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ARTICLE

Dynamic Modelling of the Impact of Fiscal and Exchange Rate Policy on Agriculture and Welfare Applied to South Africa

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ABSTRACT

This study examines the effects of macroeconomic policies on growth and equity in South Africa, focusing on agriculture's links to the broader economy. We extend existing work by employing a dynamic agriculture-centred computable general equilibrium model to quantify the impacts. The focus is on fiscal and exchange rate policies and assessing how these policies affect agriculture and the nation's welfare. Findings indicate that expansionary fiscal policies impede agricultural expansion, regardless of how the fiscal expansion is financed. Positive effects on rural consumption only arise if budget deficits are managed through taxes on household income, which minimises adverse effects on agriculture and rural growth more than on urban sectors. A depreciated exchange rate enhances sectors driven by exports, such as agriculture and mining, but slightly detracts from the economy by affecting private services industries that constitute a large share of the economy, less tradable, and sensitive to income changes. The overall impact on consumption income is neutral but is marginally challenging for urban dwellers. These findings have two main policy implication. To be suitable for the agricultural sector and the broader economy, the orientation and framework of the current macroeconomic policy need adjustment to sustain fiscal balance and prevent exchange rate overvaluation. In the policymaking, two key considerations are: first, quantifying how macroeconomic policies interact with the agricultural sector, structural factors, and broader equilibrium effects,

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as these can significantly alter policy outcomes. Second, recognising the distributive impacts of policies, especially on agriculture and rural markets, and integrating agriculture's role in income distribution and political economy consequences into policymaking.

Keywords: Agriculture; Applied Economics; Welfare; Fiscal Policy; Exchange Rate Policy; South Africa

1. Introduction

Similar to many low-income developing nations, South Africa's economy is heavily influenced by agriculture and the rural sector, albeit indirectly. With nearly 32% of South Africans residing in rural regions, agriculture constitutes about 20% of overall employment and 10% of the nation's export earnings. It also supplies raw materials for 70% of South Africa's output. Despite this, agriculture's contribution to the gross domestic product (GDP) is strikingly low, around 2.5–3.0%, highlighting the especially low income levels of farmers, notably in the semi-arid, low-productivity communal and resettlement zones. Consequently, it is not surprising that even though South Africa falls into the upper middle-income categorisation of the World Bank, it records the highest income inequality globally, with rural areas suffering significantly from poverty [1–3]. Around 70% of South Africa's poor live in rural areas, where unemployment is 81.3% compared to 40.7% in urban areas [4,5].

There is a broad consensus among development economists and practitioners that lasting economic growth in countries with a strong agricultural base is improbable without developing agriculture either beforehand or simultaneously. The empirical evidence in development economics establishes a positive correlation between agricultural advancement and overall economic progress with extensive research supporting its crucial role in enhancing yields, driving economic expansion and creating employment [6–8]. Additionally, robust arguments, supported by historical evidence and counterfactual model simulations, indicate that agricultural development plays a crucial role in driving growth in other economic sectors for various countries [9,10]. A key general insight is that the consumption linkage effect, resulting from increased rural income, is a more powerful intersectoral driver than the "production linkages" of agricultural growth. The capacity of rural consumption demand to generate and maintain a broad market for domestic goods, particularly in labour-intensive manufacturing and services, is increasingly acknowledged. The degree to which agricultural growth impacts non-agricultural expansion varies considerably from one country and region to another [11]. Furthermore, within each regional group, notable variations exist among developing nations in the interplay between agricultural and non-agricultural growth. This suggests the presence of other factors affecting non-agricultural growth, such as domestic policies and international developments at the time.

The Vision of the National Development Plan (NDP) for 2030 in South Africa, together with the medium-term development plan (MTDP) for 2025–2030, underscores the crucial role of rural and agricultural policies in fostering growth [12]. Given the considerable economic importance of agriculture, the impact on agricultural performance would be a key determinant of the success of the policy reforms that are being undertaken. Indeed, without agricultural growth and rural development to increase the real incomes of the vast majority of the poor in rural areas, it is difficult to envisage rapid, equitable and sustainable growth of the national economy as envisaged in the NDP and MTDP of the country. It is also notable that even in the context of a less heavily agrarian economy such as the case of South Africa, Mexico, Adelman and Taylor [13] concluded from their quantitative analysis of alternative policy reform scenarios that agricultural development is a key to successful adjustment policies from a macro point of view.

This study seeks to enhance our understanding of adjustments in macroeconomic policies and their impact on economic growth and equity within South Africa, with a particular focus on the connections between agriculture and the broader economy. The study focuses on fiscal policy and exchange rate policy. Generally, the government's macroeconomic tools are varied and aim to

tackle both immediate and long-term issues such as minimizing uncertainty and risk in the national economy, encouraging growth, and promoting welfare and equitable income distribution [14]. This requires assessing the coherence between macroeconomic policies and those not directly related to agriculture, considering their crowding in and out dynamics [15]. Several economic modelling methods have been applied to plan strategies for agricultural and rural progress [14,16]. These approaches can be split into two main categories: macro- and micro-analytical techniques. Micro-analytical methods typically involve using survey data from households or plots to estimate how shocks directly or indirectly affect household conditions and welfare, or agricultural production. In contrast, macroeconomic approaches evaluate the impact of economic variables such as GDP, pricing, credit, and employment on agricultural outcomes. Macro models include macro-econometric frameworks and computable general equilibrium (CGE) models. We utilise a dynamic recursive CGE macroeconomic modelling as our emphasis is on the economy-wide income effects of macroeconomic reform measures, analysed both independently and in combination with other governmental policy changes. Broad-based agricultural expansion often results in strong labour-intensive consumption links that enhance employment and income multipliers, benefiting both rural and urban areas. Conversely, if the benefits of agricultural growth are skewed towards wealthier rural households, the expenditure patterns will likely focus on capital-intensive goods and imports rather than labour-intensive, locally made products, thereby diminishing the drive towards the NDP goals. Yet, the dynamic recursive CGE model is not conducive for in-depth distributional analysis. Distributional analysis is important because agriculture's role in economic development extends beyond bolstering the national economy. In many countries such as South Africa, where poverty affects mainly rural areas, increasing agricultural production can significantly reduce poverty and income disparity. The structure of agricultural growth and its economic links are crucial determinants of this outcome. To capture these distributional effects (poverty and inequality) therefore, we integrate the CGE model with a welfare analysis module.

In our research, we augment the Partnership for Economic Policy (PEP) 1-t CGE model, originally formulated by Decaluwé et al. [17], to examine how policy shifts impact agriculture. Precedent studies, such as those by Mabugu et al. [18], Tiberti et al. [19], Fofana et al. [20], and Chitiga-Mabugu et al. [21], have utilized this model to explore the implications of policy changes within South Africa's context although none have applied the approach to assess the economy wide impact of fiscal and exchange rate policy on agriculture and welfare in South Africa. We address this research gap by extending the recent work in Mabugu et al. [22] by (a) extending the conceptual framework to accommodate quantifying how macroeconomic policy reforms influence agriculture and the rural sector by triggering changes in markets and infrastructure; (b) essential causal linkages in how agricultural growth's demand-side impacts extend to the broader economy; and (c) the influence of economic policies in steering favourable non-agricultural supply reactions. While some specifics of the model are tailored to South Africa, this framework is broadly applicable to middle-income and developing nations aiming to boost agricultural development and overall national progress through macroeconomic strategies, with Mabugu et al. [23] recently applying it across ten diverse African countries.

The paper is organised as follows: Section 2 reviews agricultural growth and rural development studies. Section 3 discusses the conceptual framework, model and data for assessing macroeconomic policy impacts on agriculture, the economy and households. Section 4 gives an overview of the South African economy. Section 5 presents simulation scenarios and results. Section 6 concludes with a summary, policy relevance, study strengths, limitations, and future research directions.

2. Agricultural Growth and the Macroeconomy: A Review

Agriculture has been crucial in economic development with the shift from agriculture to manufacturing and services an enduring theme. Modern studies have analysed this transformation in phases, starting with industrialization [24–27] and continue with Wang

and Xie [28]. The transition includes moving from agriculture to manufacturing to services, leading to a market and service-driven society. Models such as Laitner [29] highlight savings for modernization, while Hansen and Prescott [25] and Ngai and Pissaridis [30] focus on technological growth rates. Gollin et al. [26] emphasise enhancing agricultural productivity to shift labour to modern sectors. Non-balanced growth models explain reduced agricultural employment with decreased subsistence farming [31]. While Caselli and Coleman [32] study regional convergence in the United States of America, and Duarte and Restuccia [33] examine labour productivity disparities internationally. Buera and Kaboski explore technological advancements and preferences, while Buera and Kaboski [34,35] discuss mass production's role in industrialization.

Pioneering work on surplus labour economies by Lewis, Fei and Ranis, and Sen [36–39] examined their impact on labour markets and development. Lewis [36]'s 'dual economy' model distinguishes between a low-wage traditional sector reliant on old technologies and a higher-wage modern sector utilizing advanced technologies. Labour and resources from agriculture aid industrial advancement until labour surplus is absorbed, equalizing urban and rural wages. Subsequent research explored surplus labour's role, including Todaro [40] and Harris and-Todaro [41] on urban unemployment where urban wages surpass equilibrium. Khan [42] adapted this under trade theory, suggesting optimal labour and capital subsidies. Batra and Naqvi [43] argued for subsidies and free trade amid urban unemployment, while Beladi and Marjit [44] linked tariffs on urban final goods to employment. Chang et al. [45] noted tariff cuts boost efficiency but may disrupt labour markets. Dynamic analysis is introduced in Drazen and Eckstein [46] and Glomm [47] analysed dynamic models; the latter achieving Pareto optimal equilibrium. Studies such as Bencivenga and Smith [48] and Banerjee and Newman [49] linked urban low growth to negative worker selection and credit imperfections. Lucas [50] viewed migration as moving from traditional to urban sectors, with human capital driving wage gaps.

While it may be well known that governments in developing countries intervene heavily in agricultural markets, what was less emphasised in the early literature is that government policies have tended to penalize agricultural producers, particularly with respect to price incentives and public investment. Early studies on this phenomenon in developing countries focused on relative price incentives favouring agriculture [51,52]. They mainly used indicators such as the real exchange rate and sectoral price ratios. However, factors influencing agriculture and rural development go beyond price, involving diverse macroeconomic policies, as shown in industrialised countries' research [53]. Beyond exchange rates, developed country evaluations considered income effects, interest rates, and other economic variables [54,55]. This interaction is crucial in developing nations, where agriculture impacts GDP, employment, and trade [14]. The agricultural sector's success affects economic growth, inflation, balance of payments, and fiscal stability [56]. Effective policy-making in these areas requires understanding global economic dynamics [14]. Studies adopting this more comprehensive analysis routinely find that policy bias significantly harmed agricultural performance, leading to poor national income growth and macroeconomic instability.

Our work builds and contributes to this literature on agriculture's role in economic development. We follow in the tradition of general equilibrium models with an urban-rural dichotomy evaluating agricultural and economic reforms in Africa [57–60]. We customize and apply these approaches along the lines of Decaluwé et al. and Mabugu et al. [17–22] to fit South Africa realities and then simulate impacts of macroeconomic policies on agriculture, poverty and rest of the economy. The model is detailed in the next section.

3. The Model and Data

Figure 1 presents a broad conceptual framework of how macroeconomic policies affect various economic levels through agriculture and rural linkages. At the top, fiscal and exchange rate policies are highlighted. These policies influence households through meso-economic conditions such as markets and infrastructure, impacting rural and urban income and demand-supply dynamics. Rural income and its distribution depend on infras-

tructure and human resources, shaped by public spending. Product and input markets interact due to agricultural and non-agricultural sector needs, with product markets also affected by exchange rate changes. Labour markets are influenced by human capital quality and foreign trade. An overvalued exchange rate distorts factor prices, hurting labour-intensive rural industries. Rural producers' supply response depends on price signals and access to skilled labour and capital. Import restrictions and lack of investment in health, education, and skilled labour hinder rural growth. Poor infrastructure and anti-rural policies can prevent rural producers from benefiting from better market conditions, limiting income growth.

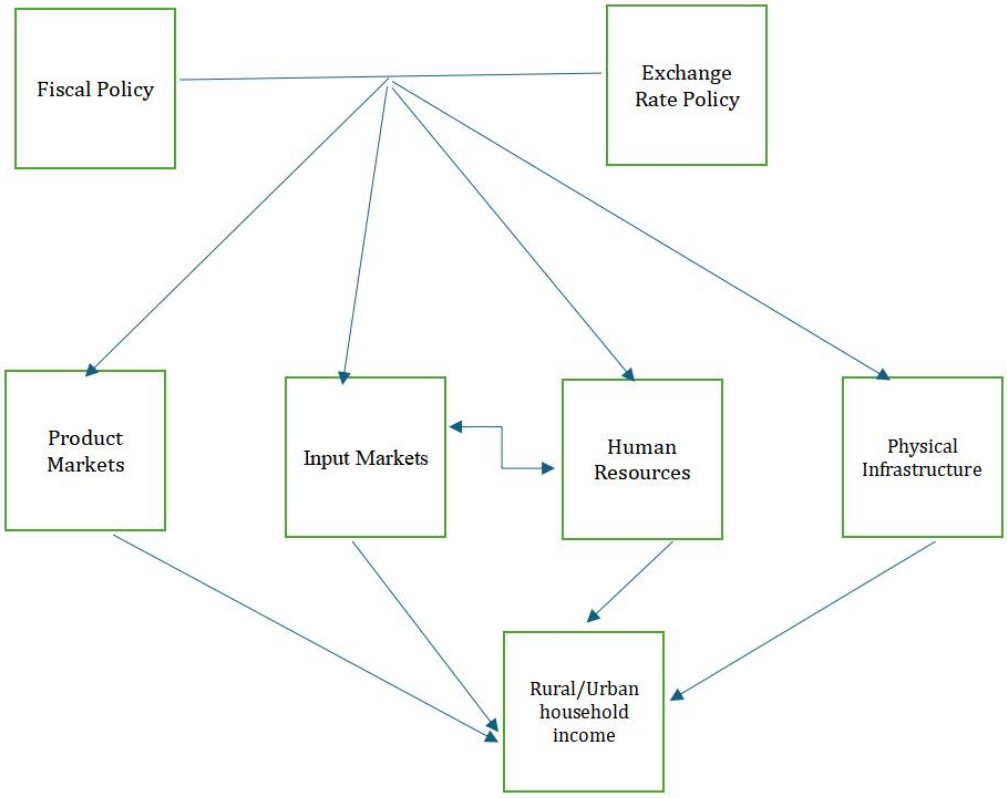

Figure 1. Macroeconomic framework and transmission channels of policies to sectors and households.

Source: Authors modification based on Diaz-Bonilla [53].

As currently depicted, **Figure 1** is limited as it only shows initial impacts of macroeconomic policies, ignoring agriculture's links to other sectors. Increased agricultural output raises demand for industrial inputs and supplies more products to non-agricultural sectors, known as backward and forward linkages. Agricultural growth also boosts farm household incomes, increasing their demand for both agricultural and industrial goods. These consumption links initially affect food processing, industry, transportation, construction, and services, creating further economic links and an income multiplier effect.

To analyse the production and consumption linkages simultaneously, macroeconomic approaches evaluate how policy shocks influence agriculture and macroeconomic indicators such as GDP, prices, sectoral output, and employment [61]. Major macroeconomic models include input-output (IO) models, social accounting matrices (SAM), macro-econometric models, and CGE models. These models rely on economic data across multiple sectors published by national statistical agencies. This research employs CGE models, which are differentiated by timeframe and scope. Timeframe distinguishes between comparative-static and dynamic models, while scope pertains to national or global economics. Comparative-static models, exemplified by the Arrow-Debreu framework, concentrate on a single period and

analyse demand without considering monetary or asset markets [62,63]. Dynamic CGE models address time-based distortions from policy changes, assuming firms and households optimize choices over time [64]. Economic growth stems from saving, investment, trade efficiency, development of infrastructure that enhances total factor productivity, and education that improves labour productivity. Dynamic models are further divided into either recursive or intertemporal types.

CGE models manifest in diverse configurations, primarily categorized by their dynamics and country coverage. A recursive-dynamic CGE model connects individual static models in a sequence [65], with equilibrium transitions facilitated by capital accumulation and external variables such as demographic changes. Conversely, an intertemporal CGE model is rooted in optimal growth theory, presuming that agents possess perfect foresight to optimize utility-oriented choices [65]. Models tailored for specific countries, such as PEP1-t or PEP1-1, offer granular insights applicable to single-country policy evaluations, whereas global models such as GTAP emphasize international policies, albeit with reduced detail concerning sectors and institutions [15].

As previously mentioned, this study employs a recursive dynamic CGE model following the PEP1-t tradition for the examination of agriculture. The model is structured into three primary equation sets: the supply block, which focuses on production and trade aspects; the demand block, which deals with income, savings, and consumption; and the macroeconomic block, covering macroeconomic constraints and pricing guidelines. Detailed discussions on each block will now be provided. Full definitions of the equations, parameters, variables, and sets can be obtained from the authors upon request.

The social accounting matrix (SAM) as the core data set for implementation of the CGE model consists of 30 activities and 30 products, with each production sector employing a technology that exhibits constant returns to scale via a four-tiered production structure. At the initial level, sectoral output integrates value-added and intermediate consumption using a Leontief function. At the next tier, the value-added model incorporates a constant elasticity of substitution (CES) function that allows for the interchange between composite labour and composite capital. Concurrently at this stage, intermediate consumption is modelled as completely complementary, following a Leontief production function. Composite labour is divided into skilled and unskilled categories at the third tier using a CES function, while composite capital is a CES mix of agricultural and non-agricultural capital. Finally, at the fourth tier, labour demand is governed by a CES function distinguishing between skilled and unskilled labour for each region.

Consistent with the SAM framework, the model identifies four primary categories of institutions: households, businesses, government, and the rest of the world. Households are further divided into two groups: rural and urban. They obtain their income through labour, capital returns, and transfers from other economic agents. Total household income is used to cover direct taxes, make transfers, save, and predominantly, consume goods and services, as modelled by a linear expenditure system (LES) utility function.

Companies primarily generate income through returns on capital and transfers from other entities. They are required to pay taxes on their income, distribute dividends to other organizations, and save the remaining portion. Government revenue is sourced from direct taxes paid by both households and businesses, indirect taxes such as import duties, commodity taxes, and production taxes, as well as transfers from other institutions. This revenue is allocated by the government to public expenditure, which involves the provision of public goods, and to the payment of transfers to non-governmental organizations, with any surplus contributing to savings.

South Africa engages in economic and trade activities with other countries, involving the importation of goods and services, as well as the payment of transfers and capital income. Conversely, the nation exports goods and receives transfers from the global community. To represent the interactions between South Africa and other nations, we apply the conventional Armington framework, which suggests that enhancing competitiveness is essential for the country to boost its global market share.

Aligning with this study's aim, we move away from the conventional PEP-1-t model, which assumes an exogenous labour supply. Instead, we enhance labour mar-

kets with empirical data sourced from South Africa, as illustrated by Kingdon and Knight [68,69]. The labour market segments—unskilled, low-skilled, medium-skilled, and skilled—function under the premise of imperfect market conditions. This situation is analysed applying the wage curve model formulated by Blanchflower and Oswald [70]. The wage curve model illustrates the link between the unemployment rate (u_l) and the real and the real wage rate ($\frac{w_l}{p}$) for a given labour category l. The relationship can be expressed as follows:

$$u_l = \left(\frac{w_l}{p}\right)^{\mu} \tag{1}$$

where w_l is the wage rate for labour category l; p, the average economywide price level; and η, the elasticity of the real wage rate with respect to the changes in the unemployment rate.

Unlike other markets, the high-skilled labour market is assumed to operate on a competitive market clearing principle, implying full employment. It is assumed that workers in each skill level can freely move across various industries within all nine provinces and the two types of settlements, urban and rural. The model uses an exogenous approach to account for the movement of labour between rural and urban areas and across provinces, with this movement being specific to each skill tier. Additionally, the division of labour income into remittances sent to both the origin and destination areas is externally determined. As labour migrates from one region to another, the remittances travel in the opposite direction. This external setup suggests that a combination of economic and non-economic factors influences the migration between urban and rural areas and the flow of remittances. The model also evaluates how changes in internal remittance rates affect outcomes.

Regarding model closure, we designate the nominal exchange rate as the model's numeraire. We then apply the small-country assumption to South Africa, presuming international prices are not influenced by domestic factors. We also assume that the current account balance, government expenditure on goods and services, and all tax rates (including direct, indirect, import, and producer) remain constant. Furthermore, capital is assumed to be sector-specific, while labour is more fluid across different sectors. To construct the business-as-usual (BAU) path over time, it is assumed that capital stock grows between periods due to new investments within sectors. The distribution of new private investment aligns with the accumulation equation from Jung and Thorbecke [71]. According to the model's dynamic structure, based on prior models, both producers and consumers exhibit short-term perspectives, focusing on maximizing utility and profits within a single period. The progression between periods is determined by savings and capital accumulation. A standard capital accumulation equation is used, where savings augment the current capital stock post-depreciation. Within this framework, sectors compete for investments, with new capital allocation influenced by sector-specific costs, capital returns, and historical investment patterns. The allocation of new private investment is guided by Jung & Thorbecke's [71] accumulation equation. It is assumed that labour supply increases at the same rate as population growth, and all variables (excluding prices) grow at the rate of population increase, ensuring a stable trajectory.

The CGE model is calibrated with a SAM for the years 2015 to 2016 as referenced in van Seventer et al. and van Seventer & Davies [72,73]. Originally having 62 industries, the SAM was simplified to 30 industries for the modelling process. It includes 106 product categories, defines four types of labour based on education levels, and identifies four groups of agents: rural and urban households, firms, the government, and the rest of the world. Additionally, it comprises four tax accounts and a margin account. The model is refined to incorporate 30 industries, 30 commodity categories, 90 labour categories distinguished by province, settlement type, and education, plus a single capital factor account, four tax accounts, 21 institutional accounts, and two capital accounts. The model employs updated SAM data and supplemented by model input data (parameters and elasticities) from existing South African studies summarised in **Table 1** is used to calibrate and run the model simulations.

Table 1. Model input data.

Parameter	Value	Source
Production		
—Elasticity of substitution between capital and labour (value added)	0.3	Literature/Guestimate
—Elasticity of substitution between value-added and intermediate consumption	0.3	Literature, guesstimate
—Elasticity of substitution between intermediate demand	0.3	Literature, guesstimate
Trade		
—Export demand elasticity	6.0	Literature, guesstimate
—Elasticity of transformation between domestic and foreign markets	2.0	Literature, guesstimate
—Elasticity of substitution between domestic and foreign products	3.0	Literature, guesstimate
Consumption		
—Income elasticity, food products	0.8	Literature, guesstimate
—Income elasticity, non-food products	1.6	Literature, guesstimate
Investment		
—Investment demand parameter	2.0	Literature, guesstimate
Economic growth rate (average, 2010–2019)		
GDP growth (annual %)	1.7	World Development Indicator
Agriculture, forestry and fishing, value added (annual % growth)	2.3	World Development Indicator
Industry (including construction), value added (annual % growth)	0.7	World Development Indicator
Manufacturing, value added (annual % growth)	1.2	World Development Indicator
Services, value added (annual % growth)	2.0	World Development Indicator
Poverty and inequality (2015)		
Upper-bound poverty line	55.5	Statistics South Africa
Lower-bound poverty line	40.5	Statistics South Africa
Food poverty line	25.2	Statistics South Africa
Gini index	0.65	Statistics South Africa

Sensitivity analyses were conducted on the model setup, exploring various closures and parameter selections as per [18,20]. Calibration elasticities are informed by the literature, with trade elasticities [74], and demand elasticities ranging from −3 to −6 according to Mabugu et al. [18]. The typical supply elasticity stands at 1 but may decrease to 0.35 as noted in Mabugu et al. [18] and Fofana et al. [20], highlight that the outcomes are sensitive to the selected data series.

4. Overview of South African Economy and Agriculture

This section presents an overview of the South African economy based on the SAM, which is important to understanding how macroeconomic policies affect agriculture and households. According to the 2022 census, South Africa has a population of 62 million in 2022, with a growth rate of 1.8% per year between 2011 and 2022 [75]. South Africa's demography shows an increase in urban population and a decrease in rural population. Despite the strategic and development plans that are in place, the socioeconomic outlook of the country in terms of macroeconomic indicators has been unsteady. Between 2013 and 2023, the South African economy performed poorly. The country's GDP grew less than the population in most of those years (see **Figure 2**). The economy grew only 0.01% per year during the period 2014–2018 before increasing marginally, by 1.03%, in 2019 and then drastically falling again, by 7.1%, in 2020. Although economic growth increased significantly from −7.1% in 2020 to nearly 4% in 2021(a post-COVID-19 pandemic effect), it quickly decelerated again to 1.6% in 2022 and 0.27% in 2023. Meanwhile, the population growth rate exceeded the GDP growth rate each of those years except 2017 and 2021, implying declining per capita GDP growth rates. The country's fiscal space has deteriorated significantly due to increased public debt, which increased from 47% of GDP in 2014 to 72.8% in 2022. Rising public debt, an energy crisis (in the form of widespread electricity load reduction) that has intensified since 2015, and shocks resulting from other global crises—such as climate change, the COVID-19 pandemic and global geopolitical instability in the form of ongoing wars in Ukraine and Gaza have further deteriorated the stability of the country's macroeconomic landscape and aggravated challenges related to high levels of poverty, inequality, and unemployment, particularly among the youth population.

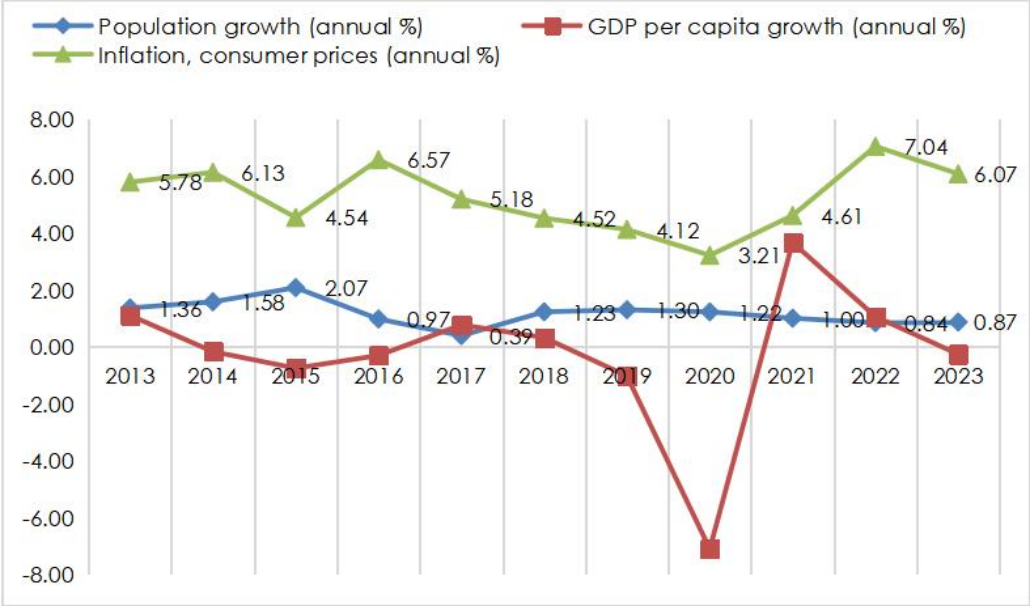

Figure 2. Population, GDP per capita, and inflation in South Africa (2013–2023).

Source: Authors compilation from the WDI database.

Figure 3 illustrates the economic sector composition. Services constitute the most significant portion, contributing 77% to the economy. In contrast, agriculture contributes the least to the value added, whereas the remaining industry sectors (including mining and manufacturing) account for 21% of the total value added.

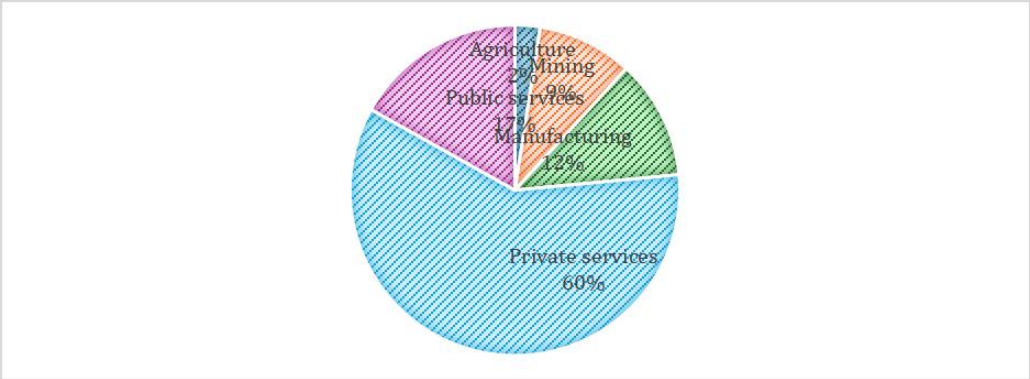

Figure 3. Composition of the Economy.

Source: Authors' computation from SAM.

Figure 4 illustrates the global trade tendencies within the South African economy. It highlights that agriculture, mining, and manufacturing have higher trade activities compared to services. Furthermore, the figure indicates that agriculture and mining are primarily export-focused, whereas manufacturing leans more towards imports.

Subsequently, we turn our attention to the labour markets specifically designed for this research to be agriculture-centric. This involves delineating distinct urban and rural labour markets across the nine provinces of South Africa, segmented by skill levels, including analyses of labour force growth, rural-to-urban migration, and remittances. Skills are divided based on educational attainment. Similarly, we establish a dichotomy of household categories representing urban and rural areas. **Figures A1** and **A2 (Appendix A)** depict urban versus rural employment structures and sectoral income intensity. As anticipated, agriculture is predominantly rural, as evidenced by its substantial employment and in-

come ties to rural areas. In conclusion, **Figure A3** illustrates that labour markets characterised by a high degree of skill tend to have reduced unemployment rates and provide greater levels of compensation. Unemployment rates are notably higher in rural regions compared to urban ones.

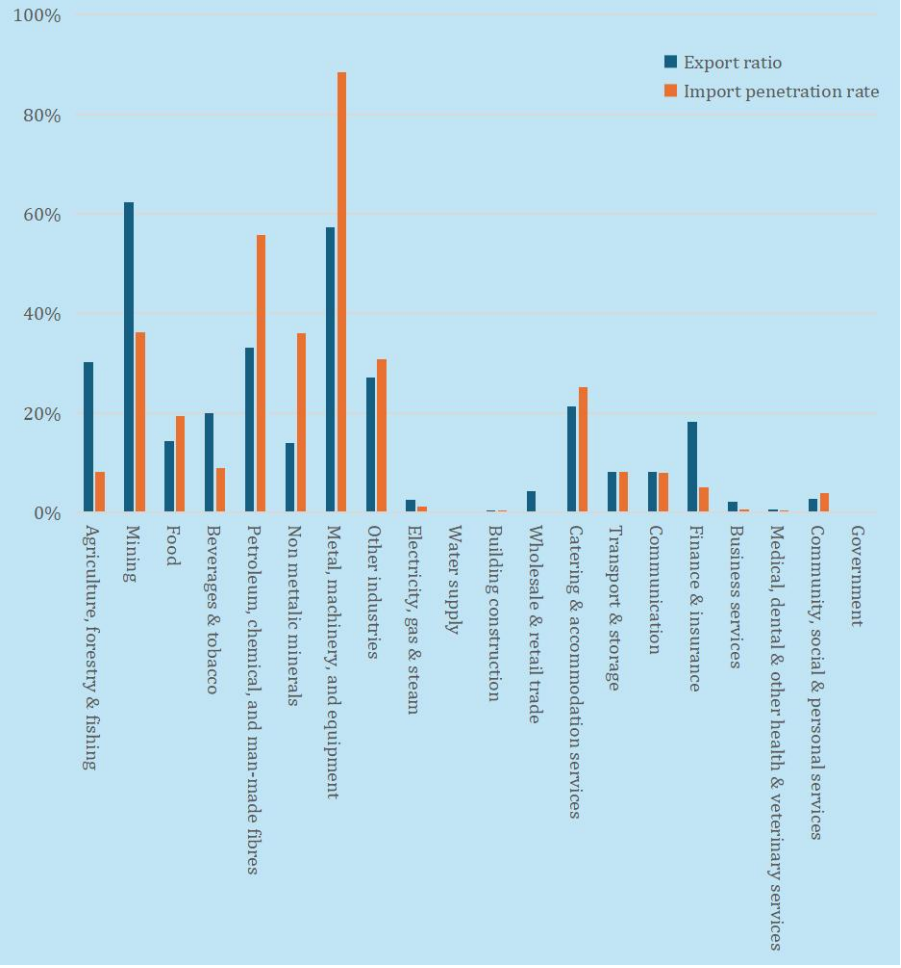

Figure 4. Trade Intensity of the South African Economy.

Source: Authors compiled figure based on SAM.

5. Scenario Simulations and Findings

This section describes the simulation scenarios and the outcomes derived from executing these simulations utilising the previously mentioned economic modelling methods and data. An extensive discussion of the results then follows.

5.1. Simulation Scenarios

To thoroughly examine the impact of specific macroeconomic policies, it is crucial to consider multiple pathways and interactions, the structural features of the domestic economy and society (including the variety of economic participants), and the international economic environment. Constructing simulation scenarios is vital to facilitate precise modelling and allow for valuable comparisons and analysis of the modelling results. Three scenarios chosen for this study are the "Business as Usual Scenario," "Fiscal Policy Scenario," and "Exchange Rate Scenario".

5.1.1. Business as Usual (BAU) Scenario

In the realm of economic modelling, it is standard to define a business as usual (BAU) scenario, which functions as a reference point for assessing policy changes. The BAU essentially maps out a growth trajectory assum-

ing no major disruptions in the economy over a designated period. In this analysis, the BAU scenario is characterized by the following assumptions: growth rates in labour demographics for rural and urban areas in South Africa are set externally, fiscal policy is characterised by balanced budget through tax adjustments, saving-investment is balanced by household savings. Consequently, the nation's economic evolution, indicated by the GDP growth rate from 2014 to 2023, shows a gradual slowing down (**Figure 5**). Household consumption expenditures display a similar pattern. Meanwhile, agricultural growth shows irregular patterns.

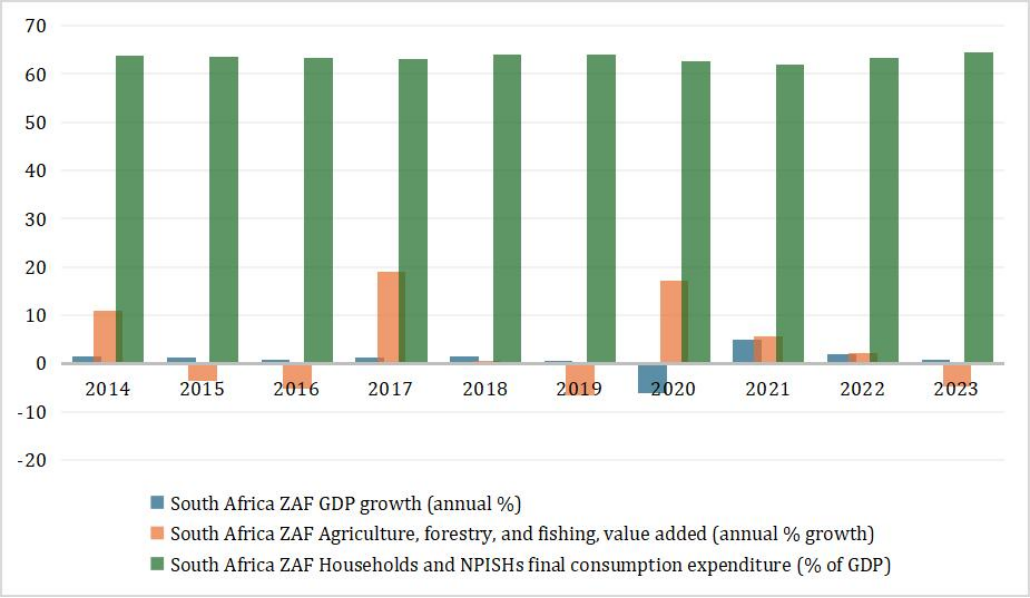

Figure 5. Economic Performance 2014–2024, Annual Growth (%).

Source: Authors' calculations from the World Development Indicators.

By employing the aforementioned hypotheses and analysis in **Figure 5**, **Figure 6** illustrates that the reference scenario establishes stability within the economic structure. It again shows a well calibrated model.

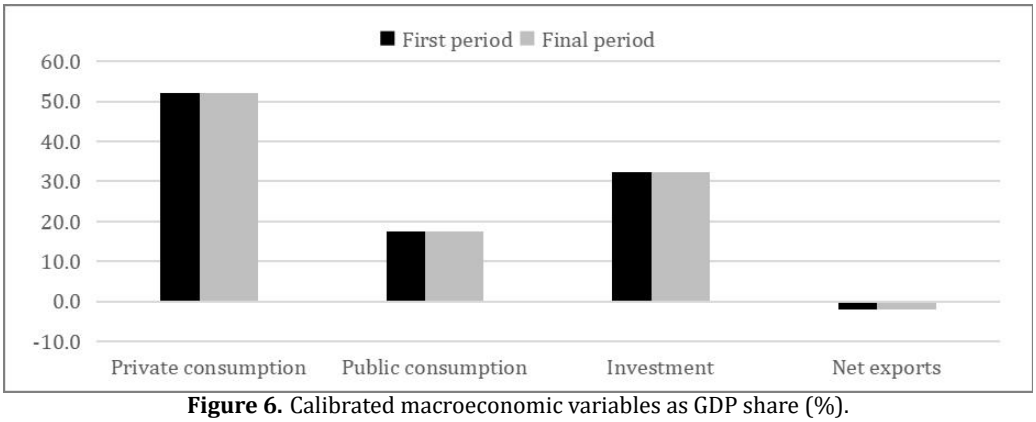

Figure 6. Calibrated macroeconomic variables as GDP share (%).

Source: Authors computation utilising model results.

The national economy and household consumption expenditures are experiencing a modest deceleration, while the agricultural sector is witnessing a rising growth rate, approaching the national economic average of approximately 1.8% annually (**Figure 7**). The proportion of rural households in total spending remains unchanged at 20%. Government expenditure as a percentage of GDP holds constant at 17.3%, with investment standing at 32.3%.

Subsequently, we utilise the aforementioned ap-

proach to calibrate the sectoral business-as-usual scenario. **Figure 8**, generated from executing the model to establish this baseline, outlines satisfactory economic and sectoral calibrations in comparison to the input data.

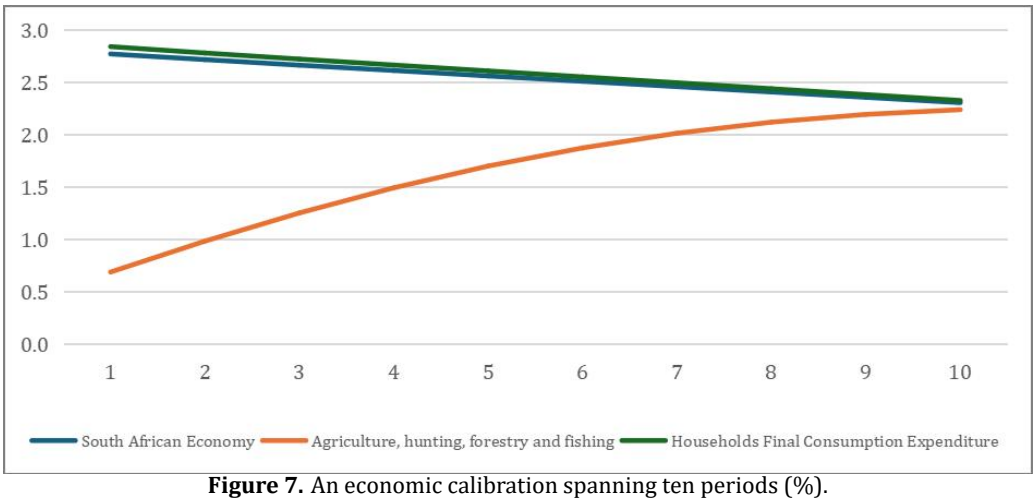

Figure 7. An economic calibration spanning ten periods (%).

Source: Authors construction utilising model results.

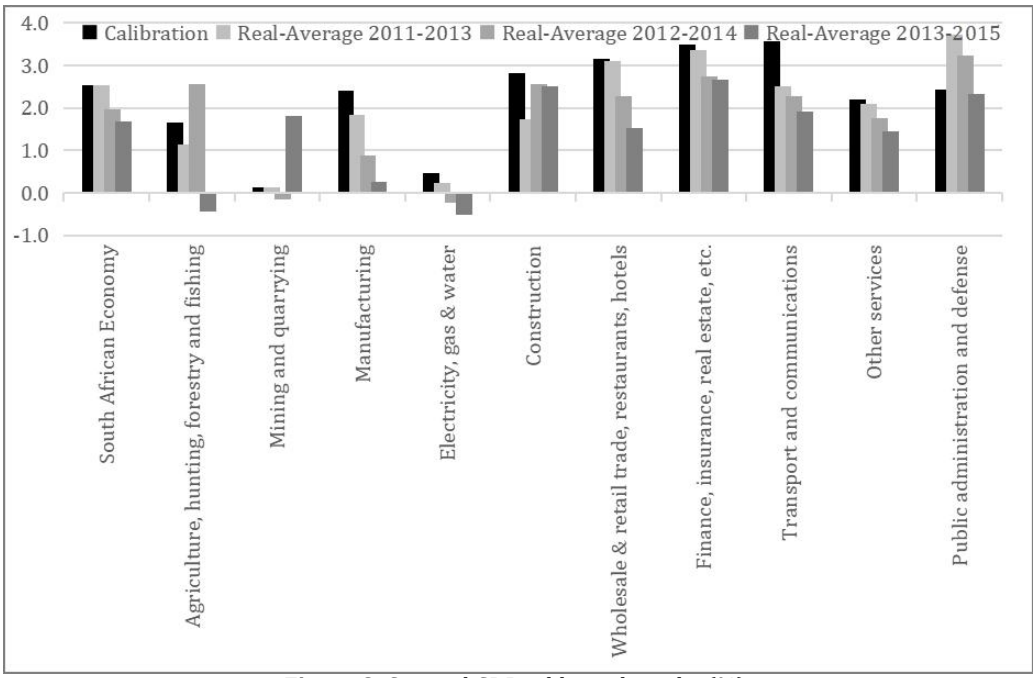

Figure 8. Sectoral GDP calibrated results (%).

Source: Authors construction utilising model results.

5.1.2. Fiscal Policy Scenario

The primary objective of fiscal policy is to boost government efficiency, allocate enough resources to prioritize public spending, and maintain the sustainability of the government's fiscal stance. In South Africa, the main strategy for this has been setting an expenditure ceiling aimed at curbing spending growth compared to previous trends. However, disappointing growth **Figures 9** and **10** depict an expansionary fiscal policy from 2014 to 2023, with government spending increasing notably in the latter half of the decade (averaging 20% of GDP) compared to the earlier half (averaging 18% of GDP). During this time, the fiscal deficit has also deteriorated, with an average deficit of 3.5% of GDP in the latter half, compared to a balanced budget in the earlier half.

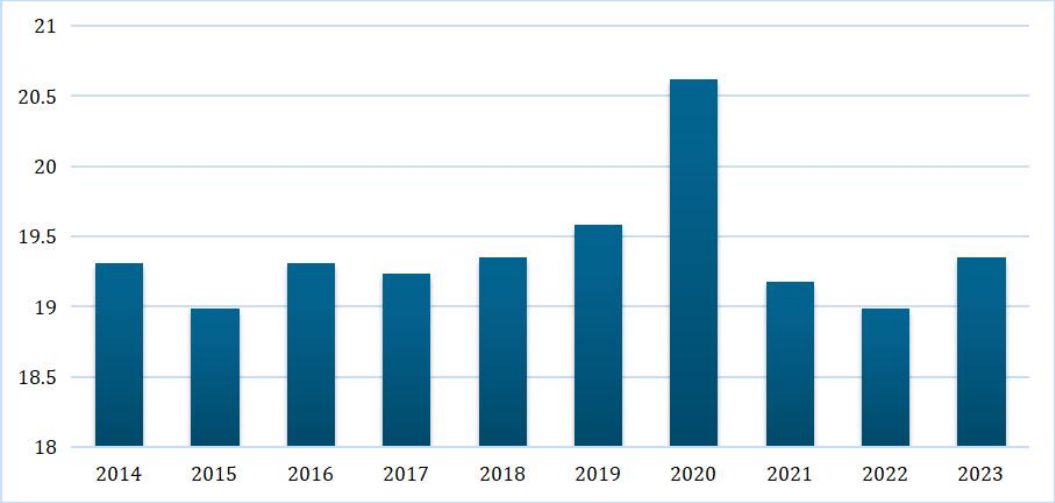

Figure 9. General government consumption expenditure (% of GDP).

Source: Authors' computations using World Development Indicators.

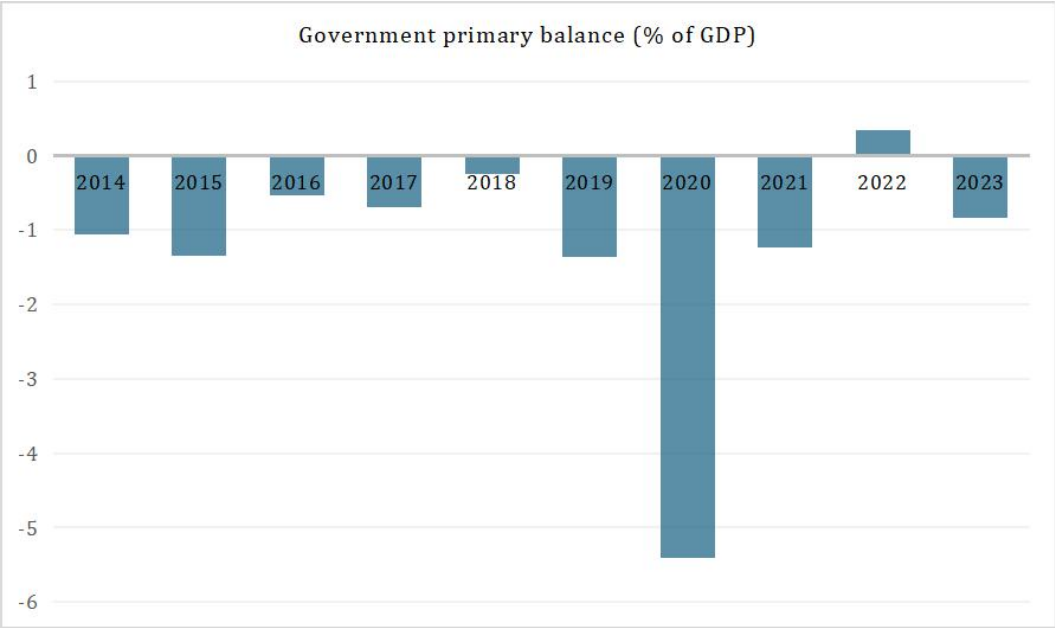

Figure 10. The Fiscal Balance as a Percentage of GDP.

Source: Authors' computations based on World Development Indicators.

To reflect the country's actual conditions, an expansionary fiscal policy is depicted by a high government spending to GDP ratio. It was assumed that government expenditures remain neutral, affecting all industries and households equally. The additional government spending is financed in sequence by:

- Test 1: Rise in personal income tax for households
- Test 2: Rise in domestic borrowing by the government
- Test 3: Growth in external government borrowing

5.1.3. Exchange Rate Policy Scenario

The foreign exchange rate acts as a vital macroeconomic tool influencing a nation's competitive stance and fostering economic growth through the forces of demand and supply. Fluctuations in exchange rates affect export competitiveness and import costs, consequently impacting production costs and consumer prices, which have important economic implications for the agricultural sector. The relationship between exchange rates and GDP growth continues to be a contentious issue in macroeconomic pol-

icy discussions, with a range of studies showing varied effects on real output growth. However, the extent to which these changes influence South Africa's issues of low growth, unemployment, and inequality remains uncertain. The agricultural sector's vulnerability to these dynamics has not been widely studied. A key research area is exploring if exchange rate policies can strengthen South Africa's agricultural exports, thus promoting growth and creating jobs. We explore the problems posed by exchange rate misalignment and volatility, analysing their effects on both the national economy and agricultural growth, with a specific emphasis on household welfare.

Figure 11 demonstrates the ongoing decline of the R/US exchange rate between 2014 and 2024, underscoring a consistent decrease over these years that averages about a 7% depreciation annually. Our simulation reflects this trend, projecting a 100% depreciation over a ten-year modelling period.

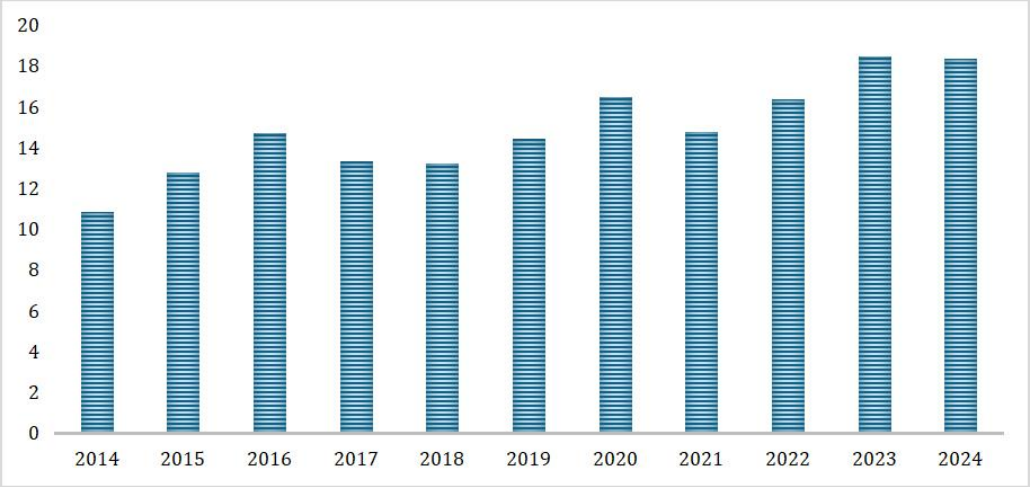

Figure 11. Average official exchange rate (local currency units per US dollar).

Source: Authors' construction using World Development Indicators.

5.2. Simulation Scenarios

This section delineates and analyses the results obtained from the simulation scenarios, particularly focusing on the Fiscal Policy Scenario and the Exchange Rate Policy Scenario, employing recursive dynamic models. The discourse proceeds by analysing the effects of fiscal policy, subsequently followed by an examination of the impact of the exchange rate scenario in comparison to the Business-as-Usual (BAU) on economic growth, sectoral expansion, and household welfare.

5.2.1. Fiscal Policy Scenario Results

Table 2 demonstrates the effect of the fiscal policy scenario on critical macroeconomic indicators. The outcomes noticeably depend on the financing method selected for the expansive fiscal policy. Notably, imposing a tax on households (test 1) significantly impacts private consumption, while increased domestic borrowing (test 2) predominantly influences investment, and reliance on external borrowing (test 3) chiefly affects net exports. When the scenario uses household tax financing, it substantially reduces household disposable income, which leads to a considerable drop in private consumption. Financing the fiscal policy through heightened domestic borrowing, with other factors unchanged, increases financing costs throughout the economy, thereby restraining production growth in different sectors and producing a domestic crowding-out effect that reduces private investment by 4.9%. In contrast, opting for external borrowing places the financial strain on exports, resulting in a 5.4% decline in net exports relative to the business-as-usual scenario.

Figure 12 depicts the effects on various sectors of production. When the government boosts expenditure by raising household income taxes, the agriculture and private services sectors suffer the most due to their heavy reliance on household consumption. On the other hand, if the increased spending is funded more through domestic borrowing aimed at investment, construction

and agriculture are notably impacted, with construction being significantly affected due to its investment focus. The rapid growth experienced by agriculture in the baseline scenario decelerates as a result of limited private investment. Additionally, external borrowing to finance the government budget harms the manufacturing and agricultural sectors, as it escalates import competition through an appreciating exchange rate. In summary, regardless of the financing strategy, expansive fiscal policy negatively impacts agricultural outcomes.

Table 2. Changes in Macroeconomic Structure (% of GDP).

	Household Expenditure	General Public Consumption	Investment	Net Exports
Funded through household income tax (test 1)	−5.0	5.0	0.0	0.0
Funded through domestic government borrowing (test 2)	−0.1	5.0	−4.9	0.0
Funded through government external borrowing (Test 3)	0.6	5.0	−0.2	−5.4

Source: Authors construction utilising model results.

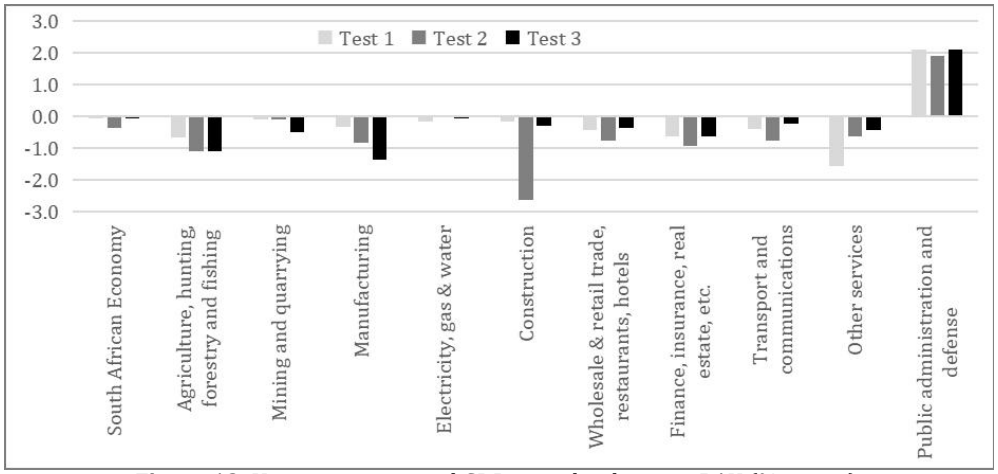

Figure 12. Variation in sectoral GDP growth relative to BAU (% points).

Source: Authors construction utilising model results.

To summarise, our focus turns to the welfare of households, signified by changes in household income. In the initial simulation, there is a decline in both urban and rural household incomes over both short and long periods. Even with these reductions of income, the results show that rural households are less severely affected than urban households when the income tax is balanced by a rise in government expenditure (see **Figure 13**). Urban households, specifically, bear the largest burden of direct taxes.

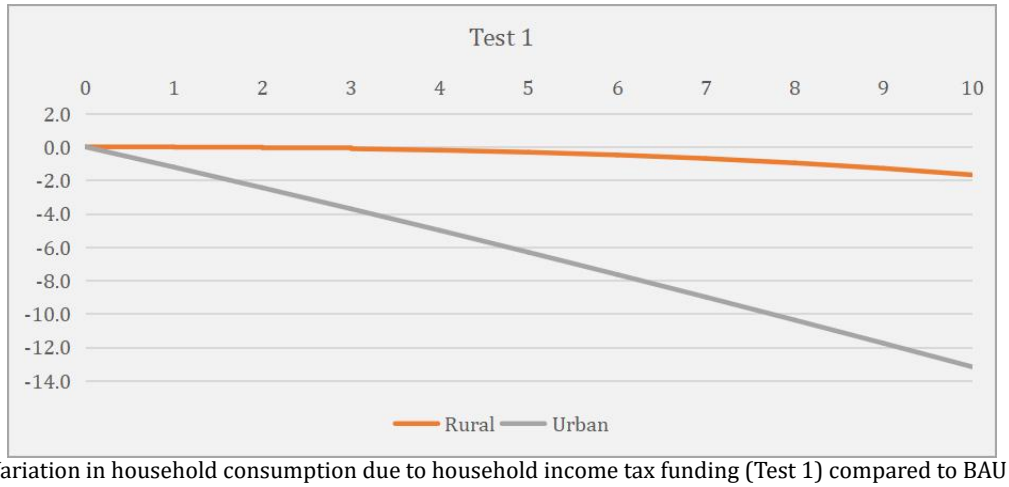

Figure 13. Variation in household consumption due to household income tax funding (Test 1) compared to BAU (% change).

Source: Authors construction utilising model results.

Rural households are at a disadvantage relative to urban households when the government opts for internal or external borrowing to balance the budget (see **Figures 14** and **15**). In the case of domestic financing (Test 2), their plight is worsened by an income effect caused by diminished agricultural growth. Regarding external borrowing (Test 3), rural families benefit less from the price effect compared to urban families, as the appreciation of the exchange rate makes imported goods, which are mainly consumed by urban residents, cheaper than domestic goods.

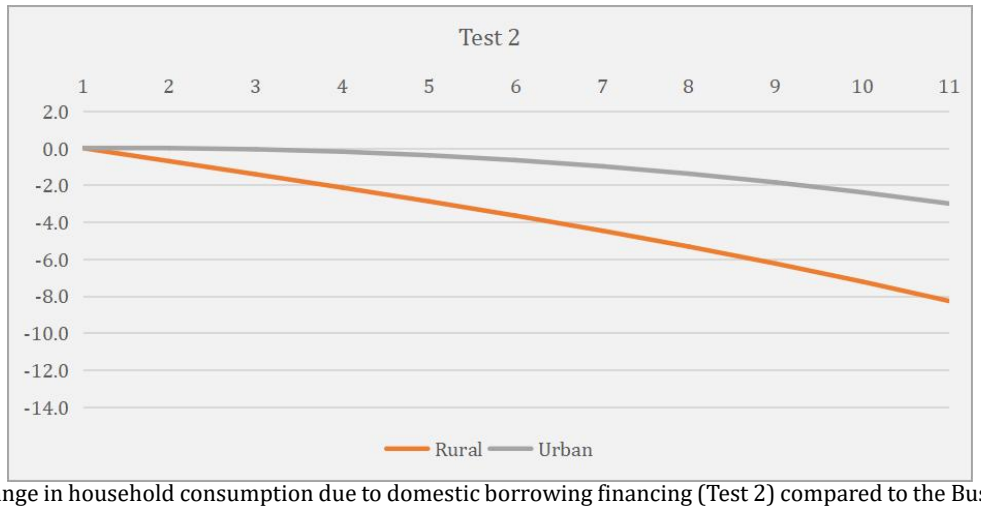

Figure 14. Change in household consumption due to domestic borrowing financing (Test 2) compared to the Business As Usual (BAU) scenario.

Source: Authors construction utilising model results.

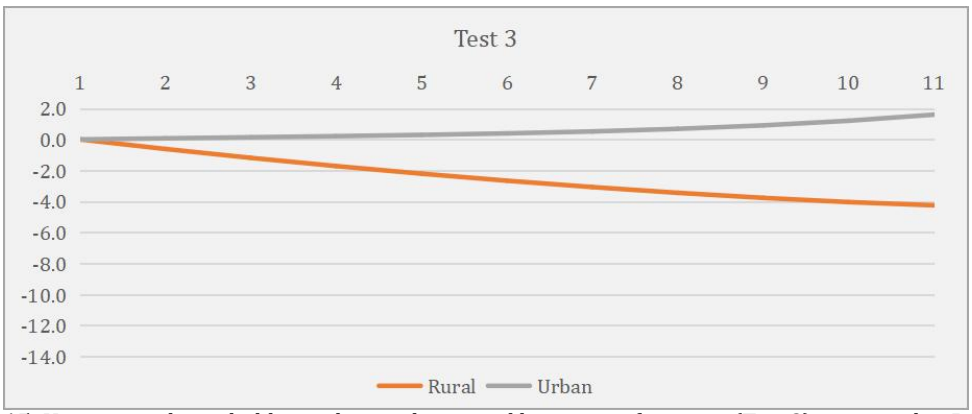

Figure 15. Variation in household spending with external borrowing financing (Test 2) compared to BAU (%).

Source: Authors construction utilising model results.

5.2.2. Exchange Rate Policy Scenario Results

An immediate effect of exchange rate depreciation is the increase in the prices of traded commodities within the domestic market, resulting in higher prices in local currency relative to the benchmark (**Figure 16**). Over ten years, this rise is progressive, as demonstrated by the widening gap between the reference and simulated price paths.

The variations in traded prices illustrated in **Figure 16** lead to heightened export volumes and decreased import volumes, as depicted in **Figure 17**. These findings are consistent with devaluation literature, suggesting that devaluation boosts exports and reduces imports by altering relative profitability. This effect is observed here due to the ongoing depreciation of the exchange rate over the modelled period. Notably, the adverse impact on imports and the positive effect on exports wane over time, with the changes between periods becoming less pronounced in the latter phases.

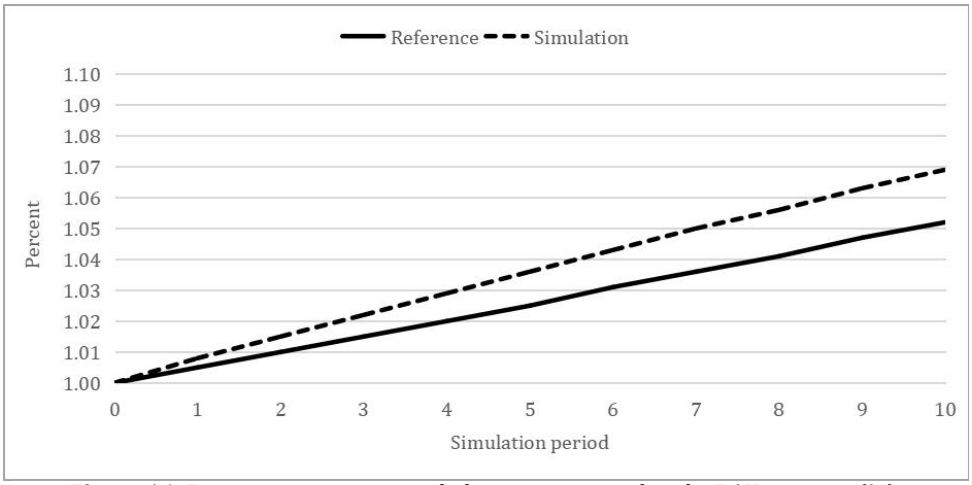

Figure 16. Percent variations in traded prices compared to the BAU scenario (%).

Source: Authors construction utilising model results.

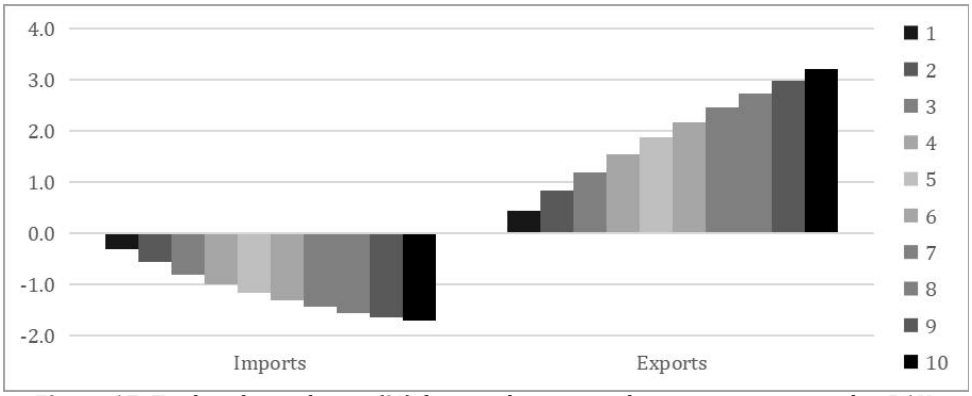

Figure 17. Trade volume change (%) from exchange rate depreciation compared to BAU.

Note: legends 1–10: Ten-year simulation period.

Source: Authors construction utilising model results.

By examining the sector-specific impacts of these changes, we see that industries such as agriculture, mining, and manufacturing benefit from a real exchange rate depreciation as they become more competitive in both global and domestic markets (see **Figure 18**). Agricultural, mining, and manufacturing goods are traded more frequently than those from the Services sector. Of these, agriculture and mining are largely export-focused, whereas manufacturing is inclined towards imports (refer to **Figure 4** above). The Services sector is negatively affected by the real exchange rate depreciation due to the drop in consumer purchasing power and its lesser focus on trade. Additionally, we conducted a sensitivity analysis on the trade elasticities used in the CGE model. The outcomes indicated minimal variation when different trade elasticity scenarios were applied (sensitivity tests 1–3).

Figure 3, shown earlier to depict the economic composition, reveals that agriculture, mining, and manufacturing collectively contribute to 23% of the total value added in the baseline year. Consequently, the positive income effect of currency depreciation has not sufficiently counterbalanced the detrimental impact of increasing prices, which weakens consumer purchasing power and diminishes consumption expenditure. As a result, less traded goods with higher income elasticity, notably private services, are most affected. As indicated in **Figure 3**, services make up more than three-quarters of South Africa's welfare production.

Ultimately, **Figures 19** and **20** depict the welfare effects on rural and urban households concerning income and consumption. The changes in household income and subsequent consumption are relatively balanced between urban and rural regions, mainly driven by the income effect; however, urban households face a marginally greater impact compared to rural ones.

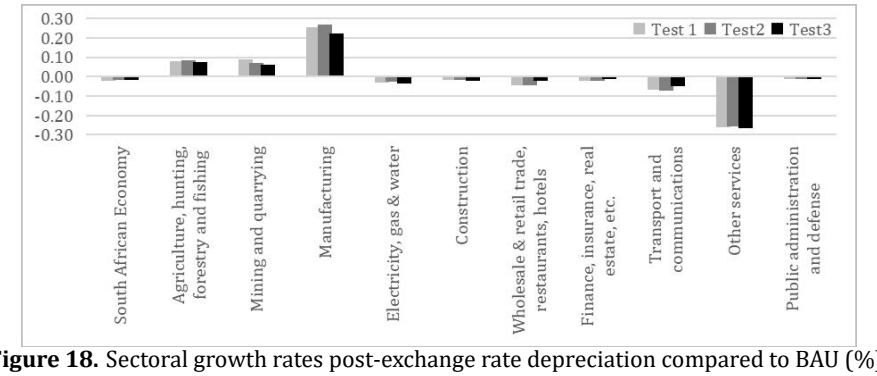

Figure 18. Sectoral growth rates post-exchange rate depreciation compared to BAU (%).
Note: Legend: Calibrated trade elasticities (test 1); Higher import elasticities (test 2); Higher export elasticities (test 3).
Source: Authors construction utilising model results.

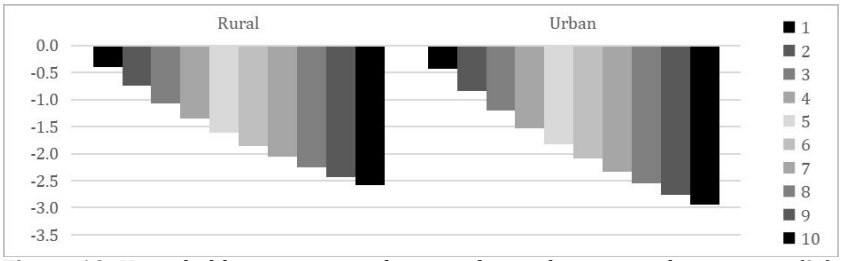

Figure 19. Household consumption changes after exchange rate depreciation (%).

Source: Authors construction utilising model results.

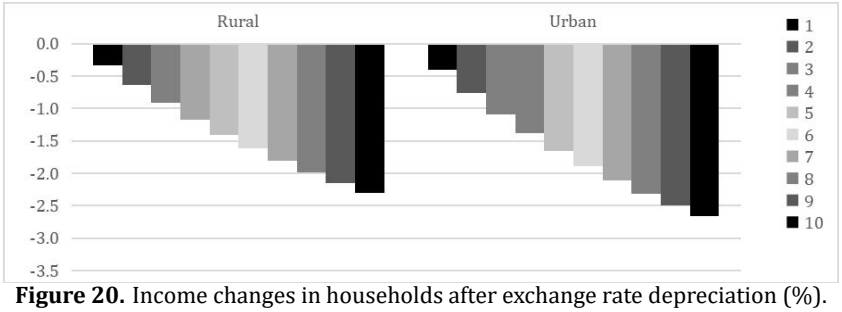

Figure 20. Income changes in households after exchange rate depreciation (%).

Source: Authors construction utilising model results.

In conclusion, the assessment of the currency depreciation scenario shows promising outcomes for the agricultural industry and the broader economy. The significant impact of ongoing currency depreciation on agriculture and GDP is crucial and can underpin South Africa's bold export-led growth objectives outlined in the progressive 2030 NDP. This plan aims for an impressive yearly growth rate of 5.4%, driven by an invigorating increase in exports.

6. Conclusions

This paper assesses the impact of fiscal policy and exchange rate changes on agricultural growth and rural development in South Africa. A dynamic agricultural oriented model is calibrated over a 10-year reference period, with the two policy scenarios tested. While agriculture's economic role in South Africa is comparatively small, integrating both the demand and supply elements of the sector into comprehensive economic modelling can provide valuable insights for strategies aimed at boosting agricultural growth and fostering national development through fiscal and exchange rate policies. The findings in this paper are that an expansionary fiscal policy hinders agricultural growth, irrespective of whether it is financed through household income taxes, domestic borrowing, or international loans. The effect on final consumption favours rural populations over ur-

ban ones, but this occurs only when the deficit is balanced by taxes on household income. If increased government spending is primarily funded by household income taxes, the negative effects on agricultural growth and rural consumption are milder than those observed in non-agricultural growth and urban consumption. A depreciated exchange rate favours the agriculture, mining, and heavy manufacturing sectors due to their export orientation. However, there is a minor overall economic downturn, as private services—being less tradable, more sensitive to income changes, and comprising the largest portion of total value added—are negatively affected. The income effect on final household consumption is neutral in both urban and rural areas, though it imposes a slightly greater burden on urban residents.

These findings have two main policy implication. To be suitable for the agricultural sector and the broader economy, the orientation and framework of the current macroeconomic policy need adjustment to sustain fiscal balance and prevent exchange rate overvaluation. In undertaking policy making, there are two important considerations: firstly, policymakers should assess and quantify the interaction between macroeconomic policies and the agricultural sector, structural circumstances, and broader equilibrium effects. The outcome of a given macroeconomic policy can vary significantly depending on these factors. Secondly, every policy has distributive consequences, primarily through its impact on agriculture and rural markets. Thus, the role of agriculture in influencing income distribution and the political economy consequences of macroeconomic policies should be recognized and incorporated into policymaking.

This study does not explore political factors or macroeconomic policy reforms in South Africa. Recognizing political constraints is crucial for any country's income growth and equity. Political considerations often hinder developing countries from adopting better economic policies. Besides economic rationality, political feasibility is vital in policymaking. However, analysis needs to go beyond accommodating actual government actions to analysing and offering alternative scenarios[76]. Developing countries frequently show a disparity between official social-welfare goals and actual government priorities. The lack of government capacity and capability to make policy decisions that attain declared development aims is a common issue, and South Africa is no exception. Despite the prioritisation of equitable growth in official documents such as the NDP and MTDP, the government's actual policy decisions have not consistently fostered economic growth or equity, as shown by ongoing stagnant growth, high unemployment, inequality, and poverty[77]. Given these negative outcomes, it is conceivable that the implementation of inappropriate policies stemmed, at least partly, from insufficient understanding of their negative impacts on government objectives. In such scenarios, insights from positive (rather than normative) analysis could have enriched the knowledge foundation and been a valuable input for more rational policymaking. Enhancing the knowledge base becomes even more vital when identifying intersectoral linkages and subtle government policy effects, as demonstrated by some findings in this study. It is essential for not only policymakers (or their advisers) but also the general public to be educated on both the direct and indirect ramifications of proposed policy changes on agriculture, the economy and welfare. Such awareness is critical to garnering the political consensus needed to make policy reforms viable. In addition, this study does not examine the possible future effects of the United States (U.S.)'s imposition of a 30% reciprocal tariff on most imports from South Africa, which poses a serious threat to the agriculture and manufacturing sectors, thereby impacting welfare. At the time this article was written, there was no available data as the tariff had not been implemented yet. Nevertheless, we can speculate on the possible consequences of this disruption. If the United States, South Africa's third-largest trading partner, raises tariffs on South African imports, it is likely to trigger a sequence of events: U.S. imports from South Africa will decrease, and the exchange rate will rise. This is because the demand for exports from its trade partner declines, resulting in lower demand and prices for South Africa's production factors. As the U.S. trade deficit shrinks (or the trade surplus expands), the capital account surplus will also decrease (or the capital account deficit will increase). Assuming reasonable closure, global savings will pursue the highest expected re-

turns, causing a redistribution of capital across regions until return rates equalize. This capital outflow is expected to diminish investment in South Africa, contributing to a drop in GDP and welfare, with the exact impact on agriculture depending on trade shares and elasticities. A more comprehensive analysis of the tariff's consequences is best conducted within a global model such as the GTAP or PEP-World framework, given the involvement of multiple countries.

This study has strengths and limitations that are largely similar to any analysis and modelling tool. The strengths of CGE models are that they effectively represent economies during policy changes, identifying winners, losers, and impact timing to aid policymakers [78,79]. Despite encompassing modifications for country-specific factors such as unemployment and economic dynamics, CGE models have certain design, data, validation, and result transmission limitations [78]. For example, most are real focused and do not incorporate financial variables hence do not account for financial feedback. Due to data limitations analysis in CGE models is usually restricted to sectoral level and do not go beyond sub-sectoral level. These limitations present opportunities for future model extension.

Author Contributions

Conceptualization, R.E.M.; methodology, I.F., R.M. and M.C-M.; software, I.F.; formal analysis, R.E.M., I.F. and M.C-M.; resources, R.E.M., I.F. and M.C-M.; writing—original draft preparation, R.E.M., I.F. and M.C-M.; writing—review and editing, R.E.M., I.F. and M.C-M.; project administration, R.E.M. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Data used in this study is available from corresponding author upon reasonable request.

Acknowledgments

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix A. Extra Labour Market Characteristics

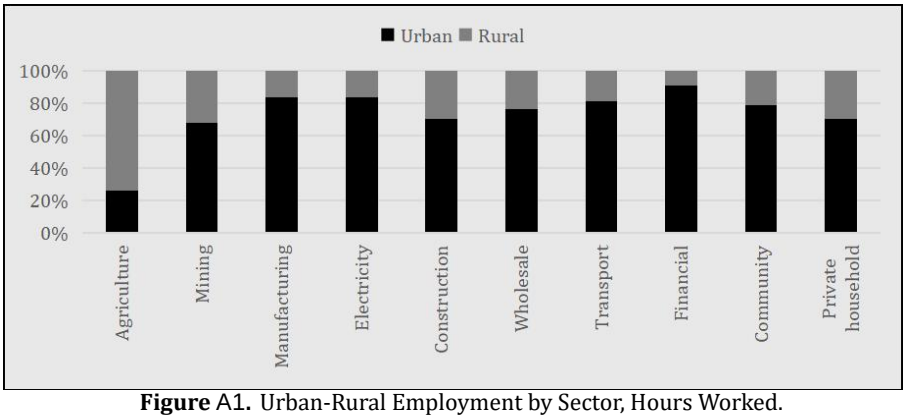

Figure A1. Urban-Rural Employment by Sector, Hours Worked.

Source: Authors' construction from Labour Force Surveys.

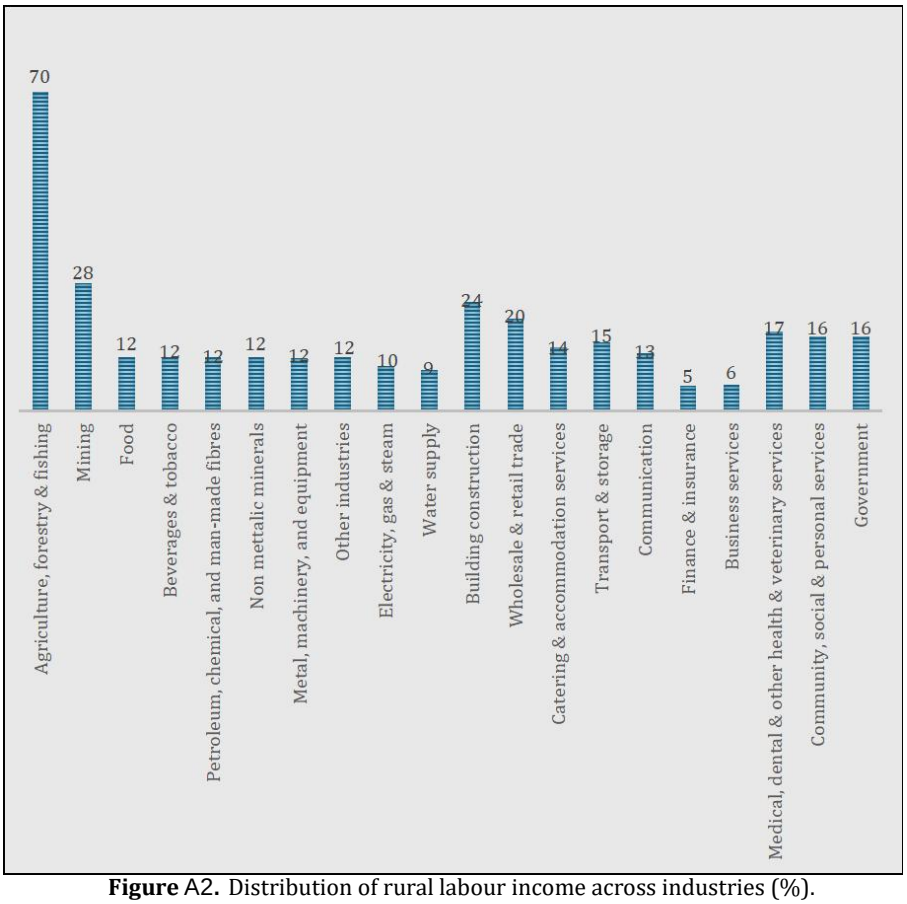

Figure A2. Distribution of rural labour income across industries (%).

Source: Authors' construction utilising Labour Force Surveys.

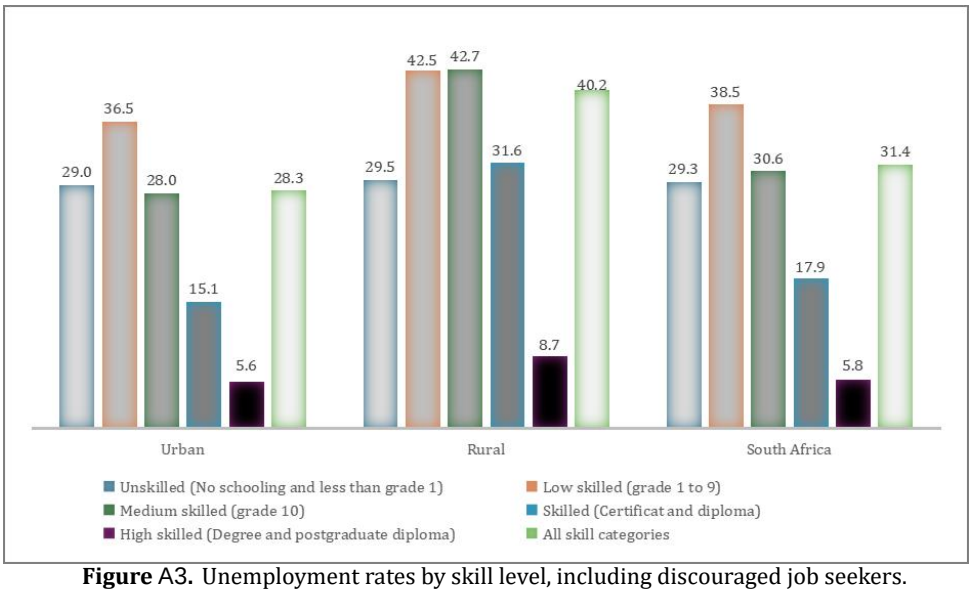

Figure A3. Unemployment rates by skill level, including discouraged job seekers.

Source: Authors' construction using Labour Force Surveys.

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