Sectoral productivity and real exchange rate effects of remittances: evidence from Nigeria

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Periola *Future Business Journal* (2025) 11:80
https://doi.org/10.1186/s43093-025-00496-9

Future Business Journal

RESEARCH Open Access

Sectoral productivity and real exchange rate effects of remittances: evidence from Nigeria

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Abstract

This study examines the impact of remittances on Nigeria's real exchange rate and the productivity of its tradable and non-tradable sectors. Drawing on the Dutch Disease Model and the Balassa–Samuelson Effect, the research investigates how remittance inflows influence economic dynamics in a developing, oil-dependent economy. Using annual data from 1980 to 2022 obtained from the World Development Indicators and the Central Bank of Nigeria, the study employs the Autoregressive Distributed Lag (ARDL) approach to analyse both short- and long-term effects. The results reveal a complex relationship that challenges traditional expectations. In the short term, remittances decrease productivity in the tradable sector while improving productivity in the non-tradable sector. However, over time, the tradable sector recovers and experiences sustained gains, whereas the non-tradable sector experiences declines in productivity. Contrary to the Dutch Disease hypothesis, remittances do not exert a long-term impact on the real exchange rate. Other factors, including trade openness, inflation, and terms of trade, also significantly influence the real exchange rate and tradable sector. The findings suggest that Nigeria should avoid over-reliance on remittances as a tool for exchange rate stabilisation. Instead, efforts should prioritise strengthening the capital market, curbing capital flight, and promoting export growth. By shedding new light on the intricate effects of remittances, this study provides valuable insights for policymakers in Nigeria and other developing economies.

Keywords Capital inflow, Autoregressive distributed lag model, Dutch disease theory, Tradable and non-tradable sector

JEL Classification E02, F24

Introduction

Within economic development, the influence of remittances, a crucial form of capital inflow, on various macroeconomic variables cannot be understated. Particularly in developing countries, such as Nigeria, remittances have a crucial impact on economic dynamics. One key area of interest is their potential effect on exchange rates and the consequent impact on the competitiveness of both tradable and non-tradable sectors in the economy.

The literature highlights the complex relationship between capital inflow and exchange rate fluctuations. This relationship can affect the competitiveness of the tradable sector. As capital inflows lead to currency appreciation, the 'Dutch Disease' can emerge, undermining export competitiveness and hindering economic stability and growth.

While developed countries may not consistently experience exchange rate appreciation following remittances inflow [38], remittance inflows often lead to local currency appreciation due to the increased foreign currency supply, benefiting recipients but affecting export competitiveness [2]. This appreciation makes imported tradable goods cheaper, increasing their demand over domestic tradable goods, thus hampering the local productivity in the tradable sector. However,

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productivity increases in the non-tradable sector because the sector benefits from increased money supply and demand in the economy.

Notably, remittance inflows to developing countries have skyrocketed over the years, surpassing other forms of financial inflow. In 2023, the World Bank reported that remittance inflows reached an estimated $669 billion in 2023 for low- and middle-income countries (LMICs), accounting for nearly 6% of GDP in low-income countries. Remittances not only contribute to economic growth but also generate positive multiplier effects [20, 22, 30, 33]. Moreover, they serve as vital income transfers, reducing poverty and income inequality [13, 15, 34].

Nigeria has consistently experienced an unstable macroeconomic space, further aggravated by a new administration in May 2023. The official exchange rate has skyrocketed: according to the CBN (2024), the rate was $1: N160 in 2016, to N360 in 2020, and N450 in mid-2023 and currently at N1480 in May 2024, coupled with high inflation, which currently stands at 33% in 2024 from 19% in 2019, a high lending rate of about 30%, and a low real interest rate of 0.9%. These implications are evident in the high cost of living, low access to finance, and an increasing number of poor people, underscoring the broader socioeconomic consequences of Nigeria's macroeconomic instability.

In Nigeria, remittance inflows surged, reaching approximately 25 billion USD in 2018. In contrast, the real exchange rate, i.e. the ratio of prices between the two countries multiplied by the nominal exchange rate multiplied, did not maintain such a trend. Therefore, the relationship between remittances and the real effective exchange rate (REER) remains ambiguous (see Fig. 1). Although there has been a slight and slow appreciation since 1999, it will be valuable to understand the causes of this appreciation, as this could provide insight into the management of exchange rate instability in Nigeria and, consequently, macroeconomic stability.

The right panel of Fig. 1 illustrates that remittances have been the highest among foreign inflows in Nigeria since the late 1990s, surpassing both FDI and ODA inflows. However, a surge in remittances and other inflows began in 2005, with a remarkable increase of over 500% relative to previous periods, reaching approximately $15 billion. This figure has risen to $24 billion in 2018 and, more recently, $20 billion in 2022. Meanwhile, ODA stood at $6 billion in 2005, marking a substantial increase of approximately 1000% compared to the previous period. However, it has maintained a moderate increase, peaking at $11 billion in 2006 and more recently at $4 billion in 2022. The surge in remittances could be attributed to the increasing emigration rate in Nigeria and the development of the financial sector.

Similarly, the trend between remittances and the Real Effective Exchange Rate (REER) is unpredictable. The left-hand panel of Fig. 1 illustrates an upward trend in remittances since 2005, which reached approximately $25 billion in 2018. In contrast, REER has remained relatively stable since 1999, with a slight upward trend. Before 1999, there were noticeable spikes in REER, such as in 1984 and 1998, indicating a significant appreciation of the Naira. One reason for this trend could be attributed

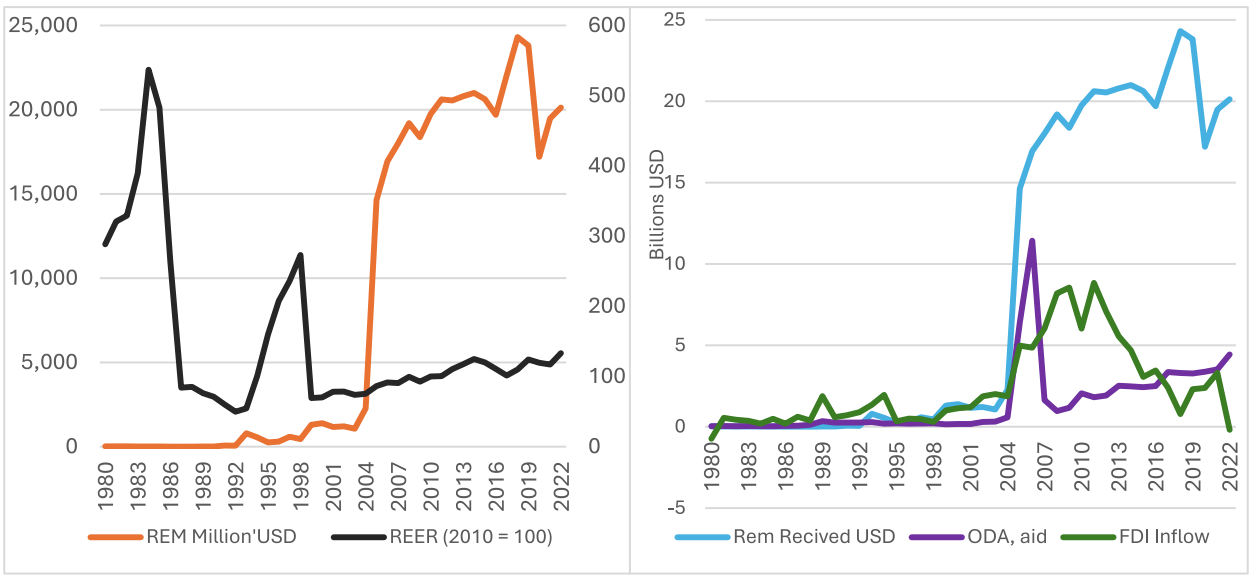

Fig. 1 Nigeria's remittances, real effective exchange rate, other development assistance (ODA), and foreign direct investment (FDI) trend

to the boom in the oil market, a combination of fixed exchange rates, and high government spending.

While some studies suggest an influence of remittances on exchange rates and the manifestation of Dutch Disease effects [48, 36], others provide contradictory evidence [3, 19, 27].

Furthermore, a brief overview of the trends in value-added by tradable and non-tradable sectors and remittances reveals an interesting pattern. Figure 2 reveals that, the tradable and non-tradable sectors experienced a dip in the late 1980s, a period associated with the global economic recession and plummeting world oil prices. However, since 2003, there has been an upward trajectory in all three indicators, with non-tradable sector balances consistently below those of the tradable sector. This period also coincided with steady growth in remittance inflows.

There was a noticeable dip in the tradable and non-tradable sectors in 2009, coinciding with a slight decline in remittances. This was followed by a spike in 2014 and another dip in 2017. Interestingly, while remittances oscillated relatively steadily, the dips and spikes in tradable and non-tradable sectors coincided with trends in remittance inflows.

Given the unpredictable and inconclusive evidence of the relationship between these indicators, this study aims to address this gap by examining the existence of Dutch Disease in Nigeria by investigating the impact of remittances on the real exchange rate and sectoral value addition. Using the real exchange rate as an indicator of Dutch Disease effects is common in the literature [13, 25], and segregating the sector into tradable and non-tradable is also informed by the spending effect of the Dutch Disease Theory and Adejumo [2]. However, by incorporating tradable and non-tradable outputs as dependent variables, we can better understand the dynamics at which remittances impact the real exchange rate. Specifically, we seek to unravel the intricate dynamics between remittance inflows, real exchange rates, and sectoral performance, thereby informing more effective policy interventions geared towards sustainable macroeconomic stability.

The rest of this research is structured as follows: "Literature review" section provides a literature review, and "Materials and method" section details the study's methodology. "Result" section presents the empirical findings, while "Conclusion and policy recommendations" section provides the conclusion of the study.

Literature review

This section provides a detailed examination of the relevant theories and empirical findings related to the impact of remittances on the real exchange rate and sectoral productivity.

Review of related theories

The Balassa–Samuelson (B–S) effect model was developed simultaneously by Balassa [14] and Samuelson [43], working independently. The model explains why prices are often higher in developed countries than in developing ones by focusing on the

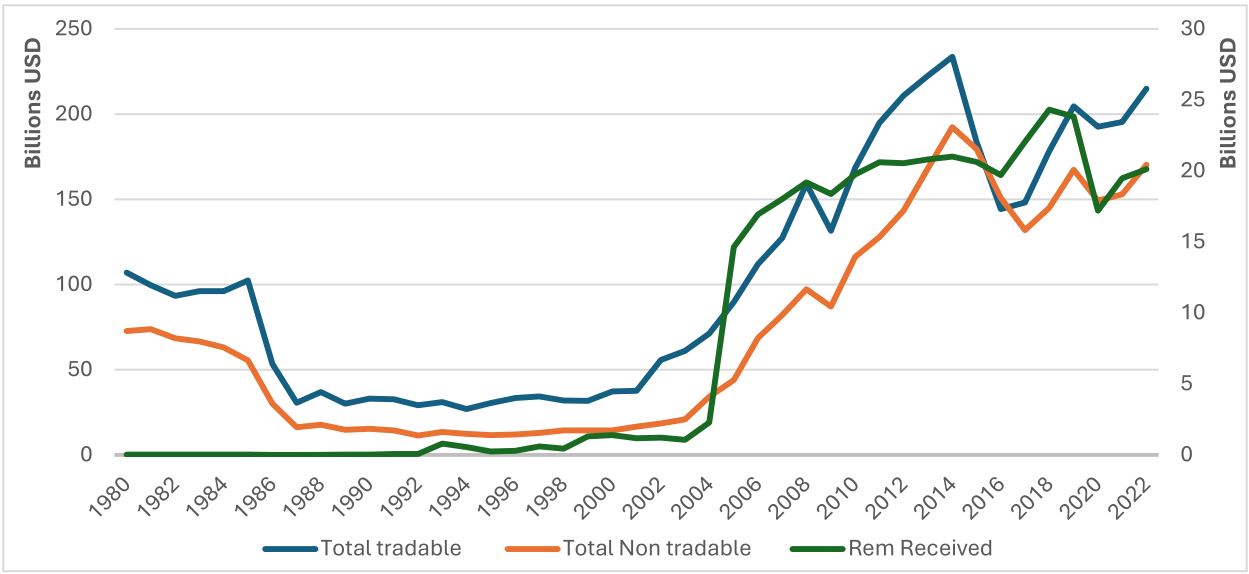

Fig. 2 Nigeria's value-added by economic activity, tradable and non-tradable sectors, and personal remittances received

productivity gap between the tradable and non-tradable goods sectors in different economies. It proposes that productivity growth tends to be faster in tradable sectors of developing economies than in non-tradable sectors due to competition.

It postulates that as productivity in the tradable sector of a developing country increases, it allows for lower production costs and potentially even higher wages in that sector. However, wages in the non-tradable sector also tend to rise because of factors such as labour mobility within the economy. Consequently, higher prices for non-tradable goods and services occur because these sectors experience increased production costs without corresponding productivity gains, and the prices of tradable goods are determined mainly by international markets and remain relatively stable, leading to a divergence in price levels between the tradable and non-tradable sectors. As a result, the overall price level in the economy rises, driven mainly by the rising prices of non-tradable goods, and the real exchange rate appreciates. Thus, increases in productivity differentials result in an exchange rate appreciation.

The core model, by Corden and Neary [17], commonly referred to as the "Dutch Disease Model", focuses on a small open economy experiencing a resource boom. It estimates that there are three sectors, namely, the Booming Sector, where there is a recently discovered natural resource, such as oil or gas, that is driving the economic boom; the Lagging Sector, which encompasses traditional manufacturing, both of which are tradable sectors; and the Non-Tradable Sector, which includes services such as healthcare, transportation, and other goods that are difficult to export or import. The model highlights two main effects of resource booms.

Spending Effect: Neary and Van Wijnbergen [35] provide insight into the Spending Effect. When revenue from the booming sector increases, more money is injected into the local economy, increasing domestic demand and prices in the non-tradable sector. However, tradable prices are set internationally and remain unchanged. This leads to an appreciation in the local exchange rate. In a flexible exchange rate system, the influx of foreign currency increases the value of the local currency, causing it to appreciate, which weakens the competitiveness of the country's exports—a part of the tradable sector.

However, productivity in the non-tradable sector increases because of higher demand. Regarding remittance influx, we expect productivity to improve in the non-tradable sector following foreign inflows, such as remittances. At the same time, there may be a decline in productivity in the tradable sector.

Resource Movement Effect: Due to the influx of foreign exchange and the spending effect, there is increased demand in the economy. This demand attracts labour and capital away from other sectors, particularly the lagging tradable and non-tradable sectors, and moves towards the booming industry. This reallocation causes a decline in productivity in the traditional export sector (part of the tradable sector) and the non-tradable sector. Consequently, the decline in output in the non-tradable sector causes an increase in the price of non-tradable relative to tradables, whose prices are set globally. As a result, the local currency appreciates. This appreciation makes exports from the domestic economy more expensive, further hindering the tradable sector's competitiveness.

Remittance inflows can mirror these effects, potentially causing Dutch Disease by decreasing productivity in the tradable sector and appreciating the local currency. Specifically, it could have two separate effects: first, a decline in productivity in the lagging industries of the tradable and non-tradable sectors, and second, due to the appreciation of the local currency, a further decline in productivity in the tradable sector relative to the non-tradable sector.

Empirical review

Remittances and real exchange rate

As international financial inflow, remittance inflow can significantly influence recipient countries by bolstering the real exchange rate of their domestic currencies against foreign currencies, potentially leading to Dutch disease. Despite this risk, remittances offer stability and support to recipient countries, supporting families, economic growth, and development. Consequently, developing nations increasingly seek higher remittance inflows, and, as a result, the impact of remittances seems more significant for developing countries.

Numerous studies provide evidence supporting the impact of remittances on the real exchange rate, leading to the Dutch Disease effect. For example, Amuedo-Dorantes and Pozo [10] reveal that workers' remittances can impose economic costs on the export sector of receiving countries by diminishing their international competitiveness. Similarly, López et al. [32] suggest that remittances lead to significant real exchange rate appreciation in several Latin American countries, albeit with potentially undesired consequences. Furthermore, over time, remittances exhibit a significant long-run relationship, confirming the Dutch Disease effect in less developed nations [24], while short-run unidirectional causality from remittances to the exchange rate is observed. Hien et al. [25] found that an increase in remittances per capita leads to an appreciation of the

real effective exchange rate (REER) in Asian developing countries, undermining their competitiveness and supporting the existence of Dutch Disease. In contrast, some studies present contrary evidence regarding the influence of remittances on the exchange rate in various contexts [4, 11, 44]. These findings suggest that the effect of remittances on the exchange rate is not uniform across different contexts and echo the concerns raised by the Dutch Disease model.

Remittances and oil-dependent economies

The literature exploring the impact of remittances on oil-dependent economies presents different findings. It has two main strands: remittance inflows and outflows in these economies. Several studies suggest that remittance inflows are positively related to economic growth in these economies. For example, Rotimi et al. [41] found that increased remittance inflows contribute to per capita growth in the short and long term. Akinlo and Ojo [6] further argue that a long-term relationship exists between remittance inflows, exchange rates, GDP per capita, and oil prices, emphasising that a depreciation in the exchange rate harms remittance inflows. They also highlight that higher GDP per capita reduces remittance flows in the short and long term. Similarly, Igbinedion and Ighodaro [28] highlighted that remittances, coupled with per capita income growth, play a positive role in educational development, which is a crucial driver of economic growth. However, not all studies support the notion that remittances always have positive effects. Roy [42] offers a contrasting view, suggesting that personal remittances, in fact, have a negative impact on economic growth in the long run.

However, the relationship between remittance outflows and economic growth in oil-dependent economies is somewhat more consistent, though largely negative. Research by Alsamara [8] indicates that remittance outflows significantly negatively affect real GDP per capita in Qatar. Alsamara and Mrabet [9] also show that increases in remittance outflows lead to a detrimental impact on non-oil real GDP, with this effect being further exacerbated by fluctuations in oil prices. Alkhathlan [7] similarly finds a negative short-term relationship between workers' remittance outflows and economic growth, although no such relationship exists in the long term.

This body of research highlights the complexity of remittance effects in oil-dependent economies. While inflows are generally beneficial to economic outcomes, remittance outflows hinder growth, especially in non-oil sectors. The varied results indicate that the effects of remittances are not uniform and may be influenced by various macroeconomic factors, including exchange rates. Thus, remittances' role in shaping the economic landscape of oil-dependent economies requires nuanced consideration of both their short- and long-term effects.

Remittances and the tradable and non-tradable sector

Foreign inflows, such as remittances, can significantly impact the tradable sector. Unlike other capital flows, remittances do not involve accumulating external debt or future repayment obligations. Also, they do not have a range of political and economic conditions to which the recipient country must adhere. However, this could lead to the Dutch Disease, which could undermine the competitiveness of the tradable sector of the economy. Acosta et al. [1] show that increased remittances reduce labour supply and raise demand for non-tradable goods, shifting labour away from the tradable sector. In contrast, Adejumo [3] indicated that remittances positively impact the tradable sector despite a negative relationship with the exchange rate. Implying that in Nigeria, the Dutch disease phenomenon does not apply to the competitiveness of the tradable sector and the exchange rate.

Table 1 summarises the key studies reviewed in this paper, highlighting relevant research on the effect of remittances on real exchange rates and sectoral productivity, including their findings, methodologies, and the research gaps addressed by this study.

Gaps in the literature

Despite extensive research on the macroeconomic effects of remittances, significant gaps remain in understanding their sector-specific impacts, particularly in oil-dependent economies like Nigeria. Existing studies often fail to differentiate between the effects on tradable and non-tradable sectors, neglect the distinction between short- and long-term dynamics, and overlook critical controlling factors.

Our study will investigate these gaps, examining the impact of remittances on the real exchange rate in an oil-rich developing country; however, from a different perspective, we examined the short- and long-run impacts with specific attention to the channel through which remittances affect the real exchange rate by focusing on the tradable and non-tradable sectors of the economy.

Our study is motivated by Essayyad et al. [19], who investigated the long- and short-run impact of remittances on the real exchange rate in Nepal, and by Adejumo [3], who analysed the transmission channels of remittances on the tradable sectors in Nigeria using an ECM approach. Our study differs from these in several ways.

Table 1 Summary of previous research and identification of the research gap (*Source*: Author's computation, 2025)

Study	Scope	Methodology	Findings	Research Gap
Acosta et al. [1]	Developing countries	Panel data analysis	Remittances shift labour resources from tradable to non-tradable sectors, affecting competitiveness	Did not address specific contexts like oil-dependent economies
Adejumo [3]	Nigeria	Error correction model (ECM)	Remittances positively impact the tradable sector; exchange rate implications are mixed	No exploration of short- versus long-term dynamics or broader mechanisms of sectoral effects
Adenutsi and Ahortor [4]	Ghana	Cointegration and vector error correction model (VECM)	Exchange rate depreciation attracts more remittances in a static model, and the relationship reverses in a dynamic model	No examination of the effects of remittances on specific economic sectors, such as tradable versus non-tradable sectors
Akinlo and Ojo [6]	Nigeria	Nonlinear ARDL	A long-run relationship exists between remittance inflows, gross domestic product per capita, exchange rate, misery index, and oil prices	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
Alkhathlan [7]	Saudi Arabia	Autoregressive distributed lag (ARDL) and the error correction model (ECM)	A negative short-term relationship exists between workers' remittance outflows and economic growth	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
Alsamara [8]	Qatar	Nonlinear ARDL	Remittances outflows negatively and significantly impact real GDP per capita in Qatar's economy	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
Alsamara and Mrabet [9]	GCC countries	Panel data analysis	Non-oil real GDP shows a negative and amplified reaction to an increase in remittance outflows compared to a decrease	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
Amuedo-Dorantes and Pozo [10]	Developing countries	Panel analysis	Remittances lead to real exchange rate appreciation, reducing export competitiveness	Limited sectoral analysis and no distinction between tradable and non-tradable impacts
Chowdhury and Rabbi [16]	Bangladesh	Cointegration and vector error correction model (VECM)	Remittances have a significant impact on appreciating the real exchange rate by reducing the relative prices of tradables compared to non-tradables	Limited sectoral analysis and no distinction between tradable and non-tradable impacts
Essayyad et al. [19]	Nepal	ARDL approach	Short-run remittances appreciate the real exchange rate; impacts on tradables vary in the long term	Did not address the role of control variables or broader policy implications in Nigeria
Hassan and Holmes [24]	Developing countries	Cointegration analysis	Long-run relationships between remittances and exchange rates with Dutch Disease implications	Did not explore productivity effects or time-dynamic impacts
Hien et al. [25]	Asian developing countries	Econometric analysis	Remittances cause a small but significant appreciation of the real effective exchange rate	Limited to regional analysis, without sectoral breakdowns

Table 1 (continued)

Study	Scope	Methodology	Findings	Research Gap
Igbinedion and Ighodaro [28]	Nigeria	Cointegration and error correction model (ECM)	Remittances and per capita income growth positively impact educational development, a key driver of economic growth	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
López et al. [32]	Latin America	Time-series analysis	Significant real exchange rate appreciation from remittances, with Dutch Disease implications	Lack of focus on sectoral productivity impacts
Rotimi et al. [41]	Nigeria	ARDL bounds test	Increasing remittance inflow enhances per capita growth in Nigeria in the long-run and short-run	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
Roy [42]	India	Dynamic autoregressive distributed lag (DARDL)	personal remittance negatively affects economic growth in the long run	Did not address the effects of remittances on the real exchange rate nor the Dutch Disease effect
Sultonov [44]	Kyrgyz Republic	GARCH modelling	REER plays a significant role in determining remittance flows rather than remittances affecting the exchange rate	No analysis of short- versus long-term dynamics or remittances' effects on specific economic sectors, like tradable versus non-tradable

First, we focus on Nigeria's considerable remittance inflows, providing a sectoral analysis highlighting the differential effects of remittances on tradable and non-tradable sectors, including the potential for Dutch Disease. Second, we employ an ARDL framework to capture both short- and long-run dynamics, enabling a comprehensive understanding of remittance impacts across different time horizons and economic conditions. By incorporating key variables such as trade openness, government expenditure, and technological progress, this research provides deeper insights into how remittances affect the real exchange rate and sectoral productivity. Finally, the study offers actionable policy recommendations for developing economies to harness remittances effectively for sectoral development, sustainable growth and stability.

Materials and method

Data sources and description

This section provides theoretical support for the relationship between Nigeria's remittances, real exchange rates, and tradable and non-tradable sectors. A time series of data from 1980 to 2022 for Nigeria was utilised using the World Development Indicators (WDI), United Nations Database, and Central Bank of Nigeria Statistical Bulletin.

Following the approach of López et al. [32] and Lartey et al. [31], we employ the Real Effective Exchange Rate (REER), tradable sector, and non-tradable sector as dependent variables to analyse the Dutch Disease Theory. The independent variable is the remittances-to-GDP ratio, which better captures the significance of remittance flows relative to the overall economy. Furthermore, we include a vector of control variables informed by previous studies such as Chowdhury and Rabbi [16] and Amuedo-Dorantes and Pozo [10]. The inclusion of these variables is further justified by their theoretical impacts on the RER, particularly in the context of the Dutch Disease and Balassa–Samuelson (B–S) effect models. This is particularly relevant given the dynamics of the Nigerian economy, characterised by import dependence, oil reliance, a booming content creator market, restrictive trade policies, and macroeconomic volatility.

With a huge informal sector and reliance on oil exports, an improvement in the Terms of Trade (TOT) affects the tradable sector by raising wages in the oil industry, leading to two effects: an income effect, which increases purchasing power, and a substitution effect, which depreciates the RER by reducing demand for non-tradable. If the income effect dominates, the RER appreciates. The overall impact depends on the dominance of one effect over the other. In developing economies, technological progress boosts productivity more in the tradable sector, usually driven by resource reallocation, leading to RER appreciation through higher income and non-tradable prices [14].

With restrictive trade policies and capital controls in place, the RER is influenced differently. Higher tariffs and quotas raise the relative price of tradable, reducing competitiveness, while limited capital inflow due to strict capital controls constrains the monetary base, reducing demand and prices for non-tradable, which may prevent RER appreciation and, therefore, could depreciate the RER. Invariably, goods market openness (restriction) is expected to depreciate (appreciate) the RER and the impact of capital market openness can be either positive or negative. Similarly, an increase in government spending boosts overall demand. If primarily directed towards non-tradable goods and services, it can lead to RER appreciation, whereas spending more on the tradable sector can result in RER depreciation.

Data is available upon reasonable request. Tables 2 and 3 outline the variables and a priori expectations.

Ethical consideration

All data used in this research are publicly available and obtained from reputable sources, including the World Development Indicators, the United Nations Database, and the Central Bank of Nigeria Statistical Bulletin. The use of these data complies with the terms and conditions of the respective sources. No personal or sensitive data were used in this study, ensuring compliance with ethical standards for data usage.

Data limitations

The data used in this study comes from reputable sources, including the World Development Indicators (WDI), the United Nations Database, and the Central Bank of Nigeria Statistical Bulletin, covering the period from 1980 to 2022, which might introduce inconsistencies in data measurement standards. Furthermore, the dataset's end year of 2022 reflects the limitations of available data at the time of writing, potentially excluding recent macroeconomic developments.

Given the structural economic changes in Nigeria before 1990, such as the 1970 oil boom and the 1986 implementation of the Structural Adjustment Programme (SAP), the trends and relationships observed in the pre-1990 period may differ from those in the post-1990 period. However, this study does not explicitly account for these changes, as it examines data spanning from 1980 to 2022. This omission could potentially lead to biased estimates, overgeneralisation of trends, and model misspecification. To address this, we conducted a diagnostic test to validate the integrity of our models. Future research could investigate the pre-1990 and

Table 2 Description of independent variable (*Source*: Authors' computation, 2025)

	Variable	Proxy	Description	Source
1	REER	Exchange rate	Real effective exchange rate index (2010 = 100)	WDI
2	TRD	Tradable	Cumulation of value-added by economic activities for ISIC A–E as a proportion of total value-added	UNSD
3	NTRD	Non-tradable	Cumulation of value-added by economic activities for ISIC F–I as a proportion of total value-added	UNSD

The tradable and non-tradable sectors were classified according to the ISIC classification [45]

UNSD means [47],WDI implies World Development Indicators Database 2024

Agriculture, hunting, forestry, fishing (ISIC A-B); Mining, Manufacturing, Utilities (ISIC C-E); Construction (ISIC F); Wholesale, retail trade, restaurants and hotels (ISIC G-H); and Transport, storage and communication (ISIC I)

Table 3 Description of dependent and control variable (*Source*: Authors' computation, 2025)

	Variable	Proxy	Description	Expectation	Source
1	REM	Remittance inflow	Personal remittances received (current US$) as a proportion of GDP	Appreciate real exchange rate. Negative on tradable (Dutch Disease theory and Balassa–Samuelson theory)	WDI
2	TP	Technology progress	GDP per capita (constant 2015 US$)	Appreciate real exchange rate. Positive on tradable—Balassa–Samuelson and spending effect	WDI
3	TOGM	Trade openness in goods market	The sum of exports and imports as a proportion of GDP (%)	Depreciate the real exchange rate—Chowdhury and Rabbi [16]. Positive on tradable	WDI
4	CMO	Capital market openness	The sum of FDI and ODA as a proportion of GDP (%)	Appreciate the real exchange rate—Negative on tradable	WDI
5	GEXP	Government expenditure	The sum of recurrent and capital government expenditure as a proportion of GDP	Appreciate the real exchange rate if more is spent on non-tradable. Depreciate, if more is spent on tradable	CBN
6	INT	Interest rate	Real interest rate (%)	Appreciate real exchange rate Negative on tradable—Balassa–Samuelson	WDI
7	INF	Inflation	Inflation, consumer prices (annual %)	Depreciate the real exchange rate—Negative on tradable—Dutch Disease theory	WDI
8	TOT	Terms of trade	Net barter terms of trade index (2015 = 100)	The real exchange rate appreciates if the income effect is stronger and depreciates if the substitution effect is stronger	WDI

1. World Development Indicators Database (WDI) 2024, Central Bank of Nigeria (CBN) Annual Statistical Bulletin 2023, International Monetary Fund (IMF) World Economic Outlook Database 2024

2. Appreciation is an increase in the real effective exchange rate, and depreciation is a reduction in the real effective exchange rate

post-1990 periods separately to better understand and unravel any structural changes.

Finally, the dataset was log-transformed to address heteroscedasticity, autocorrelation, and extreme variability. However, remittances, real interest rates, and capital market openness are not log-transformed as they have non-positive values.

Data analysis

This research employs the Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al. [40] to examine the effects of remittance inflow on the real exchange rate, tradable sector, and non-tradable sector in Nigeria. The model has several advantages over the traditional Ordinary Least Squares (OLS) method, including the ability to handle series with different levels of integration, especially series that are stationary at levels and first differences. The f-statistics values are not valid when the series are I(2) because the cointegrating relationships are only based on series at levels or first differences [21]. This capability is crucial for providing a more accurate analysis and robust model.

Another advantage of the ARDL model is its ability to estimate the speed of adjustment from short-run disequilibrium to long-run equilibrium using the error correction term (ECT). The ECT helps ensure that the

model accounts for changes in the data over time and helps correct any errors, ensuring the model's accuracy. Additionally, the ARDL model addresses the endogeneity problem, in which the independent variables are correlated with the error term, thereby enhancing the reliability of the results.

For our model, the traditional ARDL (a,b,c) model accounts for the response of remittance inflow to the real exchange rate. The tradable and non-tradable sectors are presented below.

$$\begin{aligned}\Delta \mathrm{RER}_t = \delta_0 + \sum_{i=1}^{a} \delta_1 \Delta \mathrm{RER}_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta \mathrm{REM}_{t-i} \\ + \sum_{i=0}^{c} \delta_3 \Delta Y'_{t-i} + \alpha_0 \mathrm{RER}_{t-1} + \alpha_1 \mathrm{REM}_{t-1} \\ + \alpha_2 Y'_{t-1} + \mu_t \end{aligned} \tag{1}$$

$$\begin{aligned}\Delta \mathrm{TRD}_t = \delta_0 + \sum_{i=1}^{a} \delta_1 \Delta \mathrm{TRD}_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta \mathrm{REM}_{t-i} \\ + \sum_{i=0}^{c} \delta_3 \Delta Y'_{t-i} + \alpha_0 \mathrm{TRD}_{t-1} + \alpha_1 \mathrm{REM}_{t-1} \\ + \alpha_2 Y'_{t-1} + \mu_t \end{aligned} \tag{2}$$

$$\begin{aligned}\Delta \mathrm{NTRD}_t = \delta_0 + \sum_{i=1}^{a} \delta_1 \Delta \mathrm{NTRD}_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta \mathrm{REM}_{t-i} \\ + \sum_{i=0}^{c} \delta_3 \Delta Y'_{t-i} + \alpha_0 \mathrm{NTRD}_{t-1} + \alpha_1 \mathrm{REM}_{t-1} \\ + \alpha_2 Y'_{t-1} + \mu_t \end{aligned} \tag{3}$$

where RER denotes the Real Effective Exchange Rate, TRD represents the Tradable sector, NTRD represents the Non-tradable sector, and REM represents the Remittance inflow, Y' represents the vector of other regressors, functioning as control variables, which include TOGM, TP, CMO, EXP, INF, INT, and TOT. μ_t denotes the stochastic series. a, b and c denotes the maximum lag numbers, while δ_1, δ_2 and δ_3 represent the short-run parameters of Real exchange rate (and Tradable and Non-tradable), remittance inflow, and other control variables, respectively.

The long-run slopes of dependent variables (real exchange rate, Tradable, and Non-tradable), remittance inflow, and other control series are, respectively, calculated as $\frac{\delta_0}{\alpha_0}$, $\frac{\delta_0}{\alpha_1}$, and $\frac{\delta_0}{\alpha_2}$. The optimal lags on the series with the first differences were selected based on the Schwarz Information Criterion (SIC), indicated by a, b, and c. The coefficient correlation matrix is calculated using HAC (Newey-West), which provides heteroscedasticity and autocorrelation-consistent coefficients.

To understand the linear relationship between regressands (real exchange rate, tradable, and non-tradable) and the regressors in the long run, we utilise the *F*-statistics of the ARDL bounds test of Pesaran et al. [40]. Thus, we impose restrictions on the long-run calculated coefficients of the series. Essentially, we test for the validity of the null hypothesis of no cointegration by investigating If the lagged levels of the variables in our model exhibit a zero effect on the dependent variable, which is stated as $H_0 : \alpha_0 = \alpha_1 = \alpha_2 = 0$. We test against the alternative hypothesis of $H_1 : \alpha_0 \neq \alpha_1 \neq \alpha_2 \neq 0$. Next, we use the critical values of lower and upper bounds to compare the *F*-Statistics. Cointegration exists if the computed F-statistic exceeds the upper critical bound. If it is less than the lower bound, there is no cointegration. The result is inconclusive if it is between the lower and upper bounds. This allows us to determine the long-run relationship between the variables more precisely.

While the long-run relationship between variables may be established, it is crucial to understand that reaching a steady state may take time. This delay arises from the adjustment and the lags involved when there is a change in the determinants of regressands, namely, real exchange rate, Tradable, and Non-tradable. It may take time for the effects of these changes to be fully realised; therefore, the speed of adjustment can be a factor that determines how quickly the economy returns to its steady state. Hence, the error correction term (ECT) is best used to account for this speed of adjustment, which is explained in Eqs. 4, 5, and 6 as follows:

$$\begin{aligned}\Delta \mathrm{RER}_t = \sum_{i=1}^{a} \delta_1 \Delta \mathrm{RER}_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta \mathrm{REM}_{t-i} \\ + \sum_{i=0}^{c} \delta_3 \Delta Y'_{t-i} + \rho \mathrm{ECT}_{t-1} + \tau_t \end{aligned} \tag{4}$$

$$\begin{aligned}\Delta \mathrm{TRD}_t = \sum_{i=1}^{a} \delta_1 \Delta \mathrm{TRD}_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta \mathrm{REM}_{t-i} \\ + \sum_{i=0}^{c} \delta_3 \Delta Y'_{t-i} + \rho \mathrm{ECT}_{t-1} + \tau_t \end{aligned} \tag{5}$$

$$\Delta \mathrm{NTRD}_t = \sum_{i=1}^{a} \delta_1 \Delta \mathrm{NTRD}_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta \mathrm{REM}_{t-i} + \sum_{i=0}^{c} \delta_3 \Delta Y'_{t-i} + \rho \mathrm{ECT}_{t-1} + \tau_t \quad (6)$$

From Eqs. 4, 5, and 6, ρ defines the coefficients of the ECT, which explains the long-run speed of adjustment. It must meet three conditions for it to hold. The significance at any level must be met. It must be less than one in its absolute value and negative.

Result

Discussions of findings

The discussion of the findings starts with a preliminary analysis comprising a descriptive analysis, unit root test, and cointegration analyses. Descriptive statistics offer a preliminary summary of the dataset, while unit root tests ascertain the stationarity of variables. Subsequently, cointegration analysis examines the existence of a long-run relationship among variables. An Autoregressive Distributed Lag (ARDL) analysis is conducted following this preliminary examination. The baseline regression model estimates the association between remittance inflow and real exchange rate. Furthermore, the sectoral effects are estimated to understand the channel in which remittances affect the real exchange rate. This comprehensive approach provides insights into the interplay between remittance, real exchange rate, tradable and non-tradable sectors, further highlighting the existence of the Dutch Disease syndrome.

Preliminary analysis

Table 3 presents a summary of the descriptive analysis and unit root test for the variables. On average, for the dependent variables, the RER in Table 3 has a value of 150.33, as this is analysed against a base rate of 100, i.e. this indicates a relatively higher value of the currency. On average, the Naira has experienced appreciation over the time understudy, TRD is 49.47%, and NTRD is 28.63%, further implying that the value addition in the tradable sector has been relatively high over time, while that of the non-tradable is about a half of the tradable sector. These estimates indicate that the variables are positive with relatively modest growth.

Regarding the regressors, the study estimated the average REM to be 2.5% of GDP, indicating an increasing rate over time. The control variables, which include CMO, GEXP, INF, INT, TOGM, TOT and TP, were estimated to have means of 1.74% of GDP, 8.91% of GDP, 18.74%, 0.37%, 32.55%, 93.23% and $1915.73, respectively; implying a relatively low capital market openness, but somewhat higher good and services market openness, though, this could severely impact on access to foreign capital. Furthermore, the inflation rate has been high, reflecting a meagre real interest rate.

The standard deviation suggests some varied dispersion of the variables; for example, TP, RER, and TOT are likely to be relatively unstable and less precise. Hence, we will log-transform some of the variables. Furthermore, the statistical distribution of RER, CMO, GEXP, and INF indicates that these variables are not normally distributed. Specifically, the skewness statistics for these variables are 1.85, 1.59, 1.04, and 1.91, respectively. This means that the distribution of these variables is not symmetrical and is positively skewed, which is reflected in the positive skewness statistics.

Additionally, the negative skewness statistics for INT (−2.76) suggest that the distribution of this variable is skewed to the left. This means that most of the data is below the mean, and the variables are more likely to take on lower values than higher ones. The moderate skewness of TRD, NTRD, REM, TOGM, TOT, and TP (0.16, 0.08, 0.51, −0.03, 0.08, and 0.34, respectively) indicate that the data for these variables are relatively symmetrical, with no significant skewing to either the left or right; implying that the values are more evenly distributed around the mean, without a significant bias towards either lower or higher values.

To ensure the robustness and reliability of our results, we utilise three different unit root tests: the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, and the Zivot-Andrews Unit Root Test (ZAURoot), as presented on the right-hand side of Table 4. These tests are widely used in academic research to identify if unit roots exist in time-series data [5, 18]. The ADF and PP tests are particularly useful as they account for serial correlation in the data, which improves the reliability of the results. However, the PP test has been critiqued for assuming that breakpoints are determined externally. Zivot and Andrews [49] suggest that allowing the breakpoints to be determined endogenously could lead to different conclusions regarding the unit root hypothesis, potentially altering the outcomes of earlier tests like the ADF and PP. Given Nigeria's volatile economic history, we also apply the ZAURoot to account for structural breaks. Our results show that the variables are stationary at either their levels ($I(0)$) or first differences ($I(1)$), which further supports the use of the ARDL framework. The ARDL approach is well-suited for analysing relationships between variables, as it can handle fractionally integrated data [21].

Table 4 Descriptive statistics and unit root results

Variables	Descriptive statistics				Unit root		
	Mean	SD	Skewness	Kurtosis	ADF	PP	ZA
Dependent variables							
RER	150.328	115.051	1.850	5.726	−2.892[a,**]	−4.757[b,***]	−4.523[a,*]
TRD	49.466	6.444	0.159	2.419	−5.221[b,***]	−5.226[b,***]	−5.830[b,*]
NTRD	28.626	5.101	0.083	1.850	−7.182[b,***]	−7.186[b,***]	−5.178[a,***]
Independent variable							
REM	2.503	2.548	0.516	1.870	−6.477[b,***]	−7.376[b,***]	−8.352[a,***]
Control variables							
CMO	1.738	1.524	1.595	6.375	−3.700[a,***]	−3.570[a,**]	−5.442[a,***]
GEXP	8.914	2.568	1.035	4.443	−8.467[b,***]	−8.467[b,***]	−9.292[b,***]
INF	18.737	16.315	1.914	5.589	−4.114[a,***]	−3.459[a,**]	−5.169[a,***]
INT	0.371	13.929	−2.757	13.422	−5.615[a,***]	−5.639[a,***]	−6.935[b,***]
TOGM	32.548	13.702	−0.026	3.991	−3.032[a,**]	−3.155[a,**]	−5.517 [a,***]
TOT	93.234	39.084	0.083	1.690	−5.735[b,***]	−6.549[b,***]	−6.816[b,**]
TP	1915.730	460.158	0.342	1.467	−3.373[b,**]	−3.902[a,**]	−3.812[a,***]

***, **, and * represent 1%, 5%, and 10% significance levels, respectively, while [a] and [b] represent stationarity at levels and first differences, respectively

Table 5 Bounds cointegration test results

	RER model	Tradable model	Non-tradable model
F-statistics	10.348***	5.015***	4.950***

***, **, and * represent 1%, 5%, and 10% significance levels, respectively

Table 6 Short-term dynamics: remittances on real exchange rate, tradable and non-tradable sector

Variables	RER model	Tradable model	Non-tradable model
Δ(REM)	−0.079** (0.034)	−0.023*** (0.004)	0.014 (0.009)
Δ(CMO)	0.120*** (0.039)	0.023*** (0.006)	−0.033**(0.014)
Δ(GEXP)	0.184 (0.177)	0.039 (0.026)	0.186***(0.038)
Δ(INF)	0.487*** (0.080)	0.090*** (0.012)	−0.020 (0.028)
Δ(INT)	−0.006 (0.009)	0.004*** (0.001)	−0.002 (0.224)
Δ(TOGM)	−0.112** (0.049)	−0.003 (0.019)	−0.086*** (0.030)
Δ(TOT)	−0.381* (0.199)	0.157*** (0.038)	0.093 (0.080)
Δ(TP)	5.303*** (1.445)	−0.438 (0.221)	0.314 (0.421)
ECT	−0.586*** (0.148)	−0.406*** (0.102)	−0.592*** (0.119)

***, ** and * represent 1%, 5% and 10% significance levels, respectively, while statistics in () are the standard errors of each coefficient

The pre-estimation analysis ends with estimating the ARDL bounds cointegration to establish the long-run relationships. As seen in Table 5, the *F*-test results test shows cointegration in all the models, indicating long-run relationships between the variables. This is an important finding that provides a basis for the subsequent estimation of the models.

Table 7 Long-run dynamics: remittances on real exchange rate, tradable and non-tradable sector

Variables	RER model	Tradable model	Non-tradable model
REM	0.026 (0.049)	0.091*** (0.016)	−0.032*** (0.010)
CMO	−0.191*** (0.058)	−0.071*** (0.018)	−0.056*(0.029)
GEXP	−0.525** (0.233)	−0.154 (0.092)	0.266** (0.108)
INF	0.415 (0.352)	0.439*** (0.105)	0.104 (0.092)
INT	−0.075* (0.041)	0.047** (0.018)	−0.024* (0.011)
TOGM	−0.699*** (0.134)	0.284** (0.073)	−0.174*** (0.045)
TOT	1.006*** (0.270)	−0.051 (0.083)	0.582*** (0.158)
TP	0.367 (1.188)	−2.096** (0.543)	0.968*** (0.276)
Constant	0.194 (7.132)	17.981*** (3.568)	−6.628*** (1.590)

***, **, and * represent 1%, 5%, and 10% significance levels, respectively, while statistics in () are the standard errors of each coefficient

Impact of remittance inflow on real exchange rate

According to the Dutch disease and Balassa Samuelson model, we expect that remittance inflow will improve the real effective exchange rate. As seen in Tables 6 and 7, remittances negatively impact RER, implying that remittance leads to depreciation and not appreciation, as proposed by these theories. Specifically, a per cent increase in REM as a proportion of GDP leads to a 7.9% decline in RER. However, this effect is not long-lasting as it dissipates over the long run, where REM does not significantly impact RER. This finding contradicts most of the existing literature on the relationship between the real exchange rate (RER) and remittances [10, 24, 32]. One possible explanation for this in Nigeria could be the increased consumption of non-tradable goods, such as

local goods and services [10], investment in productive activities that enhance the supply side of the economy, such as the growth of small and informal businesses supported by government reforms [23], and an increase in imports, particularly of consumer goods. Furthermore, reduced export earnings may contribute to a higher demand for foreign currency, which could put additional inflationary pressure on the economy [37].

Furthermore, variables such as CMO, INF, and TP also appear to positively impact the RER, indicating an appreciation of the Naira. Specifically, a 1% increase in capital market openness, inflation rate, and technological progress leads to increases in the RER of 12%, 0.48%, and 5.3%, respectively. Openness in the capital market and the technological progress of an economy tends to attract foreign exchange into the Nigerian economy and increase productivity, which tends to strengthen the local currency. Rotimi et al. [41]. Conversely, TOGM and TOT negatively impact the RER, indicating a depreciating effect on the Naira. Specifically, a 1% increase in trade openness in goods and services and terms of trade leads to declines in the RER of 0.11% and 0.38%, respectively. The reason for this could be a result of increased import demand in Nigeria, which has grown sporadically over the years, averaging about 20% of the total GDP (World Bank 2024).

However, in the long run, CMO no longer positively impact RER, as the positive impact dissipates, but instead has a negative effect, along with INT, GEXP and TOGM. Specifically, a unit increase in capital market openness, real interest rate, and a 1% increase in government expenditure, interest rate and trade openness in the goods and services market depreciate the real exchange rate by 19%, 7.5%, 0.53%, and 0.70%, respectively. This may be due to the massive capital outflow, such as the high demand for foreign exchange; for example, Nigerians prefer imported goods and a high demand for foreign education. Likewise, a relatively low real interest rate in Nigeria, when compared to other countries, increased government borrowing and debt, which tend to crowd out funds available to the private sector, and the inflationary pressure may be a reason for this negative impact [29, 39].

Similarly, TOT no longer has a negative impact on RER but a positive one in the long run. Specifically, a 1% increase in terms of trade leads to an appreciation of the real exchange rate by 1.00%. One viable justification may be a relatively lower cost and, hence, high demand for imported goods, a decrease in the real value of external debt due to currency depreciation, and other monetary tightening policies by the Central Bank of Nigeria.

In summary, while remittances do not exert a long-term influence on real exchange rates in Nigeria, factors such as terms of trade contribute to its improvement. Conversely, trade openness in goods and services, capital market openness, real interest rates, and government expenditure are associated with a deterioration in the real exchange rate in Nigeria.

Impact of remittance inflow on the tradable sector

In line with theoretical expectations, the influx of remittances might redirect resources away from the tradable sector due to relatively higher prices in the non-tradable sector. Consequently, the tradable sector experiences a drain on resources, resulting in diminished productivity and value-added. Additionally, if the influx causes an appreciation of the real exchange rate, as the Dutch Disease model anticipated, it will negatively impact the local tradable sector.

According to Table 6, remittances adversely affect the tradable sector in the short term. Specifically, an increase in the percentage of remittances to GDP results in a 2.3% decline in the value addition of the tradable sector. However, this effect is transient, as remittances positively impact the tradable sector in the long term. To be precise, an increase in the percentage of remittances to GDP leads to a 9.1% improvement in the value addition of the tradable sector. This suggests that remittances are effectively channelled into productive activities within the tradable sector, comprising manufacturing, agriculture, and mining. While commendable, this trend could potentially exacerbate the outflow of foreign exchange.

Furthermore, the short-run analysis reveals that the control variables CMO, INT, INF, and TOT all positively impact the tradable sector. Specifically, a unit increase in capital market openness and real interest rate, together with a percentage increase in inflation rate and terms of trade, will lead to increases of 2.3%, 0.4%, 0.09%, and 0.16% in the tradable sector, respectively. However, these impacts are only observed in the short run, as most of these effects are not sustained in the long run.

In the long run, as seen in Table 7, CMO no longer has a positive impact on the tradable sector but has a negative effect, along with TP. Notably, an increase in capital market openness relative to GDP and a percentage increase in technology progress leads to a 7.1% and 2.0% decline in the tradable sector value-added, respectively. Additionally, TOGM, INF, and INT improve the tradable sector productivity in the long run. In particular, an increase in the real interest rate, coupled with a percentage increase in the openness of the goods

and services market and the inflation rate, will lead to improvements of 4.7%, 0.28%, and 0.44% in the tradable sector, respectively. Increased capital flight, such as high import demand, foreign exchange demand, and exchange rate volatility, are viable reasons for these effects [46]. The result also indicates increased competitiveness in the local goods market and prices in Nigeria. Also, technological advancements can lead to displacement of resources in the tradable sector, especially when the required skills are not readily available in Nigeria [26].

In conclusion, remittances do positively impact the tradable sector, just as Adejumo [3] found, but this is contrary to the expectations of the Dutch Disease model, which suggests that a large influx of revenues from natural resources (in this case, remittance) can harm the tradable sector by causing exchange rate appreciation and resource movement away from the sector. However, factors such as trade openness in goods and services, real interest rates, and inflation further contribute to its improvement. Conversely, capital market openness and technological progress are associated with a deterioration in the value addition of the tradable sector.

Impact of remittance inflow on the non-tradable sector

Similar to the discussion in previous sub-sections, if the influx of remittances prompts a redirection of resources away from the tradable sector due to relatively higher prices in the non-tradable sector, the tradable sector may experience a drain on resources, resulting in diminished productivity and value-added. Consequently, we expect that the non-tradable sector will benefit from such an influx, which will positively impact it.

According to Tables 6 and 7, remittances do not significantly affect the non-tradable sector in the short term. However, an adverse effect is observed in the long term. Specifically, an increase in the percentage of remittances to GDP leads to a 3.2% deterioration in the value addition of the non-tradable sector, which contradicts the spending effect of the Dutch Disease Model. This suggests that remittances are not effectively channelled into the non-tradable sector. One reason could be the high inflation experienced in Nigeria. According to the demand-pull inflation theory, increased demand, fueled by remittances, can lead to inflation in non-tradable sectors, eroding their real output growth and lowering their contribution to GDP [12]. Another viable reason could be the huge capital flight from Nigeria via investment abroad and the demand for foreign education [46].

Furthermore, the short-run analysis reveals that the control variables, such as CMO and TOGM, negatively impact the non-tradable sector. Notably, a unit increase in capital market openness and a percentage increase in trade openness in the goods and services market and terms of trade will worsen the non-tradable sector by 3.30% and 0.09%, respectively. Conversely, GEXP improves the non-tradable sector. Specifically, a percentage increase in government expenditure leads to gains of 0.19% and 0.27% in the non-tradable sector in the short run and long run, respectively.

In the long run, CMO and TOGM continue to weaken the non-tradable sector, along with INT. Specifically, an increase in capital market openness relative to GDP, real interest rates, and a percentage increase in government expenditure led to declines of 5.6%, 2.4%, and 0.27% in the value-added of the non-tradable sector, respectively. Furthermore, in the long run, TP and TOT positively impact the non-tradable sector. To be precise, a percentage increase in technological progress and terms of trade will lead to improvements of 0.97% and 0.58% in the non-tradable sector, respectively.

In conclusion, remittances do indeed negatively impact the non-tradable sector, which contradicts the spending effect predictions of the Dutch Disease model. This model suggests that a substantial influx of foreign inflows into the local economy increases domestic demand and prices in the non-tradable sector. However, because tradable prices are set internationally and remain unchanged, productivity in the non-tradable sector should increase due to higher demand. In Nigeria, factors such as government expenditure, terms of trade, and technological progress contribute to improvements in the non-tradable sector. Conversely, capital market openness, trade openness in goods and services, and real interest rates are associated with a deterioration in the value addition of the non-tradable sector.

We further subject our models to diagnostic testing to ascertain their validity and if they satisfy the assumptions of a classical regression model.

Diagnostic check

We conduct a series of diagnostic tests to verify the robustness and reliability of our econometric model. Diagnostic testing is a critical component of econometric analysis, as it allows us to validate the assumptions underlying our model and to identify potential issues that could compromise the integrity of our results. This includes the normality test, heteroscedasticity, serial correlation test, and model specification errors. By performing these diagnostic checks, as evidenced in Table 8, we confirm that our model is well-specified, the estimators are efficient, and the conclusions drawn from our analysis are credible.

Table 8 Diagnostics test for the models

Test	RER model	Tradable model	Tradable model
Jarque–Bera normality test	0.13 (0.94)	0.27 (0.88)	7.53(0.20)
Breusch–Godfrey serial correlation	2.19 (0.18)	22.23 (0.15)	0.32 (0.73)
Breusch–Pagan–Godfrey heteroskedasticity	0.86 (0.65)	1.46 (0.39)	0.24 (0.99)
Ramsey RESET specification test	2.44 (0.16)	0.06 (0.81)	0.48 (0.51)

The *f*-statistic of each test is presented with the *p* values in parentheses

Where the null hypothesis for the Jarque–Bera normality test is that the residuals are normally distributed, that of the Breusch-Godfrey test is that there is no serial correlation in the residuals (errors are serially uncorrelated), the Breusch–Pagan–Godfrey test is that there is no heteroskedasticity in the residuals (errors have constant variance). The null hypothesis of the Ramsey RESET test states that the model is correctly specified and does not suffer from omitted variables, misspecification, or the absence of relevant nonlinear terms.

Conclusion and policy recommendations

Findings

The objective of this study is to examine how remittances influence the real exchange rate, tradable sector productivity, and non-tradable sector productivity by controlling for trade openness in the goods and services market, government expenditure, terms of trade, capital market openness, and technological progress in Nigeria using a time series of yearly data from 1980 to 2022. The ARDL technique is applied for the analysis, following the mixed integration order outcome of the unit root test and the cointegration result of the bounds test.

The results indicate that remittances do not have a long-term effect on real exchange rates in Nigeria. However, it does have a positive influence on the tradable sector and a negative impact on the non-tradable sector, contradicting the expectation of the Dutch Disease Model and the Balassa–Samuelson Effect. These models postulate that such an inflow hurts the tradable sector while the non-tradable sector flourishes; our evidence is the opposite. This effect offers an insight into why remittances might not impact the real exchange rate in Nigeria, perhaps due to increased demand for foreign currency to finance imports or investment in non-tradable sectors. Additionally, trade openness in goods and services, real interest rates, and inflation strengthen the tradable sector. Similarly, terms of trade strengthen the real exchange rate. Furthermore, government expenditure, terms of trade, and technological progress are crucial for fostering the non-tradable sector.

Moreover, capital market openness deteriorates Nigeria's real exchange rate and the tradable and non-tradable sectors. Likewise, real interest rates worsen the real exchange rate and the non-tradable sector. Furthermore, government expenditure also depreciates the real exchange rate, while technological progress adversely affects the tradable sector. Trade openness in goods and services is further associated with a decline in the real exchange rate and value addition of the non-tradable sector.

While the findings are primarily based on Nigeria's unique economic structure, the results may have broader applicability to other oil-dependent developing nations, with huge remittances influx.

Policy recommendations

Based on the results, we offer several insightful policy recommendations aimed at improving Nigeria's economic structure and ensuring sustainable growth in both the tradable and non-tradable sectors.

Firstly, the government should introduce policies that encourage the channelling of remittances into productive and tradable sectors such as agriculture and manufacturing. This can be achieved by offering targeted incentives such as tax breaks and subsidies and establishing remittance investment funds. By focusing on long-term, job-creating investments, the government can help transform remittances from mere consumption into productive economic activity.

Secondly, the government should focus on diversifying Nigeria's export base by providing incentives for non-oil exports and reducing barriers to trade. Policies aimed at simplifying export procedures, offering tax exemptions for export-oriented businesses, and improving access to global markets for Nigerian products could boost the tradable sector's competitiveness and create a more resilient economy.

Thirdly, The government should prioritise stabilising the capital market to reduce capital flight and its detrimental effects on the real exchange rate and sectoral productivity. This could include enhancing regulatory frameworks, ensuring transparency, and providing

incentives to attract long-term foreign investments. Strengthening domestic investment opportunities will also foster growth in the tradable sector.

Fourthly, Financial inclusion should be prioritised by developing financial products tailored to remittance-receiving households. The government, in collaboration with financial institutions, should expand access to formal financial services, including credit, savings, and investment opportunities. Promoting financial literacy and facilitating access to capital for small businesses will help transform remittances into long-term investments rather than short-term consumption.

Finally, addressing inflation and high interest rates should be a priority through targeted monetary and fiscal policies. The Central Bank of Nigeria (CBN) should focus on maintaining a balance between controlling inflation and providing affordable credit to businesses in the tradable sector. Government expenditure should be carefully managed to prevent further depreciation of the real exchange rate.

Research limitations and recommendations for future research

Our study is not without its limitations. First, the focus on Nigeria limits the generalisability of the findings to other developing countries with different economic structures, remittance inflows, and policy environments. However, its findings may be relevant to other oil-dependent developing nations facing similar challenges, such as reliance on oil exports and huge foreign inflow. Future research could examine the applicability of these results in other contexts, providing a broader understanding of the economic dynamics in such economies.

Second, using multiple data sources (World Development Indicators, Central Bank of Nigeria Statistical Bulletin) may introduce inconsistencies in data quality and measurement methods. Future studies could employ more consistent and harmonised data sources to manage this. Third, our study does not explore potential nonlinear relationships between remittances and the variables under consideration. The assumption of linearity may overlook complex dynamics. Future research could investigate nonlinear models or interactions to better capture the nuanced effects of remittance inflows on the economy. Fourth, trends before and after 1990 may differ due to specific structural changes in Nigeria. However, this study covers 1980–2022 and does not account for these changes. Future research could separately analyse the pre-1990 and post-1990 periods to better understand these structural shifts.

Abbreviations

ADF	Augmented Dickey–Fuller test
ARDL	Autoregressive distributed lag
CMO	Capital market openness
ECT	Error correction term
ECM	Error correction model
FDI	Foreign direct investment
GEXP	Government expenditure
INF	Inflation rate
INT	Real interest rate
LMICs	Low- and middle-income countries
NTRD	Non-tradable sector
ODA	Other development assistance
PP	Phillips Perron test
REM	Remittance inflow
REER	Real effective exchange rate
RER	Real exchange rate
TOT	Terms of trade
TOGM	Trade openness in goods and services
TP	Technology progress
TRD	Tradable sector

Acknowledgements

Not applicable.

Author contributions

The author, OP, conducted the entire research solely. All author(s) read and approved the final manuscript.

Funding

No funding was received to assist with the preparation of this manuscript.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 28 September 2024 Accepted: 20 March 2025
Published online: 17 April 2025

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