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IMPACT OF EXCHANGE RATE MISALIGNMENT ON INDUSTRIAL OUTPUT IN NIGERIA. EVIDENCE FROM NON-LINEAR ARDL

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Abstract *Real exchange rate misalignment and inflation impact domestic economic activity through trade and financial channels. Using aggregate industrial sector data and exchange rate misalignment computed using the behavioural equilibrium exchange rate approach (BEER), this paper investigate the asymmetric impact of inflation and exchange rate misalignment on industrial output in Nigeria using Non-linear ARDL approach for the period* 2007M1-2023M12. *NARDL capture the magnitude of the change in both the increase and the decrease in the inflation and exchange rate misalignment (overvaluation and undervaluation) on industrial output. The asymmetric analysis reveals that both inflation shocks and exchange rate misalignment exert non-linear and uneven effects on industrial output in Nigeria, highlighting the presence of structural rigidities within the industrial sector. Specifically, positive inflation shocks (inflation surges) are found to significantly reduce industrial output, reflecting increased production costs, uncertainty, and erosion of purchasing power. In contrast, negative inflation shocks (disinflation) exhibit weaker or statistically insignificant expansionary effects, suggesting that reductions in inflation do not automatically translate into improved industrial performance due to underlying supply-side constraints. In parallel, the results on exchange rate misalignment indicate that overvaluation of the naira significantly depresses industrial output. This outcome is consistent with the loss of external competitiveness and increased import penetration associated with an artificially strong currency. Conversely, undervaluation shows only a weak or insignificant positive effect, implying that a weaker currency does not sufficiently stimulate industrial expansion, largely due to the import-dependent structure of Nigeria's industrial sector. The findings suggest that Nigeria's industrial growth strategy should not rely on exchange rate manipulation alone. Instead, a coordinated policy mix is required that combines, credible monetary policy, exchange rate management and industrial policy reforms. These approaches will reduce the vulnerability of industrial output to adverse exchange rate shocks and foster sustainable industrial development*

1.0 Introduction

Over the last 50 years, Nigeria's industrial sector has declined considerably in both productivity and contribution to economic growth in the country. Exchange rate plays a crucial role in any economy, as it influences domestic price levels, the profitability of traded goods and services, resource allocation, and investment decisions both directly and indirectly. Investors closely monitor exchange rate fluctuations and uncertainties when making decisions about investing abroad (Unugbro, 2007). Exchange rate fluctuations or misalignment frequently raise the risk and uncertainty of both internal and external transactions, exposing a country to exchange rate-related risks. Theoretically, it is widely accepted that exchange rate fluctuations can have either negative or positive effects on output. The negative impact may arise directly from uncertainty and adjustment costs, and indirectly from its influence on resource allocation and government policies (Aliyu, Yakub, Sanni, and Duke, 2013). This is due to the potential negative effects of exchange rate misalignments on economic outcomes. In fixed and adjustable exchange rate regimes, such misalignments often indicate flawed policy fundamentals that hinder exchange rates from reaching their intended macro-economic targets. Conversely, in a floating exchange rate system, misalignments are mainly driven by factors that cause excessive fluctuations in the exchange rate, deviating from established economic rules and principles governing the price system. Nigeria's industrial sector has declined considerably in both productivity and contribution to economic growth in the country. Empirical evidence suggests that exchange rate fluctuations and rising inflation have impaired industrial output growth in the country. The asymmetric effects of inflation and exchange rate misalignment on industrial output have garnered significant attention in economic research due to their profound implications on economic stability and growth.

Exchange rate misalignment occurs when the exchange rate deviates from its equilibrium level, which is determined by fundamental economic factors such as productivity, interest rates, and trade balances. Misalignment can be categorized into overvaluation and undervaluation. When a currency is overvalued, it becomes more expensive relative to other currencies. This makes exports less competitive in the global market, reducing demand for domestically produced industrial goods. Import competition also increases, which can negatively impact domestic industries. Conversely, an undervalued currency makes exports cheaper and more competitive, potentially boosting industrial output by increasing demand for domestic goods abroad. However, it can also make imports more expensive, raising production costs for industries reliant on imported inputs.

Empirical literature has shown that exchange rate misalignment which could either be overvaluation or undervaluation has implication on misallocating resources between tradable and non-tradable goods. In particular real exchange rate overvaluation could precipitate unsustainable macroeconomic condition in a country (Williamson 1994, Edwards 1989). By contrast, persistent real undervaluation could lead to economic overheating, this put

pressure on domestic prices and misallocates resources between tradable and non-tradable sector of the economy, while an overvalued exchange rate would have an adverse impact on a country's competitiveness and its growth (Jongwanich, 2009; Fic, Barrel and Holland, 2008). In most developing countries, the real exchange rate is managed to various degrees and is largely determined by economic policies rather than by market fluctuations.

Inflation, the rate at which the general level of prices for goods and services rises, erodes the purchasing power of money and can significantly impact industrial output. High and volatile inflation increases uncertainty, complicating long-term planning and investment decisions for businesses. For industrial sectors, this can lead to higher production costs as the prices of raw materials and intermediate goods increase. Moreover, inflation can reduce consumer demand by decreasing real incomes, thereby affecting sales and profitability of industrial products. However, moderate inflation can sometimes stimulate economic activity by encouraging spending and investment, as the value of money decreases over time. This nuanced relationship highlights the complexity of inflation's impact on industrial output, where both the rate and stability of inflation play critical roles.

Several studies in Nigeria have examined the relationship between exchange rates and industrial output. Owolabi and Adegbite (2012) explored how foreign exchange regimes affect industrial growth, while David, Umeh, and Ameh (2010) focused on the impact of exchange rate fluctuations on the manufacturing sector. Barkoulas et al. (2002) studied the influence of exchange rate fluctuations on trade flows, highlighting indirect effects on industrial output. Odusola and Akinlo (2001) investigated the interplay between exchange rates, inflation, and output. Lastly, Ilechukwu and Nwokoye (2015) analyzed the long-term impact of exchange rates on industrial output. However, while Okafor, Adegbite, and Babajide (2018) examined the nexus between exchange rate fluctuations, inflation and industrial output growth in Nigeria. The study utilized SVAR which is deficient in studying the asymmetries between the variables in question. Our contribution to the literature is to utilize nonlinear ARDL to capture the asymmetries and to utilize the behavioural equilibrium exchange rate approach to estimate the real exchange rate misalignment. We further decompose the misalignment series between positive and negative shock (overvaluation and undervaluation) to capture it asymmetric effect on industrial output. Against this background, this study thus examines the impact of continuous shocks to exchange rate misalignment and inflation on industrial output growth in Nigeria.

1.1 Stylized Fact

The pressure on prices from the global economy was exacerbated by the Russia-Ukraine conflict, leading to increases in energy and food costs. Rising import prices, driven by global inflation and exchange rate pass-through, also affected domestic prices. Domestically, factors were primarily cost-push, stemming from reforms in the downstream petroleum sector, which resulted in a 226.8 percent increase in the average pump price of PMS from ₦191.65 per liter in September 2022 to ₦626.21 per

liter in September 2023. The move to a market-determined exchange rate added shocks to domestic prices. Additionally, security challenges, prolonged infrastructure deficits, and expectations of further price increases contributed to inflationary pressures. As a result, headline inflation (year-on-year) rose to 26.72 percent in the third quarter of 2023 from 22.79 percent in the second quarter of 2023. Although inflation was widespread across various components, recent evidence indicated that inflation was less pervasive in September 2023, with 71.6 percent of items in the CPI basket above the historical average of 13.10 percent (1996-2023), compared to 73.13 percent in August 2023 and 91.04 percent at the end of December 2022. As evident in Figure 1, the trend of exchange rate, industrial output, inflation and interest rate proxied with MPR. As indicated in the trend, the rise in inflation rate coincided with a dramatic fall in industrial output. Similar trend is observed with MPR and exchange rate.

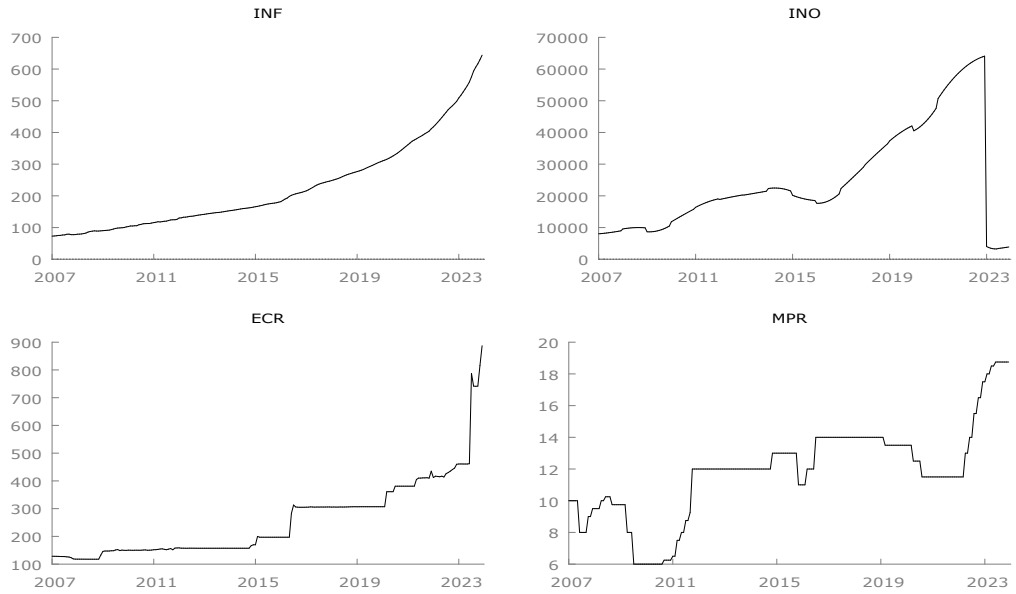


Figure 1. Trend of Exchange rate, inflation, industrial output and interest rate

2.0 Empirical Literature

Exchange rate and inflation shock has played a significant role in shaping the dynamics of micro and macroeconomic aspects of developing economies like Nigeria and has constituted an extensive topic of debate in academics and policy environment. While some argue that exchange rates act as a shock absorber, empirical evidence indicates that exchange rates act more like a source of shocks (De & Sun, 2020; Farrant & Peersman, 2006). The influence of the dollar on real economic activity and global trade seems to have increased since the global financial crisis (Erik, Lombardi, Mihaljek, & Shin, 2020). Similarly, numerous studies have explored the effect of inflation on economic growth, both positive and negative (Temple 2000; Barro 1995; Fischer 1993). A frequent inquiry is whether it is the inflation itself or

the uncertainty it brings that affects economic growth. Okun (1971) and Friedman (1977) argue that higher inflation diminishes economic growth. However, the effects of inflation are not always consistent and can be asymmetric or non-linear (Kahneman and Tversky 1979; Shiller 1998).

One of the most contested subjects in international finance is identifying the determinants of the real exchange rate. Many theories have emerged, with the earliest and most debated being the purchasing power parity (PPP) theory and Williamson's (1983) fundamental equilibrium exchange rate (FEER). The PPP theory considers equilibrium as a fixed point, while the FEER perceives it as a path. Although there is no consensus on how to determine the equilibrium real exchange rate, empirical research suggests that exchange rate misalignment—whether it be overvaluation or undervaluation—can misallocate resources between tradable and non-tradable goods. Overvaluation of the real exchange rate can result in unsustainable macroeconomic conditions (Williamson 1994; Edwards 1989), while persistent undervaluation can lead to economic overheating, increasing domestic prices and resource misallocation. An overvalued exchange rate harms a nation's competitiveness and growth (Jongwanich, 2009; Fic, Barrel, and Holland, 2008). In many developing countries, the real exchange rate is partially managed and more influenced by economic policies than by market dynamics. It depends on the balance between savings and investment, and expenditures and income. Consequently, policies that boost savings relative to investment can cause real exchange rate depreciation. The long-term equilibrium exchange rate, which the real exchange rate should aim for, is defined as the rate that simultaneously achieves both external and internal balance (Stein, 2011).

Several empirical studies have found that exchange rate fluctuations negatively impact trade growth (Cottani et al., 1990). The concern is greater with real exchange rate fluctuations, as the real exchange rate is crucial for balancing a country's international trade and payments (Harberger, 2004). Razin and Collins (1997) note that real exchange rate movements respond to both nominal and real disturbances, with inconsistent macroeconomic policies often leading to real exchange rate overvaluation. Akhtar (2011) linked misalignment to cyclical components of the budget deficit, excess money supply, and the real exchange rate. The real exchange rate's level and stability relative to the equilibrium rate significantly affect export growth, consumption, resource allocation, employment, and private investments. Persistent overvaluation has been associated with lower long-term economic growth (Macdonald & Macdonald, 2010; Aflouk & Mazier, 2011; Grekou, 2015; Schröder, 2013). Berg and Miao (2010) provided further evidence that overvaluation hinders growth, while undervaluation can be beneficial. Williamson (2008) asserted that the evidence of overvaluation's detrimental effects on development is strong enough to influence policy, including delaying capital account liberalization if it risks overvaluation. He suggested that slight undervaluation might be the best policy for maximizing growth. However, Owoundi (2015) found that the growth benefits of

undervaluation in 16 Sub-Saharan countries are negligible, and Tang (2015) concluded that there is no direct link between real exchange rate and growth in the Chinese economy.

Numerous studies in Nigeria have explored the intricate relationship between exchange rates and industrial output, highlighting various dimensions of this economic interaction.

Owolabi and Adegbite (2012) conducted an insightful investigation into the effects of foreign exchange regimes on industrial growth in Nigeria. Their study revealed significant findings on how different exchange rate policies influence industrial expansion, providing a foundation for understanding policy impacts on the industrial sector.

David, Umeh, and Ameh (2010) delved into the specific effects of exchange rate fluctuations on the Nigerian manufacturing industry. Their analysis offered a detailed examination of how volatility in exchange rates can affect manufacturing output, underlining the sensitivity of this sector to currency fluctuations.

Barkoulas et al. (2002) expanded the scope by examining the impact of exchange rate fluctuations on the volume and variability of trade flows. Their research provided a broader perspective on how exchange rate instability can affect trade dynamics, indirectly influencing industrial output through trade channels.

Odusola and Akinlo (2001) explored the relationship between exchange rates, inflation, and output in Nigeria. Their study added another layer of complexity by integrating inflation into the analysis, demonstrating the interconnectedness of these economic variables and their collective impact on industrial output.

Ilechukwu and Nwokoye (2015) focused on the long-term impact of exchange rates on Nigeria's industrial output. Their research emphasized the enduring effects of exchange rate movements on industrial growth, highlighting the importance of stable exchange rate policies for sustainable industrial development. Collectively, these studies provide a comprehensive understanding of how exchange rate dynamics affect industrial output in Nigeria.

2.2 Theoretical Literature

In the theoretical literature, the sensitivity of economic output to shocks in the exchange rate is arguably larger in the industrial sector, notably the manufacturing sector (tradeable goods) as well as the service sector. Because of its strong linkages to the whole economy (see, e.g., the seminal works of Kaldor et al. (1967) and Chenery (1960)), concerns regarding exchange rate shocks are usually focused on the manufacturing sector in most studies. Industrial growth is driven by numerous factors which cannot all be captured in one theory. As such, can be explained through numerous theories like neoclassical growth theory, endogenous growth theory, Keynesian theory, monetary theory among others. However, among these theories, Keynesian and Monetary theory best explain the mechanism through which exchange rate and inflation influence aggregate demand as well as industrial output. For instance, Monetarist Theory focuses on the role of

money supply and its effects on inflation and economic activity. According to this theory, changes in the money supply can lead to inflation, which impacts industrial output by affecting production costs and consumer demand. Exchange rates are also considered important as they influence the cost of imported goods and the competitiveness of exports. Theories often assume that one variable can affect another while keeping all other variables constant, but research has shown this assumption to be incorrect. This study will integrate variables from these theories, each of which provides a comprehensive explanation for variations in industrial output. These theories will encompass internal factors that drive output growth, monetary influences, and the policy environment that may affect industrial output growth.

3.0 Methodology

The data set used for this analysis is the monthly series of the selected relevant macroeconomic variables from 2007M01 to 2023M12. Data for real effective exchange rate is obtained from International Financial Statistics (*IFS*) database, money supply to GDP ratio (M2), inflation (INF), monetary policy rate as a proxy to interest rate (MPR) are obtained from Central Bank of Nigeria Statistical bulletin. The data sets M2 and GDP are quarterly both were interpolated to monthly using the Chow and Lin (1971) method.

3.1 Model Specification

In order to explore the asymmetric impact of inflation and exchange rate misalignment, respectively, on industrial output in Nigeria, this paper employed the non-linear ARDL model that account for other potential determinants like money supply and interest rate. The non-linear ARDL model accounts for nonlinear and asymmetric effect of exchange rate misalignment and inflation on industrial output. In terms of the control variables (M2 and MPR), we follow Ilechukwu and Nwokoye (2015)Okafor, Adegbite, and Babajide (2018) and Adofu & Okwanya (2017). To account for the asymmetric relationship between inflation and exchange rate misalignment on industrial output which are our main independent variables of interest, this study uses a cointegrating nonlinear autoregressive distributed lag (NARDL) model of Shin, Yu and Greenwood-Nimmo (2014), wherein regressors can be decomposed using the partial sum of positive and negative changes. This method allows the model to exhibit only long-run asymmetry, only short-run asymmetry or combined short and long-run asymmetries. Following the work of Lacheheb and Sirag (2019), the approach to NARDL requires us to decompose a time series, INF_t and EXM_t into two series (INF_t^+), (EXM_t^+) and (INF_t^-), (EXM_t^-) as follows:

$$INF_t^+ = \sum_{j=1}^{t} \Delta INF_t^+ = \sum_{j=1}^{t} Max(\Delta INF_t^+, 0),$$

$$INF_t^- = \sum_{j=1}^{t} \Delta INF_t^- = \sum_{j=1}^{t} Max(\Delta INF_t^-, 0)$$

$$EXM_t^+ = \sum_{j=1}^{t} \Delta EXM_t^+ = \sum_{j=1}^{t} Max(\Delta EXM_t^+, 0),$$

$$EXM_t^- = \sum_{j=1}^{t} \Delta EXM_t^- = \sum_{j=1}^{t} Max(\Delta EXM_t^-, 0)$$

Where $\Delta INF_t^+, \Delta EXM_t^+$ and $\Delta INF_t^-, \Delta EXM_t^-$ are the partial sum of inflation and exchange rate misalignment respectively. In line with Shin et al (2014) the NARDL model can be stated as

$$\Delta IND_t = \propto_0 + \beta ECM + \varphi_1 IND_{t-1} + \varphi_2^+ INF_{t-1}^+ + \varphi_3^- INF_{t-1}^- + \varphi_4^+ EXM_{t-1}^+ + \varphi_5^- EXM_{t-1}^- + \varphi_6 M2_{t-1} + \varphi_7 MPR_{t-1} + \sum_{i=1}^{p} \omega_i \Delta IND_{t-1} + \sum_{i=0}^{q} \partial_i \Delta INF_{t-1}^+ + \sum_{i=0}^{r} \sigma_i \Delta INF_{t-1}^- + \sum_{i=0}^{s} \pi_i \Delta EXM_{t-1}^+ + \sum_{i=0}^{t} \theta_i \Delta EXM_{t-1}^- + \sum_{t=i}^{u} \gamma_i \Delta M2_{t-1} + \sum_{t=i}^{v} \rho_i \Delta MPR_{t-1} + \varepsilon_t \text{----------} 1$$

The coefficients of long-run estimate of industrial output and exchange rate misalignment series can be tested using the Wald test for the null hypothesis are $\varphi_2 = \varphi_3$ for inflation and $\varphi_4 = \varphi_5$ for exchange rate misalignment respectively. Eqn.1 implies that the model may exhibit asymmetries in both the short- and the long-run, only in the long-run or only in the short-run. The positive and negative long run coefficients of inflation (INF) and exchange rate misalignment (EXM) can be calculated as: $\beta^+ INF^+ = \frac{\varphi_2}{-\varphi_1}$. $\beta^- INF^- = \frac{\varphi_3}{-\varphi_1}$ and $\beta^+ EXM^+ = \frac{\varphi_4}{-\varphi_1}$, $\beta^- EXM^- = \frac{\varphi_5}{-\varphi_1}$. The short run adjustment to a positive and a negative shock in inflation and exchange rate misalignment are taken by the parameters are ∂_i, σ_i and π_i, θ_i respectively. The short-run symmetry can equally be tested by using a standard Wald test for the null hypothesis : $\sum_{i=0}^{q} \partial_i = \sum_{i=0}^{r} \sigma_i$ for inflation and $\sum_{i=0}^{s} \pi_i = \sum_{i=0}^{t} \theta_i$ for exchange rate misalignment, respectively.

However, the estimation of equation 1 is preceded by estimating the real exchange rate misalignment. In this work, behavioural equilibrium exchange rate (BEER) approach identifies an estimated equilibrium relationship between the real effective exchange rate and economic fundamentals. Following (Clark & Macdonald, 2004), the economic fundamental are decomposed into transitory and permanents, with the later used to estimate the permanent equilibrium exchange rate (PEER).

$$\begin{aligned}\Delta(reer)_t = {} & \beta_0 + \beta_1(opv)_{t-1} + \beta_2(opp)_{t-1} + \beta_3(mpr)_{t-1} + \beta_4(gcons)_{t-1} + \beta_5(nfa)_{t-1} \\ & + \beta_6(tot)_{t-1} + \beta_7(rpro)_{t-1} + \beta_8(r - r*)_{t-1} + \beta_9(reer)_{t-1} \\ & + \sum_{i=0}^{r} \beta_{10}\Delta(opv)_{t-i} + \sum_{i=0}^{r} \beta_{11}\Delta(opp)_{t-i} + \sum_{i=0}^{r} \beta_{12}\Delta(mpr)_{t-i} \\ & + \sum_{i=0}^{r} \beta_{13}\Delta(gcons)_{t-i} + \sum_{i=0}^{r} \beta_{14}\Delta(nfa)_{t-i} + \sum_{i=0}^{r} \beta_{15}\Delta(tot)_{t-i} \\ & + \sum_{i=0}^{r} \beta_{16}\Delta(rpro)_{t-i} + \sum_{i=0}^{r} \beta_{17}\Delta(r - r*)_{t-i} + \sum_{i=0}^{r} \beta_{18}\Delta(reer)_{t-i} - - - - 2\end{aligned}$$

The a priori expectation following Clark and Macdonald (2004), (Macdonald, 2003) is presented below

$$REER = f(\underset{nfa,}{+} \quad \underset{tot,}{\pm} \quad \underset{opv,}{+} \quad \underset{mpr,}{+} \quad \underset{opp,}{-} \quad \underset{rpro,}{+} \quad \underset{r-r*,}{+} \quad \underset{gcons,}{+})$$

The exchange rate misalignment is also measured using a different m is defined as the deviation of the real effective exchange rate from the long-run equilibrium exchange rate, as suggested by (Rodrik, 2008). Misalignment can be derived from the following equation.

$$EXM_t = \frac{REER_t - \ddot{REER}_t}{REER_t} * 100$$

First the long-run relationship (cointegration) among all variables must be established and two, the long-run coefficients and the short-run coefficients are jointly estimated using the associated ARDL and error correction models (ECM). The variable OPV represents oil price volatility, OPP is openness, MPR is the monetary policy rate, GCONS represents government consumption, relative prices is RP, MPR is the monetary policy rate while R-R* represent the real interest rate differentials. Exchange rate misalignment (EXM) is obtained from the estimated by the differences between the equilibrium exchange rate equilibrium exchange rate and actual real effective exchange rate.

4.0 Empirical Analysis

Table 1 provides a summary of the unit root tests for each variable in our model. It is important to note that the ARDL approach does not require strict classification as I(0) or I(1) (Pesaran et al., 2001). We used the Augmented Dickey-Fuller (ADF) and Philip Perron (PP) tests to check for unit roots in our variables. The results indicate that, for both the ADF and PP tests, the null hypothesis of a unit root cannot be rejected for most series, implying non-stationarity, except for the exchange rate misalignment series (EXM). This mixture of I(0) and I(1) variables justifies the use of the F-test or bound test for cointegration.

Table 1: Unit Root Test Result

	ADF				PHILIP PERRON				
	Levels		1st Diff		Levels		1st Diff		OOI
	C	C&T	C	C& T	C	C& T	C	C& T	
INF	-1.93	-3.18	-3.27	-3.30	-0.24	-1.31	-2.90	-3.59	I(1)
MPR	0.06	-2.65	-8.11	-18.18	-0.59	-2.14	-14.39	-14.42	I(1)
M2	2.90	7.84	0.81	-0.16	6.25	8.46	-15.35	-15.81	I(1)
IND	-1.79	-1.42	-13.98	-14.07	-1.86	-1.57	-13.99	-14.03	I(1)
EXM	-15,05	16.00			-15.70	-16.64			I(0)
REER	-2.38	-1.98	-3.68	-3.85	-2.08	-1.74	-4.83	-4.86	I(1)
RPR0	-2.65	-0.94	-2.38	-3.32	-2.72	-1.83	-4.95	-5.41	I(1)
GCON	-0.64	-1.92	-2.00	-2.06	-1.73	-2.35	-6.36	-7.10	I(1)

OPP	-1.76	-2.25	-3.83	-3.87	-1.17	-2.81	-7.20	-7.12	I(1)
TOT	-0.91	-2.79	-3.66	-3.58	-1.38	-2.18	-5.38	-5.26	I(1)
OPV	-7.16	-6.95	-4.21	-5.13	-2.68	-4.42	-6.70	-1.14	I(0)
R-R*	-3.06	-3.98	-6.20	-6.17	-2.29	-2.99	-13.76	-13.64	I(0)
MPR	-0.80	-2.35	-3.85	-3.84	0.15	-2.33	-4.99	-4.93	I(1)

Source: Computed by the Authors

To further investigate the characteristics of our core variables of interest, we explore the descriptive statistics of our variables of interest. Specifically, by considering the measures of central tendencies, variation and symmetric distribution of the series as presented in Table 2. The kurtosis that measures the peakedness or flatness of the series distribution is greater than 3 in INF, EXM, MPR and *M2* with the exception of IND, which is suggestive that four out of the series peaked to the surface or leptokurtic relative to the normal distribution. The fact that majority of our variables exhibit and heavy tail phenomenon indicate that linear approach for our model might be biased. The standard deviation of 1.37, 16282.17, 138.72, 194.23 and 2.98 for EXM, IND, INF, M2 and MPR suggesting that the dispersion around their average is relatively wide. The negative skewness value of -0.78 for exchange rate misalignment (EXM) suggest that on the average there are more undervaluation compared to overvaluation and thus have a longer left tail. The Jarque-Bera normality test statistic for all the variables are statistically significant indicating non-normality of the distribution. The correlation statistics shows high positive correlation between IND, EXM and INF, suggesting that both exchange rate misalignment (EXM) and inflation (INF) are important determinants of industrial output (IND).

Table 2: Descriptive Statistics and Correlation Matrix

	EXM	IND	INF	M2	MPR
Mean	-0.04	24890.18	225.53	343.79	11.83
Median	0.10	19977.38	173.77	276.01	12.00
Maximum	3.31	64073.99	643.80	1133.44	18.75
Minimum	-4.88	3261.75	72.82	92.26	6.00
Std. Dev.	1.37	16282.17	138.72	194.23	2.98
Skewness	-0.78	0.93	1.10	1.55	0.04
Kurtosis	4.79	2.93	3.43	5.39	3.24
Jarque-Bera	29.94	29.95	42.97	130.45	0.60
Probability	0.00	0.00	0.00	0.00	0.73
Observations	204	204	204	204	204

Correlation

	EXM	INF	M2	IND	MPR
EXM	1.00				
INF	0.95	1.00			
M2	0.40	0.52	1.00		
IND	0.96	0.98	0.43	1.00	
MPR	0.72	0.75	0.25	0.72	1.00

Behavioural Equilibrium Exchange Rate (BEER)

The error-correction term presented in Table 3, is correctly signed and significant. This shows that, in the short run, deviation from this relationship could occur due to shock to any of the variables as a result of the differences in the dynamics governing short run real exchange rate and long run real exchange rate. Due to different forces shaping the dynamics of short run and long run, the short run interaction and the adjustment to long run equilibrium are important. The error correction term enable us to gauge the speed of adjustment of real effective exchange rate to its long run equilibrium. The intuition behind the error correction model is the need to recover the long run information lost by differencing the variables. The result shows that the speed of adjustment of the real effective exchange rate to the long run equilibrium path is very low. Specifically only about 15 percent of the disequilibrium errors, which occurred in the previous quater, are corrected in the current quater.

The signs of some of the coefficients are consistent with what is expected, indicating that the theoretical model is relevant for the Nigeria. In particular, a rise in the terms of trade leads to an appreciation of the equilibrium exchange rate. Openness (OPP) variable is negative and significant, this is because oppennes increase the value of imports relative to export thereby depreciating the real exchange rate by about 0.33 per cent point. Net foreign asset (NFA), although significant, does not carry its right sign (positive). In other words a positive sustainable NFA position allows persistent trade deficit to be run which are associated with an appreciated exchange rate. Oil price volatility (OPV) has a positive and significant effect on real exchange rate e.g exchange rate will appreciated in response to increase in government expenditure , expecially when such consumption is directed towards the non tradable sector. In other words, an improvement in government fiscal stance of 1 percentage point of GDP is associated with an appreciation of the real effective exchange rate of around 2.04 percent.

Table 3: ARDL Cointegration and Long run form for BEER Model

Cointegration Form				
Variable	***Coefficient***	***Std. Error***	***t-Statistics***	***Prob.***
Δ(REER(-1))	***0.4596***	***0.0764***	***6.0179***	***0.0000***
Δ(REER(-2))	***0.1719***	***0.0818***	***2.3950***	***0.0183***
Δ(OPV)	***0.0759***	***0.0273***	***2.7857***	***0.0063***
Δ(OPP)	***-0.2955***	***0.0557***	***-5.3017***	***0.0000***
Δ(OPP(-1))	***0.1534***	***0,0558***	***2.7479***	***0.0070***
Δ(MPR)	***-0.0190***	***0.0666***	***-0.2851***	***0.7761***
Δ(GCONS(-1))	***0.7006***	***0.2201***	***-3.1832***	***0.0019***
Δ(NFA)	***-0.0319***	***0.0159***	***2.0098***	***0.0468***
Δ(TOT)	***0.1514***	***0.0629***	***2.4062***	***0.0177***
Δ(RPRO)	***0.0067***	***0.2676***	***0.0252***	***0.9799***
Δ(R-R*)	***0.0005***	***0.0002***	***2.3012***	***0.0232***
C	***0.0523***	***0.0093***	***5.5957***	***0.0000***
CointEq(-1)	***-0.1496***	***0.0242***	***-6.1840***	***0.0000***
Cointeq = REER-(-0.1419*OPV-0.3288*OPP-0.1242*MPR+2.0419*GCONS-0.2596*NFA+0.4980*TOT+0.0472*RPRO+0.0015*(R-R*)				
Long Run Coefficients				
Variable	***Coefficient***	***Std. Error***	***t-Statistics***	***Prob.***
OPV	***-0.1419***	***0.0565***	***-2.5110***	***0.0135***
OPP	***-0.3288***	***0.1785***	***-1.8418***	***0.0681***
MPR	***-0.1243***	***0.1699***	***-0.7314***	***0.4661***
GCONS	***2.0419***	***0.3343***	***6.1085***	***0.0000***
NFA	***-0.2596***	***0.0751***	***-3.4581***	***0.0008***
TOT	***0.4980***	***0.1088***	***4.5763***	***0.0000***
RPRO	***0.0472***	***0.2528***	***0.1867***	***0.8523***
R-R*	***0.0015***	***0.0009***	***1.7206***	***0.0881***

Source Eviews 9 Output

From the estimate in Table 3 we derived the misalignment series from $EXM_t = \frac{REER_t - \ddot{REER}_t}{REER_t} * 100$ Table 4 shows the results of NARDL between industrial output and other determinants with the asymmetric effects on exchange rate misalignment and inflation in Nigeria. To achieve this, we first estimate equation 2. The optimal lag length is selected by the use of Akaike information criteria (AIC). We also test for both short and long run asymmetries which are applied to select the best specification. Our findings in Table 4 report the asymmetric evidence in both short and long runs, in which Panel A, B, and C present the short-term estimates, long-term estimates, and diagnosed effects, respectively. In other words, the asymmetric analysis reveals that both inflation shocks and exchange rate misalignment exert non-linear and uneven effects on industrial output in Nigeria, highlighting the presence of structural rigidities within the industrial sector. Precisely, positive inflation shocks (inflation surges) are found to significantly reduce industrial output in both short and

long run, this reflects increased production costs, uncertainty, and erosion of purchasing power. In addition, as inflation rises, it affect industrial output through different channels like rise in the cost of raw materials and intermediate goods typically increases. This can lead to higher production costs for industries, potentially reducing profit margins and making it more difficult to maintain output levels. Other channels include: interest rate, wages and labour cost which rises in response to increase in inflation (Okun 1971; Friedman 1977; Phelps 1969). In contrast, negative inflation shocks (disinflation) exhibit weaker or statistically insignificant expansionary effects, suggesting that reductions in inflation do not automatically translate into improved industrial performance due to underlying supply-side constraints. Additionally, deflation can cause consumers to delay purchases in anticipation of lower future prices, reducing overall demand and negatively impacting industrial output (Siaens 1969).

With regards to our main variable of interest; exchange rate misalignment (EXM), the indicate that overvaluation of the naira significantly depresses industrial output. This outcome is consistent with the loss of external competitiveness and increased import penetration associated with an artificially strong currency. This result is not surprising because real overvaluation could precipitates inflationary pressures with long term effect on competitiveness and growth (Jongwanich, 2009; Fic, Barrel and Holland, 2008) among others showed that exchange rate overvaluation decrease the ratio of manufactured exports to GDP; which can reduce exports and consequently caused reduction in industrial output performance. Conversely, undervaluation shows only a weak or insignificant positive effect, implying that a weaker currency does not sufficiently stimulate industrial expansion, largely due to the import-dependent structure of Nigeria's industrial sector.

The coefficient of MPR is negative and significant since it directly affect the cost of borrowing for businesses. Lower interest rates reduce the cost of loans, making it cheaper for companies to finance capital investments, expand operations, and purchase new equipment. This can lead to increased industrial output. Conversely, higher interest rates increase borrowing costs, which can discourage investment and slow down industrial production. Similarly, lower MPR typically lead to cheaper loans and mortgages for consumers, increasing disposable income and encouraging spending on goods and services. Higher consumer demand can drive up industrial output as businesses ramp up production to meet increased consumption.

Other diagnostic statistics show the model is correctly specified as indicated by the Ramsey RESET statistics, the result show no evidence of misspecification. CUSUM test is relied upon to check the stability of our coefficients, and the results show that our coefficients are stable as presented in figure 2. The LM statistics show no evidence of serial correlation as indicated by its insignificant statistics at 5% critical value. The result of the bound test revealed that our calculated F statistics of 14.17 is higher than the upper bound critical value at 1, 5 and 10 percent respectively which shows evidence of cointegration.

Similarly, the error correction term also shows evidence of long run relationship.

Table 4.Short run and Long run Result (Non-linear ARDL)

Panel A: Short run Result				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.094996	0.682857	-0.139115	0.8894
IND_{t-1}	1.161307	0.045767	25.37442	0.0000
ΔEXM^{+}_{t-1}	-0.053808	0.099569	-0.540406	0.5896
ΔEXM^{+}_{t-2}	-0.323364	0.068528	-4.718753	0.0000
ΔEXM^{-}_{t-1}	0.000107	0.003226	0.033233	0.9735
ΔEXM^{-}_{t-2}	0.034153	0.046182	0.739526	0.4600
ΔEXM^{-}_{t-3}	0.097088	0.068703	1.413148	0.1593
ΔINF^{+}_{t-1}	-0.710824	0.135118	-5.260767	0.0000
ΔINF^{-}_{t-2}	0.002512	0.014359	0.174972	0.8613
$\Delta M2_{t-1}$	0.058186	0.009025	6.446876	0.0000
ΔMPR_{t-1}	-0.051963	0.009241	-5.623098	0.0000
ECM	-0.1496	0.0242	-6.1840	0.0000
Panel B: Long run Result				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXM^{+}_{t}	-0.146265	0.071442	-2.047315	0.0420
EXM^{-}_{t}	0.023266	0.022398	1.038780	0.3003
INF^{+}_{t}	-0.111625	0.051892	-2.151113	0.0321
INF^{-}_{t}	0.016336	0.014738	1.108440	0.2691
$M2_{t}$	0.643217	0.146924	4.377887	0.0000
MPR_{t}	-0.111625	0.051892	-2.151113	0.0321
C	0.000418	0.000408	1.024434	0.3063
Panel C: Post estimation diagnostic results				
$\boldsymbol{ECM_{t-1}}$	**LM**	**ARCH**	**RESET**	**DW**
-0.09	0.49(0.81)	1.61(0.43)	1.44(0.26)	2.03
CUSUM(CUSUMSQ)	**Bound Test (F)**	**Wald Short run**	**Wald Long run**	
Stable (Stable)	14.17	28.51(0.09)	17.66(0.06)	

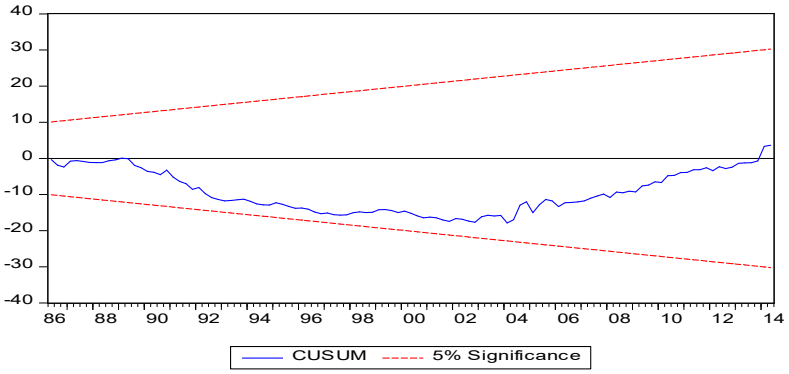


Figure 2. CUSUM Test

5.0 Conclusion and Policy Recommendation

This paper investigates the asymmetric impact of inflation and exchange rate misalignment on industrial output in Nigeria. We employ the NARDL approach to capture the magnitude of the change of both the increase and the decrease in the inflation and exchange rate misalignment (overvaluation and undervaluation) on industrial output. The result of asymmetric effect of exchange rate misalignment on industrial output indicates that an overvaluation of the naira leads to negative impact on industrial output. This outcome is consistent with the loss of external competitiveness and increased import penetration associated with an artificially strong currency. Conversely, undervaluation shows only a weak or insignificant positive effect, implying that a weaker currency does not sufficiently stimulate industrial expansion, largely due to the import-dependent structure of Nigeria's industrial sector. Put succinctly, these findings suggest that the country's industrial sector is asymmetrically exposed to macroeconomic imbalance through two reinforcing channels. First, inflation surges raise input costs—particularly for imported raw materials—while exchange rate misalignment, especially overvaluation, undermines the competitiveness of domestic industries. Second, the limited gains from disinflation and undervaluation indicate that structural bottlenecks, such as inadequate infrastructure, weak industrial linkages, and high import dependence, dampen the transmission of favorable macroeconomic conditions to industrial output. Following the findings, the study recommends that policymakers prioritize price stability, maintain an exchange rate aligned with economic fundamentals, and avoid persistent currency overvaluation. In addition, macroeconomic reforms should be complemented with industrial policies aimed at reducing import dependence, improving infrastructure, expanding access to finance, and promoting domestic production. A coordinated policy framework that combines monetary stability, exchange rate competitiveness, and industrial development is essential for achieving sustainable industrial growth in Nigeria.

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