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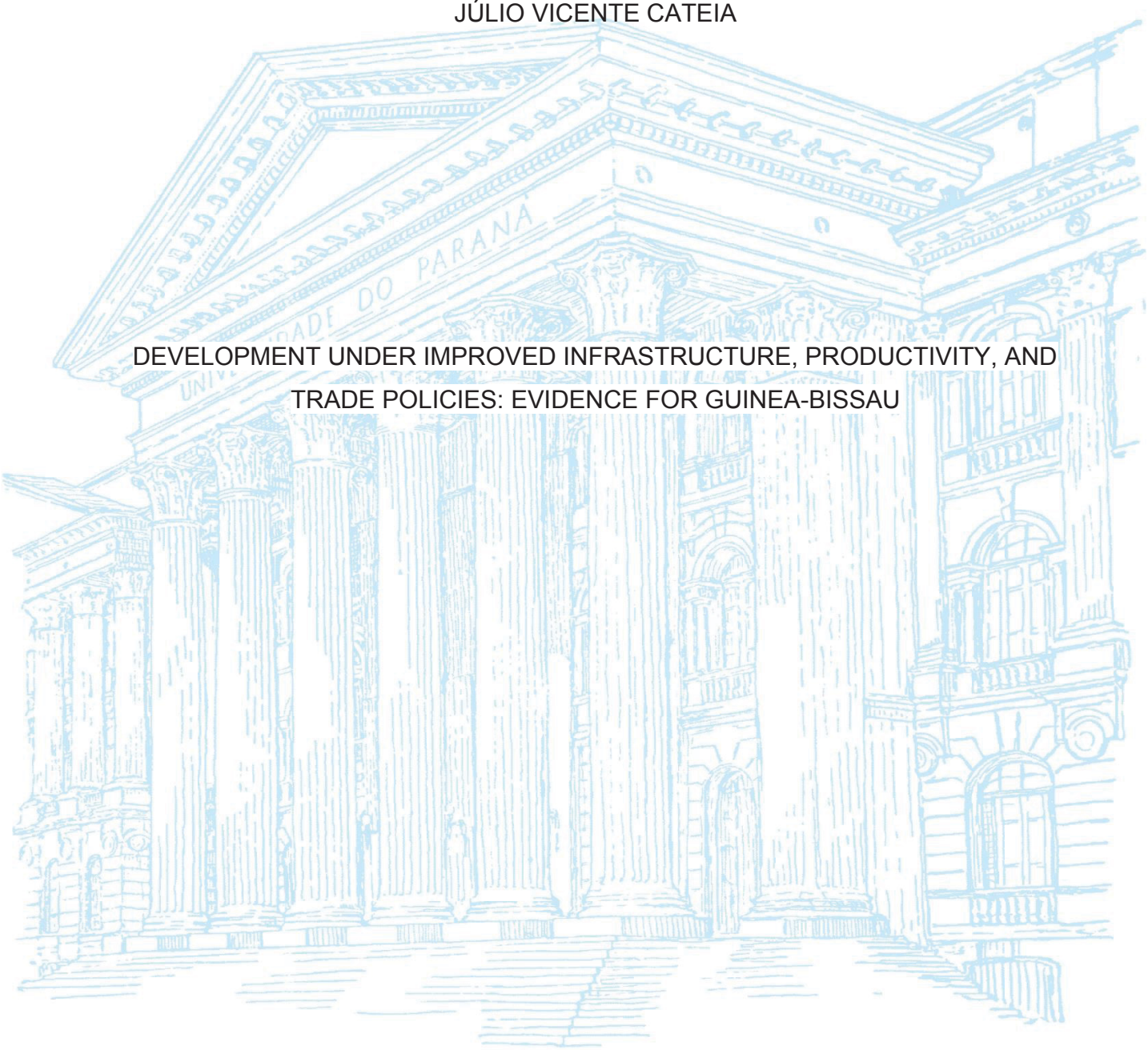

# DEVELOPMENT UNDER IMPROVED INFRASTRUCTURE, PRODUCTIVITY, AND TRADE POLICIES: EVIDENCE FOR GUINEA-BISSAU

CURITIBA

2020

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# DEVELOPMENT UNDER IMPROVED INFRASTRUCTURE, PRODUCTIVITY, AND TRADE POLICIES: EVIDENCE FOR GUINEA-BISSAU

Tese apresentada ao curso de Pós-Graduação em Desenvolvimento Econômico, Setor de Ciências Sociais Aplicadas, Universidade Federal do Paraná, como requisito parcial à obtenção do título de Doutor em Desenvolvimento Econômico.

Orientadora: Profa. Dra. Terciane Sabadini Carvalho

Coorientador: Prof. Dr. Maurício Vaz Lobo Bittencourt

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## TERMO DE APROVAÇÃO

Os membros da Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em DESENVOLVIMENTO ECONÔMICO da Universidade Federal do Paraná foram convocados para realizar a arguição da Tese de Doutorado de **JULIO VICENTE CATEIA**, intitulada: **DEVELOPMENT UNDER IMPROVED-INFRASTRUCTURE AND TRADE POLICY: EVIDENCE FOR GUINEA-BISSAU**, sob orientação da Profa. Dra. TERCIANE SABADINI CARVALHO, após terem inquirido o aluno e realizado a avaliação do trabalho, são de parecer pela sua APROVAÇÃO no rito de defesa.

A outorga do título de Doutor está sujeita à homologação pelo colegiado, ao atendimento de todas as indicações e correções solicitadas pela banca e ao pleno atendimento das demandas regimentais do Programa de Pós-Graduação.

Curitiba, 20 de Fevereiro de 2020.

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I dedicate this work to my mother and daughter!

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## RESUMO

A Guiné-Bissau enfrenta desafios de desenvolvimento socioeconômico desde que se tornou independe no final da década de 1970. Um desses desafios diz respeito a encontrar uma opção de política que permita ao país explorar suas vantagens comparativas e reduzir a pobreza. Este estudo utiliza um modelo dinâmico recursivo de equilíbrio geral computável para analisar os efeitos a longo prazo das seguintes três opções políticas de desenvolvimento neste país pequeno e extremamente pobre com a economia baseada na agrícola: comércio, produtividade e investimentos em infraestrutura. Essas políticas foram avaliadas em diferentes cenários. Para o eixo comercial, temos o cenário 1, que consiste em simular choques negativos nas tarifas de importação e o cenário 2, que representa a redução dos impostos de exportação. O cenário de produtividade representa um choque estimado de produtividade para os setores selecionados, enquanto o cenário de investimentos em infraestrutura é a simulação de novos investimentos públicos em infraestrutura e seu mecanismo de financiamento. Os choques negativos nos impostos à exportação afetaram positivamente a produção geral, as exportações, o investimento e o consumo real do governo, enquanto os cortes nas tarifas de importação têm efeitos opostos. Ambas as políticas comerciais aumentam a renda das famílias rurais e urbanas, com impactos mais fortes para os mais pobres rurais. Nossos resultados sugerem a relevância da riqueza acumulada na mitigação da pobreza a longo prazo, pois ela desempenha um papel importante no consumo das famílias. Observamos um impacto positivo de choques de produtividade e investimentos em infraestrutura no nível de atividade econômica, produtividade agregada e repercussões setoriais. Para a produtividade, observamos que os ganhos das famílias rurais decorrem do aumento da produção nos setores agrícolas, onde encontram suas fontes de renda. Para os investimentos em infraestrutura, descobrimos que os esquemas de financiamento são importantes na determinação desses resultados, pois também contribuem para aumentar a renda e o consumo das famílias urbanas e rurais. Além disso, embora todas as políticas avaliadas mostrem o potencial de reduzir a pobreza, foi a política de produtividade que apresentou os melhores resultados, porque aumentou mais a renda e o consumo das famílias e reduziu mais desigualdades de renda.



**Palavras-chave**: Comércio. Produtividade. Infraestrutura. Guiné-Bissau. Modelo CGE.

## ABSTRACT

Guinea-Bissau has been facing socioeconomic development challenges since it became in the late 1970s. One of these challenges concerns to find a policy option that allows the country to explore its comparative advantages and to reduce poverty. This study uses a dynamic recursive computable general equilibrium model to analysis the long-term effects of three development policies in this extremely poor small country with the agriculture-based economy: trade, productivity, and infrastructure investments. These policies were evaluated in different scenarios. For the trade axis, we have scenario 1 which consists of simulating negative shocks on import tariffs, and scenario 2 representing export taxes reduction. Productivity scenario represents an estimated productivity shock for the selected sectors, while infrastructure investments scenarios is the simulation of new public investments in infrastructure and its funding mechanism. Negative export taxes shocks affected positively the overall output, exports, investment, and real government consumption, while import tariff cuts have opposite effects. Both trade policies increase rural and urban households' income, with stronger impacts for rural poorer ones. Our results suggest the relevance of accumulated wealth in mitigate long-term poverty as it plays an important role in households' consumption. We observe positive impact of productivity shocks and infrastructure investments on the level of economic activity, aggregate productivity, and sectoral spillovers. For the productivity, we found that gains of rural households stemming from increasing production in the agricultural sectors where they find their sources of income. For the infrastructure investments, we find that funding schemes are important in determining these outcomes as they also contribute to increase both urban and rural households' income and consumption. Moreover, although all the evaluated policies show the potential to reduce poverty, it was the productivity policy that provided the best results, because it increased most the households' income and consumption, and further decreased income inequalities.



**Keywords:** Trade. Productivity. infrastructure. Guinea-Bissau. CGE model.

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## LIST OF ABBREVIATIONS OR ACRONYMS

| | |
|---|---|
| AGRODEP | - Development Policy Modeling Consortium |
| CES | - Constant Elasticity of Substitution |
| CET | - Constant Elasticity of Transformation |
| CGE | - Computable General Equilibrium Models |
| DDA | - Doha Development Agenda |
| DRLM | - Decaluwé, Lemelin, Robichaud and Maisonnave |
| FAO | - Food and Agriculture Organization of the United Nations |
| GATT | - General Agreement on Tariffs and Trade |
| GE | - General equilibrium |
| GDP | - Gross Domestic Product |
| H | - Household |
| HR1 | - Rural Household receiving up to 1 minimum wage |
| HR2 | - Rural household receiving up to 2 minimal wages |
| HR3 | - Rural household receiving up to 4 minimal wages |
| HR4 | - Rural household receiving up to 6 minimal wages |
| HR5 | - Rural household receiving up to 8 minimal wages |
| HR6 | - Rural household receiving up to 10 minimal wages |
| HU1 | - Urban household receiving up to 1 minimum wage |
| HU2 | - Urban household receiving up to 2 minimal wage |
| HU3 | - Urban household receiving up to 4 minimal wages |
| HU4 | - Urban household receiving up to 6 minimal wages |
| HU5 | - Urban household receiving up to 8 minimal wages |
| HU6 | - Urban household receiving up to 10 minimal wages |

| | |
|---|---|
| IFPRI | - International Food Policy Research Institute |
| ILO | - International Labor Organization |
| IMF | - International Monetary Fund |
| NEDP | - National Economic Development Plan |
| NPRSP | - National Poverty Reduction Paper |
| PAIGC | - Partido Africano para a Independência da Guiné e Cabo Verde |
| PEP | - Partnership for Economic Policy |
| PEP-1-t | - Single-Country, single period, Recursive Dynamic model |
| SAM | - Social Accounting Matrix |
| SK | - Skilled labor |
| SK1 | - Skilled labor receiving up to 1 minimum wage |
| SK2 | - Skilled labor receiving up to 2 minimal wages |
| SK3 | - Skilled labor receiving up to 4 minimal wages |
| SK4 | - Skilled labor receiving up to 6 minimal wages |
| SK5 | - Skilled labor receiving up to 8 minimal wages |
| SK6 | - Skilled labor receiving up to 10 minimal wages |
| UN | - United Nations |
| US | - United Sates |
| USK | - Unskilled labor |
| USK1 | - Unskilled labor receiving up to 1 minimum wage |
| USK2 | - Unskilled labor receiving up to 2 minimal wages |
| USK3 | - Unskilled labor receiving up to 4 minimal wages |
| USK4 | - Unskilled labor receiving up to 6 minimal wages |
| USK5 | - Unskilled labor receiving up to 8 minimal wages |
| USK6 | - Unskilled labor receiving up to 10 minimal wages |

| | |
|---|---|
| WAEMU | - Economic and Monetary Union |
| WB | - World Bank |
| WITS | - World Integrated Trade Solution |
| WTO | - World Trade Organization |

## LIST OF SYMBOLS

© - copyright

@ - at sign

® - Trademark

$\Sigma$ - sum of numbers

$\Pi$ - numbers product

**SUMMARY**

# 1 INTRODUCTION

Guinea-Bissau belongs to the group of least developed countries due to the relatively low performance of its economy, which reflects the backwardness of its sectors with low development indicators. The gross domestic product (GDP) per capita and the Human Development Index is US $ 620 and 0.424, respectively, placing it in the low category of human development, ranking 178th among the 188 countries and territories (UN, 2016).

The country has a population of about 1.8 million, of which 60% lives in rural areas and 40% in small urban cities. With one of the most precarious health systems in the world, the infant mortality rate is extremely high, around 62.4% for every 1,000 new babies born alive each year. The neonatal mortality rate is 40.6%, corresponding to the death of 4 thousand children annually. This number rises to more than 6 thousand infant deaths if considered only children under five years, explaining the low life expectancy at birth of a Guinean citizen, who is 55.2 years old (World Bank, 2017).

These results can be explained by the low expenditure of public and private health, around 1.1 and 4.4% of the Gross Domestic Product (GDP), by the little preventive health care, late diagnoses of easily curable diseases and low percentage of the population using facilities improved sanitation such as hospital infrastructures; only 20% of the population has access to basic sanitation facilities. Education indicators are also not encouraging, 60% of the Guinean population is still illiterate and public spending in the sector, 2.2% of GDP, has not helped to overcome this structural problem (World Bank, 2017).

Meanwhile, the precariousness and insufficient infrastructure increase the country's operating costs, since the asphalted proportion of roadways is only 22% of a total of 2,755 km of existing highways. In addition, 65.7% of the population does not have access to electricity. This number is more worrying when considering the proportion of access by area: 20.4% of the urban population has access to energy and only 3.9% of the rural population can access electricity (World Bank, 2017).

Guinea-Bissau's economic activity is based primarily on agricultural production, which accounts for more than 60% of its GDP and 90% of its exports. Fishing is one of the most important economic activities for the Guinean economy, with the sale of industrial

fishing licenses, mainly to the European Union and China, one of the main sources of government revenue. Other export and domestic consumption crops are also equally relevant, including the production of rice, sorghum, beans, cassava, cotton, coconut.

In response to the recommendations of its international partners and the increasing awareness of the situation in which the country was facing, in the mid-1990s government adopted a set of measures to promote the country socioeconomic development. Until the early 2000s, these initiatives were concentrated on two main axes: promoting the productivity of national sectors and to reformulating trade activities, with the aim of exporting products with greater value added.

The country's development plans (NEDP, see Guinea-Bissau, 2010) shows that the government sought to answer the observed low productivity through the first NEDP in the mid-1980s. The NEDP aims to modernize the agricultural sector through the introduction of new equipment and large-scale production machinery with the purpose of increasing the industrial share in the total output composition. This program was supported by new public investment in expanding agricultural crops by introducing new seeds as to accelerate the occupation of the interior of the country, with the purpose for funding the expansion of local communities' production. The government also would create the interconnection between the agricultural and industrial sectors through the new agro-industrial processing companies, so called *complexo agro-industrial de Cumeré*.

The reforms on production side were also the way found to overcome the supply crises and low degree of diversification with few products been exported with low value added. However, before it came into force, the NEDP was affected by the severe water crisis that strongly affected the rural area, making it impossible to produce new products that feed the nascent industries created to process agricultural production.

The second axis referring external sector reforms is one of the oldest development measures already adopted in this country. Trade reforms started in the late 1970s and were carried out in the mid-1980s, with the adoption of the so-called Structural Adjustment Program (SAP - Da Silva et al., 2018). This program was responsible for the insertion of the country in international market, as it allowed national products to be exported to various destinations, such as to the Asian countries, and not just to the traditional European markets. SAP also allowed the cashew nut to become in fact the most important

product for the economy as well as important source for households and government incomes, this through taxes on exports.

The country's participation in the Doha Round in 2001, formally known as Doha Development Agenda (henceforth DDA), cements governments' desire to promote economic integration, since it was in that round that agriculture became focus of discussion after the Uruguay Round completed in 1994. In this, a reform program containing support and protection rules was established to correct and prevent restrictions and distortions in world agricultural markets caused by high export subsidies by rich countries (WTO, 2001). Although the exact degree of tariff reductions and the level of cuts in the distortion of support for agriculture had been left for future negotiations, the DDA did in fact find some general principles in the so-called July 2004 Package[1] (see BOUET ET AL, 2005).

However, as the government agreed to reduce the import tariffs, it also adopts the so-called exportable taxes to increase its revenue. This policy consists of a percentage of taxes set on export products. Such percentage is determined once a year (during high harvest seasons) and remains invariant for the remaining 11 months. Each product is taxable according to its sectoral classification and therefore its share of the total product. This means that agricultural products, represented primarily by cashews, are charged higher rates. The idea to tax less products from other sectors is consistent with the government's argument that this could increase the concentration of the exporting grid by disintegrating its exports. However, exporters increase complains about the high taxes charged, by arguing that the government has committed in the DDA to reduce import taxes, while failing to relieve national exports. To mitigate these complaints, a government decree in May 2019 reduced export taxes by 2.5 percent.

Despite these efforts, both the initial effort to promote the sectoral productivity and the trade reforms does not achieve its proposed objectives. First, the agricultural sector did not perform significantly because production is poorly mechanized, and most activities are carried out manually. In addition, given the precariousness of qualified technicians to operate the machines installed to process agricultural production, the agro-industrial

[1] The July 2004 package refers to the text of the General Council's decision on the Doha Agenda work program, agreed on 1 August 2004, containing frameworks and other agreements designed to focus the negotiations (WTO, 2018).

companies created go into generalized bankruptcy. Thus, the main objective of exporting products with high added value was not achieved, so the country continued to export its agricultural production in nature (DA SILVA ET AL., 2018).

Back in 2015, the government elaborated another ambitious development program called *Terra Ranka* (TR) reinforcing the need for the country to overcome the underdevelopment condition it faces through the construction and rehabilitation of infrastructures. The program addresses a set of short- and long-term measures, from 2015 to 2025, able of providing adequate logistical and basic services to investors and citizens.

The purpose of this study is to evaluate the socioeconomic effects of these three development policies that have been carried out by governments. That is, to understand the macroeconomic, sectoral, and household level implications of trade, public investment in infrastructure, and productivity promotion policies in this low-development country with an agriculture-based economy.

Understanding the effects of such policies is important for several reasons for the country to find socioeconomic development options. First, they are part of the central axes of the country's development policy, and $ billions have been spent as better the condition of national production as well as the households' condition that suffer from extreme poverty.

Second, these are correlated themes, that is, there is a correlation between infrastructure, productivity and the country's trade capacity. For instance, the port and airport infrastructure can be used for a variety of purposes such as for trade in goods and services. Given a positive correlation between trade volume and GDP, the quality infrastructure availability could promote economic growth, which in turn could be used to fund policies against poverty, for example (Bhagwati, Panagariya, and Srinivasan, 1998). Therefore, elimination of tariff and infrastructure barriers to trade imply not only a more integrated world trade, but essentially a shared global prosperity. According to the world Bank (World Bank Report, 2018), due to the reduction of such barriers, developing countries increasing participation in trade, changed from 33 percent in 2000 to 48 percent in 2017, coincided with a marked decline in poverty worldwide, having been one of the

factors responsible for halving the number of people living in extreme poverty since 1990.

Conversely, the infrastructure can be used either to transport the production from a rural area to a port of shipment or to facilitate the delivery of imported inputs. The sector's current status of productivity then may reflect the speed for which a truck takes to carry out the delivery services. In short, since agriculture is an important source of households income, especially the poorest ones, with have little or no capital income, understanding the effects of infrastructure, trade and productivity can be important for the creation of development policies aimed at improving comparative advantage as well as to reduce extreme poverty in this country. The fact is that infrastructure availability may allow the country to reach its comparative advantages out, since it contributes to enlarge size of the labor market, increasing productivity and output (BARRO, 1991). Several final consumption items to households and intermediate consumption item for firms, such as water and energy and telecommunications, also depend on infrastructure services (STRAUB, 2011).

According to Krugman (1994), a country with the ability to promote its standard of living over time depends almost entirely on its ability to increase its output per worker. The productivity may increase sector output (Al-Qudsi, 2004), boost economic growth (Mankiew et al, 1992, Nachega and Fontaine, 2006; Rudolf and Zurlinden, 2010; Korkmaz and Korkmaz, 2017; Nakamura, Kaihatsu, and Yagi, 2018), increase capital employment (Alani, 2012), household income (Gollin et al., 2002), international trade (Alcalá and Ciccone, 2003) and reduce poverty (Johnston and Mellor, 1961; Dhrifi, 2014). So, in order to promote the economic development and promote national and international trade as well as to be a competitive economy, it is imperative that the productive sectors of a country reach some level of productivity (Matsuyama, 1992; Gollin, Parente, and Rogerson, 2002).

Third, this study focuses on the issues related to the long-term socioeconomic impacts of import tariffs and export taxes changes, public infrastructure investments and exogenous shocks in the productivity in a least developing. In such countries, effects of economic policies are expected to impact rural and urban households differently, once they are exposed to the different challenges and opportunities arising from these policies.

These opportunities involve the diversification of consumption and job opportunities that openness, best infrastructure, and productivity can bring up. If such policies result in long-term economic growth for industrial sectors, employment of (skilled) urban workers is expected to grow faster than employment of rural workers. This can increase the income of the former more quickly and can lead to income inequalities. In addition, by concentrating on different rural and urban household with different initial conditions, we will be able to provide instructive evidence for the elaboration of public policies consistent with the reality of each household.

Fourth, it is estimated that the citizens in the interior of the country walk about 18 miles away to get 20 liters of water. To serve a traditional Guinean household, with about 10 to 20 people, these 20 liters is supposed to be used for drinking, cooking, and for bathing. This means that either many people fail to provide this amount of water or a single person must walk miles and miles daily as often as needed to serve her household with tens of gallons of water. In the urban environment, the same problem exists, although of a slightly different nature. The people themselves walk a few miles to get water, however, it is estimated that 3 to 5 hours is the waiting time to get about 40 liters for the household. Therefore, our fourth essential contribution is that evidence found may guide the development policies design aimed at promoting the country's comparative advantages as well as establish mechanisms for private investment in priority sectors as to overcome the existing challenges (GUINEA-BISSAU, 2010).

Fifth, the quantitative analysis of the economic consequences of multilateral trade reforms is traditionally carried out from the partial equilibrium perspectives, but in the last few decades there have been increasing publications evaluating the consequences of trade reforms using computable general equilibrium (CGE) framework (see Davies et al.1994; and Mabugu, 2001; Chitiga, and Mabugu, 2008; Krishna and Mitra, 1998; Diao, Somwaru and Roe, 2001; Beghin, Roland-Holst and der Mensbrugghe, 2002). We appropriate this later tool since the CGE has the advantage of allowing to analyze interconnections between sectors and to investigate both the direct and indirect impacts of the economic policies.

Our study differs from those that simulate joint policy effects for regions or economic blocs (Achterbosch *et al.,* 2004). In such studies, the country-specific

characteristics and their potential effects may be not well captured, or they are ignored. However, the generalizations of the conclusions based on the simulated data could eventually fail when the block-based evaluations suffer greatly from the effects of the entities. For instance, besides striking difference in the size of economies, Sub-Saharan Africa has several countries, each with its own agricultural culture. Some have chestnuts-based economies and others have economies entirely based on cotton and therefore their interests must be in line with the characteristics of their economies, which suffer differently from the consequences of liberalization agreements. By focusing on one country, this study has the advantage of considering the national strategic interests and the effects of trade tariff policies on different economic outcomes.

We use a recursive dynamic model which is the first CGE model used for this economy. The choice of this dynamic version is justified because Guinea-Bissau is a typical example of a small economy that accompanies exogenous shocks. Such an economy is unstable and this instability stems from several reasons including also domestic institutions fragility that affects economy performance at both the starting point and overt time, and thus recursive dynamic model may best represent the structure of this economy.

The general objective of this study is to analyze what are the socioeconomic implications of current political options. In other words, which of the three policies can provide better results mainly in terms of household income and consumption in both rural and urban areas? This study seeks to answer the above questions with triple fundamental specific objectives: (i) to analyze the socioeconomic effects of tariff reduction proposal formalized in the Doha agreement as well as export taxes reduction that government announced recently; (ii) to discuss the economic activities, sectoral, and household level implications of public investments in infrastructure construction; and (iii) to make productivity shock into a more comprehensive model and to analyze its potential economic outcomes.

For that, these policies were evaluated separately, drawing a scenario for each one. For the trade axis, we have scenario 1 which consists of simulating cuts in import tariffs, while scenario 2 is simulating of export taxes reduction. In the productivity axis, we have a scenario that represents an estimated productivity shock for the selected sectors.

We will see that, in addition to the sector-by-sector shock, we simulated the effects of import tariffs and export taxes reductions and increased productivity simultaneously. By simultaneous shock means that tariff reductions for all sectors are simulated jointly, as opposed to the shock by sector, where the intention of each simulation is to verify what happens to the model variables when tariffs are reduced in just one sector. For infrastructure investments, we designed several scenarios that were divided into two parts: one representing the scenarios for increasing new public investments policy, as announced by the government (scenario 1 to 3), while the other brings a design for scenarios that show the alternatives for funding this policy (scenario 4 to 9).

To contemplate such objectives, this study is structured as follows: Chapter 2 makes a brief historical incursion on Guinea-Bissau economy since independence in 1973. It will be shown that in post-independence the nature of the international integration of the Guinean economy was strongly influenced by the prevailing orientation and interpretation about the ideal economic model that the country could follow as to potentiate the economic gains in the sectors with comparative advantages. This strongly planned economic model did not work properly due to internal and external factors, such as the water crisis and low flows of external funding to the projects being developed, leading to the accomplishment of structural reforms in the mid-1986s when the country began to practice the competitive economy-based model. However, because of the low capacity of the state to create revenues, the projects that were created since the early 1990s are being supported by their international partners. Initiatives in the economic sphere having been thwarted by political-institutional instability that creates several restrictions on private initiatives. The participation of governments in the international negotiations may be relevant as to promote economy integration, but more important is to know the agreements implications, as well as the productivity effects, on national economy performance. A useful tool for economic policy analysis is indeed the GE framework.

Chapter 3 presents the literature on the subject. Chapter 4 presents the methodology that will be used for simulation, including the database. The foundations of the Guinea-Bissau Dynamic CGE model stems from recursive dynamic CGE model departing from the neoclassical assumptions, essentially the Recursive Dynamic Version of PEP Standard CGE Model. The introduction of the dynamic module presents advances,

since what is important in the analysis is not only the result of the adjustment, but the adjustment trajectory of the variables: the results signal only the cumulative effects reached to the along the path or trajectory.

Chapter 5 aims to present and discuss the results of the three policy scenarios: trade liberalization, public investment in infrastructure and productivity improvement for the period from 2014 to 2030, time considered to be long enough for variables adjustment towards full employment. Conclusions are in Chapter 6.

## 2 ECONOMY OF GUINEA-BISSAU

The nature of the international integration of economy of Guinea-Bissau is influenced by national policy orientations as a result of the interpretation of the key problems that hinder the development of the productive forces. The predominant argument common among policymakers is that the historical structural problems the country faced were resulted from a long colonization. By compelling indigenous society to practice an unknown model of economy of the metropolis, the colonization brought negative heritage that deepened national poverty (see DA SILVA ET AL., 2018).

After independence, Guinean policymaker believed that the previous colonial model of economy did not bring expected results for the economic development of the country. They argue that to put the economy on self-sustaining growth path is required a new development model based on a planned economy. The centralized planning model was in force in 1973 to 1986, and found its main phases of trouble with the water crisis that hit the rural area in 1984, but also with recurrent fiscal crises that forced the government to trigger measures of economic openness in the mid-1980s. There was a very significant gap between potential and effective GDP, since sectorial output did not respond to government policy initiatives. Given the embryonic phase of the tax structure, persistent imbalances in government accounts aggravated public finance problems, hampering policies to fight against poverty (SANHÁ, 1988).

The level of agricultural production showed signs of improvement at the end of 1985 and in the first half of 1986 the production of the agricultural sectors did indeed improve at the same time that the world demand for commodities had increased as improvements of the economies that were reached by the oil crisis of the late 1970s. Agricultural products prices in international markets had also increased. Thus, the government's financial difficulties, world demand, and rising agricultural commodity prices were scenarios that led to changes in government behavior toward free trade practices (TVEDTEN, 1991).

This chapter aims to present Guinea-Bissau by discussing the main features of its economy and the policies that were implemented. Section 2.1 shows that the orientation towards an economy based on centralized governments, as well as its rupture,

were a product of the prevailing national and international scenarios. As such scenarios change, a market-oriented model was necessary to insert the economy internationally. The intention of this rudimentary discussion is only to give an idea of some important events that preceded the economic openness in the mid-1980s, and that will help to understand this economy.

Section 2.1 presents the reforms that were carried out aiming at the international insertion of the Guinean economy and its macro characteristics. Issues covered in section 2.2 include structural adjustment programs and the macroeconomics of trade. The following two sections discuss the policies that were implemented after economic openness, and that are discussed in this thesis.

## 2.1 OVERVIEW OF GUINEA-BISSAU AND SOME INTERNAL AND EXTERNAL ASPECTS BETWEEN 1973-1986

Located on the coast of West Africa and bordered by the Atlantic Ocean, Guinea-Bissau has as its contiguity Senegal to the North, Republic of Guinea to the South West and East, and Atlantic Ocean to the South and West. It is a country with a territorial extension of 36.125 km$^2$ constituted by 8 regions and 1 autonomous sector, the capital Bissau. There are more than 80 islands that constitute the archipelagos separated of the continental territory by Geba, Canhabaque, and Bolama Rivers (GUINEA-BISSAU, 2010).

The country has a population of about 1.8 million inhabitants, of whom 60% live in rural areas and 40% in small urban cities. Guinean society is formed by ethnic heterogeneity that spread throughout the regions and islands, each one with its own language. However, as a consequence of the Portuguese colonization, which begun in the middle of 1440, Portuguese is the country's official language, although it is not the most widely spoken one[2]. Guinea-Bissau was the first independent country between the Portuguese colony countries in Africa, but the last independent one among West African countries, apart from Cape Verde (LOPES, 1986).

[2] The most spoken languages are in alphabetical order: Balanta, Fula, Mandinga, Manjaca and Papel. The Balanta ethnic group is the most numerous, reaching 30% of the total population, followed by Fula with 20%, Manjaca, Mandiga and Papel with 14%, 13% and 7%, respectively.

The country became independent during a turbulent internal scenario because, although World War II had ended before 1970, this did not mean a scenario of international normality. The world was polarized, with Soviet Union on one side and the United States of America (USA) on the other one, while the other countries could fit the established rules and explicit or implicitly conform to the rules of one of these world military leaders. Until the 1950s, at least in the formal plane, the African countries were more related to Europe and the Middle East regions, explained mainly by secular colonization of Occidental European countries, which began in the first half of the 14th century, and by the geographical and cultural proximity of the North Africa countries with the Arab world (LOPES, 1986).

The struggles for independence in these countries, however, brought direct or indirectly three new partners: the USA, the Soviet Union, and China. The former entered indirectly through support for the maintenance of European colonization on the continent through financial and military assistance, which resulted in the colonization of Liberia, until then, an autonomous country. The China arrived on the continent directly by offering, in addition to the financial and military aid, the short-term exchange to national militaries and students. This contact of Soviet Union with the local leaders that fought for the end of the colonization made the majority of the countries of "Portuguese Africa", like Guinea-Bissau, lines itself with the Soviet Union and by extension to the Caribbean countries that also sponsored the entire process of combating colonization (LOPES, 1986).

In the immediate post-independence period the country faced the dilemma either to follow a centralized planning-based economic organization, the Soviet model in which the government will play an important role in the dynamics of its operation, or a competitive market-based economy where individual firms will be exposed to learning through competition for space and therefore for customers, the prevalent model in the United States and also in Western European countries. The choice of one of the models will not only have immediate implications on government finances that depended on bilateral financial flows and the assistance from multilateral agencies but will also guide future path that will mark policies and economic development in subsequent periods (DA SILVA ET AL., 2018).

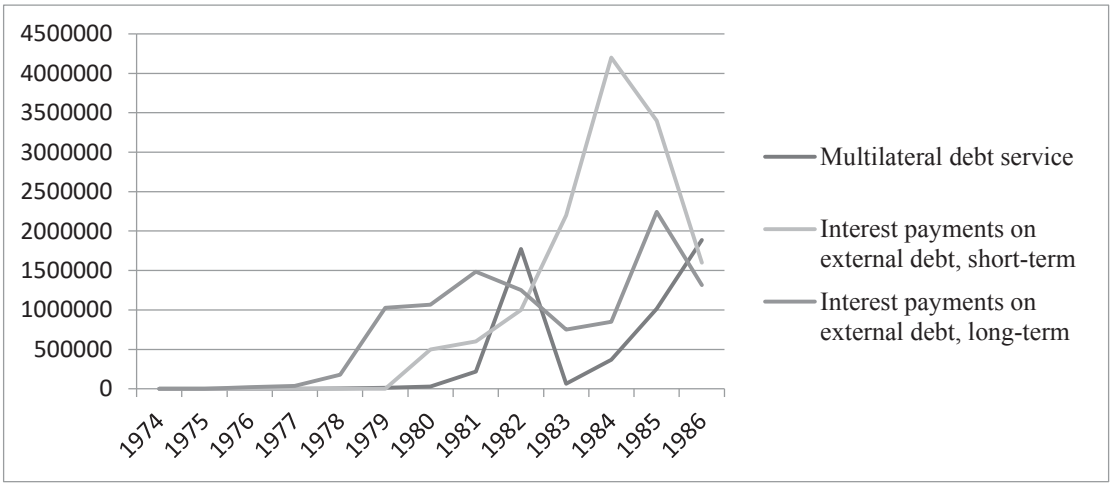
Influenced by political support received from the Soviet Union, Guinea-Bissau followed a centralized planning model (Lopes, 1986; Cateia, 2016) in the middle of a world economy with Gross Domestic Product (GDP) growth rate of 2 percent, driven by the growth of European, Asian, Latin American and other African economies, an averaging of 5 percent, as the USA economy grew at negative rates of -0.52 percent in 1974. In particular, African Sub-Saharan economies grew at rates of almost 8 percent in 1974 and 3 over 1974-1989, an average relatively lower than the world average growth rates that was 3.20 percent in the same period (World Bank Indicators, WB, 2018).

However, after years of stability, international oil price rose 205 percent in 1974 over the previous year. The behavior of the global economy as well as the Guinean economy has much to do with the 1970s oil crisis. This crisis arose out of some embargoes that affected the production and supply of oil, including *Yom-Kippur War* in 1973 and *Iranian Revolution* in 1979. The involvement of oil-exporting developing nations (OPEC) in these events resulted in a shortage of oil supply. As the rich countries, such as the United States, New Zealand, and Canada, have increased oil consumption, the price has risen rapidly (COVI, 2015).

As in most developed countries, where the price indexes responded to production inputs price, United States inflation had shown an upward trend. Interest rates had to be raised to prevent cost inflation from hampering further growth in their economy that was below the world's growth rate. This has led to an increase in the lending interest rate in international markets by more than 10 percent in 1974. As the interest rate was an instrument to combat inflation in lending countries, it has become increasingly difficult for the Guinea-Bissau government to obtain new funding to funding its development policies (Covi, 2015). Figures 1 and 2 show that in periods following the second oil shock new borrowing occurred with increasing debt service. Higher short-term interest rates were responsible for the increase in the cost of debt; as these interest rates decrease, debt service also declined, albeit in a non-proportional way. In addition, we must remember that in the first oil crisis, the Bretton Woods agreement had just ended, which also contributed to further increasing the consequences of the oil crisis (See, for example, EICHENGREEN, 2008).

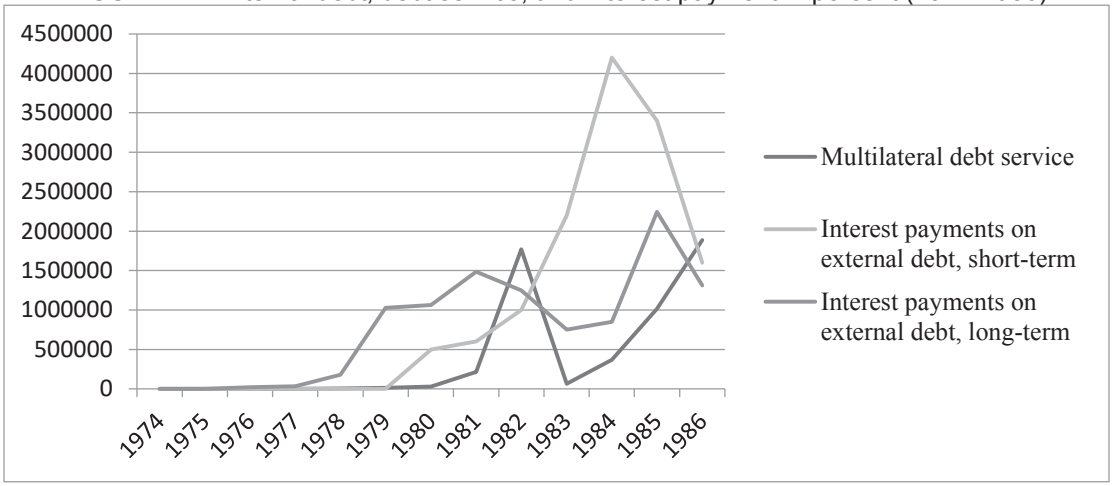
This is not predominant behavior for the whole period. In Figure 1, short-term interest rates in 1983 showed a downward trend, while debt service that had declined in the previous year showed an upward trend until 1986, at the same time as long-term interest rates were decreasing. In Figure 2, for the government to circumvent the lack of funds, it was necessary to resort to multilateral agencies, such as the International Monetary Fund (IMF). As a result, there was a certain predominance of bilateral funds as proportion of total external debt. Unlike private funds that required high interest rates, bilateral deposits could be obtained with fewer restrictions, providing official guarantees (Covi, 2015).

FIGURE 1 – External debt in current US$




SOURCE: Own elaboration. World Bank data, 2018

FIGURE 2 – External debt, debt service, and interest payment in percent (1974-1986)




SOURCE: Own elaboration. World Bank data, 2018

In the domestic sphere, two things can be observed, the political regime that influences the way the economy is organized, and the prevailing pattern of trade. The socioeconomic practices represented an attempt to eliminate the governmental structures instituted by the Portuguese, with the intention of drawing up a plan that did not break with local structures, but to move away from Portugal legislation. It was, therefore, a sudden intervention that overlaps the accommodation between the local tradition and the Portuguese colonial model, with the aim of creating institutions not controlled by the metropolis and whose base of support would occur essentially by the inclusion of the local leaders in the discussions of development projects (DA SILVA ET AL., 2018).

There was a need to create norms that guide the proper functioning of the new institutions, which had a centralizing character of power in the capital of the country and aimed at meeting the needs of the State, placing planning as the main task. Enjoying its historic role of being the only political party created before independence and able to mobilize a significant mass of the population to adhere to its ideologies, the *Partido Africano para a Independência da Guiné e Cabo Verde* (PAIGC - African Party for the Independence of Guinea and Cape Verde) was the only political party that governed the country after independence and also took all the centralizing decisions that guided the functioning of the economy during the entire first decade after independence (DA SILVA ET AL., 2018).

According to Alec Nove (1989) given the complexity of the task of planning and managing an economy, it is inevitable that the task be divided among different departments. However, tasks division among different policy-making bodies sometimes made it difficult to plan, since one department could neglect the interests of another related or complementary activity. This is because such interests were beyond its “departmental barrier”, which further increased the central government's difficulty in implementing measures of general interest as the disinterest of some departments increased relative to activities that were not directly linked to them.

Da Silva *et al*. (2018, p.110) argue that the laws or norms imposed by centralized government are not necessarily obeyed, and the reason for this contradiction between socialist economic rules and the effective conduct of the population was the lack of adequacy of the institutions created to the cultural standards of constituent ethnicities.

With the precariousness of the tax structure of the government of a newly independent country, approximately 80 percent of the financial resources of the public sector were derived from external sources (Sanhá, 1988). But because the country practiced a regime of one-party government and a planned economic system controlled by this government, access to financial resources became restricted as most of the loans and aid the country received came from international organizations, such as the IMF and the WB, with political influence of the United States. To achieve large funds, the country needed to get closer to the other USA allies hostile to Soviet Union geopolitics practices. To do so, it was necessary to adapt its institutional framework, hierarchically constructed under a totalitarian regime, to the prevailing standards. It basically involved taking two measures: reorientation of the governance system and economic openness (MENDES AND JAWAD, 1986).

Historically, trade in Guinea-Bissau has always been linked to the performance of the agricultural sector. Although the government had a predominant role in the organization of economic activities and dealt differently from private agents, the Guinean trade pattern in this period was marked by coexistence of the public and private sectors. The government operated through the *Socomin Company*, which was the fusion of the former *Empresa Ultra-Marina Portuguesa* with *Gouveia*, responsible for imports of products of special needs such as food and other categories of products demanded by

the central government. To meet the demand of the population growing at a rate above 2 percent a year, it was created a distributor in the downtown of Bissau, so called *Armazem do Povo* responsible for trading and also served as an institution that controlled inflation as it played the role of monopolist in the sector (MENDES AND JAWAD, 1986).

But while government revenue depended on the performance of the balance of payments components, there was an internal and adjacent trade that was highly profitable. This type of trade, which is still practiced today, is done by a group of private individuals called Djulas, who circumvented the strong competition of the public sector because of their technical knowledge of the domestic market. Following the trade tradition of the former traders, which was perpetuated by the interior and coastal part of the country, thanks to the proliferation of ethnic from Nile Valley, the Djulas were mostly speculators and had the most sophisticated trade techniques at the time. They were able to access places considered inaccessible by public companies (for this informal trade, see Chalfin 2001, Golub and Mbaye, 2009).

In fact, they reach farmers in distant places, with no roads that can be used by regular transport. The Djulas are divided into two major subgroups: Djulas sellers for the domestic market and Djulas traders with neighboring countries. The former made purchases from the local producers and took the products to the "*Feiras"* or "*Lumos*" that works as the physical space where the exchanges are effectively carried out. The latter engaged in cross-border trade and enjoyed greater financial capital which was applied in advance of purchases. These have been the main State competitor, since many of them did not even need to get closer to local producers but they were able to obtain enough commodities to trade (Golub, 2012).

The Djulas also took advantage of the inefficiency of the government's existing control mechanisms and the structure of tariffs had little influence on the products they trade. The truth is that increasing government requirement always increases informal cross-border trade, causing few products to be registered by official trade statistics. That is a very common practice in most developing countries, particularly in Africa. A study for Benin's economy shows that 10 percent tariff increase of a marketable product makes it

about 12 percent more likely that this product is imported informally rather than formally (BENSASSI ET AL., 2019)[3].

It is worth noting that we do not incorporate aspects related to informality in the labor market as well as in the commercial relations of the Djulas. The main reason for this is that we do not get reliable statistics that are consistent with the national accounts we model. In a country where the proportion of informal employment in non-agricultural employers (i.e. informality) is 60.6 percent, our model does not well propagate the potential effects of present policies on poverty. As we will see, an immediate alternative was to incorporate heterogeneous workers and households, some with wages and income compatible with those of the population below the universal poverty line, while others above that level. The model calibrated for this purpose may help to report something about consumption gains and their direct correspondence, welfare changes.

## 2.2 STRUCTURAL ADJUSTMENT AND THE CURRENT TRADE PATTERN

The preliminary discussion illustrated Guinea-Bissau's economy in the first decade of 1970. Despite the importance of the past to understand the country, the prevailing model of centralized planning will not allow a direct link to the period since 1980s, when several economic reforms were carried out as to insert the economy internationally. These reforms were necessary because the state's intention to be the main economic agent proved to be inefficient for reasons explained above, such as the difficulty of obtaining financial resources and organizing productive activities given the present institutional framework.

The first macroeconomic stabilization initiatives were taken in 1983, through the first National Economic Development Plan (see Guinea-Bissau, 2010), which aims to: modernize the agricultural sector, introducing new equipment and large-scale production machinery with the purpose of increasing its share in the total output composition; expand

[3] Although it can be imagined that tariff reductions can reduce informal trade, those interested in studying trade issues in Guinea-Bissau should note that this work does not consider the commercial practices of the Djulas, given the lack of reliable data for analysis that may suggest policy measures that improve trade with neighboring countries practiced for them. This means that the policies that this study will address are supposed to result in data compiled from formal trade.

new agricultural crops, by introducing new seeds; accelerate the occupation of the interior of the country, with the purpose to financing the expansion of local communities' production; create the interconnection between the agricultural and industrial sectors through the creation of agro-industrial processing companies; boost the country's foreign trade by opening possibilities for exporting products of greater value added to the rest of the world; and create a new channel for raising public resources from commercial operations and taxation to processing companies (DA SILVA EL AL., 2018).

Reforms on production side and commerce were forms found to overcome the supply crises, low degree of diversification with few products been exported with low value added, and the precariousness in the tax structure, which always contributed to the state's low capacity to make investments, including investments in basic sanitation. The purpose of the restructuring trade activities was to give this sector an important role in the process of socioeconomic development of the country (SANHÁ, 1988). This implied transformation of the main public agencies, such as public enterprises and trade ministry, giving greater space to the private agents in the operation of trade activities. Opening the economy seemed to be a feasible choice for reducing barriers to development. This option was considered important by the government since, by signaling the commitment to liberalize the economy, it increases the prestige of the government with existing multilateral organizations, and that may be a feasible way to promote inflows of financial resources to the country.

The proportion of imports of agricultural tractors rose from 30% in 1985 regarding to 1970 (FAO data, 2019). However, before it came into force, the NEDP was affected by the severe water crisis that strongly affected the rural area, making it impossible to produce new products that supply the industries that were created to process agricultural production. With technical barriers for which they were subject, at the end of 1984, only one company was still functioning, so called "*complexoagro-industrial de Cumeré*". In general, the agricultural sector did not perform significantly due to the decline in rice and peanut production. The fall in total production was not significant due to the expansion of maniocs, mangoes and guavas crops and mainly the favorable performance of cashew nuts production, with an annual growth rate above 30 percent since 1986 (FAO DATA, 2019).

Thus, having failed to sufficiently structure its economic system in the 1980s, the country entered the international market with strong imbalances in the external accounts that required the demand for loans to pay off its debt and even for the payment of civil servants. This demand surpassed the export currencies, thereby nullifying the effect of an improvement in the trade account, which was largely associated with the growth of 100.75 percent of the export production for export of cashew nuts in 1992 in relation to 1986. The 1990s represented a decade of intensification of the process of integration into international markets. During this period, the countries joined the Economic and Monetary Union (WAEMU) in 1997 and signed several unilateral and multilateral agreements, including its accession to the World Trade Organization, World Bank and the IMF in 1995 (DA SILVA ET AL., 2018).

Since then the political measures both in the economic as well as in the social area have been taken in partnerships with these institutions. But despite major advances in several sectors, socioeconomic indicators suggest that Guinea-Bissau is one of the poorest countries in the world, because of the relatively low performance of its economy that reflects the backwardness of its low-growth productive sectors. The per capita gross domestic product (GDP) and the Human Development Index are US$ 600 and 0.424, respectively, placing it in the low human development category, ranking 177th out of 189 countries and territories. From 1980 to 2017, life expectancy at the birth of a Guinean man was on average 46 years and more than 69 percent of the population live in absolute poverty (less than two dollars a day), indicating an increase in the incidence of poverty, since in 1991 this percentage was 49 percent. At the same time, extreme poverty (below US 1 per day) increased considerably from 28.8 to 33 percent from 2002 to 2017, respectively (UN-DP, 2018).

After initiating state reforms including the establishment of the multi-party system that resulted in the first presidential election in 1994, the country faced an 11-month civil war that began on June 7, 1998, which wiped out more than a third of its economy. Before even recovering from war episodes, political instability occurred, culminating in a coup d'état that disbanded the President of the Republic in 2003. The national reconciliation start following the attempt by international organism and sub-regional partners to promote

dialogue between the parties, and it enabled the holding of the second presidential election in 2005 (see GUINÉ-BISSAU, 2010).

In 2001, the first National Poverty Reduction Paper (I NPRSP) was established, which was only implemented in 2004. An IMF report at the time (IMF Country Report, 2007, p.5) notes that the country's high level of instability did not permit it to focus government initiatives on the search for ways and means to tackle the challenges of the country's development, which resulted in the failure of this plan, that involved modernize public administration, to ensure macroeconomic stability; promote economic growth; increasing access to social services and public infrastructures; and improve the living conditions of the most vulnerable populations (GUINEA-BISSAU, 2010).

As the success of the NPRSP was coupled with the improvement in the cashew nuts price, this program was suspended in 2009 due to a 30% drop in this price follow up the international crises that resulted in the fall in international demand for nuts. Because Guinea-Bissau plays an important role in the cashew nut market and was one of the world's leading producer, the fall in demand for the country's production due to persistent instabilities accelerated the fall in the international price of this commodity. Since a significant proportion of the national population is involved in the production of cashews nuts that are the sources of their income, the decrease in their price has compromised any initiative to implement anti-poverty policies. Thus, the failure of the NPRSP to achieve its objectives is officially pegged to the 30% fall in from the price of cashew nuts in 2009. Thus, in 2011, the II NPRSP was designed to promote inclusive growth and reduction of social inequalities, but their operating mechanism was less tied to the performance of a sector (CATEIA ET AL., 2018).

The country has experienced moments of political stability that have benefited economic activities practice. The challenges it has faced have been to carry out reforms of the public administration, to restructure the productive system and to formulate economic policies consistent with its comparative advantages. The actions taken by governments along with their international partners are also intended mainly to fight rural poverty, because most extremely poor people live in rural areas and the basis of their livelihood comes from the agricultural sector (BOUBACAR-SID ET AL., 2007).

## 2.3 ECONOMIC DYNAMICS AND MACROECONOMIC CONTEXT OF TRADE

The Guinea-Bissau economy is supported by a variety of sectors and products. Fishing is one of the most important economic activities, with the sale of industrial fishing licenses for the European Union and China been one of the main sources of government revenue. Since the economic openness in the mid-1980s this country has experienced significant economic growth and it is currently 20 times greater than it was in the 1970s, with GDP around US$ 100 million (FCFA 50 billion). Private final consumption expenditure represents the largest cumulative share among GDP components (Table 1).

TABLE 1 – Macro aggregates (% of GDP)

| Variable | 1970-1989 | 1980-1989 | 1990-1999 | 2000-2009 | 2010-2017 |
|---|---|---|---|---|---|
| Households consumption | 95.476 | 85.623 | 91.948 | 87.637 | 89.106 |
| Government consumption | 26.710 | 11.854 | 8.1882 | 12.548 | 9.920 |
| Investment | 11.724 | 38.353 | 21.189 | 10.241 | 8.794 |
| External balance | (33.910) | (5.831) | (21.325) | (10.427) | (7.820) |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

SOURCE: Authors' calculations. World Development Indicators: World Bank data, 2018

In terms of the productive sectors contribution, the average proportion of the industry sectors on the aggregate product shows a downward trend over the decades, while services and agricultural sectors have greater dominance in the sectors contribution to the GDP (Table 2). The performance of the industrial sector is basically explained by manufactures production that has also been losing space in the value-added share on GDP. During the period from 1970 to 2017, the service sector contributes with average share of 33%, while the agricultural proportion was over 44% during the last almost 50 decades.

Table 2– Average share of the sector value added on GDP

| Sector | 1970-1979 | 1980-1989 | 1990-1999 | 2000-2009 | 2010-2017 |
|---|---|---|---|---|---|
| Services | 26.00 | 35.00 | 29.00 | 39.00 | 35.00 |
| Industry | 18.00 | 15.00 | 12.00 | 14.00 | 12.00 |
| Agriculture | 39.00 | 46.00 | 53.00 | 41.00 | 42.00 |
| Manufacturing | 18.00 | 4.00 | 7.00 | 6.00 | 11.00 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Sources: Authors' calculations. World Development Indicators: World Bank data.

This country is considered to have an agriculture-based economy since much of the products traded are agricultural or are directly related to. Export and domestic consumption crops relevant include the production of peanuts, rice, corn, sorghum, beans, manioc, sweet potatoes, sugar cane, cotton, coconut, mangoes, guavas, papayas, and others (Table 3).In response to increasing demand from Asian countries, such as India and Singapore in the early 1990s, cashew nuts became the main production product. In 2017, the proportion of cashew nuts produced in the total crop reaches 40%, a percentage that is highest in the historical series since the sporadic boom of natural Rubber in 1980.

TABLE 3 – Crop production share over the decades

| **Product** | **1970** | **1980** | **1990** | **2000** | **2010** | **2017** |
|---|---|---|---|---|---|---|
| Banana | - | - | 1.00 | 1.00 | 1.00 | 1.00 |
| Cashew nuts | 1.00 | 1.00 | 6.00 | 11.00 | 15.00 | 18.00 |
| Cassava | - | 0.00 | 3.00 | 5.00 | 8.00 | 6.00 |
| Cereals | - | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 |
| Coconuts | 10.50 | 7.00 | 7.00 | 7.00 | 5.00 | 5.00 |
| Cotton | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 |
| Fonio | 3.00 | 2.00 | 0.00 | 1.00 | 0.00 | 0.00 |
| Fruit, Fresh | 4.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Groundnuts | 12.50 | 9.00 | 7.00 | 6.00 | 5.00 | 4.00 |
| Lemons | 0.00 | 0.30 | 1.00 | 1.00 | 0.00 | 0.00 |
| Maize | 1.00 | 3.00 | 3.00 | 4.00 | 1.00 | 1.00 |
| Mangoes and Guavas | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Millet | 2.00 | 3.00 | 3.00 | 3.00 | 2.00 | 2.00 |
| Oil palm fruit | 23.00 | 24.00 | 13.00 | 13.00 | 1.00 | 9.00 |
| Oil palm | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Palm kernels | 2.00 | 2.00 | 1.00 | 1.00 | 1.00 | 0.00 |
| Oranges | 0.00 | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Papayas | 0.00 | 0.40 | 0.30 | 0.20 | 0.30 | 0.30 |
| Pineapples | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 |
| Plantains and others | 8.00 | 7.00 | 6.00 | 6.00 | 6.00 | 6.00 |
| Pulses | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 |
| Rice, paddy | 11.50 | 10.00 | 24.00 | 17.00 | 25.00 | 22.00 |
| Roots and tubers | 13.00 | 12.00 | 10.00 | 1.00 | 7.00 | 11.00 |
| Rubber, natural | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Seed cotton | 0.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Sorghum | 1.00 | 4.00 | 2.00 | 3.00 | 2.00 | 2.00 |
| Sugar cane | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Vegetables | 6.00 | 5.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

SOURCE: Authors' elaboration. FAO data.

In short, the Guinean economy can be characterized as follows: first, it is an economy that depends crucially on the performance of cashew nut production, which represents 98% of export earnings and about 17% of government revenues based on export tariffs. More than 85% of the population employed in agriculture sector is directly involved in cashew nut production process. The cashew nuts plantation occupies approximately 6% of the national territory, that is, an area of almost 210,000 hectares, and on average each Guinean produces more than 53 kg of cashew nut a year, that is, an average of more than 90,100 tons produced annually in the country (CATEIA ET AL., 2018).

Second, it is an economy with infrastructure base that suffers with the chronic degradation problem since, according to Guinea-Bissau (2010, p.01), both roads and port facilities have received little maintenance or improvement since 1975 and continue to suffer from the effects of the civil war that took place in 1998/99. The low provision of the infrastructure to improve economic activities contributes to lower the country's overall Logistic Performance Index (LPI), ranking it in 145th positions globally. Third, due to the difference observed between demand and domestic production, with a still growing population, the country has increased its imports to meet this gap. Because demand for imports is strongly dependent on the movement of international food prices, the increase in the incidence of extreme poverty in recent years is largely associated with the rise in the staple food commodity price, rice. Fourth, a major contributor to government revenue is fishing activity, which account for about 50% of government revenue[4].

This study focuses on the first part and rule out the issues linked to the fishing sector because data on these operations do not appear in official statistics since, as the country grants licenses to foreign ships, all exports of fish are counted in the statistics of the vessel's flag country. Therefore, when it is mentioned the importance of exports on government revenue is limited to those of other all categories of exported products, except fish.

The points to be addressed encompass essentially trade and infrastructure or productivity, in the narrower sense. Policymakers recognize a clear intersection between

[4] This proportion refers to government receipts as a form of rights to licenses granted to foreign fishing boats legally authorized to operate in the country, as well as taxes levied on the sale of fish in the national market (see Guinea-Bissau, 2010).

trade and local development, since the main crop of the country, cashew nuts, is also its main export product; the main cereal base, rice, is also one of the main imports. Thus, the Government policy regarding to these two crops also will play a key role in promoting economic growth and reducing poverty (GUINEA-BISSAU, 2010). However, promoting productivity growth is a relatively low priority for policymakers because national development strategy has concentrated on the inclusion and expansion of new agricultural crops relegating productivity to secondary measures that eventually may take place at some point. Instead, according to Briones (2010), an alternative strategy may be to reconcile competition and productivity, that is, to promote integration with the international economy through trade, as well as national investments at productivity growth.

Trade and productivity affect each other, and both can be affected by the same factors. For instance, in the Melitz trade-type model, the wage rate, normalized to unity, is the same for all firms and countries. The trade shock, which induces competition among firms for scarce labor, causes real wages to be increased by relatively more productive firms. Such firms can enter export markets and thus be able to expand production. Therefore, promoting productivity growth is one way of increasing the export opportunity while trade liberalization can increase the firms' growth productivity. Major factors influencing productivity that the literature considers include: rates of investments in capital stocks and allocation of capital services, domestic infrastructure, changes in labor force composition, energy prices, among others (see Nadiri and Mamuneas, 1996; Schneider and Gugerty, 2011; Tanaka and Hosoe, 2011), while trade may be affected by additional factors such as the exchange rate, tariffs, distance, and so on.

Reconciling strategy that is competitive-oriented and productivity-based may be as good as providing either trade liberalization or promoting improvements in productivity alone. After we review the literature on these points, for which different simulation scenarios will be drawn, a CGE model will be presented in the next chapter. This model was then used to simulate the economy-wide impact of range economic policies, including trade liberalization, improvement in total factor productivity, and infrastructure investment. The simulation of trade liberalization will be based on a real policy of tariff reduction that will be the object of the discussion of the following subsection.

### 2.3.1 Doha round: an overview

Because a detailed review of the DDA has been already done by several authors and institutions including reports from international organizations, such as International Monetary Fund (IMF) and World Bank (see, for example, Francois, Meijl and Tongeren, 2003; IMF and WB, 2005), this section summarizes the tariffs and subsidies topics which are important to this study. By the end of the 1980s, all trade negotiations were governed by the GATT (General Agreement on Tariffs and Trade), an organization created in 1947 to harmonize the customs policies of its signatories. However, for an organization that sought to improve the quality of international trade with only 22 members, it was very difficult to adopt measures to harmonize trade policies, even at the regional level. The African continent at the time was represented only by South Africa, which despite having a booming economy, its political and commercial influences on the continent were still very low. There was general resistance from other States to joining the GATT because they saw it as an organization that excluded their commercial interests, since until then it did not regulate trade in agricultural products.

The rapid trade expansion of developing economies such as China, Ivory Coast, Ghana in 1980s required the creation of a broader organization dealing with a variety of issues, not only those benefiting developed countries that produce industrialized goods. Thus, a round of negotiations for the liberalization of international trade was launched in 1986 in Punta Del Este, Uruguay, which would be important for regulating current trade relations.

The Uruguay Round resulted in the creation of the World Trade Organization (WTO) in 1995, with 148 members accounting for 97% of world trade, of which 2/3 were from the least developed and developing countries, indicating a broad participation of their States in new international trade agreements. However, it took another 16 years for agriculture to become an effective forum for discussion, which occurred only in the DDA in 2001 where the needs and interests of least developed and developing countries were first put at the heart of a negotiation (ELLIOT, 2007).

The DDA is the new round of negotiations from the first round in Geneva in 1947 to the Annecy rounds in 1949, Torquay in 1951, Geneva again in 1956, Dillion Round,

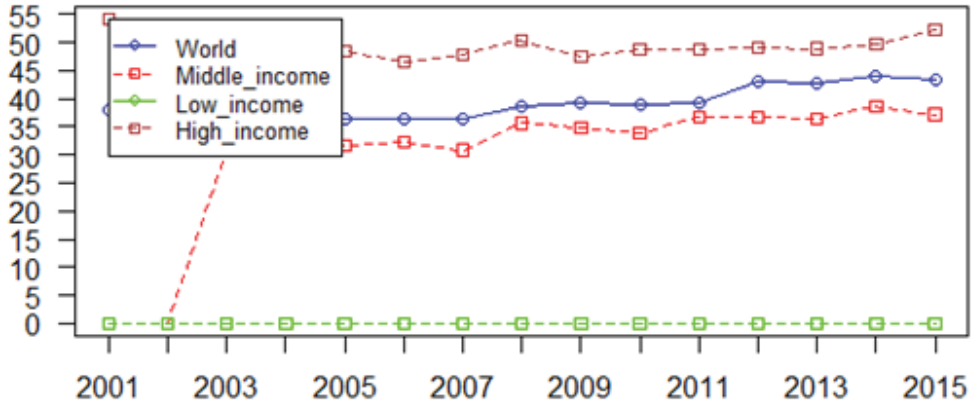
1960-61, Kennedy Round, 1964-67, Tokyo Round, 1973-1979, and Uruguay Round 1986-94. Several reform programs proposed in the immediately preceding round (as property anti-dumping measures, rules of origin, etc.) have been revised and extensively discussed, but fundamentally a reform program has correcting and preventing restrictions and distortions in world agricultural markets (WTO, 2001).

Such distortions stem from excessive agricultural subsidies by developed country governments, which have spent billions of dollars each year to support their agricultural sectors. For example, support for agriculture in 3/4 of the Organization for Economic Co-operation and Development (OECD) countries was estimated at US$ 318 billion in 2002, however, agriculture in these economies employs around 5 percent of GDP, while in less developed countries, such as Guinea-Bissau, agriculture accounts for around 70 percent of employment and more than 36 percent of GDP (FAO, 2003).

FAO shows that subsidies affect agriculture in developing countries in different ways. The main direct effect is competition since it allows the production of developed countries to be offered in international markets at prices below the value of production. This is harmful to poor countries, since because of the lack of advanced technology applied to production, the high costs make them unable to compete with their rich counterparts, causing farmers to lose a lot of money and invest less in the improvement of the production chain. Ultimately, populations in poor countries end up increasing demand for staple food imports.

Figure 3 shows the evolution of subsidies and other transfers carried out by the world, by low-income, middle-income and by high-income countries in the period 2001-2015. Although middle-income countries increased their support after the DDA, wealthy nations continued to support their domestic sectors even more, while subsidies and transfers from low-income nations were negligible or nearly zero throughout the period.

FIGURE 3 – Subsidies and transfers (in US$ million)




SOURCE: Own elaboration. World Bank data, 2018

To complete the commitments of members to promote substantial reductions in market access difficulties, it was recommended that export subsidies should also be reduced gradually to a date to be negotiated. For developed countries, it is recommended to eliminate domestic support that creates distortions to world trade, quantitatively corresponding to a cut of 20% of subsidies from the first day of the DDA (WTO, 2001).

The elimination or reduction of tariff peaks and tariff scale on products of interest to developing countries are expected to have a positive impact on the level of employment, output and poverty in Guinea-Bissau. The tariff data are shown in Table 4 for both the developed and developing economies and the world. Tariffs for primary commodities globally dropped by 68 percent, while declined by 33.4 percent for manufactured goods in the 10-year interval. Middle-income countries cut tariffs for primary products by 80 percent and tariffs for manufactured goods by 52 percent. In the same period, the low-income countries' tariff cuts for both products were 23 and 11 percent, respectively, while high-income countries cut tariffs for primary products by 61 percent and 11 for manufactured goods.

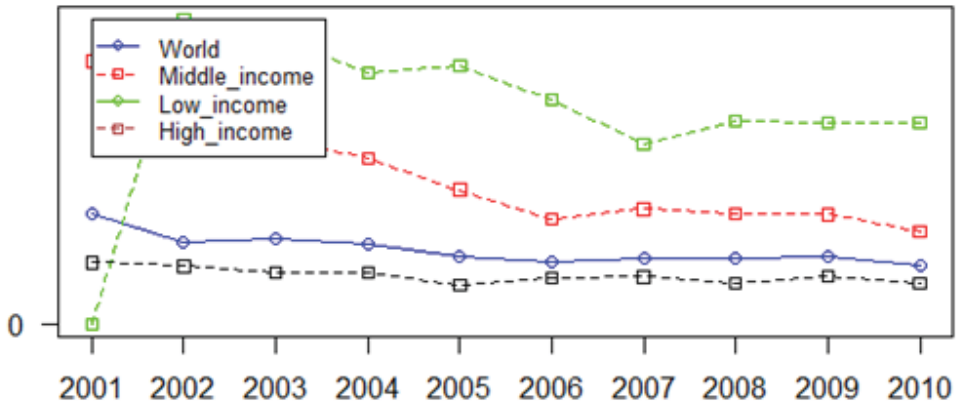
Table 4– Applied tariff rate, weighted mean (%)

| Country | Products | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| World | Primary | 6.47 | 5.26 | 4.68 | 4.59 | 3.14 | 3.08 | 3.2 | 2.53 | 2.68 | 2.08 |
| | Manufactured | 4.55 | 3.26 | 3.59 | 3.27 | 3.04 | 2.75 | 2.9 | 3.21 | 3.32 | 3.03 |
| Middle income | Primary | 12.65 | 8.14 | 7.83 | 7.67 | 5.94 | 3.82 | 3.91 | 3.33 | 3.39 | 2.53 |
| | Manufactured | 11.64 | 8.46 | 8.76 | 7.23 | 6.11 | 5.14 | 5.85 | 5.73 | 5.72 | 5.06 |
| Low income | Primary | 10.78 | 13.09 | 13.35 | 10.81 | 9.15 | 7.14 | 7.27 | 7.48 | 7.92 | 8.33 |
| | Manufactured | 10.89 | 14.24 | 12.94 | 11.75 | 13.06 | 12.02 | 8.69 | 10 | 9.79 | 9.65 |
| High income | Primary | 4.63 | 4.62 | 3.75 | 3.62 | 2 | 2.8 | 2.92 | 2.07 | 2.4 | 1.77 |
| | Manufactured | 2.19 | 1.98 | 1.89 | 1.87 | 1.68 | 1.78 | 1.76 | 1.78 | 2.06 | 1.91 |

SOURCE: Authors' calculations. World Bank data.

The tariffs for all products by type of economy are shown in Figure 4. With the same pattern as in Table 4 and Figure 3 above, rich nations adopt more export subsidy policies rather than cuts/reduction tariffs policies, which historically are lower than the reductions practiced in developing and less developed economies.

FIGURE 4 – Total applied tariff rate, in weighted average (%)




SOURCE: Own elaboration. World Bank data, 2018

Although there was no agreement on the band and the exact threshold of tariff reductions and the level of cuts in the distortion of support to the agricultural sector, in the General Council Decision 579, also known as July 2004 Package, the DDA found greater acceptance from WTO members (ANDERSON and MARTIN, 2006). These authors argue that the WTO DDA provides important new guidelines for negotiations on access to agricultural markets because it proposes tariff reduction through higher cuts in higher

tariffs. For the Guinea-Bissau, whose performance of the aggregate macroeconomics is heavily dependent on the performance of the agricultural sector, the agreement was signed with some enthusiasm.

The tariff rates applied by Guinea-Bissau individually to primary and manufactured products are close to those charged by least developed countries (Table 5). The important fact is that the country entered the DDA as a potential beneficiary of global tariff cuts but would have to reduce tariffs on all imported items.

Table 5 – Guinea-Bissau Applied tariff rate (%)

| **Tariff rate** | **2001** | **2003** | **2005** | **2007** | **2009** | **2011** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|---|
| Manufactured products | 15.03 | 13.59 | 13.56 | 13.48 | 12.97 | 12.78 | 13.43 | 12.99 |
| Primary products | 16.54 | 16.04 | 16.17 | 16.38 | 14.65 | 15.02 | 16.59 | 15.53 |
| Averages | 15.79 | 14.82 | 14.87 | 14.93 | 13.81 | 13.90 | 15.01 | 14.26 |

SOURCE: Authors' calculations. World Bank data.

As a country with an agriculture-based economy, the entry of Guinea-Bissau into the WTO may be of great importance for the sector's exports, because it will be treated in the same way as other countries. Table 6 shows the tariffs applied by the rest of the world to Guinea- Bissau products (Column 2) and tariffs applied to products from the rest of the world (Column 3). Tariffs were aggregated according to the SAM sectors.

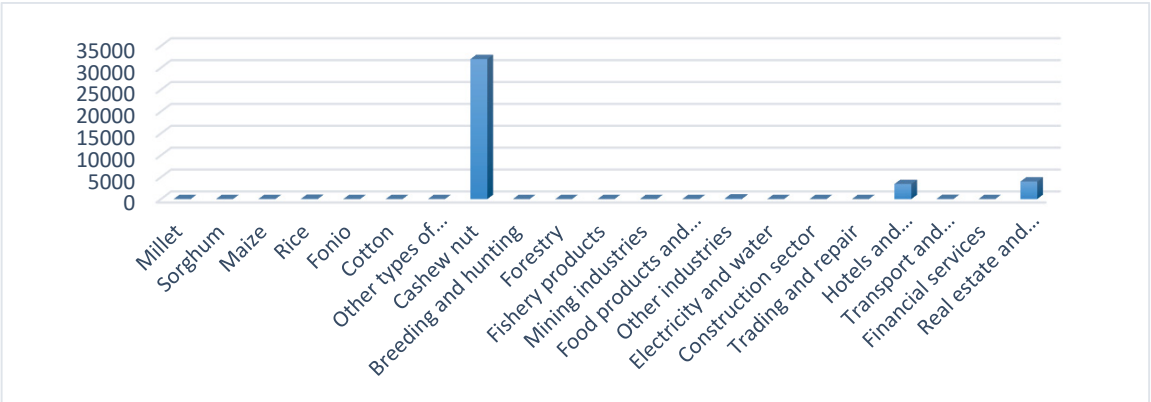
Table 6 - Tariffs on exports and imports (%) 2007

| Sector | Exports by destination | Imports by origin |
|---|---|---|
| Millet | 6.10 | 11.50 |
| Sorghum | 6.13 | 11.50 |
| Maize | 6.10 | 16.00 |
| Rice | 6.10 | 11.10 |
| Fonio | 6.10 | 7.00 |
| Cotton | 9.83 | 10.00 |
| Other types of agriculture | 7.67 | 11.50 |
| Cashew nut | 0.00 | 17.00 |
| Breeding and hunting | 6.10 | 11.20 |
| Forestry | 0.00 | 9.40 |
| Fishery products | 0.00 | 13.32 |
| Mining industries | 14.85 | 4.51 |
| Food products and beverages | 18.56 | 15.30 |
| Other industries | 14.45 | 10.07 |
| Electricity and water | 0.00 | 0.00 |
| Construction sector | 0.00 | 0.00 |
| Trading and repair | 0.00 | 0.00 |
| Hotels and restaurants | 0.00 | 0.00 |
| Transport and communications | 0.00 | 0.00 |
| Financial services | 0.00 | 0.00 |
| Services to firms | 0.00 | 6.00 |
| Public administration | 0.00 | 0.00 |

SOURCE: Authors' calculations. WTO data, 2017.

To perform the simulation, the tariff rate applied for all imported products in the 2001 (before the DDA) will be calculated. Details for shock sizes calculation was discussed in the section on the simulation strategy, after presenting the theoretical structure of the model.

FIGURE 5 – Export by product




SOURCE: Own elaboration. Social Account Matrix of Guinea-Bissau

The main exports of Guinea-Bissau are mostly raw materials, of which cashew nuts are the most representative (Figure 5). In general, the share of imports of goods and services in domestic GDP is higher than the exports one. In 2010, imports as a proportion of GDP was 31.90% and the following year rose to 34.66%, an increase of 2.76 points percent. In the same period, the export share was only 16.5%, which is equal to the average of the 1990s (WB, 2019), which has not diminished because the country has been exporting an average of more than 78,066 tons of cashew nuts each year since 1990.

## 2.4 PRODUCTIVITY ISSUES IN GUINEA-BISSAU

In order to promote the economic development and promote national and international trade as well as to be a competitive economy, it is imperative that the productive sectors of a country reach some level of productivity (Matsuyama, 1992; Gollin, Parente, and Rogerson, 2002). How sectoral productivity behaves in Guinea-Bissau? Is promoting productivity growth a feasible economic policy option to reduce national poverty?

A historical incursion into the country's development plans (NEDP) shows that the Guinean government sought to answer these questions through the first NEDP in the mid-1980s. The NED aimed to modernize the agricultural sector through the introduction of new equipment and large-scale production machinery with the purpose of increasing the industrial share in the total output composition. This program was supported by new public investment in expanding agricultural crops by introducing new seeds as to accelerate the occupation of the interior of the country, with the purpose for financing the expansion of local communities' production. The government also would create the interconnection between the agricultural and industrial sectors through the new agro-industrial processing companies.

Externally, the orientation is in line with the prevailing international trade development policies as this program aimed to boost the foreign country by opening possibilities for exporting products of greater value added to the rest of the world. The

funding sources came from raising public revenues from trade activities and taxation to the exporting enterprises, as already mentioned in the second chapter.

In the 1990s and early 2000s, the bilateral or multilateral trade was the focus of Guinea-Bissau's economic development policy. These policies include deepening economic openness, the entry into international organism such as the IMF, World Bank, WTO and the region's economic communities such as WAEMU, which resulted in the abandonment of Guinean at the expense of the current CFA Franco (CATEIA ET AL., 2018).

The recent NEDPs are more expansive than those of the 1980s and 1990s, because many of which are individual initiatives of some state institutions and do not necessarily fit into the broader national governmental plan. As mentioned in chapter two, it was only in 2015 that the government organized all these initiatives as a state macro program, in which incentive productivity came up after more than four decades following independence.

### 2.4.1 Infrastructure investment in Guinea-Bissau: terra ranka program

In 2015, the Guinea-Bissau government elaborated an ambitious development program called *Terra Ranka* (TR) reinforcing the need for the country to overcome the underdevelopment condition it faces through the construction and rehabilitation of infrastructures. The program addresses a set of short- and long-term measures, from 2015 to 2025, capable of providing adequate logistical and basic services to investors and citizens. It covers 23 areas and actions, 53 programs and 115 projects that promote industrialization and diversification of the national economy and transform the country into a competitive and stable one, job and wealth creator with food self-sufficiency and less poverty and social inequality.

The program was divided into five thematic axes, namely: Peace and Governance; Biodiversity and Natural Capital; Human Development; Business and Private Sector Development, and Infrastructure and Urban Development. In the social point of view, the main purpose is to place the country in the class of countries of intermediate income, able to offer opportunities to both national and international

investors. The expectation is that the country will reduce heavily poverty and social inequality. The Peace and good governance axis will be ensured through public investment for reform and modernization of the public administration; promotion of local peace using instruments to raise awareness of the population and the armed forces; reform in the Defense and Security sector with reintegration of the military; promotion of justice; reform of public finance management to ensure good macroeconomic management, and promotion of local development through decentralization and citizen participation.

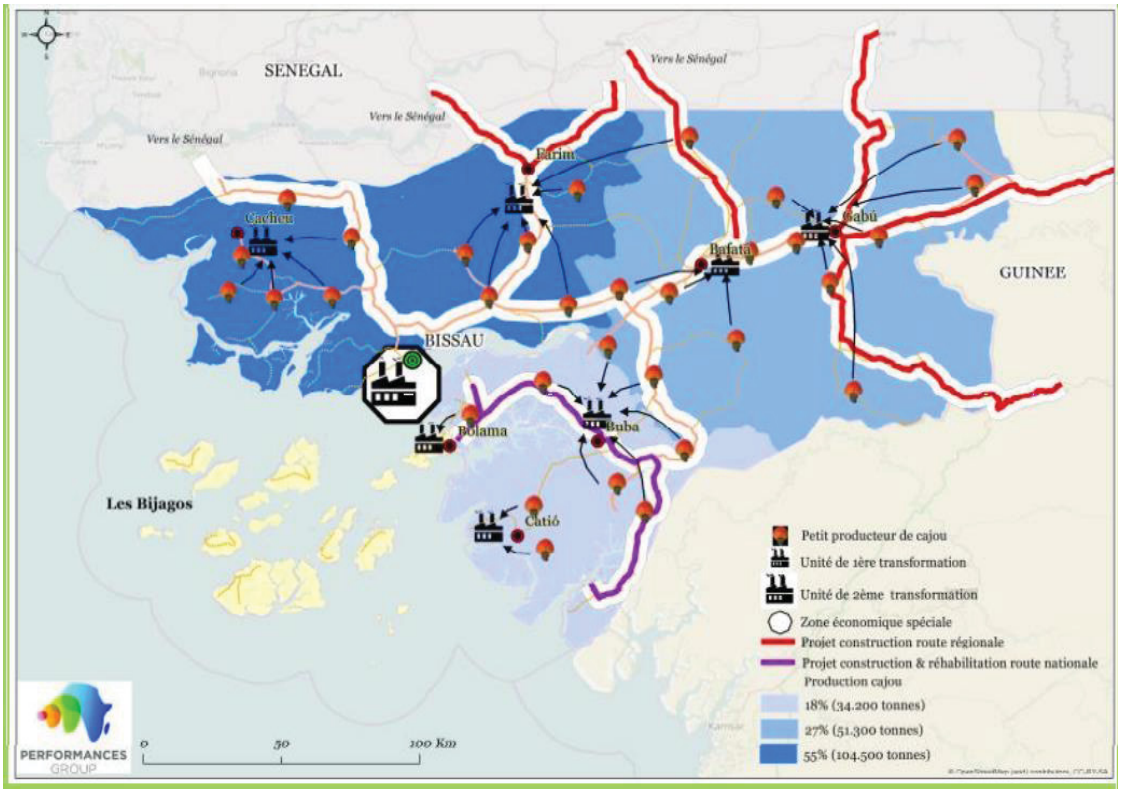
Biodiversity and Natural Capital axis aims to preserve and valorize in a sustainable manner the natural resources, establishing a normative and institutional framework to regulate human activities and promote the sustainable management of ecosystems with protection area that will increase from 13% to 26% (Guinea-Bissau, GB, 2015). Human development axis seeks to valorize the potential of the Guinean population, ensure the fulfillment of their basic needs, implement a social safety net and develop their skills, productivity and employability. The focus is on public investments for the education sector, which will be implemented through a 2015-2025 Education Director plan, but also investments in the health sector to create sectoral infrastructure, medicines and large endemics, creation of a social safety net to ensure the empowerment for underprivileged and promotion of culture and sport, especially for the youth.

The Business and Private Sector Development Scope aim to implement a good for private initiative. This involves undertaking business reforms with the development of standards and the creation of national laws for private investment and implementing integrated economic platforms with the creation of a Special Multi-Sectoral Economic Zone (SEZ) in Bissau.

Finally, the fifth axis is the Infrastructure and Urban Development one, which aims to provide the country with the logistic, energy, digital and urban and rural infrastructures necessary for its development. It focuses on four fields of action: (i) transport, where bottlenecks will be eliminated through rehabilitation of the port and urban roads, priority land routes and inland waterway shipping; (ii) energy and water resources, where it is a question of making an investment for the development of 90 Megawatts by 2020 and significantly improving access to drinking water and sewage; (iii). digital system, where

public capital will be placed to promote the transformation of the digital system that is expected to contribute to growth for the economy as a whole; and (iv) land management and urban development whose immediate objective is to renovate and build urban centers in order to provide them with infrastructures and functional systems and to establish them as epicenters of economic activity. This will be done through investments for the development of the Bolama-Bijagós Archipelago and seven main urban centers - Biombo, Cacheu, Farim, Bafatá, Gabu, Catió e Buba - in parallel with Bissau, which is the capital of the country, where several social housing will be built under the coordination of an urban development agency (see Figure 6).

FIGURE 6 – Regional distribution of infrastructure construction and rehabilitation




SOURCE: Guinea-Bissau Official Document (BG): Programa Terra Ranka, 2015.

2.4.1.1 Sectoral dimension of the program

Perhaps the main difference between the current program and other development programs created so far is its focus on a few macro sectors. In fact, its focus is on exploiting the comparative advantage of the country, through sectoral investment, improving the governance of public and private institutions as a tool for inclusion and social peace, and synergy among people with the available natural capital (GB, 2015). Investing in infrastructure that will increase productivity in the agricultural and agro-processing sectors was the way the government found to create complementary sectors to those of cashews nut that currently support the national economy.

The four macro-sectors are follows: agriculture and agroindustry, fishing, mining, and services. The first two involve basically the development of cashew and rice sectors. As the country currently captures less than 10% of the value added of cashew nuts, the Guinean government plans to quadruple gains from the export of this products (i) increasing the value of agricultural production by improving the quality of the nuts and its yields and by negotiating prices more effectively; (ii) locally transforming at least 30% of national production; and (iii) to promote the integration of the cashew nut sector into the commercial circuits of the most profitable markets. For the rice sector, the program intended to achieve self-sufficiency production by 2020 with a production of 450,000 tons compared to 200,000 in 2015, making the country the net exporter of this product in 2025, with a production exceeding 500,000 tons (GB, idem, p.15).

For the fishing sector, it is worth noting that, despite having the small continental territory, the country has a wide continental shelf and river resources. However, little has been done to inspect the maritime territory, which is estimated to have generated damages of a million of dollars proportions for the domestic economy. The program then defined as a priority to increase the maritime surveillance coverage in order to protect itself from illegal foreign fishing. Since artisanal and aquaculture processing activities are labor-intensive, the government intends to initially direct part of the budget for these activities and then to industrialize them by 2020 with the creation of the SEZ. The goal foreseen for 2025 is to produce 250,000 tons of seafood, to triple the sector's turnover and to create 100,000 direct and indirect jobs.

The spillover of fishing activities on the economy will be magnified by the productivity growth of the mining producing sectors, since the country is considered to

have a considerable stock of ores, such as bauxite and phosphate. The mining sector is environmentally sensitive and therefore its regulation is required before initiating any economically relevant activity. The TR intends to provide such regulatory institutional framework that meets the global requirements for the sector and start investing in the immediate exploitation of bauxite in Farim and Phosphate in the medium term.

The service sector, which essentially involves tourism, is one that TR favors. The investment in the services sector has a regional character and aims to promote the exploration of tourism in the islands of Bijagós with the idea of putting the country on the map of globally preferred destinations for ecotourism and sport fishing. Although nothing has been said about the job creation capacity that this sector could generate, the government believed that responsible ecosystem management will promote participatory and inclusive development as well as local communities flourishing, helping to reduce local poverty and income inequality (GUINÉ-BISSAU, 2015).

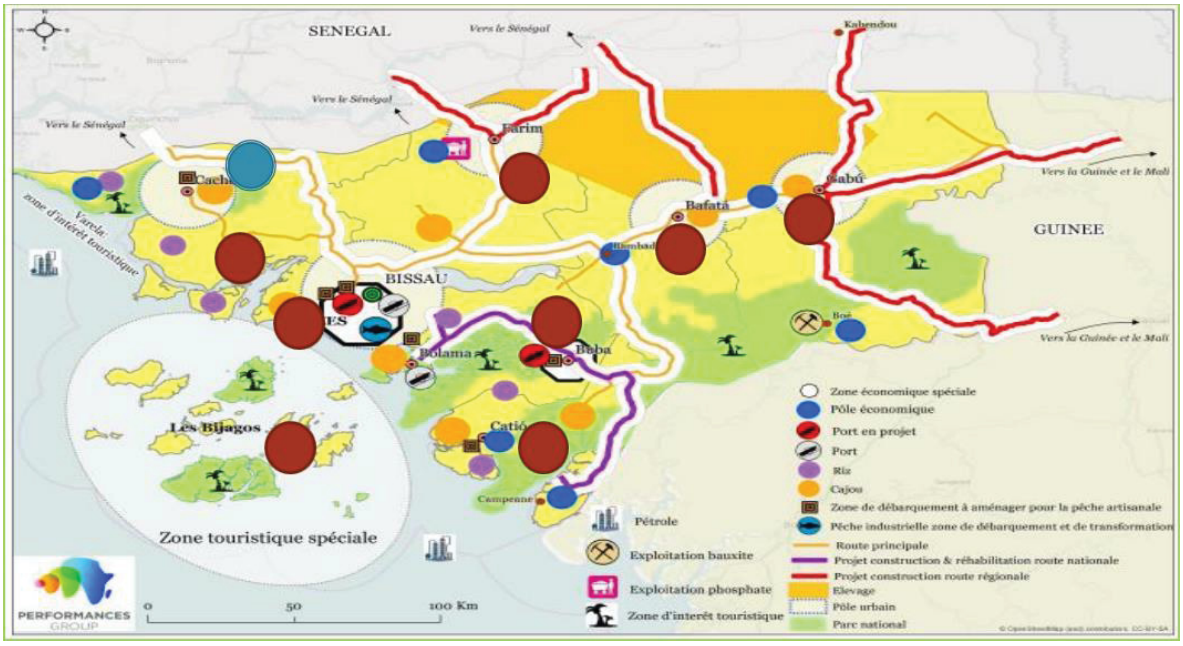
#### 2.4.1.2 Plans for 2025

A feature of Guinea-Bissau's economy, apart from cashew production, is the concentration of its economic activities and productive infrastructures around the Bissau city. This concentration has triggered the intense migratory process for this city as it weakens the important economic activities of the other regions. Therefore, decentralizing services and investing in the creation of new poles are ways that the TR found to encourage development with less regional income disparities. It is important to understand, however, that the intention here is not to insert regional inequality issues, instead is to show the new economic map of the country in 2025, which will imply in a decentralized development projected by the government as result of public capital investment. The analysis is made using as reference the same official document that describes the objectives of the *Programa Terra Ranka* that we quote to as Guiné-Bissau 2015.

Figure 7 shows the distribution of dynamic basins of economic activities, employment and urban life throughout the country as an expected result of this program.

There are nine main poles (brown balls) that will arise in the following regions: Archipelago Bolama-Bijagós, Bafatá, Biombo, Bissau, Buba, Catio, Cacheu, Farim, and Gabú. In 2025, each of these poles is expected to have its architecture and distinctive economic characteristics. The economic pole of Biombo will focus on agricultural production particularly the production of cashew and rice. In it, there will be an agro-industrial complex to transform the cashew nut into a higher added value product, creating opportunities for the emergence of related activities as well as employment. Biombo will be the host of large-scale local rice production so that the national self-sufficiency goals in food can be achieved by 2020.

Figure 7 - Map of the economic poles planned for 2025




SOURCE: GB, 2015, p.35.

Bissau will be a multisector SEZ, with the construction of the Port of Pekil and reconstruction of the International Airport of Bissau, Osvaldo Vieira Airport. For government, this city will become the economic, cultural, and administrative capital of the country, a function that it already plays. But now the ZES will host all agro-industrial (processing of agricultural products, such as cashew nuts) and other related activities, increasing the country's competitiveness vis-à-vis its neighbors. Its multisector focus will

be on building infrastructure and services that include energy, water, transportation, high-speed digital system and promotion and training services.

Executing the investments will allow Bolama-Bijagós to be a major tourist center dedicated to sustainable ecotourism and sport fishing. It is estimated 25,000 tourists by 2020 and 340,000 by 2025, who can comfortably accommodate themselves thanks to the MEd Club type hotels that will be built there and in the northern mainland of the country in the cities of Varela. In addition to a Special Tourist Zone with an agency dedicated to its management, the archipelago will also benefit from the integrated program of investment in the infrastructure of hotel, tourist, health services, security, transport, energy, and telecommunications. In particular, the government plans to increase capacity at Bubaque airport, which will receive regional flights. The former capital of Guinea Portuguesa, Bolama, in turn, will play an important economic role with the growth of tourism, artisanal fishing, cashew production and creation of new industry for processing agricultural production in general.

The economic pole of Cacheu will be object of development based on the utilization of the local agricultural potential, construction of shopping centers and industries of transformation. The public capital will be earmarked for the construction of a Cacheu-Farim-Casamance road linking the country to Senegal and Gambia.

The development of infrastructures and economic activities in the Oio region, as well as the intensification of intercontinental cross-border trade, will depend on the investments made for construct of Farim economic pole, a mining and commercial center. It will be born there two road corridors that will connect the region to a port that will be constructed specifically to export mining products.

Meanwhile, the pole of Bafatá is privileged by its geographical position to be situated in the east of the country, serving as a link between Bissau and east, on one side, and north and south, on the other one. The construction of logistics corridors that integrate the transport and trade networks of cashew nut and rice is then designed. The economic dynamics of the region will also be dependent on the advancement of water resources management projects, which aim to put the country on the map of sustainable development.

The construction of the logistic and agricultural pole in Gabu will allow the trade between Guinea-Bissau and Guinea, which today is derisory. It is precisely at the crossroads of the corridors linking the two countries where a regional trade in rice and cattle (the regional main economic activities) will be born, creating its own economic dynamism based on the food industry and service centers.

The economic pole of Catió belonging to the region of Tombali will be an agricultural, fishery and tourist pole. There the investments will be directed to increase rice production and yields in the pluvial and mange plains, which will enable the country to reach the projected objectives of food self-sufficiency. The public investments will be directed to the construction of infrastructure for the landing of artisanal fishing and the offer of ecotourism, which will generate employment for local pollution and alleviates local poverty.

Finally, the economic pole of Buba will emerge thanks to investments in the construction of a new and major port of export, the third after the ports of Pikil and Bissau. The country's international integration is expected to intensify with investments in that port because it will link the country with Senegal, Guinea, Mali and Côte d'Ivoire.

In short, it was shown that in post-independence the nature of the international integration of the Guinean economy was strongly influenced by the prevailing orientation and interpretation about the ideal economic model that the country could follow as to potentiate the economic gains in the sectors that it has comparative advantages. This strongly planned economy model did not work properly due to internal and external factors, such as the water crisis and low flows of external financing to the projects being developed, leading to the accomplishment of structural reforms in the mid-1986s when the country began to practice the competitive economy-based model. However, because of the low capacity of the state to create revenues, the projects that were created since the early 1990s are being supported by their international partners. Initiatives in the economic sphere having been thwarted by political-institutional instability that creates several restrictions on private initiatives. The participation of governments in the international negotiations may be relevant as to promote economy integration, but it also important to know the agreements implications as well as the infrastructure and

productivity effects on national socioeconomic outcomes. A useful tool for economic policy analysis is indeed the GE framework.

# 3 LITERATURE REVIEW

The governments of Guinea-Bissau have pursued an ambitious development policy based-on economy openness and developing of productive sectors as to increase the country's comparative advantage. The purpose of this chapter is to review the economic literature on these subjects. The chapter is divided into three sections, the first analyzing the trade liberalization literature, the other the productivity and finally the literature on the infrastructure investment.

## 3.1 TRADE LIBERALIZATION

### 3.1.1 Related literature

The conventional economic theory argues that fewer trade restrictions can accelerate the development of poor countries (Bhagwati 1965). This is because trade liberalization can reduce trade cost (Portugal-Perez and Wilson 2012) and increase exports (Iwanow and Kirkpatrick 2007; Coşar and Fajgelbaum 2016). The resources obtained through positive trade balance can be used for various development purposes, such as to fight against poverty (Ju, Wu, and Li 2010). Policymakers are then advised to adopt trade facilitating measures. They seem to be doing that, since the expansion of world trade by 146 per cent between 1960 and 2017 would have been their response in using such available facilitating mechanisms, thus a clear example of why open economies is preferable (WTO 2015).

Trade liberalization can also affect the development of a country because it impacts national comparative advantages (Bernard and Jensen, 1999; Bernard and Wagner, 2001). For instance, in the Melitz (see Melitz, 2003) trade-type model, trade shock, which induces competition among firms for scarce labor, causes real wages to be increased by relatively more productive firms. Such firms can enter export markets and thus be able to expand production. Therefore, promoting productivity growth is one way of increasing the export opportunity while trade liberalization can increase the firms'

growth productivity. Therefore, trade and productivity affect each other, and both can be affected by the same factors.

The present study fits into the context of economic literature that assesses socioeconomic impacts of trade liberalization by taking the labor market as the primary propagation channel (Dutt *el al*. 2009; Amiti and Cameron 2012), essentially applied studies for developing economies that use dynamic recursive CGE approach such as that of Chitiga and Mabugu (2008) for South Africa. The experiment of this literature consists of designing various economic opening policies scenarios and verifying which one contributes to the improvement of the households welfare, in terms of income and consumption gains, or in terms of income inequality reduction, using inequality measures, such as the Gini Index.

The theory seeks to capture the short, medium, or long-term outcomes of these scenarios by establishing a series of causal relationships provided by the open framework of a consistent CGE model. Although its short and medium-term effects depend on the context, in the long run, trade liberalization is expected to contribute to economic growth and the reduction of income inequality. Possible negative short-term impacts are related to the delay in contracts renegotiation and, more generally, to relative price readjustments. In such a situation, economic theory predicts that cuts in a country's tariffs, for example, tend to trigger relative price changes unfavorable to its economy (WTO 2001).

This is the result explained by the inverse relationship between demand and price. The domestic demand for imports, for example, is a function of the price of the imported good in the domestic market and this price is the sum of the international price and the tariff that acts as an addition to the cost of transportation. Thus, the reduction in the tariff will lead to a decrease in the domestic price of the imported goods (see Rutherford and Paltsev, 1999), which increases the demand for imports. For countries that export only a small proportion of their production, demanding more imports can generate negative external savings and an increase in foreign indebtedness.

By analyzing the effect of the openness because of the increase in the number of foreign competitors caused by the reduction of tariffs arising from trade agreements, Bittencourt *et al.* (2008), find that, for Brazil, unilateral liberalization generated a real trade-off between aggregate welfare gains and losses for low-income households in urban

areas. Therefore, according to Kis-Katos and Sparrow (2015), short and medium-term implications of trade liberalization in labor market are context-specific. They depend on several factors such as the previous protection structure to regional market access as well as the degree of market flexibility (see also BITTENCOURT 2004; GOLDBERG and PAVCNIK 2005; AMITI and KONINGS 2007; CHIQUIAR 2008, LEE and WIE 2015).

However, as domestic production is carried out by combining inputs from different sources, basically national and imported, the decrease in import prices means that economic activities are using more composite goods as intermediate inputs in the production process. If taxes, endowments and offer prices remain unchanged, the firm's production will increase, as well as its profit. The firm will hire workers and, consequently, income and household consumption will rise. The increase in demand for total production will increase the offer price and the firm will also win. Industries should increase their production if the weight of the foreign commodity in the composite good is greater than the weight of the domestic one. If this is case, the sector should demand more workers and capital.

The increased demand for primary factors is expected to increase its price, assuming that each factor is remunerated according to its marginal productivity. But what types of workers can benefit most from trade liberalization is an issue under investigation. What is expected is that the increase in household income and the decrease in prices of imported goods will increase household consumption. Therefore, for developing countries, trade liberalization might be a feasible way that leads to the redistribution of wealth and increases aggregate welfare in the long-term.

There is growing body of empirical literature analyzing the effect of trade liberalization through import tariff cuts. For instance, in their study for Ethiopia, Aredo *et al.* (2012) noted that liberalization resulted in a decline in economy output as well as in poverty in the short term, but it has benefited more farming agriculture sector. They also observed an increase in import volume while exports slightly increase, as it was in our results for the food sector. In the same direction, Chitinga *et al.* (2005) for Zimbabwe find also strong evidence of general decreasing in poverty and inequality due to trade liberalization.

Several studies, however, find ambiguous results of trade reform including Decaluwé *et al* (2008) or Aka (2006) for Benin or Ivory Coast, respectively. In particular, Nwafor *et al*. (2007) for Nigeria show a weak short term but a strong long-term increase in poverty resulting from trade liberalization. This contrasts the Annabi *et al* (2005) findings. Using a dynamic CGE model for Senegal, they show that, in the long-term, trade liberalization increases capital accumulation, leading to significant increases in welfare and decreases in poverty, although the effects are greatest for urban and non-poor households. Durongkaveroj (2014) applies the same methodology to simulate free trade policy effects on the Thailand economy, and they showed that removing tariffs increases the national prosperity.

Meanwhile, export taxes work as an important source of government revenue in many developing countries, particularly those with agricultural-based economies like Guinea-Bissau. In fact, many countries incorporate export taxes as an important element of their trade policy and use them as a strategic industrial policy strategy, as well as to overcome domestic economic crises (Ruta and Venables, 2012). According to Solleder (2013), the rise of export taxes relative to other trade policy measures may be explained by a lack of discipline on export taxes in the WTO law. GATT in its article XI stipulates only that export should not be subject to quantitative restrictions, but does not determine any obligation on the maximum level of export taxes defined, which makes countries take advantage of this loophole by using these taxes as restrictions on exports of raw materials.

According to a small group but of prominent economists, current trade policies, including export taxes, are inefficient suggesting that mutual gains are possible upon coordinated policy reforms (see Ruta and Venables, 2012). Our two policy scenarios, however, show that both negative shocks in import tariffs and export taxes bring long-term gains to households, the results that are in line with the standard literature that emphasizes trade gains with openness (Grossman, 1980; Staiger and Alan, 2010).

However, while it predicts these gains, trade literature discusses whether lowering import tariffs and cutting export taxes would have the same implications for economic outcomes. The Lerner Symmetry Theorem (Lerner, 1936) states that, under some conditions, import tariffs and export tax have the same effect on the economy. Note that this equivalence between the two types of taxes, however, does not imply that openness

by reducing subsidies and export and import taxes is equivalent (see Casas, 1991). According to Costinot and Werning (2017), the Lerner Symmetry Theorem can be thought as one establishing an important starting point for a broad understanding of tax neutrality in integrated economies. This is because by establishing the equivalence between import tariffs and export taxes, it has as a corollary the neutrality of any tax reform that would increase import tariffs and export subsidies by the same amount, and vice-versa.

## 3.2 SOME STUDIES ON PRODUCTIVITY SOCIOECONOMIC EFFECTS

Standard economics theory associates different socioeconomic benefits with productivity growth. A non-neutral-Hicks technical change, or productivity growth, implies decrease in the labor per unit of sector product. As an economy grows due the productivity improvements, the marginal product of labor must increase as well as the real wage. However, the increase in the marginal product of labor that means that few units of labor input are required to obtain the same or more products (weather with constant or increasing returns to scale) implies that the aggregate labor factor demand is declining, and unemployment should increase in the short-run (Hanson and Rose, 1997).

By representing efficiency in productive and organizational processes, their sectoral impact may also be immediate and perennial. Helpman, Itskhoki and Redding (2008) use GE framework to show that workers with the same characteristics, receiving the same expected *ex-ante* income, will have different *ex post* income depending on the sector they work in. Intuitively the wages inequality depends on productivity parameter value. The productivity growth leads to the displacement of the Lorenz curve upwards, and so reduces sector wage inequality. Therefore, for them the distinguishing characteristic of firms with greater productivity dispersion is that they generate greater inequality in the distribution of wages. In aggregate terms, income inequality is predicted to be higher in sectors with higher search costs and screening costs.

Over long term, however, it is expected that the adjustments in factor markets will lead to the primary factors, labor-capital, substitution towards full employment that reduce the initial negative impact on employment and real wide-wage. Thus, decreasing payroll pressure will benefit firms because it means that production costs are falling. The firms

can expand their output, at a low supply price, which in turn increases demand for labor and capital, leashing a kind of Darwinian evolution within economy on the supply and demand sides as follows. When faced with lower production costs, the firm has a financial structure that enables it to demand more capital and expand the production, which will beneficiate the production of other firms. As the price decreases, consumers with different incomes and consumption patterns can now access commodities that being sold at a lower supply price, which increases aggregate demand (Melitz and Gianmarco, 200).

The relationship between productivity and other socioeconomic variables is assessed from different theoretic and empirical framework. For instance, at micro level Melitz (2003) trade-type model with heterogeneity of firms is the most widely used approach to integrated trade to productivity or vice-versa. Through GE theoretical structure, although with imperfect competition (Melitz and Gianmarco, 2008), the model predicts that firm profit depends on the sunk cost that incurs in the export market and the proportion earned in the domestic market. Total profit is limited by some threshold productivity level. With trade openness, the entry of new firms makes that all firms incur a loss in domestic market share. Those that export more than the loss of domestic share increase their total revenue and industry revenue share, but non-exporters incur a total revenue loss. This process within an industry described by Melitz can be summarized as: the most efficient and technology-intensive firms, i.e., the most productive ones, grow and acquire more financial capacity; they can sell their production abroad and increase profits and market share. Some of the less efficient firms can still export and increase their market share but lose profits. Another part (the less productive firms) can still remain in the industry but can no longer export, which generates loss in both market share and profits, because they do not match the market condition, and then they are forced to exit (MELITZ, 2003, p.1714).

In short, if productivity growth implies a larger number of firms exporting more products, the economy's aggregate output should rise. Growing economies can finance different development projects including those aimed at reducing the poverty level. Increases in total productivity can reduce poverty through multiple transmission channels. However, we address only three of these paths, which are economic activities, income changes, and employment generation.

It worth emphasizing that if the increase in total factor productivity implies higher wage rates and capital prices, it is not clear the quantity of labor and capital to be employed. However, if productivity growth results in lower production costs, the result will be an economy that grows thanks to higher production volume. Bravo-Ortega and Lederman (2005) find that agricultural labor productivity has a significant effect on the average income of the first income quintile (the poorest) and this relationship is consistent across regions. A recent Bureau of Labor Statistics (BLS) report shows that as production increased by 1.9% and hours worked decreased by 0.4%, the nonfarm business sector labor productivity increased by 2.3 percent in the second quarter of 2019 (BLS, 2019).

In the specific case of household-level gains from changing agricultures sectors output parameters, it is noted that as such sectors increase their output, a range of gains for poor households may surface. First, because poor people are net food consumers, increasing farm productivity will drive relative prices down, implying in an increase in their consumption. Second, poor households will be able to release their income for other expenses, including for consumption of other goods. It is precisely this income effect that will change their position in the long run. The Datt and Ravallion (1998) findings for India support these propositions. In fact, they observed that poor households' share in productivity gains shifted to a positive scale, and that their relative position improved as a result of growing agricultural production.

Janvry and Sadoulet (2010) also have a lot to say about the subject. In their cross-regions study, they observed several micro outcomes associated with increased agricultural yields: (a) the persistent fall in rural poverty is associated with both increased agricultural income as well as labor productivity; (b) the depth of poverty reduction depends on the region; (c) poverty reduction occurred not only due to relative price changes but also due to the linkage power of agriculture sector with other sectors of the economy; and (d) the rural area is responsible for the fall in poverty, although the share of the fall in urban poverty is not negligible.

Impact of increased production on labor demand depends on the intensity of labor use by the sector. If output from the agricultural sector (rice and millet, for example) is increasing, it is expected that demand by rural workers will also increase as well as their labor income. In this case, Loayza and Raddatz (2010) draw attention to the importance

of the composition of growth when the analysis focuses on the labor market. In a cross-country study, they observed that it is not just the size of growth that matters for poverty reduction for sectors that are intensive in the use of unskilled labor, such as agriculture and construction.

In agricultural based-economies, as sector productivity grows, the pro-poor development process is being promoted in both rural and urban areas (Thirtle *et al*., 2001).This is because agricultural output growth will increase the incomes of the poorest rural households, increasing the demand for goods and services that are produced outside the rural environment (Mellor 1999). As the demand for urban production increases, the urban household incomes also must increase, which should increase the aggregate demand in the economy.

As a result, the households' incomes will be at higher level, so that they can use them to meet their basic needs including to invest in their children's education and to buy health products and services. The increase in comparative advantage is the result of the assertion that productivity has generated greater production, which has translated into higher income for the country, either through international trade or through increased opportunities for citizens.

## 3.3 INFRASTRUCTURE INVESTMENT

The discussion on potential effects of public investments in infrastructure on the private sector output is widely spread and goes back to seminal studies of Aschauer (1989a), Munnell (1990a). Subsequently Munnell (1990b), Holtz-Eakin (1992), Nadiri and Mamuneas (1994), and Wolff (1996) show positive impact of such investments on economic growth. Particularly, considering the role of government spending in long-term movements in productivity, Aschauer (1989b) associated the general decline in the rate of productivity growth that emerged in the early 1970s in the United States with the decline in federal productive government services.

Thus, the low standard of living in developing countries may be reflecting the precariousness of their domestic infrastructures which causes low productivity. This argument is reinforced by the Munnell (1990a)'s findings , for whom productivity growth is

the major determinants of the future standard of living and, as a rule of thumb, people can expect their real wages and their standards of living to double within a generation as a result of the a 2.5% increase in efficient use of resources.

Subsequent to these seminal studies, several empirical studies assess the implications of public investments in infrastructure on productivity and the implications this for the population living standard. These works generated debates, not only in the academic field, but among policy makers and international institutions that recommend good practice in the execution of large and money-intensive projects.

The debate among academics involved those who believe in the positive externalities of infrastructure calling for attention to the lagged adjustment that involves large-scale investments, and those who are skeptic to this practice. While the first ones trust their respective findings, the latter tend to focus essentially on the methodological question where macro and micro effects of infrastructure are explicitly addressed.

Studies that confirmed positive effects of public investments place the infrastructure as the main transmission channel. They point out that infrastructure availability creates production facilities and stimulates economic growth (Romp and de Haan, 2005; Sahoo, Dash, and Nataraj, 2010; Warner, 2014). Direct effects operate through the factors market: in an economy where both primary factors are required for production, as public capital invested in infrastructure grows, it must increase the productivity of other productive inputs, such as private capital and labor. Productivity growth means that a higher product is being obtained with the same amount of inputs, at lower production costs, which must increase aggregate product, with greater intensity for low-income countries than for rich ones, given decreasing return to scale. Labor income should increase as well as households' consumption.

Therefore, there is a complementary assumption between public investment, rather than eviction, that justifies why, in recession period, several governments invest in building infrastructure to leverage their economies. According to Keynesian approach, in a situation of underemployment, the private investment can go up rather than down when agents realize that that the government is investing to improve domestic infrastructure (AGÉNOR AND MORENO-DODSON, 2006).

Indirect socioeconomic effects of public investment are varied and involve a range of sectors, including health and education. For instance, experimental health economics literature has reporting that individuals with higher incomes can invest in their health and in the health of their children (Agénor and Moreno-Dodson, 2006). Given that households' income come from the work they do and as it depends on productivity, with public capital goods availability, individuals with best health condition tends to have higher job returns (that is, magnification effects of health). Citizens of rich countries are supposed to be healthier because their governments invest more in health, through capital goods, social protection, social capital, and they can prevent diseases (Deaton, 2003).

A recent body of literature in this area has examined impact of health on productivity. Dupas and Miguel (2016) bring a compendium of such empirical and theoretical studies. They show that investments in iron consumption increase labor productivity as well as working probability of men and women by 3 and 5%, respectively. In their study on nutrition status and expenditure in rural Maharashtra in India, Subramanian and Deaton (1996) estimates show that the elasticity of caloric intake with respect to total expenditure is 0.3-0.5, and that the calories required for one-day activity is around 5% of the salary daily. The fact is that health capital availability tends to change the demand for health (Grossman, Michael. 1972; Cohen, Jessica, and Dupas, 2008; Dupas, 2009 and 2011a) and, according to this literature, sick individual stays at home in Africa because there are no hospital infrastructures for accommodate them. They often also report that the price elasticity of demand for health goods and services is different from zero and that therefore the increase in the disposability of health infrastructure can generate a significant change in the demand for such goods and services.

Meanwhile, the magnification effect of education is that education returns are high and that there is high correlation between levels of education and productivity. Therefore, public investment that increase productivity is expected to affect the education of citizens, since individuals can also use income from an increased productivity to invest in the education of their children. Moreover, construction of a new infrastructure itself (technology, transport, and the road condition) influences the school attendance rate, learning environment and students' outcomes (Earthman, 2004; Miguel and Kremer, 2004). In an academic test, students may have different scores depending of the

conditions of infrastructure of their schools. For instance, after controlling for socioeconomic status, Earthman (2004) brings the evidence showing that scores of students in poor buildings in Maryland are 10% lower than those in the best building. In this same line, Agénor and Moreno-Dodson (2006, p.13) point out that after rural roads were built in the Philippines, school enrollment increased by 10% and dropout rates fell by 55%.

Infrastructure also contributes to poverty reduction. With the implementation of the infrastructure investment project, several direct and indirect jobs vacancies must be announced in recruitment agencies and many workers are being called for interview, with a significant portion being effectively hired for employment. With higher numbers of citizens being employed, including the poorest ones, households' real income should increase, as well as their consumption, a trigger for warming aggregate demand. Thus, practical implications of infrastructure on household living standards have also been the object of empirical evaluation. For example, Ogun (2010 reports that rural poverty has decreased in Nigeria as a result of public investment in infrastructure. Moreover, access to basic sanitation infrastructure and clean water may reduce mortality in developing countries (NEWMAN *ETAL*.; 2002; LAVECCHIA and OREOPOULOS, 2014; DUFLO ET AL., 2015).

Another link in this chain states that infrastructure availability affects bilateral trade of a country, since each new road built can imply in good clearance, as traders can use it to transport their commodities from producers to the port of shipment. This is recent in economic theory of trade and it was during the 1996 WTO Ministerial Conference in Singapore that WTO members conducted new trade relationships in which it was recognized that in addition to liberalization within a rules-based system, such as the reduction of tariff barriers accentuated by regional trade agreements, the trade facilitation is essential to reduce the costs of trade, to increase output, and to create more jobs in many countries. Thus, as transportation and trade services depend on the availability and quality of infrastructure, the removal of infrastructure bottlenecks contributes to growth (ESTACHE, FOSTER, and WODON, 2002).

However, subsequently some authors (see Garcia-Mila and McGuire, 1992; Holtz-Eakin, 1994; Morrison and Schwartz, 1996; Garcia-Milà, McGuire and Porter, 1996)

are skeptical of the potential of the infrastructure in promote economic development, generating a mix of evidences provided by applied economists. The later literature tends to look in the background at some econometric questions of identifying the effect of the infrastructure and how the specificities of the entities can radically change the magnitude and the simulated parameters. Just as better infrastructure quality can drive growth, countries with a growing economy can use their income to invest in infrastructure improvement through the expansion of new roads, ports, and so on. That is, there is a reverse causality or endogeneity between infrastructure and economic growth. Moreover, for the neoclassical approach, unlike the Keynesian approach, there is crowding out of private investments, since public investments can raise interest rates and shift private investments to nonproductive assets (Fatás and Mihov, 2001; Blanchard and Perotti, 2002).

Further studies in these issues were accomplished, which until the 2000s involved the construction of new theoretical and empirical models used for estimation. Gramlich (1994), Sturm, Kuper, and Haan (1998) and more recently Romp and Haan (2005) carry out surveys about these models that are used to evaluate the socioeconomic effects of the infrastructure. In its survey, Ayogu (2007) concluded that the question that should be asked is not whether infrastructure really matters, but how it should be more important in different contexts. Gramlich, particularly, emphasizes the difficulties involving identifying the transmission channels of infrastructure on economic growth. So, while Devarajan, Swaroop, and Zou (1996) point out that, holding global government spending constant, if the initial share of spending on capital expenditures is too high, as it is expected to be in developed countries, increasing government expenditures tends to lower the economy long run growth rate.

Canning and Pedroni (2004) perform a study of the consequences of infrastructure provision on per capita income in pairs of countries and provide evidence that in most cases investment in infrastructure stimulates long run growth. Calderon and Serven (2010) also show a positive correlation of 0.35 between GDP annual growth and indices of infrastructure quantity in African countries, but Oseni (2012) argues that, while infrastructure may promote economic growth, it has no effect on agricultural sector.

For Ndulu (2006), one of the main challenges of sub-Saharan African countries is to find mechanisms to accelerate their economic growth, and that infrastructure and regional integration may be two potential mechanisms that can help foster stronger economic growth in this region. By analyzing long-term trends in the development of South Africa's economic infrastructure and its relationship with the country's long-term economic growth, Perkins, Fedderke, and Luiz (2005) reported positive relationship between the two variables, that is, infrastructure is important to support economic activity in a growing economy.

Due to the different channels of transmission and difficulty in capturing their indirect effects, some authors tend to focus on investment in social infrastructure, essentially in the health and education sectors. This literature argues that a $ 1 spent on public health and education will be more effective in reducing poverty than putting that money, for example, for road construction (Jerome and Ariyo, 2004, Jahan and McCleery, 2005).

Practical implications of infrastructure on household living standards have also been the object of empirical evaluation. For example, Ogun (2010) brings evidence showing rural poverty reduction in Nigeria as a result of public investment in infrastructure. Moreover, access to basic sanitation infrastructure and clean water may reduce mortality in developing countries (Newman *et al*.; 2002; Lavecchia and Oreopoulos, 2014; Duflo et al., 2015)

In short, that public investment for creating basic infrastructural facilities (highways, railways, ports, and so on) encourages private enterprise is what show the results of Aschauer (1989) and Erden and Holcombe (2005) works, among others. These studies that are based on complementary hypothesis of the two types of investments, however, are recurrently confronted with the crowding out hypothesis (COH) for which an increase in public investment may lead to a decrease in private investment. According to COH defenders, the most important question under investigation is not just whether public investment will increase aggregate demand, which should in fact increase in many contexts, but how the different available instruments for financing a public expenditure influence private agent’s decision. They argue that public investment will increase interest rate and that if government decides to finance its spending through taxation it is expected

private investments to reduce, even in the short term. Recent evidences for this hypothesis were provided by Cavallo and Daude (2011) and Everhart and Sumlinski (2001), among others. However, Moreno-Dodson (2006) point out that, if intra-temporal elasticity of substitution between domestic and imported goods is low, the real exchange rate decrease will generate a positive net effect on domestic product by resulting in a long-term growth, eliminating short-term crowding out effects that could displace private investment and may even inhibit growth over time.

In short, the recent infrastructure economics application and the results that are generated have to do with the refinement given to the methods that best report the results, ranging from the choice of the functional form to the details of econometric methods relevant to the context. Authors, such as Gu and Macdonald (2009), resort to a dual approach to estimating the effects of public capital on production, since earlier studies by Aschauer (1989) used primal approach, which allowed only estimating the production function to deduce the contribution of public capital in terms of output in the economy (JOANIS, 2017, p.192).

The methodology we have chosen to analyze productivity effects from the construction of new roads, for example, is the computable general equilibrium (CGE) framework as proposed by Savard and Adjovi (1998) and Savard (2010), who first introduced the positive externalities associated to the public investment in infrastructure into CGEs models. This approach was later adopted by Boccanfuso *et al.* (2014) to analyze the effects of public investments in the Quebec economy, and Estache, Perrault and Savard (2012) for selected countries in sub-Saharan Africa.

In this line, some authors have sought to answer several questions using CGE framework and they have reporting results that help policymakers to make important decisions. For example, Sangare and Maisonnave (2018) show that, for the case of Niger, if government uses part of its revenue to invest in the construction of road infrastructure, GDP should increase in the long run and unemployment should fall even in the short run. Indeed, the key for using public funds is their response to productivity and supply. For Go et al. (2016), if governments choose to fund their spending using only the interest earned on revenue in a sovereign wealth fund, socio-economic benefits are guaranteed.

Through its micro-simulated GCE model for South Africa, Chitiga (2016) found that as the government uses its revenues to build new infrastructure, unemployment decreases in all occupations, even though it has only decreased in low pay occupations in the short term. This is an interesting matter, because what is expected from an investment program is its result in the adjustment of several model variables in the medium and long term, that is, over time. Looking at short-term effects, however, may be important in redistributing available investment funds, including those for income inequality reduction among.

It is also worth emphasizing that, within this GCE literature, while several studies report the potential of public investments in improving the condition of the poor, many others show the poor were harmed as a result of these policies (see, for example, Jung and Thorbecke, 2003; Adam and Bevan, 2006; Wiebelt et al., 2011; Schürenberg-Frosch, 2014). But in their study for Iran economy, Arman et al. (2015), show that investment in roads can affect household's welfare more than other infrastructure expansions, while Soumaila (2015) suggests that there is a complementary effect between investments in education and infrastructure in Uganda.

## 4 CGE MODELS AS TOOLS FOR DEVELOPMENT POLICIES

Although the general equilibrium (GE) theory is considered to trace its direct origin in the theory of value of the classic economists (see DELPIAZZO, 2011), it is widely recognized that it was with Léon Walras that this theory was effectively considered a central sub-field within the economic theory. The Walras' GE theory explains the behavior of demand and supply (agents' behavior) in competitive markets. This behavior can eventually lead to the supply and demand excesses in each market, but these excesses are automatically eliminated by the movement of the relative price vectors that lead all markets to be in equilibrium simultaneously.

Later, Walras' theory was expanded by Kenneth Arrow and Gerard Debreu. In their works, Debreu (1954, 1959) and Arrow (1971) demonstrated the existence and stability of equilibrium for a competitive economy without any loss of generality (Duffie and Sonnenschein, 1989). However, these studies were general, abstract, and rigorous and did not worry about performing the numerical analysis (HOSOE, 2010).

The link between theory and applied models to policies evaluation was conceived by Scarf (1967b, 1973) and according to Shoven and Whaley (1992) the pioneering computable General Equilibrium Models (CGE) were developed by Johansen (1960). Since then CGE has become one of the most used tools in empirical analysis (Shoven and Whalley, 1973, 1984, 1992; Taylor and Black, 1974; Whalley, 1975; Harris, 1984; De Melo 1988; Despotakis and Fisher, 1988; Pereira and Shoven. 1988; Conrad and Schroder. 1993; Nestor and Pasurka Jr, 1995; Waters et al., 1997; Taylor and Arnim, 2007; Liu et al. 2017).

Deterministic mathematical models are said to have a general equilibrium structure since they are designed to represent an economy in which it is possible to achieve equilibrium for all markets via supposedly flexible price mechanisms and are computable because they aim to establish a numerical structure for empirical analysis and evaluation of relevant economic policies (CARDERNETE, GUERRA and SANCHO, 2012).

CGE models can also be broadly defined as economic models that clearly show how policy initiatives in an integrated world through trade provoke substantial adjustments

of the different patterns of production and consumption in an open economy. In such a world, national policies are highly subject to external shocks, such as changes of terms of trade or international prices that may change the direction and size of policy effects (BÖHRINGER and LÖSCHEL, 2006).

Domingues (2002) argues that the nature of explicit representation of the CGE models has very important methodological implications when compared to partial equilibrium ones. First, the CGE approach allows analyzing interconnections between sectors, so that exogenous shocks in one sector can have direct impacts in that sector and indirect impacts in other sectors. As analysis using the partial equilibrium tool allows to investigate only the direct impacts, CGE models has the advantage of enabling policymakers to better understand the effects of sector policies in both industry level and economy as a whole. Second, CGE has an open framework that allows to analyze either specific-sectors or region features by introducing corresponding modules that take them into account. For instance, a CGE model that assesses the effects of deforestation on major macroeconomic aggregates and sector outcomes tends to require data, mainly on the return of the land factor (see, for example, Carvalho, Magalhães, and Domingues, 2016). Such data are incorporated on a more comprehensive basis with information on the flows of payments and receipts from other institutions and factors that are used for the proposed simulation. Third, a CGE model also can incorporate important insight from other studies into its general structure and specification.

Devarajan and Robinson (2013) classify CGE models applied to development policies into two categories: analytic to applied and reduced form to deep structural. The analytic models are theoretical models that can be solved mathematically, whereas the applied models are the complex ones that can only be solved numerically. The former establishes relationships between the several variables and tries to find out the optimal walrasian GE solution by defining a vector of endogenous prices for which all competitive markets are simultaneously in equilibrium. Models numerically solved incorporate institutional features of a given country or region and provide quantitative results of the policy implications.

The procedure by which the researcher relates economic theory to the structure of the model is called reduced form to deep structural. The term reduced form is an

analogy to the term known by econometricians by reduced equations from a simultaneous equations system. This system is economically grounded, but the reduction procedure generates the loss of important parameters to be estimated, which significantly takes it away from economic theory. Deep structural refers to the CGE models designed to generate a solution of an economic model formed by a system of demand and supply equations to private sector agents, typically labeled consumers and firms.

In practice, CGE models are considered to be very important since they embed policies instruments into its structure and can be used to understand the mechanisms through which these policies affect relative prices; however, the contribution of the simulated results goes beyond those of the instruments that form the CGE models. Essentially Devarajan and Robinson (2013, p.282) classify such CGE models relevance issues in terms of nature of the equilibrium and domain of their application.

The nature of equilibrium is linked to the intertemporal aspects of dynamic adjustment that characterize an applied GE model. There are three major CGE models' classes dealing with these aspects: The standard static equilibrium approach, intertemporal dynamic equilibrium approach, and recursive sequence equilibrium approach (see Mohora, 2010).

The static CGE model incorporates only one period Walras' equilibria and no capital accumulation is considered. It is used for comparative static analyses typically with short- and long-term closures. The static pattern includes the fact that this approach specifies a CGE model such that agents make their consumption and savings, or investment decisions based only on the information they have in the period that occurs, for instance, tax policies. Previous and future information on government behavior is not taken into account, i.e., nothing matters beyond what is observed in the current period. Early static models include those developed by Shoven and Whalley (1972) and Dervis, De Melo and Robinson (1982). Lofgren et al. (2002) provide a more recent version of these CGE models.

However, there are so many common criticisms of the static approach, as well summarized by Devarajan and Go (1998). The first concerns the analytic inconsistency of static CGE models: Agents' allocation decisions happen only within-period, but not between, because they are myopic and thus no longer optimize when confront between-

period decisions. Second, they do not incorporate explicitly developing country features and many of the questions they were designed to answer were fully dynamic ones. Such questions involve, for instance, tariff cuts policy that have a different impact on the sectors of an economy over time. As the capital stock is exogenous, raising the capital import tariff may decrease investment, but the welfare level remains unchanged (Dahl, Devarajan, and Panagariya, 1994). Another limitation is, as long as it does not incorporate wealth accumulation, the static CGE models capture only statics gains from trade liberalization, rather than dynamic gains.

Two dynamic models are built as alternatives to static ones. The forward-looking dynamic CGE models incorporate neoclassical growth theory à la Romer (1986; 1990; 1994) and Grossman and Helpman (1994); Diao et al. (1996) developed one of its earliest versions. In this approach, the agents' choices are also guided by an optimizing behavior, but instead of maximizing or minimizing only within period, they adopt life cycle-type behavior making perfect predictions about relevant events they may face. The models then describe transition path from an earlier equilibrium to the new equilibrium point. Mohora (2006) argues that this approach, however, are little used for policy debates in developing countries because they are highly stylized due to the model solution for equations defined over the entire time horizon carried out at once increases their computational costs, and they require statistical information that are often not available in a developing country.

Meanwhile, recursive dynamic models have been increasingly used as a tool for policy analysis in developing countries. Devarajan and Robinson (2013) show that the dynamic process of these models occurs in two steps. A static CGE within-period-based model is solved, generating within-period equilibrium set, and then specifying how the parameters that are exogenous in the previous period are updated and resolving between-period model. There is no intertemporal optimization; the new equilibrium point is achieved only as being a sequence of static equilibria.

The model to be used in this study is a dynamic recursive CGE model that adopts a perspective of investment theory based on adaptive expectations with lagged adjustment and allows the propagation of wealth accumulation and saving over time. The choice of this dynamic CGE model derives from the need to understand the behavior of

economic variables in the long term, as response to the relevant economic policy, and its structural effects, such that it is possible to provide evidence for socioeconomic policies. This may be important for assessing the Guinea-Bissau's trade policies that change relative prices and influence the course of the economy over time.

Since independence, Governments of Guinea-Bissau have been participating in many trade agreements, both at the bilateral and multilateral levels, with the aim of promoting economic growth and the development of the productive forces important to fight against structural poverty. Nevertheless, few studies assess the achievements of these initiatives that have been materialized in trade liberalization policies. For a long period, the potential policy effects could not be analyzed due to lack of adequate data and partial equilibrium approaches have been the workhorse for these purposes.

## 4.1 THE COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR GUINEA-BISSSAU

This section aims to presents a recursive dynamic CGE model representing the main features of the economy of Guinea-Bissau. This model applied for policy analysis, to best of our knowledge, is the country's first CGE model. The foundations of the Guinea-Bissau CGE model stems from recursive dynamic CGE model departing from the neoclassical assumptions in the tradition of Dervis, De Melo and Robinson (1982), essentially the dynamic version developed by Decaluwé, Lemelin, Robichaud and Maisonnave (henceforward DLRM, 2012) and can be used for different purposes of policy analysis.

It is the second research tool of the *PEP (Partnership for Economic Policy) Model* project that emerged spontaneously from the long-standing association between the co-authors (see DLRM, 2012). The PEP-1-t is a *Single-Country, single period, Recursive Dynamic model* designed for the study of a national economy.

However, note that we only take the generic equations of this model to construct a model that takes into account the characteristics of the present economy. So, some of the equations described here you probably will not be found in the original version. For this reason, we call our model BISSAU-DYN in reference to its dynamic structure combined with the country final suffix. This model was used initially to simulate trade

liberalization and productivity policies. Also, from BISSAU-DYN, we derive the Infrastructure Investment Dynamic Computable General Equilibrium Model for economy of Guinea-Bissau, although the latter is simulated using the GAMS codes developed by SAVARD (2011), rather than those of the PEP framework.

The main striking difference regarding to the pep model is related to the assumptions, the way households are modeled, and a clear distinction between public and private investment. In addition to the usual assumption that Guinea-Bissau has a small economy, we assume that the government may face funding constraints on infrastructure spending. The government will incur a deficit whenever the spending is greater than the revenue. However, if the externalities of public investments are positive, then the accumulated deficit can be smoothed over time. Therefore, our model incorporates the externalities of public investments and a public debt function. It also shows a clear separation between public and private investments.

To show a compact structure through which the goods, services and factors markets are sensitive to changes in demand and supply conditions, which in turn are affected by policies that generate changes in relative prices, next subsections present the model general functional form of the model.

### 4.1.1 Production function

The theoretical structure of the model describes productivity activities and consumer and producer demands for commodities over time in an interconnected environment. Productive activities and time are respectively indexed as j and t, so that for all activities

$$j, jj \in J = \{j_1, ..., j_{22}\} \qquad \text{j=1,…,22 sectors} \qquad (1)$$

Firms are assumed to operate in a perfectly competitive environment and each firm j in an industry maximizes the following profits:

$$XS_{j,i,t}=\frac{XST_{j,t}}{\left(B_j{}^{XT}\right)^{1+\sigma_j{}^{XT}}}\left[\frac{P_{j,i,t}}{B_{j,i}{}^{XT}PT_{j,t}}\right]^{\sigma_j{}^{XT}} \quad (2)$$

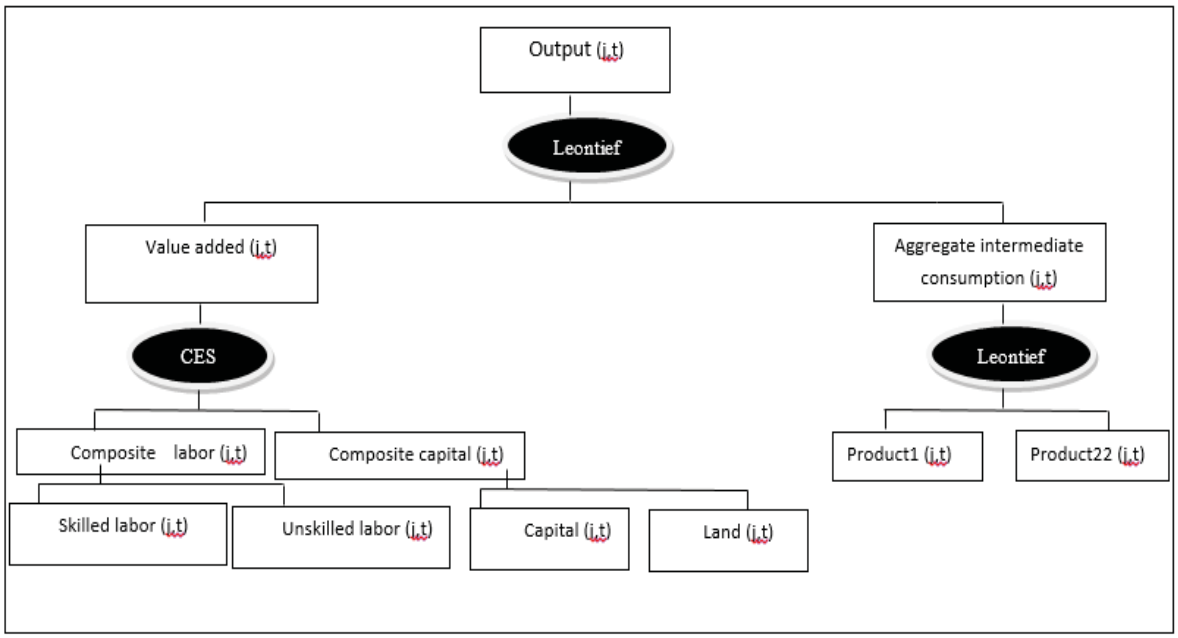
subject to its production technology constraints described as:

$$XST_{j,t}=B_j{}^{XT}\left[\sum_i B_{j,i}{}^{XT}XT_{j,i,t}{}^{\rho_j{}^{XT}}\right]^{\frac{1}{\rho_j{}^{XT}}} \quad (3)$$

taking the prices of factors, goods and services as given. Where $XS_{j,i,t}$ is industry j production of commodity i at time t; $XST_{j,t}$: total aggregate output at time t; $P_{j,i,t}$: basic price of industry j's production of commodity i at time t; $PT_{j,t}$: basic price of industry j's output at time t; $B_j{}^{XT}$: scale parameter; share parameter; $\sigma_j{}^{XT}$: elasticity of transformation, $0 < \sigma_j{}^{XT} < \infty$; and $\rho_j{}^{XT}$: elasticity parameter, $\rho_j{}^{XT}=\frac{1+\sigma_j{}^{XT}}{\sigma_j{}^{XT}}$, $1 < \rho_j{}^{XT} < \infty$.

Figure 8 illustrates structure of production technology that shows the different levels of optimization during the production process of the domestic firms, a theoretical representation as much as usual in standard CGE models.

FIGURE 8 –Nested structure of production technology




SOURCE: Own elaboration.

At the top level, intermediate inputs and value added are combined in fixed shares to produce the sectorial output of each productive activity. The strictly complementary in inputs use is modeled by Leontief production function.

At the second level, each industry's value added consists of transformation of composite labor and composite capital. There are two types of labor (skilled and unskilled) and two types of capital (capital and land) that can be used as primary inputs, with the requirement that each factor receive the value of its marginal product. Labor and capital are substitute for each other, and a constant elasticity of substitution (CES) function is used to model this substitution.

The definition of skilled and unskilled work was done by collecting information regarding the characteristics of workers and their occupation. Initially these workers were separated in the same way as households (rural and urban). The unskilled worker is set to be one who does not even attend to secondary school and finds employment in the activities that does not require specialization as, for example, cleaning services for urban workers or weeding for rural workers. Conversely, skilled workers they have at least

secondary education and their occupation is supposed to be more specialized. Their professional activities include being teacher, specialized mechanic, among others.

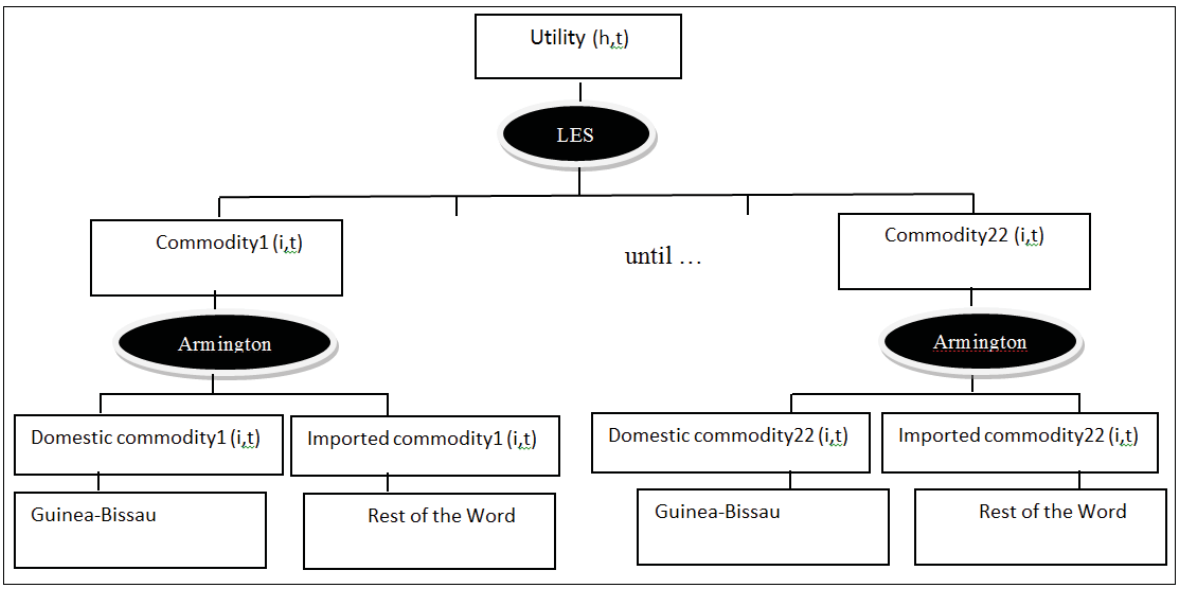
4.1.2 Households demand

There are two types of households, urban and rural, demanding local and imported commodities. It is assumed that they have Stone-Geary utility function from which derives the Linear Expenditure System (LES). A characteristic of this function is that there is a minimum level of consumption of each commodity (so-called subsistence consumption), which may be zero for some commodities. Demand equations are derived from each type household h maximizing utility function for each commodity i subject to the budget constraints, so that

$$PC_{i,t}C_{i,h,t} = PC_{i,t}C_{i,h,t}^{MIN} + \gamma_{i,h}^{LES}\left(CTH_{h,t} - \sum_{ij} PC_{ij,t}C_{ij,h,t}^{MIN}\right) \quad (4)$$

where $PC_{i,t}$ is purchaser price of composite commodity *i*(including all taxes and margins) at time t; $C_{i,h,t}$: consumption of commodity *i* by type *h* households at time t; $C_{i,h,t}^{MIN}$: minimum consumption of commodity *i* by type *h* households at time t; $\gamma_{i,h}^{LES}$: marginal share of commodity *i* in the consumption budget for type h household at time t; and $CTH_{h,t}$ : consumption budget of type *h* households at time t.

FIGURE 9 – Household demand for commodities




SOURCE: Own elaboration.

This functional form adopted does not impose that cross-price elasticities are zero across all pairs of commodities, nor unit income elasticities for all available commodities, which offers a degree of flexibility with respect to substitution possibilities in response to relative price changes (DLRM, 2012). So, at the lowest level of households' utility-maximizing, that follows hierarchical steps (Figure 9), the choice between domestic commodity and composite commodity is carried out in a combined system of CES/LES preferences. At the highest level, the utility generated by the consumption of theses commodities is maximized using this function.

### 4.1.3 Demand for investment

Investors are responsible for creating capital goods in each sector of the national economy. They choose the inputs used to create capital through the process of minimizing costs subject to technological constraints (Figure 10). This representation resembles that

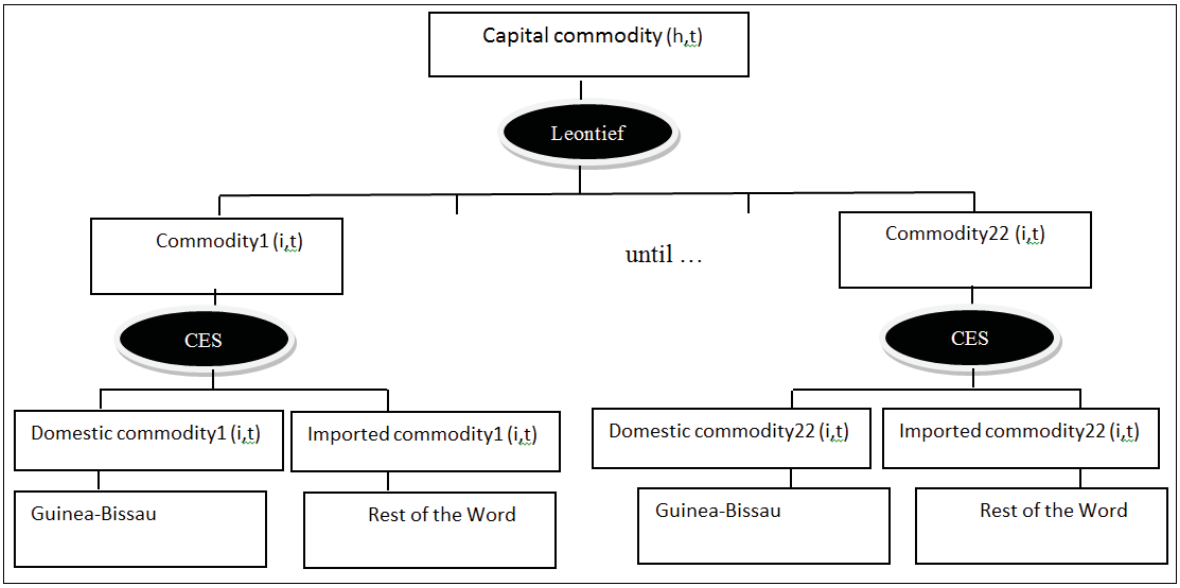
of the production technology of firms, but with subtle difference. Here investment demand includes both gross fixed capital formation and changes in inventories.

It is assumed that the quantity demanded of each commodity for investment purposes is the sum of the quantity demanded for private investment and for public investment, and that, for a given amount of investment expenditures, this demand is inversely related to its purchaser price (Equation 5)

$$INV_{j,t} = INV_{i,t}^{PRI} + INV_{i,t}^{PUB} \quad (5)$$

where $INV_{j,t}$ is the final demand of commodity *i* for investment purposes at time t; $INV_{i,t}^{PRI}$ : final demand of commodity *i* for private investment purposes at time t; and $INV_{i,t}^{PUB}$ : final demand of commodity *i* for public investment purposes at time t. As both private and public investments are distributed among commodities in fixed shares, an implicitly Cobb-Douglas production function of new capital is derived. Available information contained in the SAM clearly shows that both public and private investments

FIGURE 10 – Final demand for investment




SOURCE: Own elaboration.

The optimization of investors during the production process also follows hierarchical steps. At the top level, aggregated intermediate inputs chosen over fixed proportions of Leontief are transformed into domestic commodity capital k. These intermediate commodities are produced adopting the substitution of inputs that come from two sources: domestic and imports. The capital accumulation equation describes the sector's level of investment in the economy.

4.1.4 Demand for margin

Firms use transport, and retail and wholesale trade services to lead commodities to the final consumer. The commodities services are paid. Usually, the payment is made in terms of marginal rates that are applied to the value of domestic production and imports to determine the quantities of this margin services necessary to distribute goods to potential demanders, local or foreigners.

4.1.5 Government demand

Although government does not maximize any function, its introduction into the model enriches further analysis, since it receives tax transfers, but also makes expenditures. The government demand in this model is identified from the flows of payment and receipts of the SAM such as

$$PC_{i,t}GC_{i,t} = \gamma_i{}^{GOV} G_{i,t} \quad (6)$$

PEP-1-thypothesis regarding government final expenditures is made the same as that of investment demand from the previous subsection: for a given current expenditure budget, the quantity demanded of each commodity varies inversely with its price, where $\mathrm{GC_{i,t}}$ is public consumption of commodity i (volume) at time t; $\gamma_i^{GOV}$ : share of commodity *i* in total current public expenditures on goods and services; and $G_{i,t}$: current government expenditures on goods and services at time t.

4.1.6 Producer supply functions and international trade

The underlying assumption of Guinea-Bissau's economy is that it is a small open economy to foreign trade, implying that the world price of traded goods (imports and exports) is exogenous. Trade relations with the rest of the world need to be defined through specification of domestic consumer's behavior with respect to the different supply sources and domestic producers' supply behavior. The supply side comprises two things: first, the transformation of the composite product into the supply of final products, and, second, the supply of each product to destination markets.

The first case has already been treated by equations (1) and (2). For the second, the model ensures that the output of every product of each industry is shared out among domestic or export markets. However, it is assumed that production directed to consumer of Guinea-Bissau is somewhat different from that for exports. This differentiation is explained because, for example, "electronic appliances are commonly used all over the world but are often customized by country considering the preferences of targeted users" (HOSOE, 2010, p.99-100). A constant elasticity of transformation (CET) aggregator function is used to represent this imperfect substitution, showing how readily the production of an industry can be redirected from Guinea-Bissau to export market and vice-versa (Equation 7), thais is:

$$XS_{j,i,t} = B_{j,i}{}^{X}\left[\beta_{j,i}{}^{X} EX_{j,i,t}{}^{\rho_{j,i}{}^{X}} (1-\beta_{j,i}{}^{X}) DS_{j,i,t}{}^{\rho_{j,X}{}^{X}}\right]^{\frac{1}{\rho_{j,i}{}^{X}}} \quad (7)$$

where $EX_{j,i,t}$ is quantity of product *i* exported by sector *j* at time t; $DS_{j,i,t}$: supply of commodity *i* by sector *j* to the domestic market at time t; $B_{j,i}{}^{X}$ : scale parameter (CET – exports and local sales); and $\rho_{j,i}{}^{X}$: elasticity parameter (CET – exports and local sales), $1 < \rho_{j,i}{}^{X} < \infty$ .

Relative supply functions are derived from the first-order conditions of profit-maximizing problem subject to the Equation (7), yielding Equation (8)

$$EX_{j,i,t} = \left[ \frac{\beta_{j,i}^{X} PE_{i,t}}{\beta_{j,i}^{X} PL_{i,t}} \right]^{\sigma_{j,i}^{X}} DS_{j,i,t} \quad (8)$$

where $PE_{i,t}$ is price received for exported commodity *i*(excluding export taxes) at time t; $PL_{i,t}$: price of local product *i*(excluding all taxes on products) at time t; and $\sigma_{j,i}^{X}$ is elasticity of transformation (CET – exports and local sales), for all $0 < \sigma_{j,i}^{X} < \infty$ and $\rho_{j,i}^{X} = \frac{1+\sigma_{j,i}^{X}}{\sigma_{j,i}^{X}}$.

Buyer's behavior is derived symmetrically by assuming that local products are imperfect substitutes for imports, or that goods are differentiated with respect to their origin. Commodities demanded on the domestic market are composite goods, combinations of locally produced goods and imports. Then a constant elasticity of substitution (CES) aggregator function is used to represent the imperfect substitutability between the two (Equation 9), that is:

$$Q_{i,t} = B_i^{M} \left[ \beta_i^{M} IM_{i,t}^{-\rho_i^{M}} (1-\beta_i^{M}) DD_{i,t}^{-\rho_i^{M}} \right]^{\frac{1}{\rho_i^{M}}} \quad (9)$$

where $Q_{i,t}$ is quantity demanded of composite commodity i at time t; $IM_{i,t}$: quantity of product i imported at time t ; $DD_{i,t}$ :domestic demand for commodity i produced locally at time t; $B_i^{M}$ : scale parameter (CES – composite commodity); $\beta_i^{M}$ :share parameter (CES – composite commodity); and $\rho_i^{M}$: elasticity parameter (CES – composite commodity), for any $-1 < \rho_i^{M} < \infty$.

$$IM_{i,t} = \left[ \frac{\beta_i^{M}}{1-\beta_i^{M}} \frac{PD_{i,t}}{PM_{i,t}} \right]^{\sigma_i^{M}} DD_{i,t} \quad (10)$$

where $PD_{i,t}$: price of local product *i* sold on the domestic market (including all taxes and margins) at time t; $PM_{i,t}$: price of imported product *i*(including all taxes and margins) at time t; $\sigma_i{}^M$: Elasticity of substitution (CES – composite commodity), assuming that $0 < \sigma_i{}^M < \infty$ and by derivation $\rho_i{}^M = \frac{1-\sigma_i{}^M}{\sigma_i{}^M}$.

4.1.7 Price system

The model has at least 25 types of prices, including wages and other production costs. As represented by DLRM (2012), prices and price indexes are defined according to the hypotheses and functional forms already declared. This means that, in aggregations, the price of an aggregate variable is a weighted sum of the prices of its components. For instance, it has already been referred that commodities purchased on the domestic market are composites. The price of the composite is a weighted sum of the price paid for domestically produced and imported goods (equation 11), that is:

$$PC_{i,t} = \frac{PM_{i,t}IM_{i,t} + PD_{i,t}DD_{i,t}}{Q_{i,t}} \tag{11}$$

It is worth noting that, in the aggregations of Leontief-type function, the weights are invariant to relative price change. The model's price indexes include the GDP deflator and the consumer price index, the former being the Fisher index and the latter is the Laspeyres one.

4.1.8 Market Clearing

A given market is in equilibrium when there is neither excess demand nor supply, i.e., demand must be equal to supply. That means, for instance, that the sum of supplies of every commodity by local producer must be equals to domestic demand for that commodity (Equation 12), such that:

$$Q_{i,t} = \sum_{h} C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t} + DIT_{i,t} + MRGN_{i,t} \quad (12)$$

where $VSTK_{i,t}$ is inventory change of commodity i(an exogenous variable) at time t; $DIT_{i,t}$ is total intermediate demand for commodity i at time t and $MRGN_{i,t}$ is the demand for commodity i at time t as a trade or transport margin.

This notion of equilibrium was verified for factor markets and other goods and services market. Market clearing for export market means that supply of Guinea-Bissau commodities to the external market should be exactly equal to the demand of rest of the world for those exports.

4.1.9 Dynamic module

The introduction of the dynamic module presents advances in many directions. As the investment is no longer kept fixed, the model incorporates the dynamics of investment and endogenous accumulation of capital, as well as the savings dynamics and the accumulation of wealth over time. The model is also no longer concerned with comparative static analysis, but with the cumulative effects on the economy of an economic policy, for example.

Therefore, by putting time as a variable, the model acquires singular relevance, since what is important in the analysis is not only the result of the adjustment, but mainly the adjustment trajectory of the variables: the results signal only the cumulative effects reached to the along the trajectory. As dynamics of the model constitute the link from within-period equilibrium to the next between period-equilibrium, they basically fall into two important categories: one set of statements update variables that grow at a constant rate per period and other equations controlling the accumulation of capital. The former is governed by official population growth rates over time (which enters the model as a free parameter), while capital accumulation rule is given by equation (13):

$$KD_{k,j,t+1} = KD_{k,j,t}(1-\delta_{k,j}) + IND_{k,j,t} \quad (13)$$

where $KD_{k,j,t+1}$ is the stock of type *k* capital in industry *j* in period *t* + 1 ; $KD_{k,j,t}$ : the stock of type *k* capital in industry *j* in period *t;* $IND_{k,j,t}$ : volume of new type *k* capital investment to sector *j* (whether public or private); and $\delta_{k,j}$ : depreciation rate of capital *k* used in industry *j.* Equation (13) then states that stock of type *k* capital in industry *j* in period *t* + 1 is equal to the stock of the preceding period, minus depreciation, plus the volume of new capital investment in the preceding period.

As in the case of no-capital goods where demand for each good depends on the market price of that good, demand for capital goods for investment depends on the stock and capital price in the period. It has already been discussed that both the private and the public sectors demand capital goods for investment purposes. Volume of new type capital allocated to private sector industry is proportional to the existing stock of capital, and this proportion varies according to the ratio of the rental rate to the user cost of that capital (Tobin's *q)*, which depends on the price of new capital (or replacement cost of capital), the rate of depreciation, and the rate of interest. In the PEP-1-t, the latter cost variable is not included in any equation and therefore is only a rationing tool dictating the investment demand, so that the total expenditure of private investment remains within an imposed constraint.

## 4.2 PRODUCTIVITY MODEL ASSUMPTIONS

The value-added equation is presented as follows:

$$VA_{j,t} = B_j{}^{va}\left[\beta_j{}^{va} Ldc_{j,t}{}^{-\rho_j{}^{va}} + \left(1-\beta_j{}^{va}\right) Kdc_{j,t}{}^{-\rho_j{}^{va}}\right]^{\frac{1}{\rho_j{}^{va}}} \qquad (14)$$

where $Ldc_{j,t}$ and $Kdc_{j,t}$ are the industry j demand for composite labor and composite labor at time t, respectively; ${B_j}^{va}$ and ${\beta_j}^{va}$ are the scale and share parameters (CES-value-added), respectively; and ${\rho_j}^{va}$ is the elasticity parameter (CES-value added).

However, the value-added equation is modified to accommodate productivity and propagation mechanisms for other sets of model variables.

$$VA_{j,t} = \theta_{j,t} {B_j}^{va} \left[ {\beta_j}^{va} {Ldc_{j,t}}^{-{\rho_j}^{va}} + \left(1 - {\beta_j}^{va}\right) {Kdc_{j,t}}^{-{\rho_j}^{va}} \right]^{\frac{1}{{\rho_j}^{va}}} \quad (15)$$

where $\theta_{j,t}$ is the industry j productivity at time t. Positive $\theta_{j,t}$ shock is expected to increase the level of economic activity as it increases sector value added. The mechanisms of transmission occur through profit maximization (or cost minimization) by individual firm that leads it to employ labor and capital to the point where the value marginal product of each is equal to its price (the wage rate and the rental rate of capital respectively). As in DRLM (2012, p.13-14), we described such behavior by the demand for each factor relatively to another factor (Equation 16 and 17):

$$Ldc_{j,t} = \left[ \frac{{\beta_j}^{va}}{1-{\beta_j}^{va}} \frac{RC_{j,t}}{WC_{j,t}} \right]^{{\sigma_j}^{va}} Kdc_{j,t} \quad (16)$$

$$Kdc_{j,t} = {B_j}^{Kd} \left[ \sum_k {\beta_{k,j}}^{Kd} {Kd_{k,j,t}}^{-{\rho_j}^{Kd}} \right]^{-\frac{1}{{\rho_j}^{Kd}}} \quad (17)$$

where $\mathrm{RC_{j,t}}$ is the rental rate of industry j composite capital at time t; $\mathrm{WC_{j,t}}$ is the wage rate of industry j composite labor at time t; ${\sigma_j}^{\mathrm{va}}$ the elasticity of transformation (CES-value added); $0 < {\sigma_j}^{\mathrm{va}} < \infty$; $\mathrm{Kd_{k,j}}$ is the demand for type k capital by industry j at time t; and ${\rho_j}^{\mathrm{Kd}}$ is the elasticity parameter (CES- composite capital); $-1 < {\rho_j}^{\mathrm{Kd}} < \infty$.

Increasing total factor productivity (TFP) means that it uses less and less of both factors and pays less wages and rental rate of capital, which lowers the cost of production. Note that because industries always seek to obtain the product at lower costs, our model assumes that each individual industry will seek to employ factors with lowest production

cost and highest profitability possible. Production should increase as costs fall, or that the demand for factors will occur in the sense of the one that manages to increase the product and reduce costs. Each industry is expected demanding more skilled labor and capital and less and less unskilled labor that generates high costs and less product. However, the replacement occurs only if the unskilled labor price is higher than the skilled labor one and /or the rental price. As a result, the weight of the skilled labor in the composite labor must be higher than that of unskilled labor over time.

Increasing demand for capital increases rental rate of capital, investment and business income. Households are expected to benefit positively from productivity growth, because as productivity raises production, goods prices should decrease, and should also increase wages and employment, income from factor rent as well as labor income. These variables lead to an increase in household consumption and less poverty.

Exports, investment, and consumption are expected to impact positively the GDP as government spending and current account balance. On the supply side, the trade balance is exogenous, while on the demand side with given public expenditures, household consumption and endogenous capital accumulation serve as adjustment variable. Thus, the effect of productivity on GDP depends on the activity and substitution effects. It is expected lead to real GDP growth.

## 4.3 INFRASTRUCTURE MODEL ASSUMPTIONS

We model economic effects of infrastructure as proposed by Savard and Adjovi (1998) and Savard (2010), who first introduce the positive externalities associated to the public investment in infrastructure into CGEs models. This approach was later adopted by Boccanfuso *et al*. (2014) to analyze the effects of public investments in the Quebec economy, and Estache, Perrault and Savard (2012) for selected countries in Sub-Saharan Africa.

However, our model has its own specificities since it is based on country with different socioeconomic characteristics. In addition, the present model is richer in tax instruments than the one calibrated for the Quebec economy. The choice of this version is justified since the effects of building, for example, a new road may take some time to

manifest in the economy as a whole and, with this model, it will be possible to understand the behavior of some economic variables over time and its structural effects.

As in Savard (2010), the key elements of this model concern assumptions on infrastructure spending, externalities of public infrastructure and the budget constraint faced by government to funding this infrastructure. Official government funds its investments in infrastructure through its own revenues that come from several sources, such as direct taxes on household ($Tdht$ ) and firms' incomes ($Tdft$ ), indirect taxes on industry production ($Tipj,t$ ), taxes on commodity ($Tici,t$ ), and imports duties on commodity ($Timi,t$). Therefore, Equation (18) says that an amount spent on a new building is supposed to depend on the government's ability to collect taxes. To what extent taxes scale impacts the economic activity is a subject matter under investigation in some simulation scenarios. In addition, there are receipts as remuneration of public capital ($Ypkt$) and transfers from other agents ($Tri,t$ ), typically households ($Trgov,h,t$ ), firms ($Trgov,f,t$ ), and the rest of the world ($Trgov,row,t$ ).

$$Yg_t = Tdh_t + Tdf_t + Tip_{j,t} + Tic_{i,t} + Tim_{i,t} + Ypk_t + \sum_i Tr_{i,t} \quad (18)$$

where $\sum_i Tr_{i,t} = Tr_{gov,h,t} + Tr_{gov,f,t} + Tr_{gov,row,t}$

Income taxes are described in Equations 19 and 20 as linear function of total incomes of households ($Yh_{h,t}$) and firms ($Yf_{f,t}$), respectively. Note that the marginal rate ($ttdh1_{h,t}$) are different from the average rate of taxation for any non-zero intercepts ($ttdh0_{h,t}$) that are fully index to changes in the consumer price index ($Cpi_t$).

$$Tdh_{h,t} = Cpi_t^{\,n}.ttdh0_{h,t} + ttdh1_{h,t}.Yh_{h,t} \quad (19)$$

$$Tdf_{f,t} = Cpi_t^{\,n}.ttdf0_{f,t} + ttdf1_{f,t}.Yf_{f,t} \quad (20)$$

Next, government also may finance its policy through a tax applied to the value of each industry production (Equation 21).Taxes on production therefore are industry *j* unit

cost at time t ($Pp_{j,t}$), excluding taxes directly related to the use of capital and labor, but including other taxes on total aggregate output of industry j at time t ($XST_{j,t}$).

$$Tip_{j,t} = \quad ttip_{j,t}.Pp_{j,t}XST_{j,t} \tag{21}$$

where, at time t, $\mathrm{ttip_{j,t}}$ is tax rate on the production of industry j.

Finally, the government can implement two types of taxes on products or commodities. Taxes applied on the sales value at domestic market include margins (trade and transport margins) and custom duties (Equation 22). In a static version of the model, the production and sales taxes are emerged and modeled accordingly, restricting the government's ability to carry out double taxation at the stage of production and at the final consumption. However, as the goal is also to check each funding source and its effect on model variables over time, we separate production from sales taxes in the model dynamic version of the model.

$$Tic_{i,t} = \quad ttic_{i,t}\begin{bmatrix}\left(Pl_{i,t} + \sum_{ij} Pc_{ij,t}\, tmrg_{ij,i}\right)Dd_{i,t} + \\ \left(\left(1 + ttim_{i,t}\right)PWm_{i,t}e_t + \sum_{ij} Pc_{ij,t}\, tmrg_{ij,i}\right)IM_{i,t}\end{bmatrix} \tag{22}$$

where, at time t, $Pl_{i,t}$ is the price of local product (excluding all taxes on products) ; $Pc_{ij,t}$: purchaser price of composite commodity (including all taxes and margins);$PWm_{i,t}$: the world price of imported product(expressed in foreign currency); $Dd_{i,t}$: the domestic demand for commodity *i* produced locally; $e_t$: exchange rate; price of foreign currency in terms of local currency; and $IM_{i,t}$: the quantity of the product imported. $ttic_{i,t}$ is a tax rate on commodity;$tmrg_{ij,t}$ is the rate of margin *i* applied to commodity *i; and* $ttim_{i,t}$ is the rate of taxes and duties on imports of commodity

In our model, part of the government revenue that comes from transfers is obtained without any counterpart since it is not explicitly related to a specific form of agent behavior. So, the sign of these transfers between government and non-governmental institutions depend on the economic characteristic of Guinea-Bissau and be may positive or negative depending of national data characteristics contained in SAM, that may have positive or negative values. The households and firms' transfers to government are

defined as a proportion of their disposable incomes. Like income taxes, these transfers are supposed to represent contribution of the social program and, for modeling purposes, they are treated in the same way (Equation 23 and 24).

Government transfers from rest of the world are addressed differently because they can be derived from the other nature regardless of its income. All forms of aid (or interest-bearing external loans) to Guinea-Bissau are the transfer of the rest of the world to the country and, for one of simulation scenarios, they are a source of infrastructure investment funding. Technically, ROW transfers are initially set equal to their SAM values ($Tr^0{}_{gov,row}$) and grow each period at the same population ($pop_t$) growth rate, being indexed fully to the consumer price index (Equation 25).

$$Tr_{gov,h,t} = Cpi_t{}^n . tr^0{}_{h,t} + tr^1{}_{h,t} Yh_{h,t} \quad (23)$$

$$Tr_{gov,f,t} = \gamma^{TR}{}_{gov,f} . Yf_{f,t} \quad (24)$$

$$Tr_{gov,row,t} = Cpi_t{}^n . Tr^0{}_{gov,row}\, pop_t \quad (25)$$

Where, at time t, $tr^0{}_{h,t}$ represents transfers by type *h* households to government (an intercept); $tr^1{}_{h,t}$ is the marginal rate of transfers by type *h* households to government; $\gamma_t{}^{TR}$ is the share parameter (or transfer functions).

The last three equations, however, are insufficient to provide the general framework for analyzing effects of public investment policy. A more accurate analysis requires looking at the public accounts background, that is, how the government distributes its revenue between several public service expenses. Current government budget or deficit (positive or negative savings - $Sg_t$) constraint equation (Equation 26) shows deficit used entirely for public investment as difference between revenue and its expenditures, which consist of transfers to non-governmental agents ($Tr_{gov,agng,t}$) and current expenditures on goods and services ($G_t$).

$$Sg_t = Yg_t - Tr_{gov,agng,t} - G_t \quad (26)$$

There are now important elements to look at the model default closure, in order to define the behavior over time of the model variables that adjust to meet the current policy. It is assumed that public expenditure is exogenous and grows over time as population growth rate. The amount of public investment in infrastructure (ITgt) will be allowed to change when it changes the closure as to take into account the fiscal instruments. From the above relationships, the government will fund its policy objective using current savings and deficit. Equation (27) considers the two funding sources.

$$ITg_t = Sg_t + Deficit \tag{27}$$

As in Boccanfuso *et al.* (2014), we assume that if infrastructure construction is fully funded only with public savings, the government will not change its debt stock and will not incur in deficit from one period to another. However, if government resorts to debt stock, it should not only get a deficit, but the amount of deficit should increase from one period to another depending on the interest rate charged on the initial loan. In the simulation process, different policy alternatives will be considered, that is, it will be left some taxes or transfers (from the rest of the world) to adjust as to balance out Equation 26.

We will return in the next section with simulation closure and scenarios discussions. What is most interesting to emphasize now is the statement that public investment can have externalities, which is the cornerstone of this study. The externality assumption was brought up by Savard and Adjovi (1998) and Savard (2010), and subsequently adopted by Estache, Perrault and Savard (2012) and Boccanfuso *et al.* (2014), and set as follows:

$$\theta_{i,t} = \left(\frac{Kg_t}{Kg_{t-1}}\right)^{\varepsilon_i} \tag{28}$$

where $\theta_{i,t}$ is the externality (or sectoral productivity effect) set as a function of the ratio of current stock of public capital ($Kg_t$) over public capital of the previous period ($Kg_{t-1}$), and $\varepsilon_i$ is a sector-specific elasticity. The values of these parameters will come from Harchaoui

and Tarkhani (2003) study who estimated externalities by sector for Canadian economy. This choice is justified because there is no data at the sectoral level that allow such estimation for the Guinean economy. However, since the literature recurrently reveals decreasing returns in the public infrastructure investment and the present study is about a developing economy, the use of elasticities estimated for developed country can be considered as conservative (Estache, Perrault, and Savard, 2012, p.5).

The current stock of public capital is the sum of stock of public capital of the previous period, which grows at a rate of the level of investment required to maintain the capital stock ($g_{kg}$), and public investment in new capital of the previous period ($ITg_{t-1}$), both terms associated with a discount factor, which is the depreciation rate of public capital ($\delta_g$) – Equation 29:

$$Kg_t = Kg_{t-1}(1 + g_{kg})^t\left(1 - \delta_g\right)^t + ITg_{t-1}(1 - \delta_g)^{t-1} \quad (29)$$

The motivation to use the externalities function (as in Equation 27) is due to its role in increasing the total factor productivity. The causality can be described as follows: a new investment program in the infrastructure carried out by the official government, that is, increase in $ITg$, will increase the public capital stock through the time and generate a positive production externality (captured by parameter $\theta_i$). This force appears in the value-added ($Va_{i,t}$) equation (Equation 30) through this theta parameter, such as:

$$Va_{i,t} = \theta_{i,t}A_i{Ld_{i,t}}^{\alpha_i}{Kd_{i,t}}^{1-\alpha_i} \quad (30)$$

where, at time t, $A_i$ is the scale parameter; $L(d_{i,t})^{a_i}$ and $K(d_{i,t})^{1-a_i}$ are the labor and capital demand by industry $i$ at time t, respectively; and $\alpha_i$ the Cobb–Douglas parameter. Hence, like in Yeaple and Golub (2007) and Boccanfuso *et al.* (2014), an increase in $\theta_i$ represents a Hicks neutral productivity improvement. This formulation is also commonly used in the empirical literature estimating externalities parameters of infrastructure public investment on the total factor productivity (see Lynde and Richmond, 1993b; Bajo-Rubio and Sosvilla-Rivero, 1993; Gramlich, 1994; Herrera, 1997 among others). Estache,

Perrault and Savard (2012) argue that adopting this formulation in the CGE framework implies that investment in infrastructure can act as a source of comparative advantage since the function is sector specific. This is important for the development policies to maximize the capacity of the sectors and to exploit the resulting gains.

In fact, this formulation will enable the government to design policies consistent with the comparative advantage of the country as it will show which sectors respond more to public investments. Another advantage is that it helps the private sector direct its investments to the sectors of greater productivity and profitability and may also encourage the inflow of foreign investments towards the competitive industries. We also limit ourselves to also exploring the potential that this formulation gives us to look at the distribution of gains among agents resulting from the investment package in the construction and rehabilitation of infrastructure.

It is worth noting that externalities from past public capital stock are calibrated in the $A_i$ parameter of the $Va_{i,t}$ function, non in $\theta_{i,t}$ function, since the externality measure by $\theta_i$ represents the portion associated with the new investments of 100 million per year for 25 years, the investment time-calendar described in the *Programa Terra Ranka*. In other words, every FCFA 1(Guinea-Bissau currency) spent on infrastructure construction will have effects on total factor productivity through the $\theta_i$, affording the scale of production $A_i$. The externalities arising from the same amount of new public investment are again added to the value of $A_i$, which already carries the effects of past investment, and impact for the economy must be greater than the previous period. In the dynamic environment, however, it is expected that the effects of $\theta_i$ will be smoothed due to adjustment in the factor market, since $\theta_{i,t}$ is exogenous in $Va_{i,t}$.

The specification is completed by introducing the dynamics in the model. If the government uses the surplus of its revenue resulting from a year of good growth as a public investment, the current GDP should increase. In this case, a standard static model would count for modeling the externalities of public investments. However, with the evidence that public investments do not have an explicit correlation with contemporary GDP, this scenario is unlikely to occur, first because governments have announced investments in public works to boost their economies during the reception and do not have time to wait for golden periods to start such investments and, second, because the

majority of public investments are operational only several years after expenditures have occurred. For example, after announcing the package of new public investments in infrastructure construction, a road may take 7 years to be completed; an airport may take more time, and so on for other investment categories. This delayed makes the impact of public investments to be no instantaneous. An appropriate theoretical framework should be called. Therefore, it is the existence of important lags of several years between expenditures on public investment and completion of the capital stock the main motivation behind the choice of the dynamic CGE model.

The introduction of the dynamic implies that the model considers the dynamics of investment and endogenous accumulation of capital, as well as the savings dynamics and the accumulation of wealth over time. As labor force as well as technological progress are time-indexed, the model is no longer concerned with comparative static analysis, but with the cumulative effects on the economy of current policy.

The evolution of capital stock is modeled through the investment demand functions (Equation 31) where the volume of new type of capital allocated to business-sector industry is proportional to the existing stock of capital ($Ind_{k,i,t}$). The proportion varies according to the ratio of the rental rate ($R_{k,i,t}$) and the user cost of that capital ( ($U_{k,i,t}$- Tobin's q), which depends on the price of new capital (or replacement cost of capital - $PK_t^{new}$), the rate of interest ($IR_{k,t}$), and the rate of depreciation -see DRLM (2012) - (Equation 32).

$$Ind_{k,j,t=}\phi_{k,i}\left[\frac{R_{k,j,t}}{U_{k,j,t}}\right]^{\sigma_{k,j}{}^{INV}} Kd_{k,j,t} \quad (31)$$

$$U_{k,j,t=} = PK_t^{new}\,(\delta_{k,j} + IR_{k,t}) \quad (32)$$

where $\phi_{k,j,t}$ is the scale parameter (allocation of investment to industries) and $\sigma_{k,j}{}^{INV}$ is the elasticity of private investment demand relative to Tobin's q.

The level of investment demand at time $t$ is used in the capital accumulation rule equation (defined in Equation 13).

$$Lcs_{t+1} = Lcs(1+n) \quad (33)$$

The dynamic specification is completed through another set of update variables that grow at a constant rate per period, governed by official population growth rates over time which enters the model as a free parameter *n.* We use this parameter to introduce the labor force growth ($Lcs_{t+1}$) in the usual way as in Equation 33.

## 4.4 DATA BASE AND MODEL CALIBRATION

The model above described is applied to evaluate the potential effects of trade agreements and productivity on economy of Guinea-Bissau. This section is designed to treat the data for those purposes. The economic features of Guinea-Bissau economy is represented through 2007 Social Accounting Matrix, with acronym of SAM, bring a set of data required for modeling. Next subsections provide a discussion around this SAM and the structure and sources of the additional data.

### 4.4.1 General overview of the SAM

There are several separate institutions or agents. The SAM represents a picture of the monetary flows accounts of these agents in an economy (national or regional) that one wishes to distinguish, for a given year. It is possible to have an integrated system of accounts that relate multiple accounts in a consistent and closed manner. Consistency can be understood both in the micro and macro senses. The SAM of an economy is micro consistent when the income expenditure flow of each agent satisfies its budgetary constraint, while a macro consistent SAM is that if the aggregate flows of all agents satisfy the standard aggregates (PYATT and ROUND, 1979; PYATT, 1988). According to Cardenete, Guerra and Sancho (2012), such double consistency is relevant for modeling an economic policy, since it allows combining available monetary data with CGE model, whose analytic structure this study is based on.

The technical result of a consistent SAM is what makes it different from rectangular input-output tables: each row and column in a SAM reflects a separate account to which expenses and receipts must balance, hence their quadratic nature. The

technical implications of a quadratic SAM are that the matrix is computationally feasible if balanced. The focus is on nominal flows, with rows representing revenues, and columns the expenditure account categories (PYATT and ROUND, 1985; DERVIS, DE MELO and ROBINSON, 1982; LOFGREN ET AL., 2002).

Recursive dynamic CGE model in GAMS needs SAM data, whose features, include: Local agents' consumption; Trade and transport marketing margins; and multiple activities producing any commodity. Additional data are the followings: trade and production elasticities; household consumption elasticities; savings; interest rate; and population growth rate.

### 4.4.2 2007 SAM for Guinea-Bissau

With the support of the International Food Policy Research Institute (IFPRI), the SAM of Guinea-Bissau to be used in this study was built by Cabral (2015), from the African Growth and Development Policy Modeling Consortium (AGRODEP) and it provides comprehensive information on the country's economy in the 2007[5].

This circular flow picture is presented in a single unified set of accounts (Figure 11, and for real SAM see Appendix B.1, Figure 1). The SAM has 22 sectors, 9 production factors and 85 accounts, classified into the following six accounts: factor, institutions, activity, domestically sold commodity, export commodity, and accumulation. Each account represents the agent's relationships determining the dynamics of the economy in the period in question.

The factors of production are offered in the market and their effective use for production represents costs in terms of wages and rent; they are remunerated conventionally, that is, paid based on their marginal costs; the revenues are transferred to households in the form of factor income. The family income, already in the accounts of the institutions, comes from two sources: wages and transfers from the government.

After the receipts, the income is used by the families in several ways: one part is destined for the payment of taxes, another for the consumption of domestically offered

[5] The Social Accounting Matrix of Guinea-Bissau is obtained by request. Interested parties can access: http://www.agrodep.org/dataset/2007-social-accounting-matrix-sam-guinea-bissau.

goods and another for savings. In addition to normal operations, firms receive subsidies and pay taxes to the government, which they also receive from family and the rest of the world. Through redistributive policies, the government transfers can go as income to households, subsidies to companies, and accumulates international reserves that can be used for a variety of purposes, mainly for offsets between residents and non-residents or the rest of the world. The government consumes and saves part of its revenues. International capital entering the country can be used to buy domestic production (exports) or to finance domestic consumption. The accumulation accounts and their interconnections with the other matrix vectors complete the interconnection of the flows.

FIGURE 11 – Structure of a macro social accounting matrix for Guinea-Bissau, 2007

| Expenses | | Factors (1) | | | Agents (2) | | | | Activity (3) | Commodity (4) | Exports (5) | Accumulations (6) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Receipts | | Labor | Capital | Land | Family | Entreprise | Gov. | Rest of the World | | | | Investment-saving | Inventories |
| 1 | Labor<br>Capital<br>Land | | | | | | | | Wages<br>Rentals<br>Rentals | | | | |
| | Family | Labor Income | Capital Income | Land Income | | | Transfer | Capital inflow | | | | | |
| | Entreprise | | | | | | Subsidies | | | | | | |
| 2 | Gov. | | | | Tax on income and wealth | Tax on production | | Custom Duties | Value added tax | Tariffs | | | |
| | Rest of the World | | | | | | Intern. Reserves | | | Imports | | | |
| 3 | | | | | | | | | | Domestic Commodity Supplies | Exports | | Inventor. |
| 4 | | | | | Private Consump. | | Gov. Consump. | | Intermediate inputs | | | Invest. | |
| 5 | | | | | | | Export subsidy | Exports | | | | | |
| | Investment-savings | | | | Private Savings | | Gov. Savings | | | | | | |
| 6 | Inventory | | | | | | | | | | | | |
| TOTH | | Factor Income | Factor Income | Factor Income | Household Income | | Gov. Expendit. | Foreign Exchange Inflow | Total costs | Total Absortion | Exports | Invest. | Inventor. |

Source: Own elaboration. Macro SAM of Guinea-Bissau.

### 4.4.3 Model calibration, parameters and elasticities

Successive shocks in the economies may cause changes in relative prices, but how much this may imply in the change in signal and magnitude of the relevant variables in the short and long run is an empirical task under investigation. It is possible to understand something about economic effect of the shock after performing a kind of counterfactual analysis (Dawkins et al., 2001, p.3656). According to these authors, the motivation for using calibration arises from the belief that performing any counterfactual analysis requires a coherent theoretical framework and that only consistent models with economic theory can be used for that purpose. They argue that estimation and test are useful ways to verify the model consistency. However, the response of the effect of a shock in the course of the economy often requires the construction of large and non-trivially solvable models that do not allow estimation or testing, but involve parameterizing, being calibration a way to find model unavailable parameters that need to be obtained as to perform the counterfactual analysis (for further discussion on calibration).

The following parameters are derived from a CGE model applied to the Tanzanian economy: Constant elasticity of substitution (CES) demand for commodity; elasticity of international demand for exported commodity i; constant elasticity of transformation (CET) between the two destinations, local and foreign markets; activity level CES of the quantities of value-added and aggregate intermediate input use; and CES between factors, at the bottom of technology nest (see Appendix B.2.1 , which shows how the sectors of the SAM are compatible with those of elasticities).

It is worth emphasizing that it is from the above model that we will establish the general assumptions regarding the functioning of the Guinean economy. We have already observed that trade liberalization policy simulations were entirely based on the BISSAU-Dyn model. However, productivity simulations require additional data. We will present these data requirements separately, and then turn to the model closure and some technical aspects involving simulation into GAMS.

### 4.4.4 Additional data on productivity

Productivity shocks will be an estimated shock described in the next subsection (see equation 34). The following data used to estimate the econometric productivity model are as follows: Agricultural sectors production (millet, sorghum, maize, rice, fonio, cotton, other agricultural, and cashew nuts and breeding and hunting) - source: FAO; production of Forestry, Fishery products, and Mining industries and all service sector (World Bank); sectorial employment (ILO); capital by sector is the amount of machinery for the agricultural sectors (FAO) or the amount of credit for the other sectors (World Bank); exports, Logistic Performance Quality Index, Infrastructure Quality Index (World Bank).

Note that the database starts in 1989 so as not to nullify the 1990 observation when growth rate for each variable is calculated. Note also that data from service sectors is not observable, rather the added value of the macro-sectors such as agriculture, services, industry and manufacture production. Thus, to obtain the productivity growth rates, some data desegregations were made. The values of service sectors productions were obtained as follows: (i) calculate the share of each of these four sectors in the total value added and (ii) emerge the resulting values with the total production of the agricultural sectors[6].

It is important to observe that neither FAO nor the World Bank provided data on service sectors production included in our SAM separately. Thus, the production and productivity of the trading and repair, hotels and restaurants, transport and communications, financial services, real state and services to firms, and public administration sectors are the same over time. The implications from this are that the shock sizes observed are also the same for all service sectors. But once we preserve the SAM flows, each sector productivity shock is expected to propagate effects on the model differently.

[6] Production data taken from FAO refer only to the agricultural sectors. But since we already know the share of the agricultural sector (the sum of all agricultural sectors), the industry and the services sectors in the composition of value added, we calculate each macro sector shares and then use them to open up the other sectors whose data are not initially disaggregated.

The same criterion was used to disaggregate the amount of labor and capital (machinery-credit) by sector. For instance, the share of employment (between 15- and 65-year working age) for the four macro-sectors was calculated. Since data on agricultural employment are already available, the shares corresponding to the missing sectors were used to extract the employment series in these sectors.

To obtain a joint series of productivity, that is, the total factor productivity, the labor and capital productivity was calculated by dividing the output of each sector by the labor and capital factors. Therefore, aggregate of the two variables corresponds to the observed total productivity of the sectors in the period in question (Table 7).

TABLE 7 - Sectoral productivity growth (% change) (1990 -2017)

| Year | Millet | Sorghum | Maize | Rice | Fonio | Cotton | Other agricul | Cashew | Hunting | Food | Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | 0.342 | 0.525 | 0.713 | 0.436 | 0.579 | 0.694 | 0.315 | 0.284 | 0.310 | 0.284 | 0.284 |
| 1991 | 0.237 | -0.088 | -0.284 | -0.237 | -0.475 | -0.288 | -0.219 | -0.470 | -0.227 | -0.237 | -0.237 |
| 1992 | -0.192 | -0.211 | -0.204 | -0.003 | 0.243 | -0.467 | 0.017 | 0.432 | 0.041 | -0.006 | -0.006 |
| 1993 | 0.141 | 0.291 | 0.208 | 0.011 | 0.454 | 0.389 | 0.015 | -0.125 | 0.029 | -0.008 | -0.008 |
| 1994 | 0.085 | 0.022 | 0.027 | 0.041 | 0.180 | -0.142 | 0.023 | -0.062 | 0.029 | 0.001 | 0.001 |
| 1995 | 0.215 | 0.096 | 0.198 | 0.020 | -0.269 | 0.672 | 0.025 | 0.173 | 0.023 | 0.003 | 0.003 |
| 1996 | -0.385 | -0.192 | -0.417 | -0.092 | 0.089 | 0.171 | 0.028 | 0.339 | 0.030 | 0.007 | 0.007 |
| 1997 | -0.497 | 0.022 | 0.736 | -0.145 | 0.261 | -0.204 | 0.050 | 0.543 | 0.052 | 0.029 | 0.029 |
| 1998 | 0.998 | -0.122 | -0.038 | -0.161 | 0.658 | 0.002 | -0.026 | 0.063 | -0.016 | -0.038 | -0.038 |
| 1999 | -0.022 | 0.310 | 0.646 | -0.083 | 0.107 | 0.275 | 0.004 | 0.139 | 0.019 | -0.004 | -0.004 |
| 2000 | 0.006 | 0.428 | 0.043 | 0.329 | -0.085 | 0.031 | 0.011 | 0.00 | 0.011 | 10.997 | 3.060 |
| 2001 | 0.364 | -0.281 | 0.101 | -0.193 | -0.272 | 0.227 | 0.011 | 0.176 | 0.015 | 0.033 | 0.051 |
| 2002 | -0.162 | -0.036 | -0.221 | 0.022 | -0.473 | 0.086 | -0.005 | 0.001 | -0.011 | 0.382 | -0.221 |
| 2003 | -0.066 | -0.319 | -0.067 | 0.005 | -0.541 | 0.098 | 0.004 | -0.009 | -0.038 | 0.106 | -0.039 |
| 2004 | 0.391 | 0.549 | 0.547 | 0.011 | 1.635 | -0.170 | 0.017 | 0.048 | 0.058 | -0.266 | 0.229 |
| 2005 | 0.500 | 6.956 | 0.250 | 0.103 | 0.250 | 0.100 | 0.019 | -0.003 | 0.026 | -0.076 | -0.080 |
| 2006 | 0.052 | -0.800 | 0.056 | 0.082 | -0.197 | -0.088 | 0.027 | 0.071 | 0.075 | 0.096 | -0.092 |
| 2007 | -0.471 | -0.403 | -0.668 | 0.201 | -0.821 | 0.334 | 0.037 | 0.032 | 2.016 | -0.123 | 0.155 |
| 2008 | 0.195 | 0.246 | 0.196 | 0.165 | -0.107 | -0.078 | 0.042 | 0.128 | -0.024 | 0.047 | 0.025 |
| 2009 | -0.607 | -0.200 | -0.001 | 0.228 | 0.812 | -0.240 | 0.052 | 0.113 | -0.581 | 0.059 | 0.045 |
| 2010 | 0.221 | 0.209 | -0.258 | 0.151 | -0.015 | 0.072 | 0.049 | -0.014 | 0.072 | 0.097 | 0.110 |
| 2011 | -0.063 | 0.087 | -0.346 | -0.157 | 0.009 | 0.007 | 0.056 | 0.033 | 0.064 | -0.126 | 0.357 |
| 2012 | 0.205 | 0.230 | -0.107 | 0.125 | 0.097 | -0.107 | 0.045 | -0.063 | 0.000 | 0.103 | -0.087 |
| 2013 | 0.070 | 0.146 | 0.022 | 0.061 | 0.250 | 0.004 | 0.046 | 0.172 | 0.056 | 0.067 | 0.026 |
| 2014 | -0.446 | -0.479 | -0.009 | -0.365 | 0.128 | -1.000 | -0.093 | 0.145 | -0.032 | 0.046 | 0.141 |
| 2015 | 0.401 | 0.144 | 0.005 | 0.280 | -0.075 | 0.000 | 0.018 | -0.028 | 0.009 | 0.057 | 0.087 |
| 2016 | 0.005 | 0.068 | 0.002 | 0.100 | 0.000 | 0.000 | 0.021 | 0.017 | 0.039 | 0.019 | 0.087 |
| 2017 | 0.090 | 0.092 | 0.005 | 0.011 | -0.004 | 0.000 | 0.020 | 0.016 | 0.014 | 0.204 | 0.106 |

SOURCE: Authors elaboration. FAO Stata 2019 and World Bank indicators 2019.

We plot productivity values over 1990-2017 periods for all represented sectors (Figure 12). Four important lessons can be learned from these Figures. First, there is a positive productivity level for all sectors, although the growth rate is negative in some cases. Second, productivity level between 2000 and 2010 is higher on average in agricultural, industrial, and service sectors. Third, only the cashew nut, fishing, food and beverage and other industries sectors have increasing productivity (albeit with small oscillations) since the 2000s. Finally, productivity of the sectors from 2010 onwards was lower on average than the productivity levels observed in previous decades.

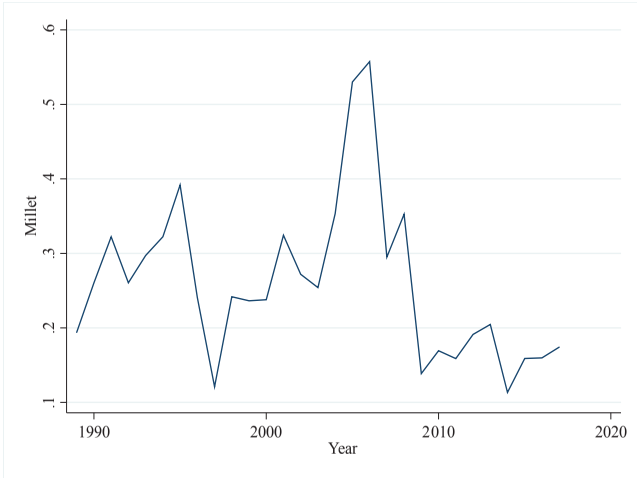
The productivity behavior of the sector in each period has to do with the current situation in the country that affected positive or negatively the production. At the beginning of the period, we were seeing higher levels of productivity that declined from the first half of the 1990s, possibly due to the civil conflict of 1998-1999, which paralyzed economic activities. The rapid recovery of the economy in the immediate post-conflict also reflected in increased productivity that had been stifled during the war period. From then on, not only the cashew nut sector that grew, but also some agricultural and industrial sectors followed the period of political and economic stability and grew equally.

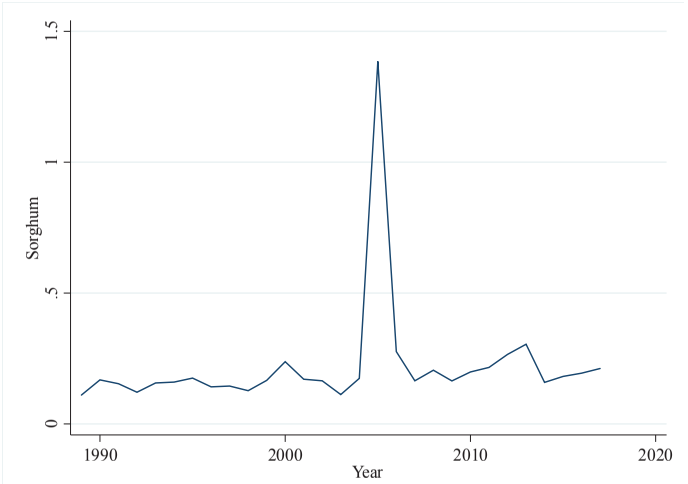
On the other hand, the drop in productivity in more recent periods can be attributed to factors of political instability since the Parliament was closed between 2015 and 2018, as a political crisis response that succeeded the exchange of five Prime Ministers, to whom only two managed to approve their government programs. Thus, the decline in productivity since then must have been associated with the interruption of economic activities, especially those related to the productive investments. In addition, the economy was characterized by a low capacity to create employment opportunities for the population growing at rate of 2% per year, and there was zero percentage change in aggregate employment from 2008 to 2017.

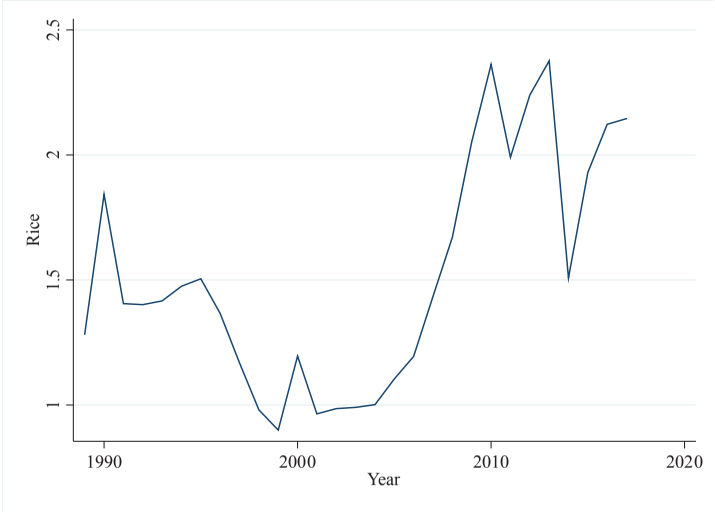
We can also note an important factor in these sectors, which are the low productivity levels of the agricultural sectors. This is an interesting matter, because if the increase in output per unit of the employed factor benefits both rural and

urban households due to the downward trend in food prices, then low productivity should at least keep them in poor condition. This also justifies the relevance of our study: since, as we encourage positive shocks in agricultural productivity, we can explore to what extent a poverty-stricken household whose source of employment, income and expenditure depends on given level of specific commodities production can tap into the gains from product increase.

Figure 12 – Productivity growth (1990-2019): Millet, Sorghum, Rice, and Fonio sectors



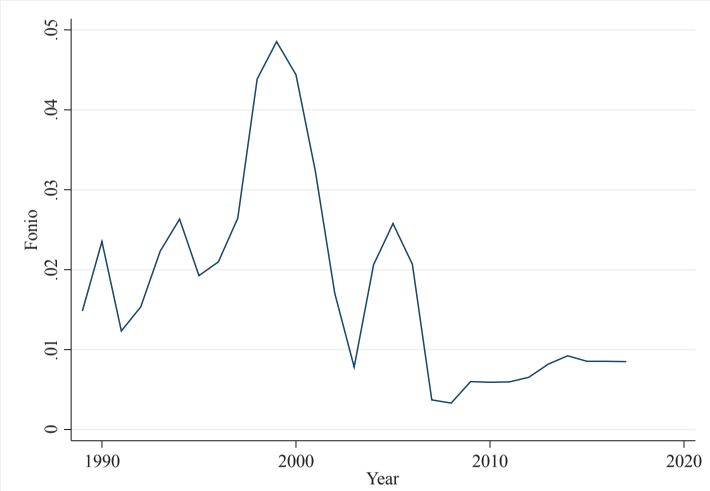



Figure 12 – Productivity growth (1990-2019) – continuation: cotton, other agriculture sectors, maize, and cashew nuts

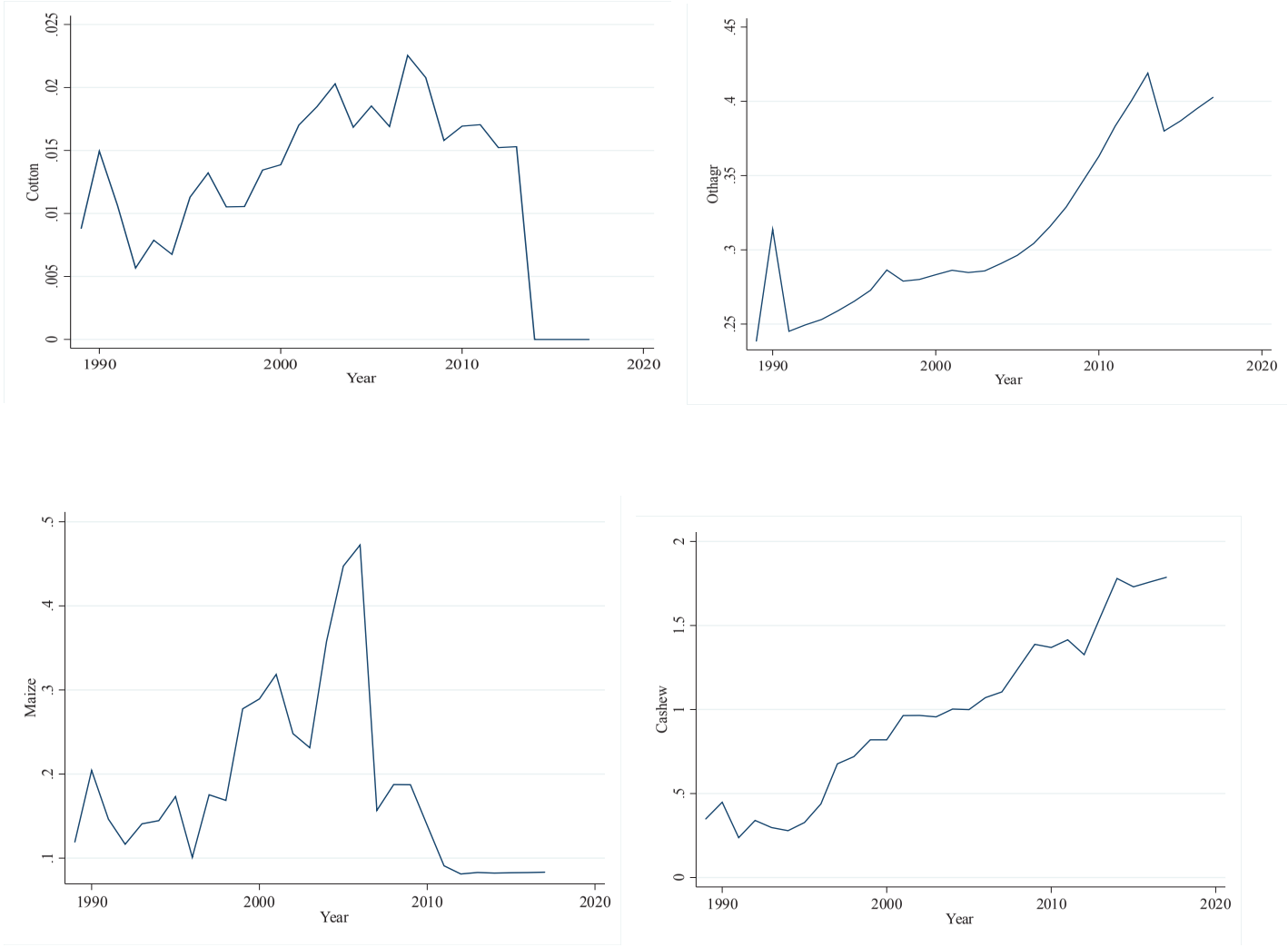
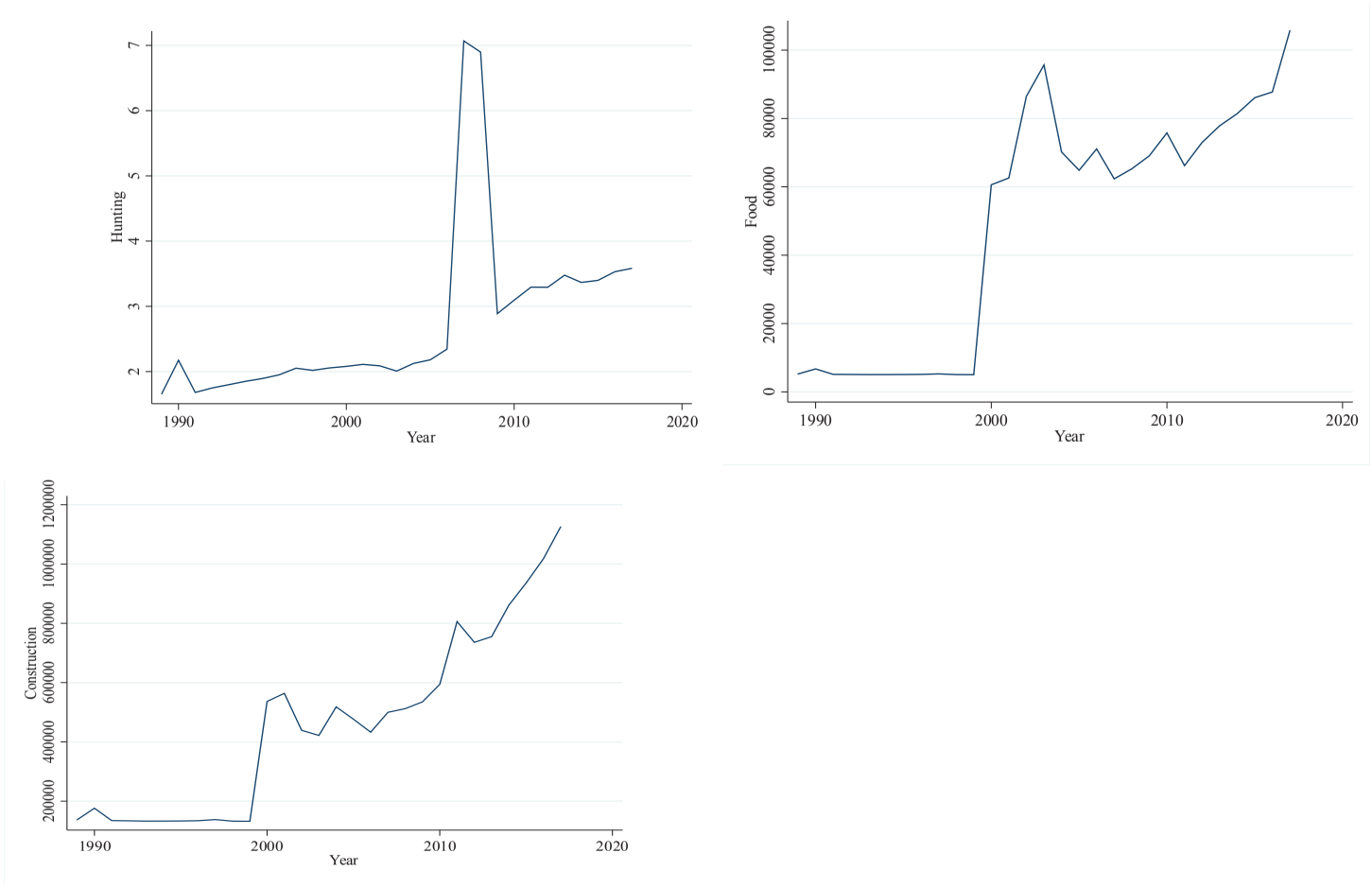


Figure 12 – Productivity growth (1990-2019) – continuation: hunting, food, and services sectors




SOURCE: Authors elaboration. FAO Stata 2019 and World Bank indicators 2019

It is also required additional data on income and household expenditures among different goods. These micro data allow disaggregating the two households contained in the SAM into several rural and urban Households. The disaggregation is important for analyzing other indirect impacts of economic policy that are not limited to productivity alone, such as public investments and trade policies. Disaggregating households into 6 urban and 6 rural types is also important in identifying, for example, how rural road construction, as recently projected by the government, will impact those households that are directly engaged in agriculture activities. The micro data will come from 2014 minimum wage annunciated by official government, from which we expand household into different types calculating the shares, as represented in Table 8.

TABLE 8 – Household disaggregation by minimum wage

| Types of household | Code | Monthly income of households | Value in Franco XOF | Share |
|---|---|---|---|---|
| Household 1 | H1 | ≤ 1 minimum wage | 50,000* | 0.018 |
| Household 2 | H2 | ≤ 2 minimum wage | 100,000 | 0.036 |
| Household 3 | H3 | ≤ 4 minimum wage | 200,000 | 0.072 |
| Household 4 | H4 | ≤ 6 minimum wage | 600,000 | 0.218 |
| Household 5 | H5 | ≤ 8 minimum wage | 800,000 | 0.290 |
| Household 6 | H6 | ≤ 10 minimum wage | 1,000,000 | 0.363 |

SOURCE: Authors elaboration. *:50,000 is the current official minimum wage announced by the government in 2014.

We emerge this share with every row and column in the SAM data as to obtain a new level of consumption and income for every household, generating an updated SAM for the current minimum wage base year. The main general observation for households is that we respect the initial classification that there are two types of workers (skilled and unskilled) and two types of households (urban and rural). Therefore, in terms of the treatment of the labor market, all urban households offer skilled labor, while their rural counterparts offer unskilled labor. The reason for disaggregating workers in several types is that it allows to visualize which sector demands more the labor offered by poor households, for example (see Appendix A, Table 1 that shows the proportion of the intensity of use of the factors). We observe that, for a given total supply of factors, the agricultural sectors demand more unskilled labor from the rural environment, while the industrial and service sectors demand more skilled labor.

The purpose model will be calibrated in GAMS (General Algebraic Modeling System). According to Dawkins et al. (2001), the motivation for using calibration arises from the belief that performing any counterfactual analysis requires a coherent theoretical framework and that only consistent models with economic theory can be used for that purpose. They argue that estimation and test are useful ways to verify the model consistency. However, the response of the effect of a shock in the course of the economy often requires the construction of large and non-trivially solvable models that do not allow estimation or testing, but involve parameterization, being calibration a way to find model unavailable parameters that need to be obtained as to perform the counterfactual analysis.

The calibration process requires additional data, such as trade and production elasticities, household consumption elasticities, interest rate, and population growth rate. While the latter two are from the World Bank, the production, trade and substitution elasticities have not yet been estimated for Guinea-Bissau. As mentioned, we will use the already estimated elasticities for Tanzania, which is an economy with the production technology like Guinea-Bissau.

## 4.5 SIMULATION SCENARIOS

The three policies (trade, productivity, investments in infrastructure) are evaluated considering different scenarios. Trade policy consists of two scenarios: simultaneous and sectoral tariff cuts on the one hand, and reductions in export taxes on the other. The productivity scenario consists of simulating the total factor productivity increase in the selected sectors. The infrastructure investment policy comprises two groups of simulations, one referring to the increase in new public investments and the other referring to the increase in taxes and debts as souces of funding. Although the impulse and propagation mechanisms may be different from one scenario to another, the initial and final periods are the same for all simulations.

We use the following macroeconomic variables to update the 2007 SAM for 2014: Household aggregate consumption, government expenditure, investment, export, and import. These variables were retracted from the World Bank Development Indicators. To

facilitate comparison with SAM data, monetary flows are expressed in current Franco CFA (currency of Guinea-Bissau), not in US dollars. So, the base year is 2014. The choice of 2014 as a base year over any other period is since this is a year that we observe for greater stability of macroeconomic series. Before 2014, unstable series are observed, and our model could perpetuate them more intensely by determining activities growth rate. After 2014, the economy began to show some stability, but it was a period in which several investment programs stated to operate, which could also affect the dynamics of the trajectory. So, 2014 is an ideal base year, because besides enjoying some stability, it allowed to update SAM to the latest period using the latest household information such as the minimal wages.

The projection is for 16 years, covering the period 2014 to 2030. Our model is calibrated such that the shock manifests at t + 1, that is, in 2015. The projection for 2030 is carried out as to consider the lag and dissemination of trade policy over time. As a result, it is primarily the economic activity generated by change in relative prices what is widespread in the model during the first year of trade policy. The initial projection that generated the *baseline solution* is *Business as Usual* (BAU) simulation*,* where it is assumed 2 % growth corresponding to the growth of the stock of capital in the economy in the last decade. As the BAU reproduces the behavior of the model variables in the absence of the shock, the numerical values in the other scenarios are interpreted as being variations relative to the BAU.

*Trade policy simulations*

The trade liberalization policy is simulated based on two scenarios. The first scenario is the reduction of import tariffs, simultaneously and by sector. The shock size of this scenario is obtained by taking tariff data on product level provided by WTO before (Column 3) and after (Column 4) the Doha Round (Table 9). The size of the shock is given by tariffs prevailing in 2007 minus tariffs in 2001 applied by Guinea-Bissau to the products of the rest-of the-world (Scenario 1). For example, the size of the shock in the Millet sector is -9.00 (11.46-12.57). All other tariff shock sizes for each sector are calculated in the same way and they appear with negative values in the same column. A simultaneous shock is one in which the tariffs in all sectors are reduced at the same time, whereas a

shock by sector occurs when only the tariff in the Millet sector, for example, is reduced, leaving the other tariffs unchanged.

The scenario 2 consists to realize the shock based on the export taxes cuts. It refers to mentioned government's response in 2019 to the exporters claims that the export tax charge is too high. The government reduced taxes for exported products by 2.5 percent on April 2019. Therefore, our shock size in this scenario is based on this value across all exporter sectors (Table 9, Scenario 2). As in the scenario 1, we also carry out simultaneous and sector export taxes cuts.

TABLE 9 – Shock size for trade policy scenarios

| Sector | Code | Import Tariffs, 2001 | Import Tariffs, 2007 | Scenario1 | Scenario 2 |
|---|---|---|---|---|---|
| Millet | Sec1 | 12.57 | 11.46 | -9.00 | -2.50 |
| Sorghum | Sec2 | 12.57 | 11.46 | -9.00 | -2.50 |
| Maize | Sec3 | 17.61 | 15.85 | -10.00 | -2.50 |
| Rice | Sec4 | 12.66 | 11.10 | -12.00 | -2.50 |
| Fonio | Sec5 | 7.71 | 6.57 | -15.00 | -2.50 |
| Cotton | Sec6 | 11.44 | 9.59 | -16.00 | -2.50 |
| Other types of agriculture | Sec7 | 12.57 | 11.46 | -9.00 | -2.50 |
| Cashew nut | Sec8 | - | - | - | -2.50 |
| Breeding and hunting | Sec9 | 14.25 | 11.20 | -21.00 | |
| Forestry | Sec10 | - | - | - | -2.50 |
| Fishery products | Sec11 | - | - | - | |
| Mining industries | Sec12 | 5.57 | 4.52 | -19.00 | |
| Food products and beverages | Sec13 | 17.20 | 15.28 | -11.00 | -2.50 |
| Other industries | Sec14 | 11.55 | 10.07 | -13.00 | -2.50 |
| Electricity and water | Sec15 | - | - | - | |
| Construction sector | Sec16 | - | - | - | |
| Trading and repair | Sec17 | - | - | - | |
| Hotels and restaurants | Sec18 | - | - | - | |
| Transport and communications | Sec19 | - | - | - | |
| Financial services | Sec20 | - | - | - | |
| Real state and services to firms | Sec21 | 7.17 | 5.97 | -17.00 | |
| Public administration | Sec22 | - | - | - | |

SOURCE: Authors' elaboration.

*Productivity simulation*

The productivity scenario is unique in the sense that we perform only one productivity increase simulation for each sector based on the econometric estimates (Table 10). Total factor productivity for each industry ($TFP_{i,t}$) is estimated as a function of capital and labor factors ($FAC_t$), Logistic Performance Index ($OVLPI_t$), quality of

infrastructure ($INFRA$), exports ($EXP_t + \theta_5$) and the country fixed effects ($X_{i,t}$) – Equation 34.

$$TFP_{i,t} = \theta_1 FAC_t + \theta_2 OVLPI_t + \theta_3 INFRA_t + \theta_4 EXP_t + \theta_5 X_{i,t} \quad (34)$$

Productivity policy is evaluated only for sectors that we obtained data to estimate the econometric model. There is on service sector representing all service sectors in the activities account, two industries sector, and 11 agriculture sectors. The results of the above model allow us to design the productivity scenario. The residuals obtained from the sectorial TFP estimate (see Appendix F, Figure 1) are the size of the shocks used as a proxy for productivity increase. For instance, by estimating TFP in the Millet sector, we obtain a residual of 3.279. This value is then applied to analyze the effect of a 3.279% growth in the TFP in this sector on Guinea-Bissau economy outcomes. The shock size varies from one sector to another, being on average larger in the industrial sectors and smaller in the service sectors.

TABLE 10 – Shock size for productivity scenario

| Sector | Millet | Sorghum | Maize | Rice | Fonio | Cotton | Other agricul | Cashew | Hunting | Food | Services |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | Sec1 | Sec2 | Sec3 | Sec4 | Sec5 | Sec6 | Sec7 | Sec8 | Sec9 | Sec13 | All services |
| Shock size | 3.279 | 4.969 | 6.250 | 1.473 | 7.946 | 1.340 | 0.118 | 1.974 | 1.368 | 4.349 | 0.3174 |

SOURCE: Authors' elaboration.

*Infrastructure simulations*

The public investment program in promoting national development through the construction of modern productive sectors is evaluated by considering different scenarios. The program covers the period from 2015 to 2025, with investments already applied between 2015 and 2018. It is worth to emphasize that it is the effect of public investments aimed at building new construction infrastructures that is widespread in the models; those investments for rehabilitation or maintenance are not considered. As an effect, the model can carry the cumulative effects of the infrastructures being built as well as their impacts

at the end of the program. Table 11 summarizes the main infrastructure scenarios to be simulated in the model.

TABLE 11 – Scenarios of infrastructure simulations

| **Reference Scenario** | |
|---|---|
| Business as Usual | Growth of 2 % per year of the 2015–2030 period (from t to t + 16) |
| **Simulations 1, 2, and 3** | |
| Scenario 1 | 10% increase in public investment program from 2015 to 2030 |
| Scenario 2 | 3.3 % increase in public investment program from 2015 to 2030 |
| Scenario 3 | 6.7 % increase in public investment program from 2015 to 2030 |
| **Simulation 4, 5, 6,7,8, and 9** | |
| Scenario 4 | $1 billion investment program of 16 years funded 100% by debt |
| Scenario 5 | $1 billion investment program of 16 years funded 50% by debt and 50 by sale taxes |
| Scenario 6 | $1 billion investment program of 16 years funded 50% by debt and 50% by transfers from abroad |
| Scenario 7 | $ 1 billion investment program of 16 years funded 50% by debt and 50% from firm tax |
| Scenario 8 | $1 billion investment program of 16 years funded 50% by debt and 50% from income tax |
| Scenario 9 | $1 billion investment program of 16 years funded 50% by debt and 50% from production tax |

SOURCE: Authors elaboration.

**Simulations 1, 2, and 3:** An amount of 1 billion announced for 10 years corresponds to a 100 million investments per year. In this case, new public investments are made based on a 10 per cent increase in public spending per year from 2015 to 2025. In order to considerer separately the effects of the investments already made and those planned, the time-calendar of this program is divided in two periods, from 2015 to 2018 and from 2019 to 2025. In the first 3 years the government invested 33 million and should invest the remainder 67 million in the upcoming years. For *scenario 1*, the shock size is 10% increase in new public investment from 2015 to 2030[7]. For *scenario2*, the shock size of 3.3 per cent corresponds to the proportion of money spent on public investments over the program budget in the first period, and 6.7 per cent is the proportion of the remainder spending over this budget in the second period (*Scenario 3*).

[7] Note that the program ends in 2025, but we extended simulation period until 2030 to take into account the lags in new public investments.

**Simulations 4, 5, 6, 7, 8, and 9:** That public investments may raise indebtedness is what underlies the present scenarios. The goal is to conduct a comparative analysis of various funding schemes for implementing the government program in 2015. By comparison, we assume that the official government can use different fiscal instruments and external resources to fund its investment package, as well as its current deficit. We assume also that the government has access to domestic private funding and other external resources. It is not the level of the current deficit that the government will use for its policy purposes, but rather the proportion of public debt to household, firms and to the rest of the world. Of course, if these shares increase then the current public debt should increase and in the next period the government must either cease investing or will incurs in high deficits. The extent to which private funding can increase the public deficit will depend on the interest rate. If it is unsustainable, that is, if the interest rate of the economy grows faster than the resources the government can earn as a benefit of the program, an increasing budget imbalance is expected as the government continues its investment initiatives. Otherwise, there will be a level of public revenue compatible with the current deficit and the public investment program is sustained.

Scenario 4 considers the case where the government uses the 100% of debt to fund its program for 16 years. In Scenario 5 the government uses half the debt and other half comes from indirect sales taxes as the funding mechanisms. In the next scenario, the government mixes the debt and external resources, the half coming from each source. In Scenarios 7 and 8 there is the possibility of taxing firms and households, respectively, at a margin corresponding to 50% of their incomes as resources needed for investments. To complete the required resources, the government must still increase its debt by 50%. In the last scenario (9), half of the resources available for funding comes from the public debt and the other half from production taxes.

## 4.6 MODEL CLOSURES

A closure can be defined as follows: (i) the number of endogenous variables must be consistent with the number of equations; and (ii) the set of declared equations is not structurally or numerically singular. The dynamic CGE model frees the modeler from the

task of designing the simulation closure, since this is important only in static models to which capital stock adjustment needs to be addressed properly.

The references scenarios are simulated with the model default closures, incorporating some assumptions regarding consumption and other expenses. It is assumed that disposable income after savings and transfers to other agents is entirely dedicated to household consumption and that household savings are a linear function of disposable income, which differs from the frequently used specification where savings are a fixed proportion of income. This is consistent with the socioeconomic characteristic of the households in poor countries like Guinea-Bissau where it is common for certain household categories to have negative savings.

This closure, however, may generate undesirable results since, according to DRLM (2012), if marginal propensity to save is equal to the average propensity to save, and if the first parameter is calibrated on negative observed savings, then fall in the poor households' income will increase their savings, or rising income leads to poorer household's indebtedness. The formulation of the model, however, circumvents this potential problem by introducing free parameter to determine the marginal propensity to save, rather than just calibrating the average propensity.

Marginal propensity to save can be either determined from literature or econometric estimation, and then the savings function intercept calibrated from the SAM. Such an intercept is determined to be negative for categories of households with negative savings, while the marginal propensity (the slope) is positive. In the default specification of BISSAU-DYN model (set from PEP models), the intercept can be indexed to both population growth rate and price index. If it indexed the population index, the intercept grows each period at the same rate $\eta_t$ as population growth rate. Also, this intercept can also be fully indexed to changes in the consumer price index. This latter case is useful for testing the model homogeneity by setting price elasticity at unity. The present study determined it using population growth rate of Guinea-Bissau, at 2 percent (see Appendix B.4, Table 6).

For the government, it is assumed that income tax is described as a linear function of the total income of households and firms. This specification makes it possible to differentiate the marginal rate of taxation from the average rate when a nonzero intercept

is determined, a specification as much as useful for fiscal policy modeling. The marginal rate of taxation can be obtained by estimating fiscal parameters. Given this propensity, the intercept is calibrated using SAM data. As in the case of households, in the default specification of the model, income tax intercepts (average rates of taxation) are time-indexed, and they grow each period at the same rate $\eta_t$ as population.

The small-country hypothesis is adopted; meaning that share of world trade for the Guinea-Bissau is small that it faces an infinitely elastic supply curve at the prevailing world price. From this hypothesis, exogeneity of world price of imports and exports is derived. But while it is often assumed that countries can always sell as much as they want in the world market at the current exogenous price, the default specification of the model assumes that Guinea-Bissau, for example, can increase its share of the world market by offering FOB price that is more advantageous than the given world price. This specification may be consistent with developing countries' strategy to promote their exports (DRLM, 2012). However, apart from being vulnerable to the retaliation of their partners, their impact on exports obviously depends on the elasticity of substitution and price-elasticity of export demand.

The model also specifies several constants and variables to grow at the same rate of population growth. The constants are the follows: households and firms' income tax function intercepts, intercept of the household transfers to government function, transfers from government, and from the rest of the world. Exogenous variables are labor supply; government current expenditures; current account balance; minimum consumption of commodities in the LES demand equations; changes in inventories; and public investment by category and by public sector industry (Table 12).

Table 12 – Default closure variables and simulation horizon

| **Exogenous** | **Specification** | | | **2015-2030** |
|---|---|---|---|---|
| Exchange rate | e.fx(time) | = | 1 | |
| Current account balance | CAB.fx(time) | = | CABO*pop(time); | 2.00 |
| Minimum consumption | CMIN.fx(i,h,time) | = | CMINO(i,h)*pop(time) | 2.00 |
| Government expenditures | G.fx(time) | = | GO*pop(time); | 2.00 |
| Public sector investment | IND.fx(k,pub,time)$KDO(k,pub) | = | INDO(k,pub)*pop(time); | 2.00 |
| Capital stock | KD.fx(k,j,t1)$KDO(k,j) | = | KDO(k,j); | |
| Labor supply | LS.fx(l,time) | = | LSO(l)*pop(time); | 2.00 |
| World prices of imports | PWM.fx(i,time) | = | PWMO(i); | 1.00 |
| World prices of exports | PWX.fx(i,time) | = | PWXO(i); | 1.00 |
| Inventory changes | VSTK.fx(i,time) | = | VSTKO(i)*pop(time); | 2.00 |
| **Constants** | | | | |
| Income taxes of households | ttdh0.fx(h,time) | = | ttdh0O(h)*pop(time); | 2.00 |
| Income taxes of businesses | ttdf0.fx(f,time) | = | ttdf0O(f)*pop(time); | 2.00 |

SOURCE: Own elaboration.

The assumption that exogenous variables and constants grow at the same rate as population growth in the economy enables the model to simulate the balanced growth path, to which all quantities grow at a constant rate of population growth, while the relative prices remain unchanged. The balanced growth test is equivalent to the dynamic CGE model homogeneity test (see DRLM, 2012). Homogeneous model confirms indirectly the assumption that only relative prices matter. The expected result is that exogenous variables (such as government current expenditures and current account balance) to grow at the same rate of population growth, but relative prices do not change, because of shock in the model numeraire (exchange rate). The results obtained confirm this prediction and BISSAU-DYN is a consistent CGE model (Appendix D, Table D.1).

The simulations for trade liberalization as well as productivity scenarios were performed using default closure, with the only exception that introducing productivity involves exogenously introducing it into the corresponding closure block. However, closures for simulating infrastructure investment scenarios change. The simulations of the scenarios 2, 3 and 4 are performed by changing the model's default closure. As the shock is done directly on the ITg (new investment in infrastructure), then both ITg and savings are kept fixed. Therefore, if initial ITg is 100 and the government decides to increase by 10 per cent that amount without changing its deficit, the savings should increase by 10

per cent. Keeping public expenditures as well as transfers as constant, according to (18), government revenue should increase by the same proportion. Meanwhile, for simulations from 5 to 10 (scenarios 4 to 9), we also change the model dynamic default closure. Now we let ITg to adjust to balance government current accounts and then scaling taxes and debt. That involves uncovering optimal levels of taxes and loans that would match a 10 percent increase in ITg.

# 5 RESULTS AND DISCUSSIONS

Simulation results are presented and discussed separately. We follow a sequence in which macroeconomic results are presented followed by sectoral ones, and we ended the discussion of each scenario with an analysis of the impacts of shocks at the household level, in terms of consumption and income. The general sequence is as follows: scenarios of trade liberalization (section 5.1), productivity scenario (section 5.2) and finally the infrastructure investment policy scenarios (5.3). The impacts of each shock are supposed to be propagated to the model variables according to assumptions previously stated. It is worth noting, however, that the most latent common feature among the results is that they are interpreted as percentage deviations from the BAU scenario.

## 5.1 *TRADE POLICY SIMULATIONS*

In each table we present simultaneously the results of scenarios 1 and 2, which represent unilateral decision to cut down imports tariff to product from abroad sources (as Panel A) and exports taxes policy (as Panel B), respectively. In general, we first discuss the results of scenario 1 and subsequently the results of scenario 2. It is worth emphasizing that simulation was performed in two steps, first reducing tariffs uniformly for all 12 imports sectors, and then cutting them separately for each importer sector according to the size of the shock. Conversely, we cut down export taxes uniformly for all exporter sectors and for each specific exporter.

### 5.1.1 Macroeconomic results

The effects of the trade liberalization on standard macroeconomic aggregates depend on the shock size and the sector where tariff cuts policy effectively occurred. The effects of such policy change in signal over the period, but the percentage deviations from the BAU scenario show that reductions in import tariffs decrease real GDP after the shock occurred (Table 13, Panel A). The impacts

of simultaneous shocks are more intense and, although tariff reductions do not decrease real output at the end of simulations, except for the food and beverages sector, the small recovery from 2024 onwards is not enough to counteract the initial negative effects, since the accumulated result is negative even in 2030.

This result is consistent with the prevailing trade pattern of the country, since 89% of current imports are food products. Reducing tariffs for this sector means that more tons of imports in this category are being unloaded at the port, pulling down the trade balance. We will see below that the increase in aggregate imports, not offset by the exported quantum, is responsible for the fall in the level of economic activity when the shock is made in the food and beverage industry.

In contrast, the exports taxes reduction policy has lasting and stable impacts on GDP (Table 13, Panel B). Its impacts on real GDP are more intense in the first period for both simultaneous and individual taxes reduction, but larger for simultaneous cuts over the time horizon. Simultaneous negative export taxes shocks effects on real GDP range from 0.686 to 19.088 percent deviation from the BAU scenario. The cumulative value for the entire period is almost 50 percent.

The positive effects prevail with export taxes cut by specific sector. Reducing export taxes on cashew nuts has greater effects than reduction in any other sector. Effects on real GDP due to the exports tax reduction in this sector range from 0.155 to 3.284 percentage deviation from BAU, with accumulated value of 4.340 percent. These effects propagated in our model confirm the observed trend of the importance of cashews, which represents 90% of current exports.

TABLE 13– Deviation (%) compared to BAU scenario for real GDP

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Total* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Scenario 1 - Impacts of simultaneous and sector import tariff reduction** | | | | | | | | | | | | | | | | | |
| Simul | -0.959 | -0.500 | -0.380 | -0.279 | -0.198 | -0.135 | -0.084 | -0.042 | -0.008 | 0.016 | 0.038 | 0.051 | 0.063 | 0.07 | 0.078 | 0.08 | -2.189 |
| Millet | -0.078 | -0.036 | -0.027 | -0.019 | -0.013 | -0.008 | -0.004 | -0.001 | 0.002 | 0.003 | 0.005 | 0.006 | 0.007 | 0.008 | 0.008 | 0.008 | -0.139 |
| Sorg. | 0.004 | -0.037 | -0.029 | -0.023 | -0.018 | -0.014 | -0.011 | -0.008 | -0.006 | -0.004 | -0.003 | -0.002 | -0.001 | -0.001 | 0.000 | 0.000 | -0.153 |
| Maize | -0.065 | -0.035 | -0.027 | -0.019 | -0.013 | -0.009 | -0.005 | -0.002 | 0.001 | 0.002 | 0.004 | 0.005 | 0.006 | 0.006 | 0.007 | 0.007 | -0.137 |
| Rice | -0.068 | -0.035 | -0.027 | -0.019 | -0.013 | -0.009 | -0.005 | -0.002 | 0.001 | 0.003 | 0.004 | 0.005 | 0.006 | 0.007 | 0.007 | 0.007 | -0.138 |
| Fonio | -0.210 | -0.047 | -0.034 | -0.022 | -0.013 | -0.006 | 0.000 | 0.005 | 0.008 | 0.011 | 0.014 | 0.015 | 0.016 | 0.017 | 0.018 | 0.018 | -0.210 |
| Cotton | -0.210 | -0.047 | -0.034 | -0.022 | -0.013 | -0.006 | 0.000 | 0.005 | 0.008 | 0.011 | 0.014 | 0.015 | 0.016 | 0.017 | 0.018 | 0.018 | -0.210 |
| Agrig. | -0.011 | -0.036 | -0.028 | -0.022 | -0.017 | -0.012 | -0.009 | -0.007 | -0.004 | -0.003 | -0.001 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | -0.146 |
| Hunting | -0.152 | -0.041 | -0.029 | -0.020 | -0.012 | -0.006 | -0.001 | 0.003 | 0.006 | 0.009 | 0.010 | 0.012 | 0.013 | 0.013 | 0.014 | 0.014 | -0.167 |
| Mining | -0.163 | -0.042 | -0.030 | -0.020 | -0.012 | -0.006 | -0.001 | 0.003 | 0.007 | 0.009 | 0.011 | 0.012 | 0.014 | 0.014 | 0.015 | 0.015 | -0.174 |
| Food | 0.147 | -0.068 | -0.058 | -0.051 | -0.045 | -0.040 | -0.037 | -0.034 | -0.032 | -0.030 | -0.028 | -0.027 | -0.026 | -0.025 | -0.024 | -0.024 | -0.402 |
| Ot.ind | -0.147 | -0.040 | -0.029 | -0.020 | -0.012 | -0.006 | -0.001 | 0.003 | 0.006 | 0.008 | 0.010 | 0.011 | 0.012 | 0.013 | 0.013 | 0.014 | -0.165 |
| R.State | -0.006 | -0.036 | -0.028 | -0.022 | -0.017 | -0.013 | -0.010 | -0.007 | -0.005 | -0.003 | -0.002 | -0.001 | 0.000 | 0.000 | 0.001 | 0.001 | -0.148 |
| **Panel B: Scenario 2 - Impacts of simultaneous and sector export taxes reduction** | | | | | | | | | | | | | | | | | |
| Simul | 19.088 | 5.596 | 4.887 | 4.258 | 3.700 | 3.207 | 2.773 | 2.391 | 2.057 | 1.765 | 1.512 | 1.293 | 1.104 | 0.942 | 0.804 | 0.686 | 49.937 |
| Millet | 0.822 | 0.228 | 0.197 | 0.170 | 0.146 | 0.125 | 0.107 | 0.091 | 0.078 | 0.066 | 0.056 | 0.047 | 0.040 | 0.034 | 0.029 | 0.024 | 2.000 |
| Sorghum | 1.122 | 0.317 | 0.275 | 0.238 | 0.205 | 0.177 | 0.152 | 0.130 | 0.111 | 0.094 | 0.08 | 0.068 | 0.058 | 0.049 | 0.042 | 0.035 | 1.124 |
| Maize | 1.373 | 0.394 | 0.342 | 0.297 | 0.257 | 0.222 | 0.191 | 0.164 | 0.140 | 0.120 | 0.102 | 0.087 | 0.074 | 0.063 | 0.054 | 0.046 | 1.376 |
| Rice | 1.615 | 0.470 | 0.410 | 0.356 | 0.309 | 0.268 | 0.231 | 0.199 | 0.171 | 0.146 | 0.125 | 0.107 | 0.091 | 0.077 | 0.066 | 0.056 | 1.618 |
| Fonio | 1.019 | 0.286 | 0.248 | 0.214 | 0.185 | 0.159 | 0.136 | 0.116 | 0.099 | 0.084 | 0.072 | 0.061 | 0.051 | 0.044 | 0.037 | 0.031 | 1.021 |
| Cotton | 1.939 | 0.575 | 0.503 | 0.439 | 0.382 | 0.332 | 0.287 | 0.248 | 0.214 | 0.184 | 0.158 | 0.135 | 0.115 | 0.099 | 0.084 | 0.072 | 1.943 |
| Agrig. | 2.073 | 0.619 | 0.542 | 0.474 | 0.413 | 0.359 | 0.312 | 0.270 | 0.233 | 0.200 | 0.172 | 0.147 | 0.126 | 0.108 | 0.092 | 0.079 | 2.077 |
| Cashew | 3.284 | 1.050 | 0.930 | 0.821 | 0.724 | 0.637 | 0.559 | 0.490 | 0.427 | 0.372 | 0.323 | 0.280 | 0.242 | 0.209 | 0.180 | 0.155 | 4.340 |
| Forestry | 0.474 | 0.129 | 0.111 | 0.095 | 0.081 | 0.070 | 0.059 | 0.050 | 0.043 | 0.036 | 0.030 | 0.026 | 0.022 | 0.018 | 0.015 | 0.013 | 1.000 |
| Food | 1.756 | 0.515 | 0.450 | 0.392 | 0.340 | 0.295 | 0.255 | 0.220 | 0.189 | 0.162 | 0.139 | 0.119 | 0.101 | 0.086 | 0.074 | 0.063 | 1.759 |
| Ot. Ind | 1.471 | 0.424 | 0.369 | 0.321 | 0.278 | 0.240 | 0.207 | 0.178 | 0.152 | 0.130 | 0.111 | 0.095 | 0.081 | 0.069 | 0.058 | 0.050 | 1.474 |
| Restau | 0.531 | 0.145 | 0.125 | 0.107 | 0.092 | 0.078 | 0.067 | 0.057 | 0.048 | 0.041 | 0.034 | 0.029 | 0.024 | 0.021 | 0.017 | 0.015 | 1.000 |
| Transp. | 0.966 | 0.270 | 0.234 | 0.202 | 0.174 | 0.150 | 0.128 | 0.109 | 0.093 | 0.079 | 0.067 | 0.057 | 0.048 | 0.041 | 0.035 | 0.029 | 3.000 |
| R.State | 0.643 | 0.176 | 0.152 | 0.131 | 0.112 | 0.096 | 0.082 | 0.070 | 0.059 | 0.050 | 0.042 | 0.036 | 0.03 | 0.025 | 0.021 | 0.018 | 2.000 |

SOURCE: Author elaboration. Model results. *Total Accum (total accumulated deviations): represents the sum of annual percentage deviations from the BAU scenario. Simul: Simultaneous import tariff or export taxes reductions.

The imports increase for all types of imports tariff cuts, while exports decreased considerably. Simultaneous negative imports tariff shocks resulted in a positive deviation of more than 25 percent of aggregate imports and a reduction of -5.270 percent of aggregate exports regarding to BAU scenario. Imports and exports increased and decreased, respectively, because trade liberalization led to a fall in the price of imports while increasing the price of exported goods (Table 14, Panel A). Aggregate investment and government consumption fell by -0.692 and -2.620 percent, respectively.

The sectoral results follow this same simultaneous cutoff pattern, mainly in terms of signs of the percentage values obtained. In terms of the size of the effect, it appears that different shocks in different sectors have different magnitudes. For example, 9% reduction in import tariffs in the millet sector accounted for an increase in imports by 1.710 percent and decreased in exports by -0.425 percent. This policy would be also responsible for reducing aggregate investments and government consumption by -0.065 percent and -0.621 percent, respectively.

Overall, the same results are observed for sector 2 (sorghum) through Sector 9 (Mining) and sector 13 (food and beverage) and sector 14 (other industries). However, one thing that stands out is the response to the reduction in import tariffs in the food and beverage sector: an 11% drop in import tariffs reduced aggregate investments by -0.150 percent in this economy. This loss of investment occurred because, although spending on imports was high, there was not an enough volume of imports of capital goods that could translate into higher investments. As a results, we found that the drop in prices of the composite good that could potentially benefit investment spending occurred due to the fall in import prices, and not necessarily due to the increase in the amount of composite good available in this economy, which remained constant and even decreasing in some periods.

Unlike the impacts obtained in response to the shocks in other sectors, the liberalization of the food and beverage increased government real consumption by 0.496 percent. In this model, real government consumption is only a function of two nominal variables, nominal government expenditure and the public expenditures price index. The nominal expenditure is exogenous, so that the government adjusts

its real consumption to the public good price change. In principle, the price of the public good depends more on internal than external variables. However, government consumption may adjust to external factors even if this price is not directly affected, since import tariffs are also an important source of government revenue. So, tariffs reduction indirectly affects the public budget. Government consumption reduces, because we see that the government's income has also reduced as a result of this policy.

Simultaneous exports taxes cuts resulted in a positive deviation of 16.515 percent of aggregate exports, while decrease imports in almost the same percentage (Table 14, Panel B). This is expected results since variation in export rates operates in the same way as variation in the exchange rate for goods facing international competition. In the present model, reductions in the export tax rate on exported commodities will generate a decrease in the FOB price. For a given world price, external demand for national products should increase, and an increase in exports is made at the expense of decreasing imports. Therefore, the gains from exports resulting from the lowering the price of the national product in foreign markets justifies why reductions in export taxes are a pro-export policy working in the same way as exchange rate devaluations.

Aggregate investment increased by 6.317 percent, but government consumption decreased by -3.427 percent. The positive investment value was underpinned by policy in the maize, cotton and cashew sectors. The positive investment value is directly associated with the increase in aggregate income that the increase in exports would have generated. In other words, reductions in these taxes improved the balance of trade, increased aggregate income, shifting the demand curve from the initial equilibrium to a new equilibrium point with lower investment price. This reduction in the price of new investment will increase investment demand, which magnifies the initial export taxes cuts effects on aggregate product.

TABLE 14 - Aggregate macroeconomic variables at the end of simulation*

| Panel A: Scenario 1 - Impacts of simultaneous and sector import tariff reduction | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Simul | Millet | Sorghum | Maize | Rice | Fonio | Cotton | Agrig. | Hunting | Mining | Food | Ot.ind | R.State |
| Imports | 25.600 | 1.710 | 0.135 | 1.494 | 1.545 | 3.561 | 3.561 | 0.462 | 2.838 | 2.986 | 4.281 | 2.770 | 0.355 |
| Exports | -5.270 | -0.425 | -0.046 | -0.373 | -0.385 | -0.854 | -0.854 | -0.124 | -0.699 | -0.735 | -0.001 | -0.682 | -0.099 |
| Investment | -0.692 | -0.065 | -0.012 | -0.072 | -0.094 | -0.020 | -0.020 | -0.043 | -0.074 | -0.044 | -0.150 | -0.042 | -0.056 |
| Gov.Consumption* | -2.620 | -0.621 | -0.628 | -0.190 | -0.291 | -0.479 | -0.479 | -0.225 | -0.001 | -0.332 | 0.496 | -0.850 | -0.028 |
| Export price | 0.570 | 0.059 | 0.006 | 0.052 | 0.054 | 0.107 | 0.107 | 0.017 | 0.098 | 0.103 | 0.140 | 0.095 | 0.013 |
| Import price | -5.200 | -0.672 | -0.353 | -0.234 | -0.336 | -0.050 | -0.050 | -0.754 | -0.111 | -0.452 | -0.282 | -0.955 | -0.951 |
| Cons. price index | 3.931 | 0.300 | 0.317 | 0.140 | 0.410 | 0.275 | 0.275 | 0.893 | 0.791 | 0.705 | -0.919 | 0.376 | 0.374 |
| **Panel B: Scenario 2 - Impacts of simultaneous and sector exports taxes reduction** | | | | | | | | | | | | | |
| Variable | Simul | Millet | Sorghum | Maize | Rice | Fonio | Cotton | Agrig. | Cashew | Forestry | Food | Ot. Ind | |
| Import | -16.500 | -0.630 | -0.884 | -1.111 | -1.345 | -0.795 | -1.684 | -1.834 | -3.536 | -0.355 | -1.488 | -1.204 | |
| Exports | 16.515 | 0.591 | 0.853 | 1.094 | 1.346 | 0.76 | 1.716 | 1.88 | 3.737 | 0.319 | 1.502 | 1.194 | |
| Investment | 6.317 | 0.139 | 0.497 | **0.797** | 0.414 | 0.271 | **0.977** | 0.531 | 0.222 | 0.014 | 0.729 | 0.207 | |
| Gov.Consumption | - 3.427 | -0.411 | -3.427 | -0.332 | -0.249 | -0.070 | -0.55 | -0.113 | -0.841 | -0.326 | -0.805 | -0.697 | |
| Export price | -2.308 | -0.082 | -0.119 | -0.153 | -0.188 | -0.106 | -0.240 | -0.263 | -0.524 | -0.044 | -0.21 | -0.167 | |
| Import price | 13.631 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | 0.974 | |
| Cons. price index | 4.320 | 0.264 | 0.638 | 0.03 | 0.588 | 0.13 | 0.033 | 0.170 | 0.291 | 0.048 | 0.599 | 0.633 | |

SOURCE: Author elaboration. Model results. Agrig represents other agriculture sector; Hunting the breeding and hunting sector , Food the food and beverage sector, O. ind the Other industries sector, , Restau: the Hotels and restaurants sector, Transp thet Transport and communications, and R. state is real state and services to firms sector. *GAP compared to the BAU. Gov.Consumption: Government Consumption.

### 5.1.2 Sectoral results

Sector-level results are in terms of the sector's aggregate output. Due to the number of sectors reported, we split the simulation results from the two scenarios into two tables. Three lessons can be drawn from Table 15. First, that imports tariff cuts negatively affect the service sectors is what prevail in most simulations performed, both sectoral and simultaneously.

Second, the production of cashew nuts has been negatively affected by simultaneous import tariff reduction policies. This helps to explain the GDP result obtained, that is, it is the behavior of cashew nut production that justifies, for example, why the positive response in some agricultural sector production to the simultaneous shock did not translate into an increase in aggregate real output.

Third, in general, tariff cuts by sector benefits food industries more, with a value that ranges from 0.012 to 0.154 percent and further hurts the cashew nut sector. Reducing tariffs of 11% in the national food and beverage industry decreases production of seven agricultural sectors, namely millet, sorghum, maize, rice, fonio, cotton, and other agriculture, with percentage variation in relation to the reference scenario that ranging from -0.137 to -0.972 depending on the sector. It also reduces the production of industrial sectors and hotels and restaurants. However, we see that shock in the food and beverage sector that reduced output in the agricultural and service sectors did not further affects negatively aggregate output because it resulted in higher cashew production.

The characteristics of the national production sectors are important to determine these results. Given the country's dependence on food products, reducing the import tariff will increase the import coefficient. Since the domestic production is made with local and imported inputs, we saw that the increase in imports translated into higher production of the cashew nut sector. That is, the effects of the shocks that our model propagates are derived from changes in relative prices that have affected cashew nut production to a lesser or greater extent.

In fact, we have seen in previous results that government consumption was positive following a negative shock in tariffs in the food and beverage sector, but we

also saw that this same policy increased production in the cashew nut sector, which is the most dynamic sector in this economy. We see in an unreported table that government revenue from firms, probably as a production tax, increased by 3% as cashew nut production increased by 0.222 percent as a response to the imports tariff reduction in the food and beverage sector.

Meanwhile, the impacts of export taxes reductions are more direct, i.e. they do not change considerably from one shock to another (Table 16). A general observation is that only three sectors (millet, construction, and other industries) responded negatively to the fall in export taxes, while the remaining 19 sectors of the economy benefited from this policy. Therefore, the positive effects on the level of economic activity are underpinned by the growth in production of the majority economy's sectors as the government reduces current exports taxes.

This result is associated with the performance of the export sector, whose effect of folding favored the production of the national sectors. In other words, the increase in world demand due to the lower FOB price generated growth in exports, which translated into positive economic growth. Over time, this growth in aggregate product was sustained by an increase in investment demand, resulting in increased production in national sectors including those that do not export.

In addition, the results suggest the potential of current policy to promote diversification in the economy. In fact, we observe that in each period the amount of investment of the sectors grows in the same direction as the growth of capital accumulation and that sectors producing capital goods have also experienced growth in their production. This signals that the policy of reducing taxes on exports may be important for the government to start creating instruments that encourage investments in non-traditional sectors, which are those not directly linked to agriculture.

TABLE 15 - Scenario 1: GAP compared to BAU scenario for industry output

| Value added | Simul | Millet | Sorghum | Maize | Rice | Fonio | Cotton | Agrig. | Hunting | Mining | Food | Ot.ind | R.State |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Millet | 4.070 | 0.403 | 0.040 | 0.353 | 0.365 | 0.833 | 0.833 | 0.115 | 0.665 | 0.699 | -0.972 | 0.649 | 0.090 |
| Sorghum | 0.180 | 0.020 | -0.001 | 0.017 | 0.018 | 0.042 | 0.042 | 0.003 | 0.034 | 0.036 | -0.066 | 0.033 | 0.002 |
| Maize | 0.170 | 0.019 | -0.001 | 0.016 | 0.017 | 0.040 | 0.040 | 0.003 | 0.032 | 0.034 | -0.062 | 0.031 | 0.002 |
| Rice | 0.366 | 0.039 | -0.001 | 0.033 | 0.034 | 0.084 | 0.084 | 0.007 | 0.066 | 0.070 | -0.116 | 0.065 | 0.004 |
| Fonio | 0.140 | 0.016 | -0.002 | 0.014 | 0.014 | 0.034 | 0.034 | 0.002 | 0.028 | 0.029 | -0.057 | 0.027 | 0.001 |
| Cotton | 0.380 | 0.039 | 0.001 | 0.033 | 0.035 | 0.083 | 0.083 | 0.008 | 0.066 | 0.069 | -0.106 | 0.064 | 0.006 |
| Other agriculture | 0.454 | 0.047 | -0.001 | 0.040 | 0.042 | 0.102 | 0.102 | 0.009 | 0.081 | 0.085 | -0.137 | 0.079 | 0.006 |
| Cashew nut | -0.980 | -0.096 | -0.012 | -0.084 | -0.087 | -0.197 | -0.197 | -0.029 | -0.157 | -0.165 | 0.220 | -0.154 | -0.023 |
| Breeding and hunt. | -0.006 | 0.001 | -0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 | 0.001 | 0.001 | -0.012 | 0.001 | -0.001 |
| Forestry | 0.102 | 0.012 | -0.002 | 0.010 | 0.011 | 0.026 | 0.026 | 0.001 | 0.021 | 0.022 | -0.046 | 0.021 | 0.00 |
| Fishery products | 0.241 | 0.028 | -0.006 | 0.024 | 0.025 | 0.065 | 0.065 | 0.001 | 0.051 | 0.054 | -0.114 | 0.050 | -0.001 |
| Mining industries | 0.138 | 0.011 | 0.006 | 0.010 | 0.010 | 0.020 | 0.020 | 0.007 | 0.016 | 0.017 | -0.002 | 0.016 | 0.006 |
| Food products | 0.935 | 0.089 | 0.012 | 0.078 | 0.081 | 0.185 | 0.185 | 0.028 | 0.147 | 0.154 | -0.190 | 0.143 | 0.023 |
| Other industries | 0.205 | 0.014 | 0.017 | 0.014 | 0.014 | 0.016 | 0.016 | 0.016 | 0.014 | 0.014 | 0.040 | 0.014 | 0.016 |
| Electricity and water | -0.025 | -0.003 | 0.001 | -0.003 | -0.003 | -0.008 | -0.008 | 0.000 | -0.006 | -0.007 | 0.016 | -0.006 | 0.001 |
| Construction | -0.500 | -0.059 | 0.016 | -0.049 | -0.052 | -0.139 | -0.139 | 0.000 | -0.109 | -0.115 | 0.245 | -0.106 | 0.005 |
| Trading and repair | 0.045 | 0.004 | 0.001 | 0.004 | 0.004 | 0.009 | 0.009 | 0.001 | 0.007 | 0.008 | -0.009 | 0.007 | 0.001 |
| Hotels and rest. | -0.627 | -0.060 | -0.010 | -0.053 | -0.054 | -0.121 | -0.121 | -0.020 | -0.097 | -0.102 | 0.121 | -0.095 | -0.017 |
| Transport-com. | 0.072 | 0.007 | 0.001 | 0.006 | 0.006 | 0.015 | 0.015 | 0.002 | 0.012 | 0.012 | -0.017 | 0.011 | 0.002 |
| Financial services | -0.025 | -0.002 | -0.001 | -0.002 | -0.002 | -0.004 | -0.004 | -0.001 | -0.003 | -0.003 | 0.002 | -0.003 | -0.001 |
| Real state Serv. | -1.077 | -0.103 | -0.017 | -0.091 | -0.094 | -0.208 | -0.208 | -0.035 | -0.166 | -0.175 | 0.211 | -0.162 | -0.029 |
| Public administ | -0.557 | -0.055 | -0.006 | -0.048 | -0.050 | -0.113 | -0.113 | -0.016 | -0.09 | -0.095 | 0.130 | -0.088 | -0.013 |

SOURCE: Author elaboration.

TABLE 16 – Scenario 2: GAP compared to BAU scenario for industry output

| Value added | Simul | Millet | Sorghum | Maize | Rice | Fonio | Cotton | Agrig. | Cashew | Forestry | Food | Ot. Ind |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Millet | -0.062 | -0.075 | -0.083 | -0.089 | -0.071 | -0.095 | -0.097 | -0.127 | -0.041 | -0.092 | -0.086 | -0.045 |
| Sorghum | 0.037 | 0.052 | 0.066 | 0.08 | 0.047 | 0.100 | 0.108 | 0.193 | 0.020 | 0.088 | 0.072 | 0.023 |
| Maize | 0.037 | 0.053 | 0.067 | 0.082 | 0.048 | 0.103 | 0.112 | 0.202 | 0.020 | 0.091 | 0.073 | 0.023 |
| Rice | 0.026 | 0.037 | 0.047 | 0.058 | 0.033 | 0.073 | 0.079 | 0.144 | 0.014 | 0.064 | 0.052 | 0.016 |
| Fonio | 0.036 | 0.052 | 0.065 | 0.079 | 0.046 | 0.098 | 0.106 | 0.188 | 0.020 | 0.087 | 0.071 | 0.023 |
| Cotton | 0.012 | 0.018 | 0.023 | 0.029 | 0.015 | 0.038 | 0.042 | 0.082 | 0.006 | 0.033 | 0.025 | 0.007 |
| Other agri | 0.026 | 0.038 | 0.049 | 0.060 | 0.034 | 0.077 | 0.084 | 0.159 | 0.014 | 0.067 | 0.054 | 0.015 |
| Cashew | 0.046 | 0.063 | 0.077 | 0.092 | 0.057 | 0.111 | 0.119 | 0.202 | 0.027 | 0.100 | 0.083 | 0.030 |
| B.Hunting | 0.036 | 0.050 | 0.063 | 0.076 | 0.045 | 0.093 | 0.100 | 0.171 | 0.020 | 0.083 | 0.068 | 0.023 |
| Forestry | 0.028 | 0.039 | 0.049 | 0.058 | 0.035 | 0.071 | 0.076 | 0.123 | 0.016 | 0.064 | 0.053 | 0.018 |
| Fishery | 0.115 | 0.163 | 0.207 | 0.251 | 0.146 | 0.314 | 0.341 | 0.621 | 0.063 | 0.278 | 0.225 | 0.071 |
| Mining | 0.005 | 0.011 | 0.017 | 0.025 | 0.009 | 0.039 | 0.046 | 0.148 | 0.001 | 0.031 | 0.020 | 0.002 |
| Foof | 0.002 | 0.009 | 0.018 | 0.028 | 0.007 | 0.045 | 0.054 | 0.171 | -0.001 | 0.035 | 0.022 | -0.001 |
| Other ind. | -0.062 | -0.081 | -0.095 | -0.105 | -0.075 | -0.115 | -0.117 | -0.047 | -0.037 | -0.11 | -0.099 | -0.041 |
| Electri | 0.002 | 0.004 | 0.007 | 0.010 | 0.004 | 0.015 | 0.017 | 0.057 | 0.001 | 0.012 | 0.008 | 0.001 |
| Const | -0.123 | -0.172 | -0.215 | -0.257 | -0.155 | -0.315 | -0.34 | -0.575 | -0.069 | -0.282 | -0.232 | -0.078 |
| Trading | 0.000 | 0.001 | 0.001 | 0.002 | 0.000 | 0.003 | 0.003 | 0.011 | 0.000 | 0.002 | 0.001 | 0.000 |
| Hotels | 0.054 | 0.075 | 0.092 | 0.108 | 0.068 | 0.131 | 0.14 | 0.229 | 0.031 | 0.118 | 0.099 | 0.035 |
| Transp | 0.005 | 0.008 | 0.01 | 0.013 | 0.007 | 0.016 | 0.018 | 0.039 | 0.003 | 0.014 | 0.011 | 0.003 |
| Financial | 0.002 | 0.003 | 0.004 | 0.004 | 0.003 | 0.005 | 0.005 | 0.008 | 0.001 | 0.005 | 0.004 | 0.002 |
| Real Stat | 0.072 | 0.098 | 0.119 | 0.140 | 0.089 | 0.167 | 0.178 | 0.282 | 0.042 | 0.152 | 0.127 | 0.047 |
| Public | 0.026 | 0.036 | 0.044 | 0.053 | 0.032 | 0.066 | 0.072 | 0.132 | 0.015 | 0.059 | 0.048 | 0.016 |

SOURCE: Author elaboration.

### 5.1.3 Results at household level

The discussion on potential welfare effects of trade-tariff-based policies starts by looking at what happens in the labor market (Table 17). Trade liberalization by simultaneously reducing import tariffs (Panel A) on agricultural products increased the employment of both skilled and unskilled workers, but the skilled ones increased faster. This policy benefited more the poorest workers in both categories, with a cumulative percentage deviation ranging from 0.690 to 2.347 for the unskilled worker and from 1.129 to 1.322 for the skilled worker earning up to two minimal wages.

In individual terms, the employment of each type of work is sustained by cuts in specific sectors. Lowering tariffs on imports of millet, maize, rice, fonio and cotton products increased more the employment of unskilled and skilled workers receiving lower minimal wage. In fact, the higher percentage of employment resulting from the simultaneous cut for unskilled worker receiving a minimum wage was due to the sectoral employment impact of individual cuts in these sectors where this worker is potentially employed.

Import tariffs reduction for the mining sector increased employment more than any other sector, while tariff reductions in the food and beverage sector reduced workers' employment. The positive impact of the mining sector is justified by the fact that tariff cuts in this sector increased investments in the agricultural and industrial sectors, increasing their total output, which increased the demand for employment in both urban and rural areas, that is, for skilled and unskilled workers. Conversely, because negative import tariffs shocks in the food and beverage sector have reduced investments in the agricultural and industrial sectors, where most of the population is employed, their negative and more intense impacts on workers' employment receiving less minimal wages is not surprising. We found that shocks that resulted in higher employment did so because they affected labor prices to a greater or lesser extent. In particular, we found that food sector shocks increased the price of labor, which was responsible for reducing the demand for composite labor in industries and resulting in less sectoral employment.

Although their benefits are different among workers by category and type, export taxes shocks impact positively aggregate employment (Table 17, Panel B). Notable in this policy are the jobs creation resulting from the taxes shocks in the cashew nut sector, which further increased intra and inter-category employment. For instance, the difference in the percentage of employment between an unskilled worker earning up to one minimum wage (UKS1) and another same type of worker but earning up to 10 minimal wages (USK6) is 4.137 percent. For the same type of skilled workers, this difference is 0.336 percent in favor of one who receives up to one minimum wage. In short, in response to the export tax shocks, employment of unskilled labor increases by up to 5 percent more than skilled labor one. Next, we examine whether this employment gain among less skilled workers can translate into more income and consumption opportunities, which potentially suggest some distributive effect of the policies implemented.

TABLE 17 - Unskilled and skilled employment at the end of simulation

| Worker | USK1 | USK2 | USK3 | USK4 | USK5 | USK6 | SK1 | SK2 | SK3 | SK4 | SK5 | SK6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Scenario 1 - Impacts of simultaneous and sector import tariff reduction** | | | | | | | | | | | | |
| Simul | 2.347 | 0.690 | 0.622 | 0.467 | 0.455 | 0.465 | 1.322 | 1.129 | 0.968 | 0.721 | 0.581 | 0.566 |
| Millet | 0.119 | 0.099 | 0.085 | 0.066 | 0.059 | 0.054 | 0.181 | 0.151 | 0.129 | 0.100 | 0.090 | 0.082 |
| Sorg. | 0.008 | 0.007 | 0.006 | 0.004 | 0.004 | 0.004 | 0.012 | 0.010 | 0.009 | 0.007 | 0.006 | 0.005 |
| Maize | 0.103 | 0.086 | 0.074 | 0.057 | 0.052 | 0.047 | 0.158 | 0.131 | 0.113 | 0.088 | 0.079 | 0.072 |
| Rice | 0.107 | 0.089 | 0.076 | 0.059 | 0.054 | 0.049 | 0.163 | 0.136 | 0.116 | 0.091 | 0.082 | 0.074 |
| Fonio | 0.830 | 0.059 | 0.066 | 0.044 | 0.056 | 0.076 | 0.140 | 0.130 | 0.112 | 0.071 | 0.030 | 0.047 |
| Cotton | 0.831 | 0.059 | 0.066 | 0.044 | 0.056 | 0.076 | 0.140 | 0.130 | 0.112 | 0.071 | 0.030 | 0.047 |
| Agrig. | 0.031 | 0.026 | 0.022 | 0.017 | 0.015 | 0.014 | 0.047 | 0.039 | 0.034 | 0.026 | 0.024 | 0.021 |
| Hunting | 0.198 | 0.165 | 0.141 | 0.110 | 0.099 | 0.09 | 0.301 | 0.251 | 0.215 | 0.167 | 0.150 | 0.137 |
| Mining | 0.208 | 0.173 | 0.148 | 0.115 | 0.104 | 0.094 | 0.316 | 0.264 | 0.226 | 0.176 | 0.158 | 0.144 |
| Food | -0.304 | -0.254 | -0.217 | -0.169 | -0.152 | -0.138 | -0.466 | -0.388 | -0.333 | -0.259 | -0.233 | -0.212 |
| Ot.ind | 0.193 | 0.161 | 0.138 | 0.107 | 0.096 | 0.088 | 0.294 | 0.245 | 0.21 | 0.163 | 0.147 | 0.133 |
| R.State | 0.023 | 0.020 | 0.017 | 0.013 | 0.012 | 0.011 | 0.036 | 0.030 | 0.025 | 0.020 | 0.018 | 0.016 |
| **Panel B: Scenario 2 - Impacts of simultaneous and sector exports taxes reduction** | | | | | | | | | | | | |
| Simul | 17.768 | 1.929 | 1.654 | 1.286 | 1.158 | 1.052 | 2.634 | 2.195 | 1.882 | 1.464 | 1.317 | 1.197 |
| Millet | 0.630 | 0.068 | 0.058 | 0.045 | 0.041 | 0.037 | 0.094 | 0.078 | 0.067 | 0.052 | 0.047 | 0.043 |
| Sorghum | 0.905 | 0.098 | 0.084 | 0.065 | 0.059 | 0.054 | 0.134 | 0.112 | 0.096 | 0.075 | 0.067 | 0.061 |
| Maize | 1.161 | 0.126 | 0.108 | 0.084 | 0.076 | 0.069 | 0.172 | 0.143 | 0.123 | 0.096 | 0.086 | 0.078 |
| Rice | 1.430 | 0.155 | 0.133 | 0.104 | 0.093 | 0.085 | 0.212 | 0.177 | 0.151 | 0.118 | 0.106 | 0.096 |
| Fonio | 0.807 | 0.087 | 0.075 | 0.058 | 0.052 | 0.048 | 0.120 | 0.100 | 0.086 | 0.067 | 0.060 | 0.054 |
| Cotton | 1.832 | 0.199 | 0.171 | 0.133 | 0.119 | 0.109 | 0.271 | 0.226 | 0.194 | 0.151 | 0.136 | 0.123 |
| Agrig. | 2.011 | 0.219 | 0.188 | 0.146 | 0.131 | 0.119 | 0.298 | 0.248 | 0.213 | 0.165 | 0.149 | 0.135 |
| Cashew | 4.162 | 0.453 | 0.388 | 0.302 | 0.272 | 0.247 | 0.616 | 0.514 | 0.440 | 0.342 | 0.308 | 0.280 |
| Forestry | 0.344 | 0.037 | 0.032 | 0.025 | 0.022 | 0.020 | 0.051 | 0.043 | 0.037 | 0.028 | 0.026 | 0.023 |
| Food | 1.599 | 0.174 | 0.149 | 0.116 | 0.104 | 0.095 | 0.237 | 0.197 | 0.169 | 0.132 | 0.118 | 0.108 |
| Ot. Ind | 1.267 | 0.138 | 0.118 | 0.092 | 0.083 | 0.075 | 0.188 | 0.156 | 0.134 | 0.104 | 0.094 | 0.085 |

SOURCE: Author elaboration. Model results.

At household level, we analyzed whether tariff reductions on imports and exports have the same effects on rural and urban households. A general inspection of the results reported in Table 18 suggests that, *ceteris paribus*, simultaneous cut in import tariffs has positive impacts on rural and urban household incomes. Households with higher wages earn substantially higher incomes than those with lower minimal wages in both rural and urban environments. In other words, in the shock of import tariff cuts, it is the households with the highest income that benefit most, both in rural and urban areas. But with the same initial wage, negative shocks in import tariffs increase rural household incomes more than the urban household ones. The incomes gap between rural and urban households earning up to one minimum wage is 0.019 percent, while the income gap between rural and urban household earning up to 10 minimal wages is 0.327, both in favor of rural household.

Sectoral shocks impacts are more varied as not all sectors have contributed to increasing household incomes. In fact, an 11% reduction in import tariffs on food and beverage production contributes to lower incomes in rural and urban areas, with more severe negative impacts on rural households that receive less minimal wages. This seems to be somewhat counterintuitive, as household consumption is heavily based on food products the country is a net importer. In this case, lowering tariffs on imports of these products, by decreasing the imported good prices on the domestic market, it should therefore increase household incomes rather than lower them.

However, our model captures these effects through the labor market, particularly with regard to factor remuneration. This follows the fact that trade liberalization for the products of food and beverage sector was responsible for reducing investments, employment and sectoral product, while generating a fall in wages. As wages decreased and there was no compensatory increase in transfers received from other agents, then household incomes fell dramatically. This result is also not counterintuitive as the drop in GDP reduces employment and consequently consumption, with a greater effect mainly in the categories of households that are more employed in the agricultural sectors.

Impacts of export tax reductions on household incomes are more direct. Like import tariff shocks, both uniform and sectoral export tax cuts increased rural and urban households' incomes. Tax cuts in the cashew nut sector accounted for most of the gains, with a percentage deviation ranging from 0.445 to 0.623 percent for rural households receiving one and 10 minimal wages, respectively.

In general, export tax cuts policy increased more household incomes than trade liberalization policy based on negative shocks in import tariffs. Even more important is the fact that the export scenario benefits more households with lower income. The reason for this is directly associated with the performance of the sectors after each shock. In this scenario, the agricultural sectors are most benefited and, as they employ many households in the lowest income categories, the increase in their production increased the demand for employment and consequently income of such households.

Taking into account the dynamic structure of the present model, households whose income is growing faster after the shock will accumulate greater wealth along the growth trajectory and, at the end of the period, they will be in better situations than in their initial positions before the policies implementation. The implication of this is that the export promotion policy instruments that are being used for the country's socioeconomic development or, more specifically, for poverty alleviation, should be deepened, since the result shows the improvement of the condition of the poorest households, mainly in rural areas, after the shock is delivered.

TABLE 18 - Rural and urban household income at the end of simulation*

| Household | HR1 | HR2 | HR3 | HR4 | HR5 | HR6 | HU1 | HU2 | HU3 | HU4 | HU5 | HU6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Scenario 1 - Impacts of simultaneous and sector import tariff reduction** | | | | | | | | | | | | |
| Simul | 1.422 | 1.824 | 1.912 | 1.945 | 1.978 | 1.993 | 1.403 | 1.840 | 1.939 | 1.973 | 2.013 | 1.672 |
| Millet | 0.142 | 0.181 | 0.190 | 0.193 | 0.197 | 0.198 | 0.140 | 0.183 | 0.193 | 0.196 | 0.200 | 0.142 |
| Sorg. | 0.012 | 0.016 | 0.017 | 0.017 | 0.017 | 0.017 | 0.012 | 0.016 | 0.017 | 0.017 | 0.018 | 0.012 |
| Maize | 0.124 | 0.159 | 0.166 | 0.169 | 0.172 | 0.174 | 0.122 | 0.160 | 0.169 | 0.172 | 0.175 | 0.124 |
| Rice | 0.128 | 0.164 | 0.172 | 0.175 | 0.178 | 0.179 | 0.126 | 0.165 | 0.174 | 0.177 | 0.181 | 0.128 |
| Fonio | 0.293 | 0.376 | 0.394 | 0.401 | 0.408 | 0.411 | 0.289 | 0.379 | 0.399 | 0.406 | 0.414 | 0.418 |
| Cotton | 0.293 | 0.376 | 0.394 | 0.401 | 0.408 | 0.411 | 0.289 | 0.379 | 0.399 | 0.406 | 0.414 | 0.418 |
| Agrig. | 0.039 | 0.050 | 0.053 | 0.054 | 0.055 | 0.055 | 0.039 | 0.051 | 0.054 | 0.055 | 0.056 | 0.039 |
| Hunting | 0.234 | 0.300 | 0.315 | 0.320 | 0.325 | 0.328 | 0.231 | 0.302 | 0.319 | 0.325 | 0.331 | 0.234 |
| Mining | 0.246 | 0.316 | 0.331 | 0.337 | 0.342 | 0.345 | 0.243 | 0.318 | 0.335 | 0.341 | 0.348 | 0.246 |
| Food | -0.348 | -0.446 | -0.468 | -0.476 | -0.484 | -0.488 | -0.343 | -0.448 | -0.473 | -0.481 | -0.490 | -0.348 |
| Ot.ind | 0.229 | 0.293 | 0.307 | 0.312 | 0.318 | 0.320 | 0.225 | 0.295 | 0.311 | 0.317 | 0.323 | 0.229 |
| R.State | 0.030 | 0.039 | 0.041 | 0.042 | 0.042 | 0.043 | 0.030 | 0.040 | 0.042 | 0.042 | 0.043 | 0.030 |
| **Panel B: Scenario 2 - Impacts of simultaneous and sector exports taxes reduction** | | | | | | | | | | | | |
| Simul | 2.049 | 2.625 | 2.754 | 2.800 | 2.847 | 2.872 | 1.955 | 2.559 | 2.698 | 2.747 | 2.799 | 2.825 |
| Millet | 0.077 | 0.098 | 0.103 | 0.105 | 0.107 | 0.107 | 0.074 | 0.096 | 0.102 | 0.103 | 0.105 | 0.106 |
| Sorghum | 0.109 | 0.139 | 0.146 | 0.149 | 0.151 | 0.152 | 0.104 | 0.136 | 0.144 | 0.146 | 0.149 | 0.150 |
| Maize | 0.138 | 0.176 | 0.185 | 0.188 | 0.191 | 0.193 | 0.132 | 0.172 | 0.182 | 0.185 | 0.188 | 0.190 |
| Rice | 0.167 | 0.214 | 0.225 | 0.229 | 0.233 | 0.234 | 0.160 | 0.209 | 0.220 | 0.225 | 0.229 | 0.231 |
| Fonio | 0.097 | 0.125 | 0.131 | 0.133 | 0.135 | 0.137 | 0.093 | 0.122 | 0.129 | 0.131 | 0.134 | 0.135 |
| Cotton | 0.211 | 0.270 | 0.283 | 0.288 | 0.293 | 0.295 | 0.201 | 0.263 | 0.277 | 0.282 | 0.287 | 0.290 |
| Agrig. | 0.230 | 0.294 | 0.309 | 0.314 | 0.319 | 0.322 | 0.219 | 0.287 | 0.302 | 0.308 | 0.313 | 0.316 |
| Cashew | 0.445 | 0.570 | 0.598 | 0.608 | 0.618 | 0.623 | 0.421 | 0.551 | 0.581 | 0.592 | 0.603 | 0.609 |
| Forestry | 0.043 | 0.055 | 0.057 | 0.058 | 0.059 | 0.060 | 0.041 | 0.054 | 0.057 | 0.058 | 0.059 | 0.059 |
| Food | 0.186 | 0.238 | 0.250 | 0.254 | 0.258 | 0.260 | 0.177 | 0.232 | 0.244 | 0.249 | 0.254 | 0.256 |
| Ot. Ind | 0.149 | 0.191 | 0.201 | 0.204 | 0.208 | 0.209 | 0.143 | 0.187 | 0.197 | 0.201 | 0.204 | 0.206 |

SOURCE: Author elaboration. Model results. *The numerical values represent percentage variation regarding to BAU.

We also examine whether the policies implemented have affected the household consumption pattern. We simultaneously analyze the impacts of two policies, making comparisons of the potential gain obtained for each type of household according to the shock performed (Table 19). As in the previous case, simultaneous tariff reductions increase rural household consumption by 0.019 percent more than urban households receiving up to a minimum wage (HR1 and HU1). For households in the middle range of income distribution, that is, those who receive up to 4 minimum wages (HR3 and HU3), the consumption difference is 0.027 in favor of the rural household.

Rural household consumption increases more with simultaneous export tax cuts than consumption achieved with simultaneous import tariff reductions. For instance, simultaneous export tax shocks increase by 1.112 percent more the consumption of rural households receiving up to a minimum wage (HR1) than shocks in import tariffs.

The difference in consumption of urban households verified after each shock is more pronounced. Simultaneous export tax cuts accounted for increasing urban household consumption receiving up to a minimum wage (HU1) by 1.290 percent, while imports tariff cuts did so with a percentage of 0.064 percent, that is, the former policy increase the poorest household's consumption by 1.226 percent more than the latter one.. However, as we move to the household receiving higher initial wages, we see that the difference of the two results regarding to consumption drops significantly.

This is consistent with the result previously analyzed. The consumption of the rural household in the lower tail of the distribution range is increasing more than the consumption of any household because their income has increased more than the income of any household after the shock of export taxes. This policy positively impacted household consumption more than the policy based on cutting import tariffs, because it had a more intense impact on the income than the results achieved by the last policy.

Meanwhile, the export tax reduction policy has benefited relatively less the sectors that employ higher-income workers. Household income in this range then

grew less as did consumption. Thus, the smallest difference in the results obtained from consumption of households that receive higher wages obtained through the two policies also reflects the more intense sectoral impact achieved by these policies.

The same pattern of simultaneous shock is repeated in sectoral policies. However, three things should be highlighted in the latter. First, negative import tariff shocks, which reduced incomes for both rural and urban households, were also responsible for decreasing their consumption. This was not expected as more imports are expected to increase a mix of consumer goods. However, as discussed, this reduction in consumption is justified because household incomes have been sharply reduced once the government unilaterally decided to remove barriers to imports by negatively shocking imports tariffs.

Second, the increase in income from export tax cuts translated into increased in households' consumption. Our model propagates this effect directly through relative price changes that have increased exports, and indirectly through increased in employment and households' income that are involved in cashew nut production. The direct effects of increased exports may beneficiate more heavily urban households that are responsible for cashew nut trading activities, while the indirect effects may have been the greatest impacts on rural households, whose employment has increased most with this policy.

The impacts of negative export tax shocks on cashew nut exports are absolute in that they increase the consumption of rural households more than the urban households one. Finally, this policy will benefit most households that receive the least minimum wage, including those in the urban environment. The difference in the percentage of consumption between the rural household receiving up to one minimum wage (HR1) and its urban counterpart in the same distribution range (HU1) is 0.180 percent. In addition, the HR1 household increases its consumption by 0.165 percent more than the urban household that receives by up to 10 minimal wages (HU6).

TABLE 19 - Rural and urban household consumption at the end of simulation*

| Household | HR1 | HR2 | HR3 | HR4 | HR5 | HR6 | HU1 | HU2 | HU3 | HU4 | HU5 | HU6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panel A: Scenario 1 - Impacts of simultaneous and sector import tariff reduction** | | | | | | | | | | | | |
| Simul | 0.083 | 0.483 | 0.570 | 0.603 | 0.634 | 0.653 | 0.064 | 0.496 | 0.596 | 0.633 | 0.668 | 0.689 |
| Millet | 0.008 | 0.048 | 0.057 | 0.060 | 0.063 | 0.065 | 0.006 | 0.049 | 0.059 | 0.063 | 0.066 | 0.068 |
| Sorg. | 0.000 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.000 | 0.004 | 0.005 | 0.005 | 0.006 | 0.006 |
| Maize | 0.007 | 0.042 | 0.050 | 0.052 | 0.055 | 0.057 | 0.005 | 0.043 | 0.052 | 0.055 | 0.058 | 0.060 |
| Rice | 0.007 | 0.043 | 0.051 | 0.054 | 0.057 | 0.059 | 0.006 | 0.044 | 0.053 | 0.057 | 0.060 | 0.062 |
| Fonio | 0.018 | 0.100 | 0.118 | 0.125 | 0.132 | 0.135 | 0.014 | 0.103 | 0.123 | 0.131 | 0.138 | 0.142 |
| Cotton | 0.018 | 0.100 | 0.118 | 0.125 | 0.132 | 0.135 | 0.014 | 0.103 | 0.123 | 0.131 | 0.138 | 0.142 |
| Agrig. | 0.002 | 0.013 | 0.015 | 0.016 | 0.017 | 0.018 | 0.001 | 0.013 | 0.016 | 0.017 | 0.018 | 0.019 |
| Hunting | 0.014 | 0.080 | 0.094 | 0.100 | 0.105 | 0.108 | 0.011 | 0.082 | 0.098 | 0.104 | 0.110 | 0.113 |
| Mining | 0.015 | 0.084 | 0.099 | 0.105 | 0.110 | 0.113 | 0.011 | 0.086 | 0.103 | 0.109 | 0.116 | 0.119 |
| Food | -0.021 | -0.119 | -0.141 | -0.149 | -0.157 | -0.161 | -0.015 | -0.121 | -0.145 | -0.154 | -0.163 | -0.168 |
| Ot.ind | 0.014 | 0.078 | 0.092 | 0.097 | 0.102 | 0.105 | 0.010 | 0.080 | 0.096 | 0.102 | 0.107 | 0.111 |
| R.State | 0.001 | 0.010 | 0.012 | 0.013 | 0.013 | 0.014 | 0.001 | 0.010 | 0.013 | 0.013 | 0.014 | 0.015 |
| **Panel B: Scenario 2 - Impacts of simultaneous and sector exports taxes reduction** | | | | | | | | | | | | |
| Simul | 1.195 | 0.617 | 0.488 | 0.442 | 0.394 | 0.370 | 1.290 | 0.684 | 0.545 | 0.495 | 0.443 | 0.417 |
| Millet | 0.041 | 0.020 | 0.015 | 0.013 | 0.011 | 0.010 | 0.044 | 0.021 | 0.016 | 0.014 | 0.012 | 0.011 |
| Sorghum | 0.060 | 0.030 | 0.023 | 0.021 | 0.018 | 0.017 | 0.065 | 0.033 | 0.025 | 0.023 | 0.020 | 0.019 |
| Maize | 0.079 | 0.040 | 0.031 | 0.028 | 0.025 | 0.023 | 0.085 | 0.044 | 0.034 | 0.031 | 0.028 | 0.026 |
| Rice | 0.097 | 0.050 | 0.040 | 0.036 | 0.032 | 0.030 | 0.105 | 0.056 | 0.044 | 0.040 | 0.036 | 0.034 |
| Fonio | 0.054 | 0.026 | 0.020 | 0.018 | 0.016 | 0.014 | 0.058 | 0.029 | 0.022 | 0.020 | 0.017 | 0.016 |
| Cotton | 0.126 | 0.066 | 0.053 | 0.048 | 0.043 | 0.041 | 0.135 | 0.073 | 0.059 | 0.054 | 0.049 | 0.046 |
| Agrig. | 0.138 | 0.073 | 0.059 | 0.054 | 0.048 | 0.046 | 0.149 | 0.081 | 0.066 | 0.060 | 0.054 | 0.051 |
| Cashew | 0.278 | 0.152 | 0.124 | 0.114 | 0.103 | 0.098 | 0.302 | 0.171 | 0.140 | 0.130 | 0.118 | 0.113 |
| Forestry | 0.022 | 0.010 | 0.007 | 0.006 | 0.005 | 0.005 | 0.023 | 0.011 | 0.008 | 0.007 | 0.006 | 0.005 |
| Food | 0.109 | 0.057 | 0.045 | 0.041 | 0.037 | 0.035 | 0.118 | 0.063 | 0.050 | 0.046 | 0.041 | 0.039 |
| Ot. Ind | 0.086 | 0.044 | 0.034 | 0.031 | 0.028 | 0.026 | 0.093 | 0.048 | 0.038 | 0.035 | 0.031 | 0.029 |

SOURCE: Author elaboration. Model results. *The numerical values represent percentage variation regarding to BAU.

What we can conclude from these results? Are they suggesting anything about any potential gain from trade liberalization? No matter what path we take to answer these questions, whether in terms of their consistency with standard theory or their convergence or not to current empirical results, we must think more about the economic features of this country.

As previously mentioned, Guinea-Bissau is a country with an underperforming agricultural-based-economy supported by cashews nuts production. In this country, there are different households living in rural and urban environment; these households receive different starting wages, and their consumption depends on sales of agricultural surpluses and food imports, which makes them hostage to the world economy fluctuations and thus to relative price changes. So, such changes affect households differently depending on their skills levels and or initial income before the shock. The skill levels determine the sector in which they found employment opportunities after the shock, and the initial wage level characterizes the economic potential of the individual to participate in mutually beneficial exchanges.

There is positive impact of import tariffs reductions in the last simulation period, although in early years this policy negatively affected the level of economic activity. Except for the food sector whose tariff reduction impacts were negative along the trajectory, the cumulative negative deviations stem from the immediate negative impacts that affected down macroeconomic aggregates, such as aggregate investments, exports, and government consumption. The decrease in the level of economic activity was mainly driven by the reduction in investments and production of the cashew nut sector. Employment has been sustained thanks to the positive impacts on the sectors where each worker is historically employed; that is, increased agricultural sectors output benefited the least unskilled workers and increased industrial sectors output benefited more skilled workers.

Our result shows that liberalizing trade through tariff reductions will not worsen the long-term consumption of poor households in both rural and urban settings. This positive impact stems from the labor income they earned during the openness, as we observed a decrease in incomes from the government transfers, possibly because of decreasing in government revenue.

These results are consistent with standard trade theory. While trade liberalization short and medium-term effects depend on the context, in the long-term, it is expected to contribute to economic growth and poverty reduction in developing countries (WTO, 2001). The possible negative short-run impacts are linked to the delay in contracts renegotiating and more generally in the relative price adjustments. In such a situation, economic theory predicts that a country's tariff cuts, for example, tends to trigger relative price changes unfavorably to its economy.

This is the result explained by the inverse relationship between demand and price. Since domestic demand for imports is a function of the price of the imported good at the domestic market, and that this price is the sum of the international price and the tariff that acting as the addition of a cost of transportation, tariff reduction will lead to an decrease in domestic price of the imported good (see Rutherford and Paltsev, 1999), which increases demand for imports.

For countries that export only a small share of their production, demanding more imports can generate negative external savings and increased external indebtedness. However, as domestic production is performed by combining inputs from different origins, basically domestic and imported, import prices decreasing mean that activities are using more imported composite goods as intermediate inputs in production process. If taxes, endowment and supply prices remain unchanged, firm’s profit increase, as well as its output. Firm will then hire workers and households’ consumption will increase. The increase in demand for total output will increase the supply price and firm will also gain. Therefore, for developing countries, conventional trade theory states that trade liberalization is a feasible way that leads to the redistribution of wealth and increases aggregated welfare.

Our results corroborate with these insights as well as with a recent growing body of literature analyzing the effect of trade liberalization through negative import tariff shocks, such as those of Aredo *et al.* (2012), Chitinga *et al.* (2005), Annabi *et al* (2005), and Durongkaveroj (2014). However, it contrasts Decaluwé *et al* (2008) or Aka (2006), and Nwafor *et al*. (2007) studies.

Meanwhile, our results show that export taxes reductions have positive effects on economics variables. However, the discussions of export taxes impact in the current applied trade literature are not deep as those of import variation. For instance, According to Solleder (2013), the rise of export taxes relative to other trade policy measures may be explained by a lack of discipline on export taxes in the WTO law. GATT in its article XI stipulates only that export should not be subject to quantitative restrictions, but does not determine any obligation on the maximum level of export taxes defined, which makes countries take advantage of this loophole by using these taxes as restrictions on exports of raw materials.

Typically, newly acceding countries can restrict their export taxes in a similar way to restrictions on import tariffs (WTO Accession Negotiations, 2012). However, as such bindings becomes a recurring trade policy strategy, legal provisions are usually put in place to correct the problem. For example, Mexico, the United States and the European Union filed won a lawsuit against China that bound raw material exports. The claim was that China did not respect its entry commitment when taxing export products outside of those contained in its Protocol of Accession (WTO Dispute Settlement, 2012).

Argentina is another nation that use export taxes as an alternative to trade policy. After a sharp devaluation of the exchange rate in 2002, the government established an export tax for all products, with heterogeneous rates: higher for the main agri-food and petroleum export products and lower for processed products, such as heavy manufactures (Cicowiez et al, 2016). After 2019 election, the first trade measure carried out by President Alberto Fernandes was to change the tariff scale for all agricultural products.

It is worth emphasizes that neither China nor Argentina are only examples of nations whose governments use export taxes an important trade measure. Countries like Indonesia, Ukraine, Russia, Zimbabwe, and even Brazil in the past, are usually classified as leaders (in terms of the value of the tax) imposing differential export taxes on grain and oilseed products (Deese and Reeder, 2007). Proceedings like the one filed jointly by Mexico, the United States and the European Union against China highlight the possibility for countries to

take advantage of loopholes in trade regulations, just as it raises concerns about the use of export taxes as instruments of trade policy.

Thus, in light of the tariffs hereby implemented, we cannot establish a claim of whether this theory is confirmed or not. First, because the size of import tariff shocks differed from that of export tax shocks. Second, the shocks were not performed in some sectors. In such a context, the proposed neutrality could not be prevailing for economic outcomes. The cost structure of tariffs on consumption greatly explained our results.

Prewo (1978), when analyzing trade costs for Latin America, had already provided a plausible explanation of the results that trade liberalization in the food sector would have behaved differently than the same policy but for the cashew nut sector, for example. The fact is that transportation costs for both directions are mixed with tariff and tax costs in economies heavily dependent on specific sectors, usually agricultural. That is, reducing import tariffs for a product in a sector whose domestic consumption is based tends to reduce global trade costs, increases imports in the short run, but in the long-term, the government are required to review their initial decisions, raising the other trade costs such as transport costs in order to keep constant their revenues. If the government eventually decides not to change other taxes, the increase in capital goods imports due to increased domestic consumption means that the proportion of capital in total sector investments is increasing. This could increase the growth of the policy-focused-sector as well as related sectors, production and even exports. Our results show that this effect occurred in our model and was responsible for increased production in the sectors that benefited from reduced import tariffs in the food and beverage sector.

## 5.2 PRODUCTIVITY SIMULATION

The results of the sector positive shocks in the productivity parameters are summarized below. As in the previous section, we first discuss the macroeconomic results and then turns to those at the household level. The direct impacts of the productivity shock occur through its effects on production costs. However, sector discussion in this section is approached somewhat different from

those of the previous section, where it was focused more on analyzing the industry product after an exogenous shock. The discussion here focuses on verifying the behavior of factor returns and their implications for household incomes.

### 5.2.1 Economic activities

An increase in millet sector productivity immediately impacts GDP by 0.057% per year. Over time, due to capital depreciation, the impacts are smoothed, and in 2030 GDP would have been increased by 0.045% per year, a decrease of 0.012% from the initial impact (Table 20). However, this shock has effects that are recursively accumulated from one period to another, so that at the end of the simulation, we find that GDP will increase by 0.778%, a value 14 times greater than the manifested initial impact. Positive productivity shocks in the sorghum sector result in a larger GDP, even in the 2030 (0.080 %). Like the millet sector, the positive initial effects are diminishing over time and constants over the last three periods.

The cumulative percentage shows that between 2015 to 2030, increased sorghum productivity will result in a 1.084 percent increase in GDP in this economy. GDP reacts well to increased productivity in the maize sector, whose immediate effect at 2015 is 0.145 %. These effects are also decreasing and constants from one period to the next, and they last and accumulate over time, resulting in an increase of 1.987 GDP over the whole simulation period.

Rice productivity increase has positive effect on GDP and, although with a declining percentage over time, the cumulative deviation is 1.615 %. These accumulated gains will help keeping the impacts on GDP positives. This is the trend that we also verified for positive productivity shocks in the fonio, other agriculture, breeding and hunting, and cotton sectors, although we observed that the latter's impact on aggregate output is smaller compared to the cases already analyzed.

Productivity growth in the cashew nut sector immediately impacts GDP by 0.431 percent over BAU. Unlike previous sectors, the effects not dissipated rapidly over time and were above 0.20 percent at 2015 onwards. We found that

the positive variations on the productivity of the cashew nuts and the food and beverage sectors were more intense (with higher positive values) and persistent, with accumulated deviations of 5.186 and 5.218, respectively.

What explains the fact that GDP is positive for all productivity shocks? As discussed in chapter 2, increased productivity can trigger different effects on the economy, depending on its effect on wages and capital income. We have seen that the economy grows when shocks in total productivity imply lower production costs for the firm, but unclear when wide wage increases as well as the capital rent price.

The underlying idea of this lack of clarity is that we would not be able to identify whether, for example, the drop in demand for one of the factors along the trajectory was due to the substitution mechanisms carried out by the firm, since the prices of the two factors is rising. Even more important is the possibility of non-rational behavior on the firms' side, in which it reduces the employment of a factor with price below than that of factor whose employment remains constant or even increasing.

However, in our model, there is no irrational behavior, that is, the agents always optimize. Consumers with convex preferences will always seek to maximize their utility function subject to the budget constraint, while price-taker firms will always seek to minimize their cost function or (its duality) to maximize profit function given technologies constraint they face.

These behavioral assumptions allow for the substitution of factors, the most expensive factor being replaced by the less expensive one, because each firm has a set of information that allows it to monitor and make such optimizing decisions. We will see below that factor substitutions occur. However here, we must emphasize that productivity shocks decreased the price of the value added, which in turn is responsible for the drop in the unit cost of an industry's output. The firm increased demand for investments and sectoral production then grew. GDP growth was a result of this dynamism in the level of economic activity brought about by the productivity shock.

### 5.2.2 Employment, income, and consumption

Table 21 shows employment variations according to the worker qualification level and initial earnings. The results reported first in Columns 2 to 14 (USKI1 to SK6) are percentage changes in employment, Column 15 (Total) is the national employment response to productivity shocks, while the last column is the aggregate capital employment. The combination of the last two columns then shows the reallocation of the factors in the economy. It is precisely at that point we start the discussion in this subsection.

We find that sectors in which skilled workers' wages were growing faster over time replace skilled workers with unskilled workers whose wages were declining. The mechanisms that allowed these results is the growth in the demand for worker due to the increase in production. As the sector grows, it increases the demand for skilled workers, pushing up their wages. Similarly, the decline in wages has accompanied the decline in output of the industrial goods being produced. As to keep the level of production, firms react the price increasing by replacing the factor whose price is growing by another factor whose price is lower.

As noted, this is a such rational behavior that a firm adopts to take advantage of increased productivity shocks, whose initial impact is a drop in the price of added value and thus in the cost of production. In aggregate terms, the rise in the national wage pushed up the wide wage, which led to the substitution of labor for capital with lower production cost, that is, with the least expensive price.

Productivity increases in the millet, sorghum, rice, other agriculture, and breeding and hunting sectors led to reductions in demand for skilled labor and increased demand for unskilled workers. Except for the cotton sector, exogenous shocks in the agricultural sectors have benefited most the unskilled workers with lower minimal wages, although the percentages of those with relatively higher minimal wages are also positive. Overall, positive variations in productivity in the cashew nut, food and beverage, and service sectors were responsible for the increased demand for labor, which benefited the employment of both skilled and unskilled workers. Unskilled workers benefit most from positive productivity growth in the cashew sector, while skilled workers benefit most from increased productivities in the food and services sectors.

TABLE 20 - Gap compared to BAU scenario for real GDP (GDP_Real)

| Sector | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | Accum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Simul | 1.762 | 1.692 | 1.634 | 1.584 | 1.540 | 1.485 | 1.430 | 1.367 | 1.304 | 1.257 | 1.235 | 1.215 | 1.2 | 1.181 | 1.168 | 1.145 | 22.217 |
| Millet | 0.057 | 0.055 | 0.053 | 0.051 | 0.05 | 0.049 | 0.048 | 0.048 | 0.047 | 0.047 | 0.046 | 0.046 | 0.046 | 0.045 | 0.045 | 0.045 | 0.778 |
| Sorghum | 0.080 | 0.077 | 0.075 | 0.072 | 0.071 | 0.069 | 0.068 | 0.066 | 0.065 | 0.065 | 0.064 | 0.063 | 0.063 | 0.062 | 0.062 | 0.062 | 1.084 |
| Maize | 0.145 | 0.140 | 0.135 | 0.132 | 0.129 | 0.126 | 0.124 | 0.122 | 0.120 | 0.119 | 0.118 | 0.117 | 0.116 | 0.115 | 0.115 | 0.114 | 1.987 |
| Rice | 0.134 | 0.126 | 0.119 | 0.113 | 0.108 | 0.104 | 0.100 | 0.097 | 0.095 | 0.093 | 0.091 | 0.089 | 0.088 | 0.087 | 0.086 | 0.085 | 1.615 |
| Fonio | 0.145 | 0.140 | 0.135 | 0.132 | 0.129 | 0.126 | 0.124 | 0.122 | 0.12 | 0.119 | 0.118 | 0.117 | 0.116 | 0.115 | 0.115 | 0.114 | 1.987 |
| Cotton | 0.009 | 0.008 | 0.007 | 0.006 | 0.005 | 0.004 | 0.004 | 0.003 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.060 |
| Oth. agr. | 0.017 | 0.015 | 0.014 | 0.013 | 0.012 | 0.011 | 0.010 | 0.009 | 0.009 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 | 0.007 | 0.007 | 0.163 |
| Cashew | 0.431 | 0.421 | 0.418 | 0.413 | 0.408 | 0.390 | 0.365 | 0.330 | 0.290 | 0.260 | 0.255 | 0.251 | 0.248 | 0.243 | 0.238 | 0.225 | 5.186 |
| Hunting | 0.132 | 0.126 | 0.119 | 0.114 | 0.108 | 0.104 | 0.099 | 0.095 | 0.092 | 0.089 | 0.086 | 0.083 | 0.081 | 0.079 | 0.078 | 0.076 | 1.561 |
| Food | 0.391 | 0.377 | 0.365 | 0.355 | 0.346 | 0.338 | 0.331 | 0.325 | 0.319 | 0.315 | 0.311 | 0.307 | 0.304 | 0.302 | 0.299 | 0.297 | 5.282 |
| Services | 0.223 | 0.209 | 0.196 | 0.185 | 0.175 | 0.166 | 0.159 | 0.152 | 0.146 | 0.141 | 0.136 | 0.132 | 0.128 | 0.125 | 0.122 | 0.119 | 2.514 |

SOURCE: Authors' elaboration.

TABLE 21 - Aggregate employment at the end of simulation (2030)

| Sector | USK1 | USK2 | USK3 | USK4 | USK5 | USK6 | SK1 | SK2 | SK3 | SK4 | SK5 | SK6 | Total* | Capital |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Simul | 4.244 | 3.396 | 2.963 | 2.752 | 2.421 | 2.125 | 1.493 | 1.194 | 1.091 | 1.01 | 0.875 | 0.794 | 24.358 | 37.085 |
| Millet | 0.023 | 0.018 | 0.014 | 0.013 | 0.012 | 0.009 | -0.046 | -0.037 | -0.035 | -0.032 | -0.028 | -0.026 | -0.115 | 0.126 |
| Sorghum | 0.014 | 0.011 | 0.008 | 0.008 | 0.007 | 0.005 | -0.027 | -0.022 | -0.021 | -0.019 | -0.016 | -0.015 | -0.067 | 0.142 |
| Maize | 0.266 | 0.213 | 0.157 | 0.149 | 0.138 | 0.106 | -0.532 | -0.426 | -0.404 | -0.372 | -0.319 | -0.298 | -1.322 | 0.289 |
| Rice | 1.084 | 0.867 | 0.824 | 0.759 | 0.650 | 0.607 | -0.542 | -0.434 | -0.321 | -0.304 | -0.282 | -0.217 | 2.691 | 0.471 |
| Fonio | 0.532 | 0.426 | 0.404 | 0.372 | 0.319 | 0.298 | 0.266 | 0.213 | 0.157 | 0.1490 | 0.138 | 0.106 | 3.380 | 0.781 |
| Cotton | -0.150 | -0.120 | -0.089 | -0.084 | -0.078 | -0.060 | -0.300 | -0.240 | -0.228 | -0.210 | -0.180 | -0.168 | -1.907 | 0.076 |
| Oth. agr. | 0.038 | 0.030 | 0.023 | 0.021 | 0.020 | 0.015 | -0.076 | -0.061 | -0.058 | -0.053 | -0.046 | -0.043 | -0.190 | 3.335 |
| Cashew | 1.064 | 0.852 | 0.809 | 0.745 | 0.639 | 0.596 | 0.532 | 0.426 | 0.315 | 0.298 | 0.277 | 0.213 | 6.766 | 8.380 |
| Hunting | 0.132 | 0.106 | 0.078 | 0.074 | 0.069 | 0.053 | -0.265 | -0.212 | -0.201 | -0.185 | -0.159 | -0.148 | -0.658 | 1.280 |
| Food | 1.143 | 0.914 | 0.677 | 0.640 | 0.594 | 0.457 | 2.286 | 1.829 | 1.737 | 1.600 | 1.372 | 1.280 | 14.529 | 17.247 |
| Services | 0.098 | 0.079 | 0.058 | 0.055 | 0.051 | 0.039 | 0.197 | 0.158 | 0.150 | 0.138 | 0.118 | 0.110 | 1.251 | 4.958 |

SOURCE: Authors' elaboration. *Total represents the sum of the rows on the left, that is, the percentage of national employment variation due to the increase in sectoral productivity

We end our discussion by analyzing the welfare implications of the policy it adopts (Tables 22 and 23). Aggregate income rose with increased sector productivity, with values ranging from 0.027 to 4.543. The cashew nut and food and beverage sectors are responsible for this performance. Incomes are positive for all households with different initial wages, but it is rural households that have relatively high gains.

TABLE 22 -Household real income at the end of simulation (2030)

| Sector | HR1 | HR2 | HR3 | HR4 | HR5 | HR6 | HU1 | HU2 | HU3 | HU4 | HU5 | HU6 | Accum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Simul | 1.077 | 1.371 | 1.430 | 1.456 | 1.478 | 1.49 | 1.044 | 1.355 | 1.422 | 1.449 | 1.472 | 1.486 | 16.53 |
| Millet | 0.017 | 0.022 | 0.023 | 0.024 | 0.024 | 0.024 | 0.016 | 0.021 | 0.022 | 0.023 | 0.023 | 0.023 | 0.262 |
| Sorghum | 0.006 | 0.008 | 0.008 | 0.008 | 0.009 | 0.009 | 0.006 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.094 |
| Maize | 0.022 | 0.028 | 0.029 | 0.030 | 0.030 | 0.031 | 0.02 | 0.026 | 0.027 | 0.028 | 0.028 | 0.029 | 0.328 |
| Rice | 0.084 | 0.108 | 0.113 | 0.115 | 0.117 | 0.118 | 0.079 | 0.103 | 0.108 | 0.110 | 0.112 | 0.113 | 1.280 |
| Fonio | 0.140 | 0.178 | 0.186 | 0.190 | 0.193 | 0.194 | 0.140 | 0.182 | 0.191 | 0.195 | 0.198 | 0.200 | 2.187 |
| Cotton | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -.008 | -0.047 |
| Oth. agr. | 0.088 | 0.112 | 0.117 | 0.119 | 0.121 | 0.122 | 0.083 | 0.107 | 0.113 | 0.115 | 0.117 | 0.118 | 1.332 |
| Cashew | 0.286 | 0.364 | 0.381 | 0.387 | 0.393 | 0.397 | 0.296 | 0.384 | 0.404 | 0.411 | 0.418 | 0.422 | 4.543 |
| Hunting | 0.109 | 0.139 | 0.145 | 0.148 | 0.15 | 0.151 | 0.102 | 0.133 | 0.14 | 0.143 | 0.145 | 0.147 | 1.652 |
| Food | 0.221 | 0.282 | 0.296 | 0.301 | 0.306 | 0.308 | 0.210 | 0.274 | 0.289 | 0.294 | 0.299 | 0.302 | 3.382 |
| Services | 0.102 | 0.13 | 0.136 | 0.139 | 0.141 | 0.142 | 0.091 | 0.119 | 0.126 | 0.128 | 0.131 | 0.132 | 1.517 |

SOURCE: Authors' elaboration.

TABLE 23 - Household real consumption at the end of simulation (2030)

| Sector | HR1 | HR2 | HR3 | HR4 | HR5 | HR6 | HU1 | HU2 | HU3 | HU4 | HU5 | HU6 | Accum. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Simul | 0.785 | 1.404 | 3.189 | 3.677 | 3.88 | 4.066 | 3.455 | 3.089 | 3.624 | 3.812 | 4.007 | 4.107 | 38.248 |
| Millet | 0.064 | 0.088 | 0.093 | 0.095 | 0.097 | 0.098 | 0.059 | 0.083 | 0.088 | 0.090 | 0.092 | 0.093 | 0.976 |
| Sorghum | 0.075 | 0.105 | 0.112 | 0.114 | 0.117 | 0.118 | 0.068 | 0.099 | 0.107 | 0.109 | 0.112 | 0.113 | 1.174 |
| Maize | 0.134 | 0.195 | 0.209 | 0.214 | 0.219 | 0.221 | 0.124 | 0.187 | 0.202 | 0.207 | 0.212 | 0.215 | 2.205 |
| Rice | 0.127 | 0.156 | 0.162 | 0.164 | 0.167 | 0.168 | 0.117 | 0.145 | 0.152 | 0.154 | 0.156 | 0.157 | 1.698 |
| Fonio | 0.134 | 0.195 | 0.209 | 0.214 | 0.219 | 0.221 | 0.124 | 0.187 | 0.202 | 0.207 | 0.212 | 0.215 | 2.205 |
| Cotton | 0.008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.034 |
| Oth. agr. | 0.017 | 0.016 | 0.016 | 0.016 | 0.015 | 0.015 | 0.014 | 0.012 | 0.011 | 0.011 | 0.011 | 0.011 | 0.148 |
| Cashew | 0.083 | 0.275 | 0.318 | 0.333 | 0.349 | 0.357 | 0.106 | 0.325 | 0.375 | 0.393 | 0.411 | 0.421 | 3.746 |
| Hunting | 0.120 | 0.090 | 0.084 | 0.081 | 0.079 | 0.077 | 0.125 | 0.093 | 0.086 | 0.083 | 0.081 | 0.079 | 0.958 |
| Food | 0.008 | 0.152 | 1.823 | 2.273 | 2.434 | 2.601 | 2.686 | 1.829 | 2.238 | 2.383 | 2.532 | 2.609 | 23.415 |
| Services | 0.015 | 0.132 | 0.165 | 0.176 | 0.188 | 0.194 | 0.025 | 0.132 | 0.168 | 0.181 | 0.195 | 0.201 | 1.757 |

SOURCE: Authors' elaboration. Accum.: Accumulated.

Increases in income have translated into more consumption gains for households in both rural and urban settings (Table 22). Different factors explain this consumption. The rural households' consumption increased due to the increase in labor income and to a lesser extent by capital income. Government transfers are of little importance in explaining this consumption. Urban households are consuming more due to the increase in capital income, and labor income is little or not important to explain this consumption. The accumulated

wealth of households was responsible for explaining the growth in aggregate consumption in the country. In addition, much of rural household consumption is due to increased productivity in the cashew nut sector, while rural household consumption is due to increased productivity in the food and beverage sector.

## 5.3 INFRASTRUCTURE SIMULATIONS

We start the discuss with the results of scenarios 1,2 and 3, which represent a government decision to scale up new investments as to meet the policy of promoting the country's comparative advantages. These scenarios represent an increase in public investment by 10%, 3.3%, and 6.7%, respectively.

Then, we turn to the funding mechanisms, which are resources the government obtains to the infrastructure investment accomplishment purpose. In scenario 4 government uses the 100% of debt to attend its investment objectives, while in the scenario 5 he mixed debt and indirect sales taxes half from each funding source. In the scenario 6 the government mixes the debt and external resources, the half also coming from each source. In scenarios 7 and 8 the government uses taxes from firm and household incomes. In the last scenario 9, funds comes from the public debt and production taxes.

### 5.3.1 Scenarios 1, 2 and 3: An autonomous increase of new public investments

The effects of new investment on standard macroeconomic aggregates depend on the shock size and the period the government decides to increase the new public investment. *Ceteris paribus*, an increase in public investment will raise the production by the construction sector and produce externalities in subsequent periods in the model (Table 24). In fact, the growth generated by the construction of the new infrastructure is high with an increase in GDP of 0.454, 0.154 and 0.309%, respectively for scenario 1, 2 and 3, compared to the BAU scenario. This is followed by growth - generated by externalities of the investment program - ranging from 0.401, 0.135 and 0.272% for the second year to a maximum of 0.397, 0.134, and 0.269 % at the last year of the investment program (2016) and as we move further in time the externalities effects are decreased given that there is public capital depreciation.

Note that the amount required for investment purpose may not completely comes from public deficit, given that growth will increase government income and hence funding needs are below the amount announced for the investment program. We can see from Table 25 that government real income increases during greater economic growth periods and faster afterward to a maximum of 1.142. 0.369, and 0.759%, respectively for scenarios 1, 2, and 3 at the end of the simulation in 2030.

The increase in income is directly influenced by the stronger GDP growth generated by higher factors productivity (see Table 26). The deficit has increased as a result of these policies. However, current deficit starts to decrease even if funding needs are still present at the end of program in 2025, since GDP has shown a good performance through the program period, which provides enough additional government revenues to fund its investments (Table 27).

TABLE 24 - Gap compared to BAU for real GDP (GDP_Real)

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario1 | 0.454 | 0.401 | 0.366 | 0.344 | 0.333 | 0.329 | 0.330 | 0.335 | 0.341 | 0.349 | 0.358 | 0.366 | 0.374 | 0.382 | 0.390 | 0.397 |
| Scenario2 | 0.154 | 0.135 | 0.123 | 0.115 | 0.112 | 0.110 | 0.111 | 0.112 | 0.115 | 0.117 | 0.120 | 0.123 | 0.126 | 0.129 | 0.131 | 0.134 |
| Scenario3 | 0.309 | 0.272 | 0.247 | 0.233 | 0.225 | 0.222 | 0.223 | 0.226 | 0.231 | 0.236 | 0.242 | 0.247 | 0.253 | 0.259 | 0.264 | 0.269 |

SOURCE: Authors elaboration. Model results.

TABLE 25 - Gap compared to BAU for government real income (G Real)

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario1 | -2.123 | -1.278 | -0.632 | -0.148 | 0.210 | 0.472 | 0.661 | 0.798 | 0.897 | 0.968 | 1.02 | 1.058 | 1.087 | 1.109 | 1.127 | 1.142 |
| Scenario2 | -0.776 | -0.468 | -0.238 | -0.068 | 0.055 | 0.144 | 0.208 | 0.254 | 0.287 | 0.311 | 0.328 | 0.341 | 0.351 | 0.358 | 0.364 | 0.369 |
| Scenario3 | -1.495 | -0.901 | -0.452 | -0.118 | 0.127 | 0.305 | 0.433 | 0.526 | 0.592 | 0.64 | 0.675 | 0.701 | 0.72 | 0.735 | 0.747 | 0.757 |

SOURCE: Authors elaboration. Model results.

TABLE 26 - Aggregate employment (LDC) and Factors aggregate productivity

| Factors and Employment | Scenario 1 | Scenario2 | Scenario3 |
|---|---|---|---|
| Year | 2030 | 2030 | 2030 |
| Aggregate employment | 4.703 | 1.515 | 3.115 |
| Aggregate productivity | 0.134 | 0.046 | 0.091 |

SOURCE: Authors elaboration. Model results.

TABLE 27 - Gap compared to BAU for public debt (DEF)

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario1 | 58.406 | 46.396 | 36.032 | 27.589 | 21.006 | 16.038 | 12.375 | 9.713 | 7.794 | 6.412 | 5.409 | 4.673 | 4.122 | 3.698 | 3.363 | 3.089 |
| Scenario2 | 20.554 | 16.127 | 12.424 | 9.472 | 7.205 | 5.510 | 4.269 | 3.371 | 2.726 | 2.261 | 1.923 | 1.675 | 1.489 | 1.346 | 1.232 | 1.139 |
| Scenario3 | 40.365 | 31.877 | 24.662 | 18.844 | 14.341 | 10.959 | 8.473 | 6.670 | 5.372 | 4.437 | 3.759 | 3.261 | 2.888 | 2.600 | 2.373 | 2.186 |

SOURCE: Authors elaboration. Model results.

Results at sector level are presented in terms of the sector's aggregate output growth, as well as its external performance to increase or decrease exports. Table 28 reports results for both three scenarios in cumulative deviation and at end of simulation. Overall, in scenario 1, 18 out of 22 sectors had a positive accumulated percentage variation in their aggregate production regarding to the BAU, with highlights for the millet, rice, other agriculture, forestry, electricity and water and public administration sectors, whose percentages were higher. This pattern persists in other scenarios with the sharp decrease in the accumulated deviation mainly in scenario 2.

This slight drop in scenario 2 accumulated highlights the importance of public investments functioning as a complement to the private investments to encourage the sector's productivity. In fact, in this scenario, we scale public investments to reflect the lowest value of the amount spent between three scenarios. As a result, as the government invests in new constructions, the demand for products and services offered by firms also increases, increasing their production and the need for private investments. The higher production of the sectors mentioned above is an immediate reflection of the increase in their productivity following the period of the public investments shocks.

The Sorghum, maize, fonio and other industries sectors did not respond positively to the increase in new public investment, instead their aggregate outputs decreased cumulatively. For both scenarios, at the end of the simulation, we observed a decrease in production in the following 10 sectors: sorghum, maize, fonio, cashews, breeding-hunting, fishery products and mining, other industries, hotels-restaurants, and services to firms. The rapid depreciation of capital would have been responsible for such a fall.

TABLE 28 - Output at end of resolution and accumulated (XST)

| Total output) | Scenario 1 | | Scenario 2 | | Scenario 3 | |
|---|---|---|---|---|---|---|
| **Year** | **Accumulated** | **2030** | **Accumulated** | **2030** | **Accumulated** | **2030** |
| Millet | 80.356 | 6.105 | 26.69 | 2,030 | 54.016 | 4.106 |
| Sorghum | -0.731 | -0.062 | -0.312 | -0,026 | -0.559 | -0.047 |
| Maize | -2.287 | -0.153 | -0.842 | -0,057 | -1.618 | -0.109 |
| Rice | 2.506 | 0.169 | 0.777 | 0,052 | 1.630 | 0.109 |
| Fonio | -0.683 | -0.069 | -0.291 | -0,028 | -0.522 | -0.051 |
| Cotton | 1.040 | 0.112 | 0.274 | 0,032 | 0.629 | 0.071 |
| Other agriculture | 3.332 | 0.238 | 1.039 | 0,074 | 2.173 | 0.155 |
| Cashew nut | 0.707 | -0.362 | 0.428 | -0,112 | 0.663 | -0.235 |
| Breeding-hunting | 1.466 | -0.022 | 0.450 | -0,011 | 0.950 | -0.019 |
| Forestry | 2.437 | 0.108 | 0.776 | 0,033 | 1.606 | 0.070 |
| Fishery products | 1.167 | -0.071 | 0.334 | -0,030 | 0.732 | -0.054 |
| Mining | 1.664 | -0.010 | 0.585 | -0,003 | 1.150 | -0.006 |
| Food and beverages | 2.833 | 0.284 | 0.857 | 0,089 | 1.822 | 0.186 |
| Other industries | -1.247 | -0.083 | -0.476 | -0,030 | -0.898 | -0.059 |
| Electricity-water | 9.194 | 0.822 | 3.132 | 0,281 | 6.257 | 0.560 |
| Construction | 29.095 | 2.116 | 9.620 | 0,702 | 19.513 | 1.421 |
| Trading and repair | 0.478 | 0.040 | 0.155 | 0,013 | 0.318 | 0.027 |
| Hotels-restaurants | 1.002 | -0.207 | 0.394 | -0,067 | 0.733 | -0.137 |
| Transport | 5.609 | 0.463 | 1.875 | 0,156 | 3.782 | 0.313 |
| Financial services | 4.118 | 0.325 | 1.387 | 0,110 | 2.787 | 0.221 |
| Services to firms | 2.171 | -0.142 | 0.819 | -0,043 | 1.554 | -0.091 |
| Public administration | 22.663 | 1.927 | 7.845 | 0,667 | 15.545 | 1.322 |

SOURCE: Authors elaboration. Model results.

These results are associated with the decrease in new private investments in these sectors since, although rental rates of industry composite capital are positive for all sectors across all three scenarios (Table 29), the 10 sectors with the lowest aggregate output were those with the lowest returns on composite capital. The return on capital in the Millet sector was higher while the public administration sector presented negative returns on composite capital, as a result of the scaling up public capital investment. In other words, the positive values of the aggregate output of the administration sector are the result only of growing applications of public capital in the economy and not with return on capital itself.

TABLE 29 - Rental rate of composite capital at end of resolution and accumulated (RC)

| **Rental rate of capital** | **Scenario 1** | | **Scenario 2** | | **Scenario 3** | |
|---|---|---|---|---|---|---|
| Year | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 |
| Millet | 166.682 | 8.945 | 54.688 | 3.008 | 111.385 | 6.049 |
| Sorghum | 17.888 | 2.409 | 5.535 | 0.785 | 11.626 | 1.604 |
| Maize | 18.397 | 2.423 | 5.707 | 0.79 | 11.971 | 1.614 |
| Rice | 17.155 | 2.442 | 5.271 | 0.796 | 11.113 | 1.626 |
| Fonio | 17.716 | 2.405 | 5.481 | 0.784 | 11.514 | 1.602 |
| Cotton | 18.480 | 2.519 | 5.712 | 0.822 | 12.005 | 1.678 |
| Other agriculture | 16.517 | 2.474 | 5.030 | 0.806 | 10.657 | 1.648 |
| Cashew nut | 7.645 | 1.612 | 2.366 | 0.527 | 4.971 | 1.075 |
| Breeding-hunting | 15.011 | 2.350 | 4.573 | 0.766 | 9.686 | 1.565 |
| Forestry | 14.891 | 2.349 | 4.537 | 0.766 | 9.610 | 1.565 |
| Fishery products | 16.121 | 2.396 | 4.906 | 0.78 | 10.398 | 1.594 |
| Mining | 10.21 | 2.023 | 3.051 | 0.660 | 6.531 | 1.348 |
| Food and beverages | 21.238 | 2.847 | 6.574 | 0.932 | 13.806 | 1.900 |
| Other industries | 13.35 | 2.621 | 4.025 | 0.861 | 8.575 | 1.752 |
| Electricity-water | 30.844 | 3.241 | 9.995 | 1.072 | 20.489 | 2.174 |
| Construction | 52.555 | 3.049 | 17.057 | 1.004 | 34.934 | 2.040 |
| Trading and repair | 13.728 | 2.543 | 4.200 | 0.833 | 8.877 | 1.698 |
| Hotels-restaurants | 7.504 | 2.090 | 2.103 | 0.682 | 4.666 | 1.393 |
| Transport | 21.617 | 2.814 | 6.824 | 0.924 | 14.183 | 1.881 |
| Financial services | 18.661 | 2.703 | 5.861 | 0.888 | 12.214 | 1.807 |
| Services to firms | 12.333 | 2.073 | 3.850 | 0.678 | 8.050 | 1.383 |
| Public administration | -76.417 | -8.29 | -26.151 | -2.870 | -52.118 | -5.685 |

SOURCE: Authors elaboration. Model results.

In all three scenarios, sectors with the highest value added or aggregated product were those with the highest export (Table 30). The accumulated deviations regarding to BAU of exports from Millet, Rice, other industries, cashew nut, forestry, and food and beverages were positive for all sectors, although not at the end of the simulation since in 2030 the production and exports of the cashew nut sector will decline.

TABLE 30 - Exports at end of resolution and accumulated (EX)

| Exports | Scenario 1 | | Scenario 2 | | Scenario 3 | |
|---|---|---|---|---|---|---|
| Year | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 |
| Millet | 25.369 | 2.053 | 8.608 | 0.691 | 17.23 | 1.389 |
| Sorghum | -2.528 | -0.416 | -0.784 | -0.138 | -1.645 | -0.279 |
| Maize | -3.836 | -0.492 | -1.231 | -0.164 | -2.536 | -0.331 |
| Rice | 0.233 | -0.22 | 0.144 | -0.072 | 0.222 | -0.147 |
| Fonio | -2.496 | -0.424 | -0.772 | -0.14 | -1.622 | -0.284 |
| Cotton | -0.902 | -0.255 | -0.254 | -0.084 | -0.562 | -0.171 |
| Other agriculture | 1.056 | -0.150 | 0.407 | -0.049 | 0.765 | -0.100 |
| Cashew nut | 0.659 | -0.336 | 0.399 | -0.104 | 0.618 | -0.219 |
| Forestry | 0.553 | -0.254 | 0.265 | -0.082 | 0.451 | -0.168 |
| Food and beverages | 0.913 | -0.172 | 0.355 | -0.058 | 0.664 | -0.116 |
| Other industries | -1.543 | -0.36 | -0.475 | -0.119 | -1.00 | -0.242 |
| Hotels-restaurants | -0.129 | -0.362 | 0.059 | -0.117 | 0.013 | -0.240 |
| Transport | 1.844 | -0.002 | 0.675 | 0.002 | 1.301 | 0.001 |
| Services to firms | 0.662 | -0.299 | 0.333 | -0.095 | 0.555 | -0.196 |

SOURCE: Authors elaboration. Model results.

### 5.3.2 Results for scenarios 4 to 9: funding schemes

In this subsection, we investigate the four alternative funding schemes that are used to fund the investment program jointly with the debt. The first important observation in this analysis is that funding sources produce similar effects for most macroeconomic and sectoral variables. The most obvious cases are the GDP, government real income and aggregate productivity (see Table 26 to 29). Productivity plays a crucial role in the behavior of macro and sectoral outcomes. In fact, we observe that increase in GDP (Table 31) is supported by the positive aggregate productivity and less by the additional employment, as in the case of scenarios 5, 7 and 8 (Table 33). In these scenarios, the percentage changes in composite employment in the last year of simulation are negative. Government revenue as an additional funding source declined in the first three years of the policy, but from 2019 to 2030 we observe a positive and persisted percentage change in government revenue (Table 32).

Like scenarios 1 through 3, the sectoral results here also show the values for production, return to capital and exports. Results vary according to funding schemes and by sectors. In scenario 4 (Table 34), that is, when the government decides to use 100% of debt as a means of funding its investment policy, the accumulated percentages deviations from BAU grow in 20 sectors, with loss for maize and other industries. If the government uses 50% of resources from sales taxes along with 50% of the increase in debt, the cumulative output increase in 10 sectors (millet, cashews, mining, electricity-water, hotel-restaurant construction, financial services, services to firms, Public administration) and decreased in others 12. Funding through debt matching and external resources produces positive and larger results. Still in terms of cumulative variations, this policy, however, penalizes the sectors of sorghum, Maize, fonio, and other industries.

As we move right through the rows and columns, we see that in scenario 7, which corresponds an increasing taxes and debt by 50 % each, construction, Millet, cashews, water-electricity and real estate and business services were sectors with the greatest impacts, with mining, Hotels-restaurants, Transport, and Financial services having also positive cumulative deviations. Although with

slightly higher values, the same pattern is found in scenario 8, while in scenario 9 few sectors responded positively to the use of production taxes. Although the signs of the cumulative values remain in most scenarios, at the end of the simulation we observe that variations relative to BAU decreased in some sectors. For example, the percentage change in fonio production will decrease by in scenario 4, although the cumulative ratio has been positive throughout 2015 to 2030 period.

TABLE 31 - Gap compared to BAU scenario for real GDP

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario4 | 0.418 | 0.363 | 0.326 | 0.303 | 0.291 | 0.286 | 0.287 | 0.291 | 0.297 | 0.304 | 0.312 | 0.320 | 0.327 | 0.335 | 0.342 | 0.348 |
| Scenario5 | 0.426 | 0.374 | 0.340 | 0.318 | 0.305 | 0.300 | 0.300 | 0.303 | 0.309 | 0.315 | 0.323 | 0.331 | 0.338 | 0.346 | 0.353 | 0.359 |
| Scenario6 | 0.447 | 0.396 | 0.362 | 0.342 | 0.331 | 0.328 | 0.33 | 0.335 | 0.342 | 0.350 | 0.358 | 0.367 | 0.375 | 0.384 | 0.391 | 0.398 |
| Scenario7 | 0.408 | 0.339 | 0.288 | 0.253 | 0.230 | 0.215 | 0.207 | 0.204 | 0.204 | 0.206 | 0.209 | 0.214 | 0.218 | 0.223 | 0.228 | 0.232 |
| Scenario8 | 0.394 | 0.32 | 0.266 | 0.227 | 0.200 | 0.182 | 0.172 | 0.166 | 0.164 | 0.164 | 0.166 | 0.169 | 0.172 | 0.176 | 0.180 | 0.184 |
| Scenario9 | 0.383 | 0.325 | 0.284 | 0.256 | 0.238 | 0.229 | 0.224 | 0.224 | 0.226 | 0.23 | 0.235 | 0.24 | 0.245 | 0.251 | 0.256 | 0.261 |

SOURCE: Authors elaboration. Model results.

TABLE 32 - Gap compared to BAU scenario for government real income

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario4 | -2.23 | -1.332 | -0.645 | -0.131 | 0.249 | 0.526 | 0.726 | 0.871 | 0.975 | 1.050 | 1.105 | 1.146 | 1.177 | 1.200 | 1.219 | 1.235 |
| Scenario5 | -1.648 | -0.937 | -0.402 | -0.010 | 0.272 | 0.471 | 0.609 | 0.702 | 0.763 | 0.802 | 0.826 | 0.840 | 0.847 | 0.849 | 0.849 | 0.847 |
| Scenario6 | -2.054 | -1.222 | -0.586 | -0.109 | 0.243 | 0.501 | 0.687 | 0.822 | 0.920 | 0.990 | 1.042 | 1.080 | 1.109 | 1.132 | 1.150 | 1.165 |
| Scenario7 | -1.658 | -0.808 | -0.164 | 0.315 | 0.662 | 0.911 | 1.085 | 1.204 | 1.285 | 1.337 | 1.370 | 1.390 | 1.401 | 1.405 | 1.406 | 1.405 |
| Scenario8 | -1.823 | -1.025 | -0.423 | 0.020 | 0.339 | 0.562 | 0.715 | 0.817 | 0.881 | 0.920 | 0.940 | 0.948 | 0.948 | 0.943 | 0.936 | 0.926 |
| Scenario9 | -1.202 | -0.372 | 0.266 | 0.747 | 1.105 | 1.368 | 1.562 | 1.703 | 1.806 | 1.882 | 1.938 | 1.980 | 2.013 | 2.039 | 2.060 | 2.077 |

SOURCE: Authors elaboration. Model results

TABLE 33 - Aggregate employment (LDC) and Factors aggregate productivity real income

| Externalities of public investment | Scenario 4 | Scenario 5 | Scenario 6 | Scenario 7 | Scenario 8 | Scenario 9 |
|---|---|---|---|---|---|---|
| Year | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 |
| Aggregate employment | 3.603 | -0.8 | 4.79 | -1.562 | -4.352 | 0.666 |
| Aggregate productivity | 0.120 | 0.123 | 0.131 | 0.116 | 0.110 | 0.106 |

SOURCE: Authors elaboration. Model results.

TABLE 34 - Output at end of resolution and accumulated (XST)

| Total output | Scenario 4 | | Scenario 5 | | Scenario 6 | | Scenario 7 | | Scenario 8 | | Scenario 9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 |
| Millet | 36.096 | 2.928 | 34.770 | 2.597 | 80.617 | 6.118 | 29.317 | 2.235 | 15.766 | 1.154 | 46.374 | 3.628 |
| Sorghum | 0.146 | -0.011 | -5.425 | -0.453 | -0.662 | -0.058 | -9.516 | -0.781 | -13.201 | -1.08 | -3.267 | -0.261 |
| Maize | -1.248 | -0.091 | -6.907 | -0.540 | -2.19 | -0.147 | -10.972 | -0.866 | -14.638 | -1.164 | -4.559 | -0.334 |
| Rice | 3.198 | 0.209 | -3.971 | -0.366 | 2.543 | 0.170 | -8.142 | -0.688 | -13.451 | -1.111 | -1.125 | -0.108 |
| Fonio | 0.049 | -0.027 | -4.931 | -0.423 | -0.618 | -0.065 | -8.895 | -0.743 | -12.288 | -1.019 | -3.069 | -0.256 |
| Cotton | 1.683 | 0.149 | -6.137 | -0.462 | 1.121 | 0.116 | -8.98 | -0.671 | -13.393 | -1.018 | -2.918 | -0.181 |
| Other agriculture | 3.838 | 0.265 | -4.926 | -0.437 | 3.386 | 0.240 | -8.04 | -0.675 | -11.701 | -0.981 | -1.586 | -0.133 |
| Cashew nut | 0.706 | -0.387 | 16.63 | 0.836 | 0.33 | -0.383 | 16.742 | 0.792 | 24.926 | 1.401 | 7.611 | 0.092 |
| Breeding-hunting | 0.934 | -0.066 | -0.732 | -0.208 | 1.484 | -0.020 | -4.95 | -0.56 | -7.292 | -0.757 | -1.204 | -0.223 |
| Forestry | 2.685 | 0.117 | -2.015 | -0.242 | 2.444 | 0.107 | -4.91 | -0.463 | -7.877 | -0.694 | -0.954 | -0.142 |
| Fishery products | 0.472 | -0.119 | -2.195 | -0.428 | 1.215 | -0.065 | -6.841 | -0.864 | -10.48 | -1.233 | -2.13 | -0.362 |
| Mining | 1.537 | -0.021 | 2.430 | -0.016 | 1.576 | -0.014 | 2.150 | -0.044 | 2.352 | -0.063 | 1.587 | -0.049 |
| Food and bev. | 2.865 | 0.299 | -9.221 | -0.746 | 2.953 | 0.293 | -9.389 | -0.744 | -15.959 | -1.301 | -2.88 | -0.165 |
| Other industries | -2.380 | -0.149 | -1.58 | -0.091 | -1.151 | -0.077 | -4.242 | -0.235 | -4.793 | -0.254 | -2.512 | -0.126 |
| Electricity-water | 9.532 | 0.869 | 10.393 | 1.005 | 9.205 | 0.828 | 10.403 | 1.017 | 10.645 | 1.091 | 8.817 | 0.828 |
| Construction | 27.276 | 1.974 | 40.892 | 3.239 | 29.07 | 2.111 | 35.166 | 2.842 | 39.789 | 3.327 | 13.944 | 1.015 |
| Trading and repair | 0.480 | 0.040 | -0.213 | -0.015 | 0.485 | 0.040 | -0.27 | -0.018 | -0.664 | -0.05 | -0.028 | 0.003 |
| Hotels-restaurants | 0.780 | -0.236 | 5.019 | 0.153 | 0.855 | -0.215 | 4.128 | 0.054 | 5.923 | 0.217 | -0.281 | -0.276 |
| Transport | 5.820 | 0.484 | 2.724 | 0.295 | 5.629 | 0.466 | 2.519 | 0.281 | 0.46 | 0.158 | 1.291 | 0.180 |
| Financial services | 4.300 | 0.343 | 2.905 | 0.280 | 4.118 | 0.326 | 2.206 | 0.236 | 0.479 | 0.143 | -0.02 | 0.063 |
| Services to firms | 1.763 | -0.185 | 6.529 | 0.297 | 1.990 | -0.151 | 8.627 | 0.412 | 11.929 | 0.710 | 2.237 | -0.121 |
| Public administ. | 23.866 | 2.061 | 36.926 | 3.181 | 22.56 | 1.939 | 39.714 | 3.364 | 48.116 | 4.081 | 28.811 | 2.393 |

SOURCE: Authors elaboration. Model results.

TABLE 35 - Rental rate of composite capital at end of resolution and accumulated

| Rental rate of capital | Scenario 4 | | Scenario 5 | | Scenario 6 | | Scenario 7 | | Scenario 8 | | Scenario 9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 |
| Millet | 80.237 | 5.784 | 33.775 | 1.61 | 167.962 | 8.985 | 27.336 | 1.753 | -18.831 | -1.107 | 82.057 | 5.100 |
| Sorghum | 21.333 | 2.66 | -30.835 | -1.186 | 18.434 | 2.427 | -30.353 | -0.793 | -55.299 | -2.547 | -3.006 | 1.068 |
| Maize | 21.813 | 2.672 | -30.398 | -1.176 | 18.934 | 2.441 | -29.999 | -0.786 | -55.002 | -2.543 | -2.614 | 1.077 |
| Rice | 20.792 | 2.704 | -33.38 | -1.227 | 17.749 | 2.461 | -32.728 | -0.813 | -59.451 | -2.627 | -4.165 | 1.093 |
| Fonio | 21.108 | 2.656 | -30.656 | -1.172 | 18.263 | 2.424 | -29.954 | -0.769 | -54.663 | -2.512 | -2.963 | 1.074 |
| Cotton | 21.819 | 2.773 | -33.148 | -1.153 | 19.075 | 2.538 | -30.847 | -0.667 | -56.553 | -2.434 | -3.742 | 1.164 |
| Other agriculture | 20.173 | 2.736 | -36.384 | -1.271 | 17.168 | 2.495 | -34.259 | -0.808 | -59.001 | -2.577 | -6.102 | 1.098 |
| Cashew nut | 9.702 | 1.822 | -15.774 | -0.932 | 7.919 | 1.630 | -11.146 | -0.459 | -22.247 | -1.671 | -1.627 | 0.634 |
| Breeding-hunting | 18.022 | 2.597 | -32.033 | -1.171 | 15.604 | 2.370 | -30.981 | -0.722 | -55.144 | -2.431 | -5.151 | 1.058 |
| Forestry | 18.286 | 2.606 | -33.016 | -1.177 | 15.487 | 2.370 | -30.484 | -0.692 | -54.295 | -2.388 | -5.739 | 1.042 |
| Fishery products | 19.542 | 2.656 | -35.894 | -1.370 | 16.764 | 2.418 | -35.788 | -0.999 | -64.048 | -2.898 | -6.088 | 1.001 |
| Mining | 12.139 | 2.256 | -29.576 | -1.235 | 10.776 | 2.048 | -25.461 | -0.731 | -44.825 | -2.288 | -6.457 | 0.811 |
| Food and beverages | 25.597 | 3.138 | -42.739 | -1.020 | 21.967 | 2.869 | -34.865 | -0.394 | -66.291 | -2.243 | -3.935 | 1.491 |
| Other industries | 16.049 | 2.927 | -30.74 | -0.762 | 14.037 | 2.641 | -25.866 | -0.061 | -47.083 | -1.638 | -3.917 | 1.487 |
| Electricity-water | 35.821 | 3.581 | -10.501 | 0.062 | 31.517 | 3.276 | -2.241 | 0.700 | -22.214 | -0.794 | 14.334 | 2.055 |
| Construction | 53.675 | 3.277 | 27.469 | 0.448 | 53.063 | 3.062 | 27.738 | 1.024 | 14.572 | -0.193 | 16.075 | 1.554 |
| Trading and repair | 17.189 | 2.821 | -29.454 | -0.842 | 14.323 | 2.565 | -22.698 | -0.242 | -43.325 | -1.847 | -3.094 | 1.318 |
| Hotels-restaurants | 10.411 | 2.337 | -31.066 | -1.066 | 8.029 | 2.109 | -26.069 | -0.536 | -44.915 | -2.039 | -11.627 | 0.866 |
| Transport | 25.505 | 3.112 | -24.584 | -0.531 | 22.251 | 2.840 | -17.889 | 0.074 | -40.65 | -1.511 | -0.079 | 1.567 |
| Financial services | 22.457 | 2.997 | -24.355 | -0.587 | 19.263 | 2.729 | -18.263 | 0.017 | -40.038 | -1.545 | -2.367 | 1.474 |
| Services to firms | 14.957 | 2.318 | -23.738 | -0.931 | 12.732 | 2.095 | -14.847 | -0.342 | -30.739 | -1.747 | -3.839 | 0.894 |
| Public administration | -82.682 | -8.986 | -80.251 | -9.243 | -77.509 | -8.415 | -80.923 | -9.473 | -81.271 | -9.891 | -79.964 | -8.808 |

SOURCE: Authors elaboration. Model results.

Funding through debt, or through the mix of debt and external transfers, and mix of debt and production taxes result in positive variations in returns to capital, except that of public administration, as reported by the columns of scenarios 4, 6 and 9, respectively (Table 35). This result is consistent with the model representation. Return on capital is treated as the price received by owners for allowing the use of one unit of capital in industry for one period. As it enters the calculation of the capital income of households, businesses and government, and this income is growing in the same direction as the growth of the product, so the capital income for firms and families increases. But even though the government's real income was positive in most periods, the low return on capital for public administration essentially reflects the fact that the government is responsible for the initial investment expenditures.

Therefore, sectors with negative variations in returns, either in terms of cumulative deviations or percentage variation at the end of the simulation, are generally those with the lowest total investment and aggregate production. Our positive values are associated with positive public investment externalities that increased the productivity of sectors and sustained the growth of economic activities.

Throughout the period and at the end of the program in 2025, the use of external resources, household income taxes and sales taxes imply a growing official deficit (Table 36). Using resources from firms and production taxes to increase new public investment will maintain the balance of public accounts, although they are not two policies alternatives that will increase more the sectors production.

For the potential exporter, the accumulated and end-of-simulation results vary from scenario to scenario (Table 37). Overall, most sectors benefited from both funding alternatives, although some have experienced negative percentage changes. Scenario 5 is pro-exporter since the values are positive in 13 sectors and negative only for the Food and beverages sector (-0.185). The interesting fact to note is the poor performance of the production taxation policy in encouraging export growth after the end of the program. Indeed, if efforts are made to obtain funds for public investments through production taxes, by 2030 only the Millet (1.359) and cashew (0.085) sectors will be able to exports, with

Food and beverages (-0.239) and Hotels-restaurants (-0.339) the most affected ones.

TABLE 36- Gap compared to BAU scenario for public debt (DEF)

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario4 | 60.850 | 48.016 | 36.963 | 27.98 | 20.994 | 15.737 | 11.873 | 9.077 | 7.070 | 5.633 | 4.599 | 3.846 | 3.288 | 2.866 | 2.536 | 2.271 |
| Scenario5 | 50.412 | 40.356 | 31.842 | 25.048 | 19.873 | 16.075 | 13.367 | 11.479 | 10.183 | 9.302 | 8.704 | 8.293 | 8.003 | 7.789 | 7.621 | 7.479 |
| Scenario6 | 57.245 | 45.401 | 35.188 | 26.872 | 20.391 | 15.5 | 11.894 | 9.273 | 7.384 | 6.022 | 5.034 | 4.308 | 3.763 | 3.344 | 3.012 | 2.741 |
| Scenario7 | 50.476 | 37.958 | 27.336 | 18.860 | 12.428 | 7.749 | 4.470 | 2.252 | 0.807 | -0.093 | -0.618 | -0.893 | -1.006 | -1.018 | -0.971 | -0.892 |
| Scenario8 | 53.141 | 41.675 | 31.959 | 24.222 | 18.366 | 14.119 | 11.151 | 9.149 | 7.846 | 7.032 | 6.549 | 6.283 | 6.153 | 6.104 | 6.099 | 6.115 |
| Scenario9 | 42.888 | 30.322 | 19.585 | 10.930 | 4.270 | -0.661 | -4.198 | -6.662 | -8.331 | -9.426 | -10.115 | -10.523 | -10.738 | -10.825 | -10.826 | -10.773 |

SOURCE: Authors elaboration. Model results.

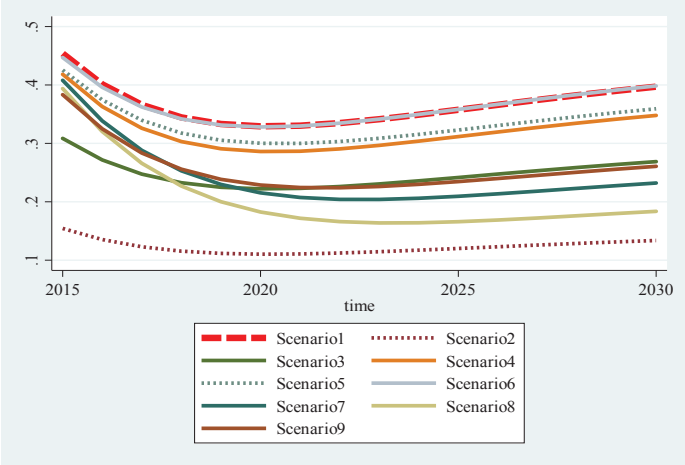
TABLE 37- Gap compared to BAU scenario for Exports (EX)

| Export | Scenario 4 | | Scenario 5 | | Scenario 6 | | Scenario 7 | | Scenario 8 | | Scenario 9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 | Accumulated | 2030 |
| Millet | 11.237 | 0.802 | 20.012 | 1.417 | 25.257 | 2.048 | 17.923 | 1.211 | 18.085 | 1.142 | 18.492 | 1.359 |
| Sorghum | -2.369 | -0.418 | 5.088 | 0.117 | -2.655 | -0.422 | 3.066 | -0.099 | 6.356 | 0.116 | 0.674 | -0.231 |
| Maize | -3.545 | -0.485 | 3.856 | 0.046 | -3.941 | -0.497 | 1.877 | -0.167 | 5.196 | 0.049 | -0.402 | -0.291 |
| Rice | 0.236 | -0.232 | 6.332 | 0.189 | 0.078 | -0.228 | 4.316 | -0.017 | 6.591 | 0.113 | 2.493 | -0.102 |
| Fonio | -2.446 | -0.433 | 5.422 | 0.135 | -2.626 | -0.43 | 3.425 | -0.082 | 6.902 | 0.147 | 0.779 | -0.232 |
| Cotton | -0.866 | -0.265 | 3.748 | 0.054 | -1.011 | -0.261 | 2.456 | -0.085 | 4.585 | 0.045 | 0.62 | -0.184 |
| Other agriculture | 0.926 | -0.17 | 5.309 | 0.116 | 0.917 | -0.157 | 3.851 | -0.04 | 6.303 | 0.112 | 2.042 | -0.123 |
| Cashew nut | 0.657 | -0.36 | 15.456 | 0.776 | 0.308 | -0.356 | 15.56 | 0.736 | 23.155 | 1.300 | 7.078 | 0.085 |
| Forestry | 0.226 | -0.29 | 7.714 | 0.264 | 0.372 | -0.263 | 6.292 | 0.107 | 9.77 | 0.348 | 2.513 | -0.149 |
| Food and beverages | 0.344 | -0.207 | 3.054 | -0.185 | 0.81 | -0.173 | 3.125 | -0.206 | 4.453 | -0.212 | 1.067 | -0.239 |
| Other industries | -2.612 | -0.442 | 4.945 | 0.126 | -1.639 | -0.363 | 3.886 | 0.022 | 7.434 | 0.281 | 0.247 | -0.232 |
| Hotels-restaurants | -0.636 | -0.414 | 8.122 | 0.313 | -0.339 | -0.374 | 8.095 | 0.259 | 12.649 | 0.616 | 0.156 | -0.339 |
| Transport | 1.587 | -0.023 | 4.033 | 0.201 | 1.741 | -0.007 | 5.539 | 0.274 | 7.415 | 0.419 | -1.737 | -0.238 |
| Services to firms | 0.138 | -0.353 | 7.877 | 0.335 | 0.447 | -0.311 | 9.579 | 0.421 | 14.367 | 0.819 | 2.244 | -0.178 |

SOURCE: Authors elaboration. Model results.

We have made an analysis of the results of scenarios 1 to 3 and those of scenarios 4 to 9 from the comparative perspective of economic activities, income, cost of living and the externalities that carry the potential of public investments for the production side. Both the increase in investment policies and the funding schemes adopted had a positive impact on the level of economic activity, with scenarios 1 and 6 showing greater effects that persisted over time (Figure 13). After an initial period of positive impacts on the level of economic activity, the effects of scenarios 4 and 5 reduced from 2015 to 2017 period and then recovered until 2020 where they remained stable until 5 years after the program is completed. Scenario 8, in turn, lost its initial impact on the aggregate product more sharply, but is scenario 2 which had the least positive effects on economic activities.

FIGURE 13 - Gap compared to BAU scenario for real GDP (GDP_Real)




SOURCE: Authors elaboration. Model results.

We start to look at externalities at the end of the simulation, in the same sense that the effects of new public investments are spread in the model after the program is completed in 2030. It is possible to observe that all scenarios produce positive productivity externalities for sectoral variables (Table 38). However, we can also note that each sector responds differently to the shock performed and that the size of the shock is not sector invariant. In the Column 2 representing *scenario* 1, externalities are most absorbed by all agricultural sectors, especially Millet and Rice (0.385), Cotton (0.240), Other agriculture (0.490), Breeding-hunting (0.394) and Cashew nuts (0.296). Percentage changes relative to the

BAU scenario of the industrial and service sectors are not negligible, but they are lower than those of the agricultural sectors. Externalities are lower for real estate and services to firms and public administration, both with a percentage variation of 0.017 five years after the policy in question.

Small changes occur when we moved to scenarios 2 (3.3% increase in new public investment) and 3 (6.7% increase in new public investment), because in these cases externalities are reduced for both sectors, but the order of impact size remains as in the scenario discussed in the previous paragraph. As they share the same production technology, the externalities of the Millet and Rice sectors are the same for all scenarios. Overall, the externalities are higher if the government only increases its investments by 10% compared to debit and taxes funding schemes, although these policy options also have positive and non-neglecting impacts on the economy sectors, as we can see from the columns of scenarios 4 through 9.

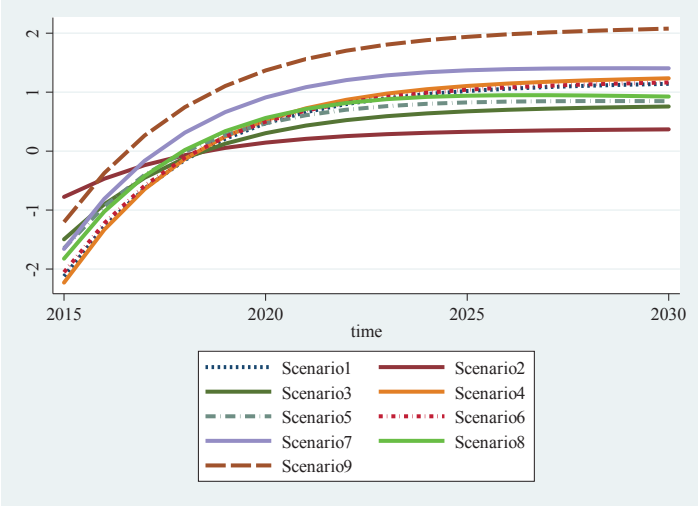
Table 38 -Externalities of public investment at end of resolution

| **Valued added (total output)** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** | **Scenario 9** |
|---|---|---|---|---|---|---|---|---|---|
| Year | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 | 2030 |
| Millet | 0.385 | 0.131 | 0.262 | 0.345 | 0.353 | 0.377 | 0.333 | 0.317 | 0.304 |
| Sorghum | 0.135 | 0.046 | 0.092 | 0.121 | 0.124 | 0.133 | 0.117 | 0.111 | 0.107 |
| Maize | 0.012 | 0.004 | 0.008 | 0.011 | 0.011 | 0.012 | 0.010 | 0.01 | 0.009 |
| Rice | 0.385 | 0.131 | 0.262 | 0.345 | 0.353 | 0.377 | 0.333 | 0.317 | 0.304 |
| Fonio | 0.157 | 0.054 | 0.107 | 0.141 | 0.144 | 0.154 | 0.136 | 0.129 | 0.125 |
| Cotton | 0.240 | 0.082 | 0.163 | 0.215 | 0.220 | 0.235 | 0.207 | 0.197 | 0.190 |
| Other agriculture | 0.490 | 0.167 | 0.333 | 0.439 | 0.449 | 0.480 | 0.424 | 0.403 | 0.388 |
| Cashew nut | 0.296 | 0.101 | 0.201 | 0.265 | 0.271 | 0.290 | 0.256 | 0.243 | 0.234 |
| Breeding-hunting | 0.394 | 0.134 | 0.268 | 0.353 | 0.362 | 0.386 | 0.341 | 0.324 | 0.312 |
| Forestry | 0.020 | 0.007 | 0.014 | 0.018 | 0.019 | 0.020 | 0.018 | 0.017 | 0.016 |
| Fishery products | 0.058 | 0.020 | 0.04 | 0.052 | 0.054 | 0.057 | 0.051 | 0.048 | 0.046 |
| Mining | 0.068 | 0.023 | 0.046 | 0.061 | 0.062 | 0.067 | 0.059 | 0.056 | 0.054 |
| Food and beverages | 0.049 | 0.017 | 0.034 | 0.044 | 0.045 | 0.048 | 0.043 | 0.041 | 0.039 |
| Other industries | 0.042 | 0.014 | 0.029 | 0.038 | 0.039 | 0.042 | 0.037 | 0.035 | 0.034 |
| Electricity-water | 0.034 | 0.011 | 0.023 | 0.030 | 0.031 | 0.033 | 0.029 | 0.028 | 0.027 |
| Construction | 0.022 | 0.008 | 0.015 | 0.020 | 0.020 | 0.022 | 0.019 | 0.018 | 0.018 |
| Trading and repair | 0.064 | 0.022 | 0.044 | 0.058 | 0.059 | 0.063 | 0.055 | 0.053 | 0.051 |
| Hotels-restaurants | 0.015 | 0.005 | 0.010 | 0.013 | 0.014 | 0.014 | 0.013 | 0.012 | 0.012 |
| Transport | 0.021 | 0.007 | 0.014 | 0.019 | 0.019 | 0.020 | 0.018 | 0.017 | 0.016 |
| Financial services | 0.019 | 0.006 | 0.013 | 0.017 | 0.017 | 0.018 | 0.016 | 0.016 | 0.015 |
| Services to firms | 0.017 | 0.006 | 0.012 | 0.015 | 0.016 | 0.017 | 0.015 | 0.014 | 0.014 |
| Public administration | 0.017 | 0.006 | 0.011 | 0.015 | 0.015 | 0.016 | 0.014 | 0.014 | 0.013 |

SOURCE: Authors elaboration. Model results.

There is a long-term tendency for the government to profit from the different policies it practices (Figure 14). Policies drawn by scenarios 1 to 6 reduce government income for period 2015 to 2018, while scenarios 7 to 9 decrease only in the first two years after the execution of governmental projects. From 2018 onwards, both policies increased government revenue, with scenario 7 and 9 having the greatest impacts, while scenario 2 was the least beneficial to the government.

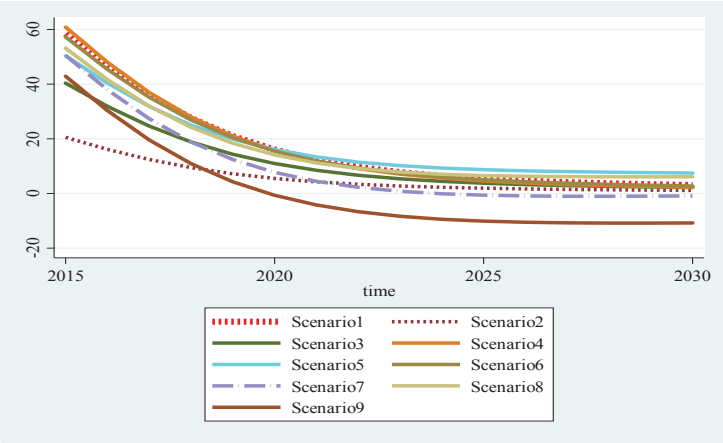
FIGURE 14 - Gap compared to BAU scenario for government real income (Yg)




SOURCE: Authors elaboration. Model results.

The potential of tax-financed policies can be seen to reduce the official deficit rather than to increase it over time (Figure 15). So, after the initial impacts up to 40 percent regarding to the BAU, when the government use fiscal instruments and external resources to raise investment funds, the deficit is reduced significantly. The positive deficits derive from a continued public investment policy, as part of the positive effects of past investments on government revenue is a fund available for use as an investment capital resource in the next period, increasing total investment in economy in one period to another. The impacts cease when public capital depreciates.

FIGURE 15 - Gap compared to BAU scenario for government deficit (Def)




SOURCE: Authors elaboration. Model results.

The extent to which new investment and the way they are funding affect the living conditions of the population is a question under investigation. In Table 39, 10% increase in new public investments without specifying the source of funding will further damage the poorest rural and urban households, whose consumption have declined by -0.078% and -0.055% percentage, respectively, compared to the BAU (Column 2). Note that an increase of 3.3% in new public investment, as represented by Columns 3 reduces by -0.026% the consumption of rural households receiving up to 1 minimum wage, by -0.003% the consumption of rural household receiving by up to 2 minimal wages, and by -0.018% the consumption of urban household receiving up to 1 minimum wage. In general, as the salary range grows, more is the positive impacts the household can get from the increase in new public investments. However, this result changes completely when government adopts fiscal instruments, since each policy option is producing different impacts on households' consumption.

Funding using 100% of the debt will benefit all households, but the poorest in both rural and rural areas will increase more their consumption than the richest ones, that is, those whose minimal wages is higher (scenario 4 – Column 5). However, when the government uses the mix debit-sales taxes, only the poorest rural household and the poorest urban household were affected as the consumption of other household are reduced: the wealthiest household will have their consumption reduced by -0,739 percent over the BAU scenario. Meanwhile, funding public investment with 50% of external resources and 50%

of the official deficit (scenario 6) will reduce by -0,081 and -0,058% the consumption of rural and urban households with less than 1 minimum wage, respectively, while increasing the consumption of their counterparts on the opposite tail by 0.047 and 0.095%.

In contrast, we observe that -0.895 and -0.763% are the consumption reductions that incur rural and urban households that receive higher wages in income distribution as a result of increasing firm tax, which will benefit the poorest households in the city and in the field (scenario 7). If the government funds its policies with tax on household income, it is only the rural household with highest (receiving up to 10) minimum wage that have its consumption increased by 0.551 percent, as the other households have been hit negatively with substantial consumption losses (Scenario 8). Although none of the urban households have obtained substantial gain, overall, this policy negatively affects more the rural households receiving up to 10 minimal wages. In scenario 9 we can see that the Column 8 pattern is repeated, since only the poorest households have experiment positive gains, with percentage change in their consumption of 0.344 for rural and 0.398 for urban households receiving less than 1 minimum wage.

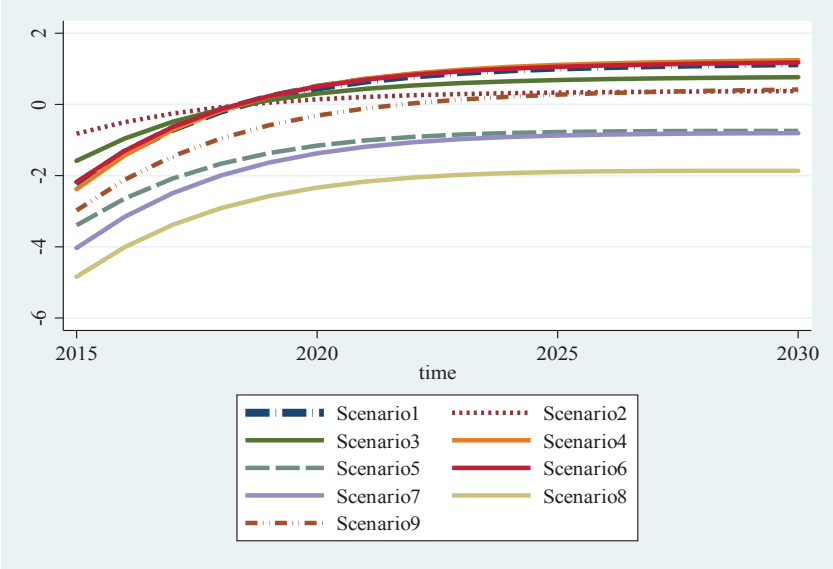
TABLE 39 - Gap compared to BAU scenario for households' consumption

| **Valued added (total output)** | **Scenario 1** | **Scenario 2** | **Scenario 3** | **Scenario 4** | **Scenario 5** | **Scenario 6** | **Scenario 7** | **Scenario 8** | **Scenario 9** |
|---|---|---|---|---|---|---|---|---|---|
| Time | **2030** | **2030** | **2030** | **2030** | **2030** | **2030** | **2030** | **2030** | **2030** |
| HR1 | -0.078 | -0.026 | -0.053 | 0.849 | 0.333 | -0.081 | 0.254 | -0.236 | 0.344 |
| HR2 | 0.004 | -0.003 | -0.002 | 0.297 | -0.391 | 0.009 | -0.553 | -1.200 | -0.123 |
| HR3 | 0.022 | 0.002 | 0.009 | 0.174 | -0.552 | 0.029 | -0.732 | -1.414 | -0.227 |
| HR4 | 0.029 | 0.003 | 0.013 | 0.131 | -0.609 | 0.036 | -0.796 | -1.49 | -0.264 |
| HR5 | 0.036 | 0.005 | 0.018 | 0.086 | -0.668 | 0.044 | -0.862 | -1.568 | -0.302 |
| HR6 | 0.039 | 0.006 | 0.02 | 0.063 | -0.698 | 0.047 | -0.895 | -1.609 | -0.321 |
| HU1 | -0.055 | -0.018 | -0.037 | 0.918 | 0.382 | -0.058 | 0.433 | 0.551 | 0.398 |
| HU2 | 0.043 | 0.009 | 0.024 | 0.333 | -0.398 | 0.049 | -0.399 | -0.506 | -0.099 |
| HU3 | 0.065 | 0.015 | 0.038 | 0.200 | -0.576 | 0.073 | -0.589 | -0.747 | -0.212 |
| HU4 | 0.073 | 0.018 | 0.043 | 0.152 | -0.64 | 0.082 | -0.657 | -0.833 | -0.252 |
| HU5 | 0.081 | 0.020 | 0.048 | 0.103 | -0.705 | 0.091 | -0.727 | -0.922 | -0.294 |
| HU6 | 0.086 | 0.021 | 0.050 | 0.078 | -0.739 | 0.095 | -0.763 | -0.968 | -0.315 |

SOURCE: Authors elaboration. Model results.

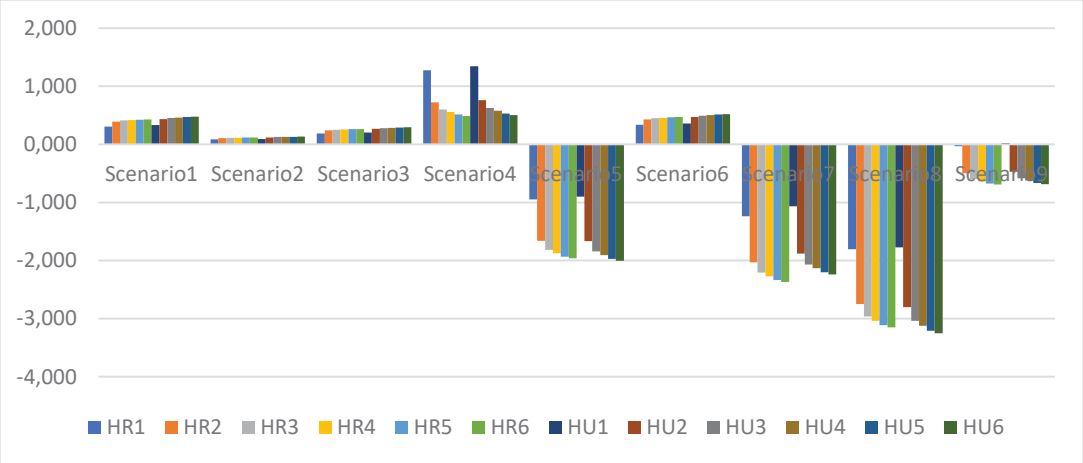
The consumer price index (CPI; Figure 16) decreases for the 2015 to 2018 period, increases between 2018-2020 and remains stable until the end of the simulation for all policy options, except for scenario 1 and 6 that present similar price effects as shown by the two overlapping lines in the positive area of the graph.

FIGURE 16 - Gap compared to BAU scenario for consumer price index




SOURCE: Authors elaboration. Model results.

FIGURE 17 – Gap compared to BAU scenario for households' income




SOURCE: Authors elaboration. Model results.

The cumulative results of household income from 2015 to 2030 are represented in Figure 17, which shows that both policies are different income effects from one household to other. However, the first important note is that scenarios 1 to 4 and scenario 6 have positive impacts on households' incomes, while scenario 5 and scenarios from 7 to 9 reduced their incomes. Second, scenarios that produce positive effects do so less intensely than scenarios producing negative results, that is, positive percentage variations are deeper than negative percentage variations. Moreover, the percentage of income variation of the poorest households is higher when policies produce positive effects and lower when income-effects are negative. It is worth emphasizing that scenarios 1, 2 and 3 provided best results for economy of Guinea-Bissau.

## 5.4 FURTHER DISCUSSIONS

It is worth noting that we perform sensitivity analysis for our model closure (Appendix E). Moreover, from the point of view of consistency of results with standard theory, it is necessary to look at each scenario separately. This section then is analyzed from a welfare perspective, that is, verifying whether the simulated results are in accordance with the theoretical prediction discussed in the chapter 3.

The trade scenarios corroborate the findings of Moreira and Correia (1998), Amiti and Cameron (2012), as it shows gains through economic liberalization. However, while these authors observed the short-term gains from trade policy due to increased factor reallocation, we found that the household wealth accumulation over time was responsible for increased consumption of rural and urban households in Guinea-Bissau due to tariff and tax reductions-, and, thus, was responsible for increasing their welfare. This study also collaborates with Brigth (2017) studies for Ghana, Ferreira and Rossi (2001) and Figini and Santarelli (2006) studies for Brazil and developing countries, respectively, as they also find production and consumption gains from tariff reforms.

In their study for Brazil, Bittencourt, Larson, and Kraybill (2008) show through a CGE model that tariff reduction policy resulted in equivalent welfare gains of 0.7% for both low-income and middle income rural households, but resulted in a loss in the same proportion for the low-income urban household, and has no impact on the middle-income

urban one. This study is important since it shows that there is no equivalence between distributive concerns, emphasized by the standard trade theory, and poverty concerns. This is the line that supports the rationale behind the comparison we make of our results for all simulations, that is, to show whether there are gains in welfare and occurrence of inequality after the policies have been implemented.

As for productivity, the standard theory sets out its effects on economic outcomes in a very clear way. Because it results from less input use, increasing productivity actually means negative reductions in the use of labor or capital inputs or both. In effect, productivity propagates through its effect on value added, whose substitution elasticity could carry more effects for some sectors than other ones. The overall effect is that productivity growth will decrease firms' costs (Gayathr et al., 2018), increase production and investments as well as the return on capital (Gabaix, 2011; Fernald, 2014; Nakamura, Kaihatsu, and Yagi, 2018). These are what the model reports here. In addition, it has been shown that the income gains of the poorest households who receive lower minimum wages suggest an increase in households' welfare as it long-term consumption rises.

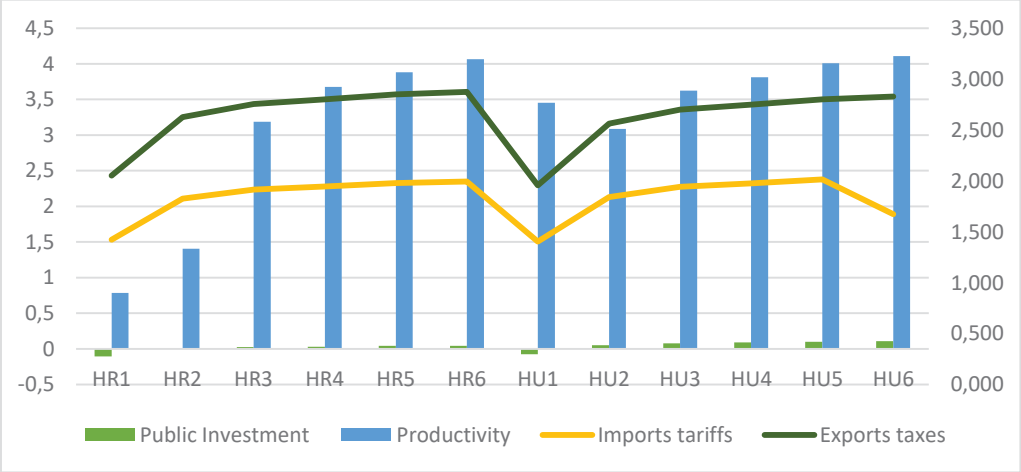
In turn, public investment in infrastructure has been responsible for increasing the level of economic activity, household consumption and long-term sectorial increase and productivity. This result is in agreement with the findings of Boccanfuso *et al.* (2014), but also with the standard economic literature that states that developing countries that need to accelerate their catching-up process should rely on the participation of public capital, which will serve as a kind of complementarity with private capital, instead of substitutes. When the country is poorer, this complementarity should be more intense in the key economic sectors, such as construction. As a result, increasing new public investment will increase private investment as well as output per worker and may result in self-sustaining economic growth. Scenarios of new types of public investment suggest that these effects are propagated to the economic activities level. The new public investment effects persisted over time and spilled over into households' income and consumption gains, including for rural households with the lowest minimal wages.

The simulations of funding mechanisms corresponding to the increase of public investments bring mixed results. While scenarios 5 shows that using the already distributed gains to increase finance investments will not bring immediate gains, other

scenarios show that redistribution and prosperity gains can be achieved through taxes increase. In both cases, the results show taxation methods as a way to control production and income and increase long-term welfare. Findings in this sense go back to the study by Diamond and Mirrless (1971), and recently Hafner *et al.* (2015) and Bosua *et al*. (2012).

We can conclude this discussion by asking what the best political alternative of this tripod would be. There are several ways to compare results obtained through differently designed scenarios, but we focus on looking at the earnings differential at the household's level. Only the new public investment policy (scenario 1 of infrastructure investments simulations) is compared with the trade liberalizations and productivity policies.

FIGURE 18 - Aggregate household consumption for all analyzed scenarios




SOURCE: Authors' elaboration. Models results.

All policies had positive impacts on household consumption, except the increasing new public investments policy, which has reduced the consumption of rural households that receive up to minimum wage (Figure 18). Productivity scenario had a greater impact on household consumption, followed by the export taxes policy. We also observe that all current policies may mitigate income inequalities in the country, since the projected inequality percentages (0.58% in BAU) are above those obtained after each shock. In specific terms, it is productivity scenario that reduces most the income inequalities, with

the Gini index of 0.50%. As a result of negative import tariff and export taxes shocks, the Gini index reduced respectively for 0.57 and 0.53%. However, this index calculated for infrastructure investment simulation shows a slight increase in income inequality, which is 0.64%.

## 6 CONCLUSIONS

This study aimed to analyze the effects of trade liberalization, productivity increase and scaling up infrastructure on socioeconomic outcomes, such as macro activities, sectoral productivity and households income and consumption from 2014 to 2030, based on unilateral import tariffs and export tax reductions, the Guinea-Bissau government investment program in infrastructure in operation since 2015 as to address the numerous development challenges in promoting national comparative advantage and increasing the population's standard of living.

We built the BISSAU-DYN model, a dynamic recursive computable general equilibrium model for Guinea-Bissau, to provide such suggestive evidence to policymakers. The simulations for trade liberalization were carried out through two policy scenarios. The impacts of the shocks are seen to depend on whether the cut is uniform or per sector but also the kind of shock performed. In general, the impacts of uniform reductions are greater than those based on sectoral tariff reductions for both openness and encouraging exports scenarios. However, while import tariff reductions negatively affected the overall economy product in the early years following the negative shock, the impacts of export taxes reductions are immediate, larger and persistent.

The same results are observed for the tariff cutting policy by sector, except that in this case the food and beverage sector responded differently. Import tariff cuts in this sector contributed to decrease the sectoral product even at the end of the simulation. The negative effect has not been even deeper because this policy has increased production in the cashew nut sector, whose share in total national output is overwhelmingly larger.

This result, however, is not incompatible with the characteristic of this sector, and our model propagated the effects of negative tariffs shocks on food and beverage products through the labor market, particularly with regard to factor remuneration: trade liberalization was responsible for decreasing in investments, employment and sectoral product, while generating a fall in wages. We see that as wages decrease, household incomes fell dramatically. Thus, trade liberalization in this particular sector, rather than contributing to increased welfare, has reduced the income and consumption of urban and rural households. However, our results show that national welfare has not declined with

import tariff cuts and separate export tax reductions have helped to stabilize household income and consumption, with stronger effects on the rural households, particularly those with lower starting minimal wages.

For productivity, we found the economic activities to respond positively to positive productivity shock, which, in turns, created factors' reallocation within the industry. This reallocation occurs whenever productivity shocks raise the price of a factor, been replaced by the factor whose price is decreasing or does not rise accordingly.

Finally, results from infrastructure investment simulations show that investment in infrastructure has a positive effect on the economy. The impacts are spread from one period to another by increasing the total productivity of the factors and the externalities that have sustained the sectoral production over time. At the beginning of each period, the execution of public investment projects raised the public deficit, but we see that this deficit is drastically smoothed out follow up the depreciation of public capital period. Moreover, the results also show that the poorest households benefited most from the investments made, both in terms of consumption and income, which suggests the potential of this policy to reduce poverty and promote socioeconomic development.

In general, it is suggested that the way in which the government directs its development projects to promote the country's comparative advantages in order to reconcile higher sector productivity and employment will be important in determining the economic performance in the following periods, as the sectors responded more or less to the policies adopted. Thus, a national development policy aimed at increasing household aggregate income and consumption through infrastructure investments can serve to stimulate economic growth, even in long run, while affecting the pattern of household consumption. The way as the policies will be funded will be important for the government that wants to maintain its long-term account balance, so that it is possible to carry out its current expenses and signal to its partners its ability to honor the signed external commitments. While external funds seem to help the government to meet its objectives, it can in the long-term become problematic as it depends on external variables such as interest rates which are completely beyond the government's control. Thus, if the official government intends to keep appropriating external resources as a funding source and if the external interest rate rises to such a level as to compromise the ability to pay the

current debt, there will be a period when he will be required to declare default. This could damage the country's image in the international creditors' square. Funding by taxation of production and firm is not recommended to developing economies whose sectors are incipient, as it may inhibit the application of private capital and eliminating the initial impacts of the policy. The income taxes-based funding suggests having positive impact on economic activity. However, if the goal is to reduce poverty in the short term, the government should adopt appropriate fiscal instruments that do not weigh on the real budget of households.

Moreover, the national trade policy aimed at defining an optimal level of imports tariffs to stimulate the country' international integration should be drawn looking at each sector profile, since tariff cuts did not have similar effects for all productive sectors. The characteristics that need to be considered include the current sector's share on national economy and its ability to respond to investment policies such as investments in infrastructure.

What is reported so far suggests the importance of productivity and liberalization, infrastructure quality as a feasible option the governments can fulfill to potentialize the country comparative advantage as well as to improve the households' living conditions, both in urban and rural areas. Technically, there is a clear need to evaluate current government policies in various dimensions as to monitor their actual impacts on the population. In this sense, BISSAU-DYN can be an important tool for this issue as it is calibrated specifically for this country.

The potential gains observed lead us to suggest that diversification of the export basket and the robust insertion in the national economy can be achieved by relieving the current restrictions on trade. Staggering the reduction in tax rates and tariffs for sectors with comparative advantages would strengthen the development of these sectors, as they will be forced to compete with others producing similar products. Naturally, although this implies the exclusion of those sectors that will not be able to participate in competitive international markets, conscious free trade will bring gains even for the poorest household in rural areas. This is because the sectors that survive economic opening will produce more, invest more and employ more workers of different levels of qualification.

We emphasize that the promotion of trade liberalization will not achieve the desired results in a small economy like ours with a low level of productivity. Institutional reforms that eliminate internal restrictions on production will also be desirable. The country will be able to exploit its condition of relative backwardness by investing in human capital, since economic openness naturally implies the existence of national and international firms demanding qualified workers. Thus, once the country's ability to exploit its comparative advantages is guaranteed, the human capital availability with different skills will enhance the diversification of the economy that our results suggest.

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# APPENDIX A - MACROECONOMIC AND SECTORAL VARIABLES OF GUINEA-BISSAU ECONOMY

TABLE A.1 – GDP and its main components

| Series Name | 1970-1989 | 1980-1989 | 1990-1999 | 2000-2009 | 2010-2017 |
|---|---|---|---|---|---|
| Gross Domestic Product | 63537700 | 1,21E+09 | 7,27E+10 | 3,13E+11 | 5,73E+11 |
| Gross fixed capital formation | 3046310 | 4,61E+08 | 1,54E+10 | 3,28E+10 | 5,03E+10 |
| Final consumption expenditure | 68219680 | 1,17E+09 | 7,26E+10 | 3,21E+11 | 5,66E+11 |
| Government final consumption | 14215230 | 1,43E+08 | 5,94E+09 | 4,02E+10 | 5,67E+10 |
| Exports of goods and services | 3900760 | 1,2E+08 | 1,19E+10 | 5,81E+10 | 1,3E+11 |
| Imports of goods and services | 21947710 | 5,51E+08 | 2,74E+10 | 9,15E+10 | 1,75E+11 |

SOURCES: Authors' calculations. World Development Indicators: World Bank data.

TABLE A.2 - Crop production over the decades in tons

| Product | 1970 | 1980 | 1990 | 2000 | 2010 | 2017 |
|---|---|---|---|---|---|---|
| Banana | 0 | 0 | 3000 | 3889 | 6582 | 7142 |
| Cashew nuts | 2500 | 16333 | 30000 | 108477 | 181505 | 155953 |
| Cassava | 0 | 0 | 17491 | 30143 | 68328 | 55302 |
| Cereals | 0 | 0 | 0 | 0 | 1681 | 1881 |
| Coconuts | 32000 | 28000 | 37000 | 45500 | 42050 | 39961 |
| Cotton | 0 | 2900 | 3410 | 4278 | 5000 | 0 |
| Fonio | 9000 | 8000 | 1574 | 3938 | 524 | 742 |
| Fruit, Fresh | 12500 | 13500 | 13612 | 17690 | 20811 | 22989 |
| Groundnuts | 38000 | 38000 | 38000 | 38000 | 38000 | 38000 |
| Lemons | 0 | 900 | 2850 | 3415 | 3941 | 4214 |
| Maize | 2000 | 12000 | 13675 | 25673 | 12312 | 7270 |
| Mangoes and Guavas | 0 | 200 | 3700 | 4565 | 6803 | 9143 |
| Millet | 6000 | 13000 | 17435 | 21096 | 15004 | 15198 |
| Oil palm fruit | 70000 | 100000 | 70000 | 80000 | 80000 | 81313 |
| Oil palm | 0 | 5000 | 6000 | 4000 | 5000 | 5900 |
| Palm kernels | 6787 | 8800 | 7000 | 8000 | 8000 | 0 |
| Oranges | 0 | 600 | 4400 | 5494 | 6284 | 6793 |
| Papayas | 1200 | 1500 | 1661 | 1433 | 2483 | 3222 |
| Pineapples | 0 | 50 | 180 | 222 | 480 | 489 |
| Plantains and others | 23000 | 30000 | 32000 | 38635 | 48560 | 54666 |
| Pulses | 1500 | 2000 | 2250 | 2368 | 3002 | 3118 |
| Rice, paddy | 35000 | 42000 | 123314 | 106081 | 209240 | 187281 |
| Roots and tubers | 40000 | 50000 | 52000 | 65154 | 58000 | 90092 |
| Rubber, natural | 80 | 80 | 0 | 0 | 0 | 0 |
| Seed cotton | 0 | 3000 | 3300 | 4081 | 5600 | 5428 |
| Sorghum | 3000 | 18000 | 11271 | 21096 | 17592 | 18493 |
| Sugar cane | 4500 | 5300 | 5500 | 5500 | 6300 | 6698 |
| Vegetables | 18000 | 22000 | 21000 | 25129 | 32155 | 35152 |

SOURCE: Own elaboration. FAOSTAT.

# APPENDIX B – MODEL EQUATIONS, SAM, PARAMETERS, AND ELASTICITIES

## Appendix B.1 – Aggregate Social Accounting Matrix

FIGURE 1 - Social Accounting Matrix

| | USK | SK | CAP | HR | HU | FIRM | GVT | TD | TM | TVA | TX | TI | ROW | ACT | ICOMM | XCOMM | INV_PRI | INV_PUB | VSTK | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63483 | 0 | 0 | 0 | 0 | 0 | 63483 |
| SK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85519 | 0 | 0 | 0 | 0 | 0 | 85519 |
| CAP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 178652 | 0 | 0 | 0 | 0 | 0 | 178652 |
| HR | 15316 | 57640 | 82908 | 0 | 0 | 9705 | 246 | 0 | 0 | 0 | 0 | 0 | 14058 | 0 | 0 | 0 | 0 | 0 | 0 | 179873 |
| HU | 48167 | 27879 | 74563 | 0 | 0 | 4853 | 442 | 0 | 0 | 0 | 0 | 0 | 6893 | 0 | 0 | 0 | 0 | 0 | 0 | 162797 |
| FIRM | 0 | 0 | 21181 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 21181 |
| GVT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6737 | 9342 | 2158 | -347 | 2098 | 43100 | 0 | 0 | 0 | 0 | | 0 | 63088 |
| TD | 0 | 0 | 0 | 3213 | 515 | 3009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 6737 |
| TM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9342 | 0 | 0 | | 0 | 9342 |
| TVA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2158 | 0 | 0 | 0 | | 0 | 2158 |
| TX | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -347 | 0 | 0 | 0 | | 0 | -347 |
| TI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2098 | 0 | 0 | | 0 | 2098 |
| ROW | 0 | 0 | 0 | 1725 | 297 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 125224 | 0 | 0 | 0 | 0 | 127246 |
| ACT | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 427184 | 39715 | 0 | 0 | 0 | 466899 |
| ICOMM | 0 | 0 | 0 | 151515 | 161281 | 0 | 58589 | 0 | 0 | 0 | 0 | 0 | 0 | 137434 | 0 | 0 | 38528 | 3811 | 12690 | 563848 |
| XCOMM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39715 | 0 | 0 | 0 | 0 | 0 | 0 | 39715 |
| INV_PRI | 0 | 0 | 0 | 23420 | 704 | 3614 | 0 | 0 | 0 | 0 | 0 | 0 | 23480 | 0 | 0 | 0 | 0 | | 0 | 51218 |
| INV_PUB | 0 | 0 | 0 | 0 | 0 | | 3811 | | | | | | 0 | 0 | 0 | 0 | | | | 3811 |
| VSTK | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12690 | | 0 | 12690 |
| TOTAL | 63483 | 85519 | 178652 | 179873 | 162797 | 21181 | 63088 | 6737 | 9342 | 2158 | -347 | 2098 | 127246 | 466899 | 563848 | 39715 | 51218 | 3811 | 12690 | |

SOURCE: AUTHORS' elaboration. IFPRI SAM for Guinea-Bissau. Where: USK and SK the Unskilled worker and skilled worker, respectively. CAP the composite capital (capital and labor factors); HR and HU the Rural and urban households, respectively; GVT government institution; TD the direct tax; TM import tax; TVA the tax on value added; Tx the export tax; TI the indirect tax; ROW the rest-of the world; ACT the aggregate activity sectors; ICOMM the aggregate commodities; XCOMM the export commodities; INV_PRI and INV_PUB private and investments, respectively; VSTK stock variation.

TABLE 1 - Proportion of labor supply by type of worker

| Factor | USK1 | USK2 | USK3 | USK4 | USK5 | USK6 | SK1 | SK2 | SK3 | SK4 | SK5 | USK6 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sec1 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec2 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.253 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec3 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec4 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec5 | 0.005 | 0.021 | 0.042 | 0.063 | 0.126 | 0.253 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.242 | 1,000 |
| Sec6 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec7 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec8 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec9 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.253 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec10 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec11 | 0.005 | 0.021 | 0.042 | 0.063 | 0.127 | 0.254 | 0.005 | 0.020 | 0.040 | 0.040 | 0.121 | 0.241 | 1,000 |
| Sec12 | 0.006 | 0.025 | 0.051 | 0.076 | 0.152 | 0.305 | 0.004 | 0.016 | 0.032 | 0.048 | 0.095 | 0.19 | 1,000 |
| Sec13 | 0.006 | 0.025 | 0.051 | 0.076 | 0.151 | 0.303 | 0.004 | 0.016 | 0.032 | 0.048 | 0.096 | 0.192 | 1,000 |
| Sec14 | 0.002 | 0.008 | 0.016 | 0.024 | 0.048 | 0.097 | 0.008 | 0.033 | 0.066 | 0.100 | 0.199 | 0.398 | 1,000 |
| Sec15 | 0.002 | 0.008 | 0.016 | 0.024 | 0.049 | 0.098 | 0.008 | 0.033 | 0.066 | 0.099 | 0.199 | 0.397 | 1,000 |
| Sec16 | 0.002 | 0.008 | 0.016 | 0.024 | 0.048 | 0.096 | 0.008 | 0.033 | 0.067 | 0.100 | 0.200 | 0.399 | 1,000 |
| Sec17 | 0.003 | 0.013 | 0.026 | 0.039 | 0.078 | 0.155 | 0.007 | 0.028 | 0.057 | 0.085 | 0.170 | 0.34 | 1,000 |
| Sec18 | 0.005 | 0.018 | 0.037 | 0.055 | 0.110 | 0.219 | 0.006 | 0.023 | 0.046 | 0.069 | 0.138 | 0.276 | 1,000 |
| Sec19 | 0.005 | 0.018 | 0.036 | 0.055 | 0.109 | 0.218 | 0.006 | 0.023 | 0.046 | 0.069 | 0.138 | 0.276 | 1,000 |
| Sec20 | 0.001 | 0.004 | 0.008 | 0.012 | 0.025 | 0.05 | 0.009 | 0.037 | 0.074 | 0.111 | 0.222 | 0.445 | 1,000 |
| Sec21 | 0.007 | 0.029 | 0.059 | 0.088 | 0.177 | 0.354 | 0.003 | 0.012 | 0.024 | 0.035 | 0.071 | 0.141 | 1,000 |
| Sec22 | 0.002 | 0.009 | 0.019 | 0.028 | 0.056 | 0.113 | 0.008 | 0.032 | 0.064 | 0.095 | 0.191 | 0.382 | 1,000 |

SOURCE: AUTHORS' elaboration. IFPRI SAM for Guinea-Bissau.

## APPENDIX B.2 CALIBRATION AND ELASTICITIES AND PARAMETERS

Calibration can be broadly defined as the procedure involving the choice of scale for some measuring instrument. Restrictively speaking, a large economic model, which Dawkins el al. call "theory with numbers", is calibrated when its parameters have been derived from what Hoover (1995, p.25) refers to as causal empiricism. In economics, calibration is related to the setting of certain parameters so that the model as a single entity mimics some particular feature of the historical record. That is, model base solution is generated by defining the numerical values of a set of endogenously calibrated parameters, while others, non-calibrated parameters, usually elasticities, are specified exogenously (DAWKINS EL AL., 2001).

Most of the numerical values of endogenously specified parameters are generated by using the SAM structure. However, perhaps the most critical issue surrounding the application of CGE modeling is to find values for elasticities. In poor countries, the lack of data and thus systematic empirical studies make it difficult to obtain elasticities that indicate, for example, the degree of substitution for the relevant commodities. When they exist, it is reasonable to assume that they are not stable. For example, in sub-Saharan Africa, there are several countries that were under colonial rule and later became independent; many countries have moved from a dictatorial regime to a partisan more diffuse one. It is not difficult also to find examples of those from socialism to a competitive market economy. All these aspects can lead to important changes in the CGE model structural parameters.

Thus, although data on the population are easily accessible, data on behavioral parameters used in the calibration process, such as trade elasticities, are difficult to obtain. The difficulty also arises since elasticities are parameters that are generated using a set of microdata that often the official statistics do not report. For example, to generate household’s consumption elasticities, it is necessary to know the structure of household demand, which is derived from the knowledge one has about household’s income and how it is distributed to relevant basket of goods and leisure. However, data on the earnings of different households and the degree of substitution of consumption of goods as a response to changes in relative prices are not available for all countries.

A variety of strategy have been used to determine these parameters: (i) calibration methods (Dawkins et al., 2001); (ii) the Entropy approach and the Bayesian Entropy method (CATTANEO, HINOJOSA-OJEDA and ROBINSON, 1999, MITKOVÁ, 2016); (iii) the optimal Fingerprint Detection Methods are also a found form for parameterization of a CGE model (KOESLER, 2015). In the absence of data that produce the historical behavior through which the elasticities are derived, (iv) it is common whether resorting to studies conducted for economics with similar characteristics that one wishes to approach (THURLOW and VAN SEVENTER 2002), or to define them in ad hoc way (Mohammed, 2016) or to estimate them using standard econometric techniques (HUBLER AND POTHEN, 2014).

Observation regarding to change of structural parameters over time, particularly in poor countries, seems to be old, as can be seen in several publications. The debate on appropriated methods for assessing the empirical relevance of economic models involved those who argued for the validity of the models by estimation (standard econometric approach) versus calibrated models (calibration approach).

For Watson (1993), the standard econometric approach traced back to Haavelmo (1944) studies, arguing that economic models that aim to provide some policy evidence should be incorporated within more general probabilistic models and analyzed accordingly by making inferences about unknown probability distributions. This approach has as its representatives Hansen and Sargent (1980).

A survey of the application of this approach to general equilibrium modeling was provided by Jorgenson (1998b). In short, econometric approach works as follows: instead of a single data point to obtain parameter values, it is necessary to have a long times series and adding stochastic error terms to the model. Errors and biases in the columns and rows that result from any scaling processes are treatable and will not influence the model parameters. Base-case equilibrium solution for some period corresponds to the endogenous price vector. Constant returns to scale for production function in each sector, as described by Jin and Jorgenson (2010), is the base assumption of this approach.

Arndt, Robinson, and Tarp (2002, p.376) provide three comments that emphasize the limitations of econometric approach: (i) Since many analysis with CGE models involve an adjustment time and the elasticities are short run because they result from the

estimates that were obtained using annual data, then the modeler is really underestimating the response capacity of economic agents over this adjustment period; (ii) large number of parameters values to be obtained require a long time series data to provide enough degrees of freedom; and (iii) the models that econometricians rely on to generate parameter values are not fully compatible with the general equilibrium system.

However, for Kydland and Prescott (1982, p.1369) modern and more advanced econometric techniques, such as those developed by Hansen and Sargent, are relevant, but precipitously applied to the validation of models that still need refinement. They argue that stochastic terms are added ad hoc. Thus, economic models as those like theirs, regardless of the outcome of the statistical test, should still be used for policy evaluation. Watson (1993, p.1012) goes further with this consideration by arguing that inference procedures usually lack statistical foundations, since economic models not nest a complete probability structure. He provides such foundations by adding a cumulative stochastic error term to the CGE model.

Shoven and Whalley (1972) study was one of the first using calibration approach. They analyze the incidence effects of the differential taxation of capital income on different United States sectors within a CGE model structure as an extension of Harberger's (1962) work. Numerical values for the parameters of such model were generated through an adjustment procedure, consisting of grouping the initial values and adjusting them interactively so that it is possible to verify the distance between the solution of the model and the benchmark equilibrium data set.

Piggott and Whalley (1985) and Shoven and Whalley (1992) adopted this approach since until then CGE models used all estimates parameter values taken from the literature in the base-case specification; they believed that the model base solution with these parameters do not reflect the actual performance of the economy known from the historical data. For example, Dawkins et al. (2001, p.3658) show that in an economy that addresses tax reforms, the specification of CGE including all these parameters might perhaps give a base-case solution in which, for example, 50 percent of employment was in manufacturing, when the national accounts data clearly showed it to be half of that amount.

For them, Shoven and Whalley rejected the use of literature base values for all parameters, but the values of a subset of parameters generated by the model structure. Consistent model necessarily needs to hold so-called reapplication test, that is, the one that produces an equilibrium solution that mimics the SAM database. Such a model, therefore, is neither estimable nor statistically testable, instead calibrated.

However, while calibration approach has the advantage of not requiring time series data and reserving estimation issues to the econometricians (See JIN, CHANNING and THOMAS, 2004, p.628), it has been criticized by many authors including Jorgenson (1984) and others. Essentially, econometric critique can be classified into three essential critiques, according to McKitrick (1998). First, CGE modeler tend to rely on elasticities from related studies, but often these studies use different classifications from what they are modeling. Therefore, those who advocate rigorous statistical testing claim that most of the parameters extracted from literature are not related to the objectives of the study and that the estimates are actually generated from no adherent-data-models, nor formally submitted to the relevant statistical test (see also DOMINGUES and HADDAD, 2005).

Second, time series are not immune from stochastic anomalies and unpredictable shocks in economies, the reason why arbitrarily using the parameters to force the model to reproduce the equilibrium solution and the imposed generalizations are equally detracted, since quality of such a basic solution will depend on the quality of the data and scaling processes that force micro-consistency (McKitrick, 1998).

The third critic that refers to the functional form, and is summarized in Jorgenson (2016, p.439), to whom the obvious disadvantage of the calibration approach is that the solution of the model depends on a set of assumptions about the state of the technology and preference that he considers to be too restrictive. The energy conservation induced by the higher energy price in early 1973 would have been clear evidence against the fixed coefficients assumption of Leontief (1951; 1953) and Johansen (1960; 1974) for demand function of intermediate goods. Moreover, the calibration approach relies on that changes in technology are exogenous, being this another apparent limitation, since, for example, it cannot explain the productivity growth rates due to the substitution of inputs as a response to relative price changes (JORGENSON, 2016, p.440).

The distinction of the two approaches is relevant to understanding the nature of the parameters and elasticities that are used in CGE models. However, in the relevant empirical applications such approaches are not completely mutually exclusive. Someone can use exogenous parameters from a related econometric study, at the same time calibrate some parameters endogenously, that is, based on the known national accounts data compressed in a SAM. For example, Arndt, Robinson, and Tarp (2002) combine the two approaches through what they call "maximum entropy approach" applicable for estimation when information is incomplete and for non-linear models. An entropy metric used consists of considering a restraint optimization problem to which distributions are chosen for parameters and error terms (set to be zero for base year equilibrium solution) that are closest to the previous distributions. Then, a structural CGE model is endogenously solved for base year.

Appendix B.2.1 – Elasticities and parameters

TABLE 1 - Compatibility SAM of Tanzania for SAM of Guinea-Bissau

| **Guinea-Bissau** | | **Tanzania** | |
|---|---|---|---|
| Sector | GAMS code | Sector | GAMS code |
| Millet | Sec1 | Agricultural food commodity | CAGFOD |
| Sorghum | Sec2 | Agricultural food commodity | CAGFOD |
| Maize | Sec3 | Agricultural food commodity | CAGFOD |
| Rice | Sec4 | Agricultural food commodity | CAGFOD |
| Fonio | Sec5 | Agricultural food commodity | CAGFOD |
| Cotton | Sec6 | Agricultural food commodity | CAGFOD |
| Other types of agricultural | Sec7 | Other agricultural commodity | CAGOTH |
| Cashew nut | Sec8 | Agricultural exports com's | CAGEXP |
| Breeding and hunting | Sec9 | Other agricultural commodity | CAGOTH |
| Forestry | Sec10 | Other agricultural commodity | CAGOTH |
| Fishery products | Sec11 | Other agricultural commodity | CAGOTH |
| Mining industries | Sec12 | Mining | CMINER |
| Food products and beverage | Sec13 | non-ag food processing commodity | CNAFOP |
| Other industries | Sec14 | non-ag other industry | CNAOIN |
| Electricity and water | Sec15 | non-ag service commodity | CNASEV |
| Construction sector | Sec16 | non-ag service commodity | CNASEV |
| Trading and repair | Sec17 | non-ag service commodity | CNASEV |
| Hotels and restaurants | Sec18 | non-ag service commodity | CNASEV |
| Transport and communications | Sec19 | non-ag service commodity | CNASEV |
| Financial services | Sec20 | non-ag service commodity | CNASEV |
| Services to firms | Sec21 | non-ag service commodity | CNASEV |
| Public administration | Sec22 | non-ag service commodity | CNASEV |

SOURCE: Own elaboration.

## APPENDIX B.2.1 – ELASTICITIES AND PARAMETERS ……..CONTINUATION

TABLE 2 - Industry CET elasticities

| Industry/commodity | SigmaXji | SigmaXTj | SigmaVAj |
|---|---|---|---|
| Sec1 | 1.25 | 1.25 | 1.5 |
| Sec2 | 1.25 | 1.25 | 1.5 |
| Sec3 | 1.25 | 1.25 | 1.5 |
| Sec4 | 1.25 | 1.25 | 1.5 |
| Sec5 | 1.25 | 1.25 | 1.5 |
| Sec6 | 1.25 | 1.25 | 1.5 |
| Sec7 | 1.25 | 1.25 | 1.5 |
| Sec8 | 1.25 | 1.25 | 1.5 |
| Sec9 | 1.25 | 1.25 | 1.5 |
| Sec10 | 1.25 | 1.25 | 1.5 |
| Sec11 | 1.25 | 1.25 | 1.5 |
| Sec12 | 1.25 | 1.25 | 1.5 |
| Sec13 | 2.00 | 2.00 | 1.5 |
| Sec14 | 2.00 | 2.00 | 1.5 |
| Sec15 | 0.50 | 0.50 | 1.5 |
| Sec16 | 0.50 | 0.50 | 1.5 |
| Sec17 | 0.50 | 0.50 | 1.5 |
| Sec18 | 0.50 | 0.50 | 1.5 |
| Sec19 | 0.50 | 0.50 | 1.5 |
| Sec20 | 0.50 | 0.50 | 1.5 |
| Sec21 | 0.50 | 0.50 | 1.5 |
| Sec22 | 0.50 | 0.50 | 1.5 |

SOURCE: Own elaboration. Data from the CGE model for Zimbabwe. SigmaXji: industry j elasticity of international demand for commodity i; SigmaXTj: Constant elasticity of transformation (CET) between the two destination, local and foreign markets; SigmaVAj: activity level is CES of the quantities of value-added and aggregate intermediate input use.

# APPENDIX B.2.1 – ELASTICITIES AND PARAMETERS …….CONTINUATION

TABLE 2 - Industry CET elasticities…….Continuation

| **Industry/commodity** | **SigmaKDj** | **SigmaLDj** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CAP | USK1 | USK2 | USK3 | USK4 | USK5 | USK6 | SK1 | SK2 | SK3 | SK4 | SK5 | SK6 |
| Sec1 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec2 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec3 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec4 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec5 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec6 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec7 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec8 | 0.75 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec9 | 0.77 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec10 | 0.77 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec11 | 0.77 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec12 | 0.50 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec13 | 1.50 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec14 | 0.90 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec15 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec16 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec17 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec18 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec19 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec20 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec21 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec22 | 1.25 | 2.0 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |

SOURCE: Own elaboration. SigmaKDj and SigmaLDj: CES between factors, respectively capital (KDj) and labor (LDj), at the bottom of technology nest. Note that for public administration, CES in the last two columns is the same for the service sectors.

## Appendix B.2.1 – Elasticities and parameters ……CONTINUATION

TABLE 3 – Agents' CES elasticities and LES parameters

| CES elasticities | CES elasticities | |
|---|---|---|
| | SigmaMi | SigmaXDi |
| Sec1 | 3.00 | 3.00 |
| Sec2 | 3.00 | 3.00 |
| Sec3 | 3.00 | 3.00 |
| Sec4 | 3.00 | 3.00 |
| Sec5 | 3.00 | 3.00 |
| Sec6 | 3.00 | 3.00 |
| Sec7 | 3.00 | 3.00 |
| Sec8 | 3.00 | 3.00 |
| Sec9 | 3.00 | 3.00 |
| Sec10 | 3.00 | 3.00 |
| Sec11 | 3.00 | 3.00 |
| Sec12 | 0.75 | 0.75 |
| Sec13 | 1.25 | 1.25 |
| Sec14 | 1.50 | 1.50 |
| Sec15 | 0.50 | 0.50 |
| Sec16 | 0.50 | 0.50 |
| Sec17 | 0.50 | 0.50 |
| Sec18 | 0.50 | 0.50 |
| Sec19 | 0.50 | 0.50 |
| Sec20 | 0.50 | 0.50 |
| Sec21 | 0.50 | 0.50 |
| Sec22 | 0.50 | 0.50 |

SOURCE: Own elaboration. Data from the CGE model for Tanzania. SigmaMi: Constant elasticity of substitution (CES) of demands for commodity i; and SigmaXDi: Elasticity of international demand for exported commodity i.

## Appendix B.2.1 – Elasticities and parameters ……..…….CONTINUATION

TABLE 4 – Agents' LES parameters

| Industry/commodity | Income elasticities | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HR1 | HR2 | HR3 | HR4 | HR5 | HR6 | HU1 | HU2 | HU3 | HU4 | HU5 | HU6 |
| Sec1 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec2 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec3 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec4 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec5 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec6 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec7 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec8 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec9 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec10 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec11 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec12 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec13 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec14 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec15 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec16 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec17 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec18 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec19 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec20 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec21 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |
| Sec22 | 2 | 1,6 | 1,2 | 0,7 | 0,4 | 0,1 | 1,01 | 1,4 | 1,8 | 2 | 2,2 | 2,5 |

SOURCE: Own elaboration. Urban and Rural households' income elasticity to each commodity.

## Appendix B.2.1 – Elasticities and parameters ……Continuation

TABLE 5 – Other elasticities

| Industry/commodity | Depreciation rates | | Investment demand elasticity | | New public capital elasticity |
|---|---|---|---|---|---|
| | Capital | Land | Capital | Land | zeta |
| Millet | 0.02 | 0.00 | 2.00 | 2.00 | 0.0403 |
| Sorghum | 0.02 | 0.00 | 2.00 | 2.00 | 0.0142 |
| Maize | 0.02 | 0.00 | 2.00 | 2.00 | 0.00125 |
| Rice | 0.02 | 0.00 | 2.00 | 2.00 | 0.0403 |
| Fonio | 0.02 | 0.00 | 2.00 | 2.00 | 0.0165 |
| Cotton | 0.02 | 0.00 | 2.00 | 2.00 | 0.0251 |
| Other agriculture | 0.02 | 0.00 | 2.00 | 2.00 | 0.0512 |
| Cashew nut | 0.02 | 0.00 | 2.00 | 2.00 | 0.0521 |
| Breeding-hunting | 0.02 | 0.00 | 2.00 | 2.00 | 0.0533 |
| Forestry | 0.02 | 0.00 | 2.00 | 2.00 | 0.0543 |
| Fishery products | 0.02 | 0.00 | 2.00 | 2.00 | 0.0553 |
| Mining industries | 0.02 | 0.00 | 2.00 | 2.00 | 0.0564 |
| Food and bever | 0.02 | 0.00 | 2.00 | 2.00 | 0.0576 |
| Other industries | 0.02 | 0.00 | 2.00 | 2.00 | 0.0567 |
| Electricity-water | 0.02 | 0.00 | 2.00 | 2.00 | 0.0556 |
| Construction sector | 0.02 | 0.00 | 2.00 | 2.00 | 0.0567 |
| Trading and repair | 0.02 | 0.00 | 2.00 | 2.00 | 0.0623 |
| Hotels-restaurants | 0.02 | 0.00 | 2.00 | 2.00 | 0.0635 |
| Transport | 0.02 | 0.00 | 2.00 | 2.00 | 0.0644 |
| Financial services | 0.02 | 0.00 | 2.00 | 2.00 | 0.0655 |
| Real estate | 0.02 | 0.00 | 2.00 | 2.00 | 0.0657 |
| Non-tradable tax | 0.02 | 0.00 | 2.00 | 2.00 | 0.0524 |

SOURCE: Own elaboration. Model default parameters.

TABLE 6 – Free parameters

| Frisch | n | IR | sh0O | tr0O | ttdh0O | ttdf0O |
|---|---|---|---|---|---|---|
| -2.00 | 0.02 | 0.07 | 0.02 | 0.02 | 0.02 | 0.02 |

Source: Own elaboration. Frisch: The same value has been assigned to the Frisch parameter for every household, urban and rural; n: population growth rate, being the same for every simulation time; IR: interest rate; sh0O: Intercepts of household savings function; tr0O: intercept of the household transfers to government function; andttdf0O and ttdf0O: households' and firms' income tax function intercepts.

## APPENDIX C - CGE MODEL WITH GAMS

The mathematical problems-solving methods undergo specialties and particularities, such that the mathematical modeling process and the solution techniques inherent in the various programming contexts vary and are usually grouped into several subareas, namely: integer programming, linear programming, and no-linear programming. Goldbarg (2005) argues that the field of mathematical programming and its application are consecrated due to their wide use in the solution of optimization problems.

Most of optimization techniques in use today trace their origin to methods developed during World War II when they began to grow at a pace hitherto never seen in the development of algorithms and computational codes to analyze and solve mathematical programming problems (Chinneck, 2001; McCARL, 2017).

The General Algebraic Modeling System (GAMS) software is a modeling system for both linear and nonlinear optimization problems, with or without objective function optimization. The idea of the development of GAMS algorithms was first presented at the International Symposium on Mathematical Programming in Budapest, Hungary, in 1976, in which two papers stood out.

The first work is by Christian C. Agunwamba, from University College of Wales, which extended the necessary condition of Kuhn Tucker and his restricted qualifications to new criteria and new qualifications in mathematical programming. The second one was by N.N. Abdelmalek of the National Research Council, Ottawa, who reduced the problem of obtaining minimal solution of infinity L from an indefinite system of equations for a linear system, giving numerical example to the new algorithm that solves complex problems in minutes. These algorithms are important for solving CGE problems with GAMS. For example, analyzing the complementary problem that will be addressed below, Horridge and Pearson (2011) argue that complementary is a suitable way to represent the Kuhn-Tucker conditions which arise from optimization by agents, and also by stepped tax schedules or game-theoretic equilibrium models (RUTHERFORD, 2002).

The purpose of this section is to provide an incomplete but relevant portrayal of the CGE theory with GAMS. This study is important for two reasons. First, understanding

the basic GAMS framework can clarify the calibration process and interpretation of the economic models used for policy analysis.

Second, CGE models can be build using numerous different programs, but GAMS has being one of the most successful post-war software and is often used to solve large-scale numerical programming problems in the various fields of knowledge, included Economics. Its application for economic modeling was born from the frustrated experience of the World Bank economists in dealing with large economic models that required the computational capacity that the algorithms for simple linear programming could hardly solve. Therefore, it had the financing of this institution in the early stages of its development, as well as the close collaboration between mathematical economists and computer engineers.

Economists' contribution to the development of GAMS can be seen from a number of studies conducted in the area during the 1970s. For example, Busieck and Meeraus (2014) comment that the Nobel Prizes in Economics of Leonid Kantorovich and Tjalling Koopmans in 1975 were really prizes in mathematical programming, in the same way can be considered the Nobel Prize of Kenneth Arrow in 1972, Wassily Leontief in 1973 and Harry Markowitz in 1990.

For Horridge and Pearson (2011, p.2), the first general-purpose software used for CGE modeling was GAMS. This software stands out for its simplicity of implementation and the ability to provide language based on algebra for compact representation of complex models. However, for a very large system, the translation of these models in the specific format of the algorithm required the computation of partial derivatives. In the 1970s, TRW developed a system called PROSE to calculate point derivatives and incorporated them into a programming language to produce exact results at a given point (BUSSIECK and MEERAUS, 2014).

Technically, GAMS language is structured into following three interconnected parts: data, model and resolution. In these basic structures, a typical GE model in economics can be represented and solved successfully.

## C.1 DATA SET

The first part in GAMS is designated for declarations and definitions of sets, declarations and definitions of parameters and assignments. This section allows the model to be expressed clearly. For instance, if the CGE model is an aggregate one, someone declares the sets that he/she wishes to modelling so that it is possible to visualize whether he/she is dealing with, for example, labor, capital, agricultural and non-agricultural sectors, or skilled labor and unskilled labor, agricultural capital and non-agricultural capital, several agricultural sectors and several non-agricultural sectors or both.

The parameters are all declared since they are important for equation definitions and for model calibration. Each specific parameter is used to enter data, indexed into one or more sets of interest. Note that, in GAMS, tables and scalars are special forms of parameters therefore a typical data entry requires both parameters and scalars or tables. With a parameter whose dimension is zero, there are no associated sets, since there is only one associated number, and then this parameter may be declared and initialized using scalar declaration. Such scalar statement is known as a list-based approach, which consists of listing all parameters of interest in the GAMS-IDE editor.

However, since the economic models are large and require more than one parameter and a larger dimension, an easiest approach to data entry is that of tabular data, consisting to import data matrix usually organized in a Excel format into the editor. Once introduced and initialized, data need to be manipulated through the assignment statement that works whether for defining values associated with sets, parameters, variables, and equations or for change them.

## C.2 MODEL DEFINITION

In this part one makes declarations of the variables, declarations and definitions of the equations and definitions of the model. GAMS variable is a endogenous variables, which are the entities whose values one does not know until the model has actually been solved successfully. Variable declarations are made in the same way as the parameter and set statements. GAM allows declaring nine types of variables: integer, non-negative,

non-positive, binary, integer, truncated to zero, non-truncated to zero for two variables whose values are adjacent, semi-continuous and semi-integer.

After declaring variables, the symbolic algebraic relations from optimization problem used to generate constraints in a CGE model is called in the GAMS of equations, which are defined using sets, functions, mathematical operators, constants, parameters, and variables. Each equation in the GAMS language can be defined on a set or group of previously declared sets. In the first case, the equation reads only the scalar, whereas in the latter the equation is expected to map the individual constraints associated with the elements of these sets.

The solution of the model requires that the equations of interest be collected in groups and labeled in a concise manner. The usual way to do this is by declaring the model using the "all", when someone wishes to include all the previous equations as the model solution. When interest is in a specific part of the equations, only those equations may be declared. Either way, the model statement requires keeping in mind the type of model to be solved, since GAMS allows to solve various types of mathematical representation. Therefore, knowledge of the model is vital to the success of the solution, since any incompatibility between the declared model and the executed one will lead to grueling computational errors.

## C.3 MODEL SOLUTION

Here solve statement is activate, whereby GAMS is being demanded to call available solvers for the chosen model type. From the resolver, action strings occur during compilation and at the time of execution. At each stage, GAMS requests that solvers verify the consistency of the model so as not to incur high waste that could be caused by the solution of a not desired or an incorrectly specified model. A consistent and error-free CGE model is solved successfully, but the consistent and poorly specified one reports strange parameters, if not antic errors that make it intractable.

## C. 4 NONLINEAR APPROACH

Equations in GAMS are typically nonlinear, household consumption demand depends on household income and composite price ratios, for example. GAMS allows solving nonlinear problems using specific algorithms. This subsection intends to summarize the three nonlinear method usually used to generate exact solutions of CGE model with GAMS.

Such a software account for the solution of economic data of the following model classes: Mixed Complementary Problems (MCP), Nonlinear Programming (NLP), and Constrained Nonlinear System (CNS). Following Horridge (2011), let a typical GE model in levels represented as a system of N simultaneous non-linear equations

$$F(W) = 0, \forall W \in R^N (MCP)$$

where F is a system of non-linear functions and W can be partitioned into Y vector of endogenous variables and X vector of exogenous variables, so

$$F(X,Y) = 0, \forall l,u \in R^N (MCP)$$

The real interest is finding Y, given X. But this is not a trivial task, since normally Y cannot be written as an explicit function (Horridge, 2011, p.3). Thus some initial solution $[Y^0, X^0]$ is assumed to be known:

$$\left[Y^0, X^0\right] = 0$$

According to Horridge and Pearson (2011, p.5), the researcher usually wants to know another solution with different settings of some X, so that

$$\left[Y^1, X^1\right] = 0$$

and to report percentage differences between $Y^1$ and $Y^0$. With MCP all F or some equations in F is generalizes, allowing the rows and columns to be combined into one-to-one complementary relationships. This means that each complementary equation $F_i$ has an associated variable $W_i$ with lower and upper values $l$ and $_u$, respectively, such that for each index $i \in \{1,...,n\}$ one of following alternatives holds:

$$W_i = l_i, F_i(W) \geq 0$$

$$l_i < W_i < u_i, F_i(W) = 0$$

$$l_i = u_i, F_i(W) \leq 0$$

For a model without discrete variables, but with general nonlinear terms involving only smooth functions, NLP or CNS reports the required solution. Essentially, GAMS/MCP language are identical to GAMS/NLP and GAMS/CNS except that in an MCP problem no objective function is specified, and bounded variables like $W_i$ must be mapped to complementary inequalities as above conditions (RUTHERFORD, 2002, p.13).

## C.5 LEVELS STRATEGY AND INTERPRETATION OF RESULTS

To ensure that only one of the above inequalities can hold, GAMS uses the so-called levels strategy (see Horridge and Pearson, 2011) which is a iterative procedure that find a solution from search through Y values.

In GAMS, usually three variants of Newton-Raphson solvers, like CANOPT for NLP and CNS, and PATH for MCP, may be used to research for Y numerical values. Basically the solvers verify if the model equations were correctly defined and that solutions really meet the specified problem, for example, constrained nonlinear system and complementarity, respectively for CNS and MCP mathematical types. By researching for Y, if the solver found any incompatibilities, the errors-informational messages are issued promptly and one will not be able to see the desired results.

Essentially GAMS does two things: (i) provide the user with GAMS-IDE interface for specifying the function F, setting up initials values for $Y^0, X^0$ and $X^1$, and call upon a desired solver CANOPT or PATH (or both), and (ii) allows these solvers to use the latest values of the endogenous variables Y to perform an evaluation of the functions F and gradients $F_i$ (Horridge and Pearson, 2011). In this process new values are assigned to the level and marginal fields for all model variables and equations.

GAMS language allows finding the simulated values either in levels or in terms of percentage changes regarding to the base solution. In a temporal static CGE model version, all interpretation is relative to percent change relatively to the base or chosen simulation. For example, assume a GDP of 20 dollars for base solution (following a normal business cycle) and the government decides to adopt a tariff cut policy and GDP has risen

to 26 dollars. We interpret this result as follows: Due to a government policy of tax cutting at x percent, the GDP of the economy, which is now 26 dollars, grew up by 30 percent compared to base GDP of 20 dollars. We can conclude that tax cut is the potential generator of aggregate income and, therefore, is an economically advisable policy. However, further conclusions should follow from welfare analysis.

**C.6: DATA BALANCING SAM**

In this part, data usually organized in the form of Social Accounting Matrix (SAM), coherent and consistent for CGE modeling, are imported with a GAMS Data eXchange (GDX) facilities, using parameter name:

```
PARAMETER
SAM(*,*,*,*);

$CALL GDXXRW.EXE SAMFINAL22.xls par=SAM rng=SAM!A4:CG88Rdim=2 Cdim=2
$GDXIN SAMFINAL22.gdx
$LOAD SAM
$GDXIN
```

Each above line must be fixed and, if necessary, SAM may be scaled and some adjustment can be made as to fit the model structure. For instance, if a factor is not employed by specific activity, you may zero out the associated cells and small SAM entry. This procedure avoids degenerate cases and scaling problems, preventing to the executions errors rising with poor scaling of the data matrix.

Since normally the SAM needs to be square, any adjustments require the re-computation of the rows/columns totals, guaranteeing that the matrix is balanced. However, it has been recommended that, if the SAM has significant imbalances, you need to look for appropriate approaches to SAM estimation for such contexts.

A variety of methods may be used for this purpose, but by far the two most popular ones are: RAS and Cross Entropy (CE) Methods. The origin of RAS method is often

attributed to the procedure of iterative proportional or least squares adjustment introduced by Deming and Stephan (1940), being first applied to input-output tables balancing by Richard Stone and Alan Brown (1962), and Michael Bacharach (1965), after becoming a recurrently used method in empirical analysis (TOH, 1998; Schneider and Zenios, 1990; LAHR and DE MESNARD, 2004; TRINH and PHONG, 2013).

RAS method is used in situations when only row and column sums of the *SAMFINAL22*matrix, for example, are known. Thus, from the initial matrix *SAMFINAL22*, a share matrix is calculated by dividing each element of *SAMFINAL22* by the total of the column in which it appears. To evaluate the matrix that respects the rows and columns totals of the initial matrix, each elements of the shares matrix may be multiplied by the corresponding columns totals, resulting in a third matrix. If the sum of each row in this latest matrix is equal to the sum of columns of the first matrix, *SAMFINAL22*, then the interaction procedure is terminated since the matrix is now a balanced one. Otherwise, the evaluation is continued by performing a sort of division of the totals of the rows of the first and second matrix and then multiplying the resulting ratio in the corresponding row.

CE Method comes from the information theory of Shannon (1948), and its first application in economics is attributed to Theil (1967) - see Fofana, Lemelin and Cockburn (2005). The earliest use of the CE for SAM estimation includes the work of Robinson, Catteneoand El-Said (2001). GAMS codes of this method were developed to balance SAM by Robinson and El-Said (2000).

Let Z0 be the initial matrix, the one containing the known data from the national accounts. Often one does treatment of Z0 as to meet the purpose of his/her study. For example, a matrix can contain only two households, urban and rural, since in the year of its building there were only data on these households. Suppose that in the year of the study the researcher somehow has in hand more data including those on rich or poor rural households and poor or rich households. This information may enrich further the analysis, mainly regarding the consumption pattern; and if this information is incorporated into the z0, the resulting new matrix is z1.

However, as the new information included in Z1 may have come from so many sources other than the data for Z0 had been extracted, the researcher needs to be careful, primarily with respect to the unit of measure. In practical terms, the major problem arises

from the moment in which this new information causes mismatches in the totals of the receipts and payments summarized at the rows and columns of Z1. Z1 solution is therefore impractical unless you adopt a procedure that minimizes the distance between the new information and those of the initial matrix Z0. This is the basis of the CE method.

Although these particularities between the two methods, both have some similarities; in particular, the CE method can be interpreted the same as the generalized RAS method (Fofana, Lemelin, and Cockburn, 2005).

GAMS codes for SAM balancing developed by IFPRI is a generalized RAS method. In the static standard model version, such codes are presented in *sambal.inc* file. However, the objective function of the SAM-balancing program contained in the *sambal.inc* is a cross-entropy distance from the initial SAM coefficients previously declared rather than column sums. The method is said to be equivalent to the RAS procedure except for treatment of negative entries and the fact that one does not have obligatorily to impose necessarily a constraint on column sums, since, though column sum constraint equation is defined, it is separated from the model definition.

As the SAM needs to be balanced for success of the model solution, since non-balancing can lead to the serious computational problems, the final SAM used in this study does not contain additional information beyond those of the initial SAM. The differences between the two are in the aforementioned aggregation in factor account.

## APPENDIX C.7 – BISSAU-DYN MODEL IN GAMS

The purpose here is to present the BISSAU-DYN model in GAMS. As the construction of this model into GAMS is facilitated by DLRM (2012), who provided the GAMS codes for the dynamic CGE model that has been applied for policies evaluation in developing countries. So, the description here follows accordingly, however, does not replace such an original reference, suggesting consulting it for further details.

*Headers and accounts*

*Factors of production - Sets L and K - Labor and Capital:* Consistent with the characteristic of the national productive system, with the high proportion of unskilled labor combined with land use for various purposes, the factors were classified into nine types according to their current use. There are two types of workers employed in the sectors: skilled and unskilled, two capitals: agricultural and non-agricultural, and five varieties of land: land for rice cultivation, land for the perennial cultivation of cashew nuts, land for forestry or livestock farming, land for forest, and land for other agricultural activities.

The two types of labor were coded by USK (unskilled) and SK (skilled). CAP is a composite of agricultural and non-agricultural capital, just as the five types of land were aggregated into a single land category called LAND (Figure C.1).

To respect the GAMS syntax, rows and columns names must be the same, as shown in the first two vectors in the Matrix (Figure C.2). The first row or column refers to the header required to identify the sets to which a given element belongs. Header is not a basic characterizer of the matrix accounts, but rather of the elements that make up the sets belonging to each account, creating a certain facility to search of the base solution values by the GAMS solvers. The second row or column symbolizes the six previously mentioned accounts.

FIGURE C.1 - Factors' aggregation from initial to the final Social Accounting Matrix

| Initial SAM | Final SAM | Header |
|---|---|---|
| Unskilled labor | USK1 | L |
| | USK2 | L |
| | USK3 | L |
| | USK4 | L |
| | USK5 | L |
| | USK6 | L |
| Skilled labor | SK1 | L |
| | SK2 | L |
| | SK3 | L |
| | SK4 | L |
| | SK5 | L |
| | SK6 | L |
| Non-agricultural Capital | CAP | K |
| Agricultural Capital | CAP | K |
| Land for Other agricultural | LAND | K |
| Land for Rice | LAND | K |
| Land for Cashew nut | LAND | K |
| Land for Livestock | LAND | K |
| Land for Forestry | LAND | K |

Source: Own elaboration.

Factors incomes are distributed to respective institutions. But while the capital income can be distributed to all agents, labor income is destined only to different types of households and, therefore, cannot be distributed to other agents.

*Institution: Set: AG – Agents*

The institutions' account was represented by AG (agents). There are four types of agents operating in this economy, namely: households, firms, government, and the rest of the world. The respective acronyms that are used in the GAMS codes are: HRR, HUR, FIRM, GVT and ROW.

*Households set: H (subset of set AG):* there are two types of households: rural (HRR) and urban (HUR). HRR and HUR receive factor incomes and transfers from other institutions. They use their income to purchase industries commodities I, pay direct taxes, make transfers to other agents, and save.

*Firms set: F (subset of set AG):* although the model can manage multiples types of businesses, the structure of Guinea-Bissau SAM includes only one firm, coded by FIRM. To keep operating, the firm earns income, but also makes the expenses. Firm income is the sum of capital income and government transfers in terms of subsidies. As

expenses, firm transfers non-fixed share of its revenue to households as factor income payment, pay taxes to the government, and invests/saves.

*Government set: GOV (subset of set AG):* this model version deals only with one government, entitled GOV; it does not allow different levels of governments, those at the regional level. Of course, the number of government categories will depend on data availability. If the information on the revenues and expenditures of the governments of the eight regions was available, one could easily disaggregate from the initial SAM the structure of governments into the model and modifying the GAMS codes.

Up to this point, it can be perceived that the model has different and multiple tax instruments, such as tax on income and wealth and tax on production, as well as subsidies and customs duties. Direct tax, indirect tax, exports subsidies and tariff are labeled by TD, TI, TE and TM, respectively. The former three taxes are locally collected; that is, taxes under autarchy, while the latter two refer to taxes with operations with the rest of the world, or tax under an open economy to trade.

Government income may come from transfers and taxes paid by agents, but also from accumulated international reserves. Direct taxes collected by government appear as amount entry in the account AG.TD, while transfers appear at the intersection of row AG.GOV and households (AG.H) and firms (AG.F) columns. Therefore, the total amount direct taxes collected from these institutions is shown at the intersection of row AG.GOV and column AG.TD.

Commodities sold domestically are subject to tax payments; indirect tax collected on the different locally sold commodities I is registered in AG.TI. Total of row AG.TI serves as income for the government that appears at the intersection of row AG.GOV and column AG.TI.

The intersection of row AG.TM and commodity-account columns I is the amount of tariff on imports, being total of row AG.TM the total import duties collected on the different imported commodities I. Then, at the intersection of row AG.GOV and column AG.TM is shown the taxes on imports paid to the government.

Another source of government revenue is the taxes applied on exports. These taxes are not registered in a separated account as AG.TM, for example, but appear at the intersection of row AG.GOV and of the exported commodity-account columns X.

Through redistributive policies, the government transfers part of its income to households H, subsidizes firms F; international reserves can be used for a variety of purposes, mainly for offsets between residents and non-residents operation, intersection of AG.GOV column and row AG.ROW. Government also consumes and saves.

*Rest of the world: set ROW (subset of set AG):* the model manages only one trading partners, labeled ROW, acronym to the rest of the world. The rest of the world income comes from capital income, transfers from domestic agents and from imports, while its spending is the sum of local purchase of export commodities and transfers to domestic agents. The rest of the world savings (current account balance with negative sign) is recorded at the intersection of row OTH.INV and column AG.ROW.

FIGURE C.2 - SAM GAMS ACCOUNT LABELS

| | | Demand side | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L | L | K | K | AG | AG | AG | AG | AG | AG | AG | AG | AG | J | I | X | OTH | OTH | OTH |
| | | USK | SK | CAP | LAND | RUR | URB | FIRM | GOV | TD | TM | TI | TE | ROW | ACT | COMM | EXPORT | INV | VSTK | TOT |
| L | USK | | | | | | | | | | | | | | | | | | | |
| L | SK | | | | | | | | | | | | | | | | | | | |
| K | CAP | | | | | | | | | | | | | | | | | | | |
| K | LAND | | | | | | | | | | | | | | | | | | | |
| AG | RUR | | | | | | | | | | | | | | | | | | | |
| AG | URB | | | | | | | | | | | | | | | | | | | |
| AG | FIRM | | | | | | | | | | | | | | | | | | | |
| AG | GOV | | | | | | | | | | | | | | | | | | | |
| AG | TD | | | | | | | | | | | | | | | | | | | |
| AG | TM | | | | | | | | | | | | | | | | | | | |
| AG | TI | | | | | | | | | | | | | | | | | | | |
| AG | TE | | | | | | | | | | | | | | | | | | | |
| AG | ROW | | | | | | | | | | | | | | | | | | | |
| J | ACT | | | | | | | | | | | | | | | | | | | |
| I | COMM | | | | | | | | | | | | | | | | | | | |
| X | EXPORT | | | | | | | | | | | | | | | | | | | |
| OTH | INV | | | | | | | | | | | | | | | | | | | |
| OTH | VSTK | | | | | | | | | | | | | | | | | | | |
| OTH | TOT | | | | | | | | | | | | | | | | | | | |
| | Check | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | |

**Supply side**

SOURCE: Own elaboration.

*Industries: Set J*

Industries refer to productive activities, labeled in GAMS code as elements of set J. As the SAM accommodates for the rectangular input-output tables structure, industries are labeled through distinct set J. The 22 sectors of the SAM of Guinea-Bissau are shown in Figure C.3. Not required, but here the nomenclatures of industries are the same used for commodities, and both were rescaled to avoid degenerate cases arising from division by zero. Because the Final SAM is balanced, no balancing procedure was required (see Appendix C.6 for details).

FIGURE C.3–Industry, commodity and exports set in GAMS

| Sector name | Industry's GAMS code | Commodity's GAMS code | Exports' GAMS code |
|---|---|---|---|
| Millet | sec1 | sec1 | sec1 |
| Sorghum | sec2 | sec2 | sec2 |
| Maize | sec3 | sec3 | sec3 |
| Rice | sec4 | sec4 | sec4 |
| Fonio | sec5 | sec5 | sec5 |
| Cotton | sec6 | sec6 | sec6 |
| Other types of agriculture | sec7 | sec7 | sec7 |
| Cashew nut | sec8 | sec8 | sec8 |
| Breeding and hunting | sec9 | sec9 | sec9 |
| Forestry | sec10 | sec10 | sec10 |
| Fishery products | sec11 | sec11 | sec11 |
| Mining industries | sec12 | sec12 | sec12 |
| Food products and beverages | sec13 | sec13 | sec13 |
| Other industries | sec14 | sec14 | sec14 |
| Electricity and water | sec15 | sec15 | sec15 |
| Construction sector | sec16 | sec16 | sec16 |
| Trading and repair | sec17 | sec17 | sec17 |
| Hotels and restaurants | sec18 | sec18 | sec18 |
| Transport and communications | sec19 | sec19 | sec19 |
| Financial services | sec20 | sec20 | sec20 |
| Services to firms | sec21 | sec21 | sec21 |
| Public administration | sec22 | sec22 | sec22 |

SOURCE: Own elaboration.

Industries can be multi-products, i.e., each productive activity can produce any commodities and sell it locally or export it to foreign market, or both, at producer prices. Local sales appear at the intersection of J-rows and I-columns, while external sales are recorded at the intersection of J-rows and X-columns.

As to produce the different commodities, industries use primary factors such as labor and capital, sum of supply of commodity I on the local market and exports market

by each industry J constitute the aggregate income for all industries, while their expenditure are payments for labor force and depreciate capital over time as well as intermediate consumption that includes duties, margins, and indirect taxes.

*Commodities Sets: I and X:*

Commodities are different goods and services produced and/or consumed in the Guinea-Bissau. In the GAMS codes, they are referred as elements of set I. Note that, in the SAM, commodities appear twice as account categories I and X. The second account category refers to exports. Such records are convenient to represent exports at both producer and purchaser prices, as well as to consider recurrent cases where, for a given commodity, the industries sell different proportions of their production in the local and international markets. The model assumes that only goods produced in Guinea-Bissau can be exported, and only domestic agents and industries can demand imports.

It is worth nothing that there are four final demands for each commodity, namely private demand, current public consumption, intermediate demand, demand for investment purposes and inventory changes. Both agents and industries purchases consist of demand for a composite commodity which is composed of local production and/or imports. Another category of demand that the model accommodates is demand by margin.

*Accumulation*

The accumulations account and its link with others complete the interconnection of the flows. Household, firm and government savings-investment, and current account balance (external savings) are grouped together in this account category, as well as inventory changes, INV and VSTK, respectively. OTH is the title for both categories, the same header for total rows and columns (TOT), as there is no set of GAMS code that represents them. Investment and inventory changes financing is made using total savings, as the sum of row OTH.INV, respectively released at the intersections of columns OTH.INV and OTH.VSTK and of the commodity rows (I).

# APPENDIX D - HOMOGENEITY TEST AND SHOCK SIZES

TABLE D.1 - Homogeneity test

| Variable | Balanced Growth Path\baseline | | | | Simulation | | | |
|---|---|---|---|---|---|---|---|---|
| Period | T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 |
| Population growth | n=2% | n=2% | n=2% | n=2% | n=2% | n=2% | n=2%% | n=2% |
| Numeraire | | | | | 5% | 5% | 10% | 10% |
| **Level** | | | | | | | | |
| Current account balance | -23480 | -23949,6 | -23480 | -23949,6 | -23480 | -23949,6 | -23480 | -23949,6 |
| Current government expenditures | 58589 | 59760,7 | 58589 | 59760,7 | 58589 | 59760,78 | 58589 | 59760,7 |
| World price of exported product | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| World price of imported product | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| **Percentage change** | | | | | | | | |
| Current account balance | -23480 | -23949,6 | -23480 | -23949,6 | 0.00 | 0.02 | 0.00 | 0.02 |
| Current government expenditures | 58589 | 59760, | 58589 | 59760,7 | 0.00 | 0.02 | 0.00 | 0.02 |
| World price of exported product | 1,00 | 1,00 | 1,00 | 1,00 | 0.00 | 0.00 | 0.00 | 0.00 |
| World price of imported product | 1,00 | 1,00 | 1,00 | 1,00 | 0.00 | 0.00 | 0.00 | 0.00 |

SOURCE: Own calculations with PEP-1-t model for Guinea-Bissau.

TABLE D.1A - Homogeneity test

| Variable | Simulation | | | |
|---|---|---|---|---|
| Period | T1 | T2 | T1 | T2 |
| Population growth | n=2% | n=2% | n=2%% | n=2% |
| Numeraire | 5% | 5% | 10% | 10% |
| **Level** | | | | |
| Current account balance | -23480 | -23949,6 | -23480 | -23949,6 |
| Current government expenditures | 58589 | 59760,78 | 58589 | 59760,78 |
| World price of exported product | 1,00 | 1,00 | 1,00 | 1,00 |
| World price of imported product | 1,00 | 1,00 | 1,00 | 1,00 |
| **Percentage change** | | | | |
| Current account balance | 0.00 | 0.02 | 0.00 | 0.02 |
| Current government expenditures | 0.00 | 0.02 | 0.00 | 0.02 |
| World price of exported product | 0.00 | 0.00 | 0.00 | 0.00 |
| World price of imported product | 0.00 | 0.00 | 0.00 | 0.00 |

SOURCE: Own calculations with PEP-1-t model for Guinea-Bissau.

TABLE D.3 – Tariff data at product level

| n | Commodities | 2001 | 2007 |
|---|---|---|---|
| 1 | Live animals | 14.25 | 11.2 |
| 2 | Meat and edible meat offal | 21.23 | 18.74 |
| 3 | Fish and crustaceans, mollusks and other aquatic invertebrates | 14.75 | 13.32 |
| 4 | Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included | 22.79 | 20.5 |
| 5 | Products of animal origin, not elsewhere specified or included | 8.59 | 7.17 |
| 6 | Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage | 12.57 | 11.46 |
| 7 | Edible vegetables and certain roots and tubers | 19.05 | 16.67 |
| 8 | Edible fruit and nuts; peel of citrus fruit or melons | 19.84 | 16.87 |
| 9 | Coffee, tea, mate and spices | 15.92 | 14.25 |
| 10 | Cereals | 12.66 | 11.1 |
| 11 | Products of the milling industry; malt; starches; inulin; wheat gluten | 16.19 | 14.19 |
| 12 | Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder | 7.71 | 6.57 |
| 13 | Lac; gums, resins and other vegetable saps and extracts | 9.64 | 6.38 |
| 14 | Vegetable plaiting materials; vegetable products not elsewhere specified or included | 6.89 | 5.68 |
| 15 | Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes | 13.76 | 12.06 |
| 16 | Preparations of meat, of fish or of crustaceans, mollusks or other aquatic invertebrates | 20.32 | 18.37 |
| 17 | Sugars and sugar confectionery | 15.78 | 15.25 |
| 18 | Cocoa and cocoa preparations | 14.68 | 13.46 |
| 19 | Preparations of cereals, flour, starch or milk; pastry cooks' products | 17.61 | 15.85 |
| 20 | Preparations of vegetables, fruit, nuts or other parts of plants | 19.7 | 18.08 |
| 21 | Miscellaneous edible preparations | 18.07 | 16.59 |
| 22 | Beverages, spirits and vinegar | 42.73 | 37.55 |
| 23 | Residues and waste from the food industries; prepared animal fodder | 7.8 | 6.76 |
| 24 | Tobacco and manufactured tobacco substitutes | 23.02 | 23.67 |
| 25 | Salt; Sulphur; earths and stone; plastering materials, lime and cement | 6.12 | 5.14 |
| 26 | Ores, slag and ash | 4.4 | 3.71 |
| 27 | Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes | 6.73 | 5.33 |
| 28 | Inorganic chemicals; organic or inorganic compounds of precious metals, of rare- earth metals, of radioactive elements or of isotopes | 5.39 | 4.25 |
| 29 | Organic chemicals | 5.2 | 3.91 |
| 30 | Pharmaceutical products | 4.58 | 3.28 |
| 31 | Fertilizers | 3.2 | 2.47 |
| 32 | Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other coloring matter; paints and varnishes; putty and other mastics; inks | 8.93 | 7.56 |
| 33 | Essential oils and resinous; perfumery, cosmetic or toilet preparations | 13.5 | 12.32 |
| 34 | Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modelling pastes, "dental waxes" and dental preparations with a basis of plaster | 13.41 | 11.76 |
| 35 | Albuminoidal substances; modified starches; glues; enzymes | 9.09 | 8.27 |
| 36 | Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations | 14.06 | 11.31 |

SOURCE: Own elaboration. WTO data. Where **n** is the quantity of products.

TABLE D.3 – Tariff data at product level (….. continuation)

| n | Commodities | 2001 | 2007 |
|---|---|---|---|
| 37 | Photographic or cinematographic goods | 10.97 | 8.85 |
| 38 | Miscellaneous chemical products | 6.96 | 5.88 |
| 39 | Plastics and articles thereof | 9.99 | 8.36 |
| 40 | Rubber and articles thereof | 10.22 | 8.61 |
| 41 | Raw hides and skins (other than foreskins) and leather | 6.55 | 5.71 |
| 42 | Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk- worm gut) | 18.31 | 16.85 |
| 43 | Foreskins and artificial fur; manufactures thereof | 11.98 | 11.07 |
| 44 | Wood and articles of wood; wood charcoal | 11.03 | 9.44 |
| 45 | Cork and articles of cork | 7.87 | 6.47 |
| 46 | Manufactures of straw, of esparto or of other plaiting materials; basket ware and wickerwork | 16.23 | 15.31 |
| 47 | Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper and paperboard | 4.32 | 3.37 |
| 48 | Paper and paperboard; articles of paper pulp, of paper or of paperboard | 10.75 | 8.71 |
| 49 | Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans | 7.17 | 5.97 |
| 50 | Silk | 8.42 | 6.88 |
| 51 | Wool, fine or coarse animal hair; horsehair yarn and woven fabric | 9.12 | 7.1 |
| 52 | Cotton | 11.44 | 9.59 |
| 53 | Other vegetable textile fibers; paper yarn and woven fabrics of paper yarn | 7.52 | 6.21 |
| 54 | Man- made filaments | 10.8 | 8.54 |
| 55 | Man- made staple fibers | 10.84 | 9.08 |
| 56 | Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof | 11.89 | 9.85 |
| 57 | Carpets and other textile floor coverings | 19.63 | 17.27 |
| 58 | Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery | 14.76 | 12.37 |
| 59 | Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use | 11.54 | 9.03 |
| 60 | Knitted or crocheted fabrics | 14.22 | 11.69 |
| 61 | Articles of apparel and clothing accessories, knitted or crocheted | 19.97 | 18.5 |
| 62 | Articles of apparel and clothing accessories, not knitted or crocheted | 20.92 | 18.81 |
| 63 | Other made up textile articles; sets; worn clothing and worn textile articles; rags | 18.91 | 16.31 |
| 64 | Footwear, gaiters and the like; parts of such articles | 18.23 | 16.21 |
| 65 | Headgear and parts thereof | 17.06 | 14.96 |
| 66 | Umbrellas, sun umbrellas, walking- sticks, seat- sticks, whips, riding- crops and parts thereof | 16.25 | 14.5 |
| 67 | Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair | 17.29 | 15.25 |
| 68 | Articles of stone, plaster, cement, asbestos, mica or similar materials | 12.25 | 11.2 |
| 69 | Ceramic products | 13.83 | 12.3 |
| 70 | Glass and glassware | 11.52 | 9.91 |
| 71 | Natural or cultured pearls, precious or semi- precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewelry; coin | 12.79 | 10.79 |
| 72 | Iron and steel | 6.99 | 5.47 |
| 73 | Articles of iron or steel | 11.88 | 9.85 |
| 74 | Copper and articles thereof | 8.34 | 6.91 |
| 75 | Nickel and articles thereof | 6.73 | 5.18 |
| 76 | Aluminum and articles thereof | 10.31 | 8.45 |
| 77 | LEAD AND ARTICLES THEREOF | 7.25 | 5.37 |

SOURCE: Own elaboration. WTO data.

TABLE D.3 – Tariff data at product level (….. continuation)

| n | Commodities | 2001 | 2007 |
|---|---|---|---|
| 78 | Zinc and articles thereof | 6.69 | 5.15 |
| 79 | Tin and articles thereof | 6.98 | 5.61 |
| 80 | Other base metals; cermet; articles thereof | 6.22 | 4.48 |
| 81 | Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base meta | 10.73 | 9.03 |
| 82 | Miscellaneous articles of base metal | 13.46 | 11.48 |
| 83 | Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof | 6.24 | 5.02 |
| 84 | Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles | 10.03 | 8.57 |
| 85 | Railway or tramway locomotives, rolling- stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro- mechanical) traffic signaling equipment of all kinds | 5.45 | 4.3 |
| 86 | Vehicles other than railway or tramway rolling- stock, and parts and accessories thereof | 14.58 | 12.47 |
| 87 | Aircraft, spacecraft, and parts thereof | 5.1 | 3.76 |
| 88 | Ships, boats and floating structures | 7.63 | 6.02 |
| 89 | Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof | 6.88 | 5.83 |
| 90 | Clocks and watches and parts thereof | 13.62 | 12.59 |
| 91 | Musical instruments; parts and accessories of such articles | 11.69 | 9.29 |
| 92 | Arms and ammunition; parts and accessories thereof | 18.4 | 16.73 |
| 93 | Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name- plates and the like; prefabricated buildings | 16.54 | 14.84 |
| 94 | Toys, games and sports requisites; parts and accessories thereof | 13.83 | 11.84 |
| 95 | Miscellaneous manufactured articles | 15.14 | 13.18 |
| 96 | Works of art, collectors' pieces and antiques | 12.37 | 10.49 |

SOURCE: Own elaboration. WTO data, 2017.

## APPENDIX E - SENSITIVITY ANALYSIS

In the GUINEA-DYN model, elasticities of substitution used in the Armington structure are employed for the following categories: production, household consumption and demand for investment goods. A total of 347 elasticities of substitution are used in the model. As observed, the base values used for these parameters were extracted from a CGE model of Tanzania and are not based on empirical evidence for Guinea-Bissau. Therefore, although both two economies share many similarities in terms of income, a sensitivity analysis is required, given the uncertainty that prevails over the values of the elasticities of substitution and consequently the results of the model. Initially, the sensitivity analysis was employed testing the substitution structure imposed between goods, with a 50% interval for substitution parameters using Gaussian quadrature's method (see Decalwe, Martens, and Savard, 2001).

This choice, however, resulted in a very high computational cost: Gaussian quadrature demanded 694 (= $2*347$) solves as to obtained results for mean and standard deviations for endogenous variables, and each resolution took an average of 6 minutes which would be approximately 3 days, from august 11th to 14th, 2019. So, we decided beforehand to restrict the test by taking only the household consumption substitution elasticities, which are 144 in total. The 95% confidence intervals are constructed based on Chebyshev's inequality by bounding 4.50 standard deviations from the mean (see Greene, 1993; Domingues, Haddad, Hewings, 2008). The conclusion that the results are or are not sensitive to the elasticities of substitution is observed directly from the signs and magnitudes of this confidence interval changes. Table E.1 reports the macroeconomic results obtained through the estimated mean and standard deviation. The productivity scenario simulation reveals that the results are robust for a significant interval of substitution parameters.

TABLE E – Sensitivity analysis of substitution parameters: macroeconomic variables

| Variable | 95% confidence interval | |
|---|---|---|
| Real GDP | 0.243 | 0.348 |
| Real household consumption | 0.566 | 0.659 |
| Investment | 0.362 | 0.568 |
| Employment | 0.598 | 0.603 |

SOURCE: Author elaboration. Model results.

## APPENDIX F – SHOCK SECTORS WERE PERFORMED

TABLE 1 – Imports sectors (Column 3), exports sectors (Column 4), and productivity sectors (Column 5)

| Industry | Code | Import tariffs scenario | Export taxes scenario | Productivity scenario |
|---|---|---|---|---|
| Millet | Sec1 | + | + | + |
| Sorghum | Sec2 | + | + | + |
| Maize | Sec3 | + | + | + |
| Rice | Sec4 | + | + | + |
| Fonio | Sec5 | + | + | + |
| Cotton | Sec6 | + | + | + |
| Other agriculture | Sec7 | + | + | + |
| Cashew nut | Sec8 | - | + | + |
| Breeding-hunting | Sec9 | + | - | + |
| Forestry | Sec10 | - | + | - |
| Fishery products | Sec11 | - | - | + |
| Mining industries | Sec12 | + | - | - |
| Food and beverages | Sec13 | + | + | + |
| Other industries | Sec14 | + | + | + |
| Electricity-water | Sec15 | - | - | - |
| Construction sector | Sec16 | - | - | - |
| Trading and repair | Sec17 | - | - | - |
| Hotels-restaurants | Sec18 | - | - | - |
| Transport | Sec19 | - | - | - |
| Financial services | Sec20 | - | - | - |
| Real estate | Sec21 | - | - | - |
| Non-tradable tax | Sec22 | - | - | - |

SOURCE: Authors' elaboration. (+) Sector involved in international trade, and (–) sectors that produce only for domestic market, and weather do not import or export.

FIGURE 1 –Estimated sector productivity

Millet

```
. reg lMILL lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 2.13 |
| Model | 1.16609097 | 4 | .291522742 | Prob > F | = | 0.1078 |
| Residual | 3.27983303 | 24 | .13665971 | R-squared | = | 0.2623 |
| | | | | Adj R-squared | = | 0.1393 |
| Total | 4.445924 | 28 | .158783 | Root MSE | = | .36968 |

| lMILL | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | -.1701159 | .0914914 | -1.86 | 0.075 | -.3589449 | .0187131 |
| lnFACL | .2445499 | .1927071 | 1.27 | 0.217 | -.153178 | .6422777 |
| OVLPI | -.3775384 | .6044979 | -0.62 | 0.538 | -1.625161 | .8700838 |
| INFRA | .3105923 | .6497258 | 0.48 | 0.637 | -1.030376 | 1.65156 |
| _cons | -1.056992 | 2.154225 | -0.49 | 0.628 | -5.503094 | 3.38911 |

Sorghum

```
. gen lSorg = ln(S2)

. reg lSorg lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 1.07 |
| Model | .889962631 | 4 | .222490658 | Prob > F | = | 0.3910 |
| Residual | 4.96959851 | 24 | .207066605 | R-squared | = | 0.1519 |
| | | | | Adj R-squared | = | 0.0105 |
| Total | 5.85956114 | 28 | .209270041 | Root MSE | = | .45505 |

| lSorg | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | .2012492 | .1126199 | 1.79 | 0.087 | -.0311869 | .4336852 |
| lnFACL | .0571489 | .2372097 | 0.24 | 0.812 | -.4324279 | .5467256 |
| OVLPI | -.3542142 | .744097 | -0.48 | 0.638 | -1.889955 | 1.181527 |
| INFRA | .304127 | .7997696 | 0.38 | 0.707 | -1.346516 | 1.95477 |
| _cons | -5.94406 | 2.651709 | -2.24 | 0.035 | -11.41692 | -.471202 |

Maize

```
. reg lnMaize lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 1.55 |
| Model | 1.61297403 | 4 | .403243506 | Prob > F | = | 0.2202 |
| Residual | 6.25033747 | 24 | .260430728 | R-squared | = | 0.2051 |
| | | | | Adj R-squared | = | 0.0726 |
| Total | 7.86331149 | 28 | .280832553 | Root MSE | = | .51032 |

| lnMaize | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | -.1375159 | .1263008 | -1.09 | 0.287 | -.398188 | .1231562 |
| lnFACL | .2148109 | .2660256 | 0.81 | 0.427 | -.334239 | .7638608 |
| OVLPI | .0169122 | .8344891 | 0.02 | 0.984 | -1.705389 | 1.739213 |
| INFRA | -.2172329 | .8969247 | -0.24 | 0.811 | -2.068395 | 1.633929 |
| _cons | -1.677838 | 2.973836 | -0.56 | 0.578 | -7.815533 | 4.459857 |

FIGURE 1 –Estimated sector productivity……..…CONTINUATION

Rice

```
. reg lnRice lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 4.38 |
| Model | 1.07471925 | 4 | .268679813 | Prob > F | = | 0.0085 |
| Residual | 1.47353109 | 24 | .061397129 | R-squared | = | 0.4217 |
| | | | | Adj R-squared | = | 0.3254 |
| Total | 2.54825034 | 28 | .091008941 | Root MSE | = | .24778 |

| lnRice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | .1859078 | .0613245 | 3.03 | 0.006 | .0593402 | .3124753 |
| lnFACL | -.2362181 | .129167 | -1.83 | 0.080 | -.5028056 | .0303693 |
| OVLPI | .3193003 | .4051805 | 0.79 | 0.438 | -.5169512 | 1.155552 |
| INFRA | -.2813447 | .4354957 | -0.65 | 0.524 | -1.180164 | .6174743 |
| _cons | -.3629742 | 1.443926 | -0.25 | 0.804 | -3.343091 | 2.617142 |

Fonio

```
. reg lnFonio lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 5.57 |
| Model | 7.37661055 | 4 | 1.84415264 | Prob > F | = | 0.0026 |
| Residual | 7.94661397 | 24 | .331108915 | R-squared | = | 0.4814 |
| | | | | Adj R-squared | = | 0.3950 |
| Total | 15.3232245 | 28 | .547258018 | Root MSE | = | .57542 |

| lnFonio | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | -.4869518 | .1424117 | -3.42 | 0.002 | -.780875 | -.1930286 |
| lnFACL | .301842 | .2999596 | 1.01 | 0.324 | -.3172443 | .9209282 |
| OVLPI | .307213 | .9409357 | 0.33 | 0.747 | -1.634783 | 2.249209 |
| INFRA | -.5327644 | 1.011336 | -0.53 | 0.603 | -2.620059 | 1.55453 |
| _cons | 1.233157 | 3.353175 | 0.37 | 0.716 | -5.687457 | 8.153771 |

Cotton

```
. reg lnCott lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 25 |
|---|---|---|---|---|---|---|
| | | | | F(4, 20) | = | 6.39 |
| Model | 1.7126585 | 4 | .428164624 | Prob > F | = | 0.0018 |
| Residual | 1.3400366 | 20 | .06700183 | R-squared | = | 0.5610 |
| | | | | Adj R-squared | = | 0.4732 |
| Total | 3.0526951 | 24 | .127195629 | Root MSE | = | .25885 |

| lnCott | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | .3590309 | .0780405 | 4.60 | 0.000 | .1962414 | .5218205 |
| lnFACL | -.1632435 | .1371338 | -1.19 | 0.248 | -.4492995 | .1228126 |
| OVLPI | -.1322279 | .5009103 | -0.26 | 0.794 | -1.177108 | .9126526 |
| INFRA | .1249626 | .5239336 | 0.24 | 0.814 | -.9679437 | 1.217869 |
| _cons | -8.896848 | 1.592376 | -5.59 | 0.000 | -12.21849 | -5.575211 |

FIGURE 1 –Estimated sector productivity……..…CONTINUATION

Other agriculture sector

```
. reg lnOtha lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 35.02 |
| Model | .689071023 | 4 | .172267756 | Prob > F | = | 0.0000 |
| Residual | .118044587 | 24 | .004918524 | R-squared | = | 0.8537 |
| | | | | Adj R-squared | = | 0.8294 |
| Total | .80711561 | 28 | .028825557 | Root MSE | = | .07013 |

| lnOtha | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | .1705005 | .0173571 | 9.82 | 0.000 | .1346772 | .2063238 |
| lnFACL | -.0812633 | .036559 | -2.22 | 0.036 | -.1567175 | -.0058092 |
| OVLPI | -.0402586 | .1146811 | -0.35 | 0.729 | -.2769488 | .1964316 |
| INFRA | .064461 | .1232615 | 0.52 | 0.606 | -.1899381 | .3188602 |
| _cons | -3.359994 | .4086846 | -8.22 | 0.000 | -4.203477 | -2.51651 |

Cashew nuts

```
. reg lnCashe lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 28.02 |
| Model | 9.22219411 | 4 | 2.30554853 | Prob > F | = | 0.0000 |
| Residual | 1.97457724 | 24 | .082274052 | R-squared | = | 0.8236 |
| | | | | Adj R-squared | = | 0.7943 |
| Total | 11.1967714 | 28 | .399884691 | Root MSE | = | .28683 |

| lnCashe | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | .6273369 | .0709891 | 8.84 | 0.000 | .4808227 | .7738512 |
| lnFACL | -.0788562 | .1495233 | -0.53 | 0.603 | -.3874571 | .2297447 |
| OVLPI | -.09585 | .4690358 | -0.20 | 0.840 | -1.063892 | .8721923 |
| INFRA | .1099827 | .5041286 | 0.22 | 0.829 | -.9304875 | 1.150453 |
| _cons | -10.69752 | 1.671484 | -6.40 | 0.000 | -14.14729 | -7.247743 |

B. Hunting

```
. reg lnBhunt lnEXP lnFACL OVLPI INFRA
```

| Source | SS | df | MS | Number of obs | = | 29 |
|---|---|---|---|---|---|---|
| | | | | F(4, 24) | = | 11.49 |
| Model | 2.62038921 | 4 | .655097302 | Prob > F | = | 0.0000 |
| Residual | 1.36892974 | 24 | .057038739 | R-squared | = | 0.6569 |
| | | | | Adj R-squared | = | 0.5997 |
| Total | 3.98931895 | 28 | .142475677 | Root MSE | = | .23883 |

| lnBhunt | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| lnEXP | .2978636 | .0591078 | 5.04 | 0.000 | .175871 | .4198562 |
| lnFACL | -.0993178 | .124498 | -0.80 | 0.433 | -.356269 | .1576334 |
| OVLPI | -.458861 | .3905346 | -1.17 | 0.252 | -1.264885 | .3471628 |
| INFRA | .5906294 | .419754 | 1.41 | 0.172 | -.2757002 | 1.456959 |
| _cons | -3.38812 | 1.391733 | -2.43 | 0.023 | -6.260514 | -.5157247 |

FIGURE 1 –Estimated sector productivity……..…CONTINUATION

Food

```
. reg lnFood1 lnEXP lnFACL OVLPI INFRA

      Source |       SS       df       MS      Number of obs   =        29
-------------+------------------------------   F(4, 24)        =     14.33
       Model |  34.2797996     4  8.56994989   Prob > F        =    0.0000
    Residual |  14.3497647    24  .597906862   R-squared       =    0.7049
-------------+------------------------------   Adj R-squared   =    0.6557
       Total |  48.6295642    28  1.73677015   Root MSE        =    .77324

------------------------------------------------------------------------------
     lnFood1 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnEXP |   1.215263   .1913713     6.35   0.000      .8202916    1.610234
     lnFACL |  -.0538631   .4030827    -0.13   0.895     -.8857849    .7780587
      OVLPI |  -.5106041    1.26442    -0.40   0.690     -3.120238    2.09903
      INFRA |   .5202131   1.359022     0.38   0.705     -2.284671    3.325098
      _cons |  -11.22717   4.505963    -2.49   0.020     -20.52702   -1.927322
------------------------------------------------------------------------------
```

Services

```
. reg lnElewat lnEXP lnFACL OVLPI INFRA

      Source |       SS       df       MS      Number of obs   =        29
-------------+------------------------------   F(4, 24)        =     71.54
       Model |  3.78507076     4  .94626769   Prob > F        =    0.0000
    Residual |  .317438801    24  .013226617   R-squared       =    0.9226
-------------+------------------------------   Adj R-squared   =    0.9097
       Total |  4.10250956    28  .146518199   Root MSE        =    .11501

------------------------------------------------------------------------------
    lnElewat |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       lnEXP |   .4085287   .0284632    14.35   0.000      .3497834    .4672739
     lnFACL |  -.1929143   .0599517    -3.22   0.004     -.3166486    -.06918
      OVLPI |  -.0732533   .1880611    -0.39   0.700     -.4613923    .3148857
      INFRA |   .1089858   .2021316     0.54   0.595     -.3081934    .5261649
      _cons |   6.513522   .6701858     9.72   0.000      5.130326    7.896717
------------------------------------------------------------------------------
```

SOURCE: Authors' elaboration