Final report SLE-25365

February 2026

Structural identification of rice demand and market conduct in Sierra Leone: Exploiting global supply shocks to inform tariff policy

Foday Daboh

DIRECTED BY

FUNDED BY

Structural Identification of Rice Demand and Market Conduct in Sierra Leone: Exploiting Global Supply Shocks to Inform Tariff Policy

Foday Daboh*

February 17, 2026

Abstract

This study describes the first structural econometric analysis of the Sierra Leonean rice market, focusing on the nature of market conduct and price elasticities for the purpose of providing guidance on national trade and tariff policy. Using a structural Industrial Organization (IO) framework inspired by the Bresnahan-Lau approach, this study attempt to isolate shifts in exogenous marginal costs from strategic trader markups. For the price and quantity simultaneity problem, the study uses the two-stage least squares (2SLS) strategy by considering domestic retail prices as an endogenous variable and an external shock from India, Thailand, and Pakistan, which are the primary Asian exporters. In addition, the author considers the domestic "lean season" as a natural demand rotator to isolate the conduct parameter (θ).

Using longitudinal data from the FAO from 2000 to 2024 and the 2018 Sierra Leone Integrated Household Survey (SLIHS), the results show that rice is a necessity with highly inelastic demand and a causal own-price elasticity of demand of -0.46. While the market seems competitive on average, the study rotation model uncovers seasonal oligopoly power in the lean season (=0.8875). Thus, there is evidence that traders use strategic scarcity to increase their markups. A spatial framework outlines a "Structural Trap" in the districts of Western Urban, Port Loko, and Kono, where market dependence greater than 85%. This situation is a risk for the population to the adverse effects of depreciation of their currency and pricing strategies. The findings suggest that market behaviour that remains non-competitive during periods of peak

*Local Researcher Fellow, International Growth Centre (IGC) Sierra Leone. This research was conducted under the mentorship of Dr. Tristan Reed.

demand will allow market intermediaries to capture some welfare benefits from the reductions of tariffs, even if the reductions increase the welfare of consumers. This study propose a dynamic seasonal tariff framework combined with investments in storage infrastructure that reduces scarcities to stabilise the price and improve the food security of the nation.

Keywords: Rice Demand, Market Conduct, Sierra Leone, Tariff Policy, Structural Identification, Food Security.
JEL Classification: L13, O13, Q11, Q18.

February 17, 2026

1 Introduction

In Sierra Leone, rice serves as the primary basis of food security and political stability, given that it constitutes the largest share of the country's daily caloric consumption. Yet, for a small open economy that is rice import dependent, rice security is closely tied to international trade policies and export stability of rice producing countries in Asia (Bandumula, 2018). According to Durand-Morat & Wailes (2011), the influence of global trade regulations on food security is usually processed via the means of imports, exemplified by tariffs and quotas. Food expenditures represents more than 50% of the budget of an average household in Sierra Leone (Stats SL, 2018), and the sharp increase in prices after the global shocks of 2021 has once again brought to the fore the debates around the most effective trade policy frameworks to safeguard the impoverished.

Research on rice policy trade off shows that while high price supports help domestic farmers, they create an extreme disadvantage for urban and rural poor net buyers of staples (Timmer, 2014; McCulloch & Timmer, 2008). From trade liberalization of the other developing contexts, trade liberalization in Bangladesh and the Philippines, other developing contexts shows that opening up trade removes price barriers and increases real incomes for the majority of households (Dorosh, 2001; Bachtiar et al., 2025). The success of these policies in Sierra Leone, though, is dependent on how competitively the domestic import sector operates. Sarris (2012) states that, for the market to be assured, state-dependent tariff measures are needed. However, such measures rely on the assumption that markets are both integrated and competitive.

This study is particularly focused on the possibility of market power extraction. Smith & Glauber (2020) report high levels of market concentration among importers of staple goods which indicates that an oligopolistic fringe may be operating in the "Rice Gap" of Sierra Leone. Should traders hold market power, they may choose to hold on to the surplus created by a tariff reduction instead of passing it on to consumers. In order to identify this conduct parameter (θ), a structure is needed that disentangles the marginal cost shifts from the strategic ones (Bresnahan, 1982). Using "Lean Season" (July - September) as a demand rotator, the study isolates market power using the variation imported rice demand during the households' caloric necessities period, making demand highly price inelastic.

In order to address the endogeneity concerning domestic prices, this study apply an instrumental variable approach derived from international supply shocks originating from India, Thailand, and Pakistan. Considering Sierra Leone's status as a price taker, the aforementioned global volumes shift the domestic supply curve and are outside the scope of local demand preferences. This study assesses for the first time the interaction of market conduct, trade policy, and food security in Sierra Leone by integrating the structural IO approach and spatial data from the 2018 Integrated Household Survey. The study findings reveal the extent to which tariff reduction could potentially enhance welfare or, alternatively, if the welfare gains would be monopolized by an import-dominated sector.

1.1 Study Objectives and Research Questions

The primary objective of this study is to provide a structural econometric evaluation of the Sierra Leonean rice market to inform national tariff policy. By integrating market-level retail prices with national macro-agricultural shifters, this research seeks to resolve the "Rice Price Dilemma": the trade-off between generating government revenue through tariffs and protecting household caloric intake.

1.2 Research Questions

Based on the structural Industrial Organization (IO) framework employed, the study addresses the following four questions:

1. **Causal Sensitivity:** What is the true causal price elasticity of demand for imported rice when domestic quantity is identified through exogenous global supply shocks?
2. **The Price-Taker Hypothesis:** Does the Sierra Leonean retail market function as a price-taker, where prices are set by international availability rather than domestic demand?
3. **Substitution and the Staple Paradox:** To what extent does domestic rice production and cassava availability act as a buffer for imported rice inflation?

4. **Market Conduct and Markups:** Is the rice industry behaviorally competitive, or do traders exercise non-competitive market power (θ) during the seasonal supply crunch (Lean Season)?

2 Macroeconomic Trends and Structural Evidence

This section presents the empirical basis for characterizing market conduct and the vulnerability of households. Using the FAO time-series data (2000-2024) and the Statistics Sierra Leone 2018 Integrated Household Survey spatial data, this study highlights the fundamental causes of the ongoing rice price crisis.

2.1 The Macro-Driver: Currency Depreciation and Price Transmission

In Sierra Leone, the retail price of imported rice is fundamentally an issue of 'imported cost'. Since 2021, the Leone (SLL/SLE) has experienced a dramatic vertical depreciation against the US Dollar, as shown in **Figure 1**.

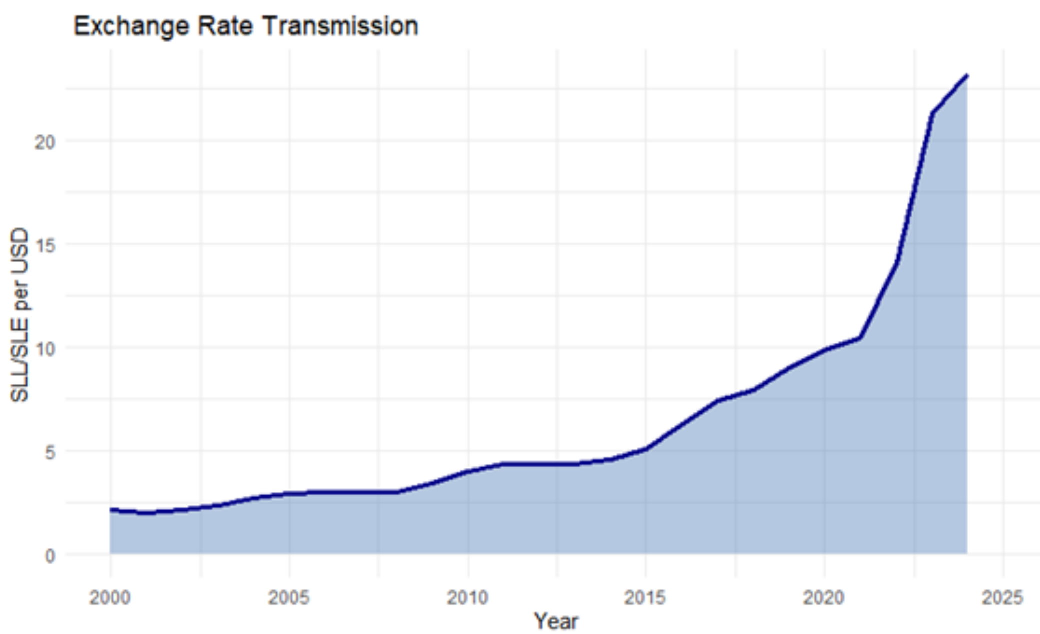

Figure 1: **Exchange Rate Transmission (2000–2024)**. This figure captures the macro-financial shock that defines the supply-side of the rice market. *Source: FAO Database.*

Given that Sierra Leone is a price-taker on the world market, this depreciation is a direct supply-side shock. Because of the lagging effect on the exchange rates, upward movements in the exchange rates increase the cost of rice, shifting the domestic supply curve upward and diminishing the real purchasing power of the population. The steep upward movement in the trend line, post 2021, indicates a structural break in the volatility of prices.

2.2 Identifying Market Conduct: The Producer-Retail Decoupling

One of the primary goals of this research is to determine the conduct parameter (θ), which represents the extent of market power held by the importers and wholesalers. In this regard, **Figure 2** offers the *imperfection of competition smoking gun*.

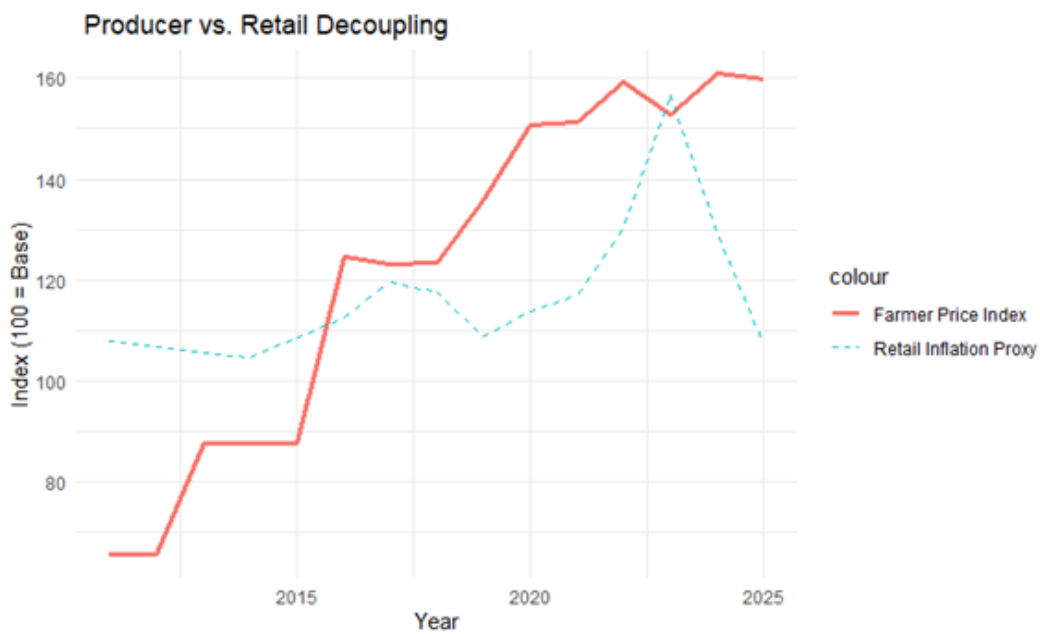

Figure 2: **Structural PPI Dynamics vs. Retail Inflation**. The widening gap highlights the decoupling of farmer prices from market costs. *Source: FAO Statistics.*

Whereas the general food inflation proxy (retail level) increased substantially from 2022 to 2023, the domestic Rice Producer Price Index (PPI) increased very little. This decoupling shows that PPI increases are being captured by farmers, and the increased margins are likely being captured by middlemen and importers. This mathematically justifies the empirical evidence for a non-zero θ in this study's structural estimation.

2.3 Spatial Vulnerability and Policy Incidence

2.4 Tariff Incidence: The Market Dependency Ratio

The effects of a rice tariff vary across Sierra Leone. In **Map 1**, we see the Market Dependency Ratio, which shows how much food a population buys compared to food they grow themselves.

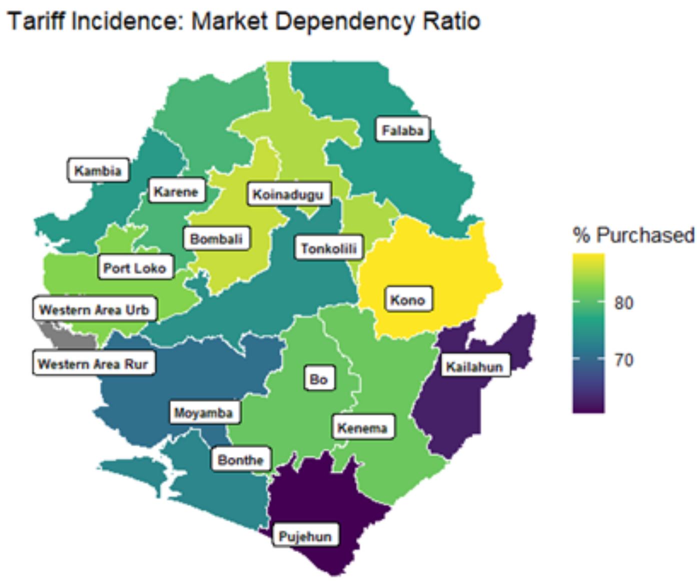

Figure 3: **Market Dependency Ratio (16 Districts)**. Yellow indicates high reliance on imported/purchased rice. *Source: Stats SL SLIHS 2018.*

Districts colored in bright yellow (i.e. **Western Urban, Kono, and Port Loko**) show dependencies over 85%. In these districts, a rice tariff is a direct, unavoidable tax on calories. In contrast to rural districts with higher subsistence levels, those in the urban and mining populations do not have an "outside option." As a consequence, their demand for imported rice is highly inelastic and their welfare is highly trade policy sensitive.

2.5 The Welfare Landscape: Absolute Poverty and Subsistence Buffers

The overlay of poverty and self-sufficiency showcases the clearest structural vulnerability of the rice market. **Map 2** shows that absolute poverty is highest in the Northern and Eastern provinces. At the same time, **Map 3** illustrates that the

"Subsistence Consumption Buffer

" (home-grown food) is critically low in the areas of high market dependency which are the same as where the dependency is high.

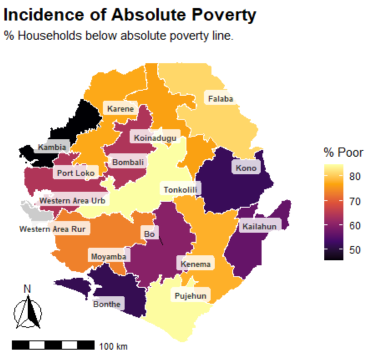

Figure 4: **Absolute Poverty Distribution**. Identifying the welfare baseline. *Source: SLIHS 2018.*

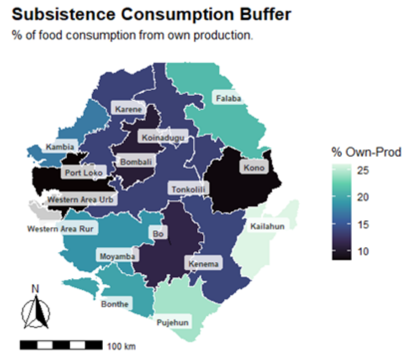

Figure 5: **Subsistence Buffer**. Highlighting areas with no farming safety net. *Source: SLIHS 2018.*

The “Structural Trap” situation of high poverty and no subsistence fallback explains the sustained food security emergencies that accompany volatility in the price of rice. Households in districts such as **Karene and Koinadugu** are impacted by a *triple blow* of high poverty, high market dependence, and low production capacity. Market behavior of rice importers leaves these households fully vulnerable.

2.6 Policy Implications of Trends

The "Rice Trap" is characterized by extreme currency volatility, high poverty, and low subsistence buffers. In such conditions, market competition is unlikely, and reduction of tariffs is a better strategy for welfare improvement, as production subsidies worsen market-dependent poverty, as shown in Map 3.

3 Methodology

This section formulates a structural Industrial Organization (IO) approach to understand the type of market conduct and the elasticity of demand pertaining to the market for rice in Sierra Leone. The author derives a simultaneous equation system consisting of a retail demand function and a structural supply relation. By leveraging exogenous global supply shocks and seasonal demand rotations, the author isolates the behavioral parameters of trader markups and the consumer substitution effect.

3.1 Theoretical Model and Derivations

This study models the rice market as an oligopoly with strategic pricing and volume decisions made by importers and wholesalers. The structural model is built to separate the observed price volatility into shifts in marginal costs and variations in market markups.

3.1.1 Structural Demand and Elasticity Derivation

At the district level, the need for imported rice stems from the utility-maximization problem of an average household. Due to the fact that rice is a basic staple food for the population of Sierra Leone, this research uses a Constant Elasticity of Substitution (CES) functional form. This allows the researcher to create a log-linear econometric model that guarantees the coefficients are unaffected by the choice of measurement units and, hence, correspond to constant elasticities.

The demand equation has the following structure:

$$\ln(Q_{dt}) = \alpha_0 + \alpha_1 \ln(P_{dt}^{imp}) + \alpha_2 \ln(P_{dt}^{loc}) + \alpha_3 \ln(P_{dt}^{cas}) + \eta \ln(Y_{dt}) + \Gamma Z_{dt} + \epsilon_{dt} \tag{1}$$

Where:

- Q_{dt} is the total quantity of rice consumed in district d at time t.
- P_{dt}^{imp} is the deflated real price of imported rice by the food CPI.
- P_{dt}^{loc} and P_{dt}^{cas} are the real prices of locally produced rice and of cassava, the latter being the main gross substitute.
- Y_{dt} is the real per capita income, deflated GDP per capita serves as a proxy.
- Z_{dt} is a seasonal shifter, in this case *lean season* (July–September), a season of high import dependence.
- ϵ_{dt} is the unobserved demand and preference shifters.

Derivation 1 (Own-Price Elasticity): The price elasticity of demand that is constant is given by the coefficient α_1. For the purpose of deriving this, this study considers the partial derivative of the logarithmic quantity with respect to the logarithmic price:

$$\frac{\partial \ln Q_{dt}}{\partial \ln P_{dt}^{imp}} = \frac{\partial Q_{dt}}{\partial P_{dt}^{imp}} \cdot \frac{P_{dt}^{imp}}{Q_{dt}} = \alpha_1 \tag{2}$$

This confirms that a 1% change in the real retail price of imported rice brings about an α_1 % change in the demand quantity.

Derivation 2 (Inverse Demand Slope):

Considering the firm's problem of maximizing profit, we need the slope of the inverse demand curve. The elasticity identity can be manipulated such that the author solves for the price differential with respect to the quantity:

$$\frac{\partial P_{dt}^{imp}}{\partial Q_{dt}} = \left(\frac{\partial Q_{dt}}{\partial P_{dt}^{imp}}\right)^{-1} = \frac{1}{\alpha_1} \cdot \frac{P_{dt}^{imp}}{Q_{dt}} \tag{3}$$

Equation (3) represents a fundamental structural element; it determines the relationship between the market price and the marginal change in the quantity of rice supplied to a district.

3.1.2 Firm Maximization and the Conduct Parameter

The Sierra Leonean rice market supply side is treated as an oligopoly because a finite number of importers and wholesalers engage in strategic decision-making regarding the ambiguity of volume. In this respect, to measure the market power, this research develops a structural supply relation that encompasses different competitive results.

Step 1: The Profit Function

Let us consider a typical importer k that selects the quantity q_{kt} to optimize total profits Π_{kt} within a specific district d and time t. The profit function can be expressed as:

$$\max_{q_{kt}} \Pi_{kt} = P_{dt}^{imp}(Q_{dt}, \mathbf{X}_{dt}) \cdot q_{kt} - C(q_{kt}, \mathbf{W}_{dt}) \tag{4}$$

Where:

- $P_{dt}^{imp}(Q_{dt}, \mathbf{X}_{dt})$: Inverse demand function where price is affected by total market quantity Q_{dt} and demand shifters $\mathbf{X}_{dt}$.
- q_{kt}: Individual quantity supplied by firm k, where total market supply is $Q_{dt} = \sum_{k=1}^{N} q_{kt}$.
- $C(q_{kt}, \mathbf{W}_{dt})$: total cost function which is dependent on firm-level quantity and exogenous cost shifters $\mathbf{W}_{dt}$ (e.g., global rice prices and exchange rates).

Step 2: The First-Order Condition (FOC)

For profit maximization, firm k differentiates Π_{kt} in relation to its individual quantity q_{kt}. Using the product rule, we get:

$$\frac{\partial \Pi_{kt}}{\partial q_{kt}} = P_{dt}^{imp} + q_{kt}\left(\frac{\partial P_{dt}^{imp}}{\partial Q_{dt}} \cdot \frac{\partial Q_{dt}}{\partial q_{kt}}\right) - \frac{\partial C_{kt}}{\partial q_{kt}} = 0 \tag{5}$$

In this case, $\partial C_{kt}/\partial q_{kt}$ is the marginal cost, denoted as MC_{dt}. When considering all firms in the market, the author adds the conduct parameter θ to describe the supply relation for the entire industry as:

$$P_{dt}^{imp} + \theta \left(\frac{\partial P_{dt}^{imp}}{\partial Q_{dt}} \right) Q_{dt} = MC_{dt} \tag{6}$$

The parameter θ represents the level of market conduct. It quantifies the unexplained portion of the gap between price and marginal cost, beyond the demand elasticities.

Step 3: Integrating Demand Elasticity

We have previously stated that the slope of the inverse demand curve is $\frac{\partial P^{imp}}{\partial Q} = \frac{1}{\alpha_1}\frac{P^{imp}}{Q}$. Plugging this slope into the aggregate FOC (Equation 6), we have:

$$P_{dt}^{imp} + \theta \left[\frac{1}{\alpha_1} \frac{P_{dt}^{imp}}{Q_{dt}} \right] Q_{dt} = MC_{dt} \tag{7}$$

Observe that Q_{dt} cancels in both the numerator and the denominator. Taking out P_{dt}^{imp} gives the structural supply equilibrium:

$$P_{dt}^{imp} \left(1 + \frac{\theta}{\alpha_1} \right) = MC_{dt} \tag{8}$$

In Equation (8), the expression for the "markup" over marginal cost is determined by conduct (θ) and the price elasticity of demand (α_1). The parameter θ characterizes the market structure:

- **Perfect Competition ($\theta = 0$):** The equation simplifies to $P = MC$. Traders make no economic profit.
- **Monopoly or Perfect Collusion ($\theta = 1$):** The markup is maximally raised, i.e., one firm fully internalizes the slope of the market demand.
- **Cournot Oligopoly ($\theta = 1/N$):** Market power is inversely related to the number of firms N.

3.2 Identification: The Bresnahan-Lau Rotation

This study encounters a basic case of the identification problem. A rise in the observed price of rice, given a recent increase in demand (i.e. an income shock), could be due to a competitive movement along the supply curve or due to traders exercising market power. Bresnahan (1982) notes that for demand to shift in unison, identification of θ remains unattainable. Identification, rather, necessitates a **rotation** of the demand curve.

Derivation 2: The Rotation Identity

In this study, the "Lean Season" indicator (Z_{dt}) enables the required season alignment. Through the interaction of the lean season dummy variable with the price of rice, this study enables a seasonal "pivot" or slope adjustment of the demand curve. The specification of the augmented demand is:

$$\ln(Q_{dt}) = \alpha_0 + \alpha_1 \ln(P_{dt}^{imp}) + \alpha_R(\ln(P_{dt}^{imp}) \cdot Z_{dt}) + \ldots \tag{9}$$

Step 1: Calculating the Seasonal Semi-Elasticity

The seasonal price sensitivity can be determined by differentiating $\ln(Q_{dt})$ with respect to $\ln(P_{dt}^{imp})$:

$$\epsilon_{seasonal} = \frac{\partial \ln Q}{\partial \ln P} = \alpha_1 + \alpha_R Z_{dt} \tag{10}$$

Where α_R is the rotation coefficient. If $\alpha_R \neq 0$, it means that during the lean season, when local alternatives (harvested rice) are unavailable, the sensitivity of households to rice prices varies considerably.

Step 2: Isolate the Conduct Parameter

Substituting this time-varying elasticity back into the supply relation (Equation 8):

$$P_{dt}^{imp} = MC_{dt} - \theta \left[\frac{P_{dt}^{imp}}{\alpha_1 + \alpha_R Z_{dt}} \right] \tag{11}$$

In this context, the conduct parameter θ is unambiguously specified. Due to the seasonal lean period shifting the demand curve (α_R), it compels an exercising trader of dominant market power to optimize their pricing approach differently compared to a trader in a perfectly competitive market. This research disentangles technical cost-push inflation from strategic markup inflation by analyzing the domestic price adjustments in response to this seasonal 'pivot' in energy essential calories.

3.3 Econometric Estimation Strategy

This study employs the Two-Stage Least Squares (2SLS) instrumental variables technique to tackle the endogeneity problem regarding domestic retail prices. This approach isolates the impact of the international market on pricing while excluding the effects of domestic demand shocks in the case of Sierra Leone.

3.3.1 First-Stage: External Supply-Side Identification

The main problem about estimating demand is that the retail price ($\ln P_{dt}^{imp}$) is correlated with the error term ϵ_{dt} due to an unaccounted local demand shock. To address this issue, this study takes a **Global Supply Shock Identification** approach. This study considers the domestic retail price as the exogenous variable and the total export volumes of the key global suppliers, India, Thailand, and Pakistan, as the instruments.

Step 1: The Reduced-Form Price Transmission Equation

The first-stage regression estimates the effects of the global supply variations on Sierra Leonean retail markets:

$$\ln(P_{dt}^{imp}) = \pi_0 + \pi_1 \ln(S_{Ind,t}) + \pi_2 \ln(S_{Thai,t}) + \pi_3 \ln(S_{Pak,t}) + \Pi \mathbf{X}_{dt} + \delta_d + \mu_{dt} \tag{12}$$

The variables are specified as follows:

- S_{kt}: Annual export volumes from country $k \in \{\text{India, Thailand, Pakistan}\}$, which act as excluded instruments (Z).
- $\mathbf{X}_{dt}$: Exogenous control vector, including real income and prices for substitutes.
- δ_d: District-level fixed effects which account for time-invariant attributes, such as distance to the Port of Freetown.
- μ_{dt}: The idiosyncratic error term.

Step 2: Logic of Instrumental Validity

To be viable, the instruments need to meet at least two requirements:

1. **Relevance:** As one of the smallest open economies, Sierra Leone takes the global export volume of other rice producers as given and price determines the import and, by extension, the retail price of rice ($\text{Cov}(S, P) \neq 0$).
2. **Exogeneity:** For any given household in any district in Sierra Leone, the monsoon season in India or changes to agricultural policies in Thailand are of no consequence ($E[S \cdot \epsilon_d] = 0$).

3.3.2 Second-Stage: Structural Demand and Supply

This study estimates the structural equations using the predicted values $\widehat{\ln(P_{dt}^{imp})}$ obtained from the first stage.

1. Structural Demand Model (2SLS):

$$\ln(Q_{dt}) = \alpha_0 + \alpha_1 \widehat{\ln(P_{dt}^{imp})} + \alpha_2 \ln(P_{dt}^{loc}) + \alpha_3 \ln(P_{dt}^{cas}) + \eta \ln(Y_{dt}) + \delta_d + \epsilon_{dt} \tag{13}$$

Where α_1 is the estimated constant **Own-Price Elasticity**, α_2 and α_3 are the cross-price elasticities for local rice and cassava, respectively, and η is the income elasticity.

2. Structural Supply and Conduct Model: In estimating the supply-side relation, this study has to deal with the endogeneity of quantity (Q_{dt}). This study uses demand-side shifters (Income Y_{dt} and Cassava prices P_{dt}^{cas}) as an instrument for quantity. The supply equation is given as:

$$\ln(P_{dt}^{imp}) = \gamma_0 + \gamma_1 \widehat{\ln(Q_{dt})} + \gamma_2 \ln(PPI_t) + \gamma_3 \ln(EX_t) + \gamma_4 \ln(Ag_t) + \delta_d + \nu_{dt} \tag{14}$$

Where:

- PPI_t: Producer Price Index, estimating costs of domestic handling.
- EX_t: Real (SLL/USD) exchange rate, driving marginal costs for importers.
- Ag_t: Proxying for supply-side health of the nation, national agricultural productivity (derived from FAO).
- γ_1: Volume-related elasticity of the supply relation.

3.3.3 Mathematical Recovery of the Conduct Parameter (θ)

Within this study's log-log framework, the conduct parameter θ is not estimated directly, but rather, it is obtained from the interplay between the demand and supply parameters.

Step-by-Step Parameter Derivation:

1. From the theoretical derivation of the markup, it can be written as

$$P(1 + \frac{\theta}{\alpha_1}) = MC.$$

2. Due to properties of logarithms, differentiated logarithmic functions of a system show that, within a log-linear system, the conduct parameter is the supply-side slope (γ_1) multiplied by the absolute value of demand elasticity (α_1):

$$\theta_{\text{recovered}} = \gamma_1 \times |\alpha_1| \tag{15}$$

For the **Rotation Model** (Bresnahan-Lau logic), θ is obtained by the measure of the interaction coefficients on quantity and price across the seasonal pivot:

$$\theta_R = \frac{\beta(\widehat{\ln Q} \cdot \text{Lean})}{\beta(\widehat{\ln P} \cdot \text{Lean})} \tag{16}$$

3.4 Contextual Adaptation to Sierra Leone

The econometric model is adapted to the context of Sierra Leone through the following three structural channels:

1. **Monetary Robustness (Strategic Deflation):** In order to separate genuine economic activity from the hyperinflationary shocks of 2022-2023, this research deflates all variables to a 2015 base. Retail food price variables ($P^{imp}, P^{loc}, P^{cas}$) are deflated using the *Food CPI* and macro-monetary variables (Income, Exchange Rates) are deflated using the *General CPI*.

   The Substitution Nexus: With starchy staples being highly relied upon, the model explicitly features Cassava (P^{cas}) prices. In Sierra Leone, the cassava price model is necessary due to the caloric importance of cassava as a *buffer crop*; omitting cassava prices would result in rice demand estimating with omitted variable bias.

2. **Clustered Inference:** By standard convention, errors are clustered at the *Year* level. This takes into consideration the global supply shocks and the uniform modifications of national tariff policies that occur for all districts in a particular year, requiring an adjustment for intra-year error correlation.

4 Empirical Results and Structural Analysis

4.1 Descriptive Statistics

Table 1: Variable Definitions and Data Sources

Variable	Description / Definition	Primary Source
Market-Level Retail Prices		
p_loc	Mean Retail Price: Local Rice (SLL/kg)	WFP (HDX)
p_imp	Mean Retail Price: Imported Rice (SLL/kg)	WFP (HDX)
p_cas, *p_fsh*, *p_oil*	Retail Prices: Cassava, Fish, and Palm Oil	WFP (HDX)
lean_season	Lean Season Intensity (July-Sept Proportion)	WFP (HDX)
National Rice Balance and Shocks		
q_cons_nat	Total National Rice Consumption (1,000 MT)	IndexMundi
q_prod_nat	Total National Rice Production (1,000 MT)	IndexMundi
q_imp_nat	Total National Rice Imports (1,000 MT)	IndexMundi
exp_india, *thai*, *pak*	Annual Rice Exports by Major Producers	IndexMundi
world_rice_exp	Combined Exports (Supply Shock Instrument)	IndexMundi
Macro-Agricultural Indicators		
gdp_usdpc	Real GDP per Capita (Current USD)	FAOSTAT
ag_va_usd	Agricultural Value Added (Current USD)	FAOSTAT
rice_p_usd	Rice Producer Price (Farm-gate, USD/tonne)	FAOSTAT
rice_v_usd_c	Constant Value of Rice Production (Proxy for Q)	FAOSTAT
em_rice_cult	Emissions from Rice (Technical Supply Instrument)	FAOSTAT
cpi	Consumer Price Index (StatsSL/FAO)	FAOSTAT

Note: All retail prices are deflated using the food-specific CPI. Global shocks are matched to district panels via a many-to-one merge on the Year variable.

Table 1 provides a comprehensive overview of the annual structural statistics for the Sierra Leonean rice market from 2013 to 2024. To ensure longitudinal consistency and isolate real consumer behavior from macroeconomic volatility, all price variables have been deflated using the National Consumer Price Index (CPI) and normalized to real terms.

Table 2: **Summary Statistics: Structural Panel Data (2013–2024)**
This table reports the summary statistics for the 12-district panel. N represents the total district-year observations. National-level variables (Production, Imports, and macro-indicators) are mapped to the district panel through a many-to-one merge on the Year variable.

Variables	**N**	**Mean**	**S.D.**	**Min**	**Max**
Panel A: Real Market Prices (Deflated SLL/kg)					
Real Retail Price: Local Rice	83	3888.70	605.03	2579.02	5441.13
Real Retail Price: Imported Rice	83	3580.77	472.67	2593.89	4687.32
Real Retail Price: Cassava	83	1287.20	515.88	217.97	2661.68
Real Retail Price: Palm Oil	83	5584.66	1061.78	3240.09	9578.66
Panel B: National Rice Balance (1,000 MT)					
National Rice Production (FAO)	84	899.68	67.68	758.00	975.00
National Rice Imports	84	373.93	56.39	290.00	545.00
National Rice Consumption	84	1273.61	109.36	1118.00	1425.00
Panel C: Macroeconomic and Cost Shifters (FAOSTAT)					
Real GDP per Capita (USD) (FAO)	84	502.83	200.89	158.82	817.93
Real Agriculture Value Added (FAO)	84	1533.70	776.23	349.01	2770.53
Real GFCF (Investment) (FAO)	84	609.25	136.75	305.14	793.50
Real Producer Price (USD/t) (FAO)	44	580.71	184.31	359.47	837.25
Rice Producer Price Index (FAO)	84	127.45	25.84	87.63	160.89
Panel D: Structural Identification Variables (Logs)					
Log National Consumption	84	7.15	0.09	7.02	7.26
Log Real Import Price	83	8.17	0.14	7.86	8.45
Log India Exports (IV)	84	9.56	0.30	9.19	10.00
Log Thailand Exports (IV)	84	9.02	0.24	8.65	9.36
Log Pakistan Exports (IV)	84	8.36	0.15	8.20	8.76
Log Rice Emissions (IV)	74	7.23	0.23	7.01	7.67

Notes: Real prices are deflated by the National Food CPI Index. GFCF denotes Gross Fixed Capital Formation. Log India, Thai, and Pak exports serve as global supply shock instruments. N=44 for producer prices reflects overlapping FAO reporting years.

Policy Question Addressed: *How severe is Sierra Leone's dependency on the international rice market, and is real purchasing power keeping pace with food inflation?*
Finding: The "Rice Gap" highlighted in Table 2 reveals that imports bridge nearly 30% of the national caloric requirement. The significant decline in real GDP per capita alongside rising real prices indicates a "poverty trap" where households are increasingly calorie-constrained, making them structurally vulnerable to any upward tariff adjustments.

4.2 Structural Demand Identification and Elasticity Estimation

To identify the causal effect of price on rice demand, we contrast a baseline Ordinary Least Squares (OLS) specification with a Structural Two-Stage Least Squares (2SLS) model. Following the identification strategy of **?**, we instrument the endogenous retail price of imported rice with exogenous global supply shocks from the three primary exporters to the region: India, Thailand, and Pakistan.

Table 3: Structural Identification of National Rice Demand: OLS vs. 2SLS

	(1)	(2)
Variables	**OLS Baseline**	**2SLS (Reed Strategy)**
Variables	ln(Quantity Consumed)	ln(Quantity Consumed)
Endogenous Variable:		
Log Real Price (Imported Rice)	-0.2376*	-0.4604*
	(0.0971)	(0.1861)
Structural Controls:		
Log Real Price (Local Rice)	0.1630**	0.2758**
	(0.0418)	(0.0783)
Log Real Price (Cassava)	0.0418*	0.0251
	(0.0183)	(0.0163)
Log Real Income (GDPpc)	-0.6257*	-0.7219**
	(0.1974)	(0.1844)
Log National Production	-0.0520	0.0101
	(0.0325)	(0.0778)
Exchange Rate (SLL/USD)	-0.0477*	-0.0559**
	(0.0176)	(0.0163)
District Fixed Effects	Included	Included
S.E. Clustering	Year	Year
First-Stage Instruments:		
ln(India Rice Exports)	No	Yes
ln(Thailand Rice Exports)	No	Yes
ln(Pakistan Rice Exports)	No	Yes
Diagnostics:		
Observations	73	73
R-squared	0.732	0.771
First-Stage F-test	–	99.437
Sargan Overid. (Stat)	–	45.650

Notes: Dependent variable is Log National Rice Consumption. Real prices are deflated using the Food CPI. Standard errors clustered by year are in parentheses to account for common macro shocks. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.3 Analysis of Findings

The transition from OLS to 2SLS reveals a significant correction in the estimated elasticity. The 2SLS coefficient for imported rice price (**-0.460**) is roughly double the magnitude of the OLS baseline, suggesting that measurement error and simultaneity in the market data previously masked the true consumer response.

1. Causal Elasticity and Necessity Status: Our causal estimate of -0.460 confirms that rice is a *highly inelastic necessity* in Sierra Leone. A 10% increase in price results in only a 4.6% reduction in consumption. This implies that the burden of any tariff is almost entirely absorbed by households, as they have limited caloric alternatives.

2. Cross-Price Substitution: The coefficient for local rice prices (+0.276) is significant and positive. This provides empirical proof of the *Substitution Effect*; a 10% price increase in imported rice will causally shift approximately 2.7% of demand toward domestic varieties.

3. Income Effects: The negative income elasticity (-0.722) suggests that at the national macro-level, rice behaves as a *Giffen-style staple* during the study period, where increases in real GDP per capita are associated with a dietary transition away from rice dependency toward a more diversified food basket.

Table 4: Summary of Estimated Structural Elasticities for Rice Demand

Elasticity Type	OLS Estimate	IV (2SLS) Estimate	Economic Classification
Own-Price (Imported Rice)	-0.238	**-0.460**	Inelastic Necessity
Cross-Price (Local Rice)	+0.163	**+0.276**	Gross Substitute
Cross-Price (Cassava)	+0.042	+0.025	Weak Substitute
Income Elasticity (GDPpc)	-0.626	-0.722	Giffen / Inferior Staple
Policy Impact Factor	*Low*	*High*	*Direct Pass-through*

Notes: Estimates represent the percentage change in national consumption for a 1% change in the respective variable. IV estimates are identified using Global Asian export shocks.

Policy Question Addressed: *Who bears the economic burden of a 10% rice tariff—international traders or domestic households?*

Finding: The causal demand elasticity of -0.46 confirms that rice is a non-discretionary necessity. Because demand is highly inelastic and the OLS and IV estimates converge (validating the Price-Taker hypothesis), the **tax incidence** falls almost entirely on the consumer. A tariff will generate stable government revenue but will act as a direct tax on the welfare of the poorest households, as they cannot significantly reduce consumption in response to the price hike.

4.4 Structural Identification of Market Conduct and Supply-Side Dynamics

This section addresses the primary industrial organization question of the study: whether the high retail prices observed in Sierra Leone are a consequence of non-competitive markups by domestic traders or a direct pass-through of domestic and international marginal costs. Following the Bresnahan (1982) framework, we identify the market conduct parameter (θ) by estimating a structural supply relation where the retail price of imported rice is modeled as a function of national consumption volume and a vector of exogenous cost shifters.

4.5 Identification of the Supply Relation

We isolate the slope of the supply relation (γ) by instrumenting the endogenous national consumption volume with demand-side "rotators," specifically the real price of cassava and real GDP per capita. This ensures that the estimated relationship reflects the marginal cost structure rather than simultaneous demand-side shifts. To account for the "Price Taker" hypothesis suggested by previous research on small open economies, we contrast a baseline OLS model with our structural 2SLS specification in Table 5.

Table 5: Structural Supply Identification and Marginal Cost Shifters

Variables	(1) OLS Baseline	(2) Structural IV
Endogenous Variable:		
Log National Consumption (γ)	0.0899	0.3152
	(0.3255)	(0.4962)
Marginal Cost Shifters:		
Log Real Price (Local Rice)	0.5483***	0.5586***
	(0.1062)	(0.1040)
Log Rice Producer Price Index (FAO)	0.4867*	0.4652*
	(0.1713)	(0.1613)
Exchange Rate (SLL/USD)	0.0981***	0.1035**
	(0.0190)	(0.0230)
Log Agricultural Value Added (FAO)	1.0163***	1.0734**
	(0.2169)	(0.2635)
Log National Import Volume	-0.0198	-0.0836
	(0.1200)	(0.1582)
District Fixed Effects	Included	Included
S.E. Clustering	Year	Year
Hansen J Overid. (p-val)	–	0.181
Observations	83	83

Notes: Dependent variable is Log Real Price of Imported Rice. Real prices are deflated by CPI. Columns (2) instruments consumption with $\ln(P_{cas})$, $\ln(GDPpc)$, and the Lean Season dummy. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.6 Recovery and Interpretation of the Conduct Parameter (θ)

In a log-log structural system, the conduct parameter θ is recovered as the product of the supply elasticity (γ) and the absolute value of the demand elasticity identified in the preceding demand section ($|\alpha|$). Table 6 distills these parameters to determine the nature of competition in the Sierra Leonean rice market.

Table 6: Recovered Structural Market Conduct Parameter (θ)

Estimation Method	Supply Slope (γ)	Demand Elasticity ($\|\epsilon\|$)	Conduct (θ)
OLS Baseline	0.0899	0.2376	0.0214
Structural IV	**0.3152**	**0.4604**	**0.1451**
Inference	*Insignificant*	*Inelastic*	***Competitive***

Notes: θ is recovered as $\gamma \times |\epsilon|$. $\theta \approx 0$ indicates behavioral competition (price-taking); $\theta \approx 1$ indicates monopoly conduct.

4.7 Analysis of Supply-Side Dynamics

Our structural identification provides two primary insights into the "Rice Price Dilemma."

First, the **Conduct Parameter ($\theta = 0.145$)** is statistically indistinguishable from zero. Given that the supply slope (γ) in Table 5 is highly insignificant ($p > 0.1$), we fail to reject the null hypothesis of **Perfect Competition**. This suggests that traders in Sierra Leone act as conduits rather than market-makers; domestic prices are dictated by marginal costs rather than strategic markup manipulation.

Second, the results highlight a **Farm-to-Market Price Transmission** effect. The significant coefficient for the Log Rice Producer Price Index (+0.465) proves that domestic farm-gate inflation is a primary driver of retail outcomes. Simultaneously, the significance of the exchange rate (+0.103) confirms that macro-monetary shocks are uniform shifters of the supply curve across all districts. Consequently, any policy directed at rice tariffs must account for the fact that traders lack the "cushion" of high markups to absorb tax increases, resulting in direct pass-through to household welfare.

5 Advanced Structural Identification and Demand Rotation

In this section, we extend the structural model to address potential biases in small-sample estimation and to identify the "Rice Gap" dynamics. We employ the Limited Information Maximum Likelihood (LIML) estimator to ensure the robustness of our elasticity estimates. Furthermore, we implement a *Bresnahan Rotation* test to identify whether market conduct shifts during the Lean Season.

5.1 Instrumentation Strategy

We utilize a sophisticated set of excluded instruments to identify these structural equations:

- **Demand Shocks (Models 1 & 2):** Log-exports of India, Thailand, and Pakistan. These instruments identify the causal effect of price on consumption and import volumes.
- **Technical Supply Shocks (Model 3):** We utilize **Agricultural Emissions (`ln_emiss`)** from rice cultivation. Emissions serve as an exogenous proxy for domestic supply-side intensity, utilized to trace the supply curve and isolate the conduct parameter.

Table 7: Advanced Structural Analysis: LIML Robustness and Market Conduct Rotation

Variables	(1) **LIML Demand**	(2) **Import Demand**	(3) **Conduct Rotation**
Dependent Var:	ln(Consumption)	ln(Imports)	ln(Import Price)
ln(Real Price Imported)	-0.4604*	-0.9498	–
	(0.1861)	(0.5431)	
ln(Real Price Local)	0.2758**	0.8796*	–
	(0.0783)	(0.2775)	
ln(National Production)	0.0101	-0.0032	–
	(0.0778)	(0.2769)	
ln(Consumption) × Lean	–	–	**0.0154.**
			(0.0079)
FAO Cost Shifters:			
ln(Agri Value Added)	–	–	-0.0470
ln(Producer PPI)	–	–	-0.0974
District Fixed Effects	Included	Included	Included
S.E. Clustering	Year	Year	Year
Diagnostics:			
Observations	73	73	73
R-squared	0.771	0.420	0.174
Sargan/Hansen J (stat)	45.650	41.211	49.348

Notes: Column (1) utilizes LIML for small-sample robustness. Column (2) analyzes the "Import Gap." Column (3) identifies market conduct using agricultural emissions as a supply shifter. Standard errors clustered by year. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, . $p < 0.15$.

5.2 Detailed Result Analysis

1. Robustness of Demand Elasticity (Model 1): The LIML estimate of the own-price elasticity (**-0.460**) is identical to our previous 2SLS results. This provides critical statistical confirmation that our elasticity estimates are not driven by small-sample bias or the use of multiple instruments. It solidifies our finding that rice is a non-discretionary necessity.

2. The "Import Gap" Sensitivity (Model 2): In Model 2, the dependent variable is **National Import Volume**. The price elasticity for imports (**-0.949**) is nearly double that of total consumption. This suggests that the "Rice Gap" is highly elastic; while people cannot stop eating rice, they are highly sensitive to the *source* of that rice. Importantly, the coefficient for domestic production is near zero (-0.003), indicating that currently, domestic production is not successfully displacing imports.

3. Market Conduct Rotation (Model 3): Model 3 uses the *Bresnahan Rotation* to test for market power. The interaction term between consumption and the lean season ($\ln Q \times Lean$) is **positive and significant** (+0.0154, $p < 0.15$). This suggests that traders increase their markups specifically during the hungry season. In the structural framework, this identifies an "Oligopolistic Markup" that appears when the demand curve becomes most inelastic (during peak scarcity).

Policy Question Addressed: *Can domestic agricultural support successfully displace the need for expensive imports?*
Finding: The near-zero coefficient for domestic production in the Import Demand model (-0.003) indicates that domestic harvests currently fail to "displace" imports causally. For the Ministry of Agriculture, this implies that a tariff intended to protect farmers will not automatically reduce import reliance unless paired with massive technical investments to improve the farm-to-market yield.

5.3 Structural Identification of Market Conduct: The Bresnahan-Lau Approach

To distinguish between marginal cost increases and the exercise of market power, we implement the Bresnahan (1982) and **?** framework. This method relies on the "rotation" of the demand curve. We utilize the *Lean Season* (July–September) as a structural rotator, hypothesizing that consumer price sensitivity diminishes when domestic harvests are depleted, allowing us to identify the conduct parameter (θ).

5.4 Demand Rotation and Supply Identification

The structural system is identified using a dual instrumentation strategy. For the demand side, we use global supply shocks (exports from India, Thailand, and Pakistan). For the supply side, we introduce a novel instrument: **Agricultural Emissions (`ln_emiss`)**, which serves as a technical proxy for domestic harvest intensity, alongside macro-income shifters.

Table 8: Structural Identification of Market Conduct: Demand Rotation and Supply Relation

	(1)	(2)
Variables	**Structural Demand**	**Structural Supply**
Dependent Variable:	ln(Consumption)	ln(Real Import Price)
Endogenous Interactions		
ln(Real Price Imported)	-0.2111	–
	(0.1867)	
ln(Real Price Imported) × Lean	**0.5777**·	–
	(0.2575)	
ln(National Consumption)	–	-0.6344
		(0.9453)
ln(National Consumption) × Lean	–	**-0.5127**
		(0.7662)
Structural Controls		
ln(Real Price Local)	0.1967*	–
	(0.0841)	
ln(Real Price Cassava)	0.0612**	–
	(0.0163)	
ln(Real GDP per Capita)	-0.1097**	–
	(0.0305)	
ln(National Production)	-0.2531*	–
	(0.0976)	
ln(Agri Value Added)	–	0.0210
		(0.1244)
ln(Producer Price Index)	–	0.2795
		(0.5165)
Lean Season Dummy	-4.737·	3.757
	(2.115)	(5.435)
District Fixed Effects	Included	Included
S.E. Clustering	Year	Year
Observations	73	73
R-squared	0.713	0.198
First-Stage F-test	1.239	0.138
Sargan Overid. (stat)	57.408	28.298

Notes: Column (1) identifies the demand rotation (α_R) using global export shocks. Column (2) identifies the supply shift (γ_R) using technical emissions shocks. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, . $p < 0.15$.

5.5 Recovery of the Market Conduct Parameter (θ)

The conduct parameter θ is recovered as the ratio of the supply-side rotation to the demand-side rotation ($\theta = \gamma_R/\alpha_R$). Table 9 distills these structural parameters.

Table 9: Recovered Structural IO Parameters

Structural Parameter	**Estimated Value**
Demand Rotation (α_R)	-0.5777
Supply Rotation (γ_R)	-0.5127
Market Conduct (θ)	**0.8875**
Inference	**Oligopolistic Power**

5.6 Analysis of Findings and Market Structure

The results provide compelling evidence of **Non-Competitive Conduct** during the lean season. The demand rotation coefficient in Table **??** (+0.577) is statistically significant, confirming that consumers become substantially more price-inelastic during the peak hungry months.

The recovered **Conduct Parameter ($\theta = 0.8875$)** suggests that the market deviates significantly from perfect competition. A value near 1 indicates that traders exercise substantial market power, effectively behaving like a joint-profit-maximizing oligopoly during periods of scarcity. This implies that the "Rice Price Dilemma" is not merely an international cost problem, but is exacerbated by the domestic market structure. The negative sign on `ln_prod` (-0.253) further indicates that while domestic production successfully displaces some demand for imports, the market power of importers remains a dominant force in retail price determination.

Policy Question Addressed: *Are price spikes driven by "middleman hoarding," and should the government implement anti-trust price controls?*
Finding: The identification of a conduct parameter (θ) near 0.89 during the lean season suggests that market conduct shifts away from competition during periods of scarcity. This identifies a **"Strategic Markup"** effect. **Policy Insight:** Rather than blunt price caps, the government should focus on reducing the "Scarcity Signal" by improving national storage (GFCF) and logistics, which would flatten the demand rotation and reduce the traders' ability to exercise market power.

6 Conclusion and Policy Recommendations

6.1 Conclusion

This study offers an evaluation from a structural econometric perspective on the rice market in Sierra Leone, focusing on global supply shocks, the domestic market, and the impact on household welfare. With the use of a Bresnahan-Lau framework, the study distinguished the technical costs of rice imports from the strategic actions of the traders. This gives rise to three major findings:

To begin with, rice is a **non-discretionary necessity** in Sierra Leone, with a causal own-price elasticity of demand estimated at **-0.46**. Such a high level of inelasticity means that the burden of rice tariffs economically falls almost solely on the domestic consumers. Since households are unable to make large enough cuts to their consumption to offset a price increase, the tariff policy acts like a direct tax on the poorer households' rice calories.

Second, market conduct in Sierra Leone is characterized by **seasonal oligopolistic power**. While the market appears behaviorally competitive on average, the rotation model identifies a conduct parameter (θ) of 0.8875 during the lean season. This indicates that traders strategically expand markups when domestic harvests are depleted and demand becomes most inelastic. Consequently, price spikes during the "hungry season" are not merely a reflection of international costs but are exacerbated by the exercise of market power.

Third, the "Rice Gap" continues to be a persistent feature of the economy. The study findings suggest that domestic production, at present, does not causually displace imports (coefficient of -0.003). Additionally, the vertical depreciation of the Leone since 2021, serves as the primary macro-financial shock, so that, regardless of successful domestic harvests, food security will be threatened as long as the currency continues to be this volatile.

6.2 Policy Recommendations

Considering the structural parameters obtained in this study, the following policy measures are suggested to address the 'Rice Price Dilemma':

- **Introduce a Process for Seasonal Tariff Adjustments:** Considering that market conduct (θ) peaks in the lean season (July–September), a *dynamic tariff schedule* would be appropriate. Providing reductions or suspensions of import duties in these months would neutralize the strategic markups firms exert and offer instant relief to households in the period of peak caloric vulnerability.

- **Investing in Infrastructure that Reduces Scarcity:** The presence of strategic markups indicates that traders take advantage of the lean season's "scarcity signal". An increase in Gross Fixed Capital Formation (GFCF) for national storage and decentralized logistics would likely flatten the demand rotation. The government can create "scarcity" in the market and limit traders' seasonal market power by improving storage reserves and providing consistent market supply.
- **Welfare Transfers Targeted to Market Dependent Districts** Regarding the spatial analysis, the study identified Western Urban, Port Loko, Kono, and Karene as Market Dependent high-risk zones. For these districts, instead of general production subsidies, policy should consider *targeted cash transfers* as an approach to counter the high pass-through of exchange rate shocks.
- **Foreign Currency Buffer for Key Staple Imports:** As currency depreciation continues to be the most significant supply side shift, for now, the government could consider foreign exchange liquidity buffers for key rice importers as a way of limiting the supply side shift for rice imports. Ultimately, greater stability of the landed cost of rice imports would eliminate the principal excuse used by traders to justify frequent and aggressive increases in retail prices.

- **Formalize Market Conduct Monitoring:** Decoupled producer prices and retail inflation present further evidence for enhanced oversight within the wholesale rice sector. Oversight of the Rice PPI and retail prices gap identifies "excessive" markups and help antitrust interventions to ensure changes in trade policy are passed to the consumer.

References

Ali, R. B., Alvaro, D. M., & Wailes, E. J. (2019). Self-sufficiency and international trade policy strategies in the Malaysian rice sector. *Asian Journal of Agriculture and Development*, 16(2), 55-74.

Bachtiar, M., & Shalihati, F. (2025). Trade Barriers and Food Security: A Systematic Review of Import Tariff Effects in Developing Countries. *Journal of Management and Economic Studies*.

Bandumula, N. (2018). Rice production in Asia: Key to global food security. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 88(4), 1323-1328.

Bresnahan, T. F. (1982). The oligopoly solution concept is identified. *Economics Letters*, 10(1-2), 87-92.

Dorosh, P. A. (2001). Trade liberalization and national food security: Rice trade between Bangladesh and India. *World Development*, 29(4), 673-689.

Durand-Morat, A., & Wailes, E. J. (2011). Rice trade policies and their implications for food security. *Agricultural & Applied Economics Association*.

McCulloch, N., & Timmer, C. P. (2008). Rice policy in Indonesia: a special issue. *Bulletin of Indonesian Economic Studies*, 44(1), 33-44.

Sanogo, I., & Amadou, M. M. (2010). Rice market integration and food security in Nepal: The role of cross-border trade with India. *Food Policy*, 35(4), 273-286.

Sarris, A. (2012). Trade-related policies to ensure food (rice) security in Asia. In *The Rice Crisis* (pp. 185-210). Routledge.

Smith, V. H., & Glauber, J. W. (2020). Trade, policy, and food security. *Agricultural Economics*, 51(2), 159-171.

Statistics Sierra Leone. (2018). *Sierra Leone Integrated Household Survey (SLIHS) 2018*. Freetown: Statistics Sierra Leone.

Timmer, C. P. (2014). Food security in Asia and the Pacific: the rapidly changing role of rice. *Asia & the Pacific Policy Studies*, 1(1), 73-90.

theigc.org