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Stochastic Modeling of Inflationary Shocks on Inter-Company Transfer Prices: Effect on Profitability in the Nigerian Quoted Consumer Goods Sector, 1998–2025

Ibeanusi Sylvanus Chigozie

Department of Banking and Finance, Faculty of Management Sciences, College of Postgraduate Studies, Nnamdi Azikiwe University, Awka

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***Corresponding Author:** Ibeanusi Sylvanus Chigozie **Email:** sylvanusibeanusi@gmail.com

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Abstract **Original Research Article**

This term paper examines the stochastic dynamics of inflationary shocks on inter-company transfer pricing decisions and their consequent effects on the profitability of quoted consumer goods firms in Nigeria over the period 1998–2025. Using secondary data sourced from the Nigerian Exchange Group (NGX), the Central Bank of Nigeria (CBN) Statistical Bulletin, the National Bureau of Statistics (NBS), annual reports of quoted consumer goods companies, and the Federal Inland Revenue Service (FIRS) guidelines, the study adopts a Geometric Brownian Motion (GBM) framework augmented by a Jump-Diffusion model (Merton, 1976) to capture both the continuous drift and discrete shock components of Nigeria's inflationary environment. The Consumer Price Index (CPI), the Producer Price Index (PPI), inter-company transfer pricing ratios, and profitability metrics, comprising Return on Assets (ROA), Return on Equity (ROE), and Net Profit Margin (NPM), are modelled through a system of stochastic differential equations calibrated to Nigerian macro-financial data. Panel data regression with firm-fixed and time-fixed effects, augmented by Generalized Method of Moments (GMM) estimation for dynamic endogeneity control, is employed across twenty-three (23) quoted consumer goods firms on the NGX. Empirical results reveal that inflationary shocks exert a statistically significant negative effect on profitability when transfer prices are inelastically managed but that firms with adaptive cost-plus transfer pricing mechanisms exhibit profitability resilience of 34–61 percent above sector median during high-inflation episodes. The stochastic volatility of inflation ($\sigma = 0.41$) substantially exceeds the transfer-price adjustment speed ($\lambda = 0.17$), creating a persistent profitability gap. Policy implications for regulatory frameworks governing Related-Party Transactions (RPTs) under the Nigerian Transfer Pricing Regulations (2018, amended 2021) are discussed, alongside recommendations for inflation-indexed transfer price corridors.

Keywords: Stochastic modeling, inflationary shocks, transfer pricing, consumer goods sector, Nigeria, geometric Brownian motion, jump-diffusion, profitability, panel data, GMM.

1. INTRODUCTION

1.1 Background to the Study

The relationship between price-level instability and corporate financial performance is among the most enduring preoccupations of managerial finance and macroeconomics. In economies characterised by high and volatile inflation, the classical assumption that factor prices adjust smoothly and proportionately to the general price level is repeatedly violated, generating asymmetric cost pressures, distorted profit signals, and sub-optimal resource allocation across firms and industries. Nigeria epitomises this challenge with singular intensity: over the twenty-seven-year window from 1998 to 2025, headline consumer price inflation averaged 14.9 percent per annum (CBN Statistical Bulletin, 2024), surged to a peak of approximately 72 percent during the 1998–2002 fiscal stress episode, declined to single digits only briefly in the 2006–2008 and 2013–2016 windows, and re-escalated sharply from 2020 onwards, reaching 33.2 percent by February 2024 (NBS, 2024), driven by food supply shocks, energy subsidy removal, exchange-rate unification, and persistent monetary financing of fiscal deficits.

Within this turbulent macro-financial environment, the consumer goods sector occupies a uniquely sensitive position. Consumer goods manufacturing and distribution in Nigeria involves extensive value chains embedded in corporate groups, multinational enterprises (MNEs) and large indigenous conglomerates alike, whose subsidiaries and affiliates transact with one another at negotiated transfer prices. Inter-company transfer pricing, defined as the pricing of goods, services, royalties, and financial assets exchanged between related parties within a corporate group (OECD, 2022), becomes a critical lever through which inflationary pressures are transmitted, absorbed, or deflected across the group's profit centres. When the inflation rate diverges sharply from transfer price adjustment speed, intra-group cost structures misalign with market realities, compressing or artificially inflating the reported profitability of individual entities and, by extension, distorting tax bases, royalty assessments, and dividend capacity.

Nigeria's regulatory response, culminating in the Income Tax (Transfer Pricing) Regulations 2018 and the 2021 Amendment, imposed arm's-length pricing standards that constrain the discretion of corporate treasurers in revising transfer prices on inflationary grounds. This regulatory overlay adds a further dimension of rigidity: firms may be unable to recalibrate transfer prices as rapidly as inflation demands without triggering audit risks or penalties, creating a wedge between economically optimal and compliance-feasible pricing strategies. The profitability consequences of this wedge, especially during high-inflation episodes (2002–2005, 2016–2017, 2020–2025), have not been rigorously quantified in the Nigerian literature using stochastic methods capable of capturing the continuous-time, path-dependent nature of inflationary processes.

1.2 Statement of the Problem

The determination of intra-group transfer prices in an inflationary environment constitutes a complex optimisation problem under uncertainty. Standard deterministic approaches, markup pricing, cost-plus models, and comparable uncontrolled price (CUP) benchmarks, presuppose stable or predictably trending price levels and are therefore inadequate when the inflation process is non-stationary, mean-reverting in some episodes and explosively divergent in others, and punctuated by discrete jump events. Nigeria's inflation history exhibits precisely these characteristics: the structural breaks of 1998–2002, 2016, and 2020–2024 represent genuine discontinuities in the price process rather than smooth cyclical fluctuations.

A consequential problem arises: if transfer prices are sticky relative to inflation, whether due to annual or semi-annual repricing cycles, contractual rigidity, regulatory compliance costs, or managerial inertia, then the purchasing power of intra-group receipts erodes faster than costs, compressing margins at the selling entity or artificially subsidising the buying entity. Conversely, if inflation-indexed transfer price adjustments are aggressive, they may generate tax or regulatory scrutiny (FIRS, 2021) while simultaneously insulating group profitability at the cost of individual-subsidiary performance transparency. The extant literature provides limited guidance on the magnitude, persistence, and distributional characteristics of this effect specifically within the Nigerian quoted consumer goods sector and over a period long enough to capture multiple inflationary regimes.

This study addresses that gap by applying stochastic differential equation (SDE) modelling, specifically Geometric Brownian Motion with Poisson jump components, to characterise the inflation process and its propagation to transfer prices and profitability, and by grounding the model in twenty-seven years of secondary firm- and macro-level panel data. The result is an empirical assessment that is both theoretically coherent and policy-relevant.

1.3 Objectives of the Study

The principal objectives of this study are as follows:

1. To model the stochastic process governing Nigeria's inflation rate over 1998–2025 and estimate the drift, diffusion, and jump parameters of the process.
2. To quantify the speed of adjustment of inter-company transfer prices to inflationary shocks among quoted consumer goods firms in Nigeria.
3. To estimate the effect of inflationary shocks, as mediated by transfer pricing strategies, on the profitability of quoted Nigerian consumer goods firms.
4. To derive policy implications for inflation-responsive transfer price regulation and recommend adaptive mechanisms for corporate treasury management.

1.4 Research Questions

This study is guided by the following research questions:

1. What stochastic process best characterises Nigeria's inflation dynamics over 1998–2025, and what are the estimated parameters of that process?
2. How rapidly do inter-company transfer prices in the Nigerian quoted consumer goods sector adjust to inflationary shocks?
3. What is the magnitude and direction of the effect of inflationary shocks, mediated through transfer pricing, on firm profitability?
4. Do profitability effects differ significantly across inflationary regimes (low, moderate, high) and across transfer pricing strategies (rigid vs. adaptive)?

1.5 Hypotheses

The following null hypotheses are tested:

1. H01: Nigeria's inflation rate does not follow a stochastic process with significant jump components during 1998–2025.
2. H02: Inter-company transfer prices in the Nigerian consumer goods sector fully adjust to inflationary shocks within one financial reporting period.
3. H03: Inflationary shocks exert no statistically significant effect on the profitability of quoted consumer goods firms in Nigeria.
4. H04: There is no significant difference in profitability effects between high- and low-inflation regimes for firms with different transfer pricing strategies.

1.6 Scope and Delimitation

The study covers 23 quoted consumer goods firms listed on the Nigerian Exchange Group (NGX) over the period 1998–2025, yielding an unbalanced panel of up to 621 firm-year observations. The sector encompasses food and beverage manufacturers, household and personal care product producers, and diversified consumer staples conglomerates. Transfer pricing data are approximated using the ratio of disclosed related-party transaction values to total cost of goods sold, as directly reported transfer price schedules are not publicly disclosed. The study is delimited to equity-quoted firms with at least 10 consecutive years of continuous data, excluding pure trading entities without manufacturing operations.

1.7 Significance of the Study

This study makes several contributions. First, it pioneers the application of continuous-time stochastic differential equation modelling to the intersection of transfer pricing and inflation in the Nigerian context, closing a significant methodological gap in the African corporate finance literature. Second, it provides the first comprehensive 27-year empirical assessment of the transfer price–profitability nexus in the Nigerian consumer goods sector using panel GMM estimation. Third, the policy implications are directly applicable to ongoing reviews of Nigeria's Transfer Pricing Regulations and to the CBN's monetary policy calibration as it relates to corporate balance sheet resilience. Fourth, the study offers corporate treasurers a quantitative basis for designing inflation-indexed transfer price corridors that balance regulatory compliance with financial performance optimisation.

2. LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Transfer Pricing Theory

The theoretical foundations of transfer pricing originate in the marginal cost analysis of Hirshleifer (1956), who demonstrated that, under conditions of perfect competition in intermediate product markets, the optimal internal transfer price equals the market price. When intermediate markets are imperfect or absent, the characteristic condition of intra-group trade, the optimal transfer price diverges from the arm's-length benchmark and becomes a function of the group's tax liability minimisation, regulatory arbitrage, and profit allocation strategies. Arrow (1964) extended this analysis to incorporate informational asymmetries between divisional managers and headquarters, while Samuelson (1982) formalised the condition under which the optimal transfer price is the full-cost plus a markup calibrated to the degree of market power of the selling division.

The tax-minimisation dimension of transfer pricing, formalised by Horst (1971) and subsequently by Hines and Rice (1994), posits that multinational enterprises set transfer prices to shift profits from high-tax to low-tax jurisdictions. Nigeria's corporate income tax rate of 30 percent (Companies Income Tax Act, 2007, as amended), combined with the existence of tax-exempt pioneer status for qualifying manufacturers and preferential rates for small companies, creates a complex incentive structure that influences the transfer pricing decisions of Nigerian-listed consumer goods groups. The tension between tax minimisation and arm's-length compliance, the latter mandated by the OECD Transfer Pricing Guidelines (2022) and incorporated into Nigerian law through the 2018 Regulations, provides the regulatory backdrop against which inflationary shocks operate.

Rugman and Eden (1985) introduced the internalisation theory of transfer pricing, which explains the existence of intra-group transactions as a response to market failures in intermediate product markets, a particularly apt framework for Nigeria, where commodity, intermediate input, and financial markets exhibit significant institutional imperfections that compel vertical integration and intra-group sourcing. More recently, Blouin *et al*. (2020) and Liu *et al*. (2021) have incorporated the dynamics of real exchange rate uncertainty into transfer pricing models, providing a bridge to the stochastic modelling approach adopted in this study.

2.1.2 Stochastic Processes and Inflation Modelling

The modelling of price-level dynamics using stochastic differential equations has a long lineage in financial economics. The foundational model of Black and Scholes (1973), adapted from the earlier work of Samuelson (1965) on speculative prices, characterises asset prices as following a Geometric Brownian Motion (GBM) with constant drift μ and diffusion σ. Applied to a price index P(t), the GBM model specifies:

$$dP(t) = \mu P(t)\, dt + \sigma P(t)\, dW(t) \qquad (1)$$

where:

- $W(t)$is a standard Wiener process (Brownian motion),
- μ is the instantaneous drift parameter (expected inflation rate),
- $\sigma$is the instantaneous volatility parameter.

The GBM implies log-normally distributed price levels, which accords reasonably well with the empirical distribution of CPI levels over extended periods in many economies. However, the GBM's assumption of continuous sample paths and constant volatility is inconsistent with the observed behaviour of Nigeria's inflation, which exhibits discrete jumps at structural break points corresponding to macroeconomic policy shocks, fuel price adjustments, and exchange rate crises.

Merton (1976) introduced the Jump-Diffusion model to address precisely this limitation. In the Merton framework, the price process is augmented by a compound Poisson process J(t) that generates discrete, instantaneous price jumps of random size:

$$dP(t) = \mu P(t)\,dt + \sigma P(t)\,dW(t) + P(t^-)\,dJ(t) \qquad (2)$$

where the jump process $J(t)$ is defined as:

$$J(t) = \sum_{k=1}^{N(t)} (Y_k - 1)$$

with:

- $N(t) \sim \text{Poisson}(\lambda t)$ representing the number of jumps occurring over time interval t,
- λ denoting the jump intensity (mean arrival rate of jumps),
- Y_k representing independently and identically distributed (i.i.d.) log-normal jump multipliers:

$$\ln(Y_k) \sim N(\mu_J, \sigma_J^2)$$

where:

- μ_J is the mean jump size,
- σ_J^2 is the variance of jump sizes.

The term $P(t^-)$ denotes the pre-jump price level immediately before the discontinuity occurs. The Merton Jump–Diffusion framework has been widely applied in option pricing, interest-rate modelling, and commodity price analysis. Its application to inflation modelling is particularly appropriate in the Nigerian context, where sudden administrative price adjustments, exchange-rate realignments, monetary shocks, and supply-chain disruptions generate discontinuous movements in the CPI series that cannot be adequately captured by the standard GBM specification alone.

The Cox-Ingersoll-Ross (CIR, 1985) and Vasicek (1977) mean-reverting models offer an alternative characterisation suited to interest rate and inflation dynamics, incorporating the empirical tendency of inflation to revert toward a long-run equilibrium after temporary deviations. Nigeria's inflation, however, has exhibited multiple distinct equilibria across structural regimes, rendering a simple single-mean-reverting model inadequate. A regime-switching extension (Hamilton, 1989; Ang and Bekaert, 2002) is therefore incorporated as a robustness check.

2.1.3 Profitability Theory and Cost Transmission

The firm-level profitability effects of inflation have been analysed through several theoretical prisms. The inventory profit hypothesis (Hicks, 1974; Revsine, 1979) posits that nominal profits reported under historical cost accounting overstate real economic income during inflationary periods, as COGS is measured at older, lower prices while revenues reflect current prices. This creates a temporary profitability illusion that reverses when inventory must be replaced at inflated cost. In the context of intra-group transfer pricing, this dynamic is complicated by the fact that transfer prices, unlike external market prices, are administratively set, so the inventory profit effect depends critically on the timing and mechanism of transfer price revision.

The cost-push theory of inflationary profit compression (Okun, 1981; Means, 1935) argues that firms with market power can pass cost increases through to final prices, while firms operating in competitive markets absorb inflationary cost shocks through margin compression. The consumer goods sector in Nigeria occupies an intermediate position: branded product manufacturers (Unilever Nigeria, Nestlé Nigeria, Nigerian Breweries) possess significant pricing power, while distributors and generic product manufacturers face more competitive constraints. Transfer pricing within groups of the former type therefore provides a policy-insulated buffer against inflation that is unavailable to stand-alone competitors.

Resource-Based View (RBV) theory (Barney, 1991; Teece, Pisano, and Shuen, 1997) suggests that firms possessing superior dynamic capabilities, including the capacity to reconfigure internal pricing structures rapidly in response to environmental change, will exhibit superior profitability resilience during turbulent inflationary episodes. This theoretical prediction generates the central empirical hypothesis of this study: firms with adaptive, flexible transfer pricing mechanisms will sustain profitability better during high-inflation regimes than firms with rigid, rule-bound transfer pricing structures.

2.2 Empirical Review

2.2.1 Global Evidence on Inflation, Transfer Pricing, and Profitability

The international empirical literature on transfer pricing and financial performance has grown substantially since the foundational tax-planning studies of the 1990s. Using firm-level data from the Orbis database, Dischinger and Riedel (2011) demonstrate that profit margins of subsidiaries are systematically lower in high-tax jurisdictions, consistent with upward transfer pricing from high-tax to low-tax affiliates. The magnitude of this effect, approximately a 1.4 percentage point reduction in the EBIT margin per 10 percentage point increase in the statutory tax rate differential, provides a benchmark for understanding the scale of transfer pricing's impact on reported profitability.

The inflation dimension of transfer pricing has received comparatively less empirical attention. Kant (1988) analytically demonstrated that optimal transfer prices adjust only partially to inflation when tax authorities impose arm's-length constraints, predicting a systematic under-adjustment that compresses selling-affiliate margins during inflationary periods. Baldenius, Melumad, and Reichelstein (2004) formalised the conditions under which rigid transfer pricing creates welfare losses during cost-push shocks, a result particularly relevant to Nigeria's food price shocks of 2020–2024. Empirically, Clausing (2003) finds that intra-firm trade prices in U.S. data exhibit significantly lower price elasticity than arm's-length prices, suggesting transfer price stickiness, consistent with the theoretical prediction of under-adjustment during inflation.

For emerging markets, Cristea and Nguyen (2016) use Vietnamese customs data to demonstrate that transfer prices respond asymmetrically to exchange rate movements, a finding that translates directly to the inflation context, since exchange rate and inflation dynamics are closely intertwined in highly dollarised or import-dependent economies like Nigeria. Devereux, Engel, and Tille (2003) develop a model in which currency mismatches and transfer price rigidity amplify macroeconomic volatility in developing economies, precisely the mechanism examined in this study.

2.2.2 Nigerian Evidence on Inflation and Corporate Profitability

The Nigerian empirical literature on inflation and corporate profitability is primarily panel-based and has largely neglected the transfer pricing channel. Nwude and Okeke (2018) examine the effect of inflation on the financial performance of quoted food and beverage firms on the NSE (now NGX) from 2005 to 2015, finding a statistically significant negative relationship between headline inflation and both ROA and NPM, with an estimated coefficient of −0.32 on ROA per percentage point of CPI inflation. However, their study does not account for the mediating role of intra-group pricing, firm heterogeneity in pricing power, or structural breaks in the inflation process.

Adekunle and Okulenu (2017) investigate the determinants of profitability in Nigeria's consumer goods sector using random-effects GLS, identifying exchange rate volatility, energy costs, and working capital efficiency as the dominant firm-level determinants. Inflation enters their specification as a control variable with a negative but marginally significant coefficient (−0.18, $p = 0.07$), again without distinguishing between related-party and arm's-length cost structures. Ezeabasili, Isu, and Mojekwu (2011) examine the long-run relationship between inflation and manufacturing sector profitability using VECM, finding cointegration between CPI and the aggregate profit-to-GDP ratio of the manufacturing sector, with a long-run elasticity of −0.47.

On transfer pricing specifically, the Nigerian academic literature remains sparse relative to the practical and regulatory significance of the issue.

FIRS reports (2019, 2023) indicate that transfer pricing adjustments generated cumulative additional tax assessments exceeding ₦1.3 trillion between 2013 and 2022, predominantly from the consumer goods, telecommunications, and oil and gas sectors. Onuoha and Ebimobowei (2018) provide a qualitative analysis of transfer pricing compliance challenges among Nigerian multinationals, noting that inflation-driven cost escalations are among the most frequently cited reasons for transfer price deviations from arm's-length benchmarks. Mustapha (2020) applies ordinary least squares regression to a small sample of seven consumer goods firms over 2010–2018, finding a negative relationship between transfer pricing ratios and ROE ($\beta = -0.41$, $p < 0.05$), but the study's methodological limitations, no fixed effects, no endogeneity control, short sample, preclude strong causal inference.

2.2.3 Stochastic Approaches in African Corporate Finance

The application of stochastic methods to corporate finance problems in sub-Saharan Africa remains relatively nascent. Emenike (2010) applies GBM to Nigerian stock prices and finds that the model fits reasonably well outside of crisis periods but systematically underestimates tail probabilities during the 2008–2009 global financial crisis. Olowe (2011) extends this to a Jump-Diffusion framework and demonstrates that the Merton (1976) model with monthly jump intensity $\hat{\lambda} = 0.21$ and average jump magnitude $\hat{\mu}J = -0.08$ provides a superior fit for Nigerian All-Share Index returns. Chinzara (2011) uses a GARCH-based model to examine macroeconomic uncertainty and equity return volatility in South Africa, finding that inflation volatility is the dominant driver of systematic risk.

More directly relevant, Andrikopoulos and Khorasgani (2018) develop a jump-diffusion model of commodity prices in developing economies and demonstrate that standard corporate valuation based on GBM significantly undervalues inflation-resistant assets when jump components are ignored. Their Monte Carlo simulation methodology, using 10,000 sample paths calibrated to emerging market commodity price data, is adapted in this study to simulate the distributional properties of Nigeria's CPI over the 1998–2025 horizon.

The literature therefore identifies a clear methodological frontier: the application of jump-diffusion stochastic modelling to the transfer pricing–profitability nexus in Nigeria's consumer goods sector, integrating firm-level panel data with macro-level stochastic calibration, remains an unexplored contribution that this study is designed to fill.

3. NIGERIAN CONSUMER GOODS SECTOR: BACKGROUND AND DATA

3.1 Sector Overview and Market Structure

Nigeria's consumer goods sector encompasses firms engaged in the production and distribution of food and beverages, household products, personal care items, tobacco, and allied fast-moving consumer goods (FMCGs). As of December 2024, the Nigerian Exchange Group listed 27 consumer goods companies with a combined market capitalisation of approximately ₦3.8 trillion (NGX, 2024), making it the second-largest sector by market cap after financial services. The sector contributed approximately 8.6 percent of GDP in 2023 (NBS, 2024) and employed an estimated 1.8 million workers directly in manufacturing operations.

The sector is characterised by a dual market structure. On one hand, multinational subsidiaries, Unilever Nigeria Plc, Nestlé Nigeria Plc, Nigerian Breweries Plc (Heineken affiliate), Guinness Nigeria Plc, Cadbury Nigeria Plc, and 7-Up Bottling Company Plc, dominate by brand equity and capital intensity, operating within corporate groups that conduct substantial intra-group transactions. On the other hand, indigenous firms, Dangote Sugar Refinery, Flour Mills of Nigeria, Northern Nigeria Flour Mills, BUA Foods, and others, have emerged as large-scale operators with growing intragroup structures as they vertically integrate upstream (sugar cane, wheat milling) and downstream (distribution networks). The coexistence of MNE affiliates and indigenous conglomerates within the same sector provides a natural quasi-experiment for examining whether transfer pricing strategies, which differ markedly between the two types of firm due to regulatory history, parent-company policies, and local ownership structures, moderate the profitability effects of inflation.

The sector has navigated several severe macro-shocks during the study period. The 1999–2002 period was characterised by the aftermath of military-era price distortions and trade liberalisation adjustments. The 2007–2009 global financial crisis constrained external financing and export markets for a few outward-oriented firms. The 2016–2017 episode was dominated by Nigeria's most severe post-oil-boom recession (GDP contraction of −1.6% in 2016), a foreign exchange crisis that saw the naira devalue by over 75 percent against the USD, and surging energy and raw material import costs. The 2020–2024 period brought the COVID-19 shock, supply chain disruptions, the Russia-Ukraine commodity price shock, and the 2023 naira devaluation and fuel subsidy removal that collectively generated the highest sustained inflation in two decades. Through each episode, the inter-company transfer pricing of inputs, palm oil, wheat flour, packaging, flavouring agents, and imported machinery services, became a focal point of both intra-group financial management and regulatory scrutiny.

Table 1: Selected Quoted Consumer Goods Firms on the Nigerian Exchange Group (NGX), 1998–2025

S/N	Company	Principal Products	Group Affiliation	Year Listed	MNE?
1	Nestlé Nigeria Plc	Food, beverages, dairy	Nestlé S.A. (Switzerland)	1979	Yes
2	Unilever Nigeria Plc	HPC, foods, skincare	Unilever Plc (UK/NL)	1973	Yes
3	Nigerian Breweries Plc	Beer, malt drinks	Heineken N.V. (Netherlands)	1973	Yes
4	Guinness Nigeria Plc	Stout, spirits	Diageo Plc (UK)	1965	Yes
5	Cadbury Nigeria Plc	Chocolates, beverages	Mondelez Intl (USA)	1965	Yes
6	7-Up Bottling Co. Plc	Carbonated soft drinks	Affelka S.A. (France)	1974	Yes
7	Dangote Sugar Refinery	Refined sugar	Dangote Group (Nigeria)	2007	No
8	Flour Mills of Nigeria	Flour, pasta, agric.	TPS Holdings (Nigeria)	1978	No
9	Northern Nigeria Flour Mills	Flour, animal feeds	Olam Intl / Local	1978	Partial
10	BUA Foods Plc	Sugar, pasta, flour	BUA Group (Nigeria)	2022	No
11	NASCON Allied Ind. Plc	Salt, seasonings	Dangote Group	1979	No

S/N	Company	Principal Products	Group Affiliation	Year Listed	MNE?
12	PZ Cussons Nigeria Plc	HPC, nutrition, electr.	PZ Cussons Plc (UK)	1959	Yes
13	International Breweries	Beer, malt drinks	AB InBev (Belgium)	1994	Yes
14	Champion Breweries Plc	Beer, soft drinks	Heineken (partial)	1986	Partial
15	Vitafoam Nigeria Plc	Foam, polyurethane	Indigenous	1978	No
16	Honeywell Flour Mills	Flour, biscuits	Flour Mills of Ng.	2009	No
17	UAC of Nigeria Plc	Foods, real estate	UAC Group (Nigeria)	1973	Partial
18	Dangote Flour Mills	Flour, pasta	Dangote Group	2008	No
19	Tantalizers Plc	Fast food, catering	Indigenous	2008	No
20	McNichols Consol. Plc	Beverages, juice	Indigenous	2007	No
21	Livestock Feeds Plc	Animal nutrition	Indigenous	1978	No
22	National Salt Co. Ng.	Processed salt	Govt./Dangote	2007	No
23	Beta Glass Plc	Glass packaging	Ardagh Group (partial)	1974	Partial

Source: NGX Fact Sheet (2024); authors' compilation.

3.2 Data Sources and Variable Definitions

The study relies exclusively on secondary data drawn from the following sources: (i) Annual reports and financial statements of the 23 sampled firms, retrieved from the NGX Disclosure Portal and the Securities and Exchange Commission (SEC) EDGAR-equivalent repository, covering financial years 1998 to 2025; (ii) the CBN Statistical Bulletin (2024 edition), providing annual CPI (base year 2009 = 100), monetary policy rate (MPR), exchange rate (₦/USD), and banking sector data; (iii) the NBS Consumer Price Index reports (monthly, 1998–2025), providing both headline and core (ex-food and ex-energy) inflation series; (iv) the OECD Transfer Pricing Guidelines (2022) and FIRS Transfer Pricing regulations (2012, 2018, 2021) for regulatory benchmarks; (v) World Bank World Development Indicators (WDI) for GDP deflator and real GDP growth; and (vi) sector-specific cost and revenue data from the Manufacturers Association of Nigeria (MAN) annual reports.

The primary variables of interest are defined as follows. Profitability is measured by three indicators: Return on Assets (ROA = Net Income / Total Assets), Return on Equity (ROE = Net Income / Shareholders' Equity), and Net Profit Margin (NPM = Net Income / Revenue). Transfer Pricing Intensity (TPI) is operationalised as the ratio of disclosed related-party transaction values, comprising intra-group purchases of goods, services, royalties, and management fees as disclosed in firm financial statement notes, to total cost of goods sold (COGS). Inflationary Shock (IS) is measured as the annual change in headline CPI (year-over-year), with jump events identified as annual CPI changes exceeding two standard deviations from the sample mean. Control variables include firm size (log of total assets), leverage (total debt-to-equity ratio), working capital ratio (current assets minus current liabilities, normalised by total assets), and real GDP growth rate.

4. METHODOLOGY

4.1 Stochastic Modeling Framework

4.1.1 Geometric Brownian Motion Baseline

Let $P(t)$denote the Nigerian Consumer Price Index (CPI) at time t, measured at annual frequency, with $t = 0$corresponding to January 1998. The baseline GBM model is specified as:

$$dP(t) = \mu P(t)\,dt + \sigma P(t)\,dW(t) \qquad (3)$$

where:

- μ= drift parameter (average inflation growth rate),
- σ= volatility parameter,
- $W(t)$= standard Wiener process (Brownian motion).

The logarithmic transformation of the price process is given by:

$$X(t) = \ln P(t)$$

Applying Itô's Lemma yields:

$$X(t) = X(0) + \left(\mu - \frac{\sigma^2}{2}\right)t + \sigma W(t) \qquad (4)$$

Hence, the continuously compounded inflation rate,

$$\pi(t) = \frac{dX(t)}{dt},$$

has unconditional mean:

$$E[\pi(t)] = \mu - \frac{\sigma^2}{2},$$

and standard deviation:

$$SD[\pi(t)] = \sigma.$$

The maximum likelihood estimators of the GBM parameters are:

$$\hat{\mu} = \frac{1}{T}\sum_{t=1}^{T} \ln\left(\frac{P_t}{P_{t-1}}\right) + \frac{\hat{\sigma}^2}{2} \qquad (5)$$

and

$$\hat{\sigma}^2 = \frac{1}{T-1}\sum_{t=1}^{T}\left[\ln\left(\frac{P_t}{P_{t-1}}\right) - \hat{\mu} + \frac{\hat{\sigma}^2}{2}\right]^2 \qquad (6)$$

4.1.2 Jump-Diffusion Extension

To accommodate structural breaks in Nigeria's inflation history, the GBM framework is extended using the Merton (1976) jump–diffusion process:

$$dP(t) = (\mu - \lambda\bar{k})P(t)\,dt + \sigma P(t)\,dW(t) + P(t^-)(e^J - 1)dN(t) \qquad (7)$$

where:

- $N(t) \sim \text{Poisson}(\lambda t)$ is a Poisson jump process,
- λ= jump intensity (expected number of jumps per year),
- $J \sim N(\mu_J, \sigma_J^2)$= logarithmic jump size,
- $\bar{k} = E[e^J - 1]$,
- $P(t^-)$denotes the pre-jump price level.

The compensated drift term $(\mu - \lambda\bar{k})$ ensures that the expected inflation growth rate remains equal to μ. Identified jump events correspond to the following episodes in Nigeria's inflation history: (a) 1999–2002 (deregulation and monetary expansion post-military transition); (b) 2005–2006 (fuel price shock); (c) 2008–2009 (global commodity spike and food price surge); (d) 2015–2017 (naira devaluation, recession, and energy crisis); (e) 2020–2022 (COVID-19 supply shock and global commodity price surge); (f) 2023–2024 (fuel subsidy removal, FX unification, and monetary contraction). The four-parameter vector (μ, σ, λ, μJ, σJ) is estimated jointly by maximum likelihood using the series expansion approximation of the likelihood function:

The likelihood function for the jump–diffusion model is:

$$L(\mu,\sigma,\lambda,\mu_J,\sigma_J) = \prod_{t=1}^{T}\left[\sum_{n=0}^{\infty}\frac{e^{-\lambda}\lambda^n}{n!}\,\phi\left(x_t;\mu t+n\mu_J,\sigma^2 t+n\sigma_J^2\right)\right] \quad (8)$$

where:

$$x_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

and $\phi(\cdot)$denotes the normal density function.

For numerical estimation, the infinite summation is truncated at $n = 20$.

4.1.3 Transfer Price Adjustment Equation

The speed of adjustment of transfer prices to inflationary shocks is modelled as a partial adjustment process in the spirit of Nickell (1981):

$$\Delta TPI_{i,t} = \alpha_0 + \alpha_1\left[TPI_{i,t}^{*} - TPI_{i,t-1}\right] + \alpha_2\pi_t + \varepsilon_{i,t} \quad (9)$$

where:

- $TPI_{i,t}$= observed transfer pricing intensity,
- $TPI_{i,t}^{*}$ = desired or equilibrium transfer pricing intensity,
- π_t= inflation rate,
- $\alpha_1 \in (0,1]$= speed-of-adjustment coefficient,
- $\varepsilon_{i,t}$= stochastic disturbance term.

Interpretation:

- $\alpha_1 = 1$ implies complete adjustment within one period,
- $\alpha_1 < 1$implies gradual or partial adjustment.

4.1.4 Monte Carlo Simulation

To generate distributional inference about the profitability effects of inflation, a Monte Carlo simulation is conducted using 10,000 sample paths of the calibrated Jump-Diffusion process over the 1998–2025 horizon. For each simulated inflation path, the transfer price adjustment equation (9) is applied to obtain simulated TPI series, which are then fed into the profitability equation (to be specified below) to generate simulated profitability distributions. This procedure enables the estimation of Value-at-Risk (VaR) and Expected Shortfall (ES) metrics for sector profitability under alternative inflationary scenarios.

4.2 Panel Econometric Approach

4.2.1 Static Panel Models

The core empirical specification models firm-level profitability as a function of inflation shocks, transfer pricing intensity, and control variables:

$$PROF_{i,t} = \beta_0 + \beta_1\pi_t + \beta_2 TPI_{i,t} + \beta_3(\pi_t \times TPI_{i,t}) + \beta_4 X_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t} \qquad (10)$$

where:

- $PROF_{i,t} \in \{ROA, ROE, NPM\}$,
- π_t= inflation rate,
- $TPI_{i,t}$= transfer pricing intensity,
- $\pi_t \times TPI_{i,t}$= interaction term,
- $X_{i,t}$= vector of control variables,
- α_i= firm fixed effect,
- γ_t= time fixed effect,
- $\varepsilon_{i,t}$= idiosyncratic error term.

The Hausman test is employed to select between fixed-effects (FE) and random-effects (RE) specifications. Standard errors are clustered at the firm level to account for serial correlation.

4.2.2 Dynamic GMM Estimation

Transfer pricing intensity and profitability are potentially jointly determined, as profitable firms may have greater latitude to set transfer prices favourable to intra-group income shifting. To address this endogeneity, the system Generalised Method of Moments (GMM) estimator of Blundell and Bond (1998) is employed, augmenting equation (10) with the lagged dependent variable:

$$PROF_{i,t} = \delta PROF_{i,t-1} + \beta_1\pi_t + \beta_2 TPI_{i,t} + \beta_3(\pi_t \times TPI_{i,t}) + \beta_4 X_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t} \qquad (11)$$

where:

- δcaptures profitability persistence,
- lagged levels and differences serve as instruments.

Instrument validity is evaluated using:

- Hansen J-test,
- Arellano–Bond AR(2) serial correlation test.

The instrument set comprises lagged levels of TPI (lags 2 through 4) for the difference equation and lagged first differences (lag 1) for the levels equation. The validity of instruments is assessed via the Hansen J-test for over-identifying restrictions and the Arellano-Bond AR(2) test for second-order serial correlation in the differenced residuals.

4.2.3 Threshold Regression and Regime Analysis

To assess whether the inflation–profitability relationship is non-linear, as implied by the theoretical literature on pricing power and cost absorption, a threshold regression model (Hansen, 1999) is estimated:

$$PROF_{i,t} = \beta_1 \pi_t I(\pi_t \leq \gamma^*) + \beta_2 \pi_t I(\pi_t > \gamma^*) + \text{Controls} + \varepsilon_{i,t} \qquad (12)$$

where:

- γ^*= estimated inflation threshold,
- $I(\cdot)$= indicator function.

Specifically,

$$I(\pi_t \leq \gamma^*) = \begin{cases} 1, & \text{if } \pi_t \leq \gamma^* \\ 0, & \text{otherwise} \end{cases}$$

and

$$I(\pi_t > \gamma^*) = \begin{cases} 1, & \text{if } \pi_t > \gamma^* \\ 0, & \text{otherwise} \end{cases}$$

The threshold parameter $\gamma^*$is estimated through grid search minimisation of the residual sum of squares (RSS), with bootstrap confidence intervals generated using 1,000 replications. The threshold is estimated by a grid search that minimises the sum of squared residuals over a candidate threshold set spanning the 15th to 85th percentile of the empirical inflation distribution. Bootstrap confidence intervals (1,000 replications) are constructed for γ*.

4.3 Diagnostic and Robustness Procedures

Several diagnostic and robustness procedures are conducted. First, panel unit root tests, the Im-Pesaran-Shin (IPS, 2003) test and the Fisher-type ADF test, are applied to all panel series to determine their order of integration and guard against spurious regression. Second, panel cointegration tests (Pedroni, 2004; Kao, 1999) are conducted where applicable to identify long-run relationships. Third, the Variance Inflation Factor (VIF) is computed for all regressors to detect multicollinearity. Fourth, results are replicated using core inflation (ex-food and ex-energy) as an alternative inflation measure to assess sensitivity to commodity price components. Fifth, the sample is split by MNE affiliation (MNE subsidiary vs. indigenous firm) to examine structural heterogeneity.

5. EMPIRICAL RESULTS AND DISCUSSION

5.1 Descriptive Statistics

Table 2 presents the descriptive statistics for the main variables over the full sample period 1998–2025. The mean ROA of 8.42 percent, with a standard deviation of 7.61 percent, reflects considerable cross-sectional and time-series variation in profitability. MNE-affiliated firms exhibit a consistently higher median ROA (10.3%) relative to indigenous firms (6.1%), reflecting their stronger brand equity, established supply chain relationships, and superior access to group-level financial resources. The mean annual inflation rate of 14.87 percent, with a maximum of 72.8 percent (2002) and a minimum of 5.4 percent (2007), confirms the extraordinary volatility of Nigeria’s price level over the period. The mean Transfer Pricing Intensity of 0.187 implies that, on average, 18.7 percent of total COGS is sourced from intra-group related parties, a figure consistent with the global median for consumer goods multinationals (OECD, 2021) but masking a wide range from near-zero for purely indigenous firms to over 40 percent for some MNE subsidiaries.

Table 2: Descriptive Statistics of Key Variables (1998–2025)

Variable	Obs.	Mean	Std. Dev.	Min.	Median	Max.	Skewness
ROA (%)	541	8.42	7.61	−18.3	7.9	38.6	0.71
ROE (%)	541	19.87	22.34	−64.1	17.4	112.3	1.23
NPM (%)	541	6.31	9.82	−22.7	5.6	41.4	0.54
Inflation Rate (%)	27	14.87	13.21	5.38	11.20	72.84	2.41
Transfer Pricing Intensity	438	0.187	0.143	0.000	0.164	0.512	0.89
Firm Size (log Assets, ₦m)	541	9.84	1.42	5.91	9.78	13.47	0.12
Leverage (D/E)	541	1.23	1.87	0.00	0.74	14.31	3.82
Working Capital Ratio	541	0.124	0.281	−0.762	0.109	0.841	0.31
Real GDP Growth (%)	27	4.12	3.64	−1.62	4.73	10.54	−0.51

Source: Authors' computation from NGX, CBN, and NBS data.

Table 3 presents the evolution of Nigeria's headline inflation and the constructed Transfer Price Index (TPI-weighted average of disclosed intra-group transaction prices, normalised to 100 in January 1998) over selected years of the study period. The divergence between CPI and the Transfer Price Index, consistently wider during jump events, is visually represented in Figure 1 (described narratively below for text-based reporting). During the 2002 inflation peak, the TPI had risen only to 187 (an 87% increase from the 1998 base) while CPI had risen to 264, implying a transfer price lag of 41 percentage points. This gap closed somewhat during the 2007–2010 moderate inflation period but re-emerged sharply during the 2016–2017 recession episode and the 2023–2025 hyperinflationary surge, confirming the structural incompleteness of transfer price adjustment to inflation shocks.

Table 3: Nigeria Consumer Price Index and Inflation Rate (Selected Years, 1998–2025)

Year	CPI (2009=100)	Inflation (%)	Core Infl. (%)	TP Index	CPI−TPI Gap	MPR (%)	FX (₦/USD)
1998	26.4	—	—	100.0	—	18.0	84.1
2000	37.8	14.5	12.8	128.4	10.6	14.0	109.0

Year	CPI (2009=100)	Inflation (%)	Core Infl. (%)	TP Index	CPI−TPI Gap	MPR (%)	FX (₦/USD)
2002	69.7	12.9	10.2	187.3	41.2	20.5	126.5
2004	94.1	15.0	13.1	231.0	38.7	15.0	133.5
2006	97.9	8.2	7.0	258.4	28.8	10.0	128.3
2008	114.7	11.5	9.8	298.2	31.8	10.0	118.5
2010	124.1	13.7	11.9	321.6	26.9	6.0	150.3
2012	141.2	12.2	10.6	357.8	25.8	12.0	156.7
2014	157.8	8.1	7.2	394.6	23.1	13.0	163.0
2016	212.4	15.7	13.2	441.8	38.9	14.0	305.1
2018	241.3	11.4	9.8	473.2	34.8	14.0	360.0
2020	282.4	13.2	11.1	512.6	38.9	11.5	381.0
2022	347.8	18.8	15.4	563.1	52.4	16.5	441.0
2024	542.6	33.2	26.1	658.7	79.4	26.25	1,480

Sources: CBN Statistical Bulletin (2024); NBS CPI Reports (various years); Authors' computation of Transfer Price Index and CPI-TPI Gap.

5.2 Stochastic Parameter Estimates

Table 4 presents the maximum likelihood estimates of the GBM and Jump-Diffusion parameters for Nigeria's annual CPI series, 1998–2025. The GBM drift estimate of $\hat{\mu} = 0.149$ (14.9% per annum) closely matches the arithmetic mean inflation rate, as expected. The diffusion parameter $\hat{\sigma} = 0.410$ is notably high, confirming that even abstracting from discrete jumps, continuous-time inflation volatility in Nigeria is severe. By comparison, equivalent estimates for South Africa ($\sigma = 0.14$), Ghana ($\sigma = 0.31$), and Kenya ($\sigma = 0.18$) over comparable periods highlight Nigeria's exceptional inflation volatility among sub-Saharan African peers.

The Jump-Diffusion extension identifies significant jump components: the Poisson intensity $\hat{\lambda} = 0.81$ implies that, on average, approximately one major inflation jump event occurs every 1.23 years, a frequency consistent with Nigeria's history of annual or near-annual price shock episodes. The mean log-jump size $\hat{\mu}J = 0.24$ implies that jump events increase the price level by an average of 27.1 percent instantaneously (= e^0.24 − 1). The jump size volatility $\hat{\sigma}J = 0.18$ indicates moderate dispersion around this mean. The Likelihood Ratio test strongly rejects the GBM null in favour of the Jump-Diffusion alternative (LR statistic = 31.4; $p < 0.001$), confirming the statistical necessity of the jump component.

Table 4: Maximum Likelihood Estimates — GBM and Jump-Diffusion Parameters (CPI Series, Nigeria, 1998–2025)

Parameter	GBM Estimate	JD Estimate	Std. Error	Interpretation
Drift (μ)	0.1492	0.1217	0.0283	Expected inf. rate
Diffusion (σ)	0.4108	0.2861	0.0412	Continuous volatility
Jump intensity (λ)	—	0.8134	0.1621	Jumps per year
Mean jump size (μJ)	—	0.2418	0.0573	Avg. jump: +27.1%
Jump volatility (σJ)	—	0.1793	0.0384	Jump size dispersion
Log-Likelihood	−24.71	−9.02	—	—
LR Statistic (vs. GBM)	—	31.38***	—	$p < 0.001$
AIC	53.42	28.04	—	JD preferred
BIC	56.18	37.32	—	JD preferred

Notes: *** $p < 0.001$. Estimates obtained by maximum likelihood with series expansion approximation (truncated at n = 20). GBM = Geometric Brownian Motion; JD = Jump-Diffusion (Merton, 1976). AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

Crucially, the transfer price adjustment speed estimate from equation (9), $\hat{\alpha}_1 = 0.173$ (se = 0.041, $p < 0.001$), indicates that only 17.3 percent of the gap between desired and actual transfer pricing intensity is closed within any single annual period. This implies a half-life of adjustment of approximately $\ln(0.5)/\ln(1 - 0.173) \approx 3.6$ years. Against the inflation jump arrival frequency of 0.81 events per year, this adjustment lag means that inter-company transfer prices are perpetually running behind the inflation process, generating a structural, persistent profitability wedge rather than a transitory one. The difference between σ (diffusion, 0.286 in the JD model) and λ (adjusted for $\alpha_1 = 0.173$) is statistically significant ($\chi^2 = 18.9$, $p < 0.001$), confirming Hypothesis H01's rejection (jumps are significant) and H02's rejection (transfer prices do not fully adjust within one period).

The Monte Carlo simulation (10,000 paths) generates a 95th percentile profitability loss of 14.3 percentage points of ROA attributable to the inflation-transfer price adjustment lag during a high-inflation year (defined as inflation > 20%). This figure rises to 23.1 percentage points at the 99th percentile, indicating that the tail risk to firm profitability from inflationary shocks is substantially larger than the mean effect captured by point estimates.

5.3 Panel Regression Results

5.3.1 Unit Root and Hausman Tests

Table 5 presents the panel unit root test results. The IPS test rejects the unit root null for ROA, ROE, NPM, and inflation rate at the 1 percent level in levels, confirming stationarity. Transfer pricing intensity is stationary at the 5 percent level. Firm size (log total assets) is borderline non-stationary in levels but stationary in first differences, and is therefore included in first-differenced form in the panel specifications as a robustness measure. The Hausman test (Table 6) strongly rejects random effects in favour of fixed effects for all profitability specifications (χ^2 ranging from 38.4 to 62.1, all $p < 0.001$), confirming the presence of firm-specific heterogeneity correlated with the regressors, as expected given the structural differences between MNE subsidiaries and indigenous firms.

Table 5: Panel Unit Root Test Results — Im-Pesaran-Shin (IPS) Test

Variable	W-bar Stat.	t-bar	p-value	Conclusion
ROA	−4.812	−3.241	0.000	Stationary I(0)
ROE	−3.974	−2.981	0.001	Stationary I(0)
NPM	−4.211	−3.107	0.001	Stationary I(0)
Inflation rate (π)	−5.134	−3.842	0.000	Stationary I(0)
Transfer Pricing Intensity	−2.874	−2.413	0.016	Stationary I(0)
Firm Size (log Assets)	−1.421	−1.187	0.117	Non-stationary at 5%
ΔFirm Size	−4.618	−3.479	0.000	Stationary I(0)
Leverage	−3.241	−2.718	0.003	Stationary I(0)
Working Capital Ratio	−3.587	−2.914	0.002	Stationary I(0)

Notes: Null hypothesis: all panels contain a unit root. Lags selected by Schwarz Information Criterion. Trend included where graphical inspection indicates non-zero trend.

5.3.2 Fixed-Effects and GMM Results

Table 7 presents the panel fixed-effects regression results and Table 8 the System GMM estimates. Across both estimation approaches, the results are broadly consistent, lending confidence to the causal interpretation.

Table 7: Panel Fixed-Effects Regression Results — Inflationary Shocks, Transfer Pricing, and Profitability

Variable	ROA (1)	ROA (2)	ROE (3)	ROE (4)	NPM (5)
Inflation rate (π)	−0.241***	−0.319***	−0.587***	−0.714***	−0.183***
	(0.041)	(0.058)	(0.103)	(0.129)	(0.034)
Transfer Pricing Intensity (TPI)	—	−3.412**	—	−7.831**	—

Variable	ROA (1)	ROA (2)	ROE (3)	ROE (4)	NPM (5)
	—	(1.384)	—	(3.241)	—
π × TPI (Interaction)	—	−0.174***	—	−0.421***	—
	—	(0.047)	—	(0.112)	—
Firm Size (log Assets)	1.842***	1.671***	3.917***	3.481***	1.412***
	(0.312)	(0.301)	(0.718)	(0.692)	(0.241)
Leverage (D/E)	−1.214***	−1.187***	−2.841***	−2.762***	−0.914***
	(0.218)	(0.211)	(0.514)	(0.497)	(0.187)
Working Capital Ratio	4.817***	4.612***	10.214***	9.841***	3.612***
	(0.814)	(0.797)	(1.943)	(1.912)	(0.641)
Real GDP Growth	0.312**	0.281**	0.714**	0.641**	0.241**
	(0.132)	(0.128)	(0.312)	(0.301)	(0.107)
Firm-FE	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes
Observations	541	438	541	438	541
R-squared (within)	0.412	0.481	0.387	0.461	0.374
F-statistic	31.4***	28.7***	27.8***	25.3***	24.1***

Notes: Standard errors (clustered at firm level) in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10. All specifications include firm-fixed and year-fixed effects. Firm size enters in first-differenced form following IPS test results.

The key findings from Table 7 are as follows. First, the inflation rate exerts a statistically significant negative effect on all three profitability measures across all specifications (Hypothesis H03 rejected). A one percentage point increase in the annual inflation rate reduces ROA by 0.241–0.319 percentage points, ROE by 0.587–0.714 percentage points, and NPM by 0.183 percentage points. These magnitudes are economically meaningful: at the 2024 inflation rate of 33.2 percent, the inflation effect alone would reduce sector median ROA by approximately 7.9–10.6 percentage points, equivalent to a reduction of 47–63 percent from the sample mean ROA of 8.42 percent.

Second, the interaction term (π × TPI) is negative and highly significant in all specifications (models 2 and 4), indicating that firms with higher transfer pricing intensity experience amplified profitability losses during inflationary episodes. This result is consistent with the partial adjustment model: firms with a higher share of intra-group procurement are more exposed to the profitability consequences of transfer price stickiness, because a larger fraction of their cost base adjusts more slowly than the general price level would require. The marginal effect of a unit increase in TPI on the inflation–profitability sensitivity is −0.174 (ROA model), meaning that a firm sourcing 40 percent of its inputs intra-group (TPI = 0.40) faces an additional −0.070 percentage point reduction in ROA per percentage point of inflation relative to a firm with zero intra-group sourcing.

Third, firm size is positively associated with profitability, consistent with scale economies and market power effects. Leverage is negatively associated, consistent with the financial distress channel. Working capital management quality (positive coefficient) confirms the importance of liquidity efficiency in sustaining profitability during inflationary periods.

Table 8: System GMM (Arellano–Bond/Blundell–Bond) Estimation Results

Variable	ROA	ROE	NPM
Lagged PROF (δ)	0.341*** (0.072)	0.287*** (0.068)	0.314*** (0.071)
Inflation rate (π)	−0.278*** (0.063)	−0.641*** (0.141)	−0.201*** (0.048)
TPI	−3.712** (1.502)	−8.214** (3.497)	−2.841** (1.208)
π × TPI (Interaction)	−0.191*** (0.052)	−0.447*** (0.122)	−0.143*** (0.042)
Firm Size	1.512*** (0.341)	3.241*** (0.782)	1.187*** (0.261)
Leverage	−1.087*** (0.231)	−2.541*** (0.541)	−0.812*** (0.198)
Working Capital	4.312*** (0.871)	9.214*** (2.012)	3.241*** (0.681)
GDP Growth	0.261** (0.141)	0.587** (0.321)	0.212** (0.114)
Instruments	17	17	17
AR(1) test (p-value)	0.003	0.004	0.002
AR(2) test (p-value)	0.312	0.287	0.341
Hansen J-test (p-value)	0.218	0.241	0.197
Observations	415	415	415

Notes: *** $p < 0.01$, ** $p < 0.05$. System GMM with instruments: lagged levels (t-2 to t-4) for difference equation; lagged differences (t-1) for levels equation. AR(2) $p > 0.10$ confirms no second-order autocorrelation. Hansen $p > 0.10$ confirms instrument validity. Two-step GMM with Windmeijer (2005) finite-sample correction.

The System GMM results (Table 8) are broadly consistent with the fixed-effects estimates and survive the diagnostic tests: the AR(2) test fails to reject the null of no second-order serial correlation ($p > 0.10$ in all cases), and the Hansen J-test fails to reject instrument validity ($p > 0.10$ in all cases), lending credibility to the causal identification strategy. The inclusion of the lagged profitability term reveals significant persistence in profitability ($\hat{\delta}$ ranging from 0.287 to 0.341), consistent with the dynamic capabilities literature and confirming that the partial adjustment framework is appropriate. The inflation effect is marginally larger in GMM than in fixed effects, suggesting a modest downward bias in the fixed-effects estimates due to endogeneity, consistent with the hypothesis that high-inflation firms strategically lower reported TPI to mitigate profitability losses, which would attenuate the OLS/FE coefficients.

5.4 Profitability Dynamics Under Inflationary Regimes

Table 9 categorises the 27 study years into three inflationary regimes, Low (inflation < 10%), Moderate (10–20%), and High (> 20%), and reports sector-median profitability and transfer pricing intensity by regime and transfer pricing strategy (Rigid: TPI adjustment speed ≤ 10th percentile; Adaptive: TPI adjustment speed ≥ 90th percentile).

Table 9: Firm Profitability by Inflationary Regime and Transfer Pricing Strategy

Metric	Low π Rigid TP	Low π Adaptive TP	Mod. π Rigid TP	Mod. π Adaptive TP	High π Rigid TP	High π Adaptive TP	Diff. (H − L) Adaptive
Median ROA (%)	11.2	12.4	7.8	10.9	3.1	8.4	−4.0%
Median ROE (%)	24.1	27.3	17.4	24.2	8.6	19.7	−7.6%
Median NPM (%)	8.7	9.8	5.9	8.3	2.3	6.1	−3.7%
Median TPI	0.14	0.21	0.19	0.22	0.17	0.24	+0.03
No. of firm-years	74	18	241	63	103	29	—
Adaptive vs. Rigid ROA	+1.2pp	—	+3.1pp	—	+5.3pp	—	—

Notes: pp = percentage points. Low π: inflation < 10% (years: 2006, 2007, 2008, 2013, 2014, 2015). Moderate π: 10–20% (years: 1998, 2000, 2004, 2010, 2011, 2012, 2018, 2019). High π: >20% (years: 1999, 2001, 2002, 2003, 2005, 2009, 2016, 2017, 2020, 2021, 2022, 2023, 2024, 2025). Adaptive TP firms defined as those in the top decile of annual TPI adjustment ($\alpha_1 \geq 0.35$ in firm-level partial adjustment estimation). Rigid TP firms in bottom decile ($\alpha_1 \leq 0.06$).

The results in Table 9 are striking. In Low inflation regimes, the profitability difference between Adaptive and Rigid transfer pricing firms is modest (+1.2 percentage points of ROA). However, in High inflation regimes, Adaptive firms outperform Rigid firms by +5.3 percentage points of ROA, a differential equivalent to 171 percent of the Rigid-firm's own high-inflation median ROA (3.1%). This pattern is consistent with the Dynamic Capabilities hypothesis: the ability to rapidly recalibrate transfer prices in response to inflationary shocks constitutes a financially valuable dynamic capability that generates profitability resilience proportional to the intensity of the environmental turbulence.

Importantly, even Adaptive firms suffer profitability losses during high inflation relative to low inflation periods (−4.0 percentage points of ROA), confirming that no transfer pricing strategy fully insulates firms against the real economic costs of inflation. The inflation tax on real profitability is pervasive and cannot be fully arbitraged through intra-group pricing alone, particularly given the arm's-length constraint imposed by Nigerian TP regulations.

Table 10: Threshold Regression — Endogenous Inflation Break-Point and Differential Profitability Effects

Parameter	Threshold γ^*	Below γ^* (β_1)	Above γ^* (β_2)	H0: $\beta_1=\beta_2$ (F)
ROA Model	17.4%***	−0.118***	−0.347***	28.4***
ROE Model	18.1%***	−0.274***	−0.814***	31.2***
NPM Model	16.8%***	−0.089***	−0.261***	24.7***

Notes: *** $p < 0.01$. Threshold estimated by grid search minimising RSS. Bootstrap 95% CI for γ^* (1,000 replications): ROA [14.2%, 20.8%]; ROE [15.1%, 21.4%]; NPM [13.9%, 19.7%]. F-test of parameter equality rejects H04 at 1% level.

Table 10 reveals that the inflation–profitability relationship is sharply non-linear. The estimated threshold $\gamma^* \approx$ 17–18 percent of annual inflation constitutes a regime boundary: below this threshold, the inflation effect on ROA is −0.118 percentage points per percentage point of inflation, while above the threshold, the effect nearly triples to −0.347 percentage points. This non-linearity reflects the combined effect of: (i) the exhaustion of firms' cost-absorption capacity as inflation rises above the threshold; (ii) the acceleration of raw material and energy cost increases above the pricing power of most consumer goods firms; and (iii) the intensification of regulatory scrutiny on transfer price adjustments precisely when firms most need to revise them. The F-test strongly rejects the null of parameter equality (H04 rejected), confirming that the inflation regime materially determines the magnitude of the profitability effect.

6. CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

This study has applied stochastic differential equation modelling and panel econometric methods to examine the effect of inflationary shocks on inter-company transfer prices and their consequent impact on the profitability of 23 quoted consumer goods firms in Nigeria over 1998–2025. The principal findings are as follows.

First, Nigeria's inflation process is best characterised not by a simple Geometric Brownian Motion but by a Jump-Diffusion model with Poisson jump intensity $\hat{\lambda} = 0.81$ per year and mean log-jump size $\hat{\mu}J = 0.24$. The GBM specification is statistically rejected in favour of the jump-diffusion alternative (LR = 31.4, $p < 0.001$). This finding has fundamental implications for corporate risk management: risk models that assume normally distributed inflationary shocks will systematically underestimate the frequency and magnitude of adverse profitability impacts.

Second, inter-company transfer prices adjust only partially and slowly to inflationary shocks, with an estimated adjustment speed of $\hat{\alpha}_1 = 0.173$, implying a half-life of approximately 3.6 years. The resulting structural lag between inflation acceleration and transfer price recalibration generates a persistent profitability wedge that is widest during high-inflation episodes and disproportionately severe for firms with rigid transfer pricing mechanisms.

Third, inflationary shocks exert statistically significant negative effects on all three profitability measures across fixed-effects and GMM specifications. The threshold regression identifies a non-linear break at approximately 17–18 percent annual inflation, above which the profitability effect nearly triples in magnitude. In the 2024 high-inflation environment (33.2%), sector median ROA is estimated to be suppressed by 7.9–10.6 percentage points relative to a counterfactual zero-inflation scenario.

Fourth, firms with adaptive transfer pricing strategies, characterised by more frequent and proportionate intra-group price revisions, outperform rigid-transfer-pricing peers by 5.3 percentage points of ROA in high-inflation regimes, confirming the value of dynamic pricing capabilities as a source of profitability resilience. MNE-affiliated firms exhibit systematically higher adaptive capacity, likely due to standardised group-wide transfer pricing policies, centralised treasury functions, and access to global benchmarking data.

6.2 Policy Recommendations

6.2.1 Inflation-Indexed Transfer Price Corridors

The FIRS should introduce formal guidance permitting intra-year or quarterly revision of arm's-length transfer price benchmarks when headline inflation exceeds the 17 percent threshold identified in this study. The current framework of annual benchmarking creates a 12-month window of price rigidity during which the arm's-length principle paradoxically encourages profitability distortion. An inflation-indexed transfer price corridor, analogous to inflation-linked bond indexation, would allow related-party transaction prices to adjust proportionally to the CPI within a regulatory safe harbour, reducing both the profitability wedge and the compliance cost of ad hoc transfer pricing documentation under inflationary stress.

6.2.2 Stochastic Risk Disclosure Requirements

The SEC and NGX should require quoted consumer goods firms with significant related-party transaction exposure (TPI > 15%) to disclose their transfer pricing sensitivity to inflationary scenarios in their annual reports, alongside quantified profitability impact estimates under two or three inflation scenarios calibrated to the CBN's Fan Chart projections. This would improve investor information quality and incentivise firms to develop and disclose more sophisticated inflation-adaptive transfer pricing frameworks.

6.2.3 Monetary Policy Coordination

The Central Bank of Nigeria should factor corporate transfer pricing rigidity into its inflation transmission models. The finding that transfer price stickiness creates a supply-side amplifier of inflationary profit compression implies that monetary tightening during high-inflation episodes generates additional contractionary effects on the consumer goods sector beyond those captured by standard interest rate channels. A coordinated monetary-fiscal approach, in which the CBN's inflation targets are communicated with sufficient lead time to allow corporate treasury planning, would reduce the welfare costs of inflation-induced transfer price distortions.

6.2.4 Capacity Building for Indigenous Firms

The gap in adaptive capacity between MNE affiliates and indigenous Nigerian firms is a policy concern, as indigenous firms bear a disproportionate profitability burden during high-inflation episodes. The FIRS, in collaboration with the Nigerian Association of Chambers of Commerce, Industry, Mines and

Agriculture (NACCIMA), should develop simplified transfer pricing documentation toolkits for indigenous conglomerates, including inflation-adjustment clauses and sector-specific benchmarking databases that reduce the compliance cost of frequent intra-year price revisions.

6.3 Limitations and Future Research Directions

Several limitations merit acknowledgement. First, the transfer pricing intensity variable is an approximation derived from related-party transaction disclosures in financial statement notes, rather than directly observed transfer price schedules, which are proprietary. Future research could collaborate with FIRS to access administrative transfer pricing audit data, enabling more precise measurement. Second, the study's stochastic model assumes time-homogeneous jump parameters; a regime-switching extension allowing λ and μJ to vary across macroeconomic states could improve model fit during the 2016–2017 and 2023–2025 crisis episodes. Third, the analysis is limited to equity-quoted firms, which are larger and more institutionally sophisticated than unlisted entities in the sector; results may not generalise to small and medium-sized intra-group transactions.

Future research directions include: the application of real options theory to model transfer pricing as a portfolio of embedded options on intra-group procurement; the extension of the framework to the financial services and telecommunications sectors; and the development of a structural dynamic model in which optimal transfer pricing, tax minimisation, and inflation hedging are jointly determined under stochastic constraints.

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APPENDICES

Appendix A: Monte Carlo Simulation Protocol

The Monte Carlo simulation proceeds in five steps: (1) Calibrate the Jump-Diffusion parameters (μ, σ, λ, μJ, σJ) from the MLE of the CPI series, 1998–2025; (2) Simulate 10,000 sample paths of the Jump-Diffusion process over a 27-year horizon using the Euler-Maruyama discretisation scheme with daily time steps ($\Delta t = 1/365$); (3) For each simulated path, compute annual inflation rates and apply the partial adjustment equation (9) to obtain simulated TPI series; (4) Insert simulated π and TPI values into the estimated panel regression equation to generate simulated profitability distributions for each year; (5) Compute summary statistics (mean, standard deviation, VaR_{95}, VaR_{99}, Expected Shortfall) of the simulated profitability distribution. The simulation is implemented in R (version 4.3.2) using the sde and SimDiffProc packages. Convergence is confirmed by comparing the first four sample moments of 1,000, 5,000, and 10,000 path sets; estimates stabilise at 10,000 paths with less than 0.3 percent change.

Appendix B: Hausman Test Results

Table A1: Hausman Specification Test — Fixed Effects vs. Random Effects

Profitability Measure	Chi-Sq. Statistic	Degrees of Freedom	p-value
ROA (Model 1)	38.41	8	0.000
ROA (Model 2 — with TPI)	54.87	10	0.000
ROE (Model 3)	47.23	8	0.000
ROE (Model 4 — with TPI)	62.14	10	0.000
NPM (Model 5)	41.88	8	0.000

Notes: Null hypothesis: RE estimator is consistent and efficient (random effects preferred). Rejection at $p < 0.001$ across all models confirms preference for fixed-effects specification.

Appendix C: Variance Inflation Factor (VIF) Analysis

Table A2: Variance Inflation Factors — Multicollinearity Assessment

Variable	VIF	1/VIF (Tolerance)
Inflation rate (π)	2.41	0.415
Transfer Pricing Intensity (TPI)	1.87	0.535
π × TPI Interaction	3.12	0.321
Firm Size (log Assets)	1.94	0.515
Leverage (D/E)	2.03	0.493
Working Capital Ratio	1.68	0.595
Real GDP Growth	2.17	0.461
Mean VIF	2.17	—

Notes: VIF < 5 for all variables; mean VIF = 2.17. No evidence of problematic multicollinearity. Threshold for concern: VIF > 10 (Kutner *et al*., 2005).

Appendix D: Robustness Check — Core Inflation Specification

To assess sensitivity to the choice of inflation measure, the main panel fixed-effects specifications were re-estimated using core inflation (ex-food and energy) as an alternative to headline inflation. The results are qualitatively identical: the core inflation coefficient on ROA is −0.271*** (se = 0.063) compared to the headline inflation estimate of −0.319*** (se = 0.058) in Model 2. The interaction term π(core) × TPI is −0.159*** (se = 0.051), statistically consistent with the headline specification. These results confirm that the profitability effects are not solely driven by food and energy price spikes but persist in the underlying core price dynamics. The somewhat smaller magnitude of core inflation effects is consistent with the greater pass-through capacity of consumer goods firms for food and energy input costs through final product pricing.