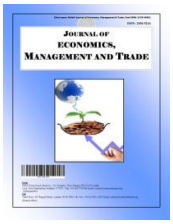

Journal of Economics, Management and Trade

27(4): 36-53, 2021; Article no.JEMT.70041
ISSN: 2456-9216
(Past name: British Journal of Economics, Management & Trade, Past ISSN: 2278-098X)

Do Diaspora Remittances Guarantee Food Security in Nigeria?

Onime, Bright Enakhe[1*] and E. Kalu, Ijeoma[1]

[1]University of Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author OBE designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Author EKI supervised the entire study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEMT/2021/v27i430339
Editor(s):
(1) Dr. Ehlinaz Torun Kayabasi, Kocaeli University, Turkey.
(2) Dr. Kamarulzaman Ab. Aziz, Multimedia University, Malaysia.
Reviewers:
(1) Hussin Jose Hejase, Al Maaref University, Lebanon.
(2) Jun Wen, Nanjing University of Science and Technology, China.
(3) Helen Elena Jekelle, Baze University, Nigeria.
Complete Peer review History: https://www.sdiarticle4.com/review-history/70041

Original Research Article

Received 01 May 2021
Accepted 06 July 2021
Published 12 July 2021

ABSTRACT

The burgeoning remittances into Nigeria and their effect on the economy have received renewed attention in recent times. Literature has suggested the existence of a relationship between remittances and food security. The extent to which this is true for Nigeria is uncertain. Using Vector Error Correction Model (VECM), this study examined the link between remittances and food security using secondary data for the period 1980 to 2018. Findings revealed a robust long and short-run relationship between remittances and food security. In the short-run, a positive and significant relationship was found between remittances and food security in the current period such that a 1 per cent increase in remittances was associated with a 5.08 per cent improvement in food security. In the long-run, a cointegrated relationship was observed as the error correction term depicting this relationship was well-behaved, properly signed and significant indicating that any previous period deviation in long-run equilibrium is corrected in the current period at an adjustment speed of 28.8 per cent. In addition, the Granger test suggests a unidirectional causality running from remittances to food security such that past values of remittances determined food security during the period investigated. Consequent to the findings, the study recommended with a caveat, the design and proper implementation of a diaspora and remittances policy to cater for the welfare of Nigerians in

**Corresponding author: Email: brighto80@yahoo.com;*

the diaspora to improve remittance receipts and by implication, food security. However, since remittances alone cannot guarantee food security in Nigeria, this study further recommends a holistic and multidimensional approach to address the food security challenge and close the food deficit gap.

Keywords: Diaspora; remittances; food security; johansen cointegration; vector error correction model; granger causality test.

1. INTRODUCTION

The subject of remittance inflows hitherto limited to migrants, recipient's families and relatives have recently assumed an important agenda in government, multilateral organizations and academics. Such diaspora remittances have an economic cushioning effect and it is a source of foreign exchange. It has both micro and macroeconomic implications. At the microeconomic level, it has a coping effect, improves individual welfare by reducing poverty, it serves as a relief, a palliative and an insurance premium to indemnify against unexpected peril [1]; [2], it aids consumption, improves income and savings and support investments. At the National level, it contributes to GDP, improves the balance of payment position, external reserves and provides a source for financing capital formation [3].

In recent times, remittances have dwarfed foreign direct investment (FDI) and official development assistance (ODA) as the highest source of foreign inflows into Nigeria. This volume and the increasing importance of remittances into Nigeria have continued to generate huge interest in government especially through the creation of the Nigeria Diaspora Commission (NIDCOM) and from the Central Bank of Nigeria, for example through the recently introduced Naira for Dollar scheme [4]. According to PricewaterhouseCoopers [5], an estimated 15 million Nigerians representing 7 per cent of the population of the country (using 201 million total population estimate by World Bank, [6] lives in the diaspora and remittance inflows from these Nigerians which was a meagre $1.4 billion in 2001 rose astronomically to $19.745 billion in 2010, averaging $24 billion in 2019 [6]. Data from the Central Bank of Nigeria confirms the continuous contribution of remittances to GDP rising steadily from 1.576 per cent in 2001 to 8.3 per cent in 2005. Though it fell drastically to 4.5 per cent in 2012, it has since recovered to 6.1 per cent in 2018 [7].

However, the paradox is that despite the growth in the volume of remittance inflows into the country, Nigerians remain food insecure. Food inflation is replete while hunger is endemic. Despite the huge foreign exchange spent on food imports, the number of undernourished people rose from 11.4 million people between 1999 and 2001 to 15.2 million people during the period 2013 to 2015, peaking at 25.6 million people in 2016 to 2018 [8].

According to FAO et al [9,10], food security is advanced by several factors including economic growth, agricultural productivity, functioning markets for both national and international trade and social protection. In the Nigeria case, the highlighted factors have not contributed effectively to promote food security in Nigeria. For instance, agricultural production in Nigeria has remained subsistence, highly rudimentary and mainly rain-dependent, especially in the South. The result is the dwindling of agriculture's contribution to Gross Domestic Product which was 37.2 per cent in 2002, failing sharply to 20.2 per cent in 2014 but only slightly improved to 21.4 per cent in 2018 [7]. Due to the decline in food production which has made it impossible to produce enough food to feed the growing population, food imports soared, rising from a modest N1.44 billion in 1980 to N88 billion in 1995. From its 1995 position, it rose astronomically to a whopping N2276.2 billion in 2018 [7].

The renewed concerns about remittances in academics have raised questions as to the possible socio-economic contribution of remittances to the country. It has been documented that remittances are associated with a decline in poverty, improved level of education, increased access to health and substantially increased availability of funds for businesses and investment [11]. In the same vein, a few works of literature have documented a positive relationship between remittances and food security [12,13,14,15]. Despite this renewed interest among researchers, the nexus between

remittances and food security is sparsely investigated.

Thus, the objective of this study is to investigate the nexus between remittances and food security in Nigeria. Following the introduction, the rest of the paper is organized as follows; Section 2 reviews related literature. The model estimated in this study is presented in section three while the fourth section presents and discusses the estimated model. The paper concludes by making recommendations based on the findings in section five of the study.

2. LITERATURE REVIEW

2.1 Trends in Remittance Inflows

Over the past decade, remittances have become an important source of foreign inflows into Nigeria. Available data shown in Table 1 revealed that remittances rose from an average of $15billion or 8.3 per cent of GDP and $18.4billion or 6.3 per cent of GDP between 2005 and 2009 to a significant $20.62 billion or 5.02 per cent of GDP in 2011, representing an increase of about 10.8 per cent when compared to the volume received in 2009. Although it fell to $19.7 billion or 4.9 per cent of GDP in 2016, it immediately recovered to $22 billion or 5.9 per cent of GDP in the following year of 2017. The subsequent period of 2018 equally witnessed a sustained increase, rising to $24.3 billion or 6.1 per cent of GDP, albeit with some minor fluctuations recorded in 2019 when it dropped to $24billion or 5.3 per cent of GDP.

According to Solimano [3], remittances are the financial equivalent of the outflow of persons and represents a steady element of external foreign inflows hence its contribution to Nigeria's GDP over the past decade has remained consistent though fluctuates between 8.3 per cent and 5.3 per cent. As shown in Table 1, remittances to Nigeria equalled 8.3 per cent of GDP in 2005, dropping to 4.5 per cent in 2012 but recovered to 6.1 per cent of GDP in 2018. At current levels, remittances contribution to GDP averaged 5.3 per cent in 2019.

Remittance receipts have continued to play an important role as a source of external financing to Nigeria and compete favourably in importance to foreign direct investment (FDI) and Official Development Assistance (ODA). In terms of total external foreign inflows, remittances have consistently overtaken all other sources of foreign inflows especially beginning from the year 2007. When compared to other sources of external finance, remittances have become larger than foreign direct investment and official development assistance. For instance, as Table 2 shows, remittances of $18 billion received in 2007 surpassed both foreign direct investment of $6 billion and official development assistance of $13 billion received in the same year.

Table 1. Remittances and percentage of GDP, 2005 – 2019

Year	Remittance Inflow (US$ Billions)	Remittances received (% of GDP)
2005	14,640.08	8.311
2006	16,932.14	7.171
2007	18,014.43	6.536
2008	19,203.32	5.698
2009	18,368.11	6.293
2010	19,744.69	5.434
2011	20,616.89	5.024
2012	20,542.96	4.472
2013	20,797.13	4.039
2014	20,806.07	3.659
2015	21,157.72	4.278
2016	19,679.39	4.863
2017	22,000.71	5.855
2018	24,311.03	6.119
2019	23,809.00	5.310

Source: World Bank, 2019

Table 2. Remittances and other foreign inflows, 2005 – 2019

Year	Remittance Inflows (US$ Billions)	Foreign Direct Investment (US$ Billion)	Official Development Assistance (US$ Billion)
2005	14,640.08	4.98	46.101
2006	16,932.14	4.85	80.203
2007	18,014.43	6.04	13.384
2008	19,203.32	8.19	8.609
2009	18,368.11	8.56	10.622
2010	19,744.69	6.03	12.948
2011	20,616.89	8.84	11.117
2012	20,542.96	8.07	11.458
2013	20,797.13	5.56	14.646
2014	20,806.07	4.69	14.051
2015	21,157.72	3.06	13.424
2016	19,679.39	4.45	13.434
2017	22,000.71	3.50	17.598
2018	24,311.03	2.001	16.873
2019	23,809.00	3.30	17.502

Source: World Bank, 2019

Whereas foreign direct investment (FDI) and official development assistance (ODA) are subject to vagaries occasioned by unfavourable economic conditions, political instability and recession, remittances are more stable, consistent, and least affected by externalities. As shown in Table 2, remittance inflows have consistently surpassed foreign direct investment and official development assistance put together. For instance, beginning from 2010, remittance receipt of $19.7 billion surpassed the sum of $18.98 billion representing both FDI and ODA received that same year. When remittances increased by $1,052.44 from its 2010 position to $20.8 billion in 2013, FDI and ODA put together managed to close the gap to $20.2 billion in the same year. At current levels, whereas remittances recorded an inflow of $23.8 billion in 2019, FDI and ODA managed to genuflect behind by recording a combined receipt of $20.8 billion in 2019.

Overall, with the current growth in remittances, they have become the largest foreign inflows to Nigeria, now first to foreign direct investment and official development assistance.

2.2 Nigeria's Food Security Situation

FAO (2004) provided a succinct definition of food security to include the availability of food, accessibility to food, utilization of food, and stability of available food at all times, first at the micro-level and more generally at a macroeconomic level. Food security is guaranteed to occur when everyone in a given country physically and economically has access to sufficient and safe food to maintain a healthy lifestyle.

In the food security literature, famine and drought, poor yield due to continuous cropping, subsistence farming, non-irrigated farming system, civil unrest and internal insecurity, heightened by farmers/herders clashes, insurgency and terrorism, flooding and rudimentary cultivation, neglect of agriculture, poor funding are all threats to food security. These threats are all endemic in Nigeria. In light of the above, Nigeria is food insecure. Available data shows that on all parameters, there is a wide food deficit gap in the country. As shown in Table 3, the country is yet to close its food deficit gap. Such food deficits (defined as the number of calories required to close the gap between the undernourished and the nourished population) remained 49kcal in 2005, declining by a mere 13kcal to 37kcal in 2011. This has since recovered to 42kcal in 2016. To augment local production with a view of bridging the food deficit gap, the country has continuously resorted to heavy importation, such that the food import bills have since exacerbated. For instance, as shown in Table 3, from a modest N1.82 billion in 1981, food imports rose quickly to N193 billion in 2005, escalating to N1712 billion in 2013 before peaking at their current level of N2276 billion in 2018.

The implication of the huge import bills is grave. The bulk of the country's export receipts is used to fund food importation. As reported in Table 3,

out of N7247 billion export receipts in 2005, N193billion of this figure was used for food imports. This has since increased to N2276.2 billion for food imports out of the N19280 billion export receipts in 2018. The neglect of agriculture has resulted in its lacklustre contribution to GDP. Table 3 revealed that agriculture's contribution to GDP hovered between 27 per cent in 2005 and 20.86 per cent in 2015 before settling at 21.4 per cent in 2018.

Food security is elusive in a situation where food production declines as the population increases. Thus, as observed in table 3, whereas the population consistently grows at the rate of 2.59 per cent and 2.71 per cent, the food production index merely increased from 99.59 indexes in 2005 to 124.9 index in 2018 by 25.31 index growing at an average annual rate of 3.32%. Food sufficiency, accessibility and affordability continue to pose substantial challenges but are desirable policies for Nigeria to achieve the objective of the second sustainable development goal which commits to end hunger and guarantee food security by 2030 [16].

2.3 Theoretical Background

Theoretically, three major lines of argument have been used in the literature to explain the motives for remittances. The first credited to Johnson and Whitelaw [17] and Banerjee [18] is the Altruistic motive. The second which focuses on self-interest motive is associated with Solimano [3] while the third which concerns the risk-sharing and insurance premium hypothesis is attributed to the works of Stark and Levhari [19], Stark [2], Lucas and Stark [20] and Stark and Lucas [1].

Simply defined, altruistic is unselfish, humane and selfless. The Altruistic motive of remittances, therefore, describes the readiness and emotional commitment of migrants to give up part of their resources for the satisfaction of their relatives, families and loved ones back in their home countries. Their intention in doing this is to guarantee an improvement in their family's welfare, increasing their living standard, income and consumption. Lucas and Stark [20], Cox et al [21], Rapoport and Docquier [22]. According to Becker [23], pure altruism involves giving without recourse to recognition or expectation for any future reward. Thus, the model concludes that sending remittances gives a certain satisfaction to the migrant that the welfare of their families back home has been meant. It follows therefore that since these remittances increase incomes and support consumption; it can equally help in no small way to improve the food security situation of the receiving household.

Table 3. Food security indicators for Nigeria

Year	Total Export Earnings (Nbillions)	Food Imports (Nbillions)	% of Agriculture in total GDP (Percentage)	Food deficit (Kilocalories/ person/day)	Food production index (Index)	The growth rate of Population (Percentage)
1981	11.023	1.8196	11.773831	NA	30.1	2.71
1990	109.886	3.4745	21.33913	NA	49.19	2.58
2000	1945.723	113.6305	21.868976	NA	81.81	2.50
2005	7246.535	193.2591	27.087285	49	99.59	2.59
2006	7324.681	214.4877	26.213017	43	105.97	2.61
2007	8309.758	269.9245	25.91872	39	99.23	2.63
2008	10387.694	311.3882	25.793848	36	105.45	2.65
2009	8606.32	446.8957	26.25109	35	93.29	2.66
2010	12011.476	693.2554	23.893704	36	105.9	2.67
2011	15236.666	2885.4371	22.289199	36	100.13	2.68
2012	15139.326	1294.0352	22.054288	37	112.61	2.68
2013	15262.014	1712.049	20.996398	37	111.1	2.68
2014	12960.493	1841.708	20.235716	39	123.92	2.67
2015	8845.159	1927.365	20.858226	40	125.8	2.65
2016	8835.612	1973.249	21.207627	42	124.6	2.63
2017	13988.143	2506.348	21.064295	NA	125.20	2.61
2018	19280.04	2276.168	21.423568	NA	124.90	2.59

Source: NBS & CBN Statistical bulletin, several years.
www.knoema.com, 2020.

The self-interest hypothesis of remittance explains the selfish motive of the migrants who only send remittances for economic reasons and financial self-interest [3]. In this case, the migrant saves money in their resident foreign country to accumulate substantial wealth and then send remittances not to support welfare but to acquire properties, assets and financial investments in their home country. In this case, there is no direct transfer of resources to the households of the individual in the diaspora. This self-interest motive, therefore, is capable of worsening the economic condition, welfare and wellbeing of families of the individual in the diaspora, thus capable of inducing food insecurity.

The risk-sharing and insurance premium hypotheses of remittances describe remittances to be synonymous with risk sharing, which may take the form of insurance to minimize economic risks through diversification of the income avenues of families [24]. The insurance premium payments to migrant's families, relatives and loved ones indemnify them against adverse and unexpected shocks [1], [2]. Gubert [25] validated the insurance premium hypothesis using sample data from Kayes in Mali. He found that remittances covered a wide array of risks including disease, death and agricultural production. Therefore, this study is anchored on the Altruistic theory and the Insurance Premium hypothesis of remittances as the baseline theory.

2.4 Empirical Literature

Empirically, there is a dearth of literature on the relationship between remittances and food security. Such empirical literature suggests a positive relationship between remittances and food security. For instance Crush and Caesar, [26, 12], Crush, [27]; Lacroix, [15]. Most of the current work focuses on African and Asian countries such as the works of Sulemana et al., [28]; Mabrouk and Mekni, [28]; Choithani, [30]; Hussain et al., (2016); Musemwa et al., (2015); Generoso, (2015); Regmi and Paudel [31] and Sharma, [14]. Babatunde [32] in a microeconomic study examined the effect of remittances on food security and nutrition of farming households in Kwara State, Nigeria using descriptive analysis. His findings revealed that households that receive remittances from migrants abroad are well-off using parameters such as income, assets and micronutrients supply.

Mora-Rivera and Gameren [33] investigated the impact of remittances on food insecurity in Mexico by estimating ordered probit regressions with instrumental variables. Their findings revealed that both international and internal remittances have significant effects on food insecurity in rural Mexico and that international remittances appear to reduce food insecurity more than internal remittances but were not a sufficient condition to make receiving households food-secure.

Kangmennaang et al., [34] in their study on Malawi using a structured questionnaire discovered that households with migrants from whom they receive remittances have a lower propensity to be food insecure. Their study, therefore, called for policies to be designed to improve remittance inflows while reducing the cost of receiving remittances and by implication, guarantee a more positive effect of remittances.

Regmi, et. al [35] investigated the impact of remittance on food security in Bangladesh using two indicators of food consumption score (FCS), household hunger scale (HHS) and ordered probit regression models. They found that remittances play an important role in improving the food security status of a household. They suggested increasing income from the agriculture sector to raise the probability of a household being food secure and made a recommendation for government to make the agriculture sector strong enough to provide employment opportunities for households. In a similar study on Bangladesh, Moniruzzaman [36] observed that remittances increase dietary variety and enable households to cope with vagaries that impede their food security status, Further; he found that remittance-receiving households have better food security than non-receiving families.

Using a propensity matching score technique, Mahapatro et.al [37] investigated the relationship between remittances and consumption expenditure patterns in India and found that a high proportion of inflows by both remittance-receiving and non-receiving households were spent on food. However, the proportion of expenditure spent on food by remittance-receiving households was higher when compared to those of non-receiving households.

Using a sample of 301 farmer's households from Tigray Regional State in Ethiopia, Abadi, et.al

[38] studied the impact of remittances on farm household's food security status and found that remittances reduce the incidence of survival strategies. Further, households with remittances were found to have lower anxiety about insufficient food; have the capacity to acquire quality food and lower experience of inadequate quantity of food consumption than those without remittance. They, therefore, concluded that migration and remittances are vital components of food security programs and policies in Ethiopia. In a related survey-based study, Sharma [14] investigated the impact of migration on-farm production and household-level food security. Using a survey method conducted in Nepal, he found that migration has a negative relationship with farm production while remittances have the effect of reducing food insecurity levels.

Oguniyi et al [39] in their study on Sub-Saharan Africa (SSA) using panel data in a dynamic and static econometric model found that an increase in remittance inflows positively influences food and nutritional security. In the same vein, Zezza et al [40] examined the impact of migration on food and nutrition security and found that remittances reduce food insecurity. They argued that migration reduces food insecurity through remittances arising from money transfers, which is a major element of coping strategies of poor persons in developing countries.

The importance, motives and implications of remittances have been widely studied in the literature. However, the links between remittances and food security are yet to receive such elaborate research. This current study is to complement the perceived gap observed in literature in this respect.

3. MATERIALS AND METHODS

The study used data obtained through secondary sources such as the Central Bank of Nigeria statistical bulletin, the National Bureau of Statistics and the World Bank to carry out the empirical evaluation. Following the altruistic theory, which suggests that remittances improve food security and the insurance premium hypothesis, which proposed that remittances act as an indemnity against adverse shocks, and Mora-Rivera (2003), this study specified a simple model where food security was expressed as a function of remittances below.

$$\boldsymbol{fose} = \boldsymbol{f}(\boldsymbol{remi}) \qquad (\boldsymbol{i})$$

Expressing the equation (i) above linearly by adding an intercept and a stochastic disturbance term gives the following transformation;

$$\boldsymbol{fose} = \boldsymbol{\beta 0} + \boldsymbol{\beta 1 remi} + \boldsymbol{\varepsilon t} \qquad (\boldsymbol{ii})$$
$$\boldsymbol{\beta 1} > 0$$

Where **fose** is the food security variable, which was obtained through aggregation, normalization and averaging of various indicators representing the four dimensions of food security as explained further in the next section. **Remi** represents the remittance variable. Apriori, the relationship between food security and remittances is expected to be positive. An increase in remittances is expected to improve food security.

3.1 Measure and Derivation of Food Security Index

Following the communiqué reached at the World Food Summit [41], food security was agreed to provide both physical and economic access to all people, at all times to sufficient, safe and nutritious food to meet their food preferences. Broadly defined, it covers four important dimensions including availability, accessibility, utilization and stability. When these four dimensions are fulfilled concurrently, food security is guaranteed. The question to ask therefore is, how is food security measured? The answer is uncommon, as no universally acceptable measure currently exists. Thus, different authors in the literature have adopted several one-dimensional measures in their various studies. For instance, Oguntegbe et al. [42] used food production index; Onime [43] utilized value-added in agriculture, forestry and fishing; Weezel [44] and Cafiero [45] employed dietary energy supply while Smith & Wiesmann [46] used food energy deficiency to capture food security.

However, some studies have faulted the use of these single-dimensional measures. Thus, Napoli [47], Food and Agriculture Organization [48] and others have advocated for the use of a suite of indicators to capture all the essence of the concept of food security. Such suites of indicators must include all the four dimensions of food security, such as food availability, access, utilization and food stability. Table 4 shows the indicators from which data were derived to compute the food security index used as the dependent variable in this study.

The data transformation procedure involves the aggregation of all indicators each representing the different dimensions. The selected indicators are proxies for the different dimensions of food security. Next, the data aggregated were normalized by converting all the indicators to a common scale using the Z-score. This was achieved using the Statistical Product and Service Solutions, version 25 [49]. Thereafter, the food security index was obtained through the computation of the average of all the aggregated normalized data.

4. RESULTS AND DISCUSSION

This section presents and discussed the empirical regression results conducted to determine and establish the short and long-run relationship among the variables in the model. To proceed, some preliminary diagnostic test was conducted. First, the trend analysis through the plotted graph of the variables shown in Fig. 1 revealed an upward trend, an indication that the variables in the model are time-variant.

From Fig. 1, it was observed that remittances grew steadily beginning from the 1990s and rose drastically in the following decade, especially reaching an all-time high in 2005, hitting the over twenty billion-dollar mark in 2015 and have continued in this upward trend ever since. However, food security did not proceed similarly. As also shown in Fig. 1, food security has been galloping rising in one period, and falling drastically in the next period and ranging between 0.2 and 0.39 absolute index in 1980 and 2015 respectively.

Furthermore, the descriptive statistics as depicted in Appendix 1 showed that with 39 observations, the variables significantly differ from their means, such as (0.000512) for the food security variable and 7488 for remittances. The averages computed differ from their median values signifying some degree of skewness. Finally, the classical regression result displayed in Appendix 2 showed a high R-square of 83 per cent and a low Durbin Watson of 0.87 suggesting that the probability of a spurious regression cannot be rejected. The diagnostic test implies that the variables are not stationary. The outcome of the preliminary diagnostic test is a precondition for the examination of the stationarity status of the variables in the model. The stationarity test was carried using the Augmented Dickey-Fuller (ADF) and Phillip-Perron (P-P) test. The outcomes are displayed in Table 5.

As shown in Table 5, the Augmented Dickey-Fuller test showed that the two variables have unit roots and that none of the variables including fose and remi were stationary at levels, that is no integration at I(0). However, when they were first differenced, there was evidence of stationarity with integration at order I(1). In the same vein**,** the Phillip-Perron test confirmed the same result obtained under the Augmented Dickey-Fuller test. Consequently, the outcome of the stationarity test wherein the variables in the model followed the same order of integration is a prerequisite for the specification and estimation of the vector error correction model (VECM).

However, before the estimation of the vector error correction model, Engle and Granger (1987) [50], recommended the test of cointegration as a satisfactory condition for a vector error correction model (VECM) representation. Thus, this study utilized the Johansen cointegration procedure to confirm the long-run relationship among the variables in the model. In the Johansen test, the null hypothesis of no cointegrating equation is tested against the alternative that the null hypothesis is not true. The presence of cointegration is proof that variables in the model have a long-run relationship. To conduct the test, the appropriate lag length to use was determined. The result, which is presented in Appendix 3, was obtained using two information criteria including final prediction error (FPE) and Akaike information criteria (AIC). The outcome revealed the appropriate lag length to be two.

4.1 Result of Johansen Cointegration Test

In Table 6, both the Trace and Maximum Eigenvalue statistics indicated the existence of one (1) cointegrating equation at the 5 per cent level of significance, as one of the Trace and Maximum Eigenvalue statistics were greater than their critical values at 5 per cent. This result suggests a long-run relationship between the variables in the model thereby confirming the rejection of the null hypothesis of no cointegration amongst the variables.

Following the existence of cointegration among the variables in the food security model, the vector error correction model (VECM) can be

specified and estimated. As proposed by Engle and Granger [50], the construction of a VECM presupposes the loss of a lag hence this study constructed a VECM with a (p-1) lag length for all the variables in the model. Such VECM as constructed facilitates the examination of both the long and short-run dynamics of the cointegrated series. The model is specified in equation (iii).

$$\Delta foset = \beta 0 + \sum_{i=1}^{d} \beta 1i \Delta foset - 1 + \sum_{i=1}^{h} \beta 2i \Delta remit - 1 + \lambda \mathrm{ECMt} - 1 + \mathrm{U}t \quad (\mathrm{iii})$$

Where Δ as used in the equation is the first difference operator, $\beta's$ are short-run dynamic coefficients and λ is the adjustment parameter, while ECM is the error correction term, which represents the long-run model, which can be obtained from the residual of the long-run equation.

4.2 Result of Vector Error Correction Model

An assessment of the result of the Vector Error Correction Model presented shows that the only variable in the model (remittances) explained about 9.3 per cent systematic variation in food security during the short-run period, this is evident in the R-squared of 0.9333 as shown in Table 7. The overall model is statistically significant with the value of the F-statistic of 1.132 passing the significance test at the 5 per cent level of significance. The error correction term is well behaved and correctly signed as it appeared with the expected negative sign, signifying the existence of a long run relationship among the variables in the model. Clearly, any prior year's deviation from long run equilibrium is adjusted in the current year at an adjustment speed of 28.8 per cent.

In terms of the performance of the coefficients of the variables in the model, the remittance variable appeared with the expected positive sign. This implies that a positive relationship exists between remittances and food security during the period under review, such that a percentage change in remittances during the period is associated with a 5.03 per cent increase in food security on average ceteris paribus in the short run.

To isolate the direction of causality between the variables, the Granger causality test was conducted. The null hypothesis of no causality is tested against the alternative causality at the 5 per cent level. The results reported in Table 8 shows that we cannot reject the null hypothesis that remi does not Granger-cause fose, hence we conclude that unidirectional causality runs from remittances to food security and that past values of remittances determine food security during the period reviewed.

Consequently, following the performance of the coefficient of the remittance variable, evidence exists supporting the existence of a relationship between food security and remittances both in the short and long run.

4.3 Diagnostic Test

The result of the VEC Residual Serial Correlation LM Test as shown in Appendix 4 confirms the absence of autocorrelation as the probability values of the F-statistic of 0.5248 and 0.5136 were higher than the 5 per cent level of significance; an indication of the absence of autocorrelation. The normality test (displayed in Appendix 5) conducted and captured by the Jarque-Bera test shows that one out of the two variables used in the model is normally distributed. The study tested the stability of the model by conducting the cumulative sum of recursive (CUSUM) test. The result displayed in Appendix 6 shows the model is stable as it lies within the 5 per cent boundary. The implication, therefore, is that the results of the regression coefficients are suitable for policy making.

4.4 Impulse Response Function

The impulse response function in Fig. 2 shows the response of remittances to a one standard deviation shock on food security. The blue line represents the impulse response function. A one standard deviation shock to remittances increased food security steadily up to period two. A further innovative shock to remittances caused a continuous increase in food security reaching a peak in period five and maintained a flat shape thereafter up to period ten.

Table 4. Indicators for the food security index

Dimension	Indicators	Data source
Availability	Cereal per yield (kg/hectare)	World Bank
	Net trade	World Bank
	Fertility rate	World Bank
	Population (millions)	National Population Commission
	Food production index (2005=100)	World Bank
Accessibility	Consumer price index (2010=100)	Central Bank of Nigeria
	GDP per capita (Current US$)	Central Bank of Nigeria
	Improved water source (% of rural population)	World Bank
	Rural population (% of the total population)	World Bank
Utilization	Mortality rate, under-five/1000	World Bank
	Prevalence of undernourishment (% of the population)	Food & Agriculture Organization
	Life Expectancy rate (%)	World Bank
Stability	Food inflation, consumer prices (Annual %)	World Bank
	Food Imports (% of merchandise imports)	World Bank
	Unemployment rate (%)	National Bureau of Statistics
	Arable land (hectares/capita)	World Bank

Source: Adapted from Napoli [47] and FAO [48] but modified for Nigeria (2021).

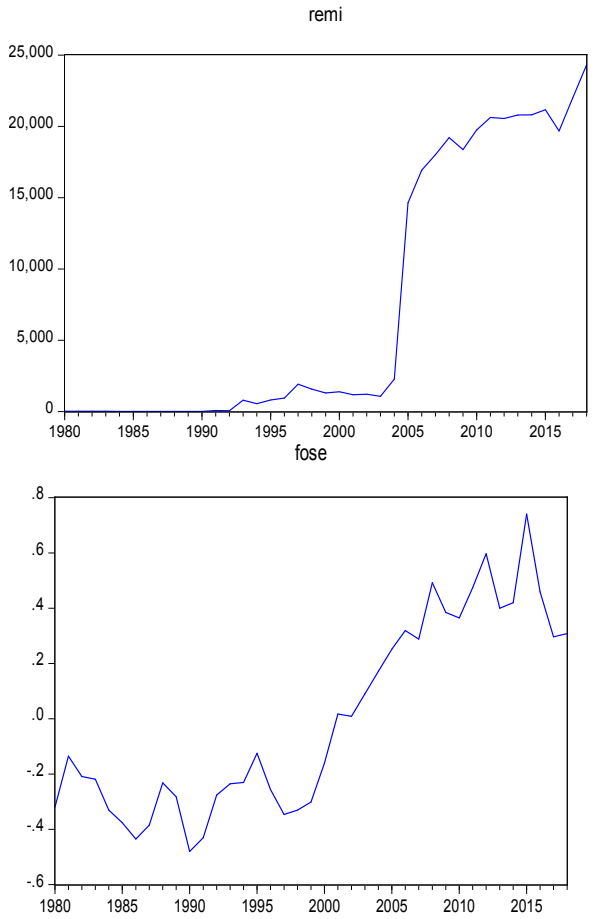

Fig. 1. Trends of remittances and food security for Nigeria, 1980 - 2018
Source: Author's computation from Eviews, [51]

Table 5. Unit root test – trend and intercept

Variables	ADF (level)	P-P (level)	5% critical values	ADF (1st Diff)	P-P (1st Diff)	5% critical values	Order of Integration
fose	2.323	2.351	3.533	6.000	6.576	3.537	I(1)
remi	1.672	1.768	3.533	4.904	4.909	3.537	I(1)

Source: Authors Computation from Eviews10 [51]
Note: All tests of significance were conducted at the 5% level

Table 6. Johansen cointegration test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.359402	16.70818	15.49471	0.0327
At most 1	0.006201	0.230135	3.841466	0.6314
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.359402	16.47805	14.26460	0.0220
At most 1	0.006201	0.230135	3.841466	0.6314
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source: Author's computation from Eviews [51].

Table 7. Vector error correction estimates

Date: 06/23/21 Time: 23:37		
Sample (adjusted): 1982 2018		
Included observations: 37 after adjustments		
Standard errors in ( ) & t-statistics in [ ]		
Cointegrating Eq:	**CointEq1**	
FOSE(-1)	1.000000	
REMI(-1)	-3.52E-05	
	(3.0E-06)	
	[-11.5535]	
C	0.254623	
Error Correction:	**D(FOSE)**	**D(REMI)**
CointEq1	-0.288167	8962.098
	(0.17723)	(2695.95)
	[-1.62597]	[3.32429]
D(FOSE(-1))	0.092092	-7562.919
	(0.19681)	(2993.78)
	[0.46793]	[-2.52621]
D(REMI(-1))	5.03E-06	0.285177
	(9.9E-06)	(0.15037)
	[0.50913]	[1.89648]
C	0.007449	613.0739
	(0.02126)	(323.328)
	[0.35045]	[1.89614]
R-squared	0.093331	0.290718
Adj. R-squared	0.010906	0.226238
Sum sq. resids	0.504965	1.17E+08

S.E. equation	0.123701	1881.709
F-statistic	1.132318	4.508636
Log likelihood	26.94170	-329.3617
Akaike AIC	-1.240092	18.01955
Schwarz SC	-1.065938	18.19371
Mean dependent	0.011971	656.6173
S.D. dependent	0.124381	2139.186
Determinant resid covariance (dof adj.)		49437.88
Determinant resid covariance		39326.41
Log likelihood		-300.7250
Akaike information criterion		16.79595
Schwarz criterion		17.23133
Number of coefficients		10

Source: Author's computation from Eviews, [51].

Table 8. Pairwise granger causality tests

Date: 06/25/21 Time: 01:51

Sample: 1980 2018

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
REMI does not Granger Cause FOSE	37	1.27853	0.2923
FOSE does not Granger Cause REMI		5.72065	0.0075

Source: Author's computation from Eviews10, [51].

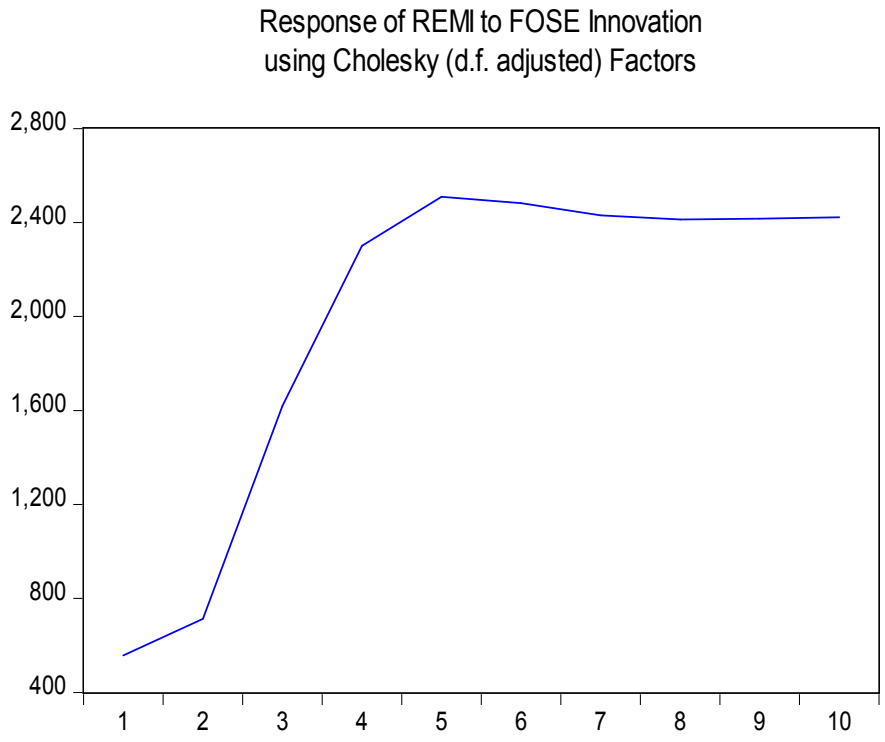

Fig. 2. The impulse response of remittances to food security

Source: Author's computation from Eviews10, [51].

4.5 Relationship between Remittances and Food Security

The vector error correction results of a 1 per cent increase in remittances associated with a 5.03 per cent increase in food security on average ceteris paribus in the short-run confirm the earlier expectation of a positive relationship between remittances and food security. That relationship was equally significant in the current period, passing the significance test at the 10 per cent level of significance. This result is consistent with the findings of Regmi et al. [35] for Bangladesh and Oguniyi et al. [39] for Sub-Saharan Africa. In their studies, they both found a positive relationship between remittances and food security Therefore, a diaspora and remittances policy should be articulated as a necessary but not sufficient condition to improve the food security situation in Nigeria.

5. CONCLUSION

The volume of remittances to Nigeria in recent times has attracted the attention of the government and the Central Bank. In the literature, it has been argued that remittances have a positive effect on food security, following; the study investigated the nexus between remittances and food security in Nigeria Findings from this study revealed that a robust relationship exists between remittances and food security in both the short and the long-run period. In the short run, a positive and significant relationship was observed between remittances and food security in the current period such that a 1 per cent increase in remittances was associated with a 5.03 per cent increase in food security on a regular, ceteris paribus in the short run.

Following the above findings, this study recommends the design and proper implementation of a diaspora and remittances policy to cater for the welfare of Nigerians in the diaspora to improve remittances receipts and by implication, improve food security. However, Remittances alone cannot guarantee food security in Nigeria. Therefore, a multidimensional approach comprising a comprehensive agricultural policy is equally important to holistically address the food security challenges and close the food deficit gap. Such an approach must be complete with improved sectoral credit to boost production, population control policy to tame the increasing population, nutrition policy to improve nutrition needs, employment creation strategies to increase job, boost income and enhance consumption and internal security policy to curb civil conflict.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix 1. Descriptive statistic

Statistic	fose	remi
Mean	-0.000512	7488.246
Median	-0.135324	1210.000
Maximum	0.740032	24311.03
Minimum	-0.480276	2.424527
Std. Dev.	0.349062	9429.115
Skewness	0.400659	0.639848
Kurtosis	1.764785	1.505278
Jarque-Bera	3.522785	6.291704
Probability	0.171805	0.043030
Sum	-0.019959	292041.6
Sum Sq. Dev.	4.630088	3.38E+09
Observations	39	39

Source: Author's computation in Eviews, 2021

Appendix 2. Classical regression result

Dependent Variable: FOSE				
Method: Least Squares				
Included observations: 39				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.252907	0.030067	-8.411510	0.0000
REMI	3.37E-05	2.52E-06	13.39151	0.0000
R-squared	0.828967	Mean dependent var		-0.000512
Adjusted R-squared	0.824345	S.D. dependent var		0.349062
S.E. of regression	0.146296	Akaike info criterion		-0.956444
Sum squared resid	0.791897	Schwarz criterion		-0.871133
Log likelihood	20.65066	Hannan-Quinn criter.		-0.925835
F-statistic	179.3327	Durbin-Watson stat		0.874159
Prob(F-statistic)	0.000000			

Source: Author's computation from Eviews10, (2021).

Appendix 3. Optimal lag length

VAR Lag Order Selection Criteria

Endogenous variables: FOSE REMI
Exogenous variables: C
Date: 06/23/21 Time: 23:22
Sample: 1980 2018
Included observations: 30

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-303.3869	NA	2381937.	20.35913	20.45254	20.38901
1	-252.2447	92.05595*	102940.2	17.21632	17.49656*	17.30597*
2	-247.8225	7.370348	100578.4*	17.18817*	17.65523	17.33759
3	-244.7366	4.731714	108106.2	17.24911	17.90300	17.45829
4	-240.0081	6.620017	105120.3	17.20054	18.04126	17.46949
5	-239.0729	1.184581	133346.0	17.40486	18.43240	17.73358
6	-236.7560	2.625778	156992.3	17.51707	18.73144	17.90555
7	-235.9792	0.776841	209696.0	17.73194	19.13314	18.18020
8	-231.7717	3.646494	230057.9	17.71811	19.30613	18.22613
9	-229.6650	1.544878	303487.7	17.84433	19.61918	18.41212

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion

SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Author's computation from EVIEWS, [51].

Appendix 4. Test for serial correlation

VEC Residual Serial Correlation LM Tests						
Date: 06/25/21 Time: 03:00						
Sample: 1980 2018						
Included observations: 37						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	3.201627	4	0.5247	0.808312	(4, 60.0)	0.5248
2	3.271224	4	0.5135	0.826359	(4, 60.0)	0.5136

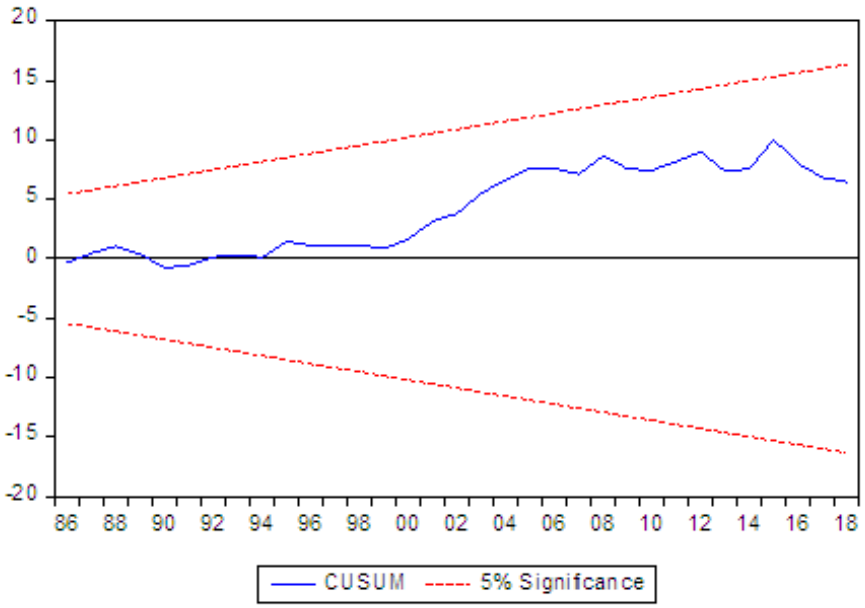
Source: Author's computation from Eviews, [51]

Appendix 5. Normality test

VEC Residual Normality Tests			
Orthogonalization: Cholesky (Lutkepohl)			
Null Hypothesis: Residuals are multivariate normal			
Date: 06/25/21 Time: 02:55			
Sample: 1980 2018			
Included observations: 37			
Component	Jarque-Bera	df	Prob.
1	0.302466	2	0.8596
2	287.3638	2	0.0000
Joint	287.6663	4	0.0000

Source: Author's computation derived from Eviews10 [51].

Appendix 6. Model stability test



Source: Author's computation derived from Eviews10 [51]

Appendix 7. Regression data

Year	Food Security (fose)	Remittances (remi)
1980	-0.319408667	22
1981	-0.13532375	16
1982	-0.209619375	18
1983	-0.219086875	14
1984	-0.33099375	12
1985	-0.376054375	10
1986	-0.435628125	4
1987	-0.385145625	3
1988	-0.2320725	2
1989	-0.282376875	10
1990	-0.48027625	10
1991	-0.4310175	66
1992	-0.276061875	56
1993	-0.23574625	793
1994	-0.230555	550
1995	-0.12489375	804
1996	-0.256409375	947
1997	-0.3463075	1,920
1998	-0.33053125	1,570
1999	-0.30187	1,300
2000	-0.160723125	1,390
2001	0.01714125	1,170
2002	0.008650625	1,210
2003	0.090031875	1,060
2004	0.171693125	2,270
2005	0.25113375	14,640
2006	0.31904625	16,932
2007	0.288006875	18,014
2008	0.492364375	19,203
2009	0.38473125	18,368
2010	0.364640625	19,745
2011	0.4739275	20,617
2012	0.5968125	20,543
2013	0.3994325	20,797
2014	0.419775625	20,806
2015	0.740031875	21,158
2016	0.458798125	19,679
2017	0.30	22,001
2018	0.31	24,311

Source: Food Security Index construction, 2021
World Bank, 2019

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