SIMULATING CONTEMPORANEOUS EFFECTS OF INFLATION AND EXCHANGE RATES ON ECONOMIC PROSPERITY PATH FOR NIGERIA USING EVIDENCE FROM DYNAMIC ARDL AND KRLS TECHNIQUES

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Abstract

This study relied on a dataset from 1970 to 2020 to assess the contemporaneous shock effects from inflation and exchange rates for 20 years (2020 to 2040) on economic prosperity for Nigeria. Also, the short and long-term simultaneous impact of both variables with other complementary measures such as deficit financing, foreign investment, and financial development on economic prosperity were determined. Empirical inferences were derived by applying the novel DYNARDL and KRLS models, which enabled the response of economic prosperity to future counterfactual shocks in the inflation and exchange rate variables. It was observed that by maintaining an 18% annual shock to the inflation and exchange rate variables, inflationary shocks may have long-term beneficial effects, first, at an increasing and later at a decreasing rate on economic prosperity. However, the negative effect of exchange rate shocks will overwhelm inflation's positive impact on future economic prosperity. Further results demonstrated that the inflation rate and deficit financing variables adversely impacted economic wealth in the short and long term. At the same time, the exchange rate and financial development only benefited economic prosperity in the long term. In contrast, foreign investment was reported to be prosperity-decelerating in the long term. The study recommends for the alignment of fiscal and monetary policy targets in order to effectively control inflation and exchange rates in Nigeria.

Keywords: Inflation, exchange rate; economic prosperity, DYNARDL, KRLS

JEL Classifications: E6, O11, O47.

Introduction

Every nation's government aims to ensure or sustain economic prosperity at the expiration of any economic policy's lifespan. The most prominent measures to indicate a country's wealth increases are the gross domestic product (GDP) growth rate and the GDP per capita (Petrakis, 2020; Batrancea et al., 2021). Consequently, policymakers have been fascinated with the combinations of macroeconomic indicators that can drive long-term wealth in different countries. For many, the inflation and exchange rates constitute crucial 'economic pulse' indicators. If both measures are not adequately managed, structural economic problems such as poor economic productivity, weak fiscal management, weak foreign reserves, credit crunch, etc., can weaken economic prosperity. The inflation and exchange rate variables have long been considered essential economic strength and competitiveness measures (Aladejare, 2018a,b; Aladejare and Musa, 2023). Today, countries worldwide (developed or developing) are grappling with the adverse effects of inflation. Similarly, a poor exchange rate management regime can dissuade investors' interests and create uncertainty in an economy. Especially when the economy is predominantly mono-cultural, and the export commodity price is characterised by volatility.

The Nigerian economy is the focus of this study because it has continuously exhibited inflationary and exchange rate challenges due to its structural distinctiveness (Aladejare, 2022a). Despite being the first and sixth oil-producing nation in Africa and the world, Nigeria lags behind some of its African and world contemporaries in income growth (measured in GDP per capita). This is an indication that the oil wealth has not translated to further prosperity sources for the nation over time. From the 1970s to date, the country has continued implementing various development plans anchored predominantly on oil receipts, hoping to attain more incredible economic wealth (Aladejare, 2021). Nevertheless, aside from the economic recession the country experienced in the mid-1980s, it has also suffered two quick recessions within the decade (2016 and 2020). At the same time, government revenue has also dwindled in recent times, irrespective of the booms in crude oil prices, thus indicating that economic prosperity for Nigeria might be threatened by erratic inflationary and exchange rate behaviours. Other complementary indicators in the literature

have been identified to include foreign direct investment (FDI), capital formation, government receipt and outlay, deficit financing, commodity prices, export and import, financial development, etc. (Tung, 2018; Ahmed et al., 2019; Aladejare, 2020; Ehigiamusoe and Lean, 2020; Wu et al., 2020; Osondu and Adiele, 2021).

Consequently, by relying on a dataset from 1970 to 2020, this study assessed the contemporaneous shock effects of inflation and exchange rates for 20 years (2020 to 2040). Also, both variables' short- and long-term simultaneous impact with other complementary measures such as deficit financing, foreign investment, and financial development. It is opined that knowing the future path of inflation and exchange rate can aid policymakers in planning to mitigate any adverse response from economic growth, whose consequences can be dire on every sector. Empirically, the inflation and exchange rate variables interact with these complementary indicators to affect economic wealth, especially in a developing country.

Nigeria has been running a deficit budget since 1970 due to the inability of its revenue, predominantly from oil, to meet its development needs. Recent empirical findings by Ebi and Aladejare (2022) and Aladejare (2022b) have further shown that despite growth in deficit financing, they have not helped to generate the necessary wealth due to poor fiscal management. Foreign investment is another critical indicator of economic prosperity through job creation, primarily when it flows to the real sectors. A situation where foreign investors prefer portfolio investment over real investment in an economy cannot spur long-term economic growth and prosperity (Aladejare, 2022c). Also, a country's financial development level is essential for long-term economic prosperity. Financial development helps effectively mobilise savings for investment, irrespective of whether the economy is developed or developing. It constitutes a primary means of resource accumulation for job creation and poverty reduction investment. In the past three decades, Nigeria has embarked on different reforms to develop its financial sectors, such as interest rate liberalisation, elimination of direct and subsidised credit schemes, introducing open market operations, bank consolidations and mergers, etc. However, the financial sector is still incapacitated to finance enormous capital investments that can produce jobs and income growth.

Methodologically, the objective of this study was accomplished through the dynamic autoregressive distributed lag (DYNARDL) and the Kernel regularised least squares (KRLS) methods. Empirically, these methods are predominantly growing in the energy, environment, and health-related literature and are somewhat rare in macroeconomic-related studies. Extant studies such as Pegkas (20180, Chirwa and Odhiambo (2020), Ali and Sardar (2020), Thaddeus et al. (2021), Waheed and David

(2021), etc., have primarily relied on the conventional ARDL procedure. One essential benefit of the DYNARDL model to the mainstream ARDL technique is its ability to visualise further the impact of a counterfactual change in a regressor at a specific time, ceterisparibus, through a stochastic simulation approach. Hence, by adopting the DYNARDL technique, this study could simulate the future path of economic prosperity, ceterisparibus, inflation, and exchange rate shocks persist in the economy. Also, the model's explanatory power is robustly assessed using the KRLS approach. Hence, this study extends the literature on this front. The remainder of the study is of the following order. Section two is the literature review, section three is the data and research methodology, and sections four and five contain results, discussions, and the study conclusions.

Empirical Review

Zubair and Aladejare (2017) adopted the ordinary least squares (OLS) technique and concluded that FDI inflows and exports determine Nigeria's short- and long-term GDP growth. Kollie (2018) demonstrated with the ARDL approach that trade openness, FDI inflows, exchange rate, and political instability are critical determinants of GDP growth for Liberia. Another study by Barguellil et al. (2018) adopted the difference and system generalised method of moments (GMM) technique. It showed that real and nominal exchange rate volatility affects GDP in 45 developing and emerging economies. Bekere and Bersisa (2018) found through the dynamic GMM that FDI is crucial for GDP growth in 14 East African countries. In the study by Tung (2018), the cointegration and error correction model (ECM) was applied to deduce a long-run effect of fiscal deficit on GDP growth for Vietnam. Pegkas (2018) conducted a study for Greece by employing the ARDL methodology. The study inferred that private investment, government consumption, and trade openness exacted a positive effect on GDP. However, public debt and population growth adversely impacted GDP.

Furthermore, the significance of remittances and FDI in GDP per capita growth for seven Central and Eastern European countries was confirmed through the panel OLS procedure by Comes et al. (2018). Park et al. (2019) were able to show using the system generalised method of moments (GMM) that initial income level, population growth, human capital, and fixed capital investment determined the standard of living (measured by GDP per capita growth) in 60 selected countries. By employing an extreme bounds analysis, Hosseinpour et al. (2019) affirmed for 40 developing countries that investment and trade indicators are significant GDP determinants. Chirwa and Odhiambo (2019) employed the ARDL technique and showed that inflation, government consumption, trade

openness, and real exchange rate impacted GDP per capita for Zambia. Wu et al. (2020) used the seemingly unrelated regression (SUR) procedure to indicate that FDI and government expenditure significantly impacted China's GDP and GDP per capita.

Aladejare (2020) applied the pool mean group (PMG) method and submitted that the gross fixed capital formation and exchange rate determine long-run GDP per capita growth in the ECOWAS region, while in the COMESA region, exchange rate and degree of openness are determinants of long-run GDP per capita growth. Ho and Iyke (2020) demonstrated with the ARDL technique that in the long-term, human capital and foreign aid are GDP-enhancing, while labour, debt servicing, and financial development are GDP-reducing for Ghana. A more comprehensive study of 21 African countries by Oyebowale and Algarhi (2020) revealed through the PMG technique that growth in exports, government outlay, and gross capital formation significantly improves GDP. Similarly, Ali and Sardar (2020) showed for seven South Asian economies through the PMG approach that unemployment, access to electricity, financial inclusion, FDI, inflation, and public debt significantly determine GDP. Yakubu et al. (2020) used the dynamic and fully modified (OLS) and submitted that financial liberalisation, government expenditure, and political instability are critical determinants of real GDP per capita for Kenya. Ehigiamusoe and Lean (2020) employed the mean group (MG) and PMG methods for West African countries and indicated that fiscal deficit and public debt impacted GDP.

Zeng and Zhou (2021) demonstrated with panel GMM that FDI substantially impacted China's provinces' GDP per capita. Thaddeus et al. (2021) applied the ARDL method. They concluded that government spending, exchange rate, inflation, FDI, trade openness, human capital development, gross capital formation, money supply, and foreign aid are determinants of GDP growth in Cameroon. Wen et al. (2021), in a panel study of 120 countries, applied the system GMM and found that financial development exerts an adverse effect on GDP growth. Ustarz and Fanta (2021) used the GMM and SUR approaches to conclude that financial development positively affects the service and agricultural sectors' contributions to GDP for sub-Saharan Africa (SSA) countries. The ARDL method was applied by Verma et al. (2021) for a study in Bangladesh. Empirical findings from the study revealed that FDI, public spending, foreign aid, and trade openness positively impacted GDP growth, while public debt had an adverse effect. Rehman et al. (2021) studied 23 emerging economies using the GMM approach and found that trade openness is a crucial determinant of GDP.

Gurdal et al. (2021) considered the time and frequency domain techniques for G7 countries and concluded that tax receipts and public spending impacted GDP. The vector error correction model (VECM) was applied by Zuhroh (2021). Findings from the study revealed that inflation, exchange rate and money supply impacted Indonesia's GDP. Waheed and David (2021) showed using the ARDL procedure that inflation and exchange rates, capital, and tax receipts determine GDP growth for Pakistan. By applying a multimodal panel procedure for 34 African countries, Batrancea et al. (2021) showed that exports, imports, gross domestic savings, and gross capital formation are crucial determinants of GDP. Another study by Batrancea et al. (2022) applied a descriptive statistical analysis and observed that GDP growth in Bolivia, Estonia, Poland, the Czech Republic, Malaysia, and Thailand is a function of bank capital to asset ratio. Abate (2022) conducted a panel study for 44 developing countries using the system GMM method and concluded that foreign aid, inflation, investment, and government expenditure significantly determined real GDP/per capita. Chowdhury et al. (2023) observed through pooled OLS that remittances played a primary role in the GDP per capita growth of low-income Asian frontier economies.

From the above review, inflation and exchange rates, deficit financing, foreign investment, and financial development have featured dominantly as economic prosperity determinants. Prominently, the ARDL methodology has been extensively applied (either for country or panel analysis). However, the novel DYNARDL and KRLS procedures are rarely available in macroeconomic literature, thus constituting the core value addition of this study.

Theoretical Framework

The theoretical leaning of this study is the immiserising growth (IG) theorem. It is a long-term phenomenon whereby the benefits of a country's social welfare due to its economic growth are eroded by the loss in such welfare resulting from an adverse change in the country's terms of trade. There are two propositions to the IG theorem, which are considered herein. First is the proposition by Bhagwati (1958), who revealed how IG could happen in a country exporting a commodity good with highly inelastic price or income elasticities of demand, or both. The higher quantity of exports would result in a decline in the foreign price of its export commodity. In Bhagwati's argument, if the conventional exports (commodity A) of a rapidly growing developing country are confronted with world demand curves known to be highly price and income-inelastic, then the relative price of commodity A is expected to decline. When the price fall is significantly massive, welfare will also decrease. Consequently, a

paradoxical effect of economic growth resulting in falling national welfare exists. In most instances, such IG prevails in a developing nation whose exports are predominantly a single primary commodity. Bhagwati et al. (2004) further investigated some associated scenarios. An example is the outcome of outsourcing, which produces an adverse change in terms of trade as a result of its induced enlargement of the output of the exported commodity. Furthermore, if a non-neutral shift in the production frontier happens, the course of IG can either be retarded or quickened (Pryor, 2007).

A second proposition of the IG theorem was given by Samuelson (2004), where a decline in social welfare could also exist in a home country, given its trade partner aligned to a specific growth strategy of locally producing more of the commodity that the home country exports. In other words, the partnership has a biased form of economic growth. In particular circumstances, this would yield a rise in the world output of the commodity and, in turn, negatively change the terms of trade against the home country. The Samuelson proposition specifically observed that when the trade partner adopts an import substitution form of economic growth, it elevates its production frontier, particularly along the course of the imported commodity. Therefore, in the subsequent period, its output of imported goods will relatively increase while it imports less. In a traditional demand condition, the world's terms of trade will change against this commodity since more of it is produced (Pryor, 2007).

From the home country's perspective, the terms of trade for its exports will be inverse. Where its economic growth is relatively sluggish, this price change may lead to considerable social welfare loss beyond what is gained through economic growth. Unlike Bhagwati's proposition, where the home country's action is responsible for a decline in social welfare, this type of IG appears more prevalent and less paradoxical. For instance, Samuelson noted that such a phenomenon is specifically likely for an industrialised country when its economically developing trade partner is experiencing rapid economic growth and is attempting to industrialise by producing commodities it had been importing. Hence, economic growth in the developing nation creates IG in the industrialised country. Social welfare could also decline in the industrialised country, especially if the developing country is large while the industrialised country is small. Suppose the developing nation should undergo an economic depression. In that case, its commodity imports from the industrialised country may decline substantially, resulting in a fall in the relative price of commodity A. Also, the developing nation could mount trade barriers that could enormously impact adversely on the terms of trade of the industrialised country.

Research Methodology

The data applied for this study spanned from 1970 to 2020. Economic prosperity, as previously noted, is often measured either with the GDP growth rate or GDP per capita. Although the GDP gives an aggregate perspective of an economy's wealth, the GDP per capita provides a more efficient individual account for the total wealth. Hence, the real GDP per capita is adopted for this study. Theoretically, it represents each individual's share in an economy and is adjusted for inflationary effects, making it a better measure of economic prosperity. Furthermore, the real GDP per capita is very significant to this study, given that its increase in an economy may connote improvement in factor inputs' productivity (intensive economic growth).

Aside from the critical role of inflation and exchange rates, deficit financing, foreign investment, and financial development were considered complementary in economic prosperity determination. A stable inflationary path and predictable exchange rate are important determinants for enhanced economic wealth. While inflation can erode the value of money, the exchange rate can restrict individuals' access to essential foreign goods. Thus, both indicators can widen a country's income inequality gap. Similarly, Nigeria, as a developing country, has consistently engaged in deficit financing to fund essential economic infrastructure in healthcare, education, housing, transportation, energy, etc. Over time, Nigeria's deficit financing has witnessed tremendous growth but with a meagre impact on the pre-listed sectors. Foreign investment and a developed financial sector complete the indicators considered. Both measures can raise the output level, increase employment, and ensure a favourable trade balance for a developing nation. Thus, properly managing these measures can accelerate a country's economic wealth. The unit of measure and source for each indicator is captured in Table 1.

Table 1: Variable description

Variable	**Measurement**	**Sources**	**Symbol**
Economic prosperity	GDP per capita (constant domestic currency unit)	WDI (2022)	yp
Inflation	Consumer price index	WDI (2022)	cpi
Exchange rate	Official exchange rate per US$	WDI (2022)	xr
Deficit financing	Deficit financing (% of GDP)	CBN annual statistical bulletin (2021)	dfy
Foreign investment	FDI inflows (% of GDP)	WDI (2022)	fiy

Financial development	Domestic credit to the private sector by banks (% of GDP)	WDI (2022)	dcy

Source: Author's computation.

One essential benefit of the DYNARDL model to mainstream ARDL technique is its ability to progressively visualise the impact of a counterfactual change in one independent variable at a specific time, ceterisparibus, through a stochastic simulation approach. Dynamic simulation techniques are increasingly being deployed as a straightforward path to depict the substantive outcomes of time-series models, whose parameters usually exhibit non-intuitive or "hidden" meanings (Breunig and Busemeyer, 2012; Philips et al., 2016).

Before applying the DYNARDL method, the order of integration of the variables must strictly have the response variable as the I(1) series. At the same time, the regressors can be a combination of level (that is, I(0)) and first difference (that is, I(1)) series, but not I(2) (Jordan and Phillips, 2018). It is thus suggested that cointegration can only be attained when the response variable is stationary at I(1) (Sarkodie and Owusu, 2020). In contrast, the bounds testing technique with a stationary response variable at I(0) can be tested by applying the standard but modified ARDL bounds test with surface regression (Kripfganz and Schneider, 2020). Also, the information criterion required for choosing the best-fitted lagged-difference structure must be determined to correct normality, autocorrelation and heteroscedasticity issues and ensure no structural breaks in the model (Philips, 2018; Jordan and Phillips, 2018).

The DYNARDL procedure requires, estimating an ARDL model, as shown in Equation 1.

$$\begin{aligned}\Delta lyp_t = {} & \alpha_0 + \alpha_1 lyp_{t-1} + \alpha_2 lcpi_{t-1} + \alpha_3 lxr_{t-1} + \alpha_4 dfy_{t-1} \\ & + \alpha_5 fiy_{t-1} + \alpha_6 dcy_{t-1} + \sum_{j=1}^{m} \pi_i \Delta lyp_{t-j} \\ & + \sum_{j=0}^{m} \sigma_i \Delta lcpi_{t-j} + \sum_{j=0}^{m} \tau_i \Delta lxr_{t-j} + \sum_{j=0}^{m} \delta_i \Delta dfy_{t-j} \\ & + \sum_{j=0}^{m} \rho_i \Delta fiy_{t-j} + \sum_{j=0}^{m} \omega_i \Delta dcy_{t-j} + \emptyset_i et_{t-1} \\ & + \varepsilon_t \qquad (Equ.1)\end{aligned}$$

$$Note\ \ i = 1, 2, \dots, N; \qquad\qquad t = 1, 2, \dots, T.$$

where l is the logarithm operator, "et" denotes the error correction term and the parameter $\emptyset_i$ represents the speed of adjustment from short-term distortion to the long-term equilibrium path.

After conducting the necessary tests on the residuals of the ARDL model to ensure its conformity to the absence of serial correlation, heteroscedasticity, and no structural breaks, the DYNARDL can be estimated. Nigeria's average annual growth rate of inflation and exchange rates from 1970 to 2020 is approximately 18% (WDI, 2022); consequently, there is a ~18% shock to inflation and exchange rate in the DYNARDL estimation. They are used for counterfactual shocks over 20 years, from 2020 to 2040. Effects of shocks to both variables are known to often boomerang into every sector of the economy, which can impact income growth. Thus, the study's DYNARDL model simulation is succinctly specified in Equation 2.

$$\Delta lyp_t = \beta_0 + \beta_1 lyp_{t-1} + \beta_2 lcpi_{t-1} + \beta_3 \Delta lcpi_{t-1} + \beta_4 lxr_{t-1} + \beta_5 dfy_{t-1} + \beta_6 \Delta dfy_{t-1} + \beta_7 fiy_{t-1} + \beta_8 \Delta fiy_{t-1} + \beta_9 dcy_{t-1} + \beta_{10} \Delta dcy_{t-1} + \epsilon_t \qquad (Equ. 2)$$

Results and Discussions

Descriptive statistic test results

Contained in Table 2 is the descriptive statistic of the variables. Nigeria's mean GDP per capita is ₦275,185 (US$1,924), which exceeds the $1,676, $1,063, and $1,032 average for West, Middle, and East African countries, respectively (IMF, 2021). However, it falls short of the $2,944 and $5,426 for North and South African countries, respectively, and $4,650 and $6,625 for Southeast Asian and South American countries, respectively (IMF, 2021). The mean consumer price index is about 51.93 points, while the exchange rate averaged ₦79.18 per $1 for the study period. Deficit financing per GDP averaged 2.4%, which falls within the deficit financing cap of 5% and 3% as contained in the CBN and Fiscal Responsibility Acts of 2007. Nevertheless, the peak deficit financing-to-GDP ratio is about 8.6%. FDI per GDP has a mean of 1.4%, which is lower than the 2.7% average for most African countries (WDI, 2022)—suggesting that investors may not find the country attractive despite its vast resource wealth. Banks' domestic credit to the private sector was 8.8% of the GDP, which can be considered grossly inadequate to drive employment and output growth for the country.

Table 2: Descriptive summary statistics.

Variables	Mean	Max.	Min.	Std. Dev.
yp	275185	385349	199039	61269
cpi	51.931	267.512	0.099	74.118
xr	79.183	358.8	0.547	98.215
dfy	2.412	8.618	-9.544	3.054
fiy	1.424	4.860	-0.372	1.135
dcy	8.780	19.604	3.862	3.433
Obs.	51	51	51	51

Source: Author's computation.

Unit root test

The stationarity of the series was examined using the Philips-Perron (PP) and augmented Dickey-Fuller (ADF) unit root tests. Confirming the stationarity status of the variables can eliminate effects from potential spurious regression. Table 3 reveals that all the variables are I(1) series except for deficit financing, which was stationary at level. Hence, the null hypothesis is firmly rejected at the first difference for the regressand (lyp) and regressors except for deficit financing.

Table 3: Unit root tests

Variable	ADF (level)	ADF (1^{st} **Dif**.)	PP (Level)	PP (1^{st} **Dif**.)
lyp	-0.966	-3.189**	-1.092	-5.390***
$lcpi$	-1.234	-3.240**	-1.125	-3.055**
lxr	-0.248	-5.679***	-0.340	-5.670***
dfy	-5.753***	-	-5.878***	-
fiy	-1.493	-11.755***	-2.451	-11.843***
dcy	-2.345	-5.988***	-2.242	-11.322***
H_0	Series has a unit root.			

Note: ** and *** denote statistical significance at 5% and 1% levels, respectively.

Source: Author's computation.

Cointegration test

After fulfilling the strict first-difference stationary dependent variable criterion, the optimal lag for the proposed model was derived (as two lags) using the Schwarz and Akaike information criteria. Furthermore, the optimal lag was used to determine the presence of cointegration through the Pesaran, Shin, and Smith (PSS) bounds approach with the novel Kripfganz and Schneider (KS) critical values and approximate probability values.

Evidence in Table 4 confirms the presence of cointegration between the study series since the F-statistic (6.124) and t-statistic (-4.580) are beyond the upper bounds of critical values (4.391, -4.181) at the 5% significance level. Further validation was achieved using the KS approximate probability values (p-value<0.05). Hence, the PSS and KS critical values with approximate p-values invalidated the null hypothesis of no long-run relationship.

Table 4: Bounds test for cointegration

		1%		5%		10%		p-value	
K= 5		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F	6.124	3.973	5.941	2.840	4.391	2.360	3.730	0.001***	0.008***
T	-4.580	-3.544	-5.042	-2.815	-4.181	-2.454	-3.752	0.001***	0.024**

Note: I(0) and I(1) are the lower and upper band critical values at 1%, 5% and 10% significance levels of Pesaran et al. (2001) bounds test; the p-value is Kripfganz and Schneider's (2020) critical values and approximate p-values; ** and *** denote statistical significance at 5% and 1% levels, respectively.
Source: Author's computation.

Mainstream ARDL result

The outcome in Table 5 indicates that inflation rate, deficit financing, and foreign investment adversely impacted economic prosperity in the long term. In contrast, the exchange rate and financial development indicators are positive and significant long-term determinants of economic prosperity. In the short-term, inflation rate and deficit financing in their current and lagged form negatively and positively affected economic prosperity. However, the exchange rate and financial development measures in their current and lagged state exhibited significant positive and inverse impacts on economic prosperity. Both current and lagged foreign investment showed adverse effects on economic prosperity.

The speed of adjustment term (et) parameter indicates an annual correction of 24% distortion before the long-term equilibrium path can be restored.

Table 5: Mainstream ARDL estimates

Model	Variable	Coefficient	Std. error	Prob. value
	et_{t-1}	-0.243	0.053	0.000***

Long-term	$lcpi_{t-1}$	-0.294	0.081	0.001***
	lxr_{t-1}	0.348	0.088	0.000***
	dfy_{t-1}	-0.045	0.014	0.002***
	fiy_{t-1}	-0.146	0.033	0.000***
	dcy_{t-1}	0.056	0.012	0.000***
Short-term	$\Delta lcpi_t$	-0.165	0.059	0.008***
	$\Delta lcpi_{t-1}$	0.302	0.075	0.000***
	Δlxr_t	0.025	0.025	0.330
	Δlxr_{t-1}	-0.023	0.026	0.375
	Δdfy_t	-0.009	0.002	0.000***
	Δdfy_{t-1}	0.005	0.002	0.024**
	Δfiy_t	-0.041	0.011	0.001***
	Δfiy_{t-1}	-0.005	0.009	0.575
	Δdcy_t	0.013	0.003	0.001***
	Δdcy_{t-1}	-0.005	0.003	0.111
	Constant	2.884	0.647	0.000***
ARDL(2,2,2,2,2,2)	Obs.	49	R^2	0.74
	Root MSE	0.0345	$Adj.R^2$	0.60

Note: ** and *** denote statistical significance at 5% and 1% levels, respectively.
Source: Author's computation.

Residual tests

As a pre-condition for estimating the DYNARDL simulations, several residual tests were performed to eliminate serial correlation, heteroscedasticity, violation of normality, and structural breaks. Table 6 captures the serial-autocorrelation test conducted using the Breusch-Godfrey Lagrangian multiplier (LM) technique. The null hypothesis of no serial correlation was upheld (since p-value>0.05), thus indicating that the residuals of the estimated mainstream ARDL model are independent of autocorrelation.

Table 6: Breusch-Godfrey LM test for autocorrelation

Lags(p)	F	Df	Prob.>F
1	0.011	1, 30	0.918
2	0.006	2, 29	0.994
3	0.031	3, 28	0.992
4	0.247	4, 27	0.909

Source: Author's computation.

Output in Table 7 reveals the test for heteroscedasticity in the residuals by employing Cameron and Trivedi's decomposition of the IM-test. It can be deduced from the outcome that the null hypothesis of homoscedasticity is validated at a 5% significance level, thereby showing that the residuals are homoscedastic.

Table 7: Cameron and Trivedi's decomposition of the IM-test

Source	Chi^2	Df	Prob. Value
Heteroskedasticity	49.00	48	0.433
Skewness	9.93	17	0.906
Kurtosis	1.80	1	0.179
Total	60.74	66	0.660

Source: Author's computation.

Next, the normality test to ascertain residuals' independence using the Skewness/Kurtosis approach was conducted and the result is displayed in Table 8. A normal distribution null hypothesis is upheld from the outcome since p-values exceed the 5% significance level.

Table 8: Normality and parameter stability test

Skewness/Kurtosis tests for normality

Variable	Obs.	Pr(Skewness)	Pr(Kurtosis)	Joint adj $chi^2(2)$	$Prob>chi^2$
Residuals	49	0.293	0.443	1.78	0.411

Cumulative sum test for parameter stability

Statistic	Test statistic	1% critical value	5% critical value	10% critical value
OLS	0.398	1.628	1.358	1.224

H_O: No structural break Obs.: 49

Source: Author's computation.

Further normality validation was conducted through plots of standardised normal probability (Figure 1a) and residuals' quantiles against normal distribution (Figure 1b). The output plots captured in Figure 1 affirmed that the model residuals are normally distributed.

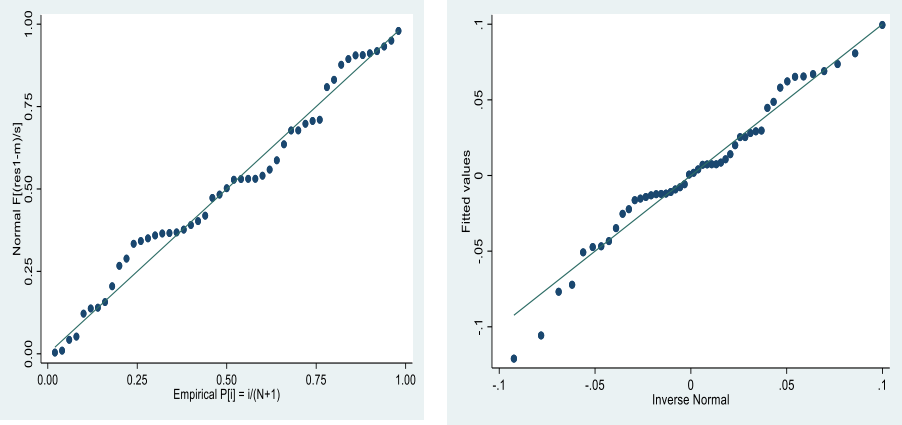

Figure 1a: Standardised normal probability plot.
Figure 1b: Quantiles of residuals against quantiles of normal distribution.

Figure 1: Normality test plot.
Source: Author's computation.

Lastly, the check for possible structural breaks using the cumulative sum test for parameter stability was performed. The estimated output in Table 8 shows the test statistic is lower than the critical values, thus implying the absence of a structural break in the model's parameters. Further validation was done through a cumulative sum plot captured in Figure 2. Evidence from the plot showed the estimated test statistic as lying within the 95% confidence band, thereby validating the stability of the estimated parameters over time.

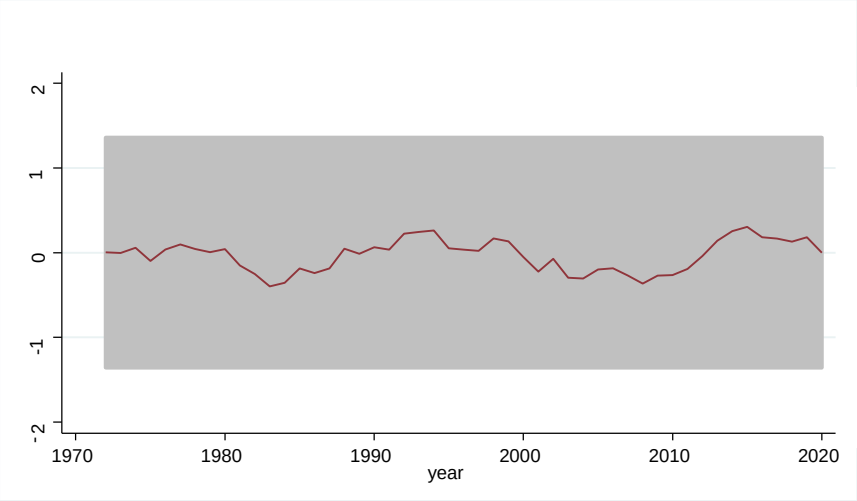

Figure 2: Cumulative sum test using OLS CUSUM plot for parameter stability.
Source: Author's computation.

Dynamic ARDL simulations

The DYNARDL simulations in this study are based on an ~18% rise in inflation and exchange rates for over 20 years (from 2020 to 2040). Table 9 contains the empirical short and long-run estimates of the DYNARDL model. Notably, there are similarities in the short and long-run outputs of the mainstream and DYNARDL estimates.

The inflation rate is revealed to have significantly and adversely affected economic prosperity in the short and long term. This result aligns with Chirwa and Odhiambo's (2019) and Abate (2022) studies for developing economies. Keeping a close watch on inflation is crucial for fixed-income investors because the inflation rate will discount future income flows to ascertain the present value of money in future terms. Stated differently, a general rise in the inflation rate over time will shrink consumers' purchasing power, given that income remains fixed. Hence, progressively, few consumptions will be afforded. If the fall in income value persists, economic prosperity will decline.

In contrast, the exchange rate exhibited a positive long-term impact on economic prosperity. Thus affirming the earlier submission by Aladejare (2020). As the nominal exchange rate rises, the country's exports become cheaper in the international market. Although Nigeria operated a fixed exchange rate regime till mid-1986, the perceptions about the country's exports as being too expensive have seen the domestic currency (naira)

undergo several liberalisation policies to date (Aladejare, 2022b). Subjecting the naira to the operations of market forces is expected to aid export demands, improve foreign earnings, and enhance the country's long-term productivity.

Table 9 further shows that deficit financing significantly negatively affected economic prosperity in the short and long term. Wu et al. (2020) and Yakubu et al. (2020) are two studies that have reported similar findings in the literature. This outcome implies that the supplementary funds derived through deficit financing to augment the use of revenue for infrastructural development have been income-diminishing. Extant studies such as Ebi and Aladejare (2022) and Aladejare (2022b) have observed that an enormous share of Nigeria's deficit financing funds are often expended on import demands and subsidy payments annually. Such measures cannot promote a country's income growth and overall economic wealth. Therefore, deficit financing can only propel prosperity in a country when channelled into capital infrastructural projects, which can later translate to economic employment and productivity.

Foreign investment, another essential indicator, was indicated not to have contributed to economic prosperity in the short and long term. This outcome negates empirical studies (such as Comes et al., 2018; Park et al., 2019; Wu et al., 2020; Abate, 2022) reporting significant impacts of foreign investment on GDP per capita. A plausible explanation for this outcome could be that most foreign investments in the country are portfolios, not real assets. On the other hand, financial development only aided economic prosperity in the long term. This outcome supports Ali and Sardar's (2020) and Yakubu et al. (2020) empirical submission. Sustained credit facilities to the private sector reduce unemployment of factor inputs. It also enhances output productivity and income growth, which are prerequisites for long-term economic prosperity.

The speed of adjustment term parameter indicates an annual correction of 12% distortion before the long-term equilibrium path can be restored. Hence, this implies that about 99 months may be required for the long-run equilibrium state to be restored in the event of short-term distortion in the determinants.

Table 9: Estimates of dynamic simulated ARDL model

Model	Variable	Coefficient	Std. error	Prob. Value
	ecm_{t-1}	-0.116	0.046	0.016**
Long-term	$lcpi_{t-1}$	-0.055	0.013	0.000***
	lxr_{t-1}	0.062	0.014	0.000***
	dfy_{t-1}	-0.005	0.003	0.075*

	fiy_{t-1}	-0.002	0.009	0.797
	dcy_{t-1}	0.006	0.003	0.075*
Short-term	$\Delta lcpi_t$	-0.150	0.060	0.016**
	Δdfy_t	-0.007	0.002	0.003***
	Δfiy_t	-0.010	0.009	0.279
	Δdcy_t	0.005	0.003	0.128
	Constant	1.389	0.567	0.019**
	Prob.>F	0.000***	R^2	0.58
	Root MSE	0.040	$Adj.R^2$	0.48

Note: *, **, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively.
Source: Author's computation.

Furthermore, the parameter plots of the DYNARDL simulations are depicted in Figures 3 and 4. The marginal returns of inflation and exchange rates on sustained economic prosperity are evaluated via the DYNARDL simulations of counterfactual shocks. The annual mean growth rate of inflation and exchange rates (~18%) was incorporated in the estimation and simulated for twenty years (2020–2040). Figure 3 reveals that the predicted dynamic shock (-18%) to the inflation rate may accelerate economic wealth at an increasing rate in the first eight-year period and later accelerate at a decreasing rate for the remaining twelve-year period. Furthermore, economic prosperity is predicted to change from 2.5% to 6% for the first eight years, and in the remaining twelve years, from 6.5% to 8%. Hence, future economic growth may be realised, first, at an increasing and later at a decreasing rate if the mean inflation rate is sustained.

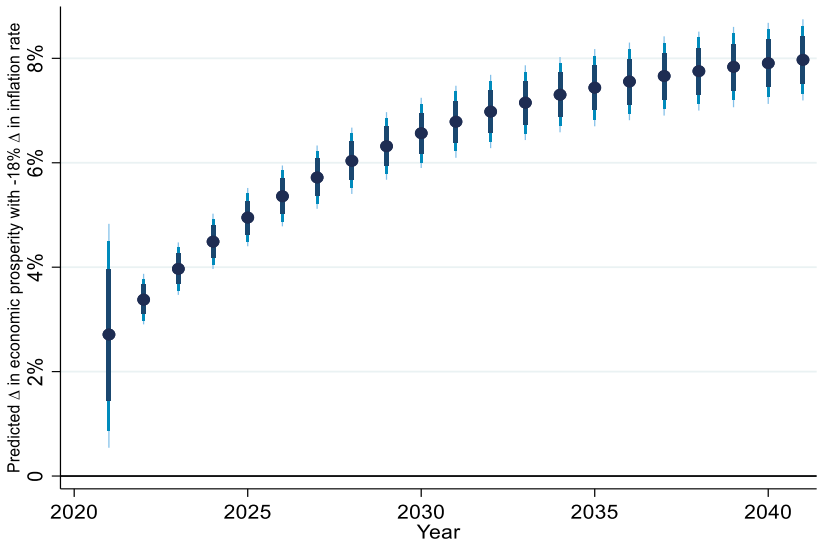

Figure 3: Simulated change in long-term economic prosperity given a shock in the inflation rate.
Source: Author's computation.

However, the predicted dynamic shock (-18%) to the exchange rate suggests no effect in the first period, but a decelerating response from economic prosperity is expected afterwards. The exchange rate's anticipated dynamic shock may decelerate economic wealth at an increasing rate for five years after the initial period and later decelerate at a decreasing rate for the remaining twelve-year period (Figure 4). From the plot, economic prosperity is predicted to change from -1.5% to -6% (five years after the initial period) and from about -6.5% to -9% in the remaining twelve-year period. Consequently, the negative effect of the exchange rate will slightly overwhelm inflation's positive impact on economic prosperity.

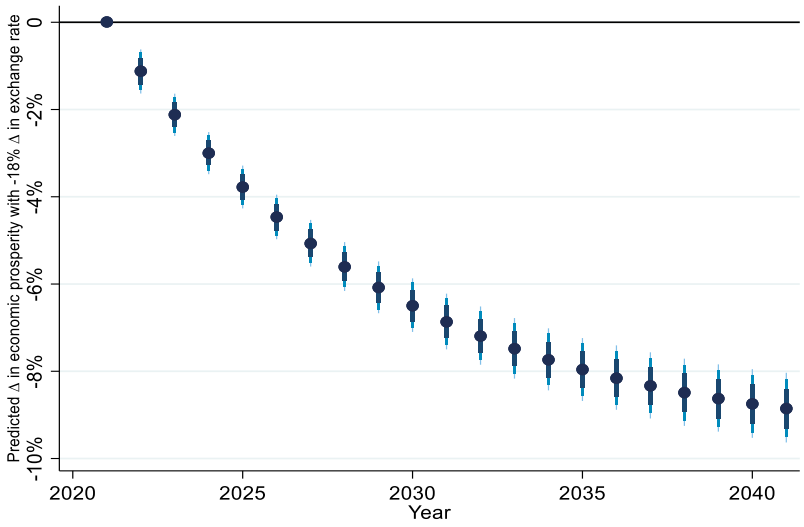

Figure 4: Simulated change in long-term economic prosperity given a shock in the exchange rate.

Source: Author's computation.

Kernel regularised least squares (KRLS) estimate

A machine learning algorithm was applied to evaluate and determine the causal-effect nexus among the variables to enhance further the reasoning presented in this study. The KRLS is known to implement pointwise derivatives in ascertaining causal-effect relationships among variables. Table 10 captures the aggregate predictive power of the model as 0.95, implying that the explanatory power of the regressors accounted for 95% of the variation in economic prosperity. Table 10 shows that the average pairwise marginal effects of inflation and exchange rates, deficit financing, foreign investment, and financial development are 0.012%, -0.008%, -0.010%, 0.039%, and 0.026%, respectively. The variables' probability values are significant, with exceptions to inflation and exchange rates, which shows evidence of causal-effect nexus in both variables.

Table 10: KRLS pointwise derivatives

lyp	**Avg.**	**Std. error**	**t-stat.**	**p>t**	**P-25**	**P-50**	**P-75**
lcpi	0.012	0.009	1.329	0.190	-0.098	0.023	0.119
lxr	-0.008	0.009	-0.834	0.408	-0.053	0.004	0.034
dfy	-0.010	0.004	-2.342	0.024**	-0.035	-0.007	0.014

fiy	0.039	0.012	3.157	0.003***	-0.012	0.016	0.104
dcy	0.026	0.005	5.776	0.000***	0.008	0.029	0.042
Diagnostics							
Lambda	0.062	Sigma	5	R^2	0.95	Obs.	51
Tolerance	0.051	Eff. D.f	25.21	Looloss	1.863		

Note: *, **, and *** denote statistical significance at 10%, 5%, and 1% levels.
Source: Author's computation.

In Figure 5 are plots of the pointwise derivative of the varying marginal effects of the shock variables on economic prosperity. Although both plots expressed similar behaviour, their duration of impact varies. For inflation, the marginal effect is negatively sluggish at low levels of economic wealth, moving towards zero at medium level, and positively faster at higher levels of prosperity (Figure 5a). Therefore indicating that inflation exhibits increasing marginal returns on economic prosperity. Thus, lower inflationary episodes decelerate economic prosperity until a threshold point is attained, beyond which higher inflationary episodes reverse the course. Inflation's marginal benefit occurs in several ways, such as producers benefitting from higher prices. Also, investors and firms benefit from additional incentives for investing in productive ventures, increasing returns. Hence, so long as producers access the appropriate investment, they are empowered to produce more goods and services to spur an increase in the employment of factor inputs and income growth.

On the other hand, the exchange rate's marginal effect is negatively faster at low levels of economic prosperity. Still, it stays harmful beyond the mid-level before sluggishly turning positive at later levels of economic prosperity (Figure 5b). Consequently, the exchange rate exerts more decreasing than an increasing marginal effect on economic prosperity. Thus, lower exchange rate episodes decelerate economic prosperity for a more extended period until a threshold is attained, beyond which higher exchange rate episodes reverse the course. Due to the developing features of the economy, the exchange rate may be devalued to make exports more attractive. However, the inadequacy to produce manufactured exports due to technological obsolescence and shortage of skilled human resources will aggravate the price of imports and imported production inputs. Consequently, a low exchange rate will not only hamper income growth for extended periods but will further overwhelm the positive impact on exports.

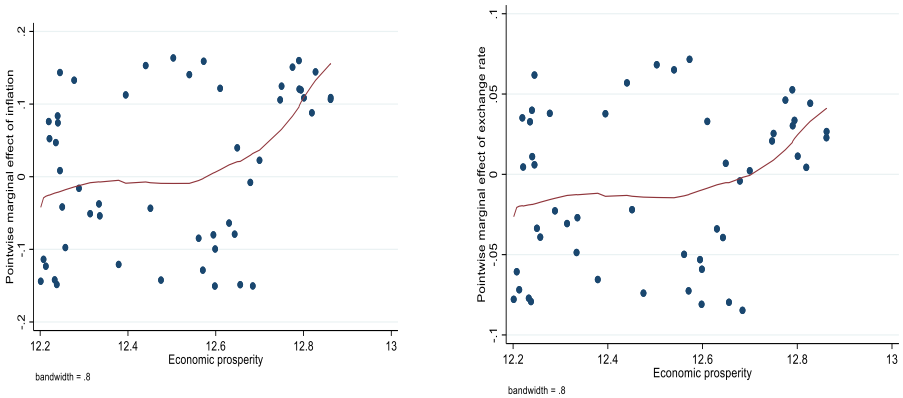

Figure 5a: Pointwise marginal effect of the inflation rate.
Figure 5b: Pointwise marginal effect of the inflation rate.
Figure 5: Representation of pointwise marginal effects.
Source: Author's computation.

Conclusion and Recommendations

This study relied on a dataset from 1970 to 2020 to assess the contemporaneous shock effects from inflation and exchange rates for 20 years (2020 to 2040) on economic prosperity for Nigeria. Also, the short and long-term simultaneous impact of both variables with other complementary measures such as deficit financing, foreign investment, and financial development on economic prosperity were determined. Empirical inferences were derived by applying the novel DYNARDL and KRLS models, which enabled the response of economic prosperity to future counterfactual shocks in the inflation and exchange rate variables. It was observed that by maintaining an 18% annual shock to the inflation and exchange rate variables, inflationary shocks may have long-term beneficial effects, first, at an increasing and later at a decreasing rate on economic prosperity. However, the negative effect of exchange rate shocks will overwhelm inflation's positive impact on future economic prosperity. Further results demonstrated that the inflation rate and deficit financing variables adversely impacted economic wealth in the short and long term. At the same time, the exchange rate and financial development only benefited economic prosperity in the long term. In contrast, foreign investment was reported to be prosperity-decelerating in the long term. Hence, the study recommends that fiscal and monetary policy targets should align for effective control of inflation and exchange rates in the country. For instance, it is unattractive for the monetary authority to be grappling with controlling the inflationary trajectory through a contractionary policy while the fiscal management is simultaneously

fuelling inflationary pressures by pursuing an expansionary policy. Inflation targeting can only be effective when there is a monetary and fiscal synergy of efforts. Furthermore, investment in sophisticated exports should be pursued to complement dwindling earnings from the predominant commodity exports to reduce the adverse effect of exchange rate shocks on economic prosperity. In other words, diversifying exports away from the near monopoly of crude oil will help stabilise the naira and grow foreign earnings for the country. If this condition is not fulfilled, subjecting the value of the naira to the forces of demand and supply will be detrimental rather than a blessing to the economy.

Traditionally, deficit financing should spur capital formation in a country and not recurrent outlays. Thus, the application of deficit financing to unprofitable ventures should be discouraged. The intuition is that so long as deficit financing for recurrent spending overwhelms capital outlay, the sustainability of economic prosperity will be eroded. The burden to repay borrowed funds, with interest, in the form of higher taxes will be borne by future generations and consequently, long-term economic and income growth will be retarded. Therefore, a policy commitment to ensure deficit financing is strictly deployed for investment in capital formation should be pursued to reverse its adverse effect on long-term income growth.

Foreign investment in the real sector of the economy should be encouraged by providing a thriving investment environment. Its insignificance for income growth may not be unconnected with the characterising uncertainty of the business sphere in the country. Therefore, having a coherent and stable policy direction geared towards attracting foreign investment inflows, especially in the real sector, is encouraged. Such measures will promote output, employment, and income levels in the economy. There is also a need to promote the evolution of the country's financial sector to meet foreign investors' significant capital financing demands. The financial sector's domestic and foreign confidence rating will soar by developing such capacity. Consequently, the size of the economy becomes more elastic due to the incentive for capital flight to diminish, thus making available investable funds to grow and become cheaper.

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Disclosure of potential conflict of interest
The authors have no competing interests to declare relevant to this article's content.

Research involving human participants and or animals
This study article does not contain any study with human participants or animals performed by the authors.

Data Availability Statement
The data that support the study's findings are available from the corresponding author upon reasonable request.

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