expansion), has its root in the classical theories of international trade (such as Adam Smith's Absolute Advantage Theory and David Ricardo's Comparative Advantage Theory) and the modern theories of trade (such as the International Trade /Factor Endowment Theory and Integration-Responsiveness Paradigm/Framework). The Adam Smith's Absolute Advantage Theory, David Ricardo's Comparative Advantage and Factor Endowment Theories stressed the simplification and harmonization of complex trade processes/procedure through the removal of trade obstructions and impediments that will result in considerable reduction of trade transaction costs to promote international trade, international competition and international exchange of goods and services. The Integration-Responsiveness Framework on the other hand emphasized the role of dynamic regional and international integration value chain through feasible strategies adumbrated in standardization, coordination and harmonization of a set of relevant political, economic, institutional and reorganizational imperatives that shape the strategy. In line with this paradigm, participants in regional or global markets develop competitive postures and edge for global integration and local responsiveness through policy reforms, coordination and synchronization.

Accordingly, increased export market transaction costs (cost to export) will reduce export performance of host countries and diminish the prospect for regional integration, where the countries are in an economic bloc. In theory, improved and efficient export facilitation fostered by transaction cost reduction, will encourage export expansion and dynamic regional trade and economic integration, arising from product competitiveness, diversification and economies of scale (Ozekhome, 2019). Simplified and harmonized trade procedures enable open economies gain greater market access, opportunities, and higher export product diversification, through the reduction of costs. In the context of dynamic regional value chain, it promotes

international shipment and greater provision of goods and services. Trade facilitation thus engenders greater market opening, in terms of higher degree of competition and growth (Amoako-Tuffor, et al. 2016).

High export transaction costs have destabilizing effect on export growth. In line with this position, significant trade costs will reduce export expansion. Anderson Wincoop (2004), Portugal- Perez & Wilson (2008) and Hoekman, & Nicita (2011) reveal that increased export transaction costs, as impediments to trade, have negative effects on export orientation and expansion. Their propositions are based on the assumptions of an export-oriented and export-led growth economy. They averred that significant trade reforms that necessitate the simplification, harmonization, modernization and transparency of trade procedures lead to lower trade transaction costs, and consequently engender trade expansion. Low and simplified export costs constitute an important aspect of trade facilitation that can encourage greater exportation of commodities (see Lee, 1996; Lall, Wang & Munthali, 2009; Lesser & Moise-Leeman, 2009). Trade liberalization (particularly export-orientation can also engender product differentiation and expand export product destinations or markets (Krugmann & Venables, 1990; Costas et al., 2008; Dennis & Shepherd, 2011).

Export-oriented trade policies and strategies encourage high productivity and expansion in domestic production (output) since export-oriented industries become more competitive. The increase in domestic output for export will induce greater international competitiveness, employment and growth (Ozekhome, 2019). Through regional trade agreement, cost to export can be significantly reduced when trade procedures are simplified through policy coordination and harmonization. This has the effect of reducing high trade costs that inhibit export growth, productivity and economic growth. Thus, trade policy synchronization and provision of sound regional infrastructure can enhance the orientation of trade sectors towards the exporting sector (World Bank 2017).

3.2. Empirical Review

It appears that there is dearth of studies in the empirical literature that have examined the impact of export transaction costs on export performance. As observed by previous studies, the effect of export transaction costs on export performance was negative and statistically significant (see Zhang & Song, 2001; Clark, Dollar & Micco, 2004; Pearson, 2007). In an investigation of the determinants of China's exports, Zhang and Song (2001) employed time series technique and found that export transaction, measured as boarder related costs was a significant determinant of Chinese exports. Against the backdrop of this finding, they recommended provision of good

infrastructure that significantly reduces export transaction costs. Clark, Dollar and Micco (2004) examined the impact of trade facilitation of maritime transport costs on bilateral trade in groups of Asia and Pacific countries. The empirical findings revealed that high transport costs had a debilitating effect on bilateral trade.

Persson (2007) investigated the impact of export transaction costs- in terms of all incidental and non-tariff cost and time delays on export flows in a sample of countries drawn from African, Caribbean and Pacific regions that were in discussion of economic cooperation with the European Union (EU). Using panel data estimation techniques, he found that that time delays and high export costs are inimical to trade. Haring, Palso and Raballand (2007) examined the relationship between trade costs measured as sum of exports and import related cost and trade volume in West and Central Africa. The results based on the Generalized Method of Moments (GMM) showed that high transport cost negatively affected trade performance in the regions. They concluded that significant measures to reduce trade costs through the provision of good trade infrastructure are important. Keane and Feinberg (2007) investigated the relationship between trade costs and international exchanges in a sample of 45 countries. They decomposed trade cost into cost to export and import, measured as the sum of all transport related and custom clearance costs, and found that higher trade flows was positively associated with lower cost of trade (measured as transportation costs, and cost of trade infrastructure).

Behars, Manners and Nelson (2008) examined the impact of trade costs (in terms of the monetary amount required to export and import a consignment) on trade volume and growth, based on a sample of industrialized and developing countries. Employing dynamic panel data analysis technique, he obtained empirical evidence that showed that trade costs was negatively related to trade volume.

Portugal-Perez and Wilson (2008a) assessed the impact of trade facilitation in the context of trade costs, encompassing transport infrastructure and boarder related costs in Africa, in a sample of 25 African countries in terms of barriers and opportunities for trade reform. The evidence revealed that high trade cost had a significant destabilizing effect on trade, while lower trade costs enhanced trade. In another dimension, Portugal-Perez and Wilson (2008b) examined the link between export performance and trade facilitation in the context of the hard and soft infrastructure for trade and integration in Asia. Employing a decomposition estimation approach, they found that high transaction cost (measured as cost of exporting one cargo) had a negative and significant effect on export performance. They concluded that lower transaction costs are export inducing. Behar, Manners and Nelson (2009) assessed the

impact of different trade facilitation variables, which include cost to export on export performance, using data from industrialized countries. The findings revealed that export was negatively and significantly affected by high transaction cost to export. They recommended trade harmonization procedures and provision of sound infrastructure to enhance exports. Other studies such as Portugal-Perez and Willson (2012), and Ramli and Ismail (2014) found evidence of a significant relationship between export performance, export costs, openness and exchange rate.

From the review of the pertinent literature, no regional study in the ECOWAS sub-region has specifically examined the effect of export cost on export performance in the sub-region. Considering the current state of affairs, where greater regional growth, employment, competitiveness and diversification are hinged on increased export performance, there is need to carry out further empirical investigation on the subject matter.

4.0 METHODOLOGY

In this section, we specify a model to address the export transaction cost-export performance nexus as well as discuss the empirical methodology of the study.

4.1 Model Specification

Following the review of the theoretical literature, the systematic relationship between exports transaction costs (proxied by costs to export) and export performance in ECOWAS countries is captured in the functional model of the form:

$$EXP_{i,t} = f\ (CEi,t,\ Xi,t) \qquad (1)$$

Where Export performance is the dependent variable, measured by the growth rate of total exports, (i.e. export trade orientation), CE is Cost to export (i.e export transaction cost- includes all costs that are incidental to the export of one consignment (other than marginal cost of producing goods) leading to the delivery of goods and services up to the final consumer (in USD Dollars). It includes transportation costs, cost of trade infrastructure, country-specific or fixed costs and time as a result of deliberate or conscious government policy, and X is a vector of a battery of export trade facilitation variables, which according to the literature influence export growth (see Liu & Shiu, 2003). These variables include:

OPEN- a measure of openness of the domestic economy to trade /trade liberalization - measured as exports plus imports as percentage of GDP
GRGDP= growth rate of real GDP (a measure of economic output)

GFCF= Gross fixed capital formation as percentage of GDP (a measure of domestic investment)
FDI= Foreign direct investment to GDP percent
FDEV= Financial development- measured as credit to private sector as percentage of GDP
EXR = Nominal exchange rate (N/S)
The inclusion of these variables provides guidance on the specification of an augmented model incorporating other variables as hypothesized determinants of export performance. They are included to, as much as possible; capture other critical variables that influence the assumed relationship in order to avoid the problem of omitted variable bias. Following this, the augmented version of the model specified to capture the determinants of export performance in the ECOWAS sub-region that is consistent with the literature and economic theories is:

$EXP_{i,t} = f(CE_{i,t}, OPEN_{i,t}, GRGDP_{i,t}, GCFC_{i,t}, FDI_{i,t}, FDEV_{i,t}, EXR_{i,t})$ (2)

Where the variables are as earlier defined
The empirical specification of the model as estimated is therefore:

$EXP_{i,t}=, a_0 + a_1CE_{i,t} + + a_3OPEN_{i,t} + a_3GRGDP_{i,t} + a_4GFCF_{i,t} + a_{45}FDI_{i,t} + a_6FDEV_{i,t} + \alpha 7EXRi,t + \varepsilon_{it}$ (3)

Where *i* represents all 15 ECOWAS member countries, t is year fixed specific effect;
a_1-a_7 are parameters to be estimated and ε is the unobserved error term.
The presumptive expectations with respect to sign are: $a_1 < 0$; $a_2, a_3 a_4, a_5, a_6, a_7 > 0$.

4.2 Justification for the Choice of the Variables

A number of variables influence export performance in the trade literature. Export transaction cost influences export performance, given that cost to export will influence the volume of exports. A high export transaction cost regme will accordingly, reduce export performance, while a low cost to export will facilitate exports, and thus encourage export expansion (see Keane & Feinberg, 2007; Hoekman & Nicita, 2011; Ozekhome, 2019). Openness of the domestic economy is an important variable that influences trade, which is consistent with the literature. A more open economy will permit considerable level of exports than in situations of trade distortions (Ozekhome, 2016).The inclusion of domestic openness is thus in line with theory. Increased economic output (indicated by growth rate of real GDP) is an important determinant of exports, as economic growth implies increased output. The resulting increase in output would imply higher level of export of the goods and services that have been produced. This position is supported by Parteka and Tamberi (2011) that larger economies produce (and consequently) export greater level of commodities than smaller economies.

Foreign direct investment is an important variable that influences the export performance through its role as a conduit for technological development, innovation and productivity growth (Lim, 2002). Through knowledge spillovers or contagion effects, foreign direct investment can result in improved production and efficiency of domestic firms and thus, greater exports. FDI is thus, perceived to be positively related to export performance of host countries (Iwamoto & Nabeshima, 2012). Capital accumulation, in theory, influences trade, as increased capital stock induces greater production level of exportable commodities, which results in export expansion.

Financial development ensures efficient allocation of credit to the export sectors of the economy (see Manova (2008a, b). Thus, a well-developed financial system is able to promote greater level of exports through the provision of trade finance and credits to exports, and hence, export expansion. Financial development is thus, a facilitator of trade, making its inclusion in the model justifiable. Exchange rate, through currency devaluation/depreciation leads to improvement in the balance of trade because of export expansion and import contraction. The devaluation/depreciation of the domestic currency could generate greater production of exportable commodities, and thus increase exports, given favourable demand for the exportable commodities that is demand elastic. The inclusion of exchange rate is thus, in line with the theory.

4.3 Estimation Technique

The panel data methodology is adopted in this study. The study adopts different panel estimators- Panel Fixed Effect (FE) and Panel Estimated Generalized Least Squares also known as Feasible Generalized Least Squares (both fixed and random), which addresses autocorrelation and Fully Modified Ordinary Least Squares (FMOLS), which corrects for autocorrelation, potential endogeneity of regressors and reverse causality. The latter method builds upon the weakness of the former since it comprehensively account for country-specific, time varying and invariant effects (characteristics) and the ensuing heterogeneity amongst them. Specifically, the FMOLS is able to account for considerable heterogeneity across individual panel to produce asymptotic unbiased estimators and nuisance parameters, free normal distributions (Pedroni, 2000). The estimates are consistent and efficient, and potentially address endogeneity and simultaneous bias arising from simultaneous or reverse causality. The main advantage of the dynamic panel estimators is that it comprehensively takes the individual characteristics of the different countries used in the study. It is generally observed that country-level characteristics are strong factors in the explanation of export performance (or variation), and hence, this differentiation may bring endogeneity bias into the estimation. The dynamic panel estimators help to correct this inherent estimation problem.

4.4 Data

The study employs panel data covering the period 2006-2018, on the fifteen ECOWAS member countries. The countries are Benin, Burkina Faso, Cape Verde, Cote D'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. ECOWAS as a regional grouping seeks to attain economic and monetary integration through the coordination and harmonization of trade, fiscal and monetary policies. The study period is dictated by data availability. All the data for this study were obtained from the World Bank's World Development Indicators (WDI).

5. 0 Empirical Results and Analysis

5.1 Descriptive Statistics

We present in Table 2, the descriptive statistics of the data on the variables used for the analysis. Average export performance (export growth) during the period is 25.1 per cent, with a median value of 26.20 per cent. The maximum and minimum growth rate in export is 53.4 percent and 2.8 percent respectively. Invariably, export performance tend to have converged around the mean value in the focus period, portraying a pronounced differential rate of export growth among the ECOWAS member countries from high export growth in some of the countries to very low export growth in others.. The mean export transaction cost (cost to export) for the sub-region is 1290, with a median value of 1300, implying a high export trade transaction cost that tend to slow export expansion. The maximum and minimum values are 2743.1 and 624.3. The wide gap between the maximum and minimum values shows that export trade transaction cost is largely dissimilar and heterogeneous among the ECOWAS countries over the period. The wide dispersion is further confirmed by the relatively high standard deviation value of 15.2. The corresponding average values for the other variable are: trade openness (61.2), growth of real GDP (4.75), gross fixed capital formation (domestic investment) (32.20), FDI (12.22), financial development (28.4) and exchange rate (195.2)

Table 2 Descriptive Statistics

	Mean	*Median*	*Max.*	*Min.*	*Std. Dev.*	*Skewness*	*Kurtosis*	*J-B*
EXP	25.06	26.20	56.43	2.78	7.33	-0.45	2.22	14.04
CE	1290.02	1300.05	2743.12	624.3	15.24	-0.53	3.70	22.18
OPEN	61.15	60.34	71.40	46.65	6.20	-0.02	2.23	2.73
GRGDP	4.75	5.05	8.20	0.76	1.65	-0.46	2.54	4.70
GFCF	32.20	32.30	48.30	18.52	7.90	-0.07	2.10	3.37
FDI	12.22	12.50	21.35	1.90	4.94	-0.14	2.09	3.60
FDEV	28.35	29.16	40.50	9.65	4.83	2.20	4.10	8.26
EXR	195.22	218.10	463.42	9.80	25.80	1.73	3.65	28.40

Source: Authors' computation

5.2. Correlation Analysis

We conduct the correlation analysis in order to examine the pattern of relationships among the variables. An incidence of high correlation among the independent variables may violate the working assumptions of our estimation technique, and, thereby, produce unrealistic estimates. The result of the pairwise correlation matrix tests are reported in Table 3. From the results, a negative correlation is observed between export transaction cost (cost to export) and export performance, while the remaining variables are observed to be positively correlated with export performance. The correlation results also show a negative relationship between exchange rate and growth rate of real GDP and a positive relationship between financial development and FDI. An overall consideration of the matrix of correlation coefficients suggests that problem of multi-collinearity is avoided, since none of the correlation coefficient exceeds 0.90.

Table 3: Correlation Matrix

	EXP	CE	OPEN	GRGDP	GFCF	FDI	FD EXR
EXP	-						
CE	-0.15	-					
OPN	0.23	0.07	-				
GRGDP	0.38	0.20	0.25	-			
GFCF	0.20	0.05	0.26	0.33	-		
FDI	0.08	0.24	0.13	0.27	0.22		
FD	0.18	0.28	0.27	0.35	0.34	0.05	-
EXR	0.06	0.19	0.38	-0.08	0.11	0.30	0.16 -

Source: Authors' computation

5.3 Multivariate Panel Analysis

The estimated results from the model using several panel estimators; Panel Least Squares (Fixed Effect), Panel Estimated Generalized Least Squares (Random Effect with cross-section weights) and Panel Estimated Generalized Least Squares (Fixed Effect with cross-section weights)- are presented in Table 4. The alternative results based on the FMOLS, which is used to test for robustness, is also presented. The goodness of fit indicated by the adjusted coefficient of determination of the Panel fixed effect and Panel EGLS (Fixed Effect with cross-section weights) show that over 76 per cent and 92 per cent of the systematic variations in export performance in the sub-region are explained by the regressors. This implies the explanatory variables are significant factors explaining export performance in the sub-region, making the predictive ability of the model good. The respective F-statistic are highly significant, passing the significance test at the 1% level; a confirmation of the reliability of the explanatory power of the model, and validating the hypothesis of a significant linear relationship between export performance and its explanatory variables.

Table 4: Export Performance and its Explanatory Variables

Variables	Panel LS (Fixed Effect)	Panel EGLS RE (with CSW)	Panel EGLS FE (with CSW	FMOLS
-	1.2061 (1.243)	1.173 (1.050)	1.021 (1.160)	
CE	-0.114 (-2.323)**	-0.077 (-2.106)**	-0.103 (-2.741)***	-0.265 (-2.182)***
OPEN	0.201 (0.614)	0.203 (0.636)	0.203 (0.763)	0.024 (0.742)
GRGDP	0.212 (2.750) ***	0.118 (2.168)**	0.106 (3.245)***	0.123 (2.140)***

GFCF	0.202 (3.402)***	0.140 (3.714)***	0.103 (2.832)***	0.216 (3.113)***
FDI	0.016 (0.671)	0.018 (0.711)	0.018 (0.950)	0.021 (0.635)
FDEV	-0.014 (-2.148)**	-0.015 (-2.145)**	-0.017 (-2.479)**	-0.013 (-2.160)**
EXR	0.022 (0.902)	0.030 (1.140)	0.010 (1.322)	0.014 (1.821)*
Diagnostic Statistics	(0.187)	(0.353)	(1.153)	0.014* (0.295)
R^2	0.782	0.29[w]	0.935[w]	
Adjusted R^2	0.761	0.27[w]	0.924[w]	
F-statistic	38.34	7.52[w]	102.70[w]	
Long-run variance				0.023

Note: ***, ** & * indicate statistical significance at 1%, 5% & 10% levels, respectively; FE= Fixed Effect; RE= Random Effect; CSW= Cross-Section Weights, W= Weighted Statistics; t-ratios are in parenthesis.
Source: Authors' computation

The coefficient of export trade transaction cost is negative in line with *a priori* expectation and it is statistically significant in all the estimated equations. Thus, high export transaction cost tends to have a debilitating effect on expansion of exports. This implies that lower export trade transaction cost is a significant trade facilitation variable, which has the capacity to stimulate export in the ECOWAS sub-region. As export cost becomes lower arising from significant trade reforms encompassing simplification, harmonization, transparency and modernization of export trade procedures, export intensification is triggered. In general, the fundamental reason for trade facilitation is to promote greater trade (particularly, export) through lower trade transaction cost as complex and uncoordinated trade procedures serves to translate to higher cost of trade, which tend to lower trade performance. The elasticity coefficient (as seen in the FMOLS equation) indicates that a 10 per cent increase in export trade cost diminishes export performance by about 2.7 per cent.

The coefficient of real output growth (a measure of output capacity) is appropriately positively signed in line with presumptive expectation and highly significant for the full panel estimation. This implies that increases in output has a stimulating effect on export.

Invariably, the larger the economic output, the greater the sub-regions export volume and growth. The elasticity coefficient indicates that a 10 per cent increase in economic output will, on the average, induce export expansion by about 1.3 per cent in the ECOWAS sub-region.

The coefficient of the gross capital formation (domestic investment) variable is positively signed in line with theoretical expectation. In addition, it passed the significance test at the 1 per cent level in all the estimations. Invariably, increased capital stock tends to engender export expansion. The elasticity coefficient indicates that a 10 per cent rise in domestic investment will trigger export expansion by about 2.2 per cent.

The coefficient of foreign direct investment though positively related with exports is not statistically significant in any of the estimations. This implies that greater focus should be on domestic investment rather than foreign direct investment to enhance export, particularly as foreign direct investment are mainly profit-oriented and tend to be characterized by capital and resource repatriation to the detriment of the host country's export. The elasticity coefficient shows that a 10 per cent rise in foreign direct investment will stimulate exports in the sub-region by about 0.2 per cent.

The coefficient of financial development (proxied by domestic credit to the private sector) is negatively related to export performance and it is significant at the 5 per cent level in all the estimations. The rather unexpected negative sign may be attributable to the fact that the sub-region's financial intermediation in terms of trade finance are concentrated in few sectors that are highly rewarding to the detriment of other tradable sectors. Such sectors are mining, quarrying, oil and gas, e.t.c (i.e primary and extractive). This is a pointer to the inefficiency of the financial system in the ECOWAS sub-region. The elasticity coefficient indicates that a 10 percent concentration of trade finance will reduce export volume and growth in the sub-region by 0.13 per cent.

The coefficient of nominal exchange rate is positively related to export output expansion but fails the significance test at conventional levels in the panel fixed effect and panel estimated generalized least squares (fixed and random with cross-section weights), except in the FMOLS, where it was statistically significant only at the 10 per cent level. The explanation may be that currency devaluation/depreciation engenders export expansion since export commodities become cheaper in the international market, given favourable demand for the export commodities that are demand elastic. Unfortunately, however, many of the countries in the ECOWAS

regional grouping lack meaningful diversification in the composition of their output and trade. The elasticity estimate of the variable indicates that a 10 per cent depreciation in nominal exchange rate will generate export expansion in the sub-region by 0.14 per cent.

Overall, the findings indicate that export trade transaction cost (cost to export), growth rate of output, gross fixed capital formation (domestic investment) and financial development are critical variables that influence export performance in the sub-region.

5.4 Policy Implications of Findings

A number of important policy implications can be deduced from the empirical findings. First, high export transaction costs tend to have a debilitating effect on export performance in the sub-region. Invariably, prohibitive cost to export undermines export competitiveness and reduces the prospect for greater market. Therefore, it is important that countries in the sub-region articulate efficient export cost-reduction strategies (i.e. export trade orientation strategies) through simplification, harmonization, modernization and transparency of trade procedures, basically geared towards reducing trade costs (export cost in this context). Improved and efficient facilitation will engender cost reduction, increase competition, stimulate economies of scale, enhance efficiency, and permit integration into value chains (regional and international value chains). In addition, reduction of costs will encourage product competitiveness in new markets and promote exportation of new and innovative products, ultimately enhancing diversification.

It is noteworthy that the quest to promote export trade, greater regional and economic integration, employment and growth cannot be achieved under a high export trade cost regime. In this connection, we are of the view that such trade reforms initiatives such as the Common External Tariff (CET) and ECOWAS Trade Liberalization Scheme (ETLS) that seek to create unimpeded and unhindered export trade will expand the sub-regional market through the reduction of cost of trade. There is also need to address such other issues as non-tariff barriers (NTBs), border post surveillance, inspection complex or duplicative trade procedures and weak trade infrastructure problem, all of which serve to raise cost of trade in the sub region. In addition, there is need to fast-track the delivery of such other initiatives that seek to reduce intra-ECOWAS trade-related costs as the Lagos-Dakar regional infrastructural development programme and the Abidjan-Lagos Transport Facilitation Scheme. A major constraint to regional trade agreement is the non-implementation of ECOWAS protocols and conventions. In this regard, strong political and economic will to implement regional

trade agreements is imperative, along with supporting institutional and legal frameworks.

Second, increased output capacity engenders export product expansion. This is because, the greater the output capacity, the greater the exportable commodities. Against this backdrop, there is need to develop increased production (output) and trade capacities in order to enhance exports in the sub-region. Increased intra-regional trade, which serves to engender increased production and exchange of goods and services, coupled with increased intra-regional investment has potential implications for the establishment of a monetary union in the long-run. Indeed, the efforts at putting in place a single currency (the Eco) which was initially billed to come into use in January 2020, in the sub-region is indicative of the possibility of establishing a monetary union which expectedly will be enhanced by greater trade facilitation.

Third, domestic investment as opposed to foreign direct investment tends to engender export expansion, since increased capital accumulation leads to greater productivity, greater output and consequently higher goods for export. Capital accumulation is therefore important to export growth (expansion) in the sub-region.

Fourth, financial development is positively related to export growth, as it helps to channel resources to finance export trade (i.e. trade finance). Efficient financial intermediation in terms of allocation of credit to the exporting sectors of the economy will enhance the performance of the sectors, and this, will engender expansion of exportable products. Therefore, strong regulation and supervision of the financial system is necessary to ensure efficient allocation of trade credits to different sectors of the economy, as this will increase the output of those sectors, and consequently, stimulate their exportable goods. Finally, the results indicate that a competitive exchange rate is critical to export trade in the sub-region. Therefore, sound, stable and competitive exchange rate policy, anchored on well-articulated macroeconomic policies are imperative for the sub-region. These policies, if implemented, can enhance the attainment of economic and monetary integration in the sub-region.

6.0 CONCLUSION

We have examined the impact of export transaction costs (cost to export), and a battery of explanatory variables on export performance in the 15 ECOWAS countries. Employing several panel data estimators that include fixed effect, panel EGLS (feasible generalized least squares) and the fully modified OLS (FMOLS), which was used to test for robustness, the empirical results show that cost to export, real output capacity, gross fixed capital formation and financial development are significant trade facilitation

variables that influence export performance in the sub-region. Specifically, increases in real economic output and gross fixed capital formation were found to significantly enhance exports, while high (low) export transaction cost were found to be negatively (positively) related to exports.

Financial development (measured by financial intermediation, that is, credit to the domestic private sector) is found to be negatively and significantly related to export expansion due perhaps to the inefficiency of the financial system to concentrate their lending pattern and activities to few dominant extractive and primary sectors to the detriment of other export-enhancing sectors. Foreign direct investment and openness of the domestic economy were also found to be positively related to export performance, but the effects were not significant. Invariably, improved trade facilitation embedded in simplifying, harmonizing, coordinating and modernizing complex trade procedures will inevitably lead to export growth in the sub-region. Given the fact that an export led-growth economy has greater productive, growth and employment capacities, the entire sub-region will be better for it.

Against the foregoing background, there is need to implement at the sub-regional level strong and effective trade facilitation policies, strategies and measures, geared towards the reduction of export trade transaction cost (cost to export). This is hinged on the fact that trade facilitation through simplified and harmonized custom procedures will engender reduction in cost of trade and, increased competition, while at the same time stimulate economies of scale and enhance efficiency, making possible integration into value chains (regional and international value chains). These, should be supported with increase domestic investment, increase output capacity, strong regulatory and effective institutional supervision of the financial institutions as well as sound and stable macroeconomic policies that will enhance the sub-region's export trade. These, no doubt, will promote greater regional economic and monetary integration, rapid economic growth, employment generation and poverty reduction.

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Appendix

Table 1: Transaction Costs in International Trade, Country/ Regional Averages (Export)

Year	2006			2008			2010			2012		
Country/Region (ECOWAS)	DTE (No)	TTE (Days)	CTE (Per Container USD	DTE	TTE	CTE	DTE	TTE	CTE	DTE	TTE	CTE
Benin	8	34	987	8	32	1057	8	30	1071	8	29	1101
Burkina Faso	11	45	2226	11	45	2262	10	41	2412	10	41	2412
Cape Verde	7	22	1074	7	19	1125	7	19	1125	7	`19	1125
Cote d' Ivoire	9	23	1494	9	23	1745	9	25	1710	9	25	1740
Gambia	6	23	1199	6	24	1141	6	19	991	6	19	1030
Ghana	6	21	624	6	19	805	6	19	815	6	19	815
Guinea	7	34	730	7	34	880	7	36	915	7	36	915
Guinea Bissau	6	27	1445	6	27	1545	6	25	1545	6	25	1448
Liberia	10	20	1132	10	20	1332	10	17	1332	10	15	1320
Mali	7	44	1752	7	38	2012	6	26	2202	6	26	2202
Niger	8	59	2743	8	59	3343	8	59	3343	8	59	3474
Nigeria	9	26	1026	9	25	1179	9	24	1263	9	24	1380
Sierra- Leone	8	31	1082	7	29	1248	7	26	1373	7	24	1185
Senegal	11	21	958	6	15	1208	6	12	1228	6	12	1228
Togo	6	24	872	6	24	940	6	24	940	6	24	940
East Asia & Pacific	6	22	865	6	20	821	6	20	804	6	19	839
OECD-High Income	4	12	917	4	11	1038	4	11	1045	4	11	1053
Sub-Saharan Africa	8	37	1642	8	35	1872	8	32	1992	8	31	2100
West Africa (ECOWAS)	8	30	1290	8	29	1455	7	27	1484	7	26	1488
World	7	26	1225	6	24	1336	6	23	1390	6	22	1484

Source: Authors' compilation from World Bank World Development Indicators (WDI)

DTE = Documents to Export

TTE= Time to Export

CTE= Cost to Export

DEMOGRAPHIC CHANGES AND WOMEN'S EMPLOYMENT IN ECOWAS COUNTRIES

Monday I. Egharevba[1]

Abstract

In this study, the relationship between demographic changes and women employment in the ECOWAS sub-region was examined. All the ECOWAS countries were included in the analysis, with annual data covering the period between 1991 and 2018. Given the nature of relationship between demographic factors and employment, a dynamic framework was devised for the study and the Fully Modified OLS and Dynamic OLS techniques were employed in the empirical analysis of the study. The study found that demographic changes has been weak for the ECOWAS countries in relation to fertility rates, while the changes have been more pronounced in terms of decline in mortality rates. It was also shown that changes in fertility rates only tend to positively affect women employment among ECOWAS countries, though the effects are mostly weak. On the other hand, the study found evidence that rising mortality rates have effectively reduced women employment in ECOWAS countries. Women employment was also shown to effectively lower the rate of demographic changes among ECOWAS countries irrespective of the measurement used. In particular, transitions in demographic patterns that involved rapid urbanisation has the capacity of boosting overall women employment in the ECOWAS sub-region. The results implied that while poor changes in fertility rates in ECOWAS countries presents challenges for women employment, adequate demographic changes lead to improvement in women employment for the ECOWAS sub-region.

Keywords: child mortality rates, ECOWAS, fertility rates, women employment rate
JEL Classification: J1, J13, J16, J82

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1.0 INTRODUCTION

The role of women in the work system is a crucial element of the linkage between employment and inclusive growth. In the first place, women make up more than half the world's population (IMF, 2015), suggesting that moving them into more productive jobs enhances a mass of the population. Moreover, the less than potential contribution of women to economic activities has led to strong productivity losses in many developing countries. In many developing countries, women are more deprived in employment, education, political power, health, and economic decision making (World Bank, 2004; UN Women, 2015; Razavi, 2016). In the same vein, highly segmented labour markets in developing countries tend to be strongly skewed against women in many respects. For instance, Steinberg and Nakane (2012) observed the disproportionate participation of women in the labour markets in developing countries, with women predominantly filling areas of low-paying and low-status jobs. This has led to lower earnings with women earning only three-quarters as much as men even with the same level of education and in the same occupation (International Labour Organisation, 2018). Thus, a germane development challenge facing countries globally is the issue of providing productive employment for women (Anyanwu, 2012).

Progress in achieving more inclusive growth through improved participation of women has included the need to ensure economic and social transformation among the countries (ILO, 2013; Golub & Hayat, 2014). A long-standing factor that has counted against women's economic and employment empowerment in this regard is the social dimensions of gender structure, especially in the African region. This includes the patterns of demographic characterization that may have contributed to social constraints on women. Furthermore, transformation and long term growth in an economy (with employment yields) are often accompanied by certain structural and social changes, one of which is demographic changes (Adegboye et al, 2019). Demographic changes, which involve "the secular shift in fertility and mortality from high and sharply fluctuating levels to low and relatively stable ones" (Lee & Reher, 2011), is among the important changes that have affected the human society over the last few centuries. Indeed, demographic changes can have substantial consequences on economic outcomes as have been seen in more advanced economies over the years. For instance, Goujon (2006) and Namasaka (2015) have noted that demographic transitions observed through age and savings relationship have explained up to one-third of the East Asian economic miracle.

Demographic changes are characterised by an initial sustained decline in mortality rates (or general deaths) and subsequently fertility rates (or general births), such that high and approximately equal death and birth rates eventually give way to low and

approximately equal rates (McNay, 2003). Though the rate of demographic changes has been slow in many African countries, the process has been steady. According to the World Bank (2016) report, total fertility fell from 6.64 to 4.85 between 1990 and 2018, while infant mortality rate has reduced from 116.2 per 1,000 births to 58.2 per 1000 births for the same periods.

As observed by Fields (1990), Campbell and Ahmed (2012), Olotu, Salami and Akeremale (2015), labour markets in developing countries mainly respond to population and demographic factors. These are accentuated by changes in participation rates, migration, age-work dependency, urbanization as well as their connections to labour markets. Thus, when demographic indicators change with population changes (which has been noted to be quite rapid in Africa), there is the possibility that employment issues would have to be re-considered not just within structural frameworks, but also from the perspective of labour supply conditions.

Apparently, the transition would tend to facilitate radical changes associated with women's economic and social roles (Lee and Reher, 2011), which is often demonstrated in terms of employment and asset ownership. Moreover, a more important implication of demographic changes relate to the position and dimensions of women activities within the family, and in society. In particular, there are declines in fertility rates as parents trade "quantity for quality" in their children, and human capital investments become increasingly important (Bhaskar, 2019). Increasing requirements for human capital investments, both for women and children, has pushed demographic transition at a high speed over time. Thus, demographic changes can be both causes and consequences of women education and employment around the world (Doepke & Tertilt, 2009; Fernandez, 2010). Studies that seek to explain determinants of employment in developing countries have focused more on general employment rates and those of the youth. Studies on women employment, that included demographic changes were either performed for advanced economies (Jacobsen et al., 1999; Erosa et al., 2005; Jaramillo-Baanante, 2017), or on broad developing countries (Van den Broeck and Maertens, 2014).

The main objective of the study is therefore to examine the effect of demographic changes on women employment in ECOWAS countries. Given the nature of population and labour markets in ECOWAS countries, this study extends the demographic change-employment literature. In particular, the study evaluates the effect of fertility and child mortality rates on women employment and also assesses whether there are reverse-effects of women employment on demographic changes among ECOWAS countries.

2.0 BRIEF REVIEW OF LITERATURE

A particular issue that has often stimulated empirical studies on the effects of demographic changes on employment is the finding by the World Bank (2012) that employment levels in a country evolves in step with the different stages of their demographic systems. Thus, the studies on demographics-employment relationships have considered all aspects of demographic changes in line with employment changes both for country groups and single country cases. Demographic effects on employment has had few empirical investigations, especially in the developing countries. For the studies that exist, focus is on the demographic characteristics of ageing, urbanization and age-dependency. For instance, Grant (2012) considered the capacity of urban areas to create jobs for youth populations and distinguished between both economic sectors and the levels of formalities in employment. His study, which covered developing economies, provided an overview of patterns of urbanization across developing countries in relation to urban economic perspectives. He found that demographic patterns that affect the urban sectors were characterised by rising competition for jobs, and the sectoral composition of economic growth hugely influenced the distribution of benefits and costs across urban populations. Thus, it is seen that high urban population tends to limit job availability in the centres.

Fuchs and Weyh (2014) analysed the relation between population aging and employment in East Germany for the years from 1996 to 2012 by considering both direct and indirect effects. Their results showed that changes in the age structure of the workforce counteracted employment growth in 2005. Their spatial panel regressions on the small-scale regional level revealed an indirect effect of aging on employment that works through the increasing competition for labour. Emara (2015) analysed the effect of female employment on fertility rate (a reverse effect to the current study) by using panel fertility regression specification with Prais-Winsten regressions procedure, panel-based corrected standard errors, as well as autoregressive errors on a sample of 29 developing countries. The empirical results showed that "the increase in female labor force participation rate has a negative impact on fertility and that this negative effect is decreasing over time".

In the study by Dieterich, Huang and Thomas (2016) for developing countries, it was found that in lower-middle income countries, there is continuous movement of population out of the agricultural sector into smaller household enterprises and into the wage sectors. The study also found that more married females have found it increasingly difficult to enter and maintain a job in the growing formal wage sector (in the modern economy) but were mainly employed in household enterprises, which are usually informal. On the other hand, Fox & Sohnesen (2012) found that other constraints

limit females' participation even for household-based enterprises (such as access to credit and other inputs). This was shown to have resulted in a lack of economies of scale and lower profitability of women-run enterprises in comparison to their male-headed enterprises. Also, Fox, Muñoz and Thomas (2013) conducted a study for advanced economies and found that "once countries hit the upper-middle income level, the gender gap starts to show in diverging labor force participation rates for men and women and unequal access to different labor market sectors".

Jaramillo-Baanante (2017) estimated the causal effects of declines in fertility rates (through demographic transition) on women's employment using instrumental variables for a wide array of countries. They also analysed the heterogeneity of the effects along three lines, including marriage status of the mother, age of the first (second) child, and mother's education. They found a strong impact of fertility on employment by showing that "29 percent of the total increase in women's rate of employment between 1993 and 2007 can be attributed to the reduction in fertility rates". The magnitude was found to be more than four times as large as the estimates for US by Jacobsen, Pearce and Rosenbloom (1999). In the study by Jacobson et al (1999), the impacts were largest in women with children who were two years old or younger and decline inversely as the first child increases in age but are still significant when she reaches. Effects were also found to vary with the mother's education level, tending to be stronger as women have more education. Finally, these effects are smaller for married women than for all women.

On the contrary, positive relationship has been found between demographic changes and women employment, especially for developed economies. For instance, Erosa, Fuster and Restucia (2005) developed a quantitative model of fertility and labour market participation decisions in order to investigate the role of labor market frictions in generating the observed positive association between fertility and employment among O.E.C.D. countries. They found that unemployment induces females to postpone and space births which, in turn, reduces the total fertility rate. Moreover, differences in female labour outcomes across the U.S. and Spain were shown to account for the low fertility rate in Spain relative to the U.S. Overall, the results found that labour market frictions can generate a positive association between female employment ratios and fertility rates across economies.

The reverse effect of women employment on demographic transition has also been studied. These studies note that more women in employment naturally lower the probability of they having more children, thereby speeding up the transition processes even for developing countries. Van den Broeck and Maertens (2014) investigated

whether female employment reduces fertility using evidence from the Senegalese horticultural export sector. They hypothesised that female wage employment may lower fertility rates through income, empowerment and substitution effects. Employing household survey data and two different regression techniques, they found that besides education, female employment has a significant negative effect on fertility rates. In particular, their results showed that "female employment reduces the number of children per woman by 25%, and that this fertility-reducing effect is as large for poor as for non-poor women and larger for illiterate than for literate women. Results imply that female employment is a strong instrument for empowering rural women, reducing fertility rates and accelerating the demographic transition in poor countries".

In the review conducted in this study, there are general indications that demographic changes tend to exert both social and economic effects on the population and overall political entities. Micro-level based effects have been the major directions of these effects both in theoretical and empirical analysis. This leaves the macro-level focus of the relationships between demographic transitions and employment (especially for various demographic groups) essential. This is a major aspect that is identified as a gap that the current study seeks to fill. In other words, the study takes a more macro-based approach by considering not just one country but a group of countries in the ECOWAS sub-region. The empirical literature reviewed also focused more on the effects of women employment on demographic changes with interest on how employment by women can be used as a tool for controlling population conditions, especially for advanced economies. This pattern of investigation is however not too critical for many developing countries considering their stages of development. The more important aspect of the relationship which is more relevant to developing countries is examination of how demographic changes (which appears to be unique in many African countries) affect women employment. This should be done with the goal of addressing both employment challenges in the region. This is another major gap the current study seeks to fill.

Furthermore, studies that seek to explain determinants of employment in developing countries (as seen in the review) have focused more on general employment rates and those of the youth. Studies on women employment, that included demographic changes were either performed for advanced economies (Jacobsen et al., 1999; Erosa et al., 2005; Jaramillo-Baanante, 2017), or on broad developing countries (Van den Broeck and Maertens, 2014). Given the nature of population and labour markets in ECOWAS countries, this study extends the demographic change-employment literature.

3.0 METHODOLOGY

3.1 Theoretical Framework and the Model

The basic relationship between demographic changes and women employment can be explained by the theoretical postulations in the microeconomic household fertility model which emphasises the place of economic attainment by women in fertility decisions. The falling birth rates associated with stage 3 of the demographic transition model is thus explained in this model by the declining taste of households (especially women) for children. Given that fertility is a rational economic response to the household's demand for children relative to other goods, the desired number of children can be expressed to depend directly on family income, and indirectly on price of children and other goods. Mathematically this is expressed as:

$$C_d = f(Y, P_c, P_x, t_x), \qquad x = 1,2,\ldots, n \qquad (1)$$

The model shows that demand for children, (C_d) is a function of the given level of household income (Y), the "net" price of children, (P_c), the prices of all other goods (P_x), and the tastes for goods relative to children (t_x). The net price of children which is the difference between anticipated costs and benefits, is directly related to the opportunity cost of a mother's time. This opportunity cost is largely linked to labour market participation of women. Hence, the theory shows that fertility and labour market participation of women are inversely related.

The model specified in this section is based on the negative relationship noted by the theoretical background between rising fertility and women employment rates. It is specified that women employment is positively influenced by a demographic changes that lead to lower fertility (and mortality) rate. Moreover, the model also relates demographic changes to women employment rate by taking into cognizance the central role of female education on employment decisions and chances as demonstrated in the theoretical framework. This is because, the major vehicle for the equal access of women economic resources is through educational development (Todaro & Smith, 2014). The specified model is in the form:

$$WEP = f(DMC, FER) \qquad (2)$$

Where

WEP = Women employment rate

DMC = demographic changes

FER = Female secondary school enrolment rate

It should be noted that demographic changes in the study are measured in terms of the patterns of changes or transitions in both fertility rates (*FTR*) and child mortality rate (*MTR*). However, other demographic shifts which are not peculiar to

females also tend to be prevalent in terms of employment characteristics (Harris & Todaro, 1970; Fields, 2011; Adegboye et al, 2019). These include population density and urban population rate. It is expected that demographic changes would mostly have negative impacts on women employment growth. In the study, fertility rates, mortality rates, and population density should reduce the chances of women obtaining more jobs in the country. On the other hand, rising urbanisation may either limit or improve employment levels in a country (Fields, 1990; Fuchs & Weyh, 2014).

Thus, the basic relationship between demographic changes and women employment shown in (2) can be extended to include other broad demographic change factors and controls in a dynamic framework as:

$$WEP_{it} = \beta_0 + \beta_1 WEP_{i,t-1} + \beta_2 DMC_{it} + \beta_3 FER_{it} + \beta_i X + \eta_i + \delta_t + \varepsilon_{it}. \quad (3)$$

In this model, demographic changes (*DMC*) now include of rate of population in urban center (*RPU*), population density (*POD*), and life expectancy for women (*LEX*), and population density (*POD*). *X* represents the vector of the control variables that are uncorrelated with the error term but are essential in the model, including GDP growth rate (*GGR*), proportion of government spending in GDP (*PGS*), gross investment rate (*IGR*), degree of trade openness (*OPN*), and an institutional quality index (*COR*). δ is the fixed effect that shows that the correlation with the error term is country-specific, and ε is the white noise (which is independently and identically distributed - *iid*). The full form of the model is therefore specified as:

$$WEP_{it} = \beta_0 + \beta_1 WEP_{i,t-1} + \beta_2 FTR_{it} + \beta_3 MOR_{it} + \beta_4 FER_{it} + \beta_5 UPR_{it} + \beta_6 POD_{it} + \beta_7 LEX_{it} + \beta_8 GGR_{it} + \beta_9 PGS_{it} + \beta_{10} IVR_{it} + \beta_{11} OPN_{it} + \beta_{12} COR_{it} + \delta_t + \varepsilon_{it} \quad (4)$$

Also, *i* is individual countries, while t represents time. The *apriori* expectations from the model restated below:

$$\beta_1, \beta_4, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11}, \beta_{12} > 0; \beta_2, \beta_3, \beta_5 < 0$$

For the purpose of this study, several aspects of women employment are engaged in order to identify the varied effects of demographic changes on employment, especially in terms of sectoral and social distribution. Hence, Equation (4) are also specified for four other different distribution of women employment, including employment in agricultural, industry and services sectors, as well as vulnerable employment.

3.2 The Reverse Effect Equation

Following the theoretical basis expanded above, there is expectation that employment of women could exert certain effects on demographic changes (fertility

and mortality rates). Hence, a reverse equation is specified. The model is based on the panel causality test that is intended to show that women employment tends to reduce fertility rates and mortality rates. The model is therefore specified as:

$$MOR_{it} = \beta_1 WEP + \beta_2 RPU_{it} + \beta_3 POD_{it} + \beta_4 LEX_{it} + \beta_5 FER_{it} + \beta_6 GGR_{it} + \beta_7 PGS_{it} + \beta_8 IVR_{it} + \beta_9 OPN_{it} + \beta_{10} COR_{it} + \eta_i + \delta_t + \varepsilon_{it} \quad (5)$$

and

$$FTR_{it} = \beta_1 WEP + \beta_2 RPU_{it} + \beta_3 POD_{it} + \beta_4 LEX_{it} + \beta_5 FER_{it} + \beta_6 GGR_{it} + \beta_7 PGS_{it} + \beta_8 IVR_{it} + \beta_9 OPN_{it} + \beta_{10} COR_{it} + \eta_i + \delta_t + \varepsilon_{it} \quad (6)$$

Where all the variables are as earlier defined; note than X stands for the control variables that were defined above. The *apriori* expectations from the model restated below:

$$\beta_3 > 0; \beta_1, \beta_2, \beta_4 \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10} < 0$$

3.3 Method of Estimation

As noted by both theoretical and empirical considerations, women's economic participation is endogenously related to their family and demographic circumstance (Fields, 2012; Anyanwu, 2012). The dependent variable in the model is therefore structurally related to the explanatory variables involving demographic changes. This makes the application of the panel data estimation framework inconsistent. The Equations in the study are therefore estimated using the Fully modified OLS (FMOLS) method. Essentially the FMOLS is a modified OLS estimator that helps to incorporate the integrating equations among the variables in order to provide a result that ensures long run stability (Balcilar et al, 2013). The method is also appropriate for heterogeneous cointegrated panels (Pedroni, 2000). This methodology addresses the problem of non-stationary regressors, as well as the problem of simultaneity bias among the variables in a reduced-form equation. Besides using the FMOLS, this study also employs the Dynamic OLS (DOLS) estimator as a robustness check. This technique is a parametric approach and takes into account the potential endogeneity of the variables as well as the presence of serial correlation by including leads and lags of the differenced explanatory variables as additional regressors (Fidrmuc, 2009).

3.4 Description of Variables

Women employment (*WEP*) represents female in employment measured in terms of the proportion of total population in employment (i.e. women employment rate). Moreover, since the type of employment in the labour market are also considered in this study, the variable also represents proportion of women employed with respect to economic nature of jobs (vulnerable employment - *VUE*) and sector of employment (agriculture – *AGE*, industry – *INE*, and services – *SVE*). Fertility rate (*FTR*) is measured by the average number of children per woman in the population. Larger average

number of children indicates higher rates of fertility. In this study, fertility rate is expected to have negative impact on women employment since rising fertility tends to hinder both the propensity and opportunities of women to participate in the labour market. Infant mortality rate (*MOR*) is another variable used to capture demographic changes. The transition is expected to be demonstrated by falling mortality rates which, in turn, should lead to increase in women employment. Lower mortality rates imply less number of times women would conceive and raise infants, leaving them with more time to be involved in employment activities.

Share of urban women population (*UPR*) represents the proportion of women in urban centres, which is also a measure of demographic transition. This variable is expected to have a positive effect on women employment since the urban centres is noted to have more employment opportunities for all segments of the population than rural centres (Fields, 1990; Fuchs & Weyh, 2014). Population density (*POD*) drops with adequate demographic transition and therefore, it is expected to exert a positive impact on women employment. The less the population density, the less to rate of demand for available jobs, and the higher the access of women to jobs. Female enrolment rate (*FER*) shows the educational status of women and is used to capture human capital for the female population. It is measured as the female secondary school enrolment rate in each of the countries. Higher levels of human capital are expected to have positive influences on the employment opportunities for the sub population group, especially when labour markets are not deeply segmented. For the ECOWAS region, the sign of the coefficient of *FEN* may however be negative, instead of the expected positive sign due to large levels of dualism and segmentation in the labour market.

Control Variables in the model include economic growth (*growth*) which is expected to exert positive impact on women employment since rising performance in the economy has the capacity to expand labour demand and employment levels. Government spending (*GOV*) is the share of government expenditure in total GDP and is expected to lead to more productive activities thereby leading to more access in employment by women. Trade openness (OPN) shows the effects of international trade on employment in the domestic markets. Theoretically, more trade openness should lead to less job opportunities for the domestic markets. Investment rate (invr) measures the rate of investment in the economies and is captured by the share of aggregate investment in total GDP. Higher rates of investment are expected to spur more production and therefore rising labour demand in the economy. Institutional factors (*inst*) are also included to capture the level of labour market bargaining power, government control of economic activities and quality of legal system in terms of

contract and property rights. Higher levels of institutional quality are expected to have positive impacts on women employment in the sub-region.

3.5 Data Issues

The study was generally based on annual secondary data analysis for a panel of sub-Saharan Africa countries. Fifteen (15) ECOWAS countries were included in the dataset. The data was sourced from two sources. First is the World Bank *World Development Indicators* (2019) data set where population, demographic and labour market data were obtained. All the employment data was sourced from the International Labour Organisation *World Employment and Social Outlook (WESO)* database for 2019. In general, for the empirical analysis, data used covered the period 1991 to 2018.

4.0 EMPIRICAL ANALYSIS

4.1 Descriptive Statistics

In Table 1, the annualised descriptive statistics for the main data and variables used for the analysis are presented for each of the countries. Total female employment rate is higher in Togo than in any other countries. The female employment rates in Mali, Cape Verde, Senegal and Gambia are all very low on average, suggesting that less women were employed in the countries over the period of the analysis. For the sectoral shares of the female employment, it is seen that more women were employed in the agricultural sector in Guinea Bissau (at 90.57), Cape Verde (at 81.8 percent) than in any of the other countries. On the other hand, Togo (at 37.02 percent) and Benin Republic (at 39.76 percent) had the lowest proportion of female employment in the agricultural sector among the countries in ECOWAS.

Female employment rates in the industry sector was generally low for all the countries in the sub-region, with Sierra Leone having as low as 0.93 percent of the female employment in the sector on average over the period. Indeed, none of the countries had average industrial sector employment rate for women that was up to 20 percent over the period, suggesting that women have been given less share of employment in the most productive sector of the economies in ECOWAS. Given that the industry sector provides more productive employment conditions (Adegboye et al, 2019), the low employment rate of women in the sector indicates that less women are in productive employment in the ECOWAs sub-region. Proportion of women in the services sector is relatively high for many of the countries, with The Gambia having the highest rate that is above half of the entire female employment. Cote d'Ivoire and Benin Republic also have high rates of female employment in the services sector. Guinea Bissau had the lowest female employment rate in the services sector with 4.93

percent, which is the only proportion that is less than 10 percent among the ECOWAS countries.

The proportion of women in vulnerable employment is very high for each of the countries. Given that "vulnerability of employment indicates the level of security of jobs as well as social and economic stability such jobs could provide" (Adegboye et al., 2019), it is clear that most of the employment that women are involved with in many of the ECOWAS countries are unsustainable. This presents very strong basis for demonstrating that women employment in the sub-region has been in the least attractive sectors of the economy. Average fertility rates were also very high for all the countries, with that of Niger reaching 7.69 and Mali reaching 6.75 on average over the period. Only Cape Verde (with 3.47) had a rate that was less than 4 among all the countries. These rates are excessive and underscores the strong point with regard to low demographic changes in the ECOWAS sub-region. Infant mortality rates are generally not too high for the countries, although many of the term can actually do better. For instance, the rates for Sierra Leone and Niger, when compared with Cape Verde (at 35.5) shows that there is room for great improvements for many of the countries. Female secondary school enrolment rate has been generally low on average for the countries. Although Cape Verde has a very impressive rate of 68.4 percent, other countries performed very poorly at this level.

Table 1: Summary Statistics

Country	WEP	AGE	INE	SVE	VUE	FTR	MOR	FER
Benin	64.09	39.76	9.40	50.84	95.50	5.78	132.73	25.63
Burkina Faso	62.59	71.98	8.95	19.06	91.96	6.29	153.52	15.34
Cabo Verde	39.18	81.80	4.22	13.99	44.76	3.47	35.50	68.39
Cote d'Ivoire	45.80	45.79	2.87	51.34	90.16	5.67	130.23	23.75
The Gambia	41.88	40.99	4.04	54.97	83.79	5.84	107.51	42.40
Ghana	68.86	45.04	14.16	40.81	84.96	4.65	88.98	40.23
Guinea	60.62	74.12	1.82	24.06	96.21	5.79	148.69	18.45
Guinea-Bissau	60.27	90.57	4.51	4.93	76.77	5.57	153.36	--
Liberia	51.06	52.93	4.61	42.47	89.40	5.54	158.75	28.25
Mali	39.29	42.68	12.05	45.28	94.53	6.75	184.18	20.75
Niger	65.90	73.91	10.33	15.77	91.51	7.59	191.90	8.57
Nigeria	46.12	42.73	10.11	47.16	87.19	6.01	163.72	33.24

Senegal	33.64	51.06	8.04	40.90	48.61	5.41	101.35	24.47
Sierra Leone	60.50	64.12	0.93	34.95	94.04	5.84	203.35	25.67
Togo	77.90	37.02	19.71	43.27	88.19	5.25	109.87	26.03

Source: Author's Computation

4.3 Properties of Dataset: Test for Stationarity and Panel Cointegration

The stationarity status of the data is determined based on both the homogeneous tests (using the LLC and Breitung methods) and the heterogenous tests using the IPS and the ADF-Fisher tests are shown in Table 2. For the first difference variables, all the test statistics are significant, thereby leading to the rejection of the null hypothesis of no unit roots in the first differences. These results strongly indicate that the variables are non-stationary in level but become stationary in first differences. This finding is supported by both the homogenous and heterogeneous panel unit root tests. Since the variables became stationary after first difference, we then proceed to establish their long run relationship below.

Table 2: Panel Unit Root Result

Variables	Homogeneous Unit Root Process				Heterogeneous Unit Root Process			
	Level		1st Diff		Level		1st Diff	
	LLC	Breitung	LLC	Breitung	IPS	ADF-Fisher	IPS	ADF-Fisher
WEP	11.11	5.32	18.19*	-3.00**	4.32	74.56	-16.07**	400.09*
GE	18.49	14.56	-4.49**	1.74*	14.73	30.86	-9.73**	289.4**
INE	-3.01	-1.19	-9.69**	-11.85**	-2.45	101.8	-20.18**	475.40**
SVE	-2.37	-2.30	-20.32**	-17.40**	-1.64	93.50***	-24.51**	602.0**
VUE	-3.42	-3.99	-23.53**	-20.00**	-3.80	127.82	-27.82**	890.9**
FTR	0.63	2.58	-21.05**	-12.16**	0.76	64.37	-19.41**	454.7**
MOR	-8.60	-7.33	-22.59**	-15.81**	-7.56	185.47	-27.11**	654.6**
FER	8.72	12.23	-9.44**	-3.99**	12.65	22.45	-11.68**	265.53**
RPU	-18.86	-16.40	-33.38**	-19.20**	-23.16	550.86	-45.5**	1704.8**

Note: ** & ** indicate significant at 1% and 5 percent respectively; IPS=Im, Pesaran & Shin; LLC=Levin, Lin & Chu

Source: Author's Computation

Table 3 shows the outcomes of Pedroni's and Kao panel cointegration tests on the series that is between the dependent variable and the explanatory variables in the model. The tests for cointegration are done with various combinations of the variables based on women employment variables categories. Hence, five groups of the

variables are generated since five employment variables are included in the study. The results of the Panel cointegration tests indicate that the null hypothesis is there is no cointegration among the variables. From the tests results, it can be seen that the results of the within-group tests and the between-group tests show that the null hypothesis of no cointegration can be rejected. This is also complemented by another residual based (Kao) panel cointgration test. The Kao residual cointegration test shown in Table 3 indicates that the null hypothesis of no cointegration can be rejected of the series.

Table 3: Panel Cointegration Test Result

Series: total employment					
Within-Dimension			**Between-Dimension**		
	Statistic	*Weighted Statistic*		*Statistic*	*Kao (ADF)*
Panel v	-4.760	-2.443	Group rho	8.121	1.673**
Panel rho	11.098**	6.669	Group PP	-3.024***	-----
Panel PP	9.886**	1.727	Group ADF	2.687	-----
Panel ADF	8.366	3.714			
Series: agricultural employment					
Within-Dimension			**Between-Dimension**		
	Statistic	Weighted Statistic		Statistic	Kao (ADF)
Panel v	0.582	-2.444	Group rho	8.338	2.511***
Panel rho	13.829**	6.669	Group PP	-3.449***	------
Panel PP	7.715	42.72***	Group ADF	7.469***	------
Panel ADF	28.936***	31.714***			
Series: industry employment					
Within-Dimension			**Between-Dimension**		
	Statistic	Weighted Statistic		Statistic	Kao (ADF)
Panel v	1.72**	-0.26	Group rho	2.27	-7.26***
Panel rho	-3.13***	-1.38*	Group PP	-2.57***	-----
Panel PP	-8.07***	-6.25***	Group ADF	-3.36***	-----
Panel ADF	-3.77***	-3.59***			
Series: services employment					

Within-Dimension			**Between-Dimension**		
	Statistic	Weighted Statistic		Statistic	Kao (ADF)
Panel v	-0.99	0.06	*Group rho*	2.62	-1.40*
Panel rho	1.79	1.13	*Group PP*	-3.39***	------
Panel PP	-2.11**	-2.47**	*Group ADF*	-0.96	------
Panel ADF	0.55	0.38			
Series: vulnerable employment					
Within-Dimension			**Between-Dimension**		
	Statistic	Weighted Statistic		Statistic	Kao (ADF)
Panel v	-4.760	-2.443	*Group rho*	8.121	4.342***
Panel rho	7.098	14.652**	*Group PP*	-6.042***	-----
Panel PP	3.886	1.727	*Group ADF*	7.263***	-----
Panel ADF	8.366	12.124***			

*Note: **. * are the level of significance for 1% and 5% respectively. Significance tests are based on t-statistics (see Eregha, 2012).*

Source: Author's Computation

4.4 Estimation Results

4.4.1 Demographic Changes and Total Women Employment

In Table 4, the results of the effects of demographic (and other) factors on total female employment rate are presented. Given the endogeneity between employment and demographic changes, we focus more on the FMOLS and the DOLS estimates. The results report the estimations using only demographic change variables alone and using all the variables in the models. The goodness of fit of the results of the estimates with only demographic change variables are impressive. For the short run (FMOLS) estimates, the results show that the lagged dependent variable is positive and significant in each of the equations. This justifies the application of dynamic panel data analysis in the study and shows that current employment rates adjust to demographic changes with a lag. However, the coefficient of adjustment is greater than 1 for the equation with only demographic change variables, showing that demographic change alone does not provide a smooth long run adjustment for the women employment when other factors are not taken into cognisance. The lag coefficients also suggest dynamic stability in the women employment equations, which show that

the employment outcomes will eventually adjust to long term equilibrium after any short term deviations.

Table 4: Total employment results

Variable	Fixed-Effect	FMOLS	DOLS	Fixed-Effect	FMOLS	DOLS
constant	0.069***	--	--	0.063	--	--
$WEPI_{t-1}$	0.986***	1.052***	--	0.806***	0.760***	--
FTR	0.025***	0.020	0.334***	0.094***	0.029	0.623***
MOR	-0.012***	-0.010**	-0.279***	-0.004	-0.030***	-0.079***
FER				-0.001	-0.004*	0.001
RPU				0.021***	0.008	-0.149***
POD				-0.004***	-0.021	-0.033
DPR				-0.094***	-0.020	-0.836***
GGR				0.001	0.002**	0.000
LEX				0.010	-0.023	0.308**
LFP				0.214***	0.279***	0.924***
PGS				0.003	0.003	0.015***
IGR				0.005***	0.002	0.010***
OPN				0.002	0.000	-0.018***
Adj. R-sq	0.926	0.988	0.997	0.953	0.991	0.998
F-stat	5221	--	--	4837	--	--
L-R Var.	--	0.001	0.000	--	0.00	0.000
N	375	375	375	375	375	375

Note: ***, ** and * indicate are the level of significance for 1%, 5% and 10% respectively.
Source: Author's computation

Only the coefficient of mortality rates is significant in the short run, while both coefficients are significant in the long run (the DOLS estimation). More importantly, the results show that only the coefficient of mortality rate has the expected negative sign and indicates that it has a negative impact on women employment. It is therefore seen that while rising fertility rate may actually contribute to more women employment in the long run, rising mortality rate will definitely reduce women employment in ECOWAS. From the results, the impact of mortality rates on women employment is higher in the long run (the DOLS estimates) than in the long run. The outcome of the estimates may be rationalised based on the findings from the trend analysis earlier performed on the dataset where it was seen that there has been little demographic

changes with regard to fertility rates in ECOWAS. Thus, the unusual impact of fertility rates on women employment may be expected.

The other results contain the control variables for the model. The long run variance coefficient in the FMOLS and DOLS results are also low implying that the model was well specified. For the results with full variables in Table 4, the lagged dependent is positive and less than 1. This shows that with all other variables taken into cognisance, women employment rates tend to adjust more smoothly to long run equilibrium. The coefficients of fertility and mortality rates retain their signs as in the non-controlled estimations, suggesting that fertility rate has a basic positive impact on women employment while mortality rate has a standard negative impact. Apparently, as women have more children, the need to get into employment becomes stronger, especially given the fact that most of the employment available to women are less-productive, low-pay jobs that are easily accessible, especially in the agricultural and services sectors. Among the other variables, the coefficient of female secondary school enrolment rate has a significant, but unexpected negative sign, while that of economic growth has a significant positive impact on women employment. This shows that economic performance has serious implications for women employment in ECOWAS, a one percent rise in economic growth leads to 0.02 percent increase in women employment in the sub-region.

4.4.2 Demographic Changes and Sectoral Women Employment

The effects of demographic changes on sectoral employment may differ from those of total employment given the wide disparities in the rates among the sectors. Thus, this section presents the relationship between women employment in each sector and demographic changes. In Table 5, the results for women agricultural employment is presented. The results without control variables have significant lagged dependent variables with positive coefficients. However, the coefficients of fertility and mortality rates fail the significance tests at the 5 percent level. The coefficients also fail the test in the results with control variables, suggesting that the demographic change variables have no significant impact on agricultural employment by women in ECOWAS even though the impact is largely negative. The implication of the result can be considered from the perspective that agricultural sector employment is largely based in the traditional/rural sector where entrance is highly unregulated and may not require modern applications.

The short run results from the FMOLS shows that population density has a strong negative impact on women agricultural employment. This result is to be expected given that rising population density has the capacity of limiting availability of farming

land for women, thereby cutting back employment opportunities. The long run (DOLS) result also confirms the negative impact of population density on women agricultural employment for ECOWAS countries. Life expectancy and trade openness also have significant negative impacts on women employment in the agricultural sector, while government expenditure has a very significant positive long run impact on the employment. This shows that improve government spending has the capacity of boosting women employment in the traditional sector in the long run. Such expenditure patterns may include expansion of infrastructural facilities and provision improved agricultural implements and other resources.

Table 5: Results for agricultural employment

Variable	Fixed	FMOLS	DOLS	Fixed	FMOLS	DOLS
constant	3.538***	--	--	8.573**	--	--
WEP_{t-1}	0.264***	1.092***	--	--	1.075***	--
FTR	-0.129	-0.028	0.310	-1.704***	-0.018	-0.762
MOR	-0.079	0.009	0.174	-0.335***	0.068	-0.038
RPU				-0.070	-0.005	0.094
POD				-0.379***	-0.121*	-1.485***
DEP				-0.125***	0.122*	-0.242
GGR				1.540***	-0.051	0.635
LEX				0.002	-0.003***	-0.004**
LFP				-1.143***	0.183	-1.220
PGS				0.136*	0.028	1.800***
INV				-0.112**	-0.011	0.030
OPN				-0.042	-0.017*	0.001
Adj. R-sq	0.09	0.976	0.976	0.418	0.975	0.992
F-stat	220.6	--	--	498.2	--	--
L-R Var.	--	0.001	0.001	--	0.002	0.001
N	375	375	375	375	375	375

Note: ***, ** and * indicate are the level of significance for 1%, 5% and 10% respectively.
Source: Author's computation

For the employment in industry, the results are shown in Table 6. The diagnostic indicators are also quite impressive, especially for the FMOLS and the DOLS results, with over 98 percent of the systematic variations in women employment in the industrial sector being explained by the demographic and other factors. In particular, the results

reveal that the lagged dependent variable is significant and positive, indicating long run stability in the models. However, the large values of the coefficients of the lagged dependent variables shows that adjustment to equilibrium is not smooth. For the effects of demographic changes, the results show that both variables have mostly negative impacts on industry employment for women, especially in the long run. Thus, with more fertility and mortality rates, women employment in the industry sector tends to largely reduce. This result suggests that demographic changes have stronger impacts on employment in the modern sector (such as industry) than in the traditional sector.

Table 6: Results for industry employment

	Fixed	**FMOLS**	**DOLS**	**Fixed**	**FMOLS**	**DOLS**
Constant	1.059	--	--	-5.673***	--	--
WEP_{t-1}	0.519***	1.065***	--	--	1.051***	--
FTR	3.057***	-0.052	-1.342**	5.629	0.139	-1.908**
MOR	-1.381***	0.014	-0.173	0.364	-0.053**	-0.004**
FER				0.806***	0.010	0.175
RPU				-1.430***	0.151	-0.673
POD				0.055	-0.121	1.185*
DEP				-6.735***	-0.145	2.961
GGR				-0.012**	-0.001**	-0.002
LEX				6.635	-0.054	-3.553*
LFP				-0.158	-0.155*	0.782*
PGS				0.343***	0.009	-0.048
INV				0.018	0.028*	0.009
OPN				0.444**	-0.006	0.085
Adj. R-sq	0.317	0.991	0.999	0.391	0.988	0.995
F-stat	890.4			612.9	--	--
L-R Var.	--	0.002	0.001	--	0.002	0.001
N	375	375	375	375	375	375

Note: ***, ** and * indicate are the level of significance for 1%, 5% and 10% respectively.
Source: Author's computation

For the control variables, the results show that while economic growth has a negative impact on women employment in industry sector, investment rate has a significant positive impact in the short run. This shows that increased gross investment has the

capacity of boosting employment for women in industry in the short run. For the long run estimates, the results show that population density and labour force participation rates are both very strong factors that drive industry employment in ECOWAS. Thus, while population density reduces women employment in the agriculture, it actually boosts women employment in industry.

The results for the women employment in services sector is reported in Table 7 and indicates impressive goodness of fit. The lagged explanatory variables are also significant at the 5 percent level. Thus, the results show stability of the sectoral employment in the long run. Only the long run impact of fertility is significant (in the non-controlled estimates) among the demographic changes results. This shows that in general, demographic changes do not have significant impact on women employment in the services sector. Just like in the agricultural sector, women employment in the services sector is into low-productivity and informal areas where entrance is quite unlimited, even in the urban areas. Thus, demographic changes appear to only have relevant impacts on employment in sectors that are modern and more productive.

The results also show that economic growth has positive impact on services sector employment for women both in the short run and in the long run. On the other hand, life expectancy has reverse effect on services sector employment between short run (negative) and the long run (positive). The impact of secondary school enrolment on women services sector employment is only felt in the short run and it is negative, while urban rate is shown to have a very large and significant positive impact on services sector employment for women. This shows that rising urban population provides a very effective background for drawing labour into the services sector, especially for women.

Table 7: Results for Services sector employment

Variable	Fixed	FMOLS	DOLS	Fixed	FMOLS	DOLS
constant	5.225***	--	--	1.842	--	--
WEP_{t-1}	-0.824***	1.033***	--	--	1.024***	--
FTR	-0.370	0.095	-0.592**	2.984***	-0.029	0.046
MOR	0.429***	-0.025	0.020	0.468***	-0.037	0.018
FER				-0.026	-0.005	-0.211***
RPU				1.178***	0.061	1.909***
POD				0.103***	-0.010	-0.694***

DEP				-3.210***	0.141	-1.662**
GGR				-0.001	0.005***	0.003***
LEX				1.091***	-0.244**	1.788**
LFP				-0.303***	-0.028	-1.861***
PGS				-0.007	0.009	-0.031
INV				0.037	0.017**	-0.005
OPN				0.222***	0.003	0.034
	0.553	0.988	0.991	0.664	0.993	0.998
F-stat	899.4			1231	--	--
L-R Var.	--	0.002	0.000		0.002	0.001
N	375	375	375	375	375	375

Note: ***, ** and * indicate are the level of significance for 1%, 5% and 10% respectively.
Source: Author's computation

Finally, women employment vulnerability is also estimated and reported in Table 8. The result also has impressive goodness of fit and the lagged dependent variables for the short run estimates are all significant and positive. The long run variance results are also impressive with very low values that highlight the appropriateness of the estimates. In the results, both coefficients of demographic changes are significant in the non-controlled results, though only that of mortality rate has the expected negative sign. In the result with control variables, the short run estimates have coefficients of the demographic change variables that failed the test even at the 10 percent level. This implies that demographic changes have no significant impact on vulnerable of employment by women. For the long run, only fertility rate has significant and negative coefficients, suggesting that less fertility raises employment vulnerability by women in ECOWAS. Secondary school enrolment and economic growth both have positive and significant impacts on employment vulnerability for the region in the short run. On the other hand, economic growth has a negative impact on employment vulnerability for the sub-region in the long run. Thus, better economic performance leads to less vulnerability of women employment in the ECOWAS sub-region.

Table 8: Vulnerable employment

Variable	**Fixed**	**FMOLS**	**DOLS**	**Fixed**	**FMOLS**	**DOLS**
constant	1.306***	--	--	-1.680**	--	--
$lwempl_{t-1}$	0.347***	-0.057**	--	--	1.017***	--
Lfertr	0.208***	0.311***	0.379***	0.377***	-0.010	-0.512***

Lmort	0.284***	-0.035***	-0.067**	0.385***	-0.004	0.039
Lfser				0.076***	0.005**	-0.018
Lurbanr				0.198***	-0.026***	0.037
Lpopden				-0.026**	-0.008	0.160**
Ldepd				0.077	-0.019	1.130***
Gdpgr				0.000	0.001***	-0.001***
Llexp				-0.064	0.006	-0.444**
Llfpr				0.555***	-0.004	-0.004
Lgsize				0.012	-0.003	0.003
INV				0.051***	-0.004***	-0.001
Lopen				0.057***	-0.001	0.015**
Adj. R-sq	0.733	0.991	0.998	0.819***	0.998	0.998
F-stat	320.3	--	--	512.9	--	--
L-R Var.	--	0.000	0.000	--	0.002	0.001
N	375	375	375	375	375	375

Note: ***, ** and * indicate are the level of significance for 1%, 5% and 10% respectively.
Source: Author's computation

4.4.3 The Panel Causality Test

The preliminary test for reverse effects of women employment on demographic change is performed using the Dumitrescu Hurlin Panel Causality testing technique. The result of the Panel causality test is reported in Table 9. The results show that there is no form of causality between fertility rates and total women employment rate. On the other hand, mortality rate is shown to cause employment rate for women, but not the other way around. This suggests a unidirectional relationship between mortality rate and total women employment rate in ECOWAS. A unidirectional relationship is also observed between agricultural employment and fertility rates, with causality running from the employment to fertility. A bi-directional or feedback relationship is shown to exist between mortality rate and agricultural employment for women, indicating that both variables cause each other. This is a basis for presenting a reverse effect estimation for the sector. A feedback relationship is also seen between the two demographic change variables and services sector employment for women. However, there does not appear to be strong interactions between women vulnerable employment and the two demographic change variables. The results from the causality tests indicates that a reverse effect estimation can present important information about the relationships in the study.

Table 9: Causality tests results

Null Hypothesis:	F-Statistic	Prob.
FERTR does not Granger Cause WEMPL	0.19	0.66
WEMPL does not Granger Cause FERTR	0.71	0.40
MORT does not Granger Cause WEMPL	7.18	0.01
WEMPL does not Granger Cause MORT	0.01	0.91
FERTR does not Granger Cause AGEMPLY	1.94	0.16
AGEMPLY does not Granger Cause FERTR	34.86	0.00
MORT does not Granger Cause AGEMPLY	4.60	0.03
AGEMPLY does not Granger Cause MORT	7.99	0.01
MORT does not Granger Cause INEMPLY	0.12	0.73
INEMPLY does not Granger Cause MORT	0.45	0.51
FERTR does not Granger Cause SVEMPLY	3.31	0.07
SVEMPLY does not Granger Cause FERTR	28.40	0.00
MORT does not Granger Cause SVEMPLY	4.98	0.03
SVEMPLY does not Granger Cause MORT	8.85	0.00
FERTR does not Granger Cause VEMPLY	2.42	0.12
VEMPLY does not Granger Cause FERTR	0.35	0.56
MORT does not Granger Cause VEMPLY	2.12	0.15
VEMPLY does not Granger Cause MORT	0.83	0.36

Source: Author's computation

Based on the results from the causality testing, we present the estimated results for the impact of women employment on demographic changes in ECOWAS. In Table 10, the results for both mortality rate and fertility rate are reported. From the results, the coefficient of the lagged dependent variable is positive and significant at the 5 percent level, indicating a long run stability in the system. The coefficient of the lagged mortality variable is however larger than 1, which shows unstable adjustment to long run equilibrium following any short-term shock. For the results for both fertility and mortality rates, the coefficient of employment rate passed the significance test at the 1 percent level for DOLS (which shows the long run estimates) but fails the test at for the FMOLS estimates (which shows the short run results). Though the coefficient of the FMOLS estimates are negative as expected, they fail the test, showing that employment does not have significant impact on demographic changes in ECOWAS. The negative effects appear in the long run, after all adjustments have been made. Apparently, a one percent rise in employment rate for women leads to a 0.452 percent drop in fertility rates and a 1.227 percent drop in mortality rate in the long.

Table 10: Effect of women employment on demographic changes

Variable	**Fertility rate**			**Mortality rate**		
	Fixed-Effect	*FMOLS*	*DOLS*	*Fixed-Effect*	*FMOLS*	*DOLS*
Constant	4.955***	--	--	14.402***	--	--
FTR_{t-1}	--	0.984***	--	--	--	--
$MORt_{-1}$	--	--	--	--	1.002***	--
WEP	-0.613***	-0.005	-0.452**	0.073	0.102	-1.227***
RPU	-0.276***	-0.009**	-0.295***	-0.100**	-0.017	-0.186
LEX	-0.373***	-0.060***	-0.784***	-1.955***	-0.032	-2.836***
LFP	0.458***	0.013	0.695***	-0.248	-0.083	1.340***
GGR	0.000	0.000	0.000	0.003***	0.001*	0.003**
Lfser	-0.029**	0.004***	0.004	-0.196***	-0.009	-0.158***
law_order	0.004	0.000	-0.008*	0.024**	-0.004**	0.001
PGS	-0.029**	0.001	-0.007	-0.049**	0.010**	-0.027
Adj. R-sq	0.511	0.987	0.995	0.433	0.981	0.991
F-stat	198.8	--	--	201.4	--	--
L-R Var.	--	0.002	0.001	--	0.001	0.000
N	375	375	375	375	375	375

Note: ***, ** and * indicate are the level of significance for 1%, 5% and 10% respectively.
Source: Author's computation

5.0 CONCLUSION

In this study, the relationship between demographic changes and women employment in the ECOWAS sub-region was investigated. The study included all countries in the ECOWAS region in the analysis, using data that covered the period 1991 and 2018. Given the nature of relationship between demographic factors and employment, a dynamic framework was devised for the study and the Fully Modified OLS and Dynamic OLS techniques were employed in the empirical analysis of the study. Based on the analysis the study found that fertility rate does not have strong effects on women employment in ECOWAS countries. Where the effects are significant, they were mostly positive. The poor changes in fertility rates over the years in ECOWAS was attributed as the main explanation for this outcome. The positive effects of fertility rates on women employment can also be considered from the perspective of the type of employment that women are mostly involved in for the ECOWAS region – low-productivity, traditional sector-based jobs. The study shows that higher fertility pushes women into more vulnerable employment in the ECOWAS

countries. The study also found that mortality rate has a strong negative impact on women employment in ECOWAS countries, suggesting that adequate demographic changes actually lead to improvement in women employment for the ECOWAS sub-region. Moreover, women employment was shown to effectively lower demographic changes among ECOWAS countries whether the changes are measured in terms of fertility or mortality rates. Thus, women employment is shown to exert an unambiguous negative impact on demographic changes for the ECOWAS countries.

There is therefore the need to evolve policies that ensure full demographic changes in the ECOWAS sub-region. Policies on number of children per household has always been held with lip service over the years by countries in the region. There is clear indication that fertility rates in the sub-region are too high and have actually limited any demographic dividend that could accrue to women in terms of employment. Education is also important in determining whether the female population in a country benefits (in terms of employment) from any form of demographic changes. The study has shown the strong positive effects of education in boosting women employment, irrespective of the direction of demographic changes. Thus, more women should be given priority in training courses with guarantees of employment. In particular, programmes should be prepared to ensure that more women take better advantage of the entrepreneurship training and financing opportunities in order to boost more modern sector employment. Moreover, efforts to close the gender gap in accessing education and employment particularly for women should be encouraged. The role of policy effectiveness is also highlighted as a basic requirement for both adjusting labour markets and ensuring effective employment distribution among ECOWAS countries. Macroeconomic and structural policies therefore need to be used as the main instruments for guiding employment-growth relationship, while labour market policies should be made to play a supportive role.

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DEMAND FOR FINANCIAL PRODUCTS IN RURAL COMMUNITIES: EVIDENCE FROM GHANA

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Abstract

The financial sector's influence on a country's economic development cannot be overstated. However, evidence shows that in most developing countries, the use of financial products tends to be concentrated in the urban communities to the neglect of the rural ones. This study addresses this challenge of urban inclination by using a sample of 3, 020 households from the Ghana Living Standard Survey (Round 6) dataset to examine the decision to demand for financial products in rural communities by using the probit and the logit regression models. The findings indicate that employment type, remittances, educational attainment, income, age and vulnerability (a measure of exogenous shocks) influence the decision to demand for financial products. In particular, wage employees and non-agricultural sector self-employees as well as those with tertiary education have high probability of patronizing financial products. The study recommends that the monetary authorities should intensify education on the benefits of financial products through rural outreach programmes aimed at equipping consumers of financial product with useful information to stimulate demand. Additional policy suggestion is that a special scheme should be set up for the rural community members, who are employed by the agricultural sector to leverage their farm produce for financial products.

Keywords: Financial market, financial products, rural communities, probit model, logit model, Ghana

JEL Code: E50; G20

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1.0 INTRODUCTION

Vibrant and well-developed financial system of a country is *sine qua non* for economic progress and helps create job opportunities as well as alleviates poverty in all forms (Sangeeta & Erwan, 2006 and Cole et al., 2010). However, lack of access to finance has been a strong inhibitive factor confronting developing and under-developed economies globally in the quest to meet their economic development goals. It is worthy to note that demand and access to financial goods and services in most developing economies are skewed towards the urban communities and particularly, in favour of the rich and well-placed individuals who use the opportunity to enhance their economic wellbeing (Claessens, 2006, Sanderson et al., 2018 and Danquah, et al., 2020).

It has been observed in sub-Saharan Africa, for instance, that the financial institutions and markets are typically concentrated in the urban centers and the patronage of the services are dominated by the wealthy people in the community (Mpuga, 2004). In Ghana, a World Bank report has pointed out that banking services are largely focused in the urban areas thereby marginalizing the rural inhabitants (World Bank, 2008). Additionally, evidence shows that only 10 per cent of Ghana's population have access to banking services and other financial goods and services while about 35 per cent of all bank branches in Ghana are located in the capital region, Greater Accra, which inhabits only 13 percent of the country's population (Bawumia *et al.*, 2008; ISSER, 2008).

The rural financial market in Ghana is dominated by three main types of institutions: (i) formal institutions such as rural and community banks (RCBs), savings and loans companies; (ii) semiformal institutions such as nongovernmental organizations (NGOs) and cooperatives; and (iii) informal institutions such as 'susu' collectors. RCBs, which are unit banks owned by community members, stand out as the largest financial player in terms of geographical coverage, depth of outreach, and number of products in rural areas (Basu et al., 2004 and Andah 2005). To achieve rural development in Ghana, government embarked on rural community empowerment through integration of the formal and the informal financial sectors for accelerated financial services in the rural areas such as mainstreaming of rural microfinance enterprises, the susu schemes and the operations of the rotational savings and credit associations (Amankwah et al (2019). It is believed that rural financial institutions are channels through which financial services are made accessible to rural dwellers since the mainstream banks often do not want to operate in the rural areas in view of the perceived risk associated with the rural economic activities. The perception of risk stems from factors such as farming which depends heavily on weather and other

natural conditions. Other factors include limited access to markets due to poor infrastructure and lack of collateral to secure loans from the commercial banks. As a result of these, report indicates that in 1999, rural lending by commercial banks amounted to only 8 per cent of total loans (IFAD, 2012). However, according to the 4th Ghana economic update, the financial sector has seen a rapid growth since 2010 with increased access to formal financial services which is estimated to have grown from 53 percent of GDP in 2010 to 78 percent in 2017. Nonetheless access to financial services across regions and within rural communities remains low but almost doubled between 2011 and 2017, due to a rising market share of non-bank financial institutions (NBFIs), including mobile money providers (World Bank, 2020).

These developments pose significant challenges to Ghana's economic growth objectives of becoming an upper middle income country in the shortest possible time. The difficulty in achieving this objective lies in the enormous size and significance of the rural economy to the overall growth agenda. This significance is amplified in the Ghana Living Standard Survey report of 2014 which provides that 55.61 percent of the Ghana's population live and work in the rural areas of which 82.60 per cent of them are economically active (GLSS Report, 2014).

Given the predominantly rural nature of the Ghanaian economy, urbanization of the financial sector does not only limit the growth of the economy but also leads to unpleasant situations of unemployment, poverty and inequality in all forms. In view of this, a restructure of the financial sector to enhance demand for financial goods and services in rural communities would go a long way to improve the economic welfare of the rural dwellers through increased economic activities, wealth creation and ability to minimize risk.

Formal financial products are associated with established, regulated and legally recognized financial institutions. As a result, they are subject to the national tax laws and all regulations that ensure the sustainable operations of corporate organizations. Common formal financial products include current accounts, savings accounts, debt and credit cards, investment accounts, mobile banking, stocks and mortgages, and pension funds as well as private and government bonds (Boakye & Amankwah, 2014). On the contrary, the informal financial goods and services are delivered under unregulated conditions, hence the informal financial market are often characterized by heightened irregularities which usually result in fraud, huge losses and mismanagement.

Ghana's financial market, however, has undergone substantial developments to formalize the system to enable it serve the generality of the populace in the country. Some of these developments over the years include the introduction and promulgation of the universal banking license (2003) and Banking Law 2004 (Act 673). Others include the Credit Reporting Act 726 and Banking Amendment Act, 2007 (Act 738) and Foreign Exchange Act 2006 (Act 723).

These regulatory and policy frameworks have chalked some success in the areas of increased financial institutions in the industry, increased competitions for efficient performance and adoption of new ways of managing the financial market. In order to enhance rural financial inclusion, government has embarked on some interventions such as innovation and expansion of digital financial services (DFS) which is helping people use financial products via mobile phones. In addition, the DFS has given rise to interoperability between mobile network operators (MNOs) and the banks. To facilitate innovative financial inclusion, government has introduced core enabling infrastructure such as the Automatic Clearing House, the real-time gross settlement, the national switch cards (gh-link), and the e-zwich biometric payment card (Ministry of Finance, 2019).

Despite these interventions, vulnerability and poverty as well as spatial factors hinder financial inclusion in Ghana. Thus, a strong and vibrant financial sector that incorporates the aforementioned factors in delivering diverse affordable financial products provided by a range of institutions is desirable. The establishment and improvement of Non-Bank Financial Institutions (NBFIs), particularly in the rural areas has increased rural access to savings and credit products thereby contributing to financial inclusion from 5 percent to 24 percent of the rural population between 2010 and 2015 (Ministry of Finance, 2019). These notwithstanding, demand for financial goods and services still remain a challenge in every part of the country as the rural communities are faced with very low patronage.

Studies, however, carried out on this subject in Ghana have not focused on the factors that affect the demand for financial goods and services in rural communities. In particular example, Vitor & Alhassan (2014) studied this subject in relation to only farmers in Ghana while Akpandja *et al.* (2013) and Steiner *et al.*(2009) focused on demand for financial products by all households in Ghana without paying any specific attention to the rural communities. Other related studies which do not directly address the subject under discussion include (Quartey, 2005; Osei-Assibey, 2009; Boakye & Amankwah, 2014). This has therefore created a lacuna in the literature for which this study attempts to fill by using probit model to examine the drivers of demand for

financial goods and services by specifically investigating the effects of employment type, remittances and educational level on the patronage of financial products in Ghana's rural communities.

The significance of this study is to contribute to knowledge on this subject. Understanding the rural dynamics of demand for the financial products would guide the financial industry operators such as the banks and non-bank financial institutions to strategize and extend their services to the rural areas for positive returns on their investments and to enhance financial inclusion which is critical for economic development.

Following this introductory section, the rest of the study is organized into five sections; the second section presents the review of related empirical studies. Section three outlines the research methodology which entails the empirical model and the analytical processes used to address the study objectives. It further presents the variables employed, and the sources of data. Section four reports the empirical results and their discussion while the final section provides the conclusion and policy recommendations.

2.0 REVIEW OF RELATED STUDIES

To examine the factors which influence customers' demand for financial goods and services in Nairobi, Ingange *et al*. (2014) used a largely descriptive method on a sample of 115 respondents selected across 13 commercial banks in Kenya. They found that income levels of respondents play a critical role in the demand for financial services where those with lower incomes are limited to short term credits and higher income individuals go for long term loans. In addition, their study revealed that poor savings culture and high interest rates characterize the financial system of Kenya; hence it is recommended that savings and lending rates be reviewed as a means of boosting the demand.

Using logit model with a binary dependent variable, on a cross-sectional data of 3643 respondents, Boakye and Amankwa (2014) found that among urban residence, financial literacy, income and educational level, among others mainly affect the demand for financial products in Ghana. Thus, the study suggested intense financial education on the benefits of financial products to encourage more patronage. In a related study, Barslund & Tarp (2008) found age, dependency ratio, credit history, assets and secured land rights to have significant effect on the demand for both formal and informal financial products.

In another study on demand for financial services in Ghana, Bendig *et al*. (2009) found that asset ownership, education and regular formal employment status largely drive the decision to demand financial services. Additionally, they revealed that income generation capabilities and consumption smoothing considerations influence the demand for formal financial products in rural Ghana. Nonetheless, their study was restricted to a small geographical area and did not include some financial products such as money transfer services and investment products.

On patronage of microfinance institutions in Ghana, Ayeetey (2008) identified that rural households prefer informal financial services to the formal ones due to the inherent transaction costs associated with the latter. In addition, the study reported that some minimum deposits, proof of identification, locational address and laborious formalities needed by the formal institutions in the financial sector could not easily be provided by rural households.

Considering specific financial market products and what drives their demand, Wireko (2015) investigated determinants of the demand for life insurance products in Ghana by sampling 300 respondents from Kumasi. The study estimated a logit regression model with endowment policy, term insurance and whole life policy as the dependent variables. The findings revealed that there is a direct relationship between income and the demand for life insurance products and the relationship is significant. On the other hand, interest rate and the level of savings are negatively related. The study therefore, recommends extensive public education to create awareness of the need for life insurance.

In a related study, Odarno (2013) also examined the determinants of another financial product, in Ghana, treasury bills, by sampling 300 respondents from six (6) municipalities across the Greater Accra region. Using a logistic regression for the estimates, the study finds sociability, saving motives, education and work experience as factors, which mainly influence the demand for treasury bills. The study therefore calls for financial investment institutions to strategize for marketing of their products.

Using a recent household survey data, Danquah *et al.* (2020) examined access of the rural populations to various types of financial services, and the influence of rural financial intermediation on poverty reduction, in Ghana. The study employed the *bivariate probit model* to account for the potential endogeneity problem in the empirical relationship. The finding indicates that rural households with access to basic financial services are significantly more likely to be non-poor than those without access. Therefore, the poor must be given more access to financial services through

the design of efficient pro-poor financial products. Typical basic rural financial products under consideration here include savings account, loans and payment services for households as these products enable savings, investment and risk mitigation, all of which contribute to poverty reduction, rural job creation and economic growth.

In summary, the existing studies have identified behavioural, demographic, geographical and economic factors which influence demand for financial goods and services. In addition, most studies on rural financial services in Ghana tend to be focused on the link between access and rural poverty and welfare as well as gender perspectives to rural finance without paying much attention to issues such as risk mitigation by rural vulnerable households. The World Bank identifies vulnerability as the possibility that a household will fall below the poverty line in future. Households who want to prevent the situation of becoming poor may demand some financial products such as savings and insurance (World Bank, 2008). In this respect, demand for financial products such as saving and insurance tend to boost living standards due to the possibility of mitigating risks and this is particularly relevant for the vulnerable population which when hit by shocks falls into poverty or precarious situations that reduce their living standards (Collins *et al*., 2009). Carmen, Ximena and Tuesta (2013) in their study indicate that vulnerability is among the most important barriers to financial inclusion in Mexican. As a result, this study points out that rural households in Ghana may become vulnerable when they are struck by death of a household member, which seldomly happens or more common occurrences of shocks such as severe illness of a household member, loss of farm produce through bushfire, severe draught and excessive rainfall among others. The use of these measures to determine vulnerability and its effect on financial inclusion is hard to find in Ghana.

This study therefore introduces a measure of vulnerability in terms of death and exogenous shocks in Ghana's rural households together with other variables to examine the drivers of demand for financial products using the Ghana Living Standard Survey (GLSS) round 6 within probit and logit models.

3.0 EMPIRICAL MODEL AND ESTIMATION PROCEDURE

The empirical model of this study follows largely the work of Sults (2006) and Chen & Chiivakul (2008) with some modifications to capture the role of vulnerability in the form of death and external shocks that may affect demand for financial products. They explain that individuals' demand for financial products are greatly influenced by their educational attainment, remittances, demographic characteristics, geographic locations, type of occupation in addition to the general macroeconomic

environment. To analyse the relationship between demand for financial products and the above factors, the empirical model is expressed as follows:

$$df = f(Inc, Remit, age, agesqr, marstat, Edu, Emp, death, shocks) \quad (1)$$

Where the dependent variable *df* is the probability that a rural adult individual or household head will demand for financial products given the vector of socio-demographic, economic and institutional variables as shown in Table 1.

Table 1: Description and Measurement of Variables

Variables	Description and Measurement	Expected Signs
logincome	Natural logarithm of income measured as average monthly earnings from work in Ghana cedis of household head.	+
remit	Remittance to household from relatives and friends measured as a binary response variable where: 1 = if household receives remittance from any person 0 = if otherwise	+
logage	Age of a household head measured in years	+/-
logagesquare	The age squared of the household head measured in years	-
Sex	Sex of the household head is measured as a binary response variable where: 1 = if male 0 = otherwise	+/-
marstat	Marital status of household head measured as a binary response variable where: 1 = if married or co-habiting 0 = if otherwise	+
Employment	Type of employment by the household head measured as a categorical variable where: 0 = if no employment 1 = if wage employee 2 = if non-agric self employed 3 = if agric self employed	+

	4 = if other employee	
Education	The level of education attained by the household head measured as as categorical variable where: 0 = if no formal education 1 = if complete basic school 2 = if complete secondary school 3 = if complete tertiary school 4 = if otherwise	+
death_dummy	Death as a measure of household vulnerability measured as a binary variable where: 1= if death of household member 0 = if otherwise	+
shock_dummy	Natural shock (i.e. climate hazards, ill health, accident, etc.) as a measure of vulnerability of household measured as a binary variable where: 1 = if household member experienced other severe shock 0 = if otherwise	+

Source: GLSS6

3.1 Estimation Procedure

This study mainly employs the probit model to examine the demand for financial products in rural Ghana in line with Potrich et al., (2015) but also estimates the logit model as a counter-check. The application of these models to the study is based on the fact that they are based on dichotomous outcome variables that reflect the choices made by individuals to personal attributes and available alternative attributes, so the probability of the choice of particular alternatives are estimated. The probabilistic description of discrete choice decisions do not relate to intrinsic probabilistic behavior of the individual. It must be noted however, that estimates from probit and logit models are similar but are not directly comparable (Gujarati, 2006). As a result of the similarity the choice between the two models for analysis usually depends on one's preference, however, this study presents both results for purposes of comparison and robustness check. The choice of these models over other competing ones such as the linear probability model which tend to describe conditional

probabilities of the alternative choices is explained as follows: the errors or the residuals from the linear probability models violate the homoskedasticity and normality of errors assumptions of OLS regression, leading to invalid standard errors and hypothesis tests (see Long, 1997). In view of this shortcoming of the linear probability model, the binary response models of probit and logit are considered appropriate for this study however, much discussion is focused on the probit model.

3.1.1 The Probit Regression Model

The probit model is based on the normal distribution while the logit model depends on the logistic distribution (Green, 2008 and Gujarati, 2004). Although the two models yield similar results, the standard deviation of the normal distribution is one (1) while that of the logistic distribution is not (Gujarati, 2004). In view of this and for ease of interpretation, the study employs the probit model for the estimation.

As a result, the probit model is expresses based on the individual's implicit decision to demand for financial goods and services as follows:

$$df = \alpha X + \varepsilon \quad (2)$$

where:

df = the desired unobserved outcome (decision to demand for financial products)

X = The independent or control variables

α = Coefficient of the explanatory variables

ε = The stochastic term which is normally distributed with a mean, 0 and variance, 1.

From the model, the dichotomous variable, *df*, is whether or not the individual will demand for financial products, *df** is the tendency for an individual to demand financial goods and services which implies that when (df* > 0) the individual demands financial products (Maddala, 2005).

Given that the probit model follows the normal distribution, the probability that df* is less than or equal to df, P($df_i^* \leq df_i$) can be computed as follows:

$$P_i = P(df = 1|X) = P(df_i^* \leq df_i) = P(Z_i \leq \beta X) = F(\beta X) \quad (3)$$

where:

P = the probability that an event will occur

$P(df = 1|X)$= the probability that an individual demand for financial products.

Z_i = the standard normal distribution variable

F = the standard normal cumulative distribution function. Specifically, F is represented as:

$$Y = F(df) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Y_i} e^{-z^2/2}\, dz \quad (4)$$

$$Y = F(df_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{BX_i} e^{-z^2/2}\, dz \quad (5)$$

To obtain information on Y*, and the inverse of equation (5) is taken. This is represented as:

$$df_i = F^{-1}(df_i) = F^{-1}(P_i) \quad (6)$$

$$df_i = \beta X_i \quad (7)$$

Unlike the linear models, estimates of non-linear models such as the probit model in (6) cannot be interpreted as effects of the control variables on the regressand (Gujarati, 2004). That is, to obtain one-unit change, the estimates from (6) are interpreted as marginal effects. The marginal effect is specified in a functional form as:

$$\frac{dP(X)}{dX_j} = F(\beta X)\beta_j \quad (8)$$

Based on the above deductions, the empirical model to be estimated is specified as:

$$df = \alpha_0 + \alpha_1 lnINC + \alpha_2 lnREMIT + \alpha_3 SEX + \alpha_4 lnAGE + \alpha_5 lnAGESQR + \alpha_6 lnMARSTAT + \alpha_7 EMP + \alpha_8 lnEDU + \alpha_9 DEATH + \alpha_{10} SHOCKS + e \quad (9)$$

where:
INC = Income of the individual
REMIT = Amount of Remittances
SEX = Gender of the individual
AGE = Age of individual in years
AGESQR= Age square of household head in years
MARSTAT = Marital status of individual
EMP = Employment type of the individual
EDU = Educational attainment of the individual
DEATH =Death of an individual in a household
SHOCKS = Exogenous shocks in the household
α_0 = the intercept term
$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7, \alpha_8, \alpha_9$ and α_{10} are the coefficient estimates
Note: Description and measurement of variables can be found in Table 1.

3.2 Definition of Variables and *Apriori* Expectations

Demand for Financial goods and services (df)

As already stated, the dependent variable for this study is the demand for financial products by rural dwellers in Ghana. The variable is a dummy and takes the value of 1 if the individual makes "use" of any formal financial products such as savings accounts, loans and withdrawals, current account, cheques, ATMs, and mobile banking. It however takes the value of zero if the individual does not in any way utilize formal financial services.

Remittances (Remit)

Remittances measure the amount of money that the individual receives either on regular or irregular terms by another individual in abroad or home other than the dwelling place of the recipient. Since remittances often work through formal channels, it is expected that the variable will influence the demand for financial services positively.

Employment Type (Emp)

This variable is measured as a categorical one and it is coded with 1 if the individual is in a non-farm wage employment, 2 if the individual is in a farm employment and 3 if the individual is an own-account holder. For ease of interpretation, the reference category is the own-account operators. Following Boakye & Amankwah (2014), the variable is expected to have a direct influence on the usage of financial services.

Sex

This variable is very critical for analytical decisions regarding demand for financial goods and services. Ackah & Acquah (2014) found that sex of an individual plays a significant role in determining the drivers of financial inclusion in Ghana. The variable is considered as a dummy which is denoted by 1 if the individual is a male and 0 if the individual is a female. The effect of this variable on demand for financial goods and services is ambiguous.

Marital status (Marstat)

Married persons have been found to have higher chances of demanding for financial products, as they are considered more responsible compared to single persons. Single people are sometimes considered less reliable or stable without family or relations to assure for them (Mwangi and Sichei, 2011). It has also been argued that financial service providers believe that married persons appear to have higher levels of responsibility hence are more trusted. Therefore, there is a positive relationship between marriage and demand for financial product. The positive relationship is also attributed to increased responsibilities of household heads as they get married so they tend to increases their demand for more financial services.

Education (Edu)

Education is an essential income earning and knowledge acquisition variable. The level of education among other things determine the kind of financial goods and services to use and how much to spend on it (Boakye & Amankwah, 2014). For instance, a highly educated person may save his wealth in savings account and other interest-bearing assets. However, uneducated individuals may not see importance of savings and other forms of investment. This makes education a critical variable that

influences the demand for financial goods and services. Education is treated in this study as a continuous variable and measured in years of formal education attained. This variable is expected to positively influence the demand for financial goods services.

Age

Age is an important indicator that affects the demand for financial goods and services and it is considered as a continuous variable and measured as the number of years of the individual. The effect of this variable on the demand for goods and services is considered to be positive with the household head. We controlled for possibly decreasing marginal effects of age by including age squared in the model. In line with the life-cycle effect, a rising age will enhance the demand for financial products like savings and insurance of the household initially because of growing experience regarding the benefits of financial products but this trend begins to fall at a certain point in life especially when the household head approaches retirement.

Income

Income plays an important role in determining an individual's demand for financial goods and services. Income is measured as the sum of all monetary income received by individual from all sources in a month. It is classified as a continuous variable and it is expected to have a positive effect on the demand for financial goods and services.

Death and Shocks

Household demand for financial products is expected to be affected when they are more exposed to risks or vulnerability. Risk exposure may have a positive effect on the demand for financial product like savings as well as loans, as they both can serve as risk management strategies. Vulnerable households may demand for loans or deplete their savings after they experienced a shock in order to make up for income losses. On the other hand, it is expected that the likelihood of demanding for financial products such as loans and savings would decrease for some households that are more exposed to risk than others. The study uses two dummies to measure the vulnerability of the household for analysis. The first variable takes the value of 1 if a household experienced the death of a household member during the previous five years and this had severe consequences and 0 if otherwise. The second variable takes the value of 1 if a household experienced any other severe shock during the last five years, and 0 if otherwise. This category captures mostly idiosyncratic shocks besides death but including severe illness.

3.3 Data Sources

The study uses a secondary data obtained from the Ghana Living Standards Survey round 6 (GLSS 6) which is a cross-sectional data collected by the Ghana Statistical Service (GSS). Eighteen thousand (18,000) households were sampled for the survey covering 1,200 enumeration areas in the 10 regions of Ghana, where 72,372 individuals were interviewed on various socio-economic issues including finance.

4.0 RESULTS AND INTERPRETATION

4.1 The Summary Statistics

According to the Banking Act of Ghana, 2004 (Act 673), the legal age for operating a bank account is 18 years and above, hence the study considers only dividuals in this age category. Three thousand and twenty (3020) micro data set, were retrieved from the GLSS 6 to address the objectives of the study. Out of this number that responded, 53.12 percent are females whilst the remaining 46.88 percent are males. Generally, 80.67 percent of the respondents do not use financial products. This means that only 19.33 percent of the respondents' demand for financial products in rural Ghana. Among the females, only 24.58 percent make use of financial products whilst 75.42 percent do not. Also, only 14.69 percent of the males that responded to demand for financial goods and services. The remaining 85.31 percent of males in the rural areas do not make use of any form of financial product.

Table 2 presents the summary statistics of remittances, income and age. The standard deviations of these variables are relatively high and this could be due to the wide disparities in income levels in Ghana (GLSS 6 Main report, 2014). The table shows that remittances received by individuals in the rural areas averaged, GH₵ 154.37, with a standard deviation of GH₵550.04. However, the minimum and maximum remittances stand at GH₵ 0.00 and GH₵12,000 respectively. The average income of the individuals is GH₵1,515.56 while the standard deviation is estimated at GH₵11, 208.54. The mean age of the respondents also stands at 40 years approximately. The summary reveals wide disparities between the incomes of the respondents in addition to the household who do not receive remittances.

Table 2: Summary Statistics of Remittances, Income and Age

Variables	Mean	Std. Dev.	Min	Max
Remittances	154.37	550.04	0	12000

Income	1515.56	11208.54	0	1225800
Age	39.60	17.45	18	99

Source: Authors' Estimate from GLSS6 dataset

In terms of education, the data show that more than half of the respondents have formal education, this represent 56.44 percent. For those with education, 34.2 percent have received basic while 6.38 percent have secondary education. Additionally, only 1.33 percent of the respondents have tertiary education. This means, there is a low share of tertiary education holders in the rural communities in Ghana. Furthermore, about 1.66 percent of the respondents have other forms of professional education, such as teacher training, agriculture and nursing training. Considering the employment status of the rural community, the result indicates that most of the individuals (60.59) are self-employed in the agriculture sector. 6.46 percent are engaged in wage employment while 13.16 percent are self-employed in non-agricultural sectors. Additionally, the analysis shows that 2.63 percent of the rural communities are engaged in other fields; however, 17.15 percent of them are unemployed.

Probit and Logit Results with Marginal Effects of Demand for Financial Products in Ghana

4.2 The Probit and Logit Estimates

The estimates of the probit and the logit models are presented in Tables 3 while the marginal effect estimates are reported in Table 4.

Table 3: Estimates of Probit and Logit Models

	PROBIT	**LOGIT**
VARIABLES	**ESTIMATES**	**ESTIMATES**
Logincome	0.0560811*** (0.0161153)	0.0947771*** (0.0265482)
logremit	0.0420438*** (0.0186861)	0.0710540** (0.0304953)
logage	0.2995945*** (0.0734300)	0.5033188*** (0.1264620)

logagesqr	-0.0075825*** (0.0140417)	-0.0128903** (0.0211316)
male_dummy	0.1052712*** (0.0816056)	0.1773819*** (0.1343802)
marstat	0.1930478** (0.1049173)	0.3252855** (0.1730242)
Employment 1. wage employee	0.4465755** (0.2146998)	0.7502468** (0.3555672)
2. non-agric self employed	0.3699851* (0.2202292)	0.6252748* (0.3593533)
3. agric self employed 4. other employee **Education** 1. basic 2. secondary 3. tertiary 4. other death_dummy shock_dummy	0.1299765 (0.2166275) 0.0973004 (0.2494882) 0.0160981** (0.0098356) 0.0714822*** (0.0965976) 0.2163325*** (0.0816349) 0.0816495** (0.0288514) 0.0121053 (0.0028550)	0.2183605 (0.3466040) 0.1649242 (0.3926767) 0.0272863*** (0.0419789) 0.1215197*** (0.1711545) 0.3634386*** (0.1387170) 0.1379877*** (0.0484167) 0.0123511 (0.0048537)

_cons	0 .0973004** (0.2494882) 2.0134484*** (0.4693353)	0.1487707* (0.0415561) 3.3866202*** (0.7803272)
Observation	3020	3020
LR chi2 (16) Log-likelihood Prob > chi2 Pseudo R2	451.16 -1318.1242 0.0000 0.3105	451.02 -1318.1257 0.0003 0.3034

Note: *Standard errors in parentheses* *** p<0.01, ** p<0.05, * p<0.1*

The reference category for remit dummy is "no remittance"; the reference category for marital status is "not married or cohabiting"; the reference dummy for sex dummy is female; the reference category for household educ is "no education"; the reference category for empl is "no employment"; the reference category for death_dummy is "no death" and the reference category for shock_dummy is "no shock".

Source: Authors' Estimation from GLSS 6 dataset

From Table 3, the Pseudo R-square is 0.3105 for probit and 0.3034 for logit which indicates the proportion of the variance in the dependent variable that is predictable from the independent variables. This implies about 31.1 percent and 30.3 percent of changes in demand for financial products can be explained by the explanatory variables in the probit and the logit models respectively, hence the probit model better predicts the outcome. The log likelihood tests whether all variable coefficients in the model are simultaneously zero and the Likelihood Ratio (LR) chi-square tests that at least one of the predictor variables' coefficients is not equal to zero. From the probit model, LR chi2 (16) is 451.16 while logit model is 451.02 and given the p-value from the LR test which are statistically significant at 1 percent level, it then concludes that at least one of the regression coefficients in the models is not equal to zero and the estimated models fit the data appropriately. This conclusion therefore rejects the null hypothesis that all of the regression coefficients are simultaneously equal to zero. Therefore since the LR statistic is statistically significant then it suggests that the estimated models fit the data well.

4.2.2 Demographic Characteristics and Demand for Financial Products

The demographic attributes of the household heads such as age, sex and marital status are all statistically significant for both the probit and the logit models. Specifically, from the probit model, the result indicates that an increase in age by one year increases the predicted probability of demand for financial product by 30% at 1 percent significance level. On the other hand, the logit model shows that one year increase in age, the log odds of demanding for financial product increase by 0.503. Considering the age square, the coefficients are negative and significant at 1 percent level for both models. This suggests an inverse relationship between age square and demand for financial products. In effect, the direct relationship between age and the inverse relationship between age square and demand for financial products means that demand for financial products increases with age until it reaches a certain age beyond which it starts to decline. In other words, as people age, they become knowledgeable about the various financial products and start using them till they reach some advanced age where they stop having interest, may be towards retirement from active work. This result follows the *apriori* expectations and it is supported by other studies (see Pena *et al.,* 2014; Hoyos *et al.,* 2013) but in contrast with Akpandja *et al*. (2013) where they found individual's age to be inversely related to the demand for financial products. However, the general conclusion is similar that the results obey the life cycle behavior of earning streams.

In term of the sex of household head, the coefficient estimate of both the probit and the logit models are statistically significant at 1 percent level. It suggests that in reference to female headed households, male headed households increase the predicted probability of demand for financial products by 11%. Also, the logit estimate indicates that male headed households increase the log odds of demand for financial products by 0.18 in rural communities in Ghana. For marital status, the result reveals from the probit estimates that in reference to unmarried household heads, married household heads tend to increase the probability of demand for financial products by 19% while the logit estimate indicates that married household heads increase the log odds of demand for financial products by 0.33 in rural communities in Ghana. This finding is in support of Mwangi and Sichei (2011) who opined that unmarried people are sometimes considered less reliable or stable to provide adequate guarantee.

4.2.3 Income and Remittances on Demand for Financial Products

In terms of effects of income and remittances on demand for financial products in rural Ghana, the results indicate that income and remittances are more likely to positively influence a rural demand for financial products. In particular, the coefficient estimates of both models are statistically significant at 1 percent levels. The probit estimate

means that a 1 unit increase in income tend to increase the predicted probability of demand for financial products by 5% while the logit estimate indicates that for every 1 unit increase in income, the log odds of demand for financial products increase by 0.095. This finding is expected as it suggests that as household's income increases, the demand for financial products also increases. The result is supported by other studies that find a direct relationship between higher incomes and demand for financial services (Murcia, 2007; Djankov et al., 2008; Allen et al., 2012; Cano et al., 2013 and Akpandjar *et al.,* 2013). The positive effect of the result could be explained that savings rise with disposable income as such individuals tend to save a proportion of their income (salaries/wages and remittances) received through financial products as mentioned in (Nwachuku & Egwaikhide, 2007 and Kulikov *et al.,* 2007).

For remittances, the coefficient estimate of the probit model is significant at 1 level while the logit model's coefficient is at 5 percent levels. The probit result indicates that relative to "no remittances" to households, receipt of remittances by households tend to increase the predicted probability of demand for financial products by 4%. On the other hand, the logit estimate indicates that remittances tend to increase the log odds of demand for financial products by 0.07. It should be noted that remittances play important role in the Ghanaian economy, particularly in rural communities as it constitute 5.26% of GDP according to data (Bank of Ghana, 2020). This finding is consistent with other studies which establish a direct relationship between remittances and demand for financial products as in (Azoategui, Demirguc-Kunt & Martinez Peria, 2011).

4.2.4 Education and Employment Type on Demand for Financial

ProductsEducation and employment are considered very important factors that influence demand for financial products positively especially in rural communities. Pena et al. (2014) argued that education is a way of measuring knowledge, skill sets and capacity to make formal financial decisions hence the positive relationship between education and demand for financial products. The results indicate that all the coefficient estimates of both the probit and the logit models are statistically significant. With respect to the reference category of "no education", the probit model indicates that basic, secondary, tertiary and other levels of education increase the predicted probabilities of demand for financial products by 1.6%, 7.1%, 21%, and 8.2% respectively. Similarly, the logit model indicates that given the reference category of "no education", household heads with basic, secondary, tertiary and other levels of education increase the log odds of demand for financial products by 0.27, 0.12, 0.36 and 0.05 respectively. This suggests that as the household head's educational attainment increases from basic through secondary to tertiary level in relation to no

edication, the log odds favour an increase in demand for financial product in rural communities in Ghana. This result is consistent with other studies such as Milton (2008), Demirguc-Kunt and Kappler (2012) and Kempson et al.(2013) where they find that higher educational level increases demand for financial products.

To find the effects of employment types on demand for financial products, the results show that all types of employment have a positive impact on the demand for financial product for both models but agriculture self-employed is not statistically significance. In particular, the probit estimate for wage employee is statistically significant at 5 percent level and for non-agriculture self-employed is significant at 10 percent level while the estimate for other types of employment is statistically significant at 5% level. For the logit model, the estimates of wage employee, non-agric self employed, agric self employed and other employment types are statistically significant at 5%, 10%, 10% and 1% respectively. The results suggest that given the reference category of "no employment" the probit model shows that wage employees, non-agric self employed and other employee tend to increase the predicted probabilities of demand for financial products by 45%, 37%, and 8.1% respectively. The logit model estimates reveals that given the reference category, wage employees, non-agric self employed, agric self-employed and other employees tend to increase the log odds of demand for financial products by 0.75, 0.62, 0.22 and 0.05 respectively. This result is similar to the findings of Ackah & Acquah (2014) who found that formal wage employees are 0.02 percent more likely to make use of financial products such as savings and current accounts.

4.2.5 Death and Shocks on Demand for Financial Products

To assess how households mitigate against their vulnerability through financial products, the study uses death of a household member and exogenous shocks in a form of severe illness, draught and bush fires to measure the risk state of the household. In view of these, the results indicate that the probit estimates and the logit estimates of the "death" variable have positive effect but not statistically significant. However, the probit estimate and the logit estimate of the "shocks" variable are statistically significant at 5 percent and 10 percent respectively. The result suggests that given "no shocks" in a household, the probit estimate reveals that households with shocks tend to increase the predicted probability of demand for financial products by 10 percent. The logit estimate on the other hand indicates that households with shocks relative to "no shocks" increase the log odds of demand for financial products by 0.15. This finding is consistent with the position that demand for financial products like savings and insurance improves standard of living due to the possibility of mitigating risks (Collins et al., 2019; World Bank, 2008).

4.3 The Marginal Effects Estimates of Probit and Logit Models

The marginal effects provide the partial estimates of the previous point estimates from the probit and the logit models. They measure the change in probability of the predicted or dependent variable when the predictor or independent variable increases/decreases by one unit and the results are reported in Table 4 and the significant results are discussed subsequently.

Table 4: The Marginal Effect Estimates

VARIABLES	**Probit Margins**	**Logit Margins**	$\bar{X}$
Logincome	0.0411725***	0.0420113***	7.105145
	(0.0116968)	(0.0118009)	
logremit	0.0202303**	0.0211051**	5.213624
	(0.0081904)	(0.0089051)	
logage	0.1233712***	0.1235837***	3.701488
	(0.0291658)	(0.0288074)	
logagesqr	-0.0021044***	-0.0020311**	1.136757
	(0.0037586)	(0.0044154)	
male_dummy	0.0358218	0.0340235	0.4754967
	(0.2487625)	(0.2396021)	
marstat	0.0166073	0.0166312	0.5520312
	(0.0087407)	(0.0096693)	
Employment			
1. wage employee	0.2190334**	0.2230142**	0.1251656
	(0.1004740)	(0.0948997)	
2. non-agric self employed	0.0110632**	0.0112041***	0.2572848
	(0.0066646)	(0.0069591)	

3. agric self employed	0.0630417	0.0620314	0.5612583
	(0.0940921)	(0.0969241)	
			0.0394041
4. other employee	0.0211065	0.0220763	
	(0.0603042)	(0.0490584)	
Education			0.4238411
1. basic	0.0023053**	0.0022037***	
	(0.0037792)	(0.0041579)	
			0.0539735
2. secondary	0.0427705***	0.0446302***	
	(0.0555461)	(0.0564939)	
			0.0211921
3. tertiary	0.0921064***	0.0915306***	
	(0.0357002)	(0.0350692)	0.0258278
4. other	0.0082436***	0.0082525***	0.0153345
	(0.0040213)	(0.0038384)	
death_dummy	0.0028434	0.0027134	0.4754967
	(0.0012581)	(0.0011746)	
shock_dummy	0.0258003**	0.0249011***	
	0.0072677)	(0.0068222)	
Observations	3020	3020	

dy/dx for factor levels is the discrete change from the base level.

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
The reference category for remit dummy is "no remittance"; the reference category for marital status is "not married or cohabiting"; the reference dummy for sex dummy is female; the reference category for household educ is "no education"; the reference category for empl is "no employment"; the reference category for death_dummy is "no death" and the reference category for shock_dummy is "no shock".

Source: Author's Estimation from GLSS 6 dataset

4.3.1 Demographic Characteristics and Demand for Financial Products

From the results, the marginal effect estimates of both the probit and the logit models of age are statistically significant at 1 percent levels. The estimates indicate that the change in probability of demand for financial products when age increases by 1 year is 12 percentage points for both models. This suggests that an increase in age by a year is capable of predicting a 12 percentage point change in the probability of demand for financial products. The results further show that the marginal effect estimate of age square for the probit model is statistically significance at 1% level while that of the logit model is statistically significant at the 5% level. This result indicates that for a unit increase in age square, the change in predicted probability of demand for financial products decreases by 0.2 percentage points depicting an inverse relationship. The inverse relationship suggests that demand for financial products increases with age to a point after which it begins to decline.

4.3.2 Education and Employment Type on Demand for Financial Products

From the result, marginal effect estimates for the probit model of wage employee and non-agric self-employed are statistically significant at 5 percent level. On the other hand, the marginal effects of the logit model for "wage employee" is significant at 5% significant level while that of "non-agric self-employed" is significant at 1% level. From the probit marginal effects, the results suggest that the probability of demand for financial products increases by 22 percentage points when household head's employment type moves from the reference category of "no employment" to "wage employee" while a move from "no employment" to "non-agric self-employed" increases the probability of demand for financial products by 1.1 percentage points. Similarly, the marginal effect from the logit model reveals that when employment changes from "no employment" to "wage employment" the probability of demand for financial products increases by 22 percentage points while the change from the reference category to "non-agric self-employed" increases the probability of demand for financial products by 1.1 percentage point just as the probit model.

On educational attainment, the estimates of marginal effects from the probit model for basic, secondary, tertiary and other levels of education are all significant at 1 percent level. This suggests that a change in educational attainment from the reference category of "no education" to basic, secondary, tertiary and other levels of education tends to increase the probability of demand for financial products by 0.23, 4.28, 9.21 and 0.82 percentage points respectively. This is clear that as educational attainment changes from lower to higher levels, the demand for financial products also increases. On the other hand, the marginal effect estimates based on the logit model for basic, secondary, tertiary and other levels of education are also statistically

significant at 1 percent level. This also shows that the probability of demand for financial products increases by 0.22, 4.46, 9.15 and 0.82 percentage points when educational attainment moves from the reference category of "no education" to basic, secondary, tertiary and other levels of educational attainment respectively. The probable explanation of this result is that education informs individuals on the inherent benefits of demanding for financial products. In addition, educated persons are usually those involved in formal wage employment, hence they receive their wages and salaries, as well as other benefits through the financial system, thereby deriving the associated advantages with the system (see: Vitor & Alhassan, 2014; Quartey, 2005). This finding is also consistent with Ackah and Acquah (2014) as well as Akpandjar *et al. (*2013) whose studies find all categories of education are significant determinant of the demand for financial products in rural Ghana.

4.3.3 Income and Remittances on Demand for Financial Products

With respect to the role of income in influencing demand for financial products, the estimates of the marginal effects from the probit and the logit models are both statistically significant at 1 percent levels. This means a unit increase in income leads to an increase in probability of demand for financial products by 4.12 and 4.20 percentage points respectively. Therefore the results from the marginal effects show that there is a positive relationship between income of the household and demand for financial products in rural communities in Ghana. On remittances, the marginal effect from the probit model and the logit models are both statistically significant at 5 percent levels. The results imply that a change from "no remittances" to "remittances" increases the probability of demand for financial products by 2.0 percentage point for the probit model and 2.1 percentage point for the logit holding other things constant. Since remittances are additional income for households they tend to demand financial products particularly savings products.

4.3.4 Death and Shocks on Demand for Financial Products

In relation to death and shocks as measures of household vulnerability, the marginal effect estimates for the probit regression as well as the logit regression for the "death" variable are not statistically significant. However, the estimates for the "shocks" variable for the probit and the logit are statistically significant at 5 percent and 1 percent respectively. The results of the shocks imply that the probability increases by 2.6 percentage points for the probit model and 2.5 percentage point for the logit model when shocks move from "no shocks" to "shocks" This suggests that demand for financial products like savings and insurance boost living standards hence an increase in demand to smooth consumption.

In sum, this study finds that demand for financial products in the rural communities in Ghana is influenced by some demographic and socioeconomic factors including, age, income, remittances, and educational attainment of the people. In addition, the employment status of the people greatly drives their demand for financial goods and services. In particular, people involved in wage employment and non-agriculture self-employment tend to demand for financial goods and services. Lastly, households that suffer from severe shocks like ill health and other exogenous conditions that tend to affect their wellbeing are more likely to demand for financial products like savings and loans to mitigate their vulnerability.

4.4 Diagnostic Test

In order to ascertain the appropriateness of the estimation model to render reliable results that can be used for inferences and draw conclusions for policy, the following diagnostic tests are carried out and they are explained below:

4.4.1 Specification Test

Table 5: Results of model specification test

Variable	Coef	Std. Err	P-value
_hat	.8102675	.3751238	0.002
_hatsq	-.0362341	.1035260	0.417
_cons	.0530522	.1263148	0.573
Number of obs = 3020			
Log likelihood = -1318.1257			
LR chi2 (16) = 451.02			
Prob > chi2 = 0.0003			
Pseudo R2 = 0.3034			

Table 5 shows the specification test conducted immediately after estimating the probit or the logit regression to ascertain how well the model is specified. The result indicates that the model is correctly specified because the first '_hat' is statistically significant at 1 percent while '_hatsq' is not statistically significant hence the evaluation criterion is satisified.

4.4.2 Multicollinearity

Table 6: Results of Collinearity Diagnostics

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Logincome	1.04	1.02	0.925	0.075
logremit	1.01	1.00	0.906	0.094
logage	1.02	1.01	0.896	0.104
logagesqr	1.03	1.01	0.914	0.086
male_dummy	1.01	1.00	0.956	0.044
marstat	1.02	1.01	0.865	0.135
wage employee	1.02	1.01	0.932	0.068
non agric self employed	1.04	1.02	0.974	0.026
agric self employed	1.05	1.02	0.912	0.088
other employee	1.05	1.02	0.888	0.112
basic	1.03	1.01	0.927	0.073
secondary	1.02	1.01	0.974	0.026
tertiary	1.02	1.01	0.933	0.067
other	1.00	1.00	0.897	0.103
death_dummy	1.06	1.03	0.803	0.197
shock_dummy	1.03	1.01	0.955	0.045

Multicollinearity test is conducted to verify if there is presence of severe correlations among regressors in the model. If all the variables are completely uncorrelated with each other, then both the tolerance and the variance inflation factor (VIF) will be exactly equal to 1. If a variable is very closely related to another variable, the tolerance level goes to 0 while the VIF gets very large. Hence, the closer the tolerance and the VIF value to 1, the less severe the multicollinearity problem in the model. In view of this and based on the tolerance and the VIF statistic in Table 6, it can be concluded that there is no severe multicollinearity problem present in the model.

5.0 CONCLUSION AND POLICY SUGGESTIONS

Research on factors affecting the use of financial products in rural communities in Ghana has received little attention despite the rural dominance of the economy. This study uses the 3020 sample from the GLSS 6 data set and the probit regression model to examine what drives the demand for financial goods and services among rural

dwellers in Ghana. The findings indicate that a person's employment type, remittances received, educational level, age, income and severe shocks tend to affect the decision to demand for financial goods and services in the rural communities. The study further reveals that individuals in wage employment and self-employed in non-agriculture sector are more likely to demand for financial goods and services. Households that are exposed to severe shocks have high probability of demanding for financial products as a means of mitigating vulnerability and risk. The study also reals that as people age, the likelihood of patronizing financial products increases but begins to decline after a certain age. In addition educational attainment tends to increase with demand for financial products. Overall, the study reveals that demographic and socioeconomic factors in the rural communities are important drivers of demand for financial products.

For purposes of policy, the government through the Ministry of Education and National Commission for Civic Education in collaboration with the traditional financial sector actors like the Ministry of Finance and the Bank of Ghana should intensify and sustain the financial literacy education in all forms to sensitize the rural communities on the importance of using financial goods and services. In particular, wage employees should be linked to various payment systems in the country such as the E-Zwich and the various mobile money platforms.

Furthermore, the Bank of Ghana should improve the financial system through legislations to ensure that incomes or remittances sent/received pass through the legal financial architecture to boost financial inclusion as people's confidence and trust in the financial system are enhanced. In addition, since income is a driver of demand for financial products in the rural communities, fiscal and monetary authorities should undertake prudent and sound macroeconomic policies to raise the general income levels of the country such as friendly tax and interest rate regimes, particularly in the rural areas to improve demand for financial products. Additionally, a special agro-based rural financial scheme should be set up for the rural communities where people who are into agriculture employment can leverage their farm outputs for financial products.

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THE INTERDEPENDENCE OR CONTAGION AMONG WEST AFRICAN EXCHANGE RATES

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Abstract

Asymmetry in dependence of financial data series, including exchange rates, is a well-established stylized fact due largely to political and monetary reasons. This paper studied dependence and contagion among the exchange rates of West African Monetary Zone (WAMZ) countries against the USA Dollar (USD) using Pearson linear and rank correlations as well as copula functions over the period 1995 to 2020. The data used in the study consisted of the whole sample (10th July 1995-7th October 2020), 10th July 1995- 31st December 1999 (Pre-WAMZ), 10th July 1995-31st December, 2009 (Pre-Liberia WAMZ Membership), 1st January 2008-31st December, 2010 (global financial crisis) and 1st March 2020-7th October, 2020 (COVID-19 pandemic). We studied different periods so as to find evidence of changing dependence structures during major events in the life of WAMZ and in financial turmoil, like the COVID19 pandemic. We employed several constant and time-varying copula models to examine the dependence structures. The results indicated significant changes at the dependence level, tail behavior and asymmetry structures among returns of the exchange rates and there was evidence of increased dependence among most currencies after the 2007-09 global financial crisis and COVID19 pandemic.

Keywords: financial crises, dependence, financial contagion, copula, correlations.
JEL Classification: F3, F30, G1, G100

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1.0 INTRODUCTION

The 2007-2009 global financial crisis and the recent COVID-19 global pandemic, together with their consequences have posed serious concerns in the international financial markets, especially in terms of risk management and asset allocation decisions. A key issue with regards to crisis is to study the extent that international and regional financial markets are connected, the type of connection, whether it is contagion or just interdependence between them and whether the markets became more connected or interdependent during these financial crises. Other crises that have been well-studied by economists, policy makers and financial markets analysts are Mexican devaluation (Tequila crisis 1994-95), the Asian flu (1997) and the Russian default (1998).

All these crises had a common theme that the chaos that started in a market or asset may stretch to other assets, markets, countries and regions such that variations in fundamentals may not describe the phenomenon. Given the interdependence of global economies, contagion may arise in dissimilar asset classes, currencies, and even markets. For instance, it is well-documented that the 2007-2009 global financial crisis originated from the US subprime mortgage market and spread to other sectors of the domestic economy as well as the overall global economy. As stated by Kaendera, Dixit & Ltaifa (2009), the currencies of several Sub-Saharan African countries, emerging and developing countries experienced huge depreciations due to the global financial crisis, beginning in mid-2008. It is therefore vital to examine, understand and possibly forecast the degree of the contagion effect on financial markets. Furthermore, it is crucial to ascertain the linkages among markets and the degree of the linkage to fund managers, risk managers, international portfolio investors, financial institutions, banking sector supervisors as well as policymakers.

There are several studies on interdependence and contagion in financial markets. The leading issue is what is contagion or how can it be recognized as investigated by Calvo and Reinhart (1996); Kaminsky and Reinhart (2000); Chan-Lau, Mathieson and Yao (2004); Longin and Solnik (2001); Forbes and Rigobon (2002); Corsetti, Pericoli, & Sbracia (2005); Valdés & Massa Roldán (2013) and Carmona & Ozgur (2013), to mention a few. The studies used different definitions of contagion and investigated dependence or contagion of currencies, stock exchanges, bonds and petroleum markets among advanced economies, emerging economies or the Asian regions. The most common techniques used to study contagion or interdependence are Pearson linear correlation as used by Carmona & Ozgur (2013) and Corsetti, Pericoli & Sbracia (2001) while Dias & Embrechts (2010), Patton (2006), Valdés & Massa Roldán (2013) and Loaiza-Maya, Gómez-González & Melo-Velandia (2015) used copula functions and

rank correlations. As stated by Patton (2001), linear correlation is a simple measure of dependence but it is not always sufficient in some situations, including the analysis of financial contagion when international markets seem more dependent in crash states than during 'normal' states.

Junior, Adam & Tweneboah (2017) used Wavelets analysis to understand significant characteristics of co-movement of the WAMZ real US dollar exchange rates and their returns from January 2001 to April 2015. The results showed that lead–lag associations at different periodicities vary across the countries. The studies of dependence among West African Monetary Zone (WAMZ) countries is very scarce for the exchange rates or stock markets. The aim of this paper is to fill some of this gap by investigating the evidence of contagion between the exchange rates of WAMZ countries against USD using Pearson linear and rank correlations as well as copula functions over the period 2000 to 2020.

The study represents two advances over previous literature. First, there are no studies on interdependence and contagion of the WAMZ exchange rates with each other despite the growing integration of these countries such as through the Africa Continental Free Trade Agreement. The second contribution of the study is to add to the empirical literature on dependence modelling using static and time-varying copula as well as tail dependences among the WAMZ foreign exchange markets.

It is very important to identify contagion or interdependence between pairs of exchange rates to guide direction of exchange rate policies in both WAMZ and the African sub-region. Also, short-term policies like capital controls or foreign currency interventions by central bank may not be effective in insulating an economy from a currency crisis that started abroad. Finally, understanding the co-movement of exchange rates in the WAMZ countries can shed more light as the region considers adopting a single currency at the sub-regional level (Junior, Adam & Tweneboah (2017).

The rest of the paper is organized as follows. Section 2 presents a brief overview of interdependence or contagion analysis using linear & rank correlations and copula functions as well as exchange rate regimes in WAMZ countries in the 2000s. Section 3 describes the copula methodology implemented in this study. An empirical application for WAMZ countries exchange rates is shown in Section 4 and Section 5 concludes the paper.

2.0 Literature Review

This section provides a brief review of literature on interdependence or contagion analysis using linear & rank correlations, copula functions as well as exchange rate regimes in WAMZ countries in the 2000s.

2.1 Interdependence and contagion analysis using linear & rank correlations as well as copula functions

2.1.1 Empirical Analysis of Financial Contagion

Contagion has no accepted definition and has therefore being viewed differently by various authors. Costinot, Roncalli, & Teiletche (2000) reviewed modelling the interdependency among financial markets and recommended using copula as the ideal tool for such task while rejecting Pearson (or linear correlation) as a dependence measure because it may produce inaccurate estimate. The authors presented an analysis of interdependency among financial markets for portfolio management and financial integration decisions as well as investigated the concept of contagion in periods of "balance of payments crises". The authors discussed the notion of contagion and stated that it can be viewed as the risk of a simultaneous crisis, changes in correlations or that the incidence of a crisis in a country increases the likelihood of a crisis in another, irrespective of the latter's local economic and financial conditions.

Forbes and Rigobon (2002) defined contagion as a substantial rise in cross-market connections after the manifestation of a shock in one country. They defined interdependence as a high level of market co-movement in all periods. They further stated that if two markets demonstrate a high level of co-movement in stable times, even when the markets remain very much correlated after a shock to a market, the scenario may not be regarded as contagion. According to Forbes and Rigobon (2002), the scenario can only be regarded as contagion when cross-market co-movement rises considerably following the shock. However, if the co-movement has not shown sizeable increment then any sustained great degree of correlation advocates robust connections among the two nations that are present in all states of the world. Forbes and Rigobon (2002) used the term interdependence to point to this scenario and emphasized that testing if contagion occurs is to relate connections between two markets in a fairly stable time (historic average taken as the general measured) with associations directly following a shock or crisis.

Fratzscher (2003) analysed the significance of emerging market contagion in the currency crises of the 1990s. The author used a non-linear Markov-switching model to carry out a comparison and assessment of contagion, weak economic fundamentals

and sunspots (i.e. unobservable shifts in agents' beliefs) as the three different sources of currency crises. The author viewed contagion as the spread of crises as a results of a nations' close real and financial "proximity" to another. He emphasized that the definition of contagion used by Forbes and Rigobon (1999) was narrower than his as their definition required interdependencies to increase in crises, and the rise may not be connected to resemblances in fundamentals among countries, in order to be regarded as contagion.

Fratzscher (2003) also presented an approach to evaluate three types of contagion channels: real interdependence among economies through trade competition; the degree of competition among nations for bank lending in third markets (financial interdependence) and the level of stock market integration among countries. According to Fratzscher, the three evaluation criteria have to be used because the probability that a crisis spreads among nations is higher when two or more countries are connected through such real or financial channels. The study used panel data to verify the robustness of the results obtained for 24 emerging markets. The study showed that the 1994/95 Latin American crisis and the Asian crisis of 1997 among emerging markets was due to a high degree of financial interdependence among the affected economies and not as a result of the weakness of those countries' fundamentals.

Loaiza-Maya, Gómez-González & Melo-Velandia (2015) presented a vine copula for contagion testing among the exchange rates of the 6 largest Latin American economies. The data used was from June 2005 to April 2012. They defined contagion as a condition in which "significantly different values of dependence coefficients are encountered during times of crises and during normal times". As investigated by other researchers, the authors estimated tail dependencies using correlation coefficients. The study revealed the presence of contagion among the exchange rates of Brazil, Chile, Colombia and Mexico and also the degree of contagion differed between depreciation and appreciation of the exchange rates. The significance of identifying contagion among exchange rates was presented by the authors. According to Loaiza-Maya et al (2015), short-run policies such as central bank's intervention or capital controls may be effective in insulating a country from a currency crisis in a situation where contagion is identified but such policies may not be effective when there is no contagion.

Corsetti, Pericoli & Sbracia (2001) introduced a general assessment of financial market contagion using bivariate correlation analysis. They defined contagion as a structural break in the data generating process of data returns. On the other hand, Valdés & Massa Roldán (2013) studied the dependence between the financial markets of

Mexico and Brazil using copula models that incorporate non-linearity and asymptotic dependence. The specific copula models used are the two-dimensional normal, Gumbel and Clayton copulas. The authors used weekly returns data of the Mexican Stock Exchange Prices and Quotations Index (IPYC) and Ibovespa Brasil Sao Paulo Stock Exchange Index (IBOV) covering January 1975 to November 2010. The data employed in the study were group into four samples (1975-1990, 1991-2000, 2001-2010 and 2008-2010) in order to find sign of varying dependence structures based on the major event in a specific time period such as the global financial crisis of 2007-2009. The study revealed that dependence structure among the two markets increased after the financial crisis of 2007-09.

Carmona and Ozgur (2013) studied contagion in Latin America due to the Asian crisis and the ruble devaluation in exchange rates, equity markets, and emerging market bond indices. The data used covered1st January, 1996 to 31st December, 1998. The data was divided into two equal parts: tranquil period and crisis periods that encompassed both the Asian and the Russian crises. Using correlation coefficients, the authors evaluated contagion across the countries, markets and the scenario periods. Carmona and Ozgur (2013) opined that when there is no substantial rise in the country correlation coefficients between the two periods then it is probable that the stress experienced by the markets were as a result of mutual cause effects. Nevertheless, if the rise in correlation is substantially greater than the historical correlation, then there is motivation to assume that investor opinions have shifted.

Rodriguez (2007) used copula with time-varying Markov-Switching parameters to study financial contagion and found indication of varying dependence structures in periods of financial turmoil. The two classes of copulas used are a finite mixture of the Frank, Gumbel and Clayton copulas. The study also revealed rising tail dependence and asymmetry when volatility is high to describe the Asian countries, while tail dependence and symmetry described the Latin-American case well. The study used data on daily returns of equity indices from 5 East Asian countries in the Asian Crisis as well as from four Latin-American countries in the Mexican Crisis. Rodriguez (2007) also stated that structural breaks in tail dependence are a possibly significant aspect of contagion and that contagion is a nonlinear occurrence and thus indicated that correlation breakdown hypothesis should not be accepted as an indication of a stable dependence structure. His study showed periods of financial turmoil exhibit rising dependence but asserted too much reliance on tail independence, while acceptable in periods of stability could lead to possibly severe underestimation of financial risks in crisis times.

Lagoarde-Segot & Lucey (2005) examined financial contagion in emerging markets of the Middle East and North Africa during seven incidents of international financial crisis. The authors rejected the hypothesis of a joint regional contagion using fixed-effect panel approach but found signs that each of the studied markets experienced contagion not less than once in the seven studied crises based on various bivariate contagion tests of Corsetti (2002), Favero & Giavazzi (2002) and Forbes & Rigobon (2002). As reported in the literature, Lagoarde-Segot & Lucey found that the likelihood of being affected by contagion appears to rise when markets in MENA grow in size and liquidity.

Chen, Fan & Patton (2004) developed two goodness-of-fit tests for evidence of asymmetry such that asset returns exhibit more correlation in volatile markets and in market downturns than in tranquil times. The authors used the proposed tests to ascertain if dependence in U.S. equity return and exchange rate data can be described by the multivariate Normal or the Student's t copula models. According to Chen, Fan & Patton (2004), the two tests were robust to the specific univariate distributions and also utilised the multivariate probability integral transform. When the tests were applied to the returns of equity and exchange rate series, the authors found strong indication that the normal copula does not describe the dependence while evidence against the more flexible Student's t copula was very limited.

Dias & Embrechts (2010) introduced a new flexible time-varying copula methodology to model the interdependence of exchange rates. The model enables exchange rates' conditional correlation to vary with time and be independent of the univariate distributions. The authors presented a dynamic model for the correlation using the Fisher transformation. The authors found that correlations between the exchange rates is not constant but varies with time and that their proposed time-varying copula specification described the dependence better than alternative two competing models. The data used consisted of spot exchange rates for the USD, euro, and yen, from 1st October, 2000 to 1st October, 2008, that spaced equally at sixty-minute time intervals.

Patton (2006) examined for asymmetry using constant and time-varying copula models in the dependence between the USD against both the Deutsche mark and the yen. The asymmetry referred to a dissimilar level of correlation shown in joint appreciations than joint depreciations. The author stated that equity returns have exhibited less joint positive extremes than joint negative extremes and investigated if the same phenomenon can be found in exchange rates due to the asymmetric central bank behavior and exchange rate portfolio rebalancing strategies. Patton

used both constant and time-varying symmetrized Joe–Clayton and normal (Gaussian) copulas, where the normal copula was considered the yardstick model. The data covered January 1991 to December 2001 yielding 2,819 observations with 2,046 observations in the period before the Euro was introduced on 1st January, 1999 and 773 observations in the period after the Euro's introduction. The sample represented when East and West Germany unified in late 1989 and included when some financial integration was in effect. The study revealed substantial evidence that the dependence structure among the exchange rates was asymmetric, in line with asymmetric policies of central bank behavior. The author also found significant evidence of change in the estimated parameters of the time-varying normal copula after the Euro was introduced and the plotted conditional correlation showed a structural break in dependence that arose when the euro was introduced.

2.1.2 Modelling Financial Contagion using Dependence Measures

As stated in section 1, the most common methods used to study contagion or interdependence are Pearson linear correlation as used by Carmona & Ozgur (2013) and Corsetti, Pericoli & Sbracia (2001) while Dias & Embrechts (2010), Patton (2006), Valdés & Massa Roldán (2013) and Loaiza-Maya, Gómez-González & Melo-Velandia (2015) used copula functions and rank correlations. The linear correlations and copula functions are multivariate models that possess two constituents: the models that describe each variable, known as the univariate or marginal model and the dependence arrangement among the univariate variables. The non-normality of financial asset return distribution has since been recognized by Mandelbrot (1963). For the Nigerian exchange rate series, Katata (2016) found that the series demonstrated serial correlation, time-varying variance and the existence of asymmetry of the return distributions. However, Pearson linear correlation has been used to describe dependence in general financial economics, even though this dependence measure is only ideal for spherical and elliptical distributions like multivariate normal but advocated copula as a better measure of dependence in financial economics (Embrechts, McNeil & Straumann, 2002; and Joe, 2014).

Financial applications that rely on copula theory utilise Sklar's 1959 theorem that allows the breakdown of any *N*-dimensional joint distribution into its *N* univariate distributions as well as a copula function that models the dependence structure among the variables (Cherubini, Luciano, Vecchiato, 2004; and Palaro & Hotta, 2006). Copulas are multivariate functions with standard uniform marginals that describe the dependence between two or more random variables. As a result of Sklar's theorem, the marginal can be dissimilar to each other, while also the selected copula needs not be particular to the chosen marginals. Measures of dependence that are scale

invariant, not affected by strictly increasing changes of the primary variables are Kendall's tau, Spearman's rho and tail dependence coefficients and they can be stated as functions of the copula functions. Copula functions can describe dependence that fluctuates through time or is constant (Fan & Patton, 2014). Nelsen (2006), Joe (2014) and McNeil et al (2005) provide a good introduction to copula functions.

2.2 Brief Overview of Exchange rate regimes in WAMZ countries in the 2000s

Onanuga & Onanuga (2015) stated that the WAMZ countries started adopting floating exchange rate regime in the 80s. In the past, these countries have used fixed regimes to managed floating and then to complete independent float. The WAMZ is the second monetary zone in West Africa and was constituted in 2000 by Gambia, Ghana, Guinea, Nigeria and Sierra Leone while Liberia was admitted in 2010.

Harvey & Cushing (2015) discussed the history of West African Monetary Union and West African Monetary Zone. In December 2000, the WAMZ, the West African Monetary Institute (WAMI) and Stabilization and Cooperation Fund (SCF) were established. The essence of setting up the WAMI was to carry out all essential tasks that will result in creation of the West African Central Bank (WACB) as well as a mutual currency by January 2003 while the planned monetary union was scheduled for January 2004. According to the authors, these goals could not be achieved by these countries because of their inability to attain the set merging criteria. Liberia became the sixth member of WAMZ in February 2010 while Cape Verde became an observer. Harvey & Cushing (2015) further stated that the main condition that ensures that the economies of the member countries come together is in terms of displaying symmetric shocks while fiscal convergence is the secondary condition.

Harvey & Cushing (2015) also tested whether the WAMZ is a common currency area and found that due to the varied economic structures of the constituent countries, the zone as a whole does not have common source of shock. The authors suggested that it was not ideal for the constituent countries to embark on a monetary union as at then or the future until their economies show a common shock or converge further.

3.0 METHODOLOGY

This study adopts Forbes and Rigobon's (2002) definition of contagion-a situation that occurs when cross-market linkages increase after the incidence of a shock in one country. The study utilized the Patton (2006) time-varying copula models for this task. The instrument of contagion transmission takes place due to high interdependency among the WAMZ exchange rates. In this study, we use the following time-varying

bivariate copulas: Normal or Gaussian, Clayton, Gumbel, Student t and Symmetrized Joe–Clayton (SJC) Copulas to study interdependence and contagion in the WAMZ foreign exchange markets. The parameters are estimated using the inference for margins (IFM) method.

Let Y and Y be a pair of random with *F* and *G* as marginal cumulative distribution functions (CDFs) and *H* as the joint CDF. Also let *f, g*, and *h* be their corresponding probability density functions (PDFs). Sklar's theorem (Nelsen, 2006) enables the decomposition of the joint PDF *h* into the product of the marginal densities and the copula density *c* and for bivariate case:

$$h(x,y) = c(F(x),G(y))\,f(x)\,f(y). \tag{1}$$

Sklar's (1959) theorem is applicable to both discrete and continuous random variables. The profound implication of this theorem is that the marginal distributions and the copula can belong to different family of distributions; they can be skewed or symmetric or thin- or fat-tailed. In most financial applications, the copula function is assumed to be parametric while the marginal distributions can be either parametric or nonparametric. The marginal distributions and the copula functions can be estimated by maximum likelihood (ML) using one-stage or multistage approach. The full (one-stage) ML approach involves the simultaneous estimation of the parameters of the marginal distributions and the copula functions at once. The multistage (also called IFM) ML method entails estimation of the parameters of the marginal distributions in the first stage and then estimates the copula parameters in the second stage.

3.1 First step of the IFM: Models for the Marginal Distribution

The Generalised Autoregressive Conditional Heteroscedasticity (GARCH) approach is frequently utilised to describe heteroscedasticity in financial series whereas autoregressive moving average (ARMA) (*p,q*) models the conditional mean and GARCH (*p,q*) to describe the conditional variances. The *p* component denotes autoregressive part while the *q* is for the moving average part in the ARMA model. For the GARCH model, *p* and *q* stand for the order of GARCH and Autoregressive Conditional Heteroscedasticity (ARCH) part, respectively. Based on the established 'sylised facts' of financial returns exhibiting asymmetry, the well-known Glosten, Jagannathan, and Runkle (GJR) 1993 model is the right model to describe this behavior.

Let μ be the expected return and εt as a zero-mean white noise. The evolution of the GJR-GARCH(P,O,Q) process for conditional variance h_t is defined as

$$r_t = \upsilon_t + \varepsilon_t \tag{2}$$

$$h_t = \omega + \sum_{p=1}^{P} \alpha_p \varepsilon_{t-p}^2 + \sum_{o=1}^{O} \gamma_o \varepsilon_{t-o}^2 I_{[\varepsilon t-o<0]} + \sum_{q=1}^{Q} \beta_q h_{t-q} \tag{3}$$

$$\varepsilon_t = h_t e_t \tag{4}$$

μ_t can be an adapted model for the conditional mean and I $[\varepsilon_{t-o}<0]$ is an indicator function that becomes 1 if $\varepsilon_{t-o} < 0$ and 0 if otherwise. The conditional variance equation contains the ARCH terms ε_{t-p}^2, the GARCH terms h_{t-p} and the GJR terms $\varepsilon_{t-o}^2 I_{[\varepsilon t-o<0]}$

Other distributions for the error term include student t, skewed student and Generalized Error Distributions, and may involve more parameters as well as restrictions. The error term e_t of equation (2) is presumed to have a conditional variance h_t that is time-varying as specified in (3).

All the parameters **(ω,α,γ,β) can be estimated** simultaneously by maximizing the log likelihood for the WAMZ exchange rate series.

3.2 Second step of the IFM: Copula Models

As earlier stated, this study use the following time-varying bivariate copulas to study contagion in the WAMZ foreign exchange markets: Normal or Gaussian, Clayton, Gumbel, Student t and Symmetrized Joe–Clayton (SJC) Copulas.

3.2.1 Normal (Gaussian) copula

Let ρ_t be time-varying correlation between any two return series X_t and Y_t at time *t*. We use the values of u_t and v_t obtained at the first step to estimate dependence parameter ρ_t of the copula function, which is conditional on Ω_{t-1} and the vector θ_c. Also, let Φ(.) be the normal distribution, Φ^{-1} the inverse normal distribution and $\Phi_\rho(.)$ *be* the bivariate normal distribution with correlation coefficient ρ restricted to [-1,1]. The Normal (Gaussian) copula is:

$$C_t(u_t, v_t \mid \rho_t) = \Phi\left[\Phi^{-1}(u_t), \Phi^{-1}(v_t) \mid \rho_t\right]. \tag{5}$$

Let $\Lambda(x) = (1 - e^{-x})/(1 + e^{-x})$ be the modified logistic transformation so that ρ_t is restricted to [-1,1]. Also, the correlation coefficient ρ_t follows a time-varying process such that

$$\rho_t = \Lambda(\omega + \beta\rho_{t-1} + \alpha|u_{i,t-1} - v_{i,t-1}|) \quad (6)$$

Then the time varying Normal copula is given as

$$C(u_{i,t}, v_{i,t}) = \int_{-\infty}^{\emptyset^{-1}(u_{i,t})} \int_{-\infty}^{\emptyset^{-1}(v_{i,t})} \frac{1}{2\pi\sqrt{(1-\rho_t^2)}} exp\left\{\frac{y_{i,t}^2 - 2\rho_t y_{i,t} z_{i,t} + z_{i,t}^2}{2(1-\rho_t^2)}\right\} dy_{i,t} dz_{i,t} \quad (7)$$

The Gaussian copula can be used to describe both positive and negative dependence. It is the most widely used copula for financial applications, hence the reason for its selection. The Gaussian copula may be used to preserve a Gaussian-type of dependence, even for non-Gaussian marginal distributions. The dependence structure implied by Gaussian copula is radially symmetric and possess no tail dependence.

3.2.2 The Student t Copula

With the purpose of capturing fat-tails in univariate models in elliptical world, the normal distribution should be replaced with the Student t distribution, with parameter υ representing the degrees of freedom and accounts for generating the fat tails.

The student t copula is symmetric like Gaussian copula, but unlike Gaussian copula, it has tail dependence. The implication is that using student t copula, assets can be 'linked together' that seem to be normally distributed, but can possibly be exposed to extreme upward or downward movements at the same time. However, the dependence coefficients of the lower and upper tail are equal because of the radial symmetry of elliptical distributions. Similar to the Gaussian copula, this copula uses the Pearson linear correlation coefficient as its dependence measure. It has been shown to fit substantial dependence structures, hence the reason for its selection.

Let *d* be the dimension of a copula, t_υ the distribution function of a standard univariate *t* distribution and $t_{\upsilon,P}$ the joint df of the vector $X \sim t_d(\upsilon, 0, P)$ with *P* as a correlation matrix. The *d*-dimensional *t* copula is given as

$$C_\upsilon^t p(u_1, \ldots, u_d) = t_{\upsilon,p}(t_\upsilon^{-1}(u_1), \ldots, t_\upsilon^{-1}(u_d)) \quad (8)$$

As specified in time-varying Normal copula, let $\Lambda(x) = (1 - e^{-x})/(1 + e^{-x})$ be the modified logistic transformation so that ρ_t is restricted to [-1,1] and is given as

$$\rho_t = \Lambda(\omega + \beta\rho_{t-1} + \alpha|u_{i,t-1} - v_{i,t-1}|)$$

For υ degrees of freedom, let the univariate Student distribution have the following distribution function

$$t_{\upsilon,\rho_t}(x,y) = \int_{-\infty}^{x} \int_{-\infty}^{y} \frac{\Gamma\left(\frac{\upsilon+1}{2}\right)}{\Gamma\left(\frac{\upsilon}{2}\right)\upsilon\pi\sqrt{(1-\rho_t^2)}}\left(1+\frac{s^2+2\rho st+t^2}{\upsilon(1-\rho_t^2)}\right)^{-\frac{\upsilon+1}{2}} dsdt \quad (9)$$

Then the time-varying Student t Copula

$$C_{t_\upsilon}(u_{i,t},v_{i,t}) = \int_{-\infty}^{t_\upsilon^{-1}(u_{i,t})} \int_{-\infty}^{t_\upsilon^{-1}(v_{i,t})} \frac{\Gamma\left(\frac{\upsilon+1}{2}\right)}{\Gamma\left(\frac{\upsilon}{2}\right)\upsilon\pi\sqrt{(1-\rho_t^2)}}\left(1+\frac{s^2+2\rho st+t^2}{\upsilon(1-\rho_t^2)}\right)^{-\frac{\upsilon+1}{2}} dsdt \quad (10)$$

Both the Gaussian and Student t copulas belong to the family of elliptical copulas which are obtained directly from the class of elliptical distributions.

3.2.3 Gumbel copula

For 1≤θ<∞, the bivariate Gumbel copula is given as

$$CG(u\ ,v\ ) = exp(-((-\ln\ \ u\ )^{\theta} + ((-\ln\ \ v\ )^{\theta})^{1/\theta} \quad (11)$$

The Gumbel copula is limited to positive dependence only and like Clayton, does not permit negative dependence but shows strong right tail dependence and relatively weak left tail dependence. It has only upper tail dependence but no dependence in the lower tail. It is selected because it can describe nonlinear dependence and possess asymmetric tail dependence. It also belongs to several important copula families.

Let the dynamic process for the time-varying dependence parameter be defined as:

$$\theta_t = \Lambda(\omega + \beta\theta_{t-1} + \alpha|u_{i,t-1} - v_{i,t-1}|)$$

and Λ(x) = $(1-e^{-x})^{-1}$

Then the time-varying version of the Gumbel copula is stated as

$$C(u_{i,t},v_{i,t}) = \exp\{-(-logu_{i,t}^{\theta_t}) + (-logv_{i,t}^{\theta_t})\}^{-1/\theta_t}\ for\ \ \theta_t \geq 1 \quad (12)$$

3.2.4 The Symmetrized Joe–Clayton copula

Let $k = \frac{1}{\log_2(2-\tau^U)}$, $\gamma = \frac{-1}{\log_2(\tau^L)}$ and $\tau^i \in (0,1)$

The Joe–Clayton copula is given as:

$$C_{JC}\left(u,v\,|\,\tau^U,\tau^L\right) = 1-\left(1-\left\{\left[1-(1-u)^k\right]^{-\gamma} + \left[1-(1-v)^k\right]^{-\gamma} - 1\right\}^{-1/\gamma}\right)^{1/k} \quad (13)$$

The original Joe-Clayton (JC) copula, also called BB7, has some slight asymmetry when there is quality in the two tails of the dependence measures. Patton (2006) proposed the "Symmetrized Joe–Clayton" copula (SJC) as the solution to the issue as follows:

$$C_{SJC}\left(u,v \mid \tau^U,\tau^L\right)=\frac{1}{2}\left(C_{JC}\left(u,v \mid \tau^U,\tau^L\right)+C_{JC}\left(1-u,1-v \mid \tau^U,\tau^L\right)+u+v-1\right) \quad (14)$$

This copula is a flexible two-parameter copula that captures both lower and upper tail dependence. The two dependence parameters (τ^U,τ^L) range freely and are independent of each other.

The time-varying SJC copula allows for changing degrees of asymmetry and level of dependence. It is defined as:

$$C\left(u_{i,t},v_{i,t}\right)=0.5\left(C_{JC}(u_{i,t},v_{i,t})+C_{JC}(1-u_{i,t},1-v_{i,t})+u_{i,t}+v_{i,t}-1\right) \quad (15)$$

where the Joe-Clayton copula, C_{JC} is give as:

$$C\left(u_{i,t},v_{i,t}\right)=1-\left(1-\left\{\left[1-\left(1-u_{i,t}\right)^{a_t}\right]^{b_t}+\left[1-\left(1-v_{i,t}\right)^{a_t}\right]^{b_t}-1\right\}^{\frac{-1}{b_t}}\right)^{\frac{-1}{a_t}} \quad (16)$$

and

$a_t=\frac{1}{Log\left(2-\tau_t^U\right)}$ and $b_t=\frac{1}{Log\left(\tau_t^L\right)}$, $\tau_t^U,\tau_t^L \in (0,1)$

Let $\Lambda(x)=(1-e^{-x})^{-1}$, the time dynamics equations of the parameters are given as:

$$\tau_t^U=\Lambda\left(\omega_U+\beta_U\tau_{t-1}^U+\alpha\left|u_{i,t-1}-v_{i,t-1}\right|\right) \quad (17)$$

$$\tau_t^L=\Lambda\left(\omega_L+\beta_L\tau_{t-1}^L+\alpha\left|u_{i,t-1}-v_{i,t-1}\right|\right) \quad (18)$$

3.2.5 Rank Correlation and Kendall's tau

Kendall's tau and Spearman's rho are the two renowned rank dependence measures. In order to estimate Spearman's rank correlation for two return series, the data is ranked individually for the two series and then the squared differences between the ranks is summed.

Formally, let ρ be Pearson 'linear' correlation, X and Y be random variables with distribution functions $F_1$and F_2 and joint distribution function F. Spearman's rank correlation is given by

$$\rho_S(X,Y)=\rho(F_1(X);F_2(Y)) \quad (19)$$

Let a sample with *n* observations (x_i,y_i) for $i=1\ldots n$, Kendall's tau, τ, is obtained by associating all the possible sets of observations$\{(x_i,y_i),(x_j,y_j)\}$ for $i \neq j$.

Given a sample with *n* observations while P_n and Q_n=number of concordant and discordant pairs, respectively, the empirical version of Kendall's tau is given by

$$\tau = \frac{P_n - Q_n}{\binom{n}{2}} = \frac{4}{n(n-1)} P_n - 1 \quad (2.0)$$

Kendall's tau can capture nonlinear dependence that cannot be described with linear correlation. Given that contagion is considered to be a nonlinear event, Kendall's tau is an important measure for contagion analysis.

3.2.6 Tail dependence

Tail dependence, like rank correlation measures, is a nonlinear correlation measure that captures the behavior of the random variables during extreme events. It is vital because it measures the asymptotic probability that two variables go up or down concurrently. The tail dependence is concerned with the dependence at the tails only.

The specification of the parameter space and tail dependence values are presented below.

Copula Family	**Parameter**	**Parameter Space**	**Lower Tail Dependence**	**Upper Tail Dependence**
Normal	ρ	(-1,1)	0	0
Student t	ρ,υ	(1,1) x (2,∞)	gT(ρ,υ)	gT(ρ,υ)
Gumbel	θ	(1,∞)	0	$2\text{-}2^{1/\theta}$
SJC	τ_t^L, τ_t^U	(0,1) X (0,1)	τ_t^L	τ_t^U

Adapted from Patton (2012)

3.3 Data Description

The WAMZ is the second monetary zone in West Africa and was constituted in 2000 by Gambia, Ghana, Guinea, Nigeria and Sierra Leone while Liberia was admitted in 2010. The data used in the study, described in Table 1, consisted of the whole sample (10th July 1995-7th October 2020), 10th July 1995- 31st December 1999 (before WAMZ was constituted), 10th July 1995-31st December, 2009 (WAMZ before the admission of Liberia), 1st January 2008-31st December, 2010 (global financial crisis) and 1st March 2020-7th October, 2020 (COVID-19 pandemic). The data was downloaded from Refinitiv datastream. The purpose is to investigate contagion and evidence of varying dependence structures based on the major events as detailed in the table 1. We study different periods so as to find evidence of changing dependence structures during major events in the life of WAMZ and in financial turmoil, such as the COVID19 pandemic.

TABLE 1: CLASSIFICATION OF THE SAMPLE

Data Sample	Reason	Length of Observations
10th July 1995-7th Oct 2020	The whole sample to examine behaviour of complete observations (Whole)	6588
10th July 1995- 31st Dec 1999	before WAMZ was constituted, WAMZ was formed in 2000 (Pre-WAMZ)	1170
10th July 1995-31st December, 2009	WAMZ before the admission of Liberia (Before Liberia)	3779
1st Jan 2008-31st Dec, 2010	global financial crisis (GFC)	784
1st March 2020-7th October, 2020	COVID-19 pandemic (COVID19)	158

Source: Author's design

4.0 EMPIRICAL RESULTS

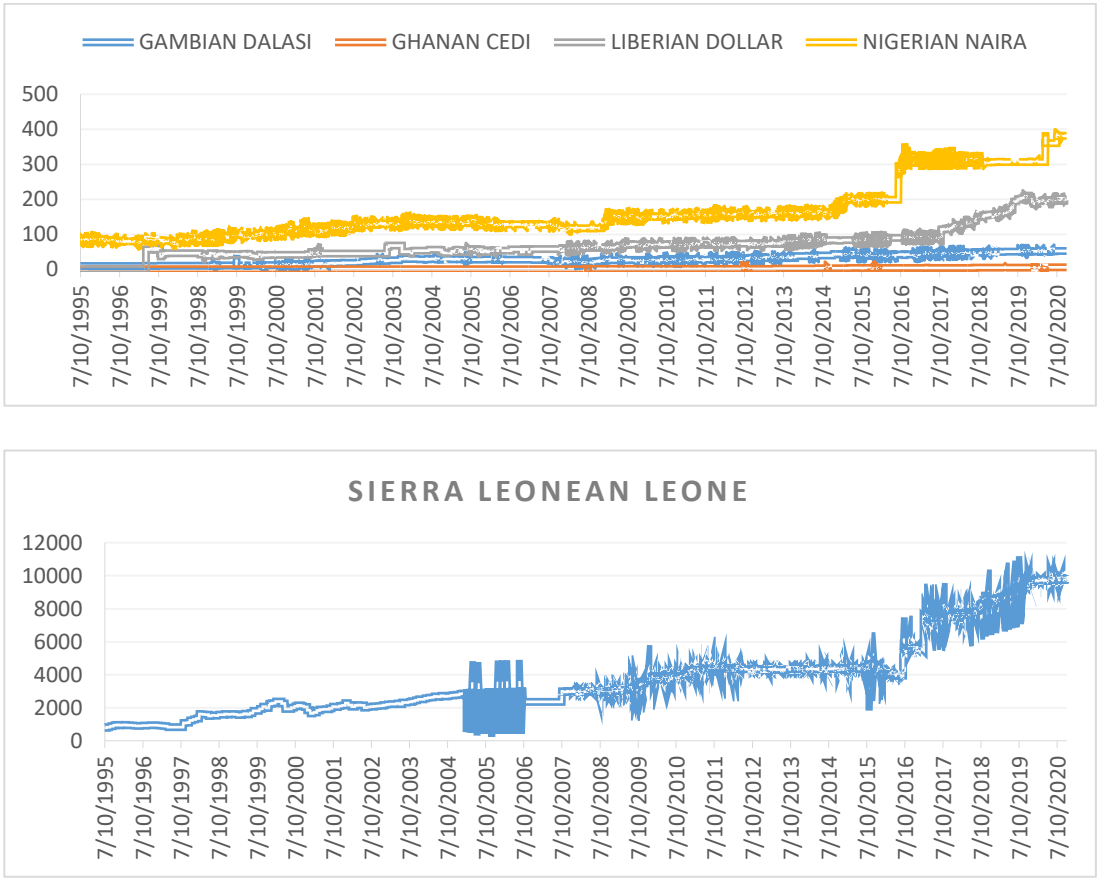
4.1 Stylised Facts

This section describes the stylised facts in terms of descriptive statistics of the foreign exchange markets in the WAMZ. The descriptive statistics of the returns are presented in table 2. The sample in figure 1 displays the behavior of 5 WAMZ exchange rates over time. The two panels in Figure 1 show that the 5 exchange rates have stochastic trend and are therefore nonstationary. The lack of stationarity and normality observed in the Naira exchange rates has been well-documented by Katata (2016). A stationary series is required if we want to analyze the dependence structure among the WAMZ exchange rates. Let P_t be the closing price on *i*th day and r_t be the continuously compounded return on *i*th day. Then the daily return of each of the currencies in the WAMZ foreign exchange markets be obtained as follows:

$$r_t = \log(P_t / P_{t-1})$$

Table 2 shows descriptive statistics for the WAMZ exchange rates returns and are plotted in figures 1-4. Augmented Dickey-Fuller test results (not reported in the table) show that the returns are stationary.

Figure 1: Wamz Exchange Rate Behavior



Source: Author(s) Design. Underlying data from Refinitiv Datastream. It should be noted from this section henceforth, all the underlying data used in tables and figures are from Refinitiv Datastream while the plotting and estimations are by the author.

Table 2 presents summary statistics on the returns in the sample.

Table 2: summary statistics on the returns in the sample.

		GAMBIAN DALASI (GD)	GHANIAN CEDI (GC)	LIBERIAN DOLLAR (LD)	NIGERIAN NAIRA (NN)	SIERRA LEONEAN LEONE (SL)
WHOLE SAMPLE	Mean	0.00026	0.00060	0.00080	0.00013	0.00038
	Median	0.00000	0.00000	0.00000	0.00000	0.00000
	Maximum	0.64961	0.12246	4.04305	0.34989	0.30321
	Minimum	-0.59933	-0.11884	-0.29385	-0.69061	-0.30062
	Std. Dev.	0.01736	0.01355	0.05176	0.01385	0.03370
	Skewness	1.74531	0.20447	72.33336	-16.07358	0.28107
	Kurtosis	553.19130	18.84878	5649.23374	1014.71726	37.68210
	Jarque-Bera *(probability)*	8.3866e+07 (0)	9.7397e+04 (0)	8.7515e+09 (0)	2.8245e+08 (0)	3.8919e+05 (0)
	Observations	6586	6586	6586	6586	6586
BEFORE WAMZ WAS FORMED		**GAMBIAN DALASI (GD)**	**GHANAN CEDI (GC)**	**LIBERIAN DOLLAR (LD)**	**Nigeria Naira (NN)**	**SIERRA LEONEAN Leone (SL)**
	Mean	0.0002	0.0009	0.0031	0.0002	0.0009
	Median	0.0000	0.0000	0.0000	0.0000	0.0000
	Maximum	0.6496	0.1225	4.0431	0.0995	0.2665
	Minimum	-0.5993	-0.1188	-0.2489	-0.0995	-0.0715
	Std. Dev.	0.0265	0.0143	0.1193	0.0122	0.0127
	Skewness	2.6813	0.0460	33.3294	-0.2354	12.7172
	Kurtosis	529.9342	25.6968	1130.4660	21.2656	222.4956
	Jarque-Bera *(probability)*	1.3563e+07 (0)	3.1877e+04 (0)	6.1932e+07 (0)	2.1840e+04 (0)	2.4220e+06 (0)
	Observations	1168	1168	1168	1168	1168
BEFORE LIBERIA JOINED		**GAMBIAN DALASI (GD)**	**GHANIAN CEDI (GC)**	**LIBERIAN DOLLAR (LD)**	**Nigerian Naira (NN)**	**SIERRA LEONEAN Leone (SL)**
	Mean	0.0003	0.0007	0.0011	0.0002	0.0004

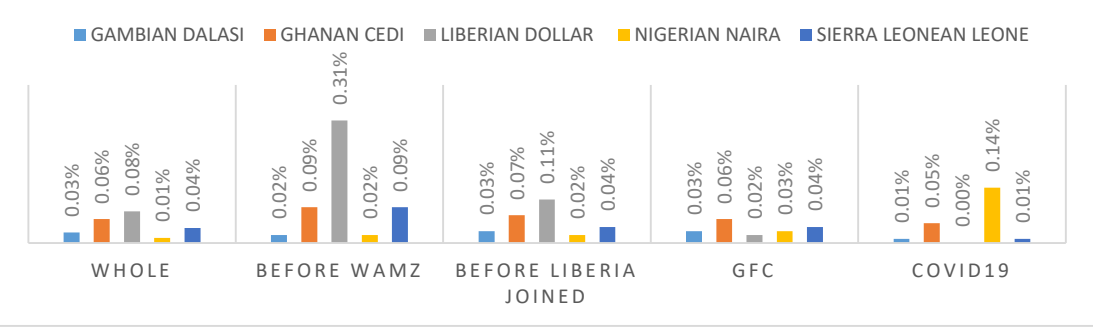
	Median	0.0000	0.0000	0.0000	0.0000	0.0000
	Maximum	0.6496	0.1225	4.0431	0.1412	0.3006
	Minimum	-0.5993	-0.1188	-0.2939	-0.1542	-0.3006
	Std. Dev.	0.0200	0.0160	0.0676	0.0100	0.0435
	Skewness	1.9642	0.1604	56.7031	-0.4768	0.0591
	Kurtosis	547.0298	14.8104	3393.1685	52.3780	21.5694
	Jarque-Bera *(probability)*	4.6983e+07 (0)	3.4447e+04 (0)	1.8097e+09 (0)	4.3084e+05 (0)	7.3034e+04 (0)
	Observations	3777	3777	3777	3777	3777
GFC		**GAMBIAN DALASI (GD)**	**GHANAN CEDI (GC)**	**LIBERIAN DOLLAR (LD)**	**Nigeria Naira (NN)**	**SIERRA LEONEAN Leone(SL)**
	Mean	0.0003	0.0006	0.0002	0.0003	0.0004
	Median	0.0000	0.0000	0.0000	0.0000	0.0000
	Maximum	0.0849	0.0632	0.0667	0.0484	0.0619
	Minimum	-0.0944	-0.0737	-0.0545	-0.0317	-0.0422
	Std. Dev.	0.0147	0.0071	0.0075	0.0062	0.0079
	Skewness	-0.4471	-0.8056	0.5582	2.0888	0.8417
	Kurtosis	11.1987	38.4551	18.5141	18.6622	9.9650
	Jarque-Bera *(probability)*	4.0599e+03 (0)	4.7698e+04 (0)	1.1072e+04 (0)	1.1776e+04 (0)	3.2857e+03 (0)
	Observations	782	782	782	782	782
COVID19		**GAMBIAN DALASI (GD)**	**GHANAN CEDI (GC)**	**LIBERIAN DOLLAR (LD)**	**Nigeria Naira (NN)**	**SIERRA LEONEAN Leone (SL)**
	Mean	0.0001	0.0005	0.0000	0.0014	0.0001
	Median	0.0000	0.0000	0.0000	0.0000	0.0000
	Maximum	0.0130	0.0211	0.0102	0.1943	0.0153
	Minimum	-0.0130	-0.0235	-0.0102	-0.0328	-0.0075
	Std. Dev.	0.0026	0.0061	0.0027	0.0163	0.0024
	Skewness	0.4142	-0.0496	-0.0787	10.8808	2.0503
	Kurtosis	10.9376	4.1357	4.7020	127.7454	13.8554
	Jarque-Bera *(probability)*	733.1100 (0)	103.0181 (0)	8.3333e-06 (0)	1.0310e+05 (0)	1.2790e+03 (0)
	Observations	156	156	156	156	156

Source: Author's analysis based on dataset

The median in all the 5 samples is 0. In the Whole, 'Pre-Liberia WAMZ Membership' and GFC samples, the Gambian Dalasi yielded average returns per day of 0.03% but 0.02% and 0.01% were reported for 'Pre-WAMZ' and COVID19 samples. Some of the currencies showed negative skewness (so they are skewed to the left) while no value is equal to zero in the 5 samples. There is adequate indication of asymmetry in the WAMZ exchange rate distributions. The WAMZ exchange rates are more positively skewed (skewed right) than negatively skewed, they are therefore mostly right-skewed and possess a longer right tail.

For Ghanian Cedi, average return per day of 0.09% was yielded by 'Pre-WAMZ' sample, then 0.07% 'Pre-Liberia WAMZ Membership', 0.06% for Whole and GFC samples while the least average return of 0.05% was produced by COVID19 sample. In the case of Liberian Dollar, the average return per day of 0.31% was yielded by 'Pre-WAMZ' sample, followed by 0.11% given by 'Pre-Liberia WAMZ Membership', 0.08% for Whole sample, while the least average return of 0.02% and 0.00% were produced by GFC and COVID19 samples, respectively. For Nigerian Naira, the highest average return per day of 0.14% was generated by COVID19 sample, followed by 0.03% from GFC sample, while the average return of 0.02% (from 'Pre-Liberia WAMZ Membership' and 'Pre-WAMZ') and 0.01% as the least return were produced by Whole samples. For the Sierra Leonean Leone, the highest average return per day of 0.09% was yielded by 'Pre-WAMZ' sample, then 0.04% given by the Whole, 'Pre-Liberia WAMZ Membership' and GFC samples while the least average return of 0.01% was given by COVID19 sample. Therefore, the highest average day return of 0.31% was produced from 'Pre-WAMZ' by the Liberian Dollar out of the 5 samples and the 5 currencies while the least average day return of 0.00% was also produced by the Liberian Dollar out of the 5 currencies from the COVID19 sample for the 5 samples. Figure 2 shows the average daily returns for the 5 currencies for the 5 samples.

Figure 2: Average Daily Returns

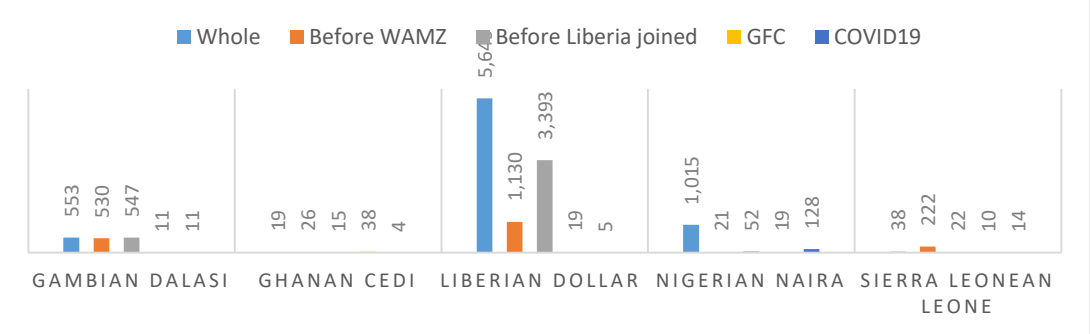


Source: Author's construction based on dataset

The mean and median, as measures of central tendency, for all the WAMZ exchange rate returns are very close to zero. That implies that the usual assumption of the random walk model that the expected value of daily returns equals zero is met.

All return series for the exchange rates and the 5 samples exhibited fat tails as indicated by the kurtosis values, all greater than 3 and in some cases in multiples of 3. The highest Kurtosis for the Whole sample was given by the Liberian Dollar (5,649) while the least (4) kurtosis was from Ghanaian Dollar. That implies that extreme returns on Liberian Dollar and Gambian Dalasi have a relatively high probability of occurrence, as shown in Figure 3.

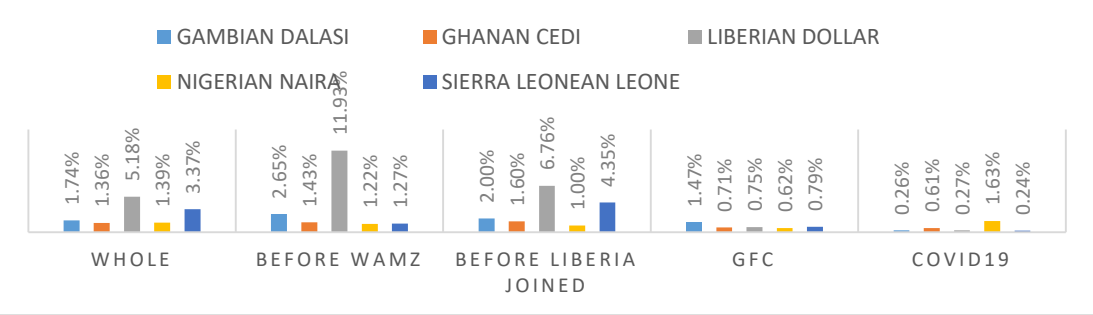
Figure 3: Kurtosis Of The Daily Returns



Source: Author's construction based on dataset

As seen in Figure 4, the most volatile currency is the Liberian Dollar followed by Sierra Leonian Leone and the sample that produced the most volatile currency is 'Pre-WAMZ' followed by 'Pre-Liberia WAMZ Membership'. The volatility observed in the currencies is least in the COVID19 sample followed GFC sample.

Figure 4: Standard Deviation Of The Daily Returns

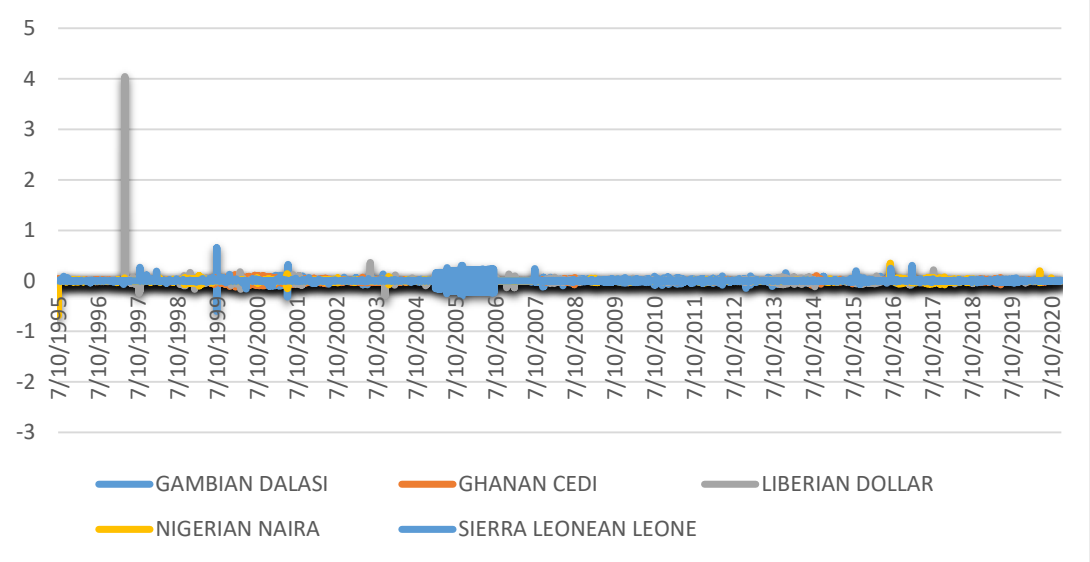


Source: Author's construction based on dataset

The Jarque-Bera normality test and their p-value for each of the logarithmic daily returns on the five series considered all rejected the null hypothesis at the default 5% significance level that the 5 series are normally distributed, as shown in Table 2. The Jarque-Bera test and coefficients of skewness and kurtosis establish the non-normality of the data in all the five different types of samples.

As expected and observed in Figure 5, all the 5 exchange series of the returns appear to be mean reverting, appear fairly stationary and exhibit periods of low volatility followed by periods of much higher volatility.

Figure 5: Daily Logarithmic Returns Of The Wamz Naira Exchange Rates



Source: Author's construction based on dataset

After the brief overview of the stylize facts of the WAMZ currencies, we then discuss the correlation and copula estimates. As stated in section 3.0, we utilize the multistage (also called Inference for Margins, IFM) ML method for the estimation of the parameters of the marginal distributions in the first stage and then estimate the copula parameters in a second stage.

4.2 Estimation of the Marginal Distribution

As implemented by Wang et al (2011), Patton (2001) and Katata (2020), we assume each of the WAMZ exchange rate series is characterized by the GJR-GARCH (1,1)-AR(1) model presented in section 3.1. However, the error we use is not student t but

Normally distributed. Table 3 presents the estimated parameters of the marginal distributions for the WAMZ exchange rate return series.

Table 3: Estimated Parameters For The Gjr-Garch(1,1)-Ar(1) Marginal Distributions For The Sample

		Conditional Mean	**Conditional Variance**			
		AR(1)	ω	α	γ	β
WHOLE	GAMBIAN DALASI (GD)	0.2584 (0.0000)	0.0000 (-0.0000)	0.0666 (-0.0000)	0.1450 (0.0002)	0.8608 (-0.0002)
	GHANIAN CEDI (GC)	0.5990 (0.0000)	0.0000 0.0000	0.1645 0.0001	-0.0452 0.0002	0.8579 0.0000
	LIBERIAN DOLLAR (LD)	0.8021 (0.0004)	0.0027 0.0000	0.0000 -0.0000	0.0000 0.0000	0.0000 0.0000
	Nigerian Naira (NN)	0.1279 (0.0000)	0.0000 0.0000	0.3275 0.0007	-0.1649 0.0012	0.6265 0.0003
	SIERRA LEONEAN Leone (SLL)	0.3846 (0.0002)	**0.0000 0.0000**	**0.0014 0.0000**	**0.2664 0.0017**	**0.7992 0.0006**
BEFORE WAMZ WAS FORMED	GAMBIAN DALASI (GD)	0.1645 (0.0006)	0.0000 0.0000	0.0888 0.0003	0.5609 0.0015	0.6305 0.0004
	GHANIAN CEDI (GC)	0.9184 (0.0002)	0.0000 (-0.0000)	0.1532 (-0.0020)	0.0100 (-0.0522)	0.8410 (-0.0009)
	LIBERIAN DOLLAR (LD)	0.0031 (0.0000)	0.0142 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
	Nigerian Naira (NN)	0.1604 (0.0001)	0.0000 (0.0000)	0.2833 (0.0030)	-0.0910 (0.0036)	0.7620 (0.0004)
	SIERRA LEONEAN Leone (SLL)	0.9129 (0.0001)	**0.1621 (0.0000)**	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
BEFORE LIBERIA JOINED	GAMBIAN DALASI (GD)	0.2726 (0.0001)	0.0000 (0.0000)	0.0616 (0.0001)	0.1525 (0.0002)	0.8619 (0.0002)
	GHANIAN CEDI (GC)	0.6607 (0.0001)	0.0000 (0.0000	0.1543 (0.0002)	-0.0560 (0.0003)	0.8734 (0.0001)

	LIBERIAN DOLLAR (LD)	0.0011 (0.0000)	0.0046 (0.0000	0.0000 -(0.0000)	0.0000 (0.0000)	0.0000 - (0.0000)
	Nigerian Naira (NN)	0.1563 (0.0000)	0.0000 (0.0000)	0.3115 (0.0004)	-0.1641 (0.0005)	0.7703 (0.0002)
	SIERRA LEONEAN LEONE (SLL)	0.4233 (0.0005)	**0.0000 (0.0000)**	**0.0000 (0.0000)**	**0.1769 (0.0004)**	**0.8726 (0.0001)**
GFC	GAMBIAN DALASI (GD)	0.2936 (0.0003)	0.0000 (0.0000)	0.0227 (0.0009)	0.2673 (0.0056)	0.7057 (0.0014)
	GHANIAN CEDI (GC)	0.5580 (0.0001)	0.0000 (0.0000)	0.1290 (0.0003)	-0.0012 (0.0000)	0.8485 (0.0002)
	LIBERIAN DOLLAR (LD)	0.1666 (0.0001)	0.0000 (0.0000)	0.0275 (0.0005)	0.1712 (0.0026)	0.6579 (0.0040)
	Nigerian Naira (NN)	0.3185 (0.0000)	0.0000 (0.0000)	0.3507 (0.0020)	-0.2061 (0.0024)	0.7521 (0.0004)
	SIERRA LEONEAN LEONE (SLL)	0.4303 (0.0001)	**0.0000 (0.0000)**	**0.0933 (0.0005)**	**0.1973 (0.0030)**	**0.8079 (0.0005)**
COVID19	GAMBIAN DALASI (GD)	1.4134e-04 (4.1551e-08)	0.0000 (0.0000)	0.4096 (0.0338)	1.1803 (0.6685)	0.0000 (0.0000)
	GHANIAN CEDI (GC)	4.8017e-04 (2.3821e-07)	0.0000 (0.0000)	0.0510 (0.0009)	-0.0302 (0.0025)	0.9302 (0.0007)
	LIBERIAN DOLLAR (LD)	1.3270e-05 (4.8159e-08)	0.0000 (0.0000)	0.6182 (0.0698)	-0.4720 (0.0780)	0.0000 (0.0000)
	Nigerian Naira (NN)	0.0014 (1.6982e-06)	0.0003 (0.0000)	0.0161 (0.0007)	-0.0161 (-0.1172)	0.0000 (0.0000)
	SIERRA LEONEAN LEONE (SLL)	8.6765e-05 (3.5221e-08)	**0.0000 (0.0000)**	**0.9998 (0.2850)**	**-0.8491 (0.2787)**	**0.0527 (0.0025)**

The numbers in parentheses are standard errors.

Source: Author's estimation based on dataset

All the estimations parameters appear to be standard. All the leverage parameters for the exchange rates are significantly positive indicating higher volatility when the currencies go down.

To determine whether the transformed series are Uniform (0,1), the Kolmogorov–Smirnov test is used and the residual series pass the goodness of-fit test for all the exchange rate returns. Given the focus of the paper is on dependence and contagion, after estimating the parameters of the marginal distributions for WAMZ exchange rate return series, we proceed to the next stage of the IFM, the estimation of the copula parameters, including the dependence parameter for contagion analysis.

4.3 Estimates from Copula Models

4.3.1 Analysis of the Whole Sample

For comparison with time-varying copula models, the estimated parameters of the constant copula models are presented in Table 4.1a for the constant Normal (Gaussian), Student t, Gumbel and SJC copula functions of the Whole sample. The value of the estimated copula parameter is given under the copula family and the next value, the Loglikelihood (LL), is given below the parameter estimated. It should also be noted that the optimal copula (in terms of log-likelihood) is one with lowest likelihood. The selected copula model is highlighted in green in all subsequent tables. From the table and all subsequent tables in 4.1, 4.2, 4.3, 4.4 and 4.5, ρ is the correlation parameter for the Normal copula, (ρ,υ) are the respective correlation parameter and degrees of freedom of student t copula, θ is the dependence parameters of the Gumbel copula while τ^U and τ^L are measures of the upper and lower tail dependences of the SJC copula.

It should be noted that all the copula functions have positive parameters for all exchange rate pairs, except for Ghanaian Cedi (GC)versus the Liberian Dollar (LD) exchange rate. That is an indication almost all the exchange rate series correlate positively with each other in the Whole sample.

The selected copula model for the Liberian Dollar (LD)/Sierra Leonian Leone (SLL) exchange rate pair is Student t, with the least negative log-likelihood, followed by Student t for the Gambian Dalasi (GD)/Liberian Dollar (LD) pair and then Gambian Dollar (GD)/Nigerian Naira (NN) pair based on SJC Copula. The copula model selected with the worst performance (the highest loglikelihood value) is Normal copula for GC versus the SLL, then Normal copula for SLL/NN pair and Normal copula for

GC/LD pair. According to the various copula functions given in Table 4.1a, it is evident that each exchange rate pair based on the Whole sample is captured by different copula functions.

The selection of Student t copula as the best copula implies the presence of symmetric tail dependence, while asymmetry in the tail dependence is also observed when the SJC Copula is selected as the best fitting copula. When normal copula is selected, the implication is that the co-movement between the relevant exchange rates is symmetric and lack of tail dependence for the relevant exchange rates as given by tail dependence measures computed and presented in table 4.1b to examine contagion for the Whole sample.

Table 4.1b presents estimates of the lower and upper tail dependence coefficients for the standardized residuals of the exchange rate pairs for the Whole sample. Upper (lower) tail dependence measures the dependence between the exchange rates on days when one rate depreciates (appreciates) against the other.

Regarding the asymmetric tail dependence, we see that the lower tail dependence parameter estimates of the Gumbel and SJC copulas are very low, with a value of 0.00 for most exchange rates while the upper tail dependence is higher in some cases with LD vs SLL presenting the highest tail dependence in this case. The symmetric tail dependence parameter estimates for the Student's t copula are also low, with a maximum value of 0.29 for the LD/SLL pair. This indicates that there are extreme dependences in this pair, which imply that extreme movements of the Liberian Dollar caused extreme movements of Sierra Leonean Leone currencies.

Next we consider two time-varying models for the conditional copula of these standardized residuals in Table 4.1c and the selected copula model is highlighted in green. For the Whole sample using time-varying copula, student t is the selected copula model for GD versus GC, GD versus LD, GD versus NN, GD versus SLL, LD versus NN, LD versus SLL. Normal is the selected copula model for GC versus LD and GC versus SL. Gumbel is the best model for GC versus NN and SLL versus NN.

LD versus SLL is, with the least negative log-likelihood, followed by Student t for GD versus LD and then GD versus NN based on SJC Copula. The copula model selected with the worst (the highest) Loglikelihood is by Normal copula for GC versus the SLL, then Normal copula for SLL versus the NN and Normal copula for GC versus LD. According to the various copula functions given in Table 4a, it is evident that each

exchange rate pair based on the Whole sample is captured by different copula functions.

We then analysed whether the time-varying copula improves the Loglikelihood over the constant copula. For the symmetric Student t constant copula produced -13.9 as Loglikelihood while its time-varying version gave 17.56 for GD versus GC. In almost all cases, the time-varying versions produced improvements on the Loglikelihood (LL) values, implying that the time-varying copula can explain the data much better than the constant copula.

4.3.2 Analysis of Pre-WAMZ Sample

It should be noted that all the copula functions have positive parameters for the Pre-WAMZ Sample as shown in Table 4.2a. That is an indication that all the exchange rate series correlate positively with each other in the Pre-WAMZ Sample. The selected copula model for all the exchange rates in this sample is Student t, except: GC versus NN whose optimal model is normal copula; LD versus SLL whose optimal model is Gumbel; and SL vs NN whose optimal model is SJC copula.

The selection of Student t copula as the best copula implies the presence of symmetric tail dependence, while asymmetry in the tail dependence is also observed when the SJC Copula is selected as the best fitting copula. When normal copula is selected, the implication is lack of tail dependence for the relevant exchange rates tail dependence as depicted in Table 4.2b for 'Before WAMZ was formed' Sample.

Student t is the selected copula model for GD versus GC, GD versus LD, GD versus NN, GD versus SLL and GC versus SLL. Normal is the selected copula model for GC versus NN and LD versus SL. Gumbel is the best model for GC versus LD, LD versus NN and SLL versus NN.

We then analysed whether the time-varying copula improves the LL over the constant copula for the 'Before WAMZ was formed' Sample. In almost all cases, the time-varying versions produced improvements on the LL values, implying that the time-varying copula can explain the data much better than the constant copula.

4.3.3 Analysis of Pre-Liberia WAMZ Membership Sample

It should be noted that not all the copula functions have negative parameters for the Pre-Liberia WAMZ Membership, also referred to as 'Before Liberia joined WAMZ', Sample as shown in Table 4.3a unlike the Whole and 'Before WAMZ was formed' samples that were positive. For the 'Before Liberia joined WAMZ' sample, Student t is

the selected copula model for GD versus GC, GD versus LD, GD versus SLL and GC versus SLL. Normal is the selected copula model for GC versus LD, GC versus SLL, LD versus NN and SLL versus NN while Gumbel is the best model for LD versus SLL. Finally, SJC Copula is the model for GD versus NN.

The selection of Student t copula as the best copula implies the presence of symmetric tail dependence, while asymmetry in the tail dependence is also observed when both the Gumbel and SJC copulas are selected as the best fitting copula models. When normal copula is selected, the implication is lack of tail dependence for the relevant exchange rates tail dependence.

From table 4.3b, the biggest tail dependence, both lower and upper, are from LD versus SLL with 0.7125 for Student t copula, with the next value being 0.3331 from Student t copula for GD versus LD. This indicates that there are extreme dependences in these pairs, which imply that extreme movements of these currencies caused extreme movements of the paired currencies. Other symmetric tail dependencies are quite low for the respective currency pairs. Regarding the asymmetric tail dependence, we see that the lower tail dependence parameter estimates of the SJC copulas are much lower than the corresponding upper tail dependence, when the two are non-zero values, except for GD versus LD. The highest is obtained for LD versus SL. The highest Gumbel copula-based tail dependence is also obtained for LD versus SLL exchange rate.

The selected copula models for the respective exchange rate vary between the constant and time-varying versions based on the 'Before Liberia joined WAMZ' sample. Student t is the selected copula model for GD versus LD, GD versus NN and GD versus SLL. Normal is the selected copula model for GC versus LD, GC versus SLL, LD versus NN and LD versus SL. Gumbel is the best model for GD versus GC, GC versus NN and SL versus NN. The SJC copula has not been selected as the best model for any exchange rate.

We then analysed whether the time-varying copula improves the loglikelihood over the constant copula for the Pre-Liberia WAMZ Membership Sample. In almost all cases, the time-varying versions produced improvements in the loglikelihood values, implying that the time-varying copula can explain the data much better than the constant copula.

4.3.4 Analysis of 2007-09 Global Financial Crisis Sample

It should be noted that not all the copula functions have positive parameters for the sample 2007-09 GFC (shown in Table 4.4a) and 'Before Liberia joined WAMZ' samples unlike the Whole and Pre-WAMZ Sample that were positive. For the 2007-09 GFC sample, Student t is the selected copula model for GD versus GC, GD versus LD, GD versus SLL , LD versus NN, LD versus SLL and SLL versus NN. Normal is the selected copula model for GD versus NN, GC versus LD, and GC versus SLL while SJC is the best model for GC versus NN. Finally, Gumbel Copula is the only model not selected as the ideal for any exchange rate.

The selection Student t copula as the best copula implies the presence of symmetric tail dependence, while asymmetry in the tail dependence is also observed when the SJC copula is selected as the best fitting copula model.

Table 4.4b, the biggest tail dependence, both lower and upper, are from student t copula as it is the most selected dependence structure for the exchange rates and it is much higher than the only instance when SJC copula is selected. The highest symmetric dependence as depicted by student t copula is for GD versus LD followed by GD versus SLL and then GD versus GC. GD versus NN, GC versus LD and GC versus SLL choose the Gaussian copula with no tail dependence.

The selected copula models for the respective exchange rate vary between the constant and time-varying versions based on the 2007-09 GFC sample. Student t is the selected copula model for GD versus GC, GD versus LD, GD versus SLL, LD versus SLL and SLL vs NN. Normal is the selected copula model for GD vs NN only. Gumbel is the best model for GC versus LD, GC versus NN, GC versus SLL and LD versus NN. The SJC copula has not been selected as the best model for any exchange rate.

In almost all cases, the time-varying versions produced improvements on the LL values for the 2007-09 GFC sample, implying that the time-varying copula can explain the data much better than the constant copula.

4.3.5 Analysis of COVID-19 Sample

Table 4.5a shows that for the GD versus NN exchange rate, SJC Copula is the selected model for the dependence structure but Normal copula has been selected as the ideal model for GC versus LD, LD versus NN and SLL versus NN of the COVID-19 sample. The dependence structure is best described by Student t copula for all other exchange rates. We observe that not all the dependence parameters are positive in the COVID-19 sample.

From Table 4.5b, the biggest tail dependence, both lower and upper, are from GD versus SLL with 0.5304 for Student t copula, with the next value being 0.1695 from Gumbel copula for GD versus LD as upper tail dependence. Out of the 10 currency pairs, 2 pairs show no tail dependence (GC versus LD and GC versus NN), 4 pairs exhibit symmetric tail dependence (GD versus GC, GD versus SLL, LD versus SLL and SLL versus NN) while 4 pairs exhibit only upper tail (GD versus LD, GD versus NN, GC versus SLL and LD versus NN).

The selected copula models for the respective exchange rates vary between the constant and time-varying versions based on the COVID-19 sample.

4.4 Contagion Analysis

This section examines the existence of the contagion effect in the exchange rate from one period to the other. In that regard, crises are increasing if the co-movement between two exchange rates is higher during the crisis period (GFC and COVID-19) than during tranquil periods (the Whole, Pre-WAMZ and Pre-Liberia WAMZ Membership) samples.

It is vital to note that copula functions model the dependence structure which implies that the higher the dependence parameter, the higher the integration or contagion between the respective exchange rate pairs relative to other periods. Consequently, the dependence parameters, Kendall's tau and tail dependence are computed for the different samples in order to get a good understanding of the contagion effect during the considered sub-periods. Table 4.6 consists of estimated dependence parameters from the selected constant copula models as described in Tables 4.1a, 4.2a, 4.3a, 4.4a and 4.5a. From the table, student t copula is the model that describes the structure of dependence structures for all the 5 samples, especially for the interdependence between GD and GC; GD and LD; and GD and SLL. The Pearson's linear correlation and Kendall tau rank correlation between the exchange rate pairs are estimated and also reported in Table 4.7.

TABLE 4.6: ESTIMATED VALUES OF DEPENDENCE PARAMETERS AND SELECTED PARAMETERS FOR ALL EXCHANGE RATES AND ALL SAMPLES

Exchange Rate/sample	Whole	Before WAMZ was formed	Before Liberia Joined	GFC	COVID19
GAMBIAN DALASI vs GHANIAN CEDI	0.0230, 15.7202 Student t	0.0523, 6.2013 Student t	0.0252,10.8077 Student-t	-0.0818, 7.3402 Student-t	0.0357, 4.0551 Student-t
GAMBIAN DALASI vs LIBERIAN DOLLAR	0.1698, 4.5788 Student t	0.6184,2.1624 Student t	0.4419, 2.3078 Student-t	0.0448,4.8312 Student-t	0.1786, 5.9956 Student-t
GAMBIAN DALASI vs NIGERIA NAIRA	{ 0.0000, 0.0046} SJC	0.0427,17.1966 Student t	0.0000, 0.7686 SJC	0.0167 Normal	0.0000, 0.2279 SJC
GAMBIAN DALASI vs SIERRA LEONEAN LEONE	{0.1672, 3.3761} Student t	0.5737,2.4156 Student t	0.3478, 3.1746 Student-t	0.0056,6.7970 Student-t	0.7240, 2.1000 Student-t
GHANIAN CEDI vs LIBERIAN DOLLAR	-0.0140 Normal	0.0169,4.6103 Student t	-0.0227 Normal	-0.0291 Normal	0.0109 Normal
GHANIAN CEDI vs NIGERIAN NAIRA	{0.0138,33.3074 } Student t	-0.0125 Normal	0.0249,17.0073 Student-t	0.0130, 0.0000 SJC	-0.0015, 16.4093 Student-t
GHANIAN CEDI vs SIERRA LEONE	0.0028 Normal	0.0106,5.8353 Student t	-0.0065 Normal	-0.0201 Normal	-0.0719, 5.3833 Student-t
LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.0277,99.0280 Student t	0.0878,9.3112 Student t	0.0279 Normal	0.0111,23.4854 Student-t	-0.0348 Normal
LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.3340, 2.1802 Student t	3.3441 Gumbel	1.6535 Gumbel	0.0168,15.5249 Student-t	0.0270,3.5607 Student-t
SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	0.0044 Normal	0.0093,0.0000 SJC	0.0098 Normal	-0.0292, 15.7384 Student-t	0.1937 Normal

Source: Author's estimation based on dataset

For the contagion effect based on the Whole and 'Pre-Liberia WAMZ Membership' samples, the dependence parameter were positive for all exchange rates except for GC versus LD, Pre-WAMZ has all positive parameters except for GC versus NN, COVID-19 sample has all positive parameters except for GC versus NN, LD versus NN and GC versus SLL while the 'GFC' sample has GD vs GC, GC vs LD and SLL versus NN have negative dependence parameter while the rest of the currency pairs in the sample have positive parameters. When the copula functions have positive parameters, then it is an indication that all the affected exchange rate series correlate positively with each other in the relevant sample.

The crisis periods are represented by 2007-09 GFC and COVID-19 samples with each period having three negative parameters among three currency pairs signalling negative correlation between them.

For GD versus GC, 'Pre-Liberia WAMZ Membership' period showed contagion effect of the Gambian Dalasi negatively transmitted to the Ghana Cedi after the GFC crisis

period but positively transmitted to the Ghanaian Cedi after the COVID-19 crisis. In terms of interdependence, the Whole period has the least dependence (integration) between the currency pairs, increased slightly within the period 'Pre-Liberia WAMZ Membership' and then during increased COVID-19 pandemic. The dependence between this currency pair increased further during Pre-WAMZ period and was highest during the 2007-08 global financial crisis. In addition, as the static Student t copula is the dependence model for GD versus GC pairs, this confirms the presence of tail dependence for these pairs which in turn implies that the extreme movement of the Ghanaian return causes the extreme movements in the currency markets of Gambian Dalasi.

The static Student t copula is the dependence model for GD versus LD pairs in the 5 periods or samples. This implies that the extreme movement of the Ghanaian Cedi return causes the extreme movements in the returns of the Liberian Dollar. There is no evidence of contagion effect from stable to crisis periods for this exchange rate. In terms of interdependency, the 2007-08 global financial crisis period has the least dependence(integration) between the currency pairs, the Whole sample is slightly more dependent, COVID-19 pandemic period is more dependent and the period 'Pre-Liberia WAMZ Membership' has the second highest dependent period while the period 'Pre-WAMZ' has the highest dependence for this exchange rate.

A notable feature of GD versus NN exchange rate is that the 5 different samples have 3 distinct copula families representing the dependence parameters. There is no evidence of contagion effect from stable to crisis periods for this exchange rate. In terms of interdependence, the entire time period (Whole sample) has the least dependence between the exchange rates, the next improved dependence period is given by the 2007-08 global financial crisis while the period with the third dependence(integration) between the currency pairs is Pre-WAMZ. The period with the highest dependence is 'Pre-Liberia WAMZ Membership' closely followed by COVID-19 pandemic period. [2] Furthermore, for this exchange rate, the Normal copula (with tail independence) characterizes the 2007-08 global financial crisis period, the SJC copula is the selected copula for tranquil times (Whole and 'Pre-Liberia WAMZ Membership') as well as COVID-19 crisis period , while the Student copula (tail dependence) turns out to be the selected copula model for 'Pre-WAMZ' period that is considered to be a period of tranquility.

[2] The dependence parameter of the SJC copula is computed as the average of the upper and lower tail dependence parameters

For GD versus SLL exchange rate, there is evidence of contagion effect for 'Pre-Liberia WAMZ Membership' and Pre-WAMZ periods. There was a positive transmission between the currencies during the COVID-19 crisis. In terms of interdependency, the period with the least dependence was during the 2007-08 global financial crisis, then the Whole period with increased dependence for the period 'Pre-Liberia WAMZ Membership' and then increased during 'Pre-WAMZ' period. The highest dependence is observed during COVID-19 pandemic. In addition, as the static Student t copula is the dependence model for GD versus SLL currency pairs, this confirms the presence of tail dependence for these pairs which in turn implies that the extreme movement of the Ghanaian Cedi return causes the extreme movements in the currency markets of Sierra Leonean Leone.

The reason for increase of dependence during crisis periods may be due to speculation or as investors seek to realize a long-term benefit by selling or purchasing specific assets. This activity leads to change in value or volatility of the exchange rate and impacts the dependence measure. The increase of the dependence measures during the crisis period is evidence of contagion among the affected currencies during the relevant periods. As investigated by Patton (2006) asymmetric dependence between exchange rates in WAMZ countries exist and could be due to asymmetric central bank behavior and currency portfolio rebalancing strategies.

The Ghanaian Cedi versus the Liberian Dollar also exhibited no sign of contagion effect but exhibited a negative dependence in some periods and only one period with symmetric tail dependence based on the selection of student t copula as the dependence model. The Ghanaian Cedi versus the Nigerian Naira also exhibited no sign of contagion effect between the stable and crisis periods, but showed some negative dependence in some periods and only one period with no tail dependence (Normal copula), one period of asymmetric dependence (SJC copula) and 3 periods of symmetric tail dependence based on the selection of student t copula as the dependence model.

For Ghanaian Cedi versus Sierra Leonean Leone, there is evidence of contagion effect from the stable periods ('Pre-Liberia WAMZ Membership', 'Pre-WAMZ' and Whole samples) to crisis periods (GFC and COVID-19). Also, some of the dependent models are normal (tail independence) while some are student t (symmetric tail dependence).

Similar to the Ghanaian Cedi versus Liberian Dollar and Ghanaian Cedi versus Sierra Leonean Leone exchange rates, there is no evidence of contagion effect but the

analysis exhibited a negative dependence in some periods and 3 periods with symmetric tail dependence based on the selection of student t copula as the dependence model. Liberian Dollar versus Sierra Leonean Leone also portrayed no evidence of contagion effect between the currency pair but exhibited positive dependence in all the periods and 3 periods with symmetric tail dependence based on the selection of student t copula as the dependence model with two asymmetric tail dependence with the selection of Gumbel as the dependence model.

For Sierra Leonean Leone versus Nigerian Naira, there is evidence of contagion effect from the stable periods (Pre-Liberia WAMZ Membership', 'Pre-WAMZ' and Whole samples) to crisis periods (GFC and COVID-19) although the transmission was negative during the global financial crisis. The reason for the extreme co-movement of the currency pairs could be due to the tight integration of financial market channels or trade improvement within these particular time periods. Also, some of the dependent models are normal (tail independence), one is student t (symmetric tail dependence) and another is SJC copula (asymmetric tail dependence).

The Pearson's linear correlation and Kendall tau rank correlation between the exchange rate pairs are estimated and also reported in Table 4.7. B4WAMZ stands for 'Pre-WAMZ' while B4Lib represents 'Pre-Liberia WAMZ Membership'.

TABLE 4.7: ESTIMATED RANK AND LINEAR CORRELATION MEASURES

	Rank and Linear Correlation											
	Exchange Rates	Whole Sample kendall	Linear	B4WAMZ kendall	Linear		B4Lib Kendall	Linear		GFC Kendall	Linear	COVID19 Kendall	Linear
	GAMBIAN DALASI vs GHANIAN CEDI	0.0172	0.0336	0.0458	0.0234		0.0294	0.0431		-0.0464	-0.0589	0.0531	0.0188
	GAMBIAN DALASI vs LIBERIAN DOLLAR	0.0046	0.0063	0.0189	0.0040		0.0188	0.0054		0.0071	0.0697	0.1176	0.1527
	GAMBIAN DALASI vs NIGERIAN NAIRA	0.0245	0.0272	0.0156	0.0089		0.0204	0.0312		0.0126	0.0196	-0.0053	-0.0049
	GAMBIAN DALASI vs SIERRA LEONEAN LEONE	0.0099	-0.0079	0.0331	0.0063		0.0026	**-0.0043**		0.0077	0.0151	0.1837	0.3696
	GHANIAN CEDI vs LIBERIAN DOLLAR	-0.0112	0.0076	0.0120	0.0169		**-0.0020**	0.0081		-0.0138	**0.0022**	0.0155	-0.0086

	GHANIAN CEDI vs NIGERIAN NAIRA	0.0133	-0.0299	**-0.0120**	-0.0163		0.0237	-0.0175		0.0411	0.0664	0.0216	**-0.0149**
	GHANIAN CEDI vs SIERRA LEONEAN LEONE	0.0047	**0.0014**	-0.0044	-0.0262		0.0046	**0.0034**		-0.0120	-0.0338	-0.0337	0.0041
	LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.0076	-1.4833e-04	0.0300	0.0052		0.0157	0.0035		0.0171	-0.0126	-0.0763	-0.0064
	LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	-0.0058	**-7.133 4e-05**	-7.0425e-04	-0.0019		-0.0193	-.5518e-04		0.0019	-0.0193	-0.0095	0.0695
	SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	**-0.0022**	-0.0052	0.0279	0.0184		**0.0045**	-0.0060		-0.0109	-0.0747	-0.0093	0.0566

Source: Author's estimation based on dataset

Both Kendall's tau and Pearson correlation are not very strong for all exchange rates and all samples. Also, in the Whole sample, there are more positive correlations than negative according to Kendall's tau while the reverse is the case for Pearson correlation. B4WAMZ sample has only 3 negative correlations while the rest are positive for both Kendall's and Pearson. B4Lib sample has 2 negative correlations according to Kendall's and 4 based on Pearson measure. Pearson has 5 negative while Kendall's tau has 4 negative correlations for GFC sample and COVID-19 sample resulted in Pearson correlation having 4 negative values while Kendall's tau has 5 negative correlations.

We can therefore infer the following from the results of the analysis:

- In the case of Liberian dollar versus Nigerian Naira exchange rate, Kendall tau correlation has a negative value but significantly highest during COVID-19. The period with the next highest value but several magnitudes lower is 'before WAMZ was formed', then followed by the '2007-09 global financial crisis' period. The next period, which has the fourth highest tau is 'before Liberia joined WAMZ' while the period for the Whole sample has the least tau. The increase of the dependence measure during the COVID19 crisis can be taken to be evidence of contagion between the two economies during this period.

- For the Ghanaian Cedi versus Sierra Leonean Leone, the tau correlation values are several magnitudes highest in the COVID-19 period among the different periods and negative. This is followed by negative correlation in the 2007-2009 global financial crisis period. The Whole sample, 'before Liberia joined WAMZ'

and 'before WAMZ was formed' are the next three periods, in slightly decreasing value of tau. It should be noted that the increase of the dependence measures during the crisis periods can be taken to be evidence of contagion between the two currencies during these periods.

- For the Ghanaian Cedi versus Nigerian Naira, tau values are relatively highest during 2007-2009 global financial crisis, which is followed by the tau values in the pre-Liberia WAMZ membership period. The third highest value of association is found in the COVID19 sample period. The period with the fourth highest tau value is the Whole sample while that with fifth highest tau or the least tau value is 'before WAMZ was formed'. This sample has a negative association as seen in the negative tau value. The increase of the dependence measure during the 2007-09 global financial crisis period is an indication of contagion between the two economies during this period.

- For the Ghanaian Cedi versus the Liberian Dollar, Kendall tau values are relatively highest during COVID-19, followed by negative association during '2007-09 global financial crisis' and the third tau value is 'before WAMZ was formed' period. The period with the fourth highest value of tau is the Whole sample while 'before Liberia joined WAMZ' period has the least but negative association. The increase of the dependence measures during the crisis periods can be taken to be evidence of contagion between the two economies during these periods.

- In the case of Gambian Dalasi versus Sierra Leonean Leone, Kendall tau correlation value is significantly highest during COVID-19, then followed by, but several magnitudes less, by 'before WAMZ was formed' as the period with the second highest tau. The period with third highest tau is the Whole sample followed by during '2007-09 global financial crisis' with the next least association. The period with the least tau is 'before Liberia joined WAMZ'. The increase of the dependence measure during the COVID-19 crisis can be taken to be evidence of contagion between the two economies during this period due to heightened risks in the respective economies coupled with trade or tight integration of their financial markets.

- For Gambian Dalasi versus Nigerian Naira, tau correlation value is highest for the Whole time period, followed by 'before Liberia joined', then 'before WAMZ was formed' as the period with the third highest tau. The 2007-09 global financial crisis period has the fourth highest tau while the least tau value is

obtained during COVID-19 and it's a negative association. Arguably, there is no evidence of contagion between these two currencies.

- For Gambian Dalasi versus Liberian Dollar, the tau correlation value is significantly highest during COVID-19, then followed by, but several magnitudes less, 'before WAMZ was formed' as the second highest tau. That is closely followed by 'before Liberia joined WAMZ' then followed by the '2007-09 global financial crisis' periods. The least tau value and hence least association of this exchange rate is obtained from the Whole time period. The increase of the dependence measure during the COVID19 crisis can be taken to be evidence of contagion between the two economies during this period.

- For Gambian Dalasi versus Ghanaian Cedi, the highest tau correlation values and therefore the highest associations, in decreasing order are during COVID-19, during '2007-09 global financial crisis, then 'before WAMZ was formed' periods. The least tau values and corresponding low associations are from 'before Liberia joined WAMZ' and Whole sample periods. The increase of the dependence measures during the crisis periods can be taken to be evidence of contagion between the two economies during these periods.

- The highest value of Kendall tau for Liberian Dollar versus Sierra Leonean Leone was negative and obtained in the 'before Liberia joined WAMZ' sample. In the case of Sierra Leonean Leone versus Nigerian Naira exchange rate, the highest value is obtained 'before WAMZ was formed'. The crisis periods are not the highest and therefore, there is no evidence of contagion during these periods.

As earlier noted, the reason for increase of dependence during crisis periods may be due to speculation or as investors seek to realize a long-term benefit by selling or purchasing specific assets. Consequently, the dependence measure is impacted due to change in value or volatility of the exchange rate.

5.0 CONCLUSIONS AND POLICY RECOMMENDATION

In this paper we investigated the presence of dependence and contagion between the exchange rates of West African Monetary Zone (WAMZ) countries against USD using Pearson linear and rank correlations as well as copula functions over the period 1995 to 2020. We study interdependence and contagion in the WAMZ foreign exchange markets using the following static and time-varying bivariate copulas: Normal or Gaussian, Clayton, Gumbel, Student t and Symmetrized Joe–Clayton (SJC) copulas. The data used in the study, consisted of the whole sample (10th July 1995-7th

October 2020), 10th July 1995- 31st December 1999 (before WAMZ was constituted), 10th July 1995-31st December, 2009 (WAMZ before the admission of Liberia), 1st January 2008-31st December, 2010 (global financial crisis) and 1st March 2020-7th October, 2020 (COVID-19 pandemic). We study different periods so as to find evidence of changing dependence structures during major events in the life of WAMZ and in financial turmoil, like the COVID-19 pandemic. The dependence among the exchange rates is modelled by the copula parameter, tail dependence and Kendall's tau. The reason for fitting copulas with diverse tail behavior makes us to investigate periods of increased dependence can be also characterized by changes in one or both tails of the distribution. time-varying copulas are used to capture changes in the dependence structure among the exchange rates.

The results indicate significant changes at the dependence level, tail behavior and asymmetry structures between returns of the exchange rates and there is evidence of increased dependency among most currencies after the 2007-09 global financial crisis and during the COVID-19 pandemic. The results are consistent with earlier findings on the existence of asymmetry in exchange rates and confirms increase in dependence during crisis periods. It is very important to identify contagion or interdependence between pairs of exchange rates to guide direction of exchange rate policies in both WAMZ and African sub-region. Also, short-term policies like capital controls or foreign currency interventions by central bank may not be effective in insulating an economy from a crisis that started abroad. Therefore, central banks, regulatory institutions, traders and analysts should identify the interdependence or contagion among currency pairs for effective risk management, hedging, portfolio diversification or other key policy decisions.

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Appendix

Table 4.1a: Estimated Copula Parameters And Log-Likelihood (LI) Values For Constant Copula Of Whole Sample Of The Standardized Residuals Of The 5 Exchange Rates.

		Constant Copula				
	Parameters	**Normal (ρ) LL**	**Student-t (ρ,υ) LL**		**Gumbel (θ) LL**	**SJC (τ^L, τ^U) LL**
whole	GAMBIAN DALASI vs GHANIAN CEDI	(0.0261) -2.2522	**(0.0230, 15.7202) -13.9224**		(1.1100) 51.3691	(0.1298, 0.0000 -6.8073
	GAMBIAN DALASI vs LIBERIAN DOLLAR	(0.0986) -32.1774	0.1698, 4.5788 -112.7922		**(1.1000) -52.1256**	(0.0461, 0.0000 -44.1929
	GAMBIAN DALASI vs NIGERIAN NAIRA	(0.0513) -8.6953	**(0.0511, 20.7208) -16.1157**		(1.1000) 39.4359	(0.0000, 0.0046} -16.5511
	GAMBIAN DALASI vs SIERRA LEONEAN LEONE	(0.0674) -14.9901	(0.1672, 3.3761) -129.3151		(1.1000) -30.8041	**(0.0129,0.0000) -21.9545**
	GHANIAN CEDI vs LIBERIAN DOLLAR	(-0.0140) -0.6430	**(-0.0146, 99.9952) 2.3913**		(1.1000) 103.5240	**(0.7728, 0.0174) 6.3463**
	GHANIAN CEDI vs NIGERIAN NAIRA	(0.0120 -0.4751	(0.0138,33.3074) -3.2856		(1.1000) 66.0906	**(0.2312,0.0000) 1.3642**
	GHANAN CEDI vs SIERRA LEONEAN LEONE	(0.0028) -0.0267	(0.0027, 99.9999) 5.4071		(1,1000) 101.9024	(0.7062, 0.0597) 5.3772
	LIBERIAN DOLLAR vs NIGERIAN NAIRA	(0.0268) -2.3749	(0.0277,99.0280) -2.7554		(1.100) 67.6501	(0.0000, 0.2197) -2.6250
	LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	(0.1160) -44.6228	(0.3340, 2.1802) -281.4035		(1.1384) -110.5944	(0.1141, 0.0000) -95.2861
	SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	(0.0044) -0.0641	(0.0050 99.9903) 1.7370		(1.1000) 90.0028	(0.8680 0.0817) 3.4890

Table 4.1b: Tail Dependence For Whole Sample

		GD vs GC		GD vs LD		GD vs NN		GD vs SL		GC vs LD	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
whole	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.12 21	0	0.1221	0	0.1221	0	0.1221
	Student t (λ^L, λ^U)	0.0010	0.0010	0.0973	0.0973	0.0002	0.0002	0.1458	0.1458	0 0.0000	0
	SJC copula	0.0000	0.0001	0.0000	0.0461	0.0046	0.000	0.0046	0.0129	0.0000	0.0000

		GC vs NN		GC vs SL		LD vs NN		LD vs SL		SL vs NN	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
whole	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1221	0	0.1221	0	0.1617	0	0.1221
	Student's t	0	0	0	0	0.0000	0.0000	0.2922	0.2922	0 0.000	0
	SJC copula	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.1141	0.0000	0.0000

Table 4.1c: Estimated Copula Parameters And Log-Likelihood (LI) Values For Time-Varying Copula

	Time-Varying Copula for Whole **Sample**				
Parameters	**Normal** **(ω, α, β)** **LL**	**Student-t** **(ω^1,α^1,β^1, ω^2,α^2,β^2)** **LL**		**Gumbel** **(ω, α, β)** **LL**	**SJC** **(ω^L,α^L,β^L, ω^U,α^U,β^U)** **LL**
GAMBIAN DALASI vs GHANIAN CEDI	{0.0968,0.1196,-1.9977} -4.0342	{0.0853, 0.0622,-1.7331 0.0691, 1.7977,-0.0564} **-17.5675**		{-1.7900 -1.7453 -1.7028} -11.8403	{-38.4123,-15.899, -28.0630 -22.9207,-8.7899,-15.4812} -0.1821
GAMBIAN DALASI vs LIBERIAN DOLLAR	{0.3742,0.3421,-2.0225} -43.7741	{0.4575 0.4140 -0.7957 -2.4047 -1.3428 -0.2457} -134.0155		**{0.8897,-1.1147,0.0377} -69.8953**	{-38.4258,-14.3334,-28.3693 -22.0874 ,-8.2068,-14.9524} -35.6723

GAMBIAN DALASI vs NIGERIAN NAIRA	{0.0055,0.0191,1.8684} -14.8852	{0.0056,0.0192 ,1.8471 6.9067,11.0215 ,-0.0647} -36.7398		{-0.2664 -0.3566 1.5265} -23.5500		{-38.4367,-15.7474,-28.1334 -21.1431,-7.9940,-14.3883} -10.4924
GAMBIAN DALASI vs SIERRA LEONEAN LEONE	{0.1799,0.4686,-0.8962} -45.7455	{0.3952,0.5236,-0.4641 -3.4062,-2.9651,-0.1459} -173.7289		{0.8911,-1.1197,0.1541} -79.3641		{-38.4320,-14.5424,-28.3340 -21.4505,-8.2635,-14.5664} -20.1755
GHANIAN CEDI vs LIBERIAN DOLLAR	{-0.0434,-0.1378,-0.8811} -1.9086	{-0.0553 -0.1175 -1.9150 3.0648 11.2185 3.3683} 1.0254		{0.6404,-0.9660,0.8788} -1.6897		{-38.4051,-16.3911,-7.9348 -23.4169,-9.2672,-15.7892} 31.3832
GHANIAN CEDI vs NIGERIAN NAIRA	{0.0559 0.0663 -1.9995} -1.6069	{ 0.0578 0.0317 -1.9994 -0.9136 0.2240 0.4442} -3.2839		{ -0.1115 0.6169 -1.1992} -11.6508		{-38.4164,-16.2184,-28.0046 -22.4670,-8.8499,-15.2084} 12.6803
GHANIAN CEDI vs SIERRA LEONEAN LEONE	{0.0048 0.1341 -0.0251} -2.3182	{0.0014,0.0975,0.3105 - 13.8367,17.0892,0.5400} -2.1320		{1.9149 -1.7023 -0.5458} 0.1387		{-38.4228,-15.9296,-28.0854 -22.2605,-8.5571,-15.0828} 27.4426
LIBERIAN DOLLAR vs NIGERIAN NAIRA	{0.0942 0.1096 -1.7950} -3.6353	{0.0980 0.0757 -1.7870 1.2021 9.9642 0.5532} -3.8251		{4.7434 -4.4028 -0.4886} -1.5928		{-38.4355,-15.8854,-28.1086 -21.3139,-8.1221,-14.4921} 7.5710
LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	{0.2648 0.5427 -0.4990} -102.8930	{0.0132 0.0728 2.0942 -6.6864 -2.9593 -0.2739} -477.3132		{0.8901 -1.1148 0.0083} -135.6807		{-39.1505,-14.9303,-27.6032 -25.8341,-10.5357,-17.2138} -43.1828
SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	{0.0181 0.0895 -1.7034} -0.6395	{0.0200 0.0660 -1.7033 1.0964 1.6203 0.8611} 1.2224		{1.8200 -1.3799 -0.9765} -6.0634		{-38.4225,-16.1565,-28.0400 -22.1040,-8.7498,-14.9839} 21.9421

Table 4.2a: Estimated Copula Parameters And Log-Likelihood (LI) Values For Constant Copula Of 'Pre-Wamz' Of The Standardized Residuals Of The 5 Exchange Rates.

		Constant Copula			
	Parameters	**Normal (*Kappa*) LL**	**Student-t (ω,α,β) LL**	**Gumbel (ω, α, β) LL**	**SJC (ω^L,α^L,β^L) LL**
PRE-WAMZ	GAMBIAN DALASI vs GHANIAN CEDI	(0.0683) -2.7326	**(0.0523, 6.2013) -13.6894**	(1.1000) -0.6928	**(0.0043, 0.0034) -5.7921**
	GAMBIAN DALASI vs LIBERIAN DOLLAR	(0.3811) -91.7128	(0.6184,2.1624) -233.1950	**(1.4231) -114.3440**	**(0.1407, 0.3929) -119.7373**
	GAMBIAN DALASI vs NIGERIAN NAIRA	(0.0408) -0.9725	**(0.0427,17.1966) -2.2331**	(1.1000) 3.8049	**(0.0014,0.0000) -2.1260**
	GAMBIAN DALASI vs SIERRA LEONEAN LEONE	(0.3544) -78.4293	(0.5737,2.4156) -182.7947	(1.3823) -100.6593	**(0.1980, 0.2771) -93.0506**
	GHANIAN CEDI vs LIBERIAN DOLLAR	(0.0253) -0.3742	**(0.0169,4.6103) -20.9528**	(1.1000) -5.0219	**(0.0401,0.0000) -8.8801**
	GHANIAN CEDI vs NIGERIAN NAIRA	(-0.0125) -0.0911	(-0.0121,99.9986) 0.1581	(1.1000) 19.6793	**(0.0054,0.3598) 2.0028**
	GHANIAN CEDI vs SIERRA LEONEAN LEONE	(0.0048) -0.0136	(0.0106,5.8353) -12.8398	(1.1000) -0.4095	(0.0025, 0.0000) -3.7230
	LIBERIAN DOLLAR vs NIGERIAN NAIRA	(0.0778) -3.5483	(0.0878,9.3112) -8.1377	(1.1000) -5.9606	(0.0078,0.0000) -7.2870
	LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	(0.7027) -397.9922	(0.9000,2.1000) -1.2672e+03	(3.3441) -713.0700	(0.4996, 0.7821) -608.5614
	SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	(0.0613) -2.2005	(0.0629,99.9612) -2.1425	(1.1000) 3.9204	(0.0093,0.0000) -3.0029

4.2b: Tail Dependence For 'Pre-Wamz' Sample

	GD vs GC		GD vs LD		GD vs NN		GD vs SL		GC vs LD	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Normal	0	0	0	0	0	0	0	0	0	0
Gumbel	0	0.12221	0	0.3725	0	0.1221	0	0.3489	0	0.1222
Student's t	0.0374	0.0374	0.4484	0.4484	0.0007	0.0007	0.3992	0.3992	0.0617	0.0617

	SJC copula	0.0034	0.0043	0.3929	0.1407	0.0010	0.0014	0.2771	0.1980	0.0000	0.0401

		GC vs NN		GC vs SL		LD vs NN		LD vs SL		SL vs NN	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1221	0	0.1221	0	0.7697	0	0.1221
	Student's t	0	0	0.0369	0.0369	0.0143	0.0143	0.7125	0.7125	0.0000	0.0000
	SJC copula	0.0000	0.0000	0.0000	0.0025	0.0000	0.0078	0.7821	0.4996	0.0034	0.0093

Table 4.2c: Estimated Copula Parameters And Log-Likelihood (LI) Values For Time-Varying Copula 'Pre-Wamz' Sample

	Time-Varying Copula for BEFORE WAMZ WAS FORMED Sample				
Parameters	Normal (ω, α, β) LL	Student-t (ω^1,α^1,β^1, ω^2,α^2,β^2) LL		Gumbel (ω, α, β) LL	SJC (ω^L,α^L,β^L, ω^U,α^U,β^U) LL
GAMBIAN DALASI vs GHANIAN CEDI	0.3258 -0.1360 -1.9469 -3.1724	{ 0.2547 -0.0606 -1.9358 -1.1197 -0.7633 -0.1787} -16.3705		1.4563 -1.5433 -0.1551 -4.4630	{ -38.58,-14.801,-27.8182 -20.46,-7.46,-13.8053} -5.5998
GAMBIAN DALASI vs LIBERIAN DOLLAR	0.0578 0.0928 1.8035 -101.7034	-0.2479 0.0322 2.7013 -3.9145 -11.0231 -11.045 -237.7496		0.9194 -1.1027 -0.0072 -56.8556	{ -31.156,-15.347,-30.6479 1.8903,-12.8024,-39.9991} -132.9222
GAMBIAN DALASI vs NIGERIAN NAIRA	0.1675 -0.1781 -1.9130 -1.6020	0.1985 0.0147 -2.0045 -4.9042 1.5923 0.0955 -13.6331		0.0512 0.4160 -0.8866 -4.0955	{-38.557,-15.2494,-27.5487 -22.1998,-8.2906,-14.8422} -0.7493
GAMBIAN DALASI vs SIERRA LEONEAN LEONE	0.0507 0.1029 1.7859 -89.1707	-0.0544 0.0884 2.3035 -13.8402 -25.4213 -1.4387 -191.8606		0.9132 -1.1074 -0.0088 -59.0256	{ -3.3101 4.3475 -2.6755 -1.9467 -0.8860 4.1657} -160.6741
GHANIAN CEDI vs LIBERIAN DOLLAR	0.1986 -0.3985 -1.9370 -5.4163	0.1915 -0.3084 -1.9333 1.5217 -0.1398 2.0354 -6.8246		-0.4398 0.9807 -1.9403 -11.7538	{-38.5198,-15.4623,-27.5025 -25.4510,-9.7385,-16.7075}

						-2.2698
GHANIAN CEDI vs NIGERIAN NAIRA	-0.0594 0.3249 -.0233 -2.7004	-0.0571 0.2586 -2.0233 1.5708 0.5251 0.1990 -2.2400		-0.8630 1.2018 -0.7566 -0.9456		-38.5704 -16.086 -27.4783 -21.0324 -8.1458 -14.2153 5.1196
GHANIAN CEDI vs SIERRA LEONEAN LEONE	0.0937 -0.6342 -1.9569 -10.0202	0.0864 -0.5087 -1.9556 1.3532 -3.9635 2.1225 -11.3272		-1.7144 1.7649 -0.9882 -6.4842		-38.5184,-15.399,-27.4877 -25.7912,-10.0422,-16.9064 0.8348
LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.3228 0.0542 -2.0216 -7.6636	0.3362 -0.0042 -1.9405 -1.7556 -0.3182 -0.0742 -8.1951		0.3229 0.3054 -1.0913 -13.1189		-38.5287,-15.6618 -27.4294 -24.1948 -9.3751 -15.9393 -4.6137
LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	2.4390 -0.0682 -0.8680 -398.7192	15.0667 -0.1114 -8.4623 -39.9836 8.6954 -4.9883 -2.1235e+03		1 -1 0 1000000		-0.7092 18.2245 -2.0936 -2.5712 -3.9284 5.4720 -367.3398
SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	0.2195 -0.0319 -1.6779 -2.2268	0.2208 -0.0339 -1.6353 0.4188 4.5456 3.3052 -2.1835		-0.1243 0.6491 -1.0607 -6.2976		-38.545,-15.746,-27.4457 -23.0006,-8.9428,-15.2225 -1.3063

Table 4.3a: Estimated Copula Parameters And LI Values For Constant Copula Of 'Before Liberia Joined Wamz' Of The Standardized Residuals Of The 5 Exchange Rates.

		Constant Copula			
	Parameters	Normal (*Kappa*) LL	Student-t (ω, α, β) LL	Gumbel (ω, α, β) LL	SJC ($\omega^L, \alpha^L, \beta^L$) LL
BEFORE LIBERIA JOINED WAMZ	GAMBIAN DALASI vs GHANIAN CEDI	0.0340 -2.1908	0.0252,10.8077 -17.1182	1.1000 11.6408	0.0020,0.0000 -7.9005
	GAMBIAN DALASI vs LIBERIAN DOLLAR	0.2170 -91.0732	0.4419, 2.3078 -278.3762	1.2101 -122.8971	0.0624, 0.1354 -108.6470
	GAMBIAN DALASI vs NIGERIAN NAIRA	0.0365 -2.5144	0.0365,50.711 -3.2793	1.1000 33.2221	0.0000, 0.7686 -5.0051
	GAMBIAN DALASI vs	0.1862 -66.6491	0.3478, 3.1746 -143.9108	1.1632 -79.3939	0.0499,0.0660 -66.6551

	SIERRA LEONEAN LEONE						
	GHANIAN CEDI vs LIBERIAN DOLLAR	-0.0227 -0.9757	- 0.0235,99.9992 4.1315		1.1000 82.3610		0.9810, 0.0268 6.5720
	GHANIAN CEDI vs NIGERIAN NAIRA	0.0194 -0.7144	0.0249,17.0073 -6.0643		1.1000 29.2995		0.0544, 0.4994 -0.6765
	GHANIAN CEDI vs SIERRA LEONEAN LEONE	-0.0065 -0.0790	-0.0072, 99.9969 6.2579		1.1001 79.7049		0.1027, 0.0041 5.7932
	LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.0279 -1.4750	0.0282, 99.9302 -0.5274		1.1000 38.8586		0.0009, 0.4846 -0.5715
	LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.3649 -269.8682	0.9000, 2.1000 -2.2017e+03		1.6535 -574.3946		0.3968, 0.2726 -436.1532
	SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	0.0098 -0.1819	0.0106,99.9999 2.8001		1.1000 56.0124		0.1360, 0.0143 2.8376

4.3b: Tail Dependence For 'Before Liberia Joined Wamz' Sample

		GD vs GC		GD vs LD		GD vs NN		GD vs SL		GC vs LD	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.2268	0	0.1221	0	0.1853	0	0.1221
	Student's t	0.0059	0.0059	0.3331	0.3331	0.0000	0.0000	0.2254	0.2254	0.0000	0.0000
	SJC copula	0.0000	0.0020	0.1354	0.0624	0.0008	0.0000	0.0660	0.0499	0.0000	0.0000

		GC vs NN		GC vs SL		LD vs NN		LD vs SL		SL vs NN	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper

	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1221	0	0.1221	0	0.4793	0	0.1221
	Student's t	0.0006	0.0006	0.0000	0.0000	0.0000	0.0000	0.7125	0.7125	0.0000	0.0000
	SJC copula	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2726	0.3968	0.0000	0.0000

Table 4.3c: Estimated Copula Parameters And Log-Likelihood (LI) Values For Time-Varying Copula

	Time-Varying Copula for BEFORE LIBERIA JOINED WAMZ Sample				
Parameters	Normal (ω, α, β) LL	Student-t (ω^1,α^1,β^1, ω^2,α^2,β^2) LL		Gumbel (ω, α, β) LL	SJC (ω^L,α^L,β^L, ω^U,α^U,β^U) LL
GAMBIAN DALASI vs GHANIAN CEDI	0.1125 0.1415 -1.6722 -3.3341	0.1087 0.1002 -1.6601 -3.8349 -0.6972 1.0587 -6.4995		1.8675 -1.9344 -0.1292 -10.2965	-38.39,-15.6028,-27.9123 -22.991,-8.6753,-15.4462 -5.2882
GAMBIAN DALASI vs LIBERIAN DOLLAR	0.4594 0.5016 -0.6679 -124.9977	0.1559 0.1888 1.6425 -3.6807 -2.8790 -0.2169 -330.3223		0.8939 -1.1182 0.0098 -134.9421	-38.514,-12.9442,-28.5623 -17.8697, -6.2158,-12.3439 -53.2418
GAMBIAN DALASI vs NIGERIAN NAIRA	0.1405 -0.1709 -1.6042 -3.8030	0.1413 -0.1502 -1.5639 -9.1265 6.4647 3.4951 -4.7791		1.4194 -0.9871 -0.9904 -1.9972	-38.4162,-15.5268 -27.9634 -21.1715 -7.8353 -14.3404 -0.0294
GAMBIAN DALASI vs SIERRA LEONEAN LEONE	0.3295 0.4957 -0.3966 -100.1008	0.3230 0.5163 0.7957 -0.7193 -16.5332 -0.0298 -279.4655		0.8935 -1.1176 0.0036 -86.4560	-38.4926,-12.8501,-28.6003 -18.1518, -6.6447,-12.5184 -40.1164
GHANIAN CEDI vs LIBERIAN DOLLAR	-0.0895 -0.2825 -0.9606 -3.2025	-0.0873 -0.2289 -1.7130 2.0991 -0.2535 2.4992 2.3028		0.5915 -0.5916 0.0005 0.0726	-38.3929,-16.5555 -27.7154 -22.7288 -9.0458 -15.2835 25.6585
GHANIAN CEDI vs NIGERIAN NAIRA	0.0741 0.2312 -2.0040 -3.4735	0.0978 0.2019 -2.0047 -0.6561 -0.2106 -0.0619 -8.8130		0.0642 0.5411 -1.3852 -18.4727	-38.4010,-16.0358,-27.8507 -21.9199 -8.5624 -14.8093 4.0651

GHANIAN CEDI vs SIERRA LEONEAN LEONE	-0.0222 0.0779 -1.7896 -0.2180	-0.0256 0.0787 -1.7983 4.9613 1.7475 6.9271 6.0459	-0.0027 0.0027 -0.0000 0.0674	-38.4004-16.1304 -27.8243 -22.3099 -8.7224 -15.034 23.1921
LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.1171 0.0414 -2.0005 -1.8732	0.0920 -0.0743 -1.1126 -2.7803 6.7590 0.2048 -0.9494	1.4085 -1.4795 0.4912 -1.4762	-38.4107,-15.7270 ,-27.9071 -21.5662 -8.0668 -14.5679 5.1139
LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.0718 0.1265 1.7769 -333.8846	-10.7967 0.2174 15.5190 -39.3318 30.2775 -24.9442 -2.6488e+03	0.9513 -1.0641 -0.0034 -62.7841	-38.5629,-13.6972 -28.0422 -22.3014,-10.3813 -14.9942 -100.3908
SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	0.0378 -0.0852 -1.9333 -0.5206	0.0400 -0.0631 -1.9350 2.3737 0.3839 1.7541 2.5179	1.4273 -1.1094 -0.7779 -0.8311	38.4097 -15.8629 -27.8982 -21.5691 -8.3110 -14.5770 14.1865

TABLE 4.4A: ESTIMATED COPULA PARAMETERS AND LL VALUES FOR CONSTANT COPULA OF 2007-09 GFC OF THE STANDARDIZED RESIDUALS OF THE 5 EXCHANGE RATE RETURNS.

		Constant Copula			
	Parameters	**Normal (*Kappa*) LL**	**Student-t ($\omega^2, \alpha^2, \beta^2$) LL**	**Gumbel (ω, α, β) LL**	**SJC ($\omega^L, \alpha^L, \beta^L$) LL**
GFC	GAMBIAN DALASI vs GHANIAN CEDI	-0.0692 -1.8794	-0.0818, 7.3402 -7.6541	1.1000 15.0804	0.0103,0.1149 2.0415
	GAMBIAN DALASI vs LIBERIAN DOLLAR	0.0438 -0.7506	0.0448,4.8312 -12.4440	1.1000 0.2014	0.0001,0.0040 -2.5827
	GAMBIAN DALASI vs NIGERIAN NAIRA	0.0167 -0.1096	**0.0168, 99.9884 0.2079**	1.1000 10.5311	**0.1273, 0.0000 0.3140**
	GAMBIAN DALASI vs SIERRA LEONEAN LEONE	0.0095 -0.0352	0.0056,6.7970 -4.2430	1.1000 6.9793	**0.0000, 0.1029 -0.5316**
	GHANIAN CEDI vs LIBERIAN DOLLAR	-0.0291 -0.3328	**-0.0299,99.9936 0.2695**	1.1000 14.4051	**0.1416,0.4479 2.0775**
	GHANIAN CEDI vs NIGERIAN NAIRA	0.0622 -1.5192	0.0632,99.9788 -1.3556	1.1000 -0.0975	**0.0130, 0.0000 -2.5317**

	GHANIAN CEDI vs SIERRA LEONEAN LEONE	-0.0201 -0.1587	-0.0198, 99.9530 -0.1064		1.1000 11.6030		0.1601,0.0002 1.1013
	LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.0087 -0.0298	0.0111,23.4854 -0.5166		1.1000 5.0115		0.0018,0.0000 -0.1786
	LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.0106 -0.0439	0.0168,15.5249 -1.1631		1.1000 6.6376		0.0005,0.1751 0.0662
	SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	-0.0348 -0.4752	-0.0292, 15.7384 -1.7024		1.1000 11.2853		0.7004, 0.3724 1.7273

4.4b: Tail Dependence For GFC

		GD vs GC		GD vs LD		GD vs NN		GD vs SL		GC vs LD	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1221	0	0.1221	0	0.1221	0	0.1221
	Student's t	0.0132	0.0132	0.0616	0.0616	0.0000	0.0000	0.0247	0.0247	0.0000	0.0000
	SJC copula	0.0000	0.0000	0.0040	0.0001	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000

		GC vs NN		GC vs SL		LD vs NN		LD vs SL		SL vs NN	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1221	0	0.1221	0	0.1221	0	0.1221
	Student's t	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0010	0.0010	0.0006	0.0006
	SJC copula	0.0000	0.0130	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000

Table 4.4c: Estimated Copula Parameters And Log-Likelihood (LI) Values For Time-Varying Copula

	Time-Varying Copula for GFC **Sample**				
Parameters	**Normal** **(ω, α, β)** **LL**	**Student-t** **(ω^1,α^1,β^1, ω^2,α^2,β^2)** **LL**		**Gumbel** **(ω, α, β)** **LL**	**SJC** **(ω^L,α^L,β^L, ω^U,α^U,β^U)** **LL**
GAMBIAN DALASI vs GHANIAN CEDI	-0.2571 0.1970 -1.9727 -2.3075	**-0.2631 0.1440 -1.4052 -1.4768 0.7122 -0.1607 -9.0836**		-1.3293 1.0387 0.7744 -0.2190	-38.5371 -15.9517 -7.5107 -20.8044 -7.8683 -14.0219 4.7817
GAMBIAN DALASI vs LIBERIAN DOLLAR	0.1089 0.3770 -1.5516 -2.6124	0.1120 0.3474 -1.5449 -3.9374 -0.0625 0.0936 -14.1226		**1.8666 -1.0584 -1.8072 -5.8662**	-38.5365 -13.7028 -8.0173 -20.3348 -7.1029 -13.8311 -2.5805
GAMBIAN DALASI vs NIGERIAN NAIRA	0.0008 0.2737 -2.0298 -1.5189	**0.0078 0.2295 -2.0299 1.8839 3.5756 1.8269 -1.1957**		0.5886 -0.2472 -0.7438 -0.2500	**-38.5333 -15.4941 -7.5802 -21.0942 -7.9101 -14.1165 1.8114**
GAMBIAN DALASI vs SIERRA LEONEAN LEONE	-0.0049 0.6511 -.1978 -4.2931	-0.0103 0.5126 -1.2284 -2.9441 5.1763 1.6416 -4.5884		-0.5016 0.2716 0.4324 -0.2864	**-38.5571 -13.5241 -8.1039 -19.3401 -6.4868 -13.1937 0.7378**
GHANIAN CEDI vs LIBERIAN DOLLAR	-0.1167,-0.1196, -1.6209 -0.4298	**-0.1181 -0.0894 -1.6321 1.5648 0.2929 0.4163 0.1894**		4.0944 -3.9644 -0.3750 -0.5182	**-38.5235 -15.6045 -7.5709 -22.2561 -8.2149 -15.0625 4.9203**
GHANIAN CEDI vs NIGERIAN NAIRA	0.3168 0.0864 -2.0314 -2.2442	0.1939 0.3768 -1.9817 -10.2411 13.5820 5.4939 -2.5512		1.3943 -1.3964 -0.3839 -3.9016	**-38.5205,-14.1159,-27.8691 -22.0762 -7.5963 -14.7789 -1.2069**
GHANIAN CEDI vs SIERRA LEONEAN LEONE	-0.0551 -0.1345 -0.7717 -0.3064	-0.0547 -0.1014 -0.8043 1.6859 2.5746 1.4691 -0.2422		-1.5115 0.9578 1.4788 -1.1622	-38.5297,-15.3865 -27.6211 -21.4763 -8.0317 -14.4358 3.5167
LIBERIAN DOLLAR vs NIGERIAN NAIRA	0.0326 -0.1314 -0.6056 -0.2371	0.0332 -0.1056 -0.5865 1.0605 -0.0984 2.0881		0.7085 -1.0986 0.8943 -2.1554	-38.5038,-15.1442 -27.6329 -

		-0.4352				23.2415 -8.4059 -15.5906 1.5371
LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.0403 0.3263 -0.5651 -1.3856	0.0429 0.2432 -0.5129 2.5722 3.9336 3.8663 -1.5490		1.5597 -1.1425 -0.7094 -0.6157		-38.5326 -14.3284 -7.8505 -21.1291 -7.3540 -14.3246 1.2675
SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	-0.0369 -0.0445 1.1115 -0.5860	-0.1714 -0.1270 -1.9438 -3.3773 -0.9969 0.0603 -3.9636		-0.8009 1.1182 -0.6959 -0.3615		-38.5203 -15.769 -27.4977 -22.0871 -8.5480 -14.6945 3.9456

table 4.5a: Estimated Copula Parameters And LI Values For Constant Copula Of Covid19 Sample Of The Standardized Residuals Of The 5 Exchange Rate Returns.

		Constant Copula			
	Parameters	**Normal (*Kappa*) LL**	**Student-t ($\omega^2, \alpha^2, \beta^2$) LL**	**Gumbel (ω, α, β) LL**	**SJC ($\omega^L, \alpha^L, \beta^L$) LL**
COVID19	GAMBIAN DALASI vs GHANIAN CEDI	0.0378 -0.1125	0.0357, 4.0551 -2.6620	1.1000 0.8794	0.0000, 0.0636 -1.0931
	GAMBIAN DALASI vs LIBERIAN DOLLAR	0.1733 -2.3923	0.1786, 5.9956 -3.2282	1.1300 -2.6450	0.0708, 0.0354 -2.7381
	GAMBIAN DALASI vs NIGERIAN NAIRA	0.2188 -3.8524	0.2353, 99.9505 -3.7850	1.1465 -1.8998	0.0000, 0.2279 -4.2078
	GAMBIAN DALASI vs SIERRA LEONEAN LEONE	0.4479 -17.5747	0.7240, 2.1000 -48.6030	1.6159 -25.4105	0.3474, 0.4212 -26.6041
	GHANIAN CEDI vs LIBERIAN DOLLAR	0.0109 -0.0094	0.0127, 99.9516 0.0722	1.1000 1.5931	0.0000, 0.2162 0.1106
	GHANIAN CEDI vs NIGERIAN NAIRA	-0.0068 -0.0036	-0.0015, 16.4093 -0.1432	1.1000 1.9667	0.0000, 0.0018 0.1304
	GHANIAN CEDI vs	-0.0609 -0.2915	-0.0719, 5.3833	1.1000 2.7281	0.0000, 0.1647 0.1499

	SIERRA LEONEAN LEONE		-1.7114				
	LIBERIAN DOLLAR vs NIGERIAN NAIRA	-0.0348 -0.0953	- 0.0362,99.9757 0.0875		1.1001 3.7184		0.0000, 0.5294 0.3542
	LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.0266 -0.0554	0.0270,3.5607 -2.3913		1.1000 -0.0939		0.0076, 0.0000 -0.3176
	SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	0.1937 -3.0016	0.2074,99.9651 -2.9050		1.1360 -2.0034		0.0515, 0.0176 -1.9245

Table 4.5b: Tail Dependence For Gfc

		GD vs GC		GD vs LD		GD vs NN		GD vs SL		GC vs LD	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
COVID19	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1533	0	0.1695	0	0.4644	0	0.1221
	Student's t	0.0816	0.0816	0.0630	0.0630	0.0000	0.0000	0.5304	0.5304	0.0000	0.0000
	SJC copula	0.0636	0.0000	0.0354	0.0708	0.2279	0.0000	0.4212	0.3474	0.0002	0.0000

		GC vs NN		GC vs SL		LD vs NN		LD vs SL		SL vs NN	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
COVID19	Normal	0	0	0	0	0	0	0	0	0	0
	Gumbel	0	0.1221	0	0.1221	0	0.1221	0	0.1221	0	0.1593
	Student's t	0.0000	0.0006	0.0328	0.0328	0	0	0.0976	0.0976	0	0
	SJC copula	0.0018	0.0000	0.2279	0.0000	0.0001	0.0000	0.0001	0.0076	0.0176	0.0515

Table 4.5c: Estimated Copula Parameters And Log-Likelihood (LI) Values For Time-Varying Copula

	Time-Varying Copula for COVID19 **Sample**				
Parameters	**Normal** **(ω, α, β)** **LL**	**Student-t** **(ω^1,α^1,β^1, ω^2,α^2,β^2)** **LL**		**Gumbel** **(ω, α, β)** **LL**	**SJC** **(ω^L,α^L,β^L, ω^U,α^U,β^U)** **LL**
GAMBIAN DALASI vs GHANIAN CEDI	0.0157 0.0501 1.4655 -0.2252	-0.0317 -0.0648 -1.9232 0.4972 -1.3495 -1.4828 -2.7932		-1.1729 1.4393 -1.9360 -1.8891	-39.1511 -14.4933 -7.0392 -16.6305 -6.0031 -11.3354 -0.3906
GAMBIAN DALASI vs LIBERIAN DOLLAR	0.5754 0.5161 -1.1785 -2.8681	0.5082 0.3566 -1.0343 3.8156 -0.2482 -2.9194 -2.7178		0.9832 -1.1585 -0.1101 -2.9236	-39.1181,-13.6977,-27.326 -18.6658 -6.0557 -12.7919 -1.7606
GAMBIAN DALASI vs NIGERIAN NAIRA	0.3247 0.6549 0.3979 -5.4977	0.2696 0.9715 1.0888 -2.5434 -39.9955 0.1398 -16.6420		-0.1243 -0.5386 3.9097 -17.5533	-39.1201,-13.6254 -27.3811 -15.1349 -5.3786 -10.7545 -1.5797
GAMBIAN DALASI vs SIERRA LEONEAN LEONE	1.7950 1.0131 -2.5898 -19.5777	4.3911 0.7643 -4.1827 -5.9818 8.8458 -14.7770 -53.0944		0.9496 -1.0727 -0.0083 -9.9172	1.9439 -8.3055 -12.7165 2.6386 -6.4052 -3.9909 -9.2465
GHANIAN CEDI vs LIBERIAN DOLLAR	-0.0250 0.6563 0.1015 -1.5995	-0.0211 0.5705 0.1081 1.9424 -0.3680 3.6507 -1.5891		6.5057 -6.1529 -0.5437 -0.6769	-39.1448 -13.1562 -7.4809 -19.4115 -6.7500 -13.2239 0.4463
GHANIAN CEDI vs NIGERIA NAIRA	-0.0419 -0.4756 -.2474 -0.5468	-0.2018 0.0173 -2.0190 1.6948 0.0832 0.9762 -0.3711		6.9172 -6.4458 -0.9333 -0.3900	-39.1441 -15.4826 -6.8746 -20.0682 -7.4964 -13.2327 0.4936
GHANIAN CEDI vs SIERRA LEONEAN LEONE	-0.2081,-0.1554, -1.4230 -0.3397	-0.2826 0.4058 -1.9714 -1.2511 2.2518 -0.8372 -0.9872		2.5509 -2.4828 -0.3209 -1.5594	-39.1475 -15.2777 -26.9676 -18.9813 -7.5544 -12.9516 0.7754
LIBERIAN DOLLAR vs NIGERIAN NAIRA	-0.1510 0.2115 -.8161 -0.1422	-0.1466 0.1389 -1.8198 1.3640 0.0340 1.0237 0.0599		3.4909 -3.4407 -0.1251 -0.4662	-39.1706 -14.6522 -7.1496 -17.4555 -6.4090 -11.9412 1.1364

LIBERIAN DOLLAR vs SIERRA LEONEAN LEONE	0.2157 0.9014 -1.8367 -1.4296	0.2311 0.7210 -1.7486 -2.0251 0.3217 -0.4399 -3.3017		-0.2417 -0.5308 1.7618 -2.3385		-39.1177 -14.9591 -6.9795 -21.2741 -7.4632 -14.4782 -0.2046
SIERRA LEONEAN LEONE vs NIGERIAN NAIRA	1.2464 2.2436 -2.4104 -5.2401	0.0135 0.5383 1.8857 -3.6328 -26.5899 0.1210 -10.7560		0.8987 -1.1098 -0.0452 -6.6155		-39.1011 -13.1707 -7.3604 -21.8316 -7.0304 -14.4995 -1.3655

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