INFRASTRUCTURE INVESTMENT, FUNDING SCHEMES, AND POVERTY REDUCTION: EVIDENCE FOR GUINEA-BISSAU

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Abstract: Guinea-Bissau is typical example of a poor country with agricultural-base economy. The government of this country therefore has elaborated development policies aimed at improving the country's comparative advantage, promoting sustained economic growth and poverty reduction. This policy initiatives resulted in an infrastructure investment program in 2015 valued at US $1 billion. The present study aims to analyze the socioeconomic impacts of this program using a dynamic recursive micro-simulated computable general equilibrium model. Our results show positive impact of infrastructure investments on the level of economic activity, aggregate productivity, and sectoral spillovers. The funding schemes are important in determining these outcomes as they contribute to increase wealth accumulation as well to mitigate in the long-term the urban and rural households' poverty.
Keywords. Infrastructure investment. Poverty. CGE modeling. Guinea-Bissau.

Resumo: A Guiné-Bissau é um típico exemplo de um país pobre com economia baseada na agricultura. O governo deste país tem elaborado políticas de desenvolvimento destinadas a melhorar a vantagem comparativa do país, promover crescimento econômico sustentado e reduzir aa pobreza. Essas iniciativas políticas resultaram em um programa de investimento em infraestrutura em 2015 no valor de US $ 1 bilhão. O presente estudo tem como objetivo analisar os impactos socioeconômicos desse programa usando um modelo dinâmico recursivo micro-simulado de equilíbrio geral computável. Os resultados obtidos mostram o impacto positivo dos investimentos em infraestrutura no nível de atividade econômica, produtividade agregada e repercussões setoriais. Os esquemas de financiamento são importantes para explicar esses resultados, pois contribuem para aumentar a acumulação de riqueza, bem como para mitigar a pobreza no longo prazo das famílias urbanas e rurais.
Palavras-chave. Investimento em infraestrutura. Pobreza. Modelagem CGE. Guiné-Bissau.

Area 6: Crescimento, Desenvolvimento Econômico e Instituições
JEL Codes: C68; H54; O12.

1. Introduction

Infrastructure has been considered as an engine a country need as to reach its comparative advantages out, since it contributes to enlarge size of the labor market, increasing productivity and output (BARRO, 1991; Prud'Homme, 2004), beside the fact

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that several final consumption items to households and intermediate consumption item for firms, such as water and energy and telecommunications, depend on infrastructure services (AGENOR, BAYRAKTAR, and AYNAOUI, 2008).

Guinea-Bissau is one of the poorest countries in the world, because of the relatively low performance of its economy and high level of poverty. The gross domestic product (GDP) per capita 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. From 1980 to 2017, life expectancy at the birth of a Guinean man was on average 46 years and more than more than 69 percent of the population live in absolute poverty (less than two dollars a day). The extreme poverty (below US 1 per day) increased considerably from 28.8 to 33 percent from 2002 to 2017, respectively (UN-DP, 2018).

These results can be explained by the low level of infrastructure availability. For example, only 20% of the population has access to basic sanitation facilities. In general, the precariousness and insufficient infrastructure increase the country's operating costs, since the asphalted proportion of roadways represents 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).

In 2015, the Guinea-Bissau government elaborated an ambitious public investment program reinforcing the need for the country to overcome the underdevelopment condition it faces through the construction of new infrastructures. The program is locally named *Terra-Ranka* since it aimed at encouraging the country comparative advantage development and economic growth. Therefore, *Terra-Ranka* 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 and 115 projects that promote industrialization and transform this poor economy into a competitive and stable one with food self-sufficiency and less poverty and social inequality (GUINEA-BISSAU, 2015).

The purpose of this study is to understand in what extend infrastructure public investments improve supply condition of national products. Do such investments affect the productivity of the sectors? What are the implications of new investments on poor households' income and consumption?

Economists usually justify public investments in infrastructure with the belief that countries that need to accelerate theirs catching up process may fail to encourage private investment to the efficient uses because institutions required to oversee and manage these investments tend to be weakest (IMF, 2015). Public investment we address is the one directed towards the creation new roads, railroads, ports, and airports, that is, new construction.

Previous literature points out infrastructure investment is relevant since its availability creates production facilities and stimulates economic growth (Romp and de Haan, 2005; Sahoo, Dash, and Nataraj, 2010; Warner, 2014). Direct effects of infrastructure investment operate through the labor markets: 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 labour. 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. Labour income should increase as well as household consumption.

Infrastructure availability also has socioeconomic indirect effects. For instance, given the high correlation between levels of education and productivity, the investment in infrastructure that increase productivity is expected to affect the education of citizens, since individuals can use income from increased productivity to invest in the education of their children. The evidence shows that construction of a new infrastructure (transport and the road condition) influences the school attendance rate, learning environment and students' outcomes (Earthman, 2004; Miguel and Kremer, 2004).

Notwithstanding these positive effects, the discussion of public investments impacts on productivity and more generally on socioeconomic development is relatively recent in the empirical economic literature and goes back to the studies of Aschauer (1989a, 1989b), Munnell (1990a). These authors show the existence of such effects in different context, which alter were confirmed by Munnell (1990b), Nadiri and Mamuneas (1994), and Wolff (1996).

However, subsequently some authors (see Garcia-Mila and McGuire, 1992; Holtz-Eakin, 1994; Morrison and Schwartz, 1996; Garcia-Milà, McGuire and Porter, 1996) have reported insignificant impact of new infrastructure public investment on economic activity, which generated a mix of findings. 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 infrastructure stimulates long run growth. Calderon and Serven (2010) also findings a positive correlation of 0.35 between GDP annual growth and indices of infrastructure quantity in African countries.

Ndulu (2006) argues that one of the main challenges of sub-Saharan African countries is to find mechanisms to accelerate their economic growth, by arguing that infrastructure and regional integration may be two potential mechanisms that can help foster stronger economic growth in Africa. 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.

Several empirical argue evidence reports that public investment in infrastructure has positive effect on the level of economic activity because of its complementary with private investment (Aschauer (1989) and Erden and Holcombe (2005). These complementary-base hypothesis studies, however, are confronted with the crowding out hypothesis (COH) for which an increase in public investment may lead to a decrease in private investment (Cavallo and Daude (2011), and Everhart and Sumlinski (2001).

The recent empirical findings from infrastructure public investment have to do with the refinement given to the method that best reports the results, ranging from the choice of the functional form to the details of econometric methods relevant to the context. That involves looking for estimation background as to take into account the existing endogeneity between best quality of infrastructure and GDP, for example, and how the specificities of the entities can radically change the magnitude and the simulated parameters. 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).

This study, built on the evaluation literature economic policy in the poor countries (Sangare and Maisonnave 2018; Go et al, 2016; Chitiga 2016), aims to analyze the macroeconomic, sectoral, and household level implications of the public infrastructure investment in Guinea-Bissau.

Our study contributes to the existing literature. First, we developed the BISSAU-DYN model, a recursive dynamic micro-simulated computable general equilibrium (CGE) model, which is the first CGE model applied for this economy. The choice of this version is justified by three reasons: (i) the effects of building a new construction 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, such that it is possible to provide evidence for socioeconomic policies; (ii) Guinea-Bissau is a typical example of a small open 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 either at starting point or overt time, and the recursive dynamic model may best represent the structure of this economy; and (iii) as for a long period the potential policy effects could not be analyzed due to lack of adequate data, the application of the CGE framework will not only help answer our question, but it will also fill this empirical gap.

Second, although governments have been practicing economic policy with the aim of promoting the development of the productive forces important to fight against structural poverty, few policies are focused on the sectors to which the households find its source of income. By concentrating on both rural and urban sectors, we will be able to provide instructive evidence for the elaboration of public policies consistent with the reality of each households.

The remaining of this study is structured as follows: In section 2 we present the CGE model used for simulation and its calibration procedures and closure, and the database. Section 3 reports and discusses the results and Section 5 concludes the discussion.

2 Methodology

We analyze new infrastructure investment socioeconomic outcomes by using the CGE framework as proposed by Savard and Adjovi (1998) and Savard (2010), who first introduce the positive externalities associated to the public investment in infrastructure into national-bilateral CGEs models. The foundations of this model stems from neoclassical assumptions in the tradition of Dervis, De Melo and Robinson (1982). These authors appropriated from an analytical framework developed almost a century ago by Leon Walras (Shoven and Whalley, 1973; Decaluwe, Martens, and Savard, 2001).

We will use a dynamic recursive CGE model as in Boccanfuso *et al.* (2014). However, our model has its own specificities since it is based on country with different socioeconomic characteristics. As in Savard (2010), the key assumptions of this model concern infrastructure spending, externalities of public infrastructure and the budget constraint faced by government to funding this infrastructure. For the first assumption we seek to understand how infrastructure investment occurs and how we can model it. The second assumption is drawing from the set of exhaustive following questions: Are there public infrastructure investments externalities? How do they propagate in the model? These questions are answered by choosing and appropriate externalities functional form. The budget constrained represent the idea that the resources for infrastructure investments are not a gift for government. They are supposed to come from government revenue. If they do not come from this source and if the government decides to pursue its policy initiatives, he must find ideal funding source either through fiscal instruments or transfers from other agents.

We present these assumptions below. We assume that the government funds its investments program through its revenues (Yg_t) that can 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 (1) 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 ($Trgov,row,t$).

$$Yg_t = \quad Tdh_t + Tdf_t + Tip_{j,t} + Tic_{i,t} + Tim_{i,t} + Ypk_t + \sum_i Tr_{i,t} \tag{1}$$

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

Income taxes are described in Equations 2 and 3 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).

$$Tdh_{h,t} = \quad {Cpi_t}^n . ttdh0_{h,t} + ttdh1_{h,t} . Yh_{h,t} \tag{2}$$

$$Tdf_{f,t} = \quad {Cpi_t}^n . ttdf0_{f,t} + ttdf1_{f,t} . Yf_{f,t} \tag{3}$$

Government also may funding its policy through a tax applied to the value of each industry production (Equation 4).Taxes on production therefore are industry j unit cost ($Pp_{j,t}$), excluding taxes directly related to the use of capital and labor, but including other taxes on total aggregate output of industry j ($XST_{j,t}$).

$$Tip_{j,t} = \quad ttip_{j,t} . Pp_{j,t} XST_{j,t} \tag{4}$$

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

Finally, the government can implement two types of taxes on products or commodities. Taxes apply on the sales value at domestic market include margins (trade and transport margins) and custom duties (Equation 5). In a static version of the model, the production and sales taxes may be 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.

$$Tic_{i,t} = \quad ttic_{i,t} \begin{bmatrix} \left(Pl_{i,t} + \sum_{ij} Pc_{ij,t}\, tmrg_{ij,i}\right) Dd_{i,t} + \\ \left(\left(1 + ttim_{i,t}\right) PWm_{i,t} e_t + \sum_{ij} Pc_{ij,t}\, tmrg_{ij,i}\right) IM_{i,t} \end{bmatrix} \tag{5}$$

where $Pl_{i,t}$ 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 may positive or negative if national data are restricted to the 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 6 and 7).

Government transfers from rest of the world (ROW) 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 an available infrastructure investments funding source. Technically, we set ROW transfers to be equal to their SAM values ($Tr^0{}_{gov,row}$) and next we allow them to grow each period at the same population (pop_t) growth rate, being indexed fully to the consumer price index (Equation 8).

$$Tr_{gov,h,t} = Cpi_t{}^n . tr^0{}_{h,t} + tr^1{}_{h,t} Yh_{h,t} \quad (6)$$

$$Tr_{gov,f,t} = \gamma^{TR}{}_{gov,f} . Yf_{f,t} \quad (7)$$

$$Tr_{gov,row,t} = Cpi_t{}^n . Tr^0{}_{gov,row}\, pop_t \quad (8)$$

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

Current government budget or deficit (positive or negative savings - Sg_t) constraint equation (Equation 9) show 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).

$$Sg_t = Yg_t - Tr_{gov,agng,t} - G_t \quad (9)$$

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 is changed the closure as to take into account the fiscal instruments. From the above relationships, the government can adjust the current budget or deficit as funding mechanism. Equation (10) considers the two funding sources.

$$ITg_t = Sg_t + Deficit \quad (10)$$

It is assumed that if infrastructure construction is fully funded only with public savings, the government will not have changed 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 will get a deficit, but the amount of debt should increase from one period to another depending on the interest rate charged on the initial loan.

We will return in the next section with the discussion of scenarios of simulation and model closure. 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 (2010), and subsequently adopted by Estache, Perrault and Savard and Boccanfuso *et al.*, and set as follows:

$$\theta_{i,t} = \left(\frac{Kg_t}{Kg_{t-1}}\right)^{\varepsilon_i} \quad (11)$$

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 ε_i is a sector-specific elasticity. The values of this parameters will be derived from Harchaoui and Tarkhani (2003) study who estimated externalities by sector for Canadian economy. This choice justified, mainly, because there is no data at the sectoral level that allow such estimation for sector of Guinean economy, but also, since the literature recurrently reveals decreasing to public infrastructure and the present study is about developing economy, the use of elasticities estimated for a developed country can be considered as conservative with respect to this literature (Estache, Perrault, and Savard, 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 (δ_g) – Eq.12:

$$Kg_t = Kg_{t-1}(1+g_{kg})^t\left(1-\delta_g\right)^t + ITg_{t-1}(1-\delta_g)^{t-1} \quad (12)$$

The motivation to use the externalities function (as in Eq.11) 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 θ_i). This force appears in the value-added ($Va_{i,t}$) equation (Eq.13) through this theta parameter, so that:

$$Va_{i,t} = \theta_{i,t}A_iLd_{i,t}{}^{\alpha_i}Kd_{i,t}{}^{1-\alpha_i} \quad (13)$$

where A_i is the scale parameter; $L(d_{i,t})^{a_i}$ and $K(d_{i,t})^{1-a_i}$ the labor and capital demand by industry i, respectively; and α_i the Cobb–Douglas parameter. Hence, like in Boccanfuso *et al.*, an increase in θ_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 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.

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 θ_i represents the portion associated with the new investments of 100 million per year for 25 years, the investment time-calendar. In other words, every XOF 1 spent on infrastructure construction will have effects on total factor productivity through the θ_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 θ_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. This mean 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. Thus, the model no longer concerned with comparative static analysis, but with the cumulative effects on the economy of current policy since labor force as well as technological progress as time-indexed.

We model the evolution of capital stock through the investment demand functions (Eq. 14) as in Decaluwé et al. (2012), where the volume of new type 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 ($R_{k,i,t}$) to 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 (Eq.15).

$$Ind_{k,j,t=}\phi_{k,i}\left[\frac{R_{k,j,t}}{K_{k,j,t}}\right]^{{\sigma_{k,j}}^{INV}} Kd_{k,j,t} \tag{14}$$

$$U_{k,j,t=} = {PK_t}^{new}\,(\delta_{k,j}+IR_{k,t})^5 \tag{15}$$

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

The level of investment demand at time t is used in capital accumulation rule equation (Eq. 16), which states that stock of capital in industry i in period t + 1 is equal to the stock in t, minus depreciation of capital ($\delta_{k,j}$), plus the volume of new capital investment in the t.

$$Kd_{k,j,t+1} = Kd_{k,j,t}(1-\delta_{k,j})Ind_{k,j,t} \tag{16}$$

$$Lcs_{t+1} = Lcs(1+n) \tag{17}$$

The dynamic specification is complete 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 17.

2.1 Data base and model closure

This study will be carried out with data from two sources: International Food Policy Research Institute (IFPRI) and World Bank. Use the Social Accounting Matrix (SAM) of Guinea-Bissau that was built by Cabral (2015) from IFPRI. This SAM provides a comprehensive information on the country's economy in the 2007. It 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. As we intend to micro-simulate infrastructure investments, we use the 2014 minimum wage annunciated by official government to disaggregate households in 6 urban and 6 rural types (Table 1), and next emerge the shares with every rows and columns 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.

Table 1 – 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

[5] For public sector, we write Eq.(18) as $U_{k,pub,t=} = {PK_t}^{pub}\,(\delta_{k,pub}+IR_{k,t})$, where pub denotes public industry. That is, the user cost of public capital depends on the price of new public capital, the rate of depreciation, and the rate of interest.

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

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. 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 investment program is evaluated by considering different scenarios. The base year is 2014, and the program covers the period from 2015 to 2025, with investments applied between 2015 and 2017. The projection for 2030 is carried out as to consider the lag and dissemination of public investments after the end of the program, with the assumption that there are positive externalities effects after construction is completed. As a result, it is primarily the economic activity generated by infrastructure construction what is widespread in the model during the first year of public investment (Boccanfuso *et al*.). The scenarios are presented in Table 2.

Table 2– scenarios of simulation of infrastructure investment policy

Reference Scenario	
Business as Usual	Growth of 2 % per year of the 2015–2030 period (from t to t + 16)
Simulations 2, 3, and 4	
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 5, 6, 7,8,9 and 10	
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.

The simulations of the scenarios 2,3 and 4 are performed by considering the follow model closure. As the shock is done directly on the ITP, the new investment in infrastructure and consequently savings is kept fixed. Therefore, if initial ITP 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 (3), government revenue should increase by the same proportion. Meanwhile, for simulations from 5 to 10 (scenarios 4 to 9), we let ITP 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 ITP.

3 Results

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 policy authorities use taxes from firm and household incomes, while in the scenario 9 funds comes from the public debt and production taxes.

3.1 Macroeconomic results

The Table 3 shows that 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.

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.

We observe 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. The that government real income increases during greater economic growth periods and faster afterward for both 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. 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 since GDP have steel shown a good performance through the program period, which provides enough additional government revenues to fund its investments.

In terms of the funding scenarios for infrastructure investment, 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 (see Table 4). Productivity plays a crucial role in the behavior of macro and sectoral outcomes.

We observe that increase in GDP is supported by the positive aggregate productivity and less by the additional employment, as in the case of scenarios 5, 7 and 8. 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 3 - Gap compared to BAU scenario 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 4 - Gap compared to BAU scenario for real GDP (GDP_Real)

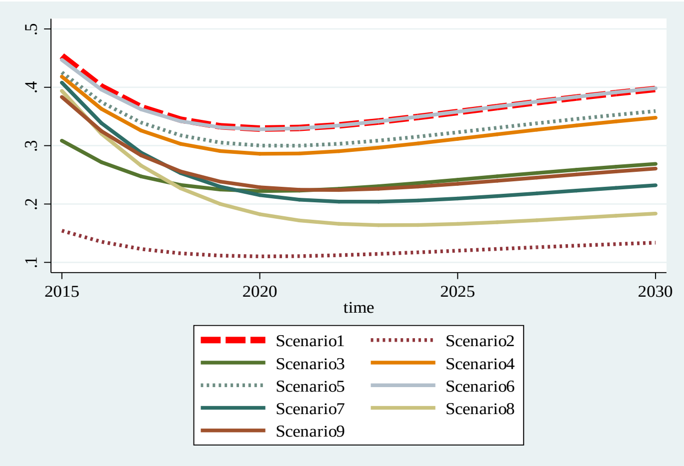
Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Scenario4	0.418	0.363	0.326	0.303	0.291	0.286	0.287	0.291	0.297	0.304	0.312	0.320	0.327	0.335	0.342	0.348
Scenario5	0.426	0.374	0.340	0.318	0.305	0.300	0.300	0.303	0.309	0.315	0.323	0.331	0.338	0.346	0.353	0.359
Scenario6	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.

3.2 Sector Results

We analyze the sectoral results of scenarios 1 to 3 and those of scenarios 4 to 9 from the comparative perspective of economic activities, income, consumption, 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 1). 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 1 - 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 2025. It is possible to observe that all scenarios produce positive productivity externalities for sectoral variables (Table 6). 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 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.

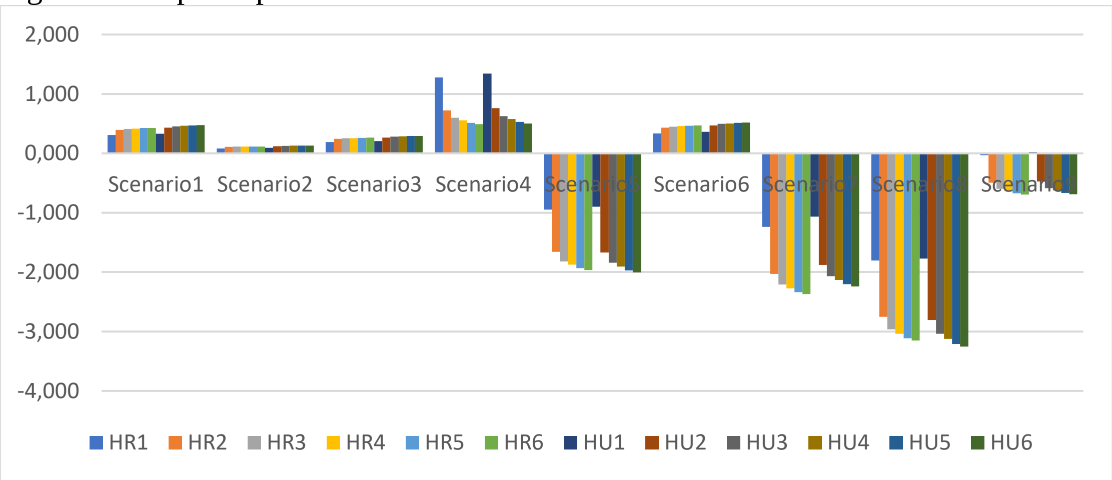
Table 5 - Gap compared to BAU scenario for externalities of public investment at end of resolution (theta)

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.

In terms of income, both policies are different income effects from one household to other (Figure 2). 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 those that those producing negative results. Moreover, the percentage of income variation of the poorest households is higher when policies produce positive effects and lower when income effects of these policies are negative.

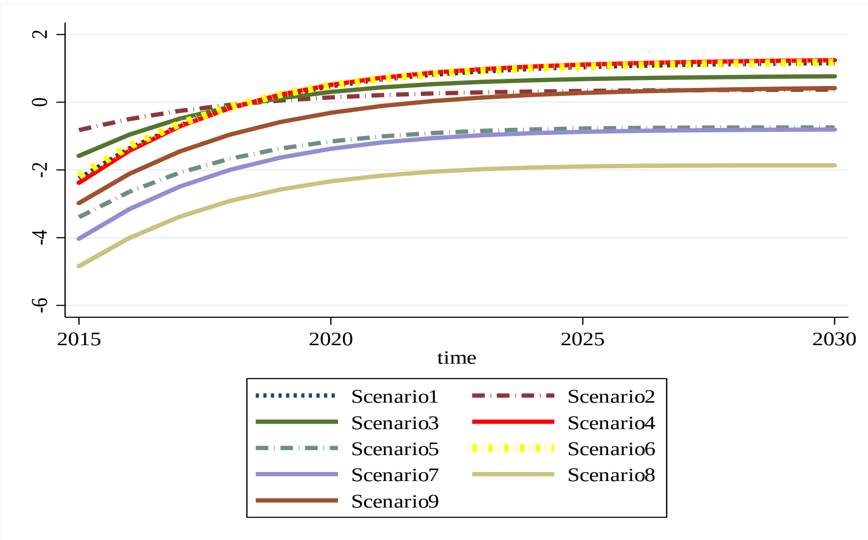
Figure 2 – Gap compared to BAU scenario for households' real income



Source: Authors elaboration. Model results.

The consumer price index (Figure 3) it 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 3 - Consumer price index – variation compared to BAU



Source: Authors elaboration. Model results.

Table 6 - Gap compared to BAU scenario for households' real consumption (CH)

Household consumption	**Scenario1**	**Scenario2**	**Scenario3**	**Scenario4**	**Scenario5**	**Scenario6**	**Scenario7**	**Scenario8**	**Scenario9**
Year	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**	**2030**
Time	**t+16**	**t+16**	**t+16**	**t+16**	**t+16**	t+16	t+16	**t+16**	**t+16**
Rural household 1:≤ 1 minimum wage	-0.078	-0.026	-0.053	0.849	0.333	-0.081	0.254	-0.236	0.344
Rural household 2: ≤ 2 minimum wage	0.004	-0.003	-0.002	0.297	-0.391	0.009	-0.553	-1.200	-0.123
Rural household 3: ≤ 4 minimum wage	0.022	0.002	0.009	0.174	-0.552	0.029	-0.732	-1.414	-0.227
Rural household 4: ≤ 6 minimum wage	0.029	0.003	0.013	0.131	-0.609	0.036	-0.796	-1.49	-0.264
Rural household 5: ≤ 8 minimum wage	0.036	0.005	0.018	0.086	-0.668	0.044	-0.862	-1.568	-0.302
Rural household 6: ≤ 10 minimum wage	0.039	0.006	0.02	0.063	-0.698	0.047	-0.895	-1.609	-0.321
Urban household 1: ≤ 1 minimum wage	-0.055	-0.018	-0.037	0.918	0.382	-0.058	0.433	0.551	0.398
Urban household 2: ≤ 2 minimum wage	0.043	0.009	0.024	0.333	-0.398	0.049	-0.399	-0.506	-0.099
Urban household 3: ≤ 4 minimum wage	0.065	0.015	0.038	0.200	-0.576	0.073	-0.589	-0.747	-0.212
Urban household 4: ≤ 6 minimum wage	0.073	0.018	0.043	0.152	-0.64	0.082	-0.657	-0.833	-0.252
Urban household 5: ≤ 8 minimum wage	0.081	0.020	0.048	0.103	-0.705	0.091	-0.727	-0.922	-0.294
Urban household 6: ≤ 10 minimum wage	0.086	0.021	0.050	0.078	-0.739	0.095	-0.763	-0.968	-0.315

Source: Authors elaboration. Model results.

The extent to which government public investment and how it funding its policies affect the living conditions of the population is a question that this study also seeks to answer (see Table 6). Therefore, a 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% and 6.7% in new public investment, as represented by Columns 3 and 4, also reduces by -0.002 the consumption of rural households receiving up to 10% of the minimum wage. In fact, as the salary range grows, more is the positive impacts one household can get from the increase in new public investments. However, this result changes completely when government adopts different funding schemes, each one 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, 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, financing public of policy investment with 50% of external resources and 50% of the official deficit will reduce by -0,081 and -0,081% the consumption of rural and urban households with less than a minimum wage, respectively, while increasing the consumption of their counterparts on the opposite tail by 0.047 and 0.095%.

In contrast, we note 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 finances its policies with income tax money, it is only the rural household with highest minimum wage that will 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 made any gain, overall, this policy negatively affects more the rural households receiving up to 30% of minimal wages. In scenario 9 of financing using 50% production taxes, 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 one minimum wage.

In short, public investment in infrastructure is 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 catch-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 show that using the already distribute 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).

4. **Conclusions**

This study aims to analyze the effects of public investments on socioeconomic results, sectoral productivity and households income and consumption from 2015 to 2030, based on the Guinea-Bissau government investment program in infrastructure that are in operation since 2015 as to address the numerous development challenges in promoting national comparative advantage and increasing the citizen's standard of living.

Simulation results 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 income 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 is 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 develop 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.

However, confirmation of this hypothesis requires more detailed studies. The results of this study indicate that infrastructure investment has positive long-term impact on several socioeconomic variables and productivity, but when the government adopt funding schemes, results shift from one sector to another. Internally, it will be necessary to understand how the design of the institutional situation in Guinea-Bissau has contributed to the country's economic development. As for the model, further studies will be required, introducing more scenarios and to consider the level of qualification of the worker and how earnings from labor market can be redistributed, including between the sexes.

References

AGENOR, P. R., BAYRAKTAR, N. AND AYNAOUI, K. E. Roads out of Poverty? Assessing the links between aid, public investment, growth, and poverty reduction. **Journal of Development Economics**, Vol.86. n.2, p.277–95, 2008.

ASCHAUER, D. A. Is Public Expenditure Productive? Journal of Monetary Economics, v.23, p.177-200, 1989a.

ASCHAUER, D. A. (1989b). Public Investment and Productivity Growth in the Group of Seven. Economic Perspectives, v.13, n.5, p.17-25, 1989b.

ASCHAUER, D. A. Does Public capital crowd out private capital? Journal of Monetary Economics, v.24, n.2, p.171−188, 1989.

BARRO, R. J. Economic growth in a cross section of countries. The Quarterly Journal of Economics, v..106, p.407-443, 1991.

BOCCANFUSO, D.; JOANIS, M.; RICHARD, P.; and SAVARD, L. A comparative analysis of funding schemes for public infrastructure spending in Quebec. Applied Economics, v.46, n.2, p.1-12, 2014.

BOSUA, R.; GLOET, M.; KURNIA, S.; MENDOZA, A.; AND YONG, J. Telework, Productivity and Wellbeing. Telecommunications Journal of Australia, v.63, n.1, p.1-25, 2012.

CABRAL, F. J. A 2007 Social Accounting Matrix for Guinea Bissau. AGRODEP Data Report, n.05. Washington, DC: International Food Policy Research Institute. AGRODEP Data Report, n.05. Washington, DC: International Food Policy Research Institute, 2015.

CALDERON, C.; and SERVEN, L. Infrastructure and Economic Development in Sub-Saharan Africa. Journal of African Economies, v.19, p. i13-i87, 2010.

CANNING. D; and PEDRONI, P. Infrastructure and long run economic growth. Working Paper 99(9), Center for Analytical Economics, Cornell University, 50p, 2004.

CAVALLO, E.; and DAUDE, C. Public investment in developing countries: A blessing or a curse? Journal of Comparative Economics, v.39, n.1, p.65-81, 2011.

CHITIGA, M. MABUGU, R.; AND MAISONNAVE. H. Analyzing job creation effects of scaling up infrastructure spending in South Africa. Development Southern Africa, p.1-16, 2016.

DECALUWÉ, B.; LEMELIN, A.; ROBICHAUD. V.; MAISONNAVE . H. **PEP-1-t** : The PEP standard single-country, recursive dynamic CGE model. Version 2.1, 2013**.**

DECALUWE, B. ; MARTENS, A. ; and SAVARD, L. La Politique Économique Du DéveloppementEtLesModèles D'équilibreGénéralCalculable. Les Presses de l'Université de Montréal, Montreal, QC, 509p, 2001.

DECALUWÉ, B.; LEMELIN, A.; ROBICHAUD. V.; MAISONNAVE . H. PEP-1-t : The PEP standard single-country, recursive dynamic CGE model. Version 2.1, 2012.

De MELO, J. Computable general equilibrium models for trade policy analysis in developing countries: A survey. **Journal of Policy Modeling**, v.10, p.469-503. 1988.

DERVIS, K.; DE MELO, J.; ROBINSON, S. General Equilibrium Models for development Policy. London: Cambridge University Press. 1982.

DEVARAJAN, S. SWAROOP, V.; and ZOU, H-F. The composition of public expenditure and economic growth. Jour al of Monetary Economics, v.37, n.2, p. 313-344, 1996.

DIAMOND, P. A.; AND MIRRLEES, J. A. Optimal Taxation and Public Production I: Production efficiency. The American Economic Review, v.61, n.1, p.8-27, 1971.

EARTHMAN, G. I. Prioritization of 31 Criteria for School Building Adequacy. American Civil Liberties Union Foundation of Maryland Baltimore. Baltimore, MD, 67p, 2004.

ERDEN, L., AND HOLCOMBE, R. G. The effects of public investment on private investment in developing countries. **Public Finance Review**, v.33, n.5, 575-602, 2005.

ESTACHE, A. ; PERRAULT, J-F ; AND SAVARD, L. The Impact of Infrastructure Spending in Sub-Saharan Africa: A CGE Modeling Approach. Economics Research International, v.012, n.18, p.01-18, 2012.

EVERHART, S. S., AND SUMLINSKI, M. A. Trends in private investment in developing countries and the impact on private investment of corruption and the quality of public investment. International Finance Corporate Discussion Paper 44. Washington D.C.: World Bank, 2001.

GARCIA-MILA, T; AND MCGUIRE, T. J. The Contribution of Publicly Provided Inputs to States' Economies. **Regional Science and Urban Economics**, v.22, P.229-41, 1992.

GARCIA-MILÀ T.; MCGUIRE, T. J.; AND PORTER, R. The Effect of Public Capital in State- Level Production Functions Reconsidered. **Review of Economics and Statistics**, v.78, p.177-180, 1996.

GU, W., and MACDONALD, R. The Impact of Public Infrastructure on Canadian Multifactor Productivity Estimates. The Canadian Productivity Review. Research paper 21, 2009.

GUINEA-BISSAU. Plan Strategique et Operationnel 2015-2020 « Terra Ranka » Document II: Rapport Final, 198p, 2015. Available at : https://prais.unccd.int/sites/default/files/2018-09/Plan%20Strategique%20GB%202025%20-%20Rapport%20Final%20-%2014-03-2015.pdf. Accessed on July 12, 2018.

HAFNER, M.; STOLK, C. V.; SAUNDERS, C. L.; KRAPELS, J.; BARUCH, B. HEALTH, wellbeing and productivity in the workplace: Health, wellbeing and productivity in the workplace. RAND Corporation: Santa Monica, California and Cambridge, 55p, 2015.

HARCHAOUI, T. M.; and TARKHANI, F. Public capital and its contribution to the productivity performance of the Canadian business sector. Economic analysis (EA) research paper series. Catalogue n.11F0027MIE - n.017, 34p, 2003.

HOLTZ-EAKIN D. Public-Sector Capital and the Productivity Puzzle. Review of Economics and Statistics, v.76, p.12-21, 1994.

IMF. International Monetary Fund. Making public investment more efficient. Washington, DC: International Monetary Fund, 2015.

JOANIS, MARCELIN(Org.). Le Québec économique : Le défici de infrastucture. Laval: Les Presses de l'Université Laval. 453p, 2017.

MIGUEL, E.; and M. KREMER. Worms: Identifying Impacts on Education and Health in the Presence of Treatment Externalities. **Econometrica**, v.72, p.159-21, 2004.

MORRISON, C., and A. SCHWARTZ. State Infrastructure and Productive Performance. **American Economic Review**, v.86, n.5, p.1095-1111, 1996.

MUNELL, A. H. Why as Productivity Growth Declined. Productivity and Public Investment. **New England Economic Review**, p.3-22, 1990a.

MUNELL, A. H. How does Public Investment affect Regional Economic Performance? In: MUNELL, A. H. (Ed.). Is There a Shortfall in Public Capital Investment? Boston: Federal Reserve Bank of Boston, 1990b.

NADIRI, M. I.; and MAMUNEAS, T. P. The Effects of Public Infrastructure and R&D Capital on the Cost Structure and Performance of U.S. Manufacturing Industries. **Review of Economics and Statistics**, v.76, p.22-37, 1994.

NDULU, B. Infrastructure, Regional Integration and Growth in Sub-Saharan Africa: Dealing with the Disadvantages of Geography and Sovereign Fragmentation. **Journal of African Economies**, v.15, n.2, p.212-244, 2006.

PERKINS, P.; FEDDERKE, J.; AND LUIZ, J. An Analysis of Economic Infrastructure Investment in South Africa. **South African Journal of Economics**, v.73, n.2, p.211-228, 2005.

PRUD'HOMME, R. Infrastructure and Development. Annual Bank Conference on Development Economics, n28975, Washington, 47p, 2004.

ROMP, W.; and HAAN, J. De. Public capital and economic growth: a critical survey, European Investment Bank Papers, v.10, n.1, p.41-70, 2005.

SAHOO, P.; DASH, R. K.; AND NATARAJ, G. Infrastructure Development and Economic Growth in China. Institute of Developing Economies. Discussion Paper n. 261, 40p, 2010.

SANGARE, S.; AND MAISONNAVE, H. Mining and petroleum boom and public spending policies in Niger: a dynamic computable general equilibrium analysis. **Environment and Development Economics**, p.1–11, 2018.

SAVARD, L. Impact Evaluation of infrastructure programs: A review and user guide for application of CGE micro-simulation. Impact Evaluation of infrastructure program. Report 2009, 105p., 2009.

SAVARD, L. Scaling up infrastructure spending in the Philippines: a top-down bottom up micro-simulation approach. **International Journal of Microsimulation**, v.3, p.43–59, 2010.

SAVARD, L.; and ADJOVI, É. Externalités de la santé et de l'éducation et bien-être: un modèled'équilibregénéral calculable appliqué au Bénin. **L'actualité Économique**, v.74, p.523-560, 1998.

SHOVEN, J.B. AND WHALLEY, J. General Equilibrium with Taxes: A Computational Procedure and an Existence Proof. **The Review of Economic Studies**, v.40, n.4, p.475-89, 1973.

UN-DP. United Nations. Human Development Report 2016: Guinea-Bissau. Available at: < http://hdr.undp.org/sites/all/themes/hdr_theme/country-notes/es/GNB.pdf >. Access date: Jun. 21th 2018.

WARNER, A. M. International Monetary Fund. Public Investment as an Engine of Growth. Working Paper n.148, 76p, 2014.

WOLFF, E. N. The Productivity Slowdown: The Culprit at Last? Follow-Up on Hutlen and Wolff. **The American Economic Review**, v.86, p.11239-52, 1996.

World Bank, 2017. World Bank Indicators: World Bank Data: Available at: http://worldbank.org. Access date: Jan. 6th , 2018.