Modelling the Effect of Macroeconomic Rigidities on Market Competition in Sierra Leone

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Abstract: This paper explores the intricate relationship between macroeconomic indicators and imperfect competition in Sierra Leone, employing a prototype of an imperfect competition structural model within the New Keynesian framework. The model incorporates nominal and real rigidities, as well as market failures. Results indicate that Sierra Leone’s imperfectly competitive market introduces inefficiencies, leading to a muted initial impact of productivity shocks on macroeconomic variables. Wages and real interest rates exhibit moderated adjustments due to deviations from perfect competition ideals, dampening the effects on investment, consumption, and output. Policy and transition functions reveal a lasting influence of past capital accumulation and external shocks on aggregate output. The analysis exposes inertia in investment decisions and strategic actions of dominant firms. Steady-state results affirm a stable equilibrium in Sierra Leone, and eigenvalues exceeding unity underscore the model’s ability to capture anticipatory behavior in imperfect market competition. The correlation matrix highlights profound connections between economic activity, wages, and capital’s role in growth. Theoretical moments demonstrate economic indicator variability, emphasizing dominant firms’ influence on capital allocation and policy measures’ role in stabilizing interest rates and labor markets. The covariance matrix of exogenous shocks underscores external influences’ persistence and correlated impacts on Sierra Leone’s economy. These findings stress the importance of tailored policy responses to address market imperfections, advocating for measures to promote competition, labor market flexibility, dynamic investment, and stabilization of interest rates and labor markets.

JEL Classification: D43; O55; E01; E23; L11.

Keywords: Imperfect Market Competition; Sierra Leone; Economic Indicators; Productivity Shock; Market Dynamics.
Introduction

Competition lies at the heart of market economies, fostering efficiency, innovation, and economic growth. It incentivizes firms to strive for excellence, offering consumers a wide array of choices while keeping prices in check. Nevertheless, in the real world, markets are rarely perfectly competitive, and when competition falls short, it can lead to market distortions that hinder economic development. Imperfect competition, characterized by firms possessing some degree of market power to influence prices and outputs, can result in suboptimal market outcomes, including reduced output, higher prices, diminished consumer welfare, and decreased economic efficiency. These imperfections have the potential to impede a country’s economic progress. In many instances, markets exhibit imperfections due to the dominance of a few key players in specific sectors. This phenomenon restricts competition, fosters oligopoly behavior, and contributes to market inefficiencies. Sierra Leone, a low-income nation in West Africa, serves as a prominent example of such market dynamics. In critical sectors such as telecommunications, banking, and manufacturing, a small number of dominant firms wield substantial influence. This prevalence of imperfect competition raises significant concerns about its potential impact on output and prices in the country. As a result, the economic progress of Sierra Leone could be hindered by these market imperfections.

While competition plays a crucial role in improving market efficiency and fostering economic development, there is a lack of comprehensive understanding regarding the degree to which market competition impacts output and pricing dynamics in Sierra Leone. The absence of a comprehensive empirical analysis focusing on market competition within the Sierra Leonean context has contributed to this knowledge gap. Hence, the principal objective of this research is to investigate the influence of imperfect competition on key macroeconomic variables such as output and prices in Sierra Leone, employing a structural modeling approach. Sierra Leone has grappled with challenges such as low economic growth, high inflation, and widespread poverty. Imperfect competition prevalent in various sectors is likely exacerbating these difficulties by distorting market outcomes. This distortion potentially leads to reduced consumer welfare, heightened costs, and diminished economic efficiency. Consequently, there is a compelling need to explore the ramifications of imperfect competition on macroeconomic variables such as output and prices in Sierra Leone. Such an exploration enhances our understanding of the nation’s economic performance and its potential for growth.

The significance of this study lies in its potential to guide policy decisions regarding market competition and its effects on output and prices in Sierra Leone. The study’s findings are expected to serve as a valuable resource for policymakers, regulators, and market stakeholders, enabling them to assess the effectiveness of existing competition policies and formulate new strategies that promote competition and market efficiency. This research makes a twofold contribution to the existing literature. First, it offers a comprehensive analysis of market competition in Sierra Leone, employing a structural modeling approach that has not been previously explored. Second, it provides empirical evidence of the impact of macroeconomic rigidities on market competition in the context of a low-income country, an area where limited research exists. The study’s findings will expand our understanding of how market competition influences economic outcomes, particularly in developing countries.

The paper is structured as follows: Section 1 provides this introduction and outlines the stylized facts. Section 2 offers a review of relevant literature concerning market competition and its impact on economic outcomes. Section 3 details the methodology utilized, encompassing data sources, model specifications, and estimation techniques. Section 4 presents the research findings, offering a comprehensive analysis of the empirical results. Finally, in Section 5, the paper concludes by summarizing the key findings, discussing their policy implications, and suggesting potential avenues for future research.
Stylized Facts

The market structure in Sierra Leone is characterized by a few dominant firms in several key sectors, such as telecommunications, banking, and manufacturing. This structure is likely to limit competition and potentially lead to higher prices and lower output in these sectors.

For example, Sierra Leone’s banking sector has exhibited a persistent trend of asset concentration, where the top five banks account for over 60 percent of total bank assets over the past five years. (Figure 1). This means that a relatively small number of banks hold a significant proportion of the sector’s total assets, indicating a notable level of concentration. This trend is reflected in the top-five-to-total asset ratio, which measures the share of total assets held by the top five banks. This ratio has remained consistently high in Sierra Leone, ranging from 65.12 percent in 2018 to 64.54 percent in 2022, indicating a sustained trend of asset concentration in the banking sector. The high level of asset concentration in Sierra Leone’s banking sector may have implications for competition, market power, and financial stability in the country’s financial system see Figure 1.

The telecommunications sector in Sierra Leone is characterized by a high level of market concentration, with only four firms operating in the market. However, the top two operators have a combined market share of over 90 percent, indicating a high degree of market power in the hands of a few dominant players (Figure 2). This concentration of market power has resulted in higher prices, lower levels of competition, reduced innovation, because the dominant firms have less incentive to innovate and invest in their networks and service delivery. This has resulted in low income consumers finding it more difficult to access telecommunications services, reducing their ability to participate in the digital economy and access critical services. Furthermore, the telecommunications sector’s constrained level of competition could discourage potential new players from joining the market, thereby reinforcing market dominance and diminishing competitive forces. This can result in a vicious cycle where the dominant players become even more entrenched and less responsive to the needs of consumers and the broader economy. (Cave and Ordoñez-Matamoros 2007)
The same phenomena in the Fuel distribution sector, a few dominant players control a large portion of the market, leading to reduced competition and higher prices for consumers (Figure 3). This lack of competition can also result in less innovation, as the dominant players have less incentive to invest in new technologies and processes. The fact that NP (SL) Limited holds a market share of 56.47% implies that it is the dominant player in the market. Its substantial market share suggests a significant influence over pricing, production, and overall market dynamics. Conex (SL) Limited, with a 23.47% market share, also holds a substantial share, contributing to the overall concentration of the market. The concentration of market shares among a few key firms, namely NP (SL) Limited and Conex (SL) Limited, raises the possibility of oligopoly behavior. Oligopoly refers to a market structure in which a small number of firms dominate the industry. Such dominance could lead to strategic interactions among firms, including price collusion, non-price competition, and market segmentation.

In the insurance industry, a few large firms control a significant portion of the market, leading to higher prices for consumers and reduced competition. This can make it difficult for smaller firms to compete, limiting consumer choice and potentially leading to higher premiums for consumers.

In the mining sector, a few large multinational firms dominate the market, leading to reduced competition and lower prices for locally produced minerals. This limit the ability of the government to capture the full value of its natural resources, potentially leading to a loss of revenue and limited economic development opportunities. In light manufacturing industries, the market is heavily influenced by a handful of dominant firms, which in turn curtails competition and hampers innovation. This can limit the development of new products and processes, potentially leading to a less diversified and less dynamic manufacturing sector.

Given the importance of market competition in promoting efficiency, innovation, and growth, understanding the extent and nature of market imperfections is crucial for policymakers and regulators. Therefore, exploring the effect of imperfect competition on output and prices in Sierra Leone using a structural modeling approach is an important step towards identifying policies that promote competition and market efficiency.

Another important aspect to consider when examining the effect of macroeconomic rigidities on market competition in Sierra Leone is the role of government policies and regulations. In some cases, government interventions may have unintentional consequences that limit competition or promote market power. For example, policies that restrict imports or limit foreign investment may protect domestic industries but may also limit competition and innovation. See Allcott, H., & Mullainathan, S. (2012). Moreover, the regulatory environment in Sierra Leone may also have implications for market competition. The presence of fragile regulatory institutions, corruption, and inconsistent enforcement of regulations could create an environment in which
dominant firms may engage in anti-competitive practices, including activities like price-fixing or exclusionary behavior. Therefore, understanding the regulatory environment and the effectiveness of competition policies is critical for assessing the impact of macroeconomic rigidities on market competition in Sierra Leone.

**Literature Review**

**Theoretical Literature Review**

Theoretical models of imperfect competition suggest that firms may engage in anti-competitive behavior, such as price-fixing, exclusionary conduct, or predatory pricing, which can lead to higher prices and lower output. In addition, market power may reduce incentives for firms to invest in innovation and efficiency, further limiting competition and economic growth.

The “Structure-Conduct-Performance” (SCP) paradigm is a theoretical framework that has been influential in analyzing the impact of market structure on firm behavior and, subsequently, market performance. This paradigm was first developed in the field of industrial organization and economics. The SCP paradigm traces its origins back to the mid-20th century. While it doesn’t have a single specific creator, it can be attributed to several economists who contributed to its development during this period. Notably, it was heavily influenced by the works of economists like Joe S. Bain and Edward S. Mason. In 1956, Joe S. Bain, an American economist, published the groundbreaking book “Barriers to New Competition.” In this work, he explored the relationship between market structure and firm behavior, highlighting how concentrated industries with few dominant firms could exhibit specific behaviors that might not align with the competitive ideal. His research laid the groundwork for the SCP paradigm.

Around the same time, Edward S. Mason, another prominent economist, conducted research on market structure and its influence on firm behavior. His work, particularly the 1949 paper titled “Price and Production Policies of Large-Scale Enterprise,” contributed to the evolving understanding of the relationship between market structure and the conduct of firms. The SCP paradigm emphasizes that the structure of a market, including factors like the number and size of firms, shapes how these firms conduct themselves. This, in turn, has implications for market performance, such as pricing, output, and innovation. The framework has been widely employed to study the behavior of firms in various industries and to assess how market structure affects competition and economic outcomes. It remains a fundamental concept in the field of industrial organization and economics, providing a lens through which economists analyze and understand the dynamics of different markets.

The “New Empirical Industrial Organization” (NEIO) paradigm is a theoretical and methodological approach to analyzing market competition in the field of industrial organization and economics. It focuses on incorporating both demand and supply side factors to estimate the impact of market structure on firm behavior and market outcomes. The development of the NEIO paradigm occurred during the latter half of the 20th century and has continued to evolve over time. It is challenging to attribute its development to a single individual or year because it represents a culmination of research efforts by various economists and scholars. The New Empirical Industrial Organization (NEIO) paradigm’s development and the application of empirical methods in industrial organization owe much to key contributors. Among them, Daniel McFadden, an American economist, made seminal contributions through his work on discrete choice models and econometric techniques, such as the multinomial logit model, which significantly advanced our understanding of consumer behavior and market parameter estimation. Jerry Hausman, another economist, played a vital role in refining empirical methods in industrial organization, particularly in demand and supply modeling, and the development of techniques for estimating demand elasticities. Ariel Pakes, a distinguished economist, further elevated the NEIO paradigm with his research on estimating market power and firm conduct,
using dynamic models and structural econometrics. The defining characteristic of the NEIO paradigm is its reliance on econometric methods to estimate crucial parameters like demand elasticities and market power, a methodology that has been applied across various industries to shed light on firm behavior and the consequences of market structure on economic outcomes.

**Empirical Literature Review**

Empirical studies have investigated the impact of market competition on output and prices in various industries and countries, providing evidence on the importance of market structure in determining market outcomes. In the context of low-income countries, where markets are often characterized by imperfect competition, understanding the impact of market structure on economic outcomes is particularly important.

Awoyemi and Olaniyan (2021) conducted a study investigating “The Impact of Market Concentration on Prices in the Nigerian Retail Sector.” Their research involved the use of a cross-sectional dataset comprising 1,000 retail firms in Nigeria to assess how market concentration affects prices. To measure market concentration, the study employed the Herfindahl-Hirschman Index (HHI), which gauges the concentration of market share among the leading firms in a market. The study revealed a positive correlation between the HHI and prices, indicating that markets with higher levels of concentration tend to have higher prices. In an effort to consider and control for other factors that could potentially influence prices, such as firm size, product quality, and location, the study implemented additional controls. Importantly, the results remained robust even after accounting for these other factors. The findings of the study are noteworthy because they suggest that market concentration can result in higher prices in developing countries. This is a matter of concern because it can negatively impact consumer welfare and hinder economic growth.

Aghion et al. (2021) conducted a comprehensive investigation into “The Impact of Competition Policy on Innovation in Developing Countries.” Their study involved the analysis of a cross-country panel dataset comprising 100 developing countries during the period from 2000 to 2015 to evaluate how competition policy affects innovation. To gauge competition policy, the study relied on a variety of indicators, including the World Bank’s Competition Policy Index and the OECD’s Product Market Regulation Index. The study’s findings consistently demonstrated a positive correlation between these competition policy measures and levels of innovation, suggesting that countries with stronger competition policies tend to exhibit higher innovation rates. In an effort to account for other potential factors that might influence innovation, such as economic growth, human capital, and research and development (R&D) expenditures, the study conducted controls. Importantly, the results remained robust even after adjusting for these additional variables. Furthermore, the study uncovered that the influence of competition policy on innovation is notably stronger in sectors characterized by substantial foreign investment. This phenomenon is likely attributed to the fact that foreign companies tend to be more inclined to invest in innovation within countries that have well-established competition policies promoting competitive environments.

Monga et al. (2020) conducted a study analyzing the Impact of Market Competition on Poverty in Sub-Saharan Africa. The study utilized a cross-country panel dataset encompassing 45 Sub-Saharan African countries spanning from 1995 to 2014 to estimate the impact of market competition on poverty. To gauge market competition, the study employed several indicators, including the number of firms in a market, the Herfindahl-Hirschman Index (HHI), and the Lerner Index. The study revealed that all of these measures of market competition exhibited negative correlations with poverty, indicating that countries with higher levels of market competition tend to have lower poverty rates. The study also incorporated controls for various other factors that could potentially influence poverty, such as economic growth, inequality, and government spending. Notably, the results remained robust even after accounting for these additional factors. The study’s findings hold particular significance as they suggest that market
competition can contribute to poverty reduction in Sub-Saharan Africa. This is especially vital because poverty remains a significant challenge in the region. For instance, according to the World Bank, in 2015, 43% of the population in Sub-Saharan Africa lived below the international poverty line of $1.90 per day.

Other studies have examined the impact of market structure on firm behavior and efficiency. For instance, a study by Janjua and Iqbal (2019) analyzed the impact of market structure on productivity in the Pakistani textile industry, and found that increased competition was associated with higher productivity. Another study by Brixiová et al. (2016) analyzed the impact of competition on efficiency in the African banking industry, and found that increased competition was associated with higher efficiency. In addition to analyzing the impact of market structure on economic outcomes, several studies have investigated the determinants of market structure in low-income countries.

The existing literature provides valuable insights into the impact of market structure on various economic outcomes, such as prices, innovation, and poverty reduction, particularly in low-income countries. However, a noticeable gap in the literature pertains to the specific context of Sierra Leone and its macroeconomic dynamics in the presence of imperfect competition. While previous studies have explored market competition and its consequences in different settings, a focused investigation into Sierra Leone’s market structure and its implications for the country’s overall economic performance is notably absent. Given that each country’s unique economic, social, and institutional factors can influence how imperfect competition plays out, it is imperative to address this gap with a dedicated study. Applying a structural model approach to Sierra Leone’s economic landscape can provide crucial insights into how market imperfections affect key macroeconomic variables in this particular context. Conducting such a study can provide customized policy recommendations that address the unique challenges and opportunities in Sierra Leone. This would contribute to a more holistic comprehension of the consequences of imperfect competition in low-income countries.

Methodology

To incorporate elements of imperfect competition within a DSGE (Dynamic Stochastic General Equilibrium) model, a crucial component of New Keynesian models, we examine the presence of imperfect competition in the production sector. This adjustment maintains the model’s structure concerning household behavior, while significantly altering the framework of the economy’s production sector. The primary challenge arises in the decision-making process of the company, necessitating the incorporation of two unique categories of products: a final product and a distinctive intermediate product. The intermediate goods sector experiences imperfect competition. These distinct intermediate products are then amalgamated to form a final product, traded in an environment characterized by perfect competition. As a result, the prices of production factors are influenced by the elasticity of substitution between these distinct products, indicating the market influence of firms in price setting. In this framework, we depart from the resource allocation efficiency commonly linked with a competitive setting.

Monopolistic Competition

The presence of imperfect competition holds a crucial role in models incorporating price rigidities. This concept is commonly integrated into DSGE models, often utilizing scenarios of monopolistic competition. Nevertheless, certain models also consider instances of oligopolistic structures, as proposed by Rotemberg and Woodford in 1992. Within this framework, a prevalent strategy is derived from Dixit and Stiglitz’s 1977 model, which assumes a continuum or discrete set of distinct goods. This strategy empowers each firm with the capacity to influence
market prices for their specific products. Subsequently, these diverse goods are aggregated into a singular end product consumed by households.

Uncompetitive markets play a pivotal role in the New Keynesian economy and establishes the basis for introducing nominal rigidities. The incorporation of monopolistic competition into DSGE models typically occurs through two primary channels. The first involves firms directly vending distinct goods to households, consolidating intermediate goods into a final product using a Constant Elasticity of Substitution (CES) function. The second pathway assumes firms sell unique goods to final product producers. In this scenario, each firm manufactures an intermediate product utilized by the final producer in crafting the end product through a CES function. In both instances, demand is assumed to be given, and it is a customary practice in the literature that only one firm finalizes goods, as elucidated in this discourse.

The introduction of monopolistic competition results in the pricing of goods surpassing their marginal production costs, giving rise to a mark-up reflective of the market power wielded by firms. Consequently, the relative prices of production factors dip below the benchmarks set in a competitive environment, despite these factors being traded in a competitive market. Thus, monopolistic competition introduces inefficiencies in the deployment of production factors, contributing to an overarching economic inefficiency. Essentially, imperfect competition introduces distortions into the pricing of production factors, thereby shaping economic dynamics.

The Model

In our model, we retain the existing household component while introducing a more detailed examination of the production sector in the economy. The model’s configuration can be succinctly outlined as follows: We examine the production of a sole final product and a continuous spectrum of intermediate products, denoted by the subscript “$j$,” with $j$ ranging across the unit interval, specifically $j \in [0, 1]$. The final product is formed by consolidating these intermediate products in a perfectly competitive context and is applicable to consumers for both consumption and investment. Conversely, the market for intermediate goods functions under conditions of monopolistic competition. This implies that each intermediate product is manufactured by a sole monopolistic entity, providing them with the market influence to set the prices of the products they generate.

Households

Within the economic framework, a representative household with preferences spanning an infinite lifespan is considered. These preferences demonstrate time-separability and can be encapsulated by the following instantaneous utility function:

$$U(C_t, 1 - L_t) = \gamma \log C_t + (1 - \gamma) \log(1 - L_t)$$

In this context, $C_t$ represents the consumption of goods and services, and leisure is defined as $1 - L_t$ where the available discretionary time has been normalized to 1. In other words, leisure is defined as the discretionary time minus the working time, $L_t$. The parameter $\gamma$, where $0 < \gamma < 1$, represents the proportion of consumption over total income. The objective of the representative consumer is to maximize the value of her lifetime utility, which can be expressed as follows:

$$\max_{C_t, L_t} \sum_{t=0}^{\infty} \beta^t (\gamma \log C_t + (1 - \gamma) \log(1 - L_t))$$

Subject to the budget constraint:

$$C_t + S_t = W_t L_t + R_t K_t$$
Where $S_t$ is saving, $W_t$ is the wage, $R_t$ is the rental rate of capital and $K_t$ is the physical capital stock.

Physical capital stock evolves according to:

$$K_{t+1} = (1 - \delta)K_t + I_t \quad (4)$$

In the equation, $\delta$ represents the depreciation rate, and $I_t$ signifies gross investment. If we make the assumption that $I_t = S_t$ and substitute the capital stock accumulation equation into the budget constraint, we arrive at the following result:

$$C_t + K_{t+1} = W_tL_t + (R_t + 1 - \delta)K_t \quad (5)$$

The equilibrium condition that equates the marginal rate of consumption to the rate of return on investment can be expressed as follows:

$$\frac{C_t}{C_{t-1}} = \beta \left[ (R_t + 1 - \delta) \right] \quad (6)$$

**The Firms**

The difference between a DSGE model featuring perfect competition and one incorporating imperfect competition hinges on the structure of the economy’s production sector. Let’s consider the scenario of imperfect competition. In this context, the productive sector of the economy is bifurcated into two segments: one dedicated to producing intermediate goods and another focused on the production of the final product. The intermediate goods sector consists of multiple firms, each manufacturing a unique product within a monopolistically competitive environment. These firms grapple with decisions related to the allocation of production factors and the pricing of their products. In contrast, the final goods sector is represented by a singular firm that amalgamates intermediate goods into a composite product for consumption (or savings) by agents, operating within a perfectly competitive framework. Additionally, we assume that the market for production factors remains competitive.

**Final Good Production Sector**

Initially, the production of the final product is undertaken by a representative firm functioning in a competitive market. This firm creates the final good by amalgamating diverse intermediate goods through the application of the following technology:

$$Y_t = \left[ \int_0^1 \frac{\xi}{J_f(t)} \, dJ \right]^{\frac{\xi}{\xi-1}} \quad (7)$$

In this scenario, the parameter $\xi$, where $\xi > 1$, signifies the elasticity of substitution among intermediate goods. The method of aggregating intermediate goods, often termed the Dixit-Stiglitz aggregator, is characterized by this parameter $\xi$, reflecting the markup in the goods market. It is plausible to consider this parameter as either a constant or a stochastic element within the model. For example, in the approach adopted by Smets and Wouters (2007), the parameter representing the elasticity of substitution among intermediate goods is treated as stochastic, associated with an inflation shock, following the process $\xi_t = \xi + V_t$, where $V_t$, follows a normal distribution with mean 0 and standard deviation $\sigma_V$. However, in our present assumption, we treat this parameter as a constant.

The firm’s objective is to maximize profits while adhering to the production function defined by equation (7). It operates under the assumption that the prices of intermediate goods, denoted as $P_{j,t}$ and the price of the composite final good, denoted as $P_t$, are given. Consequently, the maximization problem for the representative firm in the final goods sector can be expressed as:
\[
\max_{Y, j, t} \pi_t = P_t Y_t - \int_0^1 P_{j,t} Y_{j,t} \, dj
\]  
(8)

Profits are determined as the difference between the overall income derived from selling the final product and the total cost incurred in utilizing the intermediate goods. Substituting the aggregation technology outlined in equation (7), we derive the following expression:

\[
\max_{Y, j, t} \pi_t = \left[ \int_0^1 Y_{j,t} \, dj \right]^{\frac{\xi-1}{\xi}} - \int_0^1 P_{j,t} Y_{j,t} \, dj
\]  
(9)

The price for the final good can be expressed as:

\[
P_t = \left[ \int_0^1 P_{j,t}^{1-\xi} \, dj \right]^{\frac{1}{1+\xi}}
\]  
(10)

**Intermediate Goods Production Sector**

Continuing, let’s delve into the conduct of producers in the intermediate goods sector. Every individual intermediate good, labeled as j, is manufactured by a solitary firm, and this production process is depicted by the subsequent production function:

\[
Y_{j,t} = A_t K_{j,t}^{\alpha} L_{j,t}^{1-\alpha} - \Phi
\]  
(11)

Within the production function, \( \Phi \) denotes fixed costs, assumed to remain constant. The inclusion of fixed costs suggests that the technology exhibits increasing returns to scale. Assuming \( \Phi = 0 \) would place us in a scenario characterized by constant returns to scale.

Producers in the intermediate goods sector engage in a two-stage decision-making process. In the initial stage, these firms establish the optimal price for the goods they produce and the quantity they will manufacture. In the subsequent stage, firms regard the prices of production factors, specifically wages \( (W_t) \) and the capital rental rate \( (R_t) \), as given, and subsequently determine the amount of labor and capital to employ in order to minimize production costs.

Concerning the behavior of monopolistic firms, the second stage takes precedence, where the firm calculates the quantity of factors to be hired. Subsequently, in the first stage, the firm determines the price for its distinctive good.

**Second Stage**

The second step consists in solving:

\[
\min_{L_{j,t}, K_{j,t}} \text{Cost} = W_t L_{j,t} + R_t K_{j,t}
\]  
(12)

Subject to the following technology:

\[
Y_{j,t} = \{ A_t K_{j,t}^{\alpha} L_{j,t}^{1-\alpha} - \Phi_0 \ \text{if} \ A_t K_{j,t}^{\alpha} L_{j,t}^{1-\alpha} - \Phi \text{otherwise} \}
\]  
(13)

Ultimately, by substituting both of these expressions into the production function, we can calculate the marginal cost for each firm engaged in the production of intermediate goods:

\[
cm_t = \frac{1}{A_t} \left( \frac{1}{\alpha} \right)^\alpha \left( \frac{1}{1-\alpha} \right)^{1-\alpha} R_t^\alpha W_t^{1-\alpha}
\]  
(14)

It’s evident that the marginal cost remains uniform across all monopolistic firms producing intermediate goods. This uniformity can be attributed to their shared technology, exposure to identical technological shocks, and the consistent pricing of production factors.

The marginal cost signifies the cost incurred per unit of additional intermediate goods produced concerning each production factor. In other words, the marginal cost can be computed either in terms of labor services or capital services.

Consequently, the price of the intermediate goods can be determined as follows:
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\[ p_{j,t} = \frac{\xi}{\xi - 1} c_{m,t} \]  

(15)

Here, \( \frac{\xi}{\xi - 1} \) represents the mark-up, signifying the difference between the price and the marginal cost. This mark-up is assumed to be greater than 1.

When \( \xi = \infty \), the model converges to the standard scenario of perfect competition. Assuming that all intermediate producer firms are identical and normalizing the price of the final good to 1, we arrive at the following:

\[ c_{m,t} = \frac{\xi - 1}{\xi} \]  

(16)

In this scenario, the marginal cost falls below unity, especially since \( \xi > 1 \).

Equilibrium of the Model

The equilibrium of this model economy results from the combination of the first-order conditions for firms and the first-order conditions for consumers. By integrating, we obtain the two essential equations that define this DSGE model with monopolistic competition, where the pricing of production factors is established by a given framework.

\[ W_t = c_{m,t} (1 - \alpha) \frac{\xi - 1}{\xi} K_{j,t}^a L_{j,t}^{-\alpha} \]  

(17)

\[ R_t = \alpha \frac{\xi - 1}{\xi} A_t K_{j,t}^a L_{j,t}^{-\alpha} \]  

(18)

Lastly, considering that all firms are identical and employ the same quantity of labor and capital per unit of output, we can simplify the previous expressions by removing the subscript \( j \). Once the prices of the production factors have been determined, the equilibrium conditions for households are as follows:

\[ \frac{c_t}{c_{t-1}} = \beta \left[ \alpha \frac{\xi - 1}{\xi} A_t K_t^a L_t^{-\alpha} + 1 - \delta \right] \]  

(19)

This collection of equations, coupled with the feasibility condition, establishes the equilibrium of the economy.

Equations of the Model and Calibration

The equilibrium of the model economy is determined by a set of eight equations, corresponding to the endogenous variables: \( Y_t, C_t, I_t, K_t, L_t, R_t, W_t \), and the variable representing total factor productivity, \( A_t \). Total factor productivity is assumed to be endogenous and follows an autoregressive process of order 1. The set of equations is as follows:

\[ \frac{1 - \gamma}{\gamma} \frac{c_t}{c_{t-1}} = (1 - \alpha) \frac{Y_t}{L_t} \]  

(20)

\[ \frac{c_t}{c_{t-1}} \beta \left[ \alpha \frac{Y_t}{K_t} 1 - \delta \right] \]  

(21)

\[ Y_t = C_t + I_t \]  

(22)

\[ Y_t = A_t K_t^a L_t^{-\alpha} \]  

(23)

\[ K_{t+1} = (1 - \delta)K_t + I_t \]  

(24)

\[ W_t = (1 - \alpha) \frac{\xi - 1}{\xi} \frac{Y_t}{L_t} \]  

(25)

\[ R_t = \alpha \frac{\xi - 1}{\xi} \frac{Y_t}{K_t} \]  

(26)
\[
\ln A_t = (1 - \rho A)\ln \bar{A} + \rho A \ln A_{t-1} + \varepsilon_t
\]  (27)

The parameters to be calibrated include the following:
\[\Omega = \{\alpha, \beta, \delta, \gamma, \xi, \rho A, \sigma A\}\]

**Calibration of Parameters**

Table 1 provides the parameter values that have been calibrated for the model. In the output equation, the parameter \(\alpha\) represents a production factor, which is usually constrained within the range of 0 to 1 in the literature. This range tends to favor lower values, particularly for smaller, less developed nations with lower overall productivity. In this approach, an Alpha density distribution is employed with parameters (0.3, 0.4), which are consistent with the underlying theoretical framework. Accordingly, the variables align with the established mean of 0.35. The parameters for the beta distributions have been thoughtfully selected to match empirically justifiable values.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>(\alpha)</td>
<td>Technological parameter</td>
<td>0.350</td>
</tr>
<tr>
<td>(\beta)</td>
<td>Discount factor</td>
<td>0.970</td>
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<tr>
<td>(\gamma)</td>
<td>Preferences parameter</td>
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<tr>
<td>(\delta)</td>
<td>Physical capital depreciation rate</td>
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</tr>
<tr>
<td>(\xi)</td>
<td>Elasticity of substitution between differentiated goods</td>
<td>5.000</td>
</tr>
<tr>
<td>(\rho A)</td>
<td>TFP autoregressive parameter</td>
<td>0.950</td>
</tr>
<tr>
<td>(\sigma A)</td>
<td>TFP standard deviation</td>
<td>0.010</td>
</tr>
</tbody>
</table>

*Source: Author’s calibration using knowledge of the Sierra Leone economy and existing literature.*

The consumption equation incorporates a parameter denoted as \(\beta\), symbolizing a discount factor ranging from 0 to 1, typically skewed towards higher values. To establish the prior beta distribution, parameters (0.90, 0.99) are utilized, ensuring a mean of 0.95, as previously indicated. The Preferences Parameter \(\gamma\), which accounts for exemptions, deductions, or preferential rates in administered taxes, is assigned a value of 0.450 for the Capital Depreciation Parameter \(\delta\) in the capital accumulation equation. It is customary for \(\delta\) to fall within the range of 0 to 1, often tending towards the lower values and occasionally being negative in economic theory. To capture the observed lower maintenance and significant wear and tear prevalent in small developing economies like Sierra Leone, the calibration sets \(\delta\) at 0.060, aligning with the economic context of Sierra Leone.

The parameter \(\rho A\) represents a persistence parameter within the productivity equation, typically positioned towards the higher range between 0 and 1. A Rho distribution is applied, with parameters (0.66, 0.99), mirroring a mean value of 0.8. To incorporate technological shocks in the calibrated model, the standard deviation of Total Factor Productivity (TFP) is set at 0.010, as guided by existing literature. It is noteworthy that \(\rho A\) serves as a parameter describing the stochastic process for investment-specific technology shocks and mirrors the process of a neutral shock. The calibration decisions for these parameters are rooted in theoretical principles and a comprehensive understanding of Sierra Leone’s economy, including its tax structure.

In the foundational model, the parameter \(\xi\), denoted as \(x_i\), signifies the elasticity of substitution between differentiated goods and indicates firms’ market power in producing intermediate goods. The calibration for the basic model assigns a value of 5 to the elasticity of substitution, translating to a mark-up of 1.25. In accordance with literature norms, the calibration establishes the standard deviation of Total Factor Productivity (TFP) \((\sigma A)\) at 0.010.
Model Simulation Results and Analysis

Total Factor Productivity Shock

Here we explore the implications of a collective productivity disturbance within a framework of monopolistic competition. In essence, the outcomes align qualitatively with those achieved in a competitive setting, yet notable distinctions emerge in quantitative terms. Overall, our findings indicate that the immediate impacts on variables resulting from this technological shock are comparatively diminished in monopolistic competition compared to perfect competition. This discrepancy can be attributed to the introduction of inefficiencies stemming from imperfect competition, which serve to mitigate the effects of the productivity shock.

The implications arising from monopolistic competition are directly linked to the pricing dynamics of production factors. In this particular setting, the equilibrium prices for both labor and capital are lower than their corresponding marginal productivity. The extent of market power wielded by monopolistic firms directly influences the markup, thereby amplifying the disparity between the marginal productivity of inputs and their respective prices. This outcome is a direct consequence of the assumption that the elasticity of substitution between differentiated goods exceeds unity. In this scenario, a shock to the marginal productivity of production factors results in a comparatively subdued response in both wages and the rental rate of capital when contrasted with a competitive environment. Consequently, the impact of the productivity shock on the owners of production factors is perceived to be less pronounced.

Figure 4 offers a glimpse into the evolving reactions of the model’s variables following a positive surge in productivity. Notably, this shock triggers changes in the economic landscape that ripple across various dimensions. One of the striking observations is the distinct behavior of wage and real interest rate responses. Both these variables exhibit an increment, albeit at a tempered pace. This nuanced response arises from the fact that they do not fully capture the entirety of the surge in the marginal productivity of labor and capital. This deviation from an exhaustive reflection of increased productivity aligns with the inherent nature of imperfect competition within the model.

Specifically, in a competitive market setting, wage and real interest rate adjustments would promptly align with the entire enhancement in the productivity of labor and capital. However, the presence of imperfect competition introduces distortions, causing these adjustments to occur at a more restrained rate. As a result, the reverberations of the productivity shock cascade through the model, impacting multiple economic indicators. Notably, the influence of the shock on investment, consumption, and output undergoes quantitative reduction due to the incomplete transmission of the shock’s effects.

In essence, Figure 4 underscores how the dynamics of imperfect competition interact with a positive productivity shock, reshaping the magnitude and speed of responses across the economic spectrum. This visual representation illuminates the intricate web of relationships that emerge when market imperfections are considered, and how these deviations from perfect competition can lead to differentiated and potentially dampened reactions to external shocks. The figure provides a tangible illustration of the model’s core mechanisms and their implications, reinforcing the crucial role that market structure plays in shaping the dynamics of an economy’s responses to fundamental changes like productivity shocks.
Policy Transition Functions

Table 2’s coefficient matrix exhibits a structure consistent with a framework involving policy and transition functions. It unveils coefficients corresponding to various variables and their lagged counterparts, implying potential relationships within a structural model context. These components offer insights pivotal to comprehending the intricate dynamics between economic indicators.

Table 2. Policy Transition Functions

<table>
<thead>
<tr>
<th></th>
<th>Y</th>
<th>C</th>
<th>I</th>
<th>K</th>
<th>L</th>
<th>W</th>
<th>R</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.635977</td>
<td>0.51843</td>
<td>0.117548</td>
<td>1.958384</td>
<td>0.952824</td>
<td>0.960931</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(correction)</td>
<td>0.000023</td>
<td>-2.5E-05</td>
<td>0.000047</td>
<td>0.000047</td>
<td>0.000019</td>
<td>-1.8E-05</td>
<td>0.000003</td>
<td>0</td>
</tr>
<tr>
<td>K(-1)</td>
<td>0.076303</td>
<td>0.133963</td>
<td>-0.05766</td>
<td>0.882341</td>
<td>-0.03136</td>
<td>0.200433</td>
<td>-0.03552</td>
<td>0</td>
</tr>
<tr>
<td>A(-1)</td>
<td>0.763772</td>
<td>0.316055</td>
<td>0.447716</td>
<td>0.447716</td>
<td>0.134011</td>
<td>0.776428</td>
<td>0.109203</td>
<td>0.95</td>
</tr>
<tr>
<td>e</td>
<td>0.80397</td>
<td>0.33269</td>
<td>0.47128</td>
<td>0.47128</td>
<td>0.141065</td>
<td>0.817292</td>
<td>0.11495</td>
<td>1</td>
</tr>
<tr>
<td>K(-1),K(-1)</td>
<td>-0.01981</td>
<td>-0.0132</td>
<td>-0.00661</td>
<td>-0.00661</td>
<td>0.005309</td>
<td>-0.02614</td>
<td>0.015307</td>
<td>0</td>
</tr>
<tr>
<td>A(-1),K(-1)</td>
<td>0.129624</td>
<td>0.054395</td>
<td>0.075229</td>
<td>0.075229</td>
<td>0.019781</td>
<td>0.132679</td>
<td>-0.03723</td>
<td>0</td>
</tr>
<tr>
<td>A(-1),A(-1)</td>
<td>0.011452</td>
<td>-0.02096</td>
<td>0.032409</td>
<td>0.032409</td>
<td>-0.09596</td>
<td>-0.01919</td>
<td>0.001637</td>
<td>-0.02375</td>
</tr>
<tr>
<td>e,e</td>
<td>0.435832</td>
<td>0.151879</td>
<td>0.283953</td>
<td>0.283953</td>
<td>-0.03208</td>
<td>0.408887</td>
<td>0.062315</td>
<td>0.5</td>
</tr>
<tr>
<td>K(-1),e</td>
<td>0.136446</td>
<td>0.057258</td>
<td>0.079188</td>
<td>0.079188</td>
<td>0.020822</td>
<td>0.139662</td>
<td>-0.03919</td>
<td>0</td>
</tr>
<tr>
<td>A(-1),e</td>
<td>0.82808</td>
<td>0.28857</td>
<td>0.539511</td>
<td>0.539511</td>
<td>-0.06095</td>
<td>0.776885</td>
<td>0.118398</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Source: Author’s computation from the Matlab output.

The constant terms or intercepts offer foundational values for each variable devoid of external influences, thereby shaping the outset of the model’s analysis. Adjacent correction terms play a role in refining the model’s fit, addressing deviations from theoretical expectations, and mitigating potential biases. Moving to lagged variables, such as K(-1) and A(-1), the coefficients signify the enduring influence of past capital and aggregate levels on the present state of economic indicators. This suggests the significance of historical trends and market conditions in influencing the behavior of firms in the context of imperfect competition and oligopoly dynamics. Exogenous variables (e) shed light on external shocks’ impacts, unveiling the effect of policy shifts, unexpected events, or unmodeled factors on economic indicators. Interaction terms, encompassing various combinations like K(-1), K(-1), A(-1), K(-1), A(-1), A(-1), e, e, K(-1), e, A(-1), e, elucidate the combined effects of variables on economic indicators.

Source: Matlab with Dynare interface.

Fig. 4. Impulse response function output
indicators. This intricate interplay embodies the complexities of imperfect market competition and the interrelationship between economic indicators and oligopoly behavior.

In the realm of our research focus, these coefficients form the foundation for understanding the interwoven nature of macroeconomic rigidities on market competition in Sierra Leone. They offer pathways through which historical trends, external factors, and interactions mold economic indicators within an imperfect market setting. By delving into these coefficients and discerning their implications, a deeper comprehension of how market rigidities intersects with economic indicators emerges, ultimately shedding light on the intricate dynamics of Sierra Leone’s market landscape.

Model’s Coefficients of Autocorrelation

Table 3 presents the coefficients of the autocorrelation of various variables (Y, C, I, K, L, W, R, A) at different orders (1 to 5). The values indicate the strength and direction of autocorrelation between each variable and its lagged values up to the specified order. Higher values suggest a stronger autocorrelation, implying that past values of the variable have a significant influence on its current value. The coefficients provide insights into the persistence and memory of each variable’s behavior over time.

<table>
<thead>
<tr>
<th>Order</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>0.9695</td>
<td>0.9382</td>
<td>0.9065</td>
<td>0.8746</td>
<td>0.8427</td>
</tr>
<tr>
<td>C</td>
<td>0.9896</td>
<td>0.9757</td>
<td>0.9572</td>
<td>0.9364</td>
<td>0.9135</td>
</tr>
<tr>
<td>I</td>
<td>0.8957</td>
<td>0.8031</td>
<td>0.7207</td>
<td>0.6474</td>
<td>0.5821</td>
</tr>
<tr>
<td>K</td>
<td>0.9968</td>
<td>0.9883</td>
<td>0.9753</td>
<td>0.9587</td>
<td>0.9391</td>
</tr>
<tr>
<td>L</td>
<td>0.8394</td>
<td>0.6999</td>
<td>0.5788</td>
<td>0.4739</td>
<td>0.3831</td>
</tr>
<tr>
<td>W</td>
<td>0.9834</td>
<td>0.9638</td>
<td>0.9416</td>
<td>0.9175</td>
<td>0.8919</td>
</tr>
<tr>
<td>R</td>
<td>0.8524</td>
<td>0.7238</td>
<td>0.6116</td>
<td>0.514</td>
<td>0.4292</td>
</tr>
<tr>
<td>A</td>
<td>0.95</td>
<td>0.9025</td>
<td>0.8574</td>
<td>0.8145</td>
<td>0.7738</td>
</tr>
</tbody>
</table>

Source: Author’s computation from the Matlab output.

For instance, a high autocorrelation coefficient for an economic indicator like Investment (I) at lag 1 suggests that current investment levels are significantly influenced by the previous period’s investment, which could imply the presence of inertia in investment decisions. In the context of macroeconomic rigidities and imperfect competition, this persistence could relate to the strategic actions of dominant firms affecting investment decisions, potentially reflecting a lack of competition-induced flexibility.

Calibrated Model Steady-State Results

Table 4’s computed eigenvalues serve as evidence of the model’s stability, a crucial requirement for establishing the uniqueness of a stable equilibrium near the steady-state. This prerequisite implies that the count of eigenvalues surpassing unity in modulus must be equal to the number of system-wide variables possessing forward-looking components. The confirmed stability not only signals adherence to the Blanchard-Kahn criteria but also verifies the simplicity of local conditions, particularly in terms of eigenvalues computed at the model’s steady state, crucial for ensuring solution existence and uniqueness. Additionally, the subsequent model simulation outcomes underscore its proficiency in achieving a perfect foresight solution. Notable is the consistent reduction of errors following each iteration of the Newton solver utilized for estimating the model’s solution. This encouraging trend effectively negates any concerns related to convergence problems, affirming the model’s robustness in this aspect.
Table 4. Steady-State Results

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>0.635955</td>
</tr>
<tr>
<td>C</td>
<td>0.518455</td>
</tr>
<tr>
<td>I</td>
<td>0.1175</td>
</tr>
<tr>
<td>K</td>
<td>1.95834</td>
</tr>
<tr>
<td>L</td>
<td>0.347063</td>
</tr>
<tr>
<td>W</td>
<td>0.952842</td>
</tr>
<tr>
<td>R</td>
<td>0.090928</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
</tr>
</tbody>
</table>

**EIGENVALUES:**

<table>
<thead>
<tr>
<th>Modulus</th>
<th>Real</th>
<th>Imaginary</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8823</td>
<td>0.8823</td>
<td>0</td>
</tr>
<tr>
<td>0.95</td>
<td>0.95</td>
<td>0</td>
</tr>
<tr>
<td>1.21</td>
<td>1.21</td>
<td>0</td>
</tr>
<tr>
<td>1.54E+17</td>
<td>1.54E+17</td>
<td>0</td>
</tr>
</tbody>
</table>

There are 2 eigenvalue(s) larger than 1 in modulus for 2 forward-looking variable(s)

Source: Author’s computation from the Matlab output.

Table 4 offers a comprehensive insight into the outcomes of our structural model analysis, specifically tailored to the impact of macroeconomic rigidities on market competition in Sierra Leone. The details provided can be dissected into two distinctive layers for a more comprehensive understanding:

**Steady-State Results and Economic Implications**

The steady-state results, as depicted in Table 4, illuminate the equilibrium states of key economic indicators (Y - Output, C - Consumption, I - Investment, K - Capital, L - Labor, W - Wages, R - Interest Rate, A - TFP) within the context of a balanced system. These values unveil the foundational levels that these variables tend to stabilize at, unaffected by external shocks or disturbances. The steady-state value of Output (Y) at 0.635955 represents the enduring norm of output within the established equilibrium. Similarly, the values for other indicators reflect their steady-state baselines, offering a snapshot of the economy’s undisturbed state.

**Eigenvalues and their significance**

The eigenvalues, which constitute a critical aspect of our analysis, serve as a valuable lens through which we can comprehend the dynamic nature of the model. By examining their modulus (absolute value) along with the real and imaginary components, eigenvalues provide insight into the system’s responsiveness to disturbances and shocks. Notably, eigenvalues with a modulus surpassing 1 indicate a system characterized by intricate dynamics, potentially leading to oscillatory behavior in response to shifts in exogenous variables. Moreover, the presence of multiple eigenvalues larger than 1 in modulus, particularly when aligned with forward-looking variables, emphasizes the model’s aptitude for capturing agents’ anticipatory behavior within the context of imperfect market competition. This insight contributes to our understanding of how macroeconomic rigidities impact market competition in Sierra Leone, offering valuable implications for the broader economic landscape.

The correlation matrix presented in Table 5 offers insights into the relationships between economic indicators (Y - Output, C - Consumption, I - Investment, K - Capital, L - Labor, W - Wages, R - Interest Rate, A - Aggregate) in our analysis. High positive correlations (close to 1)
between Output, Consumption, Investment, and Wages suggest their alignment in direction, reflecting the connection between economic activity and wages. Moderate positive correlations (between 0.5 and 0.9) between Output and Investment, Output and Capital, and Consumption and Capital highlight the role of capital in economic growth. Low positive to negative correlations (between 0.2 and -0.3) with Interest Rates indicate their influence on economic activities. Positive correlations (between 0.2 and 0.7) between Consumption, Investment, and Wages with Labor underscore their interdependence. The negative correlation (close to -0.3) between Investment and Interest Rate conforms to the understanding that higher rates deter investment. These insights collectively reveal the intricate interplay of economic indicators in the context of Sierra Leone, providing a foundation for analyzing oligopoly behavior amidst imperfect competition.

Table 5. Approximated matrix of correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Y</th>
<th>C</th>
<th>I</th>
<th>K</th>
<th>L</th>
<th>W</th>
<th>R</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>1</td>
<td>0.9784</td>
<td>0.8834</td>
<td>0.9267</td>
<td>0.5529</td>
<td>0.9914</td>
<td>0.0934</td>
<td>0.9896</td>
</tr>
<tr>
<td>C</td>
<td>0.9784</td>
<td>1</td>
<td>0.7674</td>
<td>0.9844</td>
<td>0.3685</td>
<td>0.997</td>
<td>-0.1146</td>
<td>0.9384</td>
</tr>
<tr>
<td>I</td>
<td>0.8834</td>
<td>0.7674</td>
<td>1</td>
<td>0.6425</td>
<td>0.8789</td>
<td>0.8147</td>
<td>0.549</td>
<td>0.9416</td>
</tr>
<tr>
<td>K</td>
<td>0.9267</td>
<td>0.9844</td>
<td>0.6425</td>
<td>1</td>
<td>0.1991</td>
<td>0.9678</td>
<td>-0.2877</td>
<td>0.863</td>
</tr>
<tr>
<td>L</td>
<td>0.5529</td>
<td>0.3685</td>
<td>0.8789</td>
<td>0.1991</td>
<td>1</td>
<td>0.4394</td>
<td>0.8813</td>
<td>0.6669</td>
</tr>
<tr>
<td>W</td>
<td>0.9914</td>
<td>0.997</td>
<td>0.8147</td>
<td>0.9678</td>
<td>0.4394</td>
<td>1</td>
<td>-0.0374</td>
<td>0.9624</td>
</tr>
<tr>
<td>R</td>
<td>0.0934</td>
<td>-0.1146</td>
<td>0.549</td>
<td>-0.2877</td>
<td>0.8813</td>
<td>-0.0374</td>
<td>1</td>
<td>0.2356</td>
</tr>
<tr>
<td>A</td>
<td>0.9896</td>
<td>0.9384</td>
<td>0.9416</td>
<td>0.863</td>
<td>0.6669</td>
<td>0.9624</td>
<td>0.2356</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Author’s computation from the Matlab output.

Table 6 comprises the approximated moments of the model’s variables. The mean value encapsulates the central tendency of each variable’s behavior over the simulation period, serving as a fundamental anchor for the analysis. This is exemplified by the mean value of Output (Y) at 0.6369, representing the average output level. The standard deviation (Std. Dev.) stands as an indicator of the extent of dispersion around the mean. For instance, the higher standard deviation of Capital (K) at 0.1081 reflects notable variability in capital levels, potentially linked to shifts in investment patterns, a crucial aspect under the lens of oligopoly dynamics. Variance offers insights into the broader spread of values, and its application to Output (Y), with a variance of 0.0011, indicates the extent to which output values deviate from their mean. The substantial standard deviation and variance of Capital (K) suggest pronounced volatility in capital levels. Such fluctuations could mirror dynamic investment decisions, hinting at the influence of oligopoly behavior and market competition dynamics on capital allocation. The relatively low standard deviation and variance of Output (Y) point to a stable output landscape. This stability could be attributed to the strategic actions of dominant firms within an oligopolistic market structure, where concerted efforts to maintain consistent production levels can counteract economic turbulence. The minor standard deviations of Interest Rate (R) and Labor (L) hint at stability in these variables. This stability may stem from policy measures or regulatory interventions that exert a mitigating influence on interest rate fluctuations and labor market dynamics. The variance of TFP (A) at 0.001 suggests a moderate degree of economic variability. Exploring the interplay between this variability and oligopoly behavior unveils how dominant firms navigate economic fluctuations, offering insights into their adaptive strategies.
Table 6. Approximated theoretical moments

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>MEAN</th>
<th>STD. DEV.</th>
<th>VARIANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>0.6369</td>
<td>0.0329</td>
<td>0.0011</td>
</tr>
<tr>
<td>C</td>
<td>0.5191</td>
<td>0.024</td>
<td>0.0006</td>
</tr>
<tr>
<td>I</td>
<td>0.1177</td>
<td>0.0106</td>
<td>0.0001</td>
</tr>
<tr>
<td>K</td>
<td>1.9625</td>
<td>0.1081</td>
<td>0.0117</td>
</tr>
<tr>
<td>L</td>
<td>0.347</td>
<td>0.0026</td>
<td>0</td>
</tr>
<tr>
<td>W</td>
<td>0.9542</td>
<td>0.0457</td>
<td>0.0021</td>
</tr>
<tr>
<td>R</td>
<td>0.0909</td>
<td>0.0023</td>
<td>0</td>
</tr>
<tr>
<td>A</td>
<td>1.0005</td>
<td>0.032</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Source: Author’s computation from the Matlab output.

Table 7. Model summary

<table>
<thead>
<tr>
<th>Number of variables</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of stochastic shocks</td>
<td>1</td>
</tr>
<tr>
<td>Number of state variables</td>
<td>2</td>
</tr>
<tr>
<td>Number of jumpers</td>
<td>2</td>
</tr>
<tr>
<td>Number of static variables</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: Author’s computation from the Matlab output.

The provided model summary in Table 7 succinctly outlines the foundational components and structure of our analytical framework. With 8 variables, the model encompasses a diverse set of economic indicators and pertinent elements essential for comprehending the complexities of the economic system under investigation. The incorporation of a single stochastic shock introduces an element of uncertainty, representing external influences that can disrupt the system. Two state variables indicate a dynamic aspect, tracing the evolution of specific factors over time. Additionally, the presence of 2 jumpers signifies the inclusion of variables prone to abrupt changes, potentially driven by external shocks. Moreover, the model features 4 static variables, representing constants or parameters that establish the baseline conditions. This comprehensive approach aims to capture the intricate interplay between economic indicators, oligopoly behavior, and other pertinent factors within the unique context of Sierra Leone’s market landscape.

The matrix of covariance of exogenous shocks presented in Table 8 provides insight into the covariance relationship of a single exogenous shock variable (e) with itself within the context of our research focus. This covariance value, 0.000100, signifies a positive correlation between the fluctuations of the exogenous shock variable.

Table 8. Matrix of covariance of exogenous shocks

<table>
<thead>
<tr>
<th>Variables</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>e</td>
<td>0.000100</td>
</tr>
</tbody>
</table>

Source: Author’s computation from the Matlab output.

This holds important implications for comprehending the influence of external factors on economic indicators in our research context. Despite its seemingly small magnitude, the positive covariance suggests that external shocks tend to persist to some extent, potentially exerting lasting effects on economic indicators. Moreover, the positive covariance implies that sudden changes in the exogenous shock variable could trigger correlated responses in economic indicators, revealing a dynamic relationship between these variables. This insight not only aids in refining our model but also emphasizes the significance of considering external shocks in analyzing the interplay of economic indicators of macroeconomic rigidities on market competition in Sierra Leone, ultimately enriching the understanding of the market’s dynamics.
Conclusions

This study develops a DSGE model integrating imperfect competition, a key element in New Keynesian DSGE models. The inclusion of nominal and real rigidities, along with market failures, is crucial for comprehending the dynamics of an economy. The study sought to decipher how this unique market environment influences the responses of key economic variables to external shocks, with a specific focus on an aggregate productivity shock. Through a comprehensive analysis of model simulation results, policy and transition functions, coefficients of autocorrelation, calibrated model steady-state results, a correlation matrix, theoretical moments, model summary, and the matrix of covariance of exogenous shocks, our findings illuminate a nuanced and multifaceted landscape.

In the realm of model simulation results, we observed that the presence of imperfect competition within the Sierra Leonian market introduced inefficiencies, reducing the immediate impact of a productivity shock on economic variables. Notably, this was evidenced by a moderated pace of response in wage and real interest rate adjustments due to the deviations from perfect competition. These deviations, introduced by market imperfections, resonated through various economic indicators, ultimately dampening the effects of the shock on investment, consumption, and output. The analysis of policy and transition functions revealed a web of interactions among variables, emphasizing the enduring influence of past capital and aggregate levels, as well as the impacts of external shocks. This deepened our understanding of how historical trends, market conditions, and the combined effects of variables shape the behavior of firms within an oligopolistic and imperfectly competitive market setting in Sierra Leone. The coefficients of autocorrelation offered valuable insights into the persistence and memory of economic indicators over time, uncovering the strategic actions of dominant firms and inertia in investment decisions. These insights are pivotal in comprehending the dynamic nature of market competition and its implications on economic indicators.

Our analysis of calibrated model steady-state results and eigenvalues demonstrated the stability of the model, affirming the existence of a unique and stable equilibrium in Sierra Leone. Additionally, the presence of eigenvalues exceeding unity in modulus, particularly in forward-looking variables, showcased the model’s capacity to capture agents’ anticipatory behavior within the framework of imperfect market competition.

The correlation matrix depicted relationships between economic indicators, shedding light on the profound connection between economic activity, wages, and the role of capital in economic growth. These insights are invaluable for examining the dynamics of market competition and the potential impact of oligopolistic behavior on economic indicators. Theoretical moments provided a deeper comprehension of the stability and variability of economic indicators, highlighting the influence of dominant firms on capital allocation and the role of policy measures in stabilizing interest rates and labor markets.

Furthermore, the analysis of monopolistic competition offers specific findings regarding the impact of imperfect competition on the response to productivity shocks. The research demonstrates that under monopolistic competition, the effects of positive productivity shocks are quantitatively smaller compared to a perfectly competitive environment. This is primarily due to inefficiencies resulting from imperfect competition, which slow down the adjustments of wages and real interest rates to changes in the productivity of labor and capital. These findings underscore the importance of market structure and its implications for economic dynamics in Sierra Leone, highlighting the complexities introduced by imperfect competition. Lastly, the matrix of covariance of exogenous shocks accentuated the significance of considering external influences on economic indicators, unveiling the persistence and correlated responses of external shocks in Sierra Leone.
Policy Implications

These research paper’s findings hold several critical policy implications for Sierra Leone. Firstly, it is imperative for policymakers to recognize the substantial impact of market imperfections and oligopoly behavior on the economy’s response to external shocks. In light of the observed dampened responses to productivity shocks in imperfectly competitive markets, a more nuanced approach to managing economic fluctuations is needed. Policymakers may consider tailoring their responses to address the specific characteristics of these markets. This could include targeted measures to mitigate inefficiencies arising from oligopoly power, such as promoting competition, preventing anti-competitive practices, and encouraging market entry to enhance efficiency.

Secondly, the study underscores the importance of understanding the interplay between wages, interest rates, and productivity shocks in an imperfectly competitive environment. As wage and interest rate adjustments occur at a slower pace, it is vital for policymakers to adopt policies that enhance the flexibility of these factors. Labor market reforms, designed to facilitate more rapid wage adjustments, could contribute to a swifter recovery from external shocks. Moreover, policies aimed at promoting interest rate flexibility could lead to more effective monetary policy responses, ensuring that the impact of shocks is better absorbed by the economy.

Thirdly, the persistence observed in investment decisions highlights the need for policies that stimulate dynamic investment patterns. Policymakers may consider incentivizing innovation and competition within the business environment to counteract investment inertia. Encouraging the entry of new firms, as well as fostering entrepreneurial activities, can contribute to a more vibrant investment landscape, reducing the influence of dominant firms and promoting a competitive market.

Fourthly, the research underscores the importance of stabilizing interest rates and labor markets. This implies that macroeconomic and regulatory policies should aim to minimize fluctuations in these areas. Well-crafted monetary policies, fiscal measures, and labor market reforms can play a significant role in achieving this stability, reducing uncertainty for both firms and workers.

Lastly, this study underscores the need for monitoring external shocks and their correlated responses. Policymakers should enhance their ability to anticipate and respond to external shocks, as they can significantly affect the performance of the Sierra Leonean economy. Improved surveillance and the development of shock-absorbing mechanisms will be crucial for maintaining stability and mitigating potential disruptions.

Disclaimer

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References