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THE BEHAVIOUR OF TAX REVENUE AMID CORRUPTION IN NIGERIA: EVIDENCE FROM THE NON-LINEAR ARDL APPROACH[7]

One of Nigeria's greatest challenges is the generation of adequate tax revenue to meet her rising expenditure, and the country has continued to contend with corruption, particularly in its public sector. We employ the non-linear autoregressive distributed lag (NARDL) technique to examine tax revenue behaviour amid corruption using Nigeria's quarterly data over the 1999-2019 period. The result of the NARDL bounds test to cointegration demonstrates the presence of a long-run relationship between tax revenue and corruption along with income level, agriculture, inflation rate, foreign aid and female labour force participation. The results of estimation indicate the existence of asymmetry in tax revenue behaviour. We find evidence of a significant positive impact of negative changes in the control of corruption and a significant negative effect of positive changes in the control of corruption on tax revenue in the long run. Other long-run significant determinants of tax revenue in Nigeria include income level, foreign aid and female labour force participation. Based on these empirical outcomes, this study offers some recommendations.
Keywords: Tax revenue; Corruption; NARDL technique; Nigeria
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Introduction

There is no doubt that one of Nigeria's greatest challenges is generating adequate revenue to meet her expenditure occasioned by rising demand for socio-economic infrastructures such as portable water, electricity, roads, healthcare, education, and security, among others. A major source of government finance is the tax revenue. Interestingly, taxation has long been recognised as an important instrument used by government to regulate the national economy, intervene in resources allocation and distribution of income, and an effective tool for achieving economic development in a country (Tanchev, 2016). However, successive governments in Nigeria have not been able to mobilise adequate tax revenue to drive sustainable economic development. In an attempt to strengthen the economy's capacity to collect tax, the government enacted an act that established the Federal Inland Revenue Service (FIRS) in the year 2007. Consequently, the FIRS, which had been a Department under the Ministry of Finance, was granted autonomy. Some of the reasons why tax bodies like the FIRS are created in each country include integration of tax operations and effective collection of tax compared to the ones obtainable under the civil service (Fjeldstad, 2006). Thus, it was expected that the tax body would become more efficient and effective in the delivery of its services as well as insulating it from unnecessary political interferences. Although the amount of tax collected increased in the early years of the establishment of the FIRS, the body was unable to sustain the growth in tax revenue in the years that follow.

Whereas the desire of every government is to sustain the generation of high tax revenue, public sector corruption can be an impediment to the successful mobilisation of revenue via tax collection. It has been suggested that the common features of tax systems in poor countries (Nigeria inclusive) are corruption and tax evasion (Fjeldstad, 2003). In carrying out its daily activities, the government delegates certain responsibilities to its officials, including the collection of taxes. But these officials might exploit their position for private gain or benefit (Aidt, 2003). Therefore, high corruption among tax officials/administrators can reduce a country's capacity in the collection of tax (Ajaz, Ahmad, 2010; Friedman et al., 2000; Johnson et al., 1999; Tanzi, Davoodi, 1997), and a substantial part of funds which ought to have gone to government's treasury are never realised due to corruption (Fjeldstad, 2003; Ghura, 1998; Kiser, Baker, 1994; Ul-Hague, Sahay, 1996).

On the other hand, subscribing to the view of Leff (1964) and Huntington (1968) that corruption can be beneficial in an economy characterised by weak institutions and inefficient bureaucracy by increasing its efficiency and raising the level of economic activity, a few scholars argued that some level of corruption could be tolerated to facilitate the collection of taxes in countries where wages of tax officials are very low and there are constraints on efforts required to know taxpayers' actual liabilities (Flatters, MacLeod, 1995). It has also been suggested that at very high levels of corruption, revenue collected from taxes can rise (Akdede, 2006; Alm et al., 2014). These authors opined that if the cost of evasion (the amount of bribes required to evade tax) is higher than the tax obligations, individuals will pay their taxes rather than engaging in evasion, leading to higher tax collection.

Some of the major obstacles to tax collection in Nigeria (and other African countries) are perceived corruption among tax officials and the lack of understanding of tax systems

operated in many economies on the African continent (Aiko, Logan, 2014). In addition, many individuals often ask what the taxes they pay are used for because there is not much on the ground in terms of tangible infrastructure or public utilities. This lack of trust reduces people's commitment to pay taxes and it also raises the likelihood that they will not comply by paying taxes. Therefore, high corruption (with an unfair tax administration) is likely to promote a culture of non-compliance among taxpayers, leading to less tax collection and revenue.

Nigeria is one of the countries where corruption remains a serious problem and scholars have suggested that it has spread to almost every part and/or sector of the economy (Abu et al., 2015; Abu, Staniewski, 2019). Also, authors have emphasised that corruption is a major factor militating against the proper functioning of Nigeria's FIRS and the growth of tax revenue (Micha et al., 2012; Momoh, 2018; Salami, 2011). A substantial amount of revenue is lost due to tax avoidance and evasion (acts of corruption) by a considerable number of firms (Momoh, 2018). Moreover, despite measures put in place to check fraudulent practices including the establishment of anti-corruption agencies such as the Economic and Financial crimes Commission (EFCC) and the Independent Corrupt Practices Commission (ICPC), some tax officials still engage in corrupt acts (Salami, 2011).

Despite the existence of low tax revenue and the relatively high corruption in Nigeria, researchers have paid less attention to examining the empirical relationship between these two variables, probably due to the lack of adequate data on tax revenue and corruption. In fact, Micah et al. (2012) blamed the lack of proper record (data) keeping for the poor performance of the FIRS. The few studies conducted on the corruption-tax revenue relationship in Nigeria are Onogwu (2018) and Omodero (2019). Whereas these authors' efforts deserve some commendations, the approach they employed is not without shortcomings. For instance, the number of observations used by Omodero (i.e. 23 years) and Onogwu (i.e. 22 years) falls short of 30, which is the minimum requirement for time series analysis. Second, the authors did not conduct unit root tests to ascertain the stationarity status of the variables used in their studies. Third, the results of the OLS estimation the authors reported might be meaningless if the variables considered in their studies were non-stationary. Fourth, the authors did not conduct diagnostic tests such as serial correlation, heteroscedasticity and misspecification tests making one to doubt the validity of their results.

Thus, the present study contributes to the literature in a number of ways. First, the study uses quarterly data spanning over the 1999-2019 period, making a substantial number of observations readily available for analysis. Second, this study conducts unit root tests to ascertain the stationarity status of the variables used in the analysis. Third, our study is the first to employ the non-linear autoregressive distributed lag ARDL (NARDL) technique to examine the relationship between tax revenue and corruption. Using the NARDL method makes it possible to investigate the asymmetric (positive and negative changes) impacts of corruption on tax revenue. Lastly, the NARDL approach solves problems such as endogeneity bias and consequently the generation of reliable and/or valid results.

Following the introduction the second section highlights the trends or movements in tax revenue and corruption in Nigeria. Section three consists of a review of related studies on tax revenue and corruption, while the fourth section is for theoretical framework and model

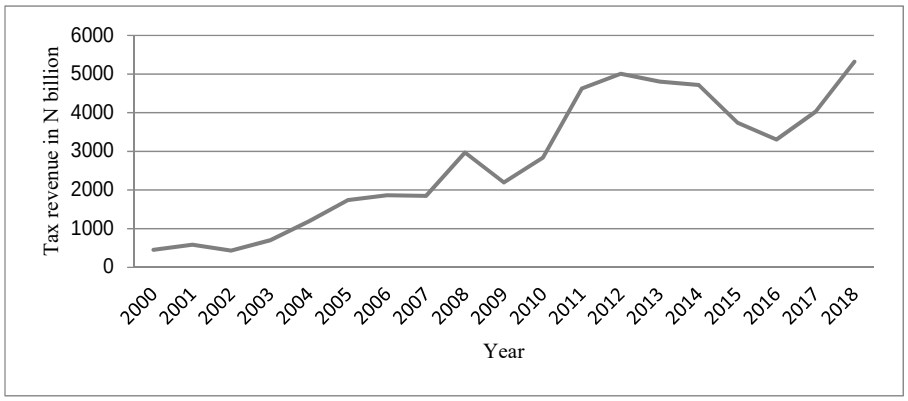
specification. The fifth section contains data and econometric techniques, while section six is the discussion of results. The last section concludes the study.

Trends in Tax Revenue and Corruption in Nigeria

As stated in the introduction, the primary goal of creating the FIRS was to raise (and sustain) the amount of revenue collected via tax. However, it appears that the establishment of the tax body has not led to a significant improvement in revenue generation and/or sustained growth in tax collection. Available statistics from Nigeria's FIRS illustrate that tax revenue (in billion Naira) fluctuated over the 2000-2018 period. For example, from N455.3 billion in 2000, tax revenue decreased to N433.9 billion in 2002 before jumping to N1,866.2 billion in 2006. Thereafter, tax revenue declined to N1,846.9 billion in 2007, but it later increased to N2,972.2 billion in 2008. The fluctuation in tax revenue continued as it decreased to 2,197.8 billion in 2009. Even though tax revenue increased to N5,007.7 billion in 2012, it soon fell to N4,716.6 billion in 2014 and further to N3,307.5 billion in 2016. The value of tax revenue was N5,320.5 billion in 2018 (Figure 1).

Figure 1

Plots of tax revenue (in N billion) in Nigeria calculated based on the data collected from FIRS



Similarly, the share of tax revenue in GDP fluctuated during the same period. In addition, tax revenue share in real and nominal GDP was less than 10 percent from 2000 to 2018 (Figure 2). The low share of tax revenue in GDP in Nigeria is consistent with the view of Besley and Persson (2014) that tax collection in low-income countries has remained low and it ranges between 10 to 20 percent of GDP compared to the 40 percent average for their high-income counterparts.

Besides unimpressive tax revenue performance, Nigeria's other challenge is public sector corruption. The Transparency International (TI) in the year 2020 ranked Nigeria as one of the leading corrupt nations in the world and the fourth most corrupt in the West African sub-region. A cursory look at the TI's corruption perception index indicates that Nigeria has not

fared well in tackling corruption. The index ranges from 0 (most corrupt) to 100 (most clean). Nigeria's corruption index, which stood at 12 in 2000, rose to 16 in 2002 before dropping to 14 in 2003. Although the index increased to 19 in 2005 and 27 in 2008, it declined to 24 in 2010-2011. The index assumed a rising trend to 27 in 2012, but it fell to 26 in 2015. The corruption index rose to 28 in 2016 and later declined to 27 in 2017-2018 (Figure 3). The low corruption index suggests that Nigeria's corruption level has remained high over the years.

Figure 2

Plots of tax revenue share in real and nominal GDP in Nigeria calculated based on the data collected from FIRS and World Bank's WDI

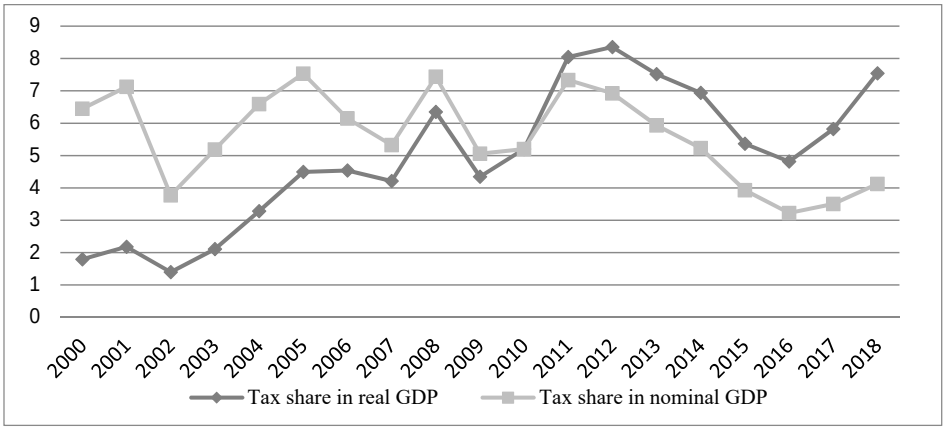
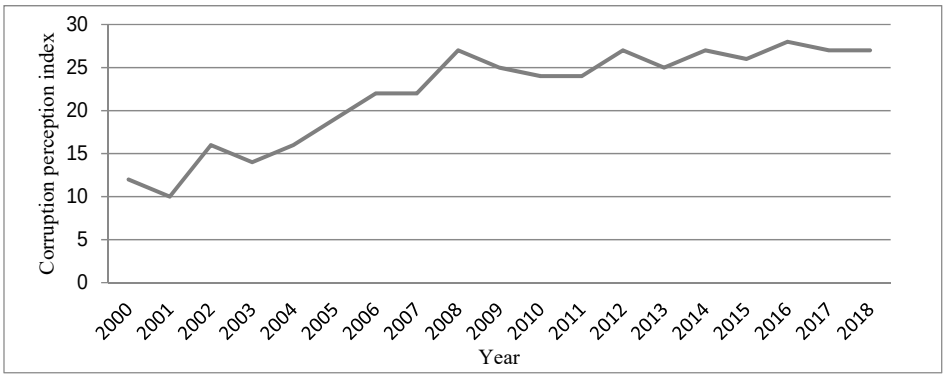


Figure 3

Plots of corruption perception index in Nigeria based on the data collected from Transparency International



Thus, the movements in tax revenue and corruption index suggest that Nigeria has been less successful in tax collection and it remains a country where corruption continues to rear its ugly head.

Review of Related Studies on Corruption and Tax Revenue

Authors have examined the empirical relationship between tax revenue and corruption. Most of these studies focused on a group of countries, employing cross-section or panel data. For example, Arif and Rawat (2019) investigated the influence of governance and corruption on the tax revenue in 10 emerging and growth-leading nations from 2001 to 2015 using the pooled mean group (PMG) estimator. The results demonstrate that improvement in governance and the fight against corruption exert a significant and positive effect on tax revenue mobilisation.

Also, Epaphra and Massawe (2017) analysed the impacts of governance and corruption on different types of taxes in selected African economies using the random effects and fixed effects estimators. Other variables, including income per capita, inflation, agriculture, trade openness, tariff rate and tax rate, were considered in the study. The authors found that good governance raises tax revenues, while corruption has a negative impact on tax revenues. Besley and Persson (2014) attempted to answer the question "why developing countries tax so low". The results of the regression analysis indicate that an improvement in the corruption index (less corruption) has a positive impact on tax revenue. In addition, tax revenue increases at a high-income level and decreases at a low level of income. Other significant drivers of tax revenue are property rights protection, average years in war, ethnic fractionalisation and executive constraints. Rodríguez (2018) employed both system system-generalised method of moments (system-GMM) and panel corrected standard error (PCSE) estimators to examine the drivers of tax revenue and/or its compositions in 138 economies from 1976 to 2015. The author discovered that the quality of governance, female labour force participation, education, international trade and democracy promote tax revenue mobilisation. On the other hand, agriculture, inflation, foreign aid, natural resource rents and population tend to reduce the amount of tax collected.

In addition, Imam and Jacobs (2014) regressed 11 types of taxes on corruption, including real income per capita, openness, share of agriculture in GDP, and inflation in 12 Middle East countries from 1990 to 2003 using the system-GMM technique. The results illustrate that reducing corruption has a negative impact on taxes collected on goods and services, while it raises other forms of tax revenue. Other important determinants of tax revenue include income per capita, agricultural share in GDP, openness and inflation. Furthermore, Ajaz and Ahmad (2010) investigated the effect of institutional variables (corruption and governance) and structural factors on tax revenue in 25 developing economies during the 1990-2005 period using the GMM estimator. The results illustrate that corruption has a negative effect on tax collection, and better governance has a positive impact on tax revenue. Also, factors such as inflation (proxied by the log of consumer price index) and industrial output share in GDP are important in explaining tax revenue.

Similarly, Mahdavi (2008) employed the GMM estimation method to assess the effect of corruption on tax revenue in 43 countries from 1973 to 2002. The results suggest that less corruption has a positive impact on tax revenue. Furthermore, Bird et al. (2008) examined the effect of governance (corruption, voice and accountability) on tax effort (proxied by tax revenue share in GDP) in a cross country study over the 1990-1999 period using the ordinary

least squares (OLS) and the two-stage least squares (TSLS) estimation methods. Other potential determinants considered in the study included GDP per capita, population growth rate, openness (exports plus imports to GDP ratio), and non-agricultural share in GDP. The results show that reducing corruption has a positive effect on tax revenue. In addition, population growth and income per capita have a negative effect on tax revenue, but the non-agriculture sector has a positive impact on tax revenue.

In the same vein, Thornton (2008) employed the OLS and TSLS estimators to evaluate the impact of corruption on the composition of tax revenue in a sample, consisted of 53 the Middle East and African countries. The results illustrate that corruption has a strong negative and significant impact on tax revenue collected on international trade transactions, domestic goods and services and social security. Also, Hwang (2002) investigated the effect of corruption (proxied by different indexes of corruption) on government revenue in 41 to 66 countries using the OLS, TSLS and seemingly unrelated regression (SUR) estimation techniques. The empirical evidence demonstrates that corruption is positively related to taxes on international trade, but negatively associated with domestic tax revenue and government revenue share in GDP.

Moreover, Alm et al. (2014) employed different estimation methods to examine the corruption and tax evasion relationship using firm-level information. The authors found that corruption raises the level of tax evasion, which consequently results in low tax revenue. In addition, Ketkar et al. (2005) evaluated the effects of corruption on tax revenue and foreign direct investment (FDI) in 54 developed and developing economies since 1996 using multiple regression analyses. The results reveal that a reduction in corruption raises revenue directly via higher tax collection and indirectly through higher FDI inflow and taxable income. Ghura (1998) assessed the effects of corruption and economic policies on tax revenue in 39 Sub-Saharan African (SSA) economies over the 1985-1996 period. The regression results indicate that tax revenue rises with a reduction in the level of corruption. In addition, agriculture, inflation, openness, human capital development, external factors, and structural reforms are equally significant in explaining tax revenue. Tanzi and Davoodi (1997) investigated the relationship between corruption, economic growth and public finances across countries from 1980 to 1995 using regression analysis. The results reveal that high corruption has a negative impact on tax revenue, including total revenue and non-tax revenue. The empirical results also indicate that income per capita is significant in explaining government revenue.

Some studies have evaluated the impact of corruption on tax compliance, tax effort, and tax morale with its consequences on tax revenue. For instance, Pessino and Fenochietto (2010) examined the determinants of tax effort (measured by tax revenue as a share of GDP) in a sample of 96 economies during the 1991-2006 period by employing the stochastic frontier method of analysis. The results demonstrate that countries with a low level of corruption have a high level of tax revenue. Gupta (2007) used various estimation approaches such as the fixed effects, random effects, PCSE, system-GMM and difference-GMM estimators to investigate factors that influence tax revenue effort in 105 developing countries for a period of 25 years. The results illustrate that less corruption has a positive effect on tax revenue, mainly in low and middle-income countries. Also, variables such as income per capita, share of agriculture in GDP, openness to trade, foreign aid, and political stability are important determinants of tax revenue. Moreover, Picur and Riahi-Belkaoui (2006) examined the

relationship between corruption, bureaucracy and tax compliance in 30 developing and developed economies using OLS with the White correction method. The empirical results show that control of corruption has a positive effect on tax compliance, and bureaucracy has a negative impact on tax compliance. These findings suggest that less corruption promotes tax compliance, which results in high tax revenue, while bloated bureaucracy encourages non-compliance, which leads to less tax revenue. On his part, Torgler (2004) used the weighted ordered probit analysis to examine corruption and tax morale relationship in transition countries during the 1995-1998 period. The author found that the higher the perceived size of corruption, the lower the tax morale and as a result, the less tax revenue.

In Nigeria, Omodero (2019) employed the OLS technique to analyse the effects of shadow economy and corruption on tax revenue performance during the 1996-2018 period. The author concluded that both corruption and the shadow economy have adverse impacts on tax revenue in Nigeria. Also, Onogwu (2018) analysed the impact of corruption on public sector revenue and investment in Nigeria from 1997 to 2017 using the OLS method. The author found that corruption raises public investment, while there was no evidence that corruption exerts an influence on government revenue.

A review of empirical literature indicates that little attention has been given to the corruption and tax revenue relationship in Nigeria. Also, existing studies on the corruption-tax revenue relationship employed inadequate sample size, did not conduct unit root tests, employed inappropriate estimation techniques, and failed to perform important tests, including serial-correlation and heteroscedasticity tests. This study contributes to the literature by employing the NARDL method to investigate the behaviour of tax revenue amid corruption in Nigeria using quarterly data over the 1999-2019 period. In addition, conventional diagnostic tests like serial-correlation and heteroscedasticity, as well as tests were conducted to ascertain the validity of the results.

Theoretical Framework and Model Specification

In building the tax model, this study relies on the theory of tax compliance of Graetz et al. (1986). The authors explained how the interaction between taxpayers and tax officials could influence the amount of tax collected via enforcement and bribery (an act of corruption). Contributing to the discourse, Flatters and MacLeod (1995) presented a model which shows that some level of corruption can be tolerated to make the tax system efficient, particularly if the wages of tax officials are very low and there are huge constraints on efforts required to know precisely taxpayers' liabilities. Supporting this argument, Akdede (2006) and Alm et al. (2014) suggested that corruption can provide a conducive environment for tax compliance. The authors opined that if the costs of evasion (i.e. the amount of bribes taxpayers are required to pay to officials to evade tax) are higher than the costs of paying tax, then, individuals (or firms) will comply and pay their tax rather than giving the huge bribes to tax officials. This will raise the level of tax revenue.

On the contrary, some scholars argue that corruption reduces the effectiveness of the government's policy instruments, leading to a reduction in the government's ability to

enforce tax laws and raise tax revenue (Chander, Wilde, 1992; Virmani, 1987). Authors have also emphasised that collusion between taxpayers and tax collectors can result in an understatement of tax liabilities and, consequently, a reduction in the amount of tax that is remitted to the treasury (Aidt, 2003; Flatters, MacLeod, 1995). To a greater extent, raising income tax will lead to a reduction rather than an increase in tax revenue in countries where tax administrators are very corrupt (Bowles, 1999; Sanyal, 2002; Sanyal et al., 2000; Tanzi, Davoodi, 1997).

The foregoing discussion illustrates that the level of corruption (COR) tends to affect tax revenue (TAX). Thus, a model in which TAX is dependent on COR is specified as:

$$LTAX_t = \beta_0 + \beta_1 COR_t + \varepsilon_t \quad (1)$$

Other than corruption (the variable of interest), certain variables which also influence tax revenue in the literature are considered in this study. They include income level, agriculture, inflation, foreign aid and female labour force participation. For example, authors argue that income level measured by GDP per capita (GDPC) goes a long way in affecting tax revenue mobilisation (Bird et al., 2008; Gupta, 2007; Imam, Jacobs, 2014; Tanzi, Zee, 2000; Teera, 2003). Thus, at a higher income level, countries have a higher capacity to collect and pay taxes (Chelliah, 1991), leading to higher tax revenue (Imam, Jacobs, 2014).

In addition, agriculture (AGR) tends to influence the revenue that can be collected via tax (Gupta, 2007; Tanzi, Zee, 2000; Teera, 2003). In developing countries where agriculture constitutes a substantial amount of economic activity and is dominated by subsistence production and farming, it may be difficult to tax those who engage in agricultural production and farming due to their low earnings. Therefore, in a country like Nigeria with subsistence agricultural production and poor farmers, agriculture is expected to have a negative effect on tax revenue.

Furthermore, inflation proxied by the consumer price index (CPI) and a measure of macroeconomic uncertainty or instability (An et al., 2016) can also affect the level of tax revenue. The higher the inflation rate (or higher uncertainty/worsening macroeconomic condition), the lesser the revenue generated from different taxes (Imam, Jacobs, 2014). In line with this view, authors, including Tanzi (1977), suggested that real tax revenue declines with high inflation. Thus, the high inflation rate in Nigeria is expected to have a dampening impact on tax revenue.

Moreover, foreign aid (AID) can influence the amount of tax collected (Gupta, 2007; Rodriguez, 2018). The effect of AID depends on whether it is used to finance consumption or expand production (Gupta, 2007). It has also been suggested that the behaviour of revenue can be influenced by the composition of AID (Gupta et al., 2003; Rodriguez, 2018). Whereas Gupta et al. (2003) and Rodriguez (2018) found that concessional loans raise tax revenue, authors such as Mahdavi (2008) and Benedek et al. (2014) confirmed a negative effect of grant on tax revenue.

Also, female labour force participation (FELP) can dictate the movement in tax revenue (Mahdavi, 2008; Rodriguez, 2018). The higher the participation of females in the labour force, the higher the labour income that is taxable. The reason behind this argument is that

housewives carry out some duties at home (considered as work) for which they receive no payment (Rodriguez, 2018). Thus, participating in the labour force, enable females to earn income that can be taxed. Authors also believe that women are more likely to comply with tax obligations compared to men as they pay greater attention to ethical issues (Rodriguez, 2018; Torgler, Schaltegger, 2005).

Taking these variables into consideration, the new tax revenue model is re-specified as follows:

$$LTAX_t = \beta_0 + \beta_1 COR_t + \beta_2 LGDPC_t + \beta_3 LAGR_t + \beta_4 LCPI_t + \beta_5 AID_t + \beta_6 FELP_t + \varepsilon_t \quad (2)$$

where L denotes the logarithm of the variables.

Data and Econometric Techniques

The major constraint of this study is the lack of data for a substantial number of observations/years (i.e. n>30 or above) required for a time series analysis. In particular, the data on control of corruption is available from the year 1996 and the data on tax revenue from 1999. It is noteworthy that previous studies on tax revenue determinants in Nigeria used federally collected revenue as a proxy for tax revenue. In our case, we use tax revenue data which are published by the FIRS and available for only a few years. Proper record (data) keeping of tax revenue has been a major problem in tax administration in Nigeria (Micah et al., 2012). On the other hand, data on other (control) variables are available for a considerable number of years. To address this issue, annual data on all variables for the 1999-2019 period were converted into quarterly data using the Gandolfo's (1981) interpolation method. This leaves us with a higher number of observations, that is, quarterly data for 1999:1-2019:4 (i.e. n=76) because the first and last years of the series were eliminated during interpolation. The Gandolfo's procedure has been used in past empirical studies (Abu, Karim, 2021; Abu et al., 2019; Baharumshah et al., 2006; Baharumshah, Rashid, 1999). In addition, it has been stated that interpolated series do not cause bias in estimates of cointegrating vectors even in finite samples (Smith, 1998).

The data were collected from various sources as follows. The data on GDP per capita, consumer price index, agriculture, foreign aid and female labour force participation were obtained from the World Bank's World Development Indicators (WDI); the control of corruption from the World Bank's World Governance Indicators (WGI); and TAX from the Federal Inland Revenue Service.

Unit root tests

Prior to the estimation of the relationship between tax revenue and corruption, the Augmented Dicker-Fuller (ADF) and Phillips-Perron (PP) tests were used to ascertain the unit root property/status of the data/series. This test (unit root test) is required to guide against the generation of misleading results. The ADF equation (Dickey, Fuller, 1979) is specified as:

$$\Delta y_t = \mathrm{a} + \rho y_{t-1} + \theta_1 \Delta y_{t-1} + \cdots + \theta_k \Delta y_{t-k} + \varepsilon_t$$

where y_t is the series, and ε_t the error term. The equation is used to test the null hypothesis:

$H_0 : \rho = 0$ (unit root)

Against the alternative hypothesis:

$H_1 : \rho < 0$ (series is stationary)

In addition, the PP test (Phillips and Perron 1988) was used as a complement to the ADF test. If the ADF/PP statistic is smaller than the critical value at 1%, 5% or 10%, the H_0 is not rejected. On the other hand, if the ADF/PP statistic is higher than the critical value, the H_1 is accepted.

Non-linear ARDL technique

In examining the relationship between tax revenue and corruption, this study employs the NARDL approach of Shin et al. (2014). The NARDL method is an asymmetric extension to the popular ARDL model (Pesaran, Shin, 1999; Pesaran et al., 2001). The rationale for using the NARDL technique is based on the opinion of scholars that the relationship that exists between variables is not always linear. This technique can be used whether the series are of order one [i.e. I(1)] or a combination of variables of [I(1)] and order zero [I(0)], but it cannot accommodate I(2) variables (Ibrahim, 2015; Jalil et al., 2014; Shin et al., 2014). Also, the method is more appropriate in estimating the relationship between variables using finite or small samples.

The NARDL model $(p, k_1, k_2, k_3, k_4, k_5)$ to be estimated is specified as follows:

$$\begin{aligned} \Delta LTAX_t = \delta_0 &+ \sum_{i=1}^{p} \delta_1 \Delta LTAX_{t-i} + \sum_{i=0}^{k_1} \delta_2^* \Delta\, COR_{t-i}^* + \sum_{i=0}^{k_2} \delta_3 \Delta LGDPC_{t-i} \\ &+ \sum_{i=0}^{k_3} \delta_4 \Delta LAGR_{t-i} + \sum_{i=0}^{k_4} \delta_5 \Delta LCPI_{t-i} + \sum_{i=0}^{k_5} \delta_6 \Delta AID_{t-i} \\ &+ \sum_{i=0}^{k_6} \delta_7 \Delta FELP_{t-i} + \beta_1 LTAX_{t-1} + \beta_2^* COR_{t-1}^* + \beta_3 LGDPC_{t-1} \\ &+ \beta_4 LAGR_{t-1} + \beta_5 LCPI_{t-1} + \beta_6 AID_{t-1} + \beta_7 FELP_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

where δ_0 is the constant, δ_1 - δ_7, and β_1 - β_7 are coefficients to be estimated. The short-run and long-run models' asymmetric parameters are decomposed into negative partial and positive partial sums in equations which are specified as (4) and (5), respectively. This enables us to determine the asymmetric impacts of COR on LTAX.

$$\sum_{i=0}^{k_1} \delta_2^* \Delta\, COR_{t-i}^* = \sum_{i=0}^{k_1} (\delta_2^+ \Delta\, COR_{t-i}^+ + \delta_2^- \Delta\, COR_{t-i}^-) \quad (4)$$

$$\beta_2^* COR_{t-1}^* = (\beta_2^+ COR_{t-1}^+ + \beta_2^- COR_{t-1}^-) \quad (5)$$

The decomposed parameters COR^+ and COR^- represent positive and negative changes in the control of corruption, respectively. A positive change implies greater control of corruption, while a negative change indicates lesser control of corruption. Thus, a positive/negative sign of the coefficient of control of corruption (COR) implies that reducing corruption has a positive/negative impact on tax revenue.

The NARDL procedure begins with the bounds test for a null hypothesis of no cointegration (H_0) against the alternative hypothesis of cointegration (H_1). The equations required to test each hypothesis are stated as follows:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$, and H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq 0$

In testing these hypotheses, the Wald test is carried out on the joint significance of the coefficients by computing the F-statistic. The statistic is then compared with the upper and lower critical bounds. Where the computed F-statistic is larger than the upper bound [I(1)], the null hypothesis of no cointegration between/among the variables is rejected. On the other hand, if the computed F-statistic is smaller than the lower bound [I(0)], then the null hypothesis is not rejected. In the event that the F-statistic lies between I(0) and I(1), the inference would be inconclusive.

The asymmetry test is conducted to ascertain whether a non-linear relationship exists between or among variables. The test accounts for asymmetric effects via the computation of decomposed negative and positive partial sums of the concerned explanatory variable or regressor. Next is to conduct the Wald test to check the joint significance of the partial sums and to test the null hypothesis of no asymmetry. If the short-run coefficient of the negative partial sum of COR is different from the positive partial sum of COR, that is,

$\sum_{i=0}^{k_1} \delta_2^+ \neq \sum_{i=0}^{k_1} \delta_2^-$. It is confirmed that asymmetric impact is present.

In the same vein, if the long-run coefficient of the negative partial sum of COR varies from the positive partial sum of COR, that is:

$\beta_2^+ \neq \beta_2^-$. Then the asymmetric effect is established.

Once the variables are found to have a cointegrating relationship, the long-run coefficients would be estimated using the model, which is specified as follows:

$$LTAX_t = \theta_0 + \theta_1^+ COR_t^+ + \theta_1^- COR_t^- + \theta_2 LGDPC_t + \theta_3 LAGR_t + \theta_4 LCPI_t + \theta_5 AID_t + \theta_6 FELP_t + \varepsilon_t \quad (6)$$

In addition, the short-run coefficients can be estimated using the model that is specified as follows:

$$\Delta LTAX_t = \Upsilon_0 + \sum_{i=0}^{p} \Upsilon_1 \Delta LTAX_{t-i} + \sum_{i=0}^{k_1} (\Upsilon_2^+ \Delta COR_{t-i}^+ + \Upsilon_2^- \Delta COR_{t-i}^-) + \sum_{i=0}^{k_2} \Upsilon_3 \Delta LGDPC_{t-i} + \sum_{i=0}^{k_3} \Upsilon_4 \Delta LAGR_{t-i} + \sum_{i=0}^{k_4} \Upsilon_5 \Delta LCPI_{t-i} + \sum_{i=0}^{k_5} \Upsilon_6 \Delta AID_{t-i} + \sum_{i=0}^{k_6} \Upsilon_7 \Delta FELP_{t-i} + \psi_1 ECT_{t-1} + \varepsilon_t \quad (7)$$

ECT_{t-1} is the error correction term lagged by one period, and its coefficient, ψ_1, is the represents the speed of adjustment required to restore the long-run equilibrium following any shock. In estimating the NARDL model, the Akaike Information Criterion (AIC) was used to select the optimal lags for the variables. The justification for using the AIC is based on its superior performance compared to other lag selection criteria, even in finite samples (Liew, 2004).

Diagnostic tests

Diagnostic tests were performed to ascertain/check the reliability of the results. These tests show whether the estimated model has problems of serial-correlation and hetero-scedasticity. The Breusch-Godfrey serial-correlation Lagrange multiplier test was used to check whether the residuals are serially correlated, and the Breusch-Pagan-Godfrey heteroscedasticity test to ascertain if the error terms in the model are homoscedastic. In addition, the Ramsey RESET test was carried out to ascertain whether the model is well specified.

Stability tests

In an attempt to evaluate the stability status of the estimated model and its parameters, the stability tests were carried out. The objective was achieved using the cumulative Sum of recursive residuals (CUSUM) and the cumulative Sum of squares of recursive residuals (CUSUMQ). If the plots of the CUSUMQ break outside the lower and/or upper bounds, it will be concluded that the parameters are not stable over the long run (Greene, 2003).

Results and Discussion

Results of unit root tests

The unit root test results in Table 1 indicate that some variables are stationary or do not have a unit root. They include LGDPC and LAGR. On the other hand, series such as LTAX, COR, LCPI, AID and FELP exhibited a unit root, but they became stationary after their first difference.

Table 1

Results of unit root tests

	ADF				PP			
Variable	Level	ρ-value	1st diff.	ρ-value	Level	ρ-value	1st diff.	ρ-value
LTAX	-1.661	0.446	-4.558***	0.000	-2.173	0.217	-4.689***	0.000
COR	-1.859	0.349	-5.218***	0.000	-2.150	0.226	-5.119***	0.000
LGDPC	-4.230***	0.001	-	-	-4.945***	0.000	-	-
LAGR	-3.072**	0.033	-	-	-4.655***	0.000	-	-
LCPI	-1.044	0.733	-3.196**	0.024	-2.646	0.088	-4.472***	0.000
AID	-2.331	0.165	-4.225***	0.001	-2.407	0.143	-4.320***	0.000
FELP	-2.441	0.134	-8.745***	0.000	-3.482**	0.011	-	-

** and *** indicate a rejection of the null hypothesis of no unit root at 5% and 1% levels, respectively.
Source: Authors' calculation.

These findings demonstrate that the series/variables are a mixture/combination of I(0) and I(1), thus, providing justification for the bounds test to cointegration.

Results of NARDL bounds test to cointegration

The result of the NARDL bounds test to cointegration in Table 2 illustrates that the calculated F-statistic (i.e. 8.42) is higher than the upper critical bound value (i.e. 3.90) at the 1% level.

Table 2

Results of bounds test to cointegration

Function = f$(TAX/COR, LGDPC, LAGR, LCPI, AID, FELP)$			
	Critical values bounds		
F-stat. = 8.4214***		I(0)	I(1)
	10%	1.92	2.89
	5%	2.17	3.21
	1%	2.73	3.90

******* denotes statistical significance at a 1% level and a rejection of the null hypothesis of no cointegration.
Source: Authors' calculation.

This finding reveals the existence of cointegration among LTAX, COR, LGDPC, LAGR, LCPI, AID and FELP. Thus, the variables have a long-run equilibrium relationship.

Results of asymmetry test

The result of the asymmetry test (for long-run relationship) in Table 3 demonstrates that the calculated F-statistic is 5.6866 with a corresponding probability of 0.0067. This finding suggests that there is an asymmetric relationship between tax revenue and corruption in the lond run.

Table 3

Result of asymmetry test

Wald Test	Results
F-stat.	5.6866(0.0067)

Note: Values in parenthesis are probability values.
Source: Authors' calculation.

Results of NARDL model estimation

The results of the estimation of NARDL model are presented in Table 4. The optimum lag length of the estimated model selected by the AIC is 4,4,1,3,3,0,4,4. The long-run results indicate that control of corruption (COR) is significantly related to tax revenue (LTAX). A positive change (or an increase) in COR by 1 unit reduces LTAX by a 2.71% at a 1% level, while a negative change (or decrease) in COR by 1 unit raises LTAX by a 2.75% at a 1% level in the long-run. In addition, income level (LGDPC) has a positive and significant impact on tax revenue. A 1% increase in LGDPC leads to a 2.73% increase in LTAX at a 1% level in the long run.

Table 4

Results of selected short-run and long-run non-linear ARDL models

Short-run coefficients (D.V is ΔLTAX)			Long-run coefficients (D.V is LTAX)		
Regressor	Coeff./Se	ρ-value	Regressor	Coeff./Se	ρ-value
$\Delta LTAX_{-1}$	0.4664*** (0.0758)	0.0000	Constant	-2.5420 (5.6597)	0.6557
$\Delta LTAX_{-2}$	0.4132*** (0.0822)	0.0000	COR^{+}	-2.7142*** (0.7101)	0.0005
$\Delta LTAX_{-3}$	0.3190*** (0.0646)	0.0060	COR^{-}	2.7500*** (0.6424)	0.0001
ΔCOR^{+}	0.3782 (0.3562)	0.2947	LGDPC	2.7277*** (0.2960)	0.0000
ΔCOR_{-1}^{+}	1.7030*** (0.4536)	0.0006	LAGR	-0.6130 (0.5525)	0.2739
ΔCOR_{-2}^{+}	1.2995*** (0.4388)	0.0051	LCPI	-0.0327 (0.2564)	0.8990
ΔCOR_{-3}^{+}	1.3194*** (0.3996)	0.0020	AID	-0.0709* (0.0379)	0.0678
ΔCOR^{-}	-1.1877*** (0.3115)	0.0005	FELP	0.0611*** (0.0172)	0.0010
ΔLGDPC	1.7620*** (0.2768)	0.0000			
$\Delta LGDPC_{-1}$	-1.2327*** (0.3793)	0.0023			
$\Delta LGDPC_{-2}$	-1.0398*** (0.3475)	0.0047			
ΔLAGR	-1.3461*** (0.2745)	0.0000			
$\Delta LAGR_{-1}$	0.9088** (0.3529)	0.0138			
$\Delta LAGR_{-2}$	0.7361** (0.3126)	0.0236			
ΔLAID	0.1140*** (0.0240)	0.0000			
$\Delta LAID_{-1}$	0.0720** (0.0293)	0.0187			
$\Delta LAID_{-2}$	0.0502* (0.0278)	0.0787			
$\Delta LAID_{-3}$	0.0252* (0.0137)	0.0573			
ΔFELP	0.0886*** (0.0322)	0.0090			
$\Delta FELP_{-1}$	-0.1317*** (0.0162)	0.0000			
$\Delta FELP_{-2}$	-0.0823*** (0.0118)	0.0000			
$\Delta FELP_{-3}$	-0.0531*** (0.0082)	0.0000			
ECT_{-1}	-0.5844*** (0.0612)	0.0000			

Δ is the first difference operator. Values in parenthesis are standard errors. *, ** and *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively. A positive/negative sign of COR indicates greater control of corruption/lesser control of corruption.

Source: Authors' calculation.

Furthermore, foreign aid (AID) has a negative and significant effect on LTAX. A 1% increase in AID causes LTAX to decline by a 0.07% at a 10% level in the long run. Moreover, female labour force participation (FELP) is significantly related to LTAX. An increase in FELP by 1% leads to a 0.06% increase in LTAX at a 1% level in the long run. However, agriculture (LAGR) and inflation rate (LCPI) have a negative and insignificant effect on LTAX in the long run.

The short-run results show that COR has a significant impact on tax revenue. A positive change in COR lagged by one period by 1 unit raises LTAX by 1.70%, while a negative change in COR by 1 unit reduces LTAX by 1.19% at a 1% level in the short-run. In addition, a 1% increase in LGDPC raises LTAX by a 1.76% at a 1% level in the short run. Moreover, an increase in LAGR by 1% reduces LTAX by 1.35% at a 1% level in the short run. Furthermore, AID and FELP have a positive and significant impact on LTAX. A 1% increase AID and FELP lead to an increase in LTAX by 0.11% and a 0.09%, respectively, at a 1% level, in the short-run.

The coefficient of the error correction term lagged by one period (ECT_{-1}) is negative and statistically significant at a 1% level. This implies that approximately 0.58% of the deviation from equilibrium will be corrected in the fourth quarter of the year.

Results of diagnostic tests

The results of diagnostic tests in Table 5 indicate that the Breusch-Godfrey serial-correlation Lagrange multiplier test statistic is 4.19, with its probability value of 0.12. This finding illustrates that there is an absence of serial-correlation in the estimated results.

Table 5

Results of diagnostic tests

Test Statistic	Results
Serial Correlation: χ^2	4.1992[0.1225]
Heteroscedasticity: χ^2	19.4846[0.9293]
Mis-specification Test: F-statistic	0.5651(0.4567)

Values in parenthesis are probability values.
Source: Authors' calculation.

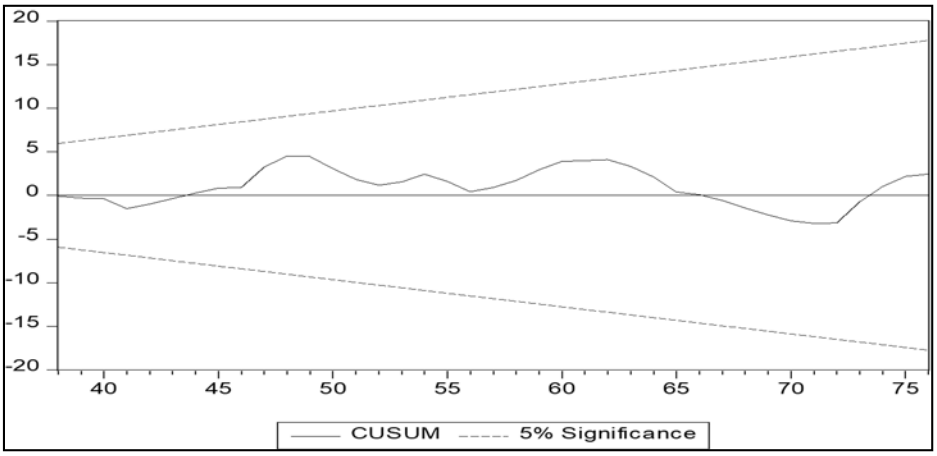
Similarly, the Breusch-Pagan heteroscedasticity test statistic (19.48) with its probability value (0.92) demonstrates that the errors are homoscedastic. Lastly, the Ramsey misspecification test statistic and probability are 0.5651 and 0.4567, respectively. This implies that the estimated model is well specified.

Results of stability tests

The results of the CUSUM and CUSUMQ tests in Figure 4 and Figure 5 reveal that the plots are within the boundaries, implying that the model and its parameters are stable in the long run.

Figure 4

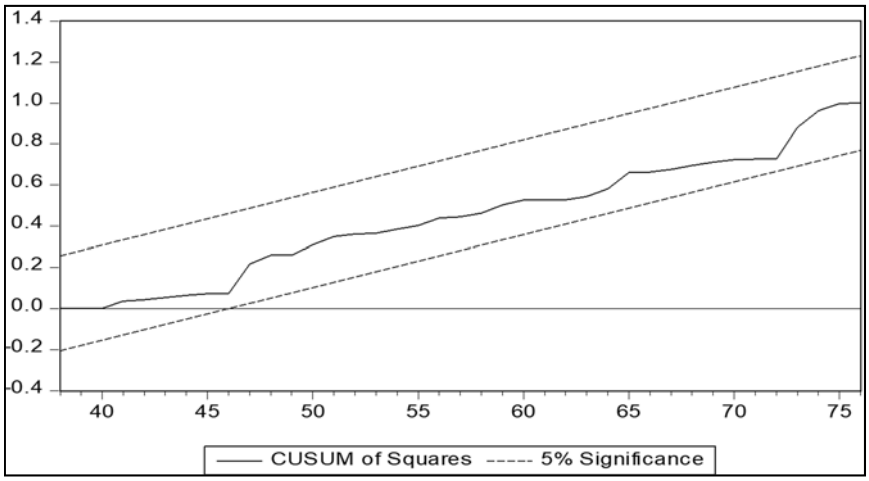
Cumulative sum of recursive residuals plots



Source: Authors' calculation.

Figure 5

Cumulative sum of squares of recursive residuals plots



Source: Authors' calculation.

Overall, the bounds test result reveals that there is a long-run relationship among tax revenue and corruption (along with GDP per capita, inflation, agriculture, foreign aid and female labour force participation). The results of estimation of the NARDL model show that corruption has asymmetric (i.e. negative and positive) effects on tax revenue in Nigeria in the short run and the long run. The negative sign of control of corruption is consistent with studies carried out earlier (Alm et al., 2014; Hwang, 2002; Imam, Jacobs, 2014). For example, Imam and Jacobs (2014) discovered that an improvement in the corruption index is associated with fewer taxes collected on goods and services, corporation and other enterprise

taxes. Similarly, the study by Hwang (2002) suggested that high corruption is positively related to taxes on international trade. Also, the results of the work of Alm et al. (2014) indicated that at higher levels of corruption (costs of bribery), firms reported their incomes or sales rather than paying huge bribes to tax officials to evade taxes. Consequently, tax revenue increased. On the other hand, the positive sign of the coefficient of control of corruption (reducing corruption) lends support to prior studies (Besley, Persson, 2014; Bird et al., 2008; Gupta, 2007; Ketkar et al., 2005; Mahdavi, 2008). These studies confirmed that less corruption raises tax revenue collection.

The negative association between an improvement in control of corruption (reducing corruption) and tax revenue supports the claim that at a higher corruption level (when tax officials demand huge bribes from taxpayers to evade taxes) payers will pay their taxes rather than incur the huge bribes officials ask them (to engage in tax evasion), leading to higher tax collection. This negative relationship portrays the situation in Nigeria, where the existence of weak institutions and inefficient bureaucracy create a conducive atmosphere for corruption to thrive within the economy, including the tax system. As stated earlier, corruption remains a serious issue in the Nigerian tax system (Micha et al., 2012; Momoh, 2018; Salami, 2011), and it might have aided tax revenue. Contrariwise, the positive linkage between control of corruption and tax revenue suggests that tackling or lowering the level of corruption leads to higher tax revenue collection.

The positive effect of income level on tax revenue lends support to past studies (Castro, Camarillo, 2014; Dioda, 2012; Ghura, 1998; Gupta, 2007; Muibi, Sinbo, 2013; Imam, Jacobs, 2014; Nwosa et al., 2012; Tanzi, Davoodi, 1997). For example, Ghura (1998) found that tax revenue increases with income level in SSA countries, while Nwosa et al. (2012), as well as Muibi and Sinbo (2013), discovered that rising level of income raises revenue in Nigeria. Thus, as income level increases the capacity to collect and pay taxes increases (Chelliah, 1971; Gupta, 2007).

The negative sign of the coefficient of agriculture in the short-run is in line with the findings of previous studies (Bird et al., 2008; Castro, Camarillo, 2014; Dioda, 2012; Ghura, 1998; Gobachew et al., 2017; Gupta, 2007; Imam, Jacobs, 2014; Zarra-Nezhad et al., 2016). This finding is a reflection of Nigeria's situation where the agriculture sector, which plays a significant role in the economy, provides employment opportunities for many who engage mainly in subsistence agriculture/farming and earn very low incomes. This makes it difficult to tax them, leading to lower tax collection.

The positive association between aid and tax revenue in the short run is consistent with the works of Gupta et al. (2003) and Rodriguez (2018), while the negative relationship between them in the long run lends support to the ones reported by Mahdavi (2008) and Benedek et al. (2014). The negative influence of aid on tax revenue portrays the Nigeria's situation where foreign aid (and other foreign capital) encourages domestic consumption rather than boosting the production of goods and services, leading to a decline in income-generating opportunities. The low levels of income have an adverse effect on tax revenue.

Conclusion

Despite its abundant natural and human resources, Nigeria has not been able to generate adequate tax revenue to meet its rising expenditure. Coupled with the low tax revenue is the corruption problem that Nigeria is contending with. We employ the NARDL estimation method to investigate tax revenue behaviour amid corruption in Nigeria using quarterly data from 1999 to 2019. We find the presence of asymmetry between corruption and tax revenue in Nigeria both in the long run and short run. Positive changes in control of corruption reduce tax revenue, while negative changes in control of corruption raise tax revenue in the long run. Other variables, including income level, foreign aid and female labour force participation, are significant determinants of tax revenue in Nigeria in the long run. Based on these findings, this study offers some recommendations.

First, although reducing corruption appears to be positively and negatively related to tax revenue in the long-run, persistent corruption can leave a devastating impact on an economy, and make a country and its citizens perpetually underdeveloped. Therefore, it is important that government take steps to further strengthen existing institutions to reduce corruption to the barest level so as to encourage tax revenue generation in the long run. To this end, the Nigerian government is advised to increase the funding of anti-corruption agencies such as the EFCC and ICPC to enhance their capacity to tackle corruption head-on. Also, special courts can be established to speed up the dispensation of justice and ensure that those found to be corrupt (both tax officials and taxpayers) are sanctioned or punished appropriately. In addition, there is a need for increased monitoring and evaluation of the operations of the FIRS to ensure that officials do not engage in any acts which are inimical to the success of the revenue agency.

Second, since income level has a positive impact on tax revenue in the long run, government and policymakers are encouraged to take steps to boost people's income. The increased level of income will raise individuals' capacity to pay taxes, leading to higher tax revenue. Third, given that aid discourages tax collection in the long run, the government should devise means to be less reliant on foreign aid in order to promote tax mobilisation. Finally, the government should encourage more female participation in the labour force. Higher female participation does not only raise overall labour income, but also increases the amount of tax collected.

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