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Emerging Markets Review

journal homepage: www.elsevier.com/locate/emr

Trade reform, infrastructure investment, and structural transformation in Africa: Evidence from Guinea-Bissau

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ARTICLE INFO

JEL classification:

C68
F13
F14
F61

Keywords:

Trade reform
Structural change
Poverty alleviation
Economic development
African economies
CGE modeling

ABSTRACT

This study examines the impacts of trade reform and infrastructure investment on structural transformation and poverty alleviation in Guinea-Bissau using a dynamic computable general equilibrium model. We found that partial or complete tariff rate cuts accompanied by a scaling-up infrastructure investment funded by debt only positively impact macro-and micro-outcomes but do not generate structural transformation. Conversely, trade reform and infrastructure investment funded by a mix of debt and tax rates on the firm's income generate structural transformation with labor reallocation from agriculture to non-agricultural sectors. This structural transformation pattern favors the poor and contributes to reducing income inequality over time.

1. Introduction

Whether trade liberalization may contribute to economic development has been a hot topic in the trade and development literatures. Presumably, the integration to international markets through trade is necessary for the catching-up process of the least developing countries since trade will allow them to take advantage of shared knowledge and technologies from developed regions (Rivera-Batiz and Romer, 1991; Goedeme and Collado, 2016). A plethora of studies have shown that trade openness impacts development because it spurs growth (Sakya et al., 2015; Malefane and Odhiambo, 2018) and total factor productivity - TFP (Pavcnik, 2002; Alcalá and Ciccone, 2004). However, empirical research on trade liberalization effects on structural transformation and poverty alleviation outcomes is sparse.

Yet, since the early development economics literature (e.g., Lewis, 1954, 1980; Kuznets, 1966), development has been defined as a process that involves structural transformation with labor reallocation from low productive, agriculture, to higher productive sector, manufacturing. Developed countries with the highest TFP were the first to liberalize trade in agricultural products, while developing regions reached trade agreement in that sector only in the 1994 Uruguay Round Agreement on Agriculture (Bureau et al., 2000; Tangermann, 2016). However, important innovations, such as those related to the *Green Revolution*, accompanied the trade reforms in developing areas, increasing the productivity of the agricultural sector.

This paper aims to examine macro-and micro-level implications of import tariff reduction and infrastructure investment in Guinea-

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<https://doi.org/10.1016/j.ememar.2023.101027>

Received 31 March 2022; Received in revised form 7 March 2023; Accepted 27 March 2023

Available online 31 March 2023

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Bissau between 2014–2031 using a recursive dynamic computable general equilibrium (CGE) model. There are several reasons to deepen our knowledge of the relationship between trade and structural transformation to guide the ongoing debate on economic integration and industrialization more broadly in Africa. Guinea-Bissau has been a member of the World Trade Organization (WTO) and the West Africa Economic and Monetary Union (WAEMU) since 1995 and 1997, respectively. Import tariffs have been harmonized or reduced, especially after the Doha Development Agenda in 2001, and governments have also made complementary investments in infrastructure to enhance their domestic effects. For instance, recognizing that past trade reforms did not have hoped-for impacts as years ago, the central government implemented an infrastructure investment program in 2014 budgeted at USD 1 billion over twelve years.

We build on, and substantively contribute to, a growing literature on the role of international trade for structural transformation (e.g., Alvarez and Lucas, 2007; Uy et al., 2013; Teignier, 2014; Betts et al., 2017; Cutrini, 2019; and Gräbner et al., 2020). Country characteristics, model and trade policy measures as well as the focus of analysis make our work unique. Alvarez and Lucas (2007) use the Ricardian framework of Eaton and Kortum (2002) where TFP is specific to each country and industry and trade allows countries to allocate more resources to the sectors with higher relative productivities. They found evidence that countries whose total product represents about 1% of world GDP have increased their productivity by about 41% due to trade opening.

Uy et al. (2013) adopted a similar model but with non-homothetic preferences and *iceberg* trade costs (see Anderson and van Wincoop, 2004) to study tariff and export subsidy policies. The linkage between international trade and structural transformation is identified through two channels: when trade cost reductions impact the patterns of specialization or when international trade allows countries to allocate more resources to the sectors that have drawn higher relative productivity. However, *iceberg* technology may provide an incomplete picture of the distributive analysis of a trade policy since it will deliver identically similar results for structural variables (see Betts et al., 2017).

Most closely related work to our is Betts et al. (2017). They developed a two country and three-sector model to quantify the effects of Korean trade policies on structural change between 1963 and 2000. However, while Ricardian comparative advantage lays the basis for inter-sector trade in their model as in Eaton and Kortum (2002), following the structural change literature (e.g., Bustos et al., 2016; Gollin et al., 2021), we use a neoclassical two-country and multisector capital accumulation model in a general equilibrium setting to focus on specialization patterns from trade reforms. Betts et al. (2017)'s work examined the intra-sector trade based on an Armington aggregation of domestic and foreign varieties of each sector's value added. The general equilibrium structure of the present model allows us to analyze bilateral trade based on the Armington aggregation of goods produced by multiproduct industries. Furthermore, we do not model trade barriers as *iceberg* costs like Betts et al. (2017) and, analytically, we differ substantially from them. The trade policy analysis in their model is based on a government offering subsidies on exports, imposing import tariffs proportionally, and then making a lump-sum transfer of tariff income net of subsidy expenditures to households. In our framework, the government reduces the import tariff rate and uses financing mechanisms to implement an infrastructure investment program to support trade reform outcomes. There is no a priori conceived transfer to the households. Instead, different groups of households can be impacted differently by government measures according to the intensity of the labor used by the sector.

The contributions of our work are multiple. First, the focus on agricultural sector is of particular interest because this sector plays a crucial role for both macro stability and financing of development programs in Guinea-Bissau. Agriculture's share of value-added is about 53%, manufacturing is 12%, and the services sectors is about 35% (World Bank, 2020). Sustaining overall product growth therefore depends on the performance of the agricultural sector. Additionally, the agricultural sector employs about 61% of workforce, while manufacturing and services employ approximately 6% and 34%, respectively (ILO, 2019). The share of agricultural products in the export grid is about 98% (WITS, 2020); about 40% of government revenues come from taxes on agriculture trade (Guinea-Bissau, 2015), and resources used for policies to alleviate poverty have been liable to the performance of agricultural sector. For instance, the fall in the international price of cashew nut, its main export product [it represents about 80% of agricultural exports (WITS, 2020)] led to the end of the II National Poverty Reduction Strategy (DENARP) in 2012.

Second, we contribute to the debate on the role of agricultural productivity in promoting structural transformation and its implications for poverty reduction in developing countries. For instance, Gollin et al. (2002) provide a model in which the state of the agricultural sector affects the reallocation of labor across sectors. The rate of technology change is similar across countries, but the TFP parameter differs across countries, being affected by country policy and institution. Preferences cause labor to be allocated entirely to agriculture up to a certain threshold, after which agricultural production shifts from traditional technology to modern technology subject to technical change. The TFP improvement will allow Agricultural production to reach such a threshold favoring modern technology over traditional technology adoption, causing labor outflows to the non-agricultural sector. Matsuyama (2008) observes that since the income elasticity of demand for agricultural goods is generally lower than that of manufactured goods, agricultural productivity growth releases labor for the non-agricultural sector, causing structural change due to the change in the intersectoral composition of employment in the economy.

Scholars also document for several development experiences that the structural transformation occurred when the accumulated wealth from improved agricultural TFP in the context of an open economy has been reinvested in manufacturing and services sectors creating job opportunities outside of agriculture (Duarte and Restuccia, 2010; Bustos et al., 2016; Bustos et al., 2020; Gollin et al., 2021). A previous trade study by Teignier (2014) found corroborative evidence that the absence of barriers to agricultural trade improves agricultural TFP and allows the outflow of production factors-and other resources-from agriculture to the manufacturing and service sectors. We are interested in identifying the effect of trade opening on agricultural TFP to understand whether agricultural labor savings and increased wealth accumulation from an improved TFP can be at the root of structural transformation and poverty reduction in Guinea-Bissau. The trade gains in terms of productivity shift set the pattern of specialization, which results in the intersectoral reallocations of factors, as shown by Echevarria (2008), Abizadeh and Pandey (2009), Ferreira and Trejos (2011) and

several intellectual works. Infrastructure investment creates productive externalities (Savard, 2010; Cateia et al., 2023) and strengthens the contribution of trade to spur growth and structural transformation. Moreover, in most developing countries, agricultural employment in Guinea-Bissau is mostly poor labor dominant, about 80%. Thus, agricultural productivity improvement may significantly reduce poverty (Lin et al., 2001; Christiaensen and Martin, 2018).

Third, this study considers not only the economy's structure but also the initial conditions of heterogeneous workers. Cutrini (2019) found evidence that initial conditions are essential to explain productivity differences across European sectors after economic integration. She showed that the manufacturing sector and with sufficiently developed highly skilled services spur growth, while services with intensively low skills contribute less to economic growth. We use microdata to partition workers by income range and settings and then deliberately discuss intersectoral labor allocations by skill level and income distribution across several household groups from trade policies. This treatment is crucial for adopting trade measures that potentially mitigate the poverty traps in developing countries considering each family's reality across and within locations.

Finally, an economic policy can take time to manifest itself in the economy. Therefore, the model's dynamic structure takes into account the various lags and dissemination of government policies after the completion of the reforms. Furthermore, the present model has replicability potential for different types of reforms analysis in developing countries. The inclusion of informal economy in the specification of the social accounting matrix (SAM) makes it of particular interest by allowing to capture more realistic economic outcomes of the simulated shocks.

The remainder of the paper is structured as follows. Section 2 presents the theoretical framework. Section 3 discusses results. Section 4 presents limitations and future works. Section 5 concludes.

2. The model

The setup of model is that there is one open economy with j sectors producing tradable of goods, using a mix of labor (L_j) and capital (K_j). The model allows for government debt or savings. On the production side, price-takers firms are assumed to operate in a perfectly competitive environment. The structure of production is presented in Fig. B (Appendix B). The representative firm in each industry combines, in a fixed share, the intermediate inputs and value added to produce the sectoral output. To identify how the externality of investment affects added value and, thus, the firm's aggregate output, the value-added of each j ($VA_{j,t}$) takes the following constant elasticity of substitution (CES) form (Eq. (1)).

$$VA_{j,t} = \theta_{j,t} A_j [\delta_j (B_j^L L_{j,t})^{-\rho_j} + (1 - \delta_j) (B_j^K K_{j,t})^{-\rho_j}]^{\frac{1}{\sigma_j}} \quad (1)$$

where A_j is the policy-free or Hicks-neutral technical change; $\theta_{j,t}$ is the externality of public investment; $B_j^L (B_j^K)$ is the labor (capital)-augmenting technical change; $\delta_j \in (0, 1)$ is the share parameter; and ρ_j is the elasticity parameter, $\rho_j = \frac{1+\sigma_j}{\sigma_j}$, $-1 < \rho_j < \infty$, and σ_j is the elasticity of substitution between labor and capital, $0 < \sigma_j < \infty$.

The composite labor is specified as (Eq. (2))¹:

$$L_{j,t} = B_j^L \left[\sum_l B_j^L L_{l,j,t}^{-\rho_j} \right]^{-\frac{1}{\rho_j}} \quad (2)$$

where $L_{l,j,t}$ is the demand of type of labor l by industry j in time t .² Sectors are multiproduct; therefore, they will produce the same number of corresponding goods using labor and capital. The proportion of each factor used to produce goods i will depend on the elasticities of substitution between the two factors. For instance, agricultural sectors may use more labor than capital to produce agricultural goods.

Given that $VA_{j,t}$ is twice differentiable, the first-order condition of Eq. (1) relative to labor factor yields the following marginal labor productivity ($\epsilon_{j,t}^L$) as set by Eq. (3):

$$\epsilon_{j,t}^L = A_j B_j^L \delta_j [\delta_j + (1 - \delta_j) (\mu_j)^{\rho_j}]^{\frac{1-\rho_j}{\rho_j}} \quad (3)$$

where μ_j is amount of capital per units of labor in efficiency units of factors in the economy, that is,

$$\mu_j = \frac{B_j^K K_t}{B_j^L L_{j,t}} \quad (4)$$

The total output function is given by Eq. (5):

¹ The composite capital is set symmetrically.

² $L_{l,j,t} = \left[\frac{B_{lj}^L W_{lj,t}}{W_{Tlj,t}} \right]^{\sigma_j} (B_j^L)^{\sigma_j - 1} L_{j,t}$, where B_{lj}^L is the share parameter; $W_{j,t}$ is the wage rate of j composite labor; and $W_{Tj,t}$ is the wage rate paid by j (including payroll taxes) for each l in time t .

$$Y_{j,t} = \gamma_j \left[\sum_i \gamma_i y_{j,i,t}^{\rho_j} \right]^{\frac{1}{\rho_j}} \tag{5}$$

where γ_j is the share parameter; $y_{j,i,t}$ is the good i of sector j at time t .

2.1. Demand side

In addition to firms, households, the rest of the world (ROW), and the government are other agents interacting in the model. Households' demand is a Linear Expenditure System (LES). Each household maximizes a Stone-Geary utility function for each commodity subject to the budget constraints (Eq. (6)):

$$p_{i,t} c_{i,h,t} = p_{i,t} c_{i,h,t}^{MIN} + \tau_{i,h}^{LES} \left(cb_{h,t} - \sum_{ij} p_{ij,t} c_{ij,h,t}^{MIN} \right) \tag{6}$$

where $p_{i,t}$ is the purchaser price of composite commodity i at time t ; $c_{i,h,t}$ is the consumption of commodity i by type h households at time t ; $c_{i,h,t}^{MIN}$ is the minimum consumption of commodity i by type h households at time t ; $\tau_{i,h}^{LES}$ is the marginal share of commodity i in type h household consumption budget; and $cb_{h,t}$ is the consumption budget of type h households.

Total income of type h household at time t ($Y_{h,t}$) is the sum of labor income ($YL_{h,t}$), capital income ($YK_{h,t}$), and transfers from other agents ($YTR_{h,t}$), set as follows (Eq. (7)):

$$Y_{h,t} = YL_{h,t} + YK_{h,t} + YTR_{h,t} \tag{7}$$

Transfers to households may be assistance to a social program from the ROW, government, and firms, i.e., the sum of all exogenously transferred resources to households. These transfers are SAM's flows identified across institutions in the base year.

Investment demand includes both gross fixed capital formation and changes in inventories. Final demand of each good for investment purposes is the sum of the quantity demanded for private investment and for public investment. We discuss in the dynamic module below how capital growth rate is specified. Investible funds will depend on aggregate savings. The household's savings ($S_{h,t}$) is consumption ($C_{h,t}$) minus disposable income after taxes ($Yd_{h,t}$) represented as in Eq. (8):

$$S_{h,t} = C_{h,t} - Yd_{h,t} \tag{8}$$

Although government does not optimize any function, it receives tax transfers and makes expenditures. The government g revenues ($Y_{g,t}$) come from direct taxes on household ($Tx_{h,t}$) and firm's incomes ($Tx_{f,t}$), indirect taxes on industry production ($Tp_{j,t}$), taxes on commodity ($Tc_{i,t}$), and imports duties on commodity ($Tm_{i,t}$), and transfers from other agents ($Tr_{i,t}$), typically households ($Tr_{g,h,t}$), firms ($Tr_{g,f,t}$) and ROW ($Tr_{g,row,t}$), menus subsidies ($S_{g,t}$):

$$Y_{g,t} = Tx_{h,t} + Tx_{f,t} + Tp_{j,t} + Tc_{i,t} + Tm_{i,t} + \sum_i Tr_{i,t} + Tx_{i,t} - S_{g,t} \tag{9}$$

In general, the government can resort to direct taxes to increase its investment funds (and the future taxes will be lower), or it can resort to debt, with taxes being paid back out in the future. We will assume debt-based funds schemes, when future transfers from private agents to the government may increase over time, reducing funding needs.

Such as firms, households can also contribute to a social program. The households and firms' transfer to government are defined as a proportion of their disposable incomes, as follows (Eqs. (10) and (11)):

$$Tr_{gov,h,t} = Cpi_t^n \cdot tr^0_{h,t} + tr^1_{h,t} Yd_{h,t} \tag{10}$$

$$Tr_{gov,f,t} = \gamma^{TR}_{gov,f} \cdot Yd_{f,t} \tag{11}$$

where Cpi_t^n is the consumer price index; $Y_{f,t}$ is the firm's disposal income in time t ; $tr^0_{h,t}$ is the transfer from household to government (SAM flows); and $tr^1_{h,t}$ and $\gamma^{TR}_{gov,f}$ are the shares of transfers.

The quantity of each commodity demanded by government varies inversely with its price (Eq. (12)).

$$P_{i,t} C_{i,g,t} = \gamma_i^G G_{i,t} \tag{12}$$

where $C_{i,g,t}$ is the public consumption of commodity i (volume) at time t ; γ_i^G is the share of commodity i in total current public expenditures on goods and services; and $G_{i,t}$ is the current government expenditures on goods and services at time t .

Income from ROW ($Y_{row,t}$) corresponds to domestic agent payments of the value of imports, income from foreign capital investments, and transfers from domestic residents ($TR_{row,i,t}$), as represented by the following Eq. (13).

$$Y_{row,t} = e_t \sum_i PW_{i,t} M_{i,t} + \sum_i \tau_{ROW,K} \left(\sum_i R_{k,j,t} K_{k,j,t} \right) + \sum_i TR_{row,i,t} \tag{13}$$

ROW's savings ($s_{row,t}$) is the difference between foreign receipts and foreign expenditures in the domestic economy as payments for

the value of exports and transfers of domestic agents. In equilibrium, Row's savings are equal in absolute value with the opposite sign to the current account balance ($CAB_{row,t}$), as in (Eq. (14)).

$$S_{row,t} = -CAB_{row,t} \tag{14}$$

where $\tau_{ROW,K}$ is the share parameter and e_t is the exchange rate.

2.2. Supply functions and international trade

The problem of sellers is to maximize sales revenues subject to total output, for a given basic price of j 's production of product i at time ($p_{j,i,t}$). The first-order conditions yield individual supply functions (Eq. (15)):

$$y_{j,i,t} = \frac{Y_{j,t}}{(B_j)^{1+\sigma_j}} \left[\frac{p_{j,i,t}}{B_{j,i} p_{j,i,t}} \right]^{\sigma_j} \tag{15}$$

where $p_{j,i,t}$ is the basic price of industry j 's output at time t .

Sellers' revenues would increase when the economy switches from autarky to free trade due to economies of scale (Krugman, 1979 and 1981). Recent extant work by Kokovin et al. (2022) adopts more general preferences with variable elasticity of substitution, in which the interval of trade costs close to the autarky trade yields losses for producers and consumers due to variable markups and underpriced imports, which become socially excessive. However, trade liberalization brings global welfare gains. Without imposing any restrictions on market structure, De Loecker et al. (2016) also found evidence that trade liberalization contributes to reducing prices and marginal costs, improving competition. The smaller prices fall relative to the fall in marginal costs has been attributed to the increase in firms' markups to compensate for reductions in their marginal costs.

Each good i ($y_{j,i,t}$) can be destined for the domestic and export markets (Eq. (16)). Formally,

$$y_{j,i,t} = B_{j,i}^X \left[\beta_{j,i}^X E_{j,i,t} \rho_{j,i}^X (1 - \beta_{j,i}^X) S_{j,i,t} \rho_{j,i}^X \right]^{\frac{1}{\rho_{j,i}^X}} \tag{16}$$

where $E_{j,i,t}$ is the quantity of product i exported by sector j at time t ; $S_{j,i,t}$ is the supply of commodity i by sector j to the domestic market at time t ; $B_{j,i}^X$ is the scale parameter; and $\rho_{j,i}^X$ is the CET- exports and local sales). Here, it assumed that Guinea-Bissau has a small open economy to foreign trade, so that world prices are exogenous.

Relative supply functions ($EX_{j,i,t}$) are derived from the first-order conditions of profit maximizing problem subject to the product of each industry, yielding Eq. (17)

$$E_{j,i,t} = \left[\frac{(1 - \beta_{j,i}^X) PE_{i,t}}{\beta_{j,i}^X p_{i,t}} \right]^{\sigma_{j,i}^X} S_{j,i,t} \tag{17}$$

where, at time t , $PE_{i,t}$ is the price received for exported commodity i (excluding export taxes); $p_{i,t}$ is the price of local commodity i (excluding all taxes on products); $\beta_{j,i}^X$ and $\sigma_{j,i}^X$ are the scale parameter and elasticity of transformation (CET - exports and local sales), respectively, for each $0 < \sigma_{j,i}^X < \infty$ and $\rho_{j,i}^X = \frac{1+\sigma_{j,i}^X}{\sigma_{j,i}^X}$.

Buyer's behavior is derived symmetrically assuming goods are differentiated with respect to their origin. There is a composite goods (Q_i,t), combinations of locally produced goods (D_i,t) and imports (M_i,t), that is demanded in the domestic market (Eq. (18)):

$$Q_{i,t} = B_i^M \left[\beta_i^M M_{i,t}^{-\rho_i^M} (1 - \beta_i^M) D_{i,t}^{-\rho_i^M} \right]^{\frac{1}{\rho_i^M}} \tag{18}$$

where B_i^M is the scale parameter (CES – composite commodity); β_i^M is the share parameter (CES – composite commodity); and ρ_i^M is the CES – composite commodity). Relative demand function is (Eq. (19)):

$$M_{i,t} = \left[\frac{\beta_i^M PD_{i,t}}{1 - \beta_i^M PM_{i,t}} \right]^{\sigma_i^M} D_{i,t} \tag{19}$$

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

2.3. Price system

The relative price changes govern the behavior of agents in this economy, and there are many prices that are defined according to the corresponding functional form. In general, price of an aggregate is set as a weighted sum of the prices of its components.

2.4. Market clearing

A given market is in equilibrium when there is neither excess demand nor excess supply. This notion of equilibrium holds for all markets. For instance, for factor markets, we set:

$$L_{j,t} = Ls_t \quad (20)$$

$$K_{j,t} = Ks_t \quad (21)$$

where Ls_t (Ks_t) is the labor (capital) supply at time t .

2.5. Trade policies and analysis

Trade and infrastructure investment policies are part of broader government measures to promote the welfare of the citizens in Guinea-Bissau. Earlier measures include the Structural Adjustment Program in 1986 and the National Strategy for Poverty Reduction in 2005 and 2011, respectively (Cateia et al., 2023). As mentioned, the proportion of the poor in agriculture is still variable despite these initiatives. This subsection and the following one describe when and why the trade and infrastructure investment policies may enhance the government's objective of promoting social welfare. Promoting structural transformation might advance that broader objective because job opportunities may not depend on agricultural performance alone.

Trade policies consist of reducing the import tariff rate, $\tau_{i,t}$, on units of good i imported from abroad by domestic agents. Formally,

$$Tm_{i,t} = \tau_{i,t}M_{i,t} \quad (22)$$

The transmission channel of trade policy to structural change is described as follows. The agricultural sector is labor-intensive and its share in the value-added is about 53%. As we have a comparative advantage in labor intensive activities, then relative prices in agricultural sectors are expected to rise due to trade liberalization. Demand for agricultural goods is expected to decline as prices rise. Agricultural TFP improvement will generate labor savings and growth of national production. The non-agricultural sectors may absorb labor surplus in agriculture as they increase investment demand. The structural change occurs through the industrial employment shares shift over long periods (Ngai and Pissarides, 2007).

Another important channel in which trade reforms can contribute to structural transformation occurs when trade gains are reinvested in the manufacturing and service sectors (Bustos et al., 2020). To examine the plausibility of this assumption, we assume an infrastructure investment package financed either by debt (transfers from abroad and domestic institutions to the government) or the mix of debt and tax on the firm's income during trade reform. Formally, we model the new infrastructure investment as follows:

$$Ilg_t = Sg_t + Deficit \quad (23)$$

The government budget (Sg_t) at time t is (Eq. (24)):

$$Sg_t = Y_{g,t} - Tr_{g,nag,t} - G_{g,t} \quad (24)$$

where, at time t , $Tr_{g,nag,t}$ are the transfers to non-governmental agents; and $G_{g,t}$ are the current government expenditures on goods and services.

As public infrastructure may have productive externalities (Savard, 2010; Boccanfuso et al., 2014), we model the externalities of infrastructure investment as follows:

$$\theta_{j,t} = \left(\frac{Kg_t}{Kg_{t-1}} \right)^{\varepsilon_i} \quad (25)$$

where, at time t , Kg_t is the current stock of public capital; Kg_{t-1} is the public capital of the previous; and ε_i is a sector-specific elasticity of public investment.

The externality of public investment, $\theta_{j,t}$, can be interpreted as sector-specific productivity because their intensity depends on investment elasticity (ε_i), which differs across sectors. In aggregate terms, public investment affects the level of TFP. However, a positive externality will not translate into perpetual growth regardless of what happens in the rest of the economy. Because, on the one hand, public capital depreciates over time and, on the other one, as in Gollin et al. (2021), public investment affects only one component of TFP. Other factors may affect the level of TFP, such as absorption capacity, weather events, Etc. (Fugile, 2017; Männasoo et al., 2018). Moreover, the present CGE model allows for the complementarity between public and private investments. Private agents may respond to the initial impulse from public investment, investing in sectors with a higher return on capital. Thus, even when public investment growth rate is slow, the TFP level may not decrease because public investment is not the only determinant of the TFP. Acting as a source of deepening comparative advantage (see Estache et al., 2012; Sangare and Maisonnave, 2018), the externalities from public investment enhance the effects of trade reforms on economic outcomes because of their impacts on value added and TFP (Cateia et al., 2022; Cateia et al., 2023).

Now, the law of motion of capital in the economy is given by (Eq. (26)):

$$KD_{k,j,t+1} = KD_{k,j,t}(1 - \delta_{k,j}) + Ind_{k,j,t} \quad (26)$$

where, at time t , the stock of capital in industry i in period $t + 1$ ($KD_{k,j,t+1}$) is equal to the stock of the preceding period ($KD_{k,j,t}$), minus depreciation of capital ($\delta_{k,j}$), plus the volume of new capital investment in the preceding period ($Ind_{k,j,t}$).

The capital stock is modeled through the investment demand functions (Eq. (27)), where the volume of new type of capital allocated to business sector is proportional to the new capital investment. The proportion varies according to the ratio of the rental rate ($R_{k,j,t}$) over the user cost of that capital ($u_{k,j,t}$ Tobin's q).

$$Ind_{k,j,t} = \phi_{k,i} \left[\frac{R_{k,j,t}}{u_{k,j,t}} \right]^{\sigma_{k,j}} K_{k,j,t} \quad (27)$$

where $\phi_{k,j}$ is the scale parameter and $\sigma_{k,j}$ the elasticity of private investment demand relative to Tobin's q . This elasticity is also sector-specific; that is, it differs across sectors of the economy.

Capital stock reflects the investment just made since time-structure underlies the dynamic specification of the CGE models (Savard, 2010). New capital is *putty-clay* type; that is, it can be destined for any sector but fixed after being allocated to the corresponding industry (Decaluwé et al., 2012).

Eq. (23) is consistent with various specifications of dynamic CGE models. Most like ours are Diao and Thurlow (2012), Boccanfuso et al. (2014), Costantini and Sforza (2020), and Freire-González and Ho (2019). In work by Diao and Thurlow (2012), the savings collected in the economy are used to fund investments converted into capital stock to determine the capital accumulation rate. The amount of new capital (private or public) is determined by dividing the total investment (equal to the total value of all investment spending in the economy) by the normalized capital goods price. New capital is allocated endogenously to balance capital returns across sectors in economy, so that sectoral capital accumulation rates are also endogenously determined based on previous investment levels.

In Boccanfuso et al. (2014), the amount of private investment is endogenous and determined by the level of savings generated by non-governmental agents after adjusting for capital depreciation. As in Diao and Thurlow (2012)'s model, investments are endogenously distributed across sectors according to the investment decision rule described in (31), with implicit capital mobility across industries. At time $t + 1$, the new capital is added to the capital stock at t and until the capital depreciates. The total value of investable funds is therefore determined from SAM's flows.

Costantini and Sforza (2020) and Freire-González and Ho (2019) adopted a similar treatment of capital growth. However, in the model by Costantini and Sforza (2020), only the private investment allocation was determined in the capital accumulation equation. Public investment decisions were not addressed. Freire-González and Ho (2019) also present a dynamic module in which the factors are determined endogenously in the capital equation. An endogenous growth rate of the capital stock is determined by the capital stock of the last period.

2.6. Data and simulation scenarios

We use an updated 2014 Social Accounting Matrix (SAM) of Guinea-Bissau originally built by Cabral (2015) from the International Food Policy Research Institute IFPRI, 2022.³ This matrix has 22 sectors, two production factors, and 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 base year.

Initially, two types of production factors - composite labor (urban and rural) and composite capital (capital and land) - are offered in the market. The remuneration of households in this country may reflect their poverty status. There are several remuneration ranges across workers, so a distributive analysis may require dividing two families into various types. We partitioned workers and households into six rural and six urban types using the household's wage share in the total national minimum wage in 2014, emerged with every row and column in the SAM (Table 1).

In addition to the SAM flows, additional data are required to calibrate the models, such as household consumption, trade, production, investment elasticities, and Frisch parameter. The household consumption elasticities and Frisch (see Frisch, 1959) are used to calibrate the LES demand system. Trade elasticities make it possible to model the response of producers and consumers to supply or demand goods to and from local or foreign markets when the relative price changes. Other substitution elasticities are CES Armington (see Armington, 1969), which allows substitution between imported and domestic goods. Under the small-country assumption, world price of imports and exports are normalized to the unit during calibration. Production elasticities are activity level CES of the quantities of value-added and aggregate intermediate input use or CES between factors at the bottom of the technology nest. Additionally, private investment and the sector-specific elasticities of public capital are employed. The production, trade, and substitution elasticities are from the recent CGE model applied for the economy of Guinea-Bissau by Cateia et al. (2022) and Cateia et al. (2023).

The following external/free parameters are also used: savings rates, interest rate, and population growth rate. The savings rates are zero in the base year,⁴ while the interest rate (7%) and population growth rate (2%) are data from the World Bank. We assume a known depreciation rate of 2%. Public spending growth is 0.067% and corresponds to the proportion of infrastructure investment in the base year relative to the total budget.

As several parameters are sector-specific, we calibrated them, assuming they differ between sectors. The externality of public

³ <http://www.agrodep.org/dataset/2007-social-accounting-matrix-sam-guinea-bissau>.

⁴ Savings rates are generally low in African countries (Arndt et al., 2010).

Table 1
Household disaggregation by minimum wage for Guinea-Bissau.

Household type	Rural	Urban	Wage limit	Wage in Franco CFA	%
Household 1	HR1	HU1	≤ 1 minimum wage	\$ 50,000*	0.018
Household 2	HR2	HU2	≤ 2 minimal wages	\$ 100,000	0.036
Household 3	HR3	HU3	≤ 4 minimal wages	\$ 200,000	0.072
Household 4	HR4	HU4	≤ 6 minimal wages	\$ 600,000	0.218
Household 5	HR5	HU6	≤ 8 minimal wages	\$ 800,000	0.290
Household 6	HR6	HU6	≤ 10 minimal wages	\$ 1,000,000	0.363

Source: The Authors. Note: Household type is household classification by effective received wage. For instance, type of HR1 Household 1 is rural household receiving up to one minimum wage. Its urban counterpart is HU1. *Wage limit* is the maximum amount the household can receive. In general, we observe that each household receives wage below this bound. *Wage in Franco CFA* is the current official wage in 2014 (source: INE/MICS: <https://mics.unicef.org/surveys>, 2014). * 50,000(=\$ US 93) is the minimum wage. The wage below the minimum is 10,000 CFA Francs (=\$US 19). The corresponding workers are unskilled 1 (USK1) to unskilled 6 (USK6) and skilled (SK1) to skilled 6 (SK6) supplied labor in this economy. Thus, the rural and urban households that receive at most a minimum wage offer unskilled and skilled labor USK1 and SK1, respectively. Individuals in this category are said to live in extreme poverty as defined by the World Bank. And % is the proportion of the household's wage in total wage.

investment is expected to be lower among sectors with lower elasticity while more significant across sectors with higher elasticity. Therefore, the length of the externality will be governed by the elasticity of public investment.

The simulations strategies are represented in the Table 2. The possible trade reform scenarios are classified into two types: partial uniform trade liberalization, whereby the import tariffs are reduced by 50%, and complete uniform trade liberalization, whereby the import tariffs are 100% eliminated. However, a study by Cateia et al. (2022) suggests that the development plans in Africa have changed: on the one hand, tariffs no longer have the same effects they had decades ago and, on the other hand, because development strategies in many African countries have prioritized infrastructure investments to enhance the domestic impacts of trade openness. Particularly in Guinea-Bissau, the central government implemented an infrastructure investment program in 2014 budgeted at US\$1 billion. A previous study by Cateia et al. (2023) suggests that the economic outcomes of this program depend on the financing scheme adopted. As mentioned earlier, since independence in 1973, the development measures implemented, such as the structural adjustment program in 1986 and DENARP I and II, aimed to improve the individual welfare in Guinea-Bissau; however, the continuity of these initiatives depended on the availability of financing.

We assume four policy scenarios. In the first development strategy, the government adopts a 50% reduction in the rates of import tariff and an infrastructure investment program funded only by debt (Scenario 1). An alternative to this scenario is when the government decides to reduce import tariff rates by 50% and adopts an infrastructure investment program financed by a mix of debt and tax on firms' income (Scenario 2). In the following scenarios, tariff rates are reduced by 100%, and an infrastructure investment program is funded only by debt (Scenario 3) or by half of debt and half of taxes on firms' income (Scenario 4).

The base year is 2014, and the projection for 2031 is carried out to account for the lag and dissemination of government policy after the reforms are completed. For the initial business as usual (BAU) projection, we assume exogenous variables [such as current government expenditures ($G_{g,t}$) and capital stock ($K_{k,j,t}$)] will grow at the same population growth rate of 2% per year between 2014 and 2031.

For calibration, we set a dynamic closure of the model. In the default closure, inventory changes, minimum consumption, labor supply, and world prices are exogenously determined. In general, all not price variables grow at same n_t . $G_{g,t}$ and $K_{k,j,t}$ are fixed in each period. The intercepts of agents' savings and income taxes and import tariff rates are fixed. Since $IT_{g,t}$ is fixed, public savings and public deficit vary in each period to balance public accounts.

How well-calibrated the model is entails evaluating whether this model is consistent through the homogeneity test. A consistent CGE model meets Walras's law that only relative prices matter to balance markets. We performed shocks of 5% and 10% of the numeraire, and in both cases, the exogenous variables increased at the population growth rate; however, the relative prices remained at their BAU values, suggesting that the model is well-calibrated.

3. Results and discussions

This section presents the results of trade reforms with funded-infrastructure investment schemes. It focuses on macroeconomic impacts, especially effects on GDP, aggregate employment, and trade balance. Subsequent discussions concern the effects of structural change so that the focus will be at the sectoral level. Finally, the results at the household level are presented in order to understand the impacts of current development strategies on long-term well-being. The values are interpreted as percentage changes relative to the BAU scenario.

Fig. 1 depicts the dynamic trajectory of GDP for the four scenarios over time. The vertical axis measures GDP growth under each scenario relative to the BAU scenario with no intervention, while the horizontal axis shows the periods considered. When the government uses partial trade reforms, cutting import tariff rates by 50% (scenarios 1 and 2), GDP rises because of the increase in investment facilitated by the decline in the price of the composite good. Although the initial boost has been reduced (because the cashew nut production fall reduced the trade gains since the cashew nut sector represents about 80% of the export grid), GDP maintains a growth trajectory over time due to the positive externalities of public investments on the level of economic activity. The partial tariff reform accompanied by implementing an infrastructure investment program funded by debt only has produced more significant effects

Table 2
Simulations of different scenarios of trade reform in Guinea-Bissau.

Reference scenario	
Business as Usual	Growth of 2% per year for the 2015–2031 period (from t to t + 17)
Development strategies adopted by government	
Scenario 1	Partial trade reform and \$1 billion investment program of 17 years funded by 100% debt
Scenario 2	Partial trade reform and \$1 billion investment program of 17 years funded 50% by debt and 50% by firm income tax
Scenario 3	Complete trade reform and \$1 billion investment program of 17 years funded by 100% debt
Scenario 4	Complete trade reform and \$1 billion investment program of 17 years funded by 50% debt and 50% firm income tax

Source: The authors.

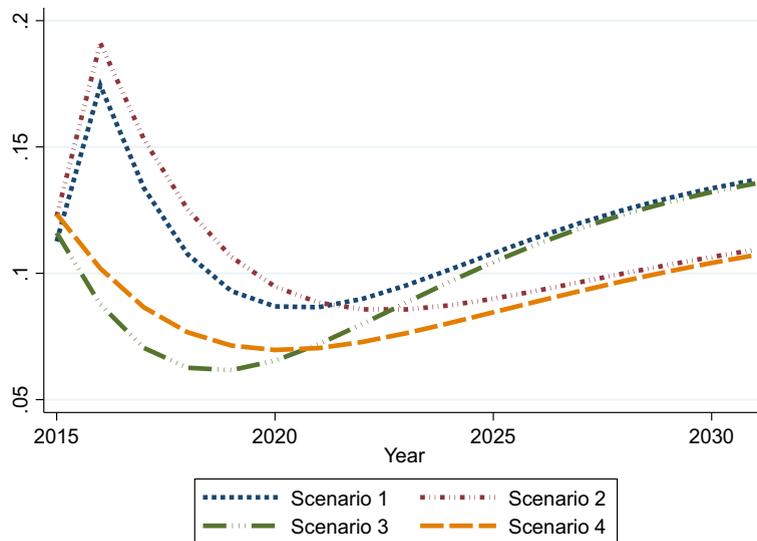


Fig. 1. GDP growth path (%).
Source: The authors.

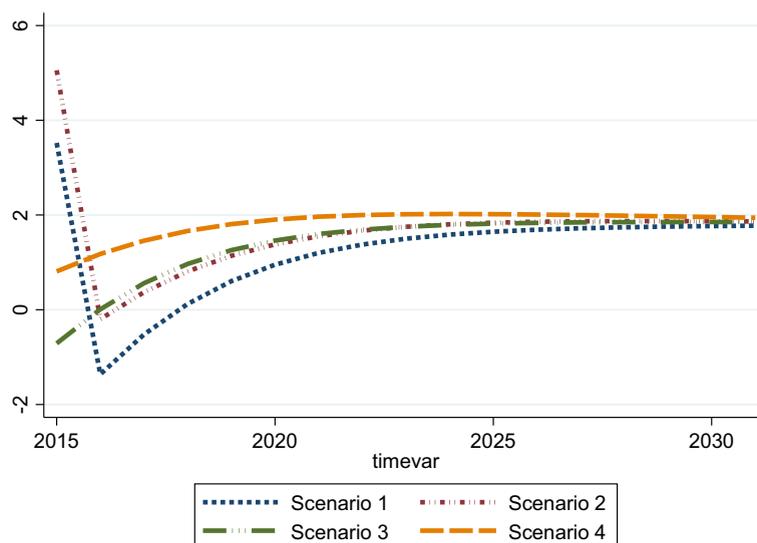


Fig. 2. Government income (%).
Source: The authors.

than by mixing debt and firm income taxes. The difference in these results is mainly due to the impacts of government measures on production costs since taxation of firm income reduces the volume of available investible funds. Conversely, GDP exhibited an initial downward trajectory in the complete trade liberalization strategy (scenarios 3 and 4) but recovered in the following periods. The infrastructure investment funding scheme through debt only produces more significant impacts on GDP in each period due again to the tax's direct impact on the firm's resources for investment purposes.

Concerning the outcomes of scenarios 1 and 2 (partial liberalization) relative to scenarios 3 and 4 (full liberalization), we observe that in both scenarios the economic growth boosts other agents transfers to the government, raising total government income over time (Fig. 2). The funding needs reduce as government revenue grows, and the government resorts less to debt to finance infrastructure construction to boost the domestic economic impacts of trade liberalization. We observed that this government's diminishing need for financial resources before the program was completed contributed to a decrease in the public deficit (see Fig. A.1 in Appendix). In general, the impacts are smoothed over time due to capital depreciation.

Meanwhile, Fig. 3 shows the results at the sector level, i.e., the change, in percentage points, of the contribution to each sector to total value added. Funding infrastructure investment by debt to support partial or complete tariff reforms (i.e., scenarios 1 and 3), agricultural sector production does not decline as much as when the government uses the mix of debt and firm's income tax strategies (scenarios 2 and 4). The return on investment explains this difference. As the return on non-agricultural sectors is higher than in agricultural ones, the firm tends to allocate more investible funds to the former when its revenue is affected by government taxes, though the fall in the price of inputs due to the increase in imports has favored a reduction in production costs in both sectors.

The redirection of investments to non-agricultural sectors had essential effects on the economy's structure. First, we observed in an unreported Figure that the externalities of public infrastructure investments were not the main determinants of the intersectoral reallocation of labor because they were positive and similar in the different policy scenarios.

However, infrastructure investment created productive externalities and potentiated the indirect impacts of current trade reform strategies for the economy. Second, agricultural sectors lost leadership regarding their contribution to value added (Fig. A.2). In fact, unlike in scenarios 1 and 3, in scenarios 2 and 4, only the cashew nut sector marginally benefited from these measures, while the others were negatively impacted. Finally, as agricultural sector's share of the product falls, demand for labor in the agriculture is reduced subsequently. In scenarios 1 and 3, most of the drop in labor demand was explained by the decreased job opportunities in the millet and

Sector	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Millet	-8.993	-3.714	-8.806	-3.536
Sorghum	0.431	-0.436	0.465	-0.402
Maize	0.363	-0.517	0.397	-0.482
Rice	0.669	-0.331	0.715	-0.284
Fonio	0.379	-0.415	0.410	-0.384
Cotton	0.507	-0.384	0.550	-0.341
Other agr,	0.679	-0.333	0.734	-0.278
Cashew nut	-0.637	0.493	-0.706	0.423
Breeding	0.043	-0.372	0.062	-0.353
Forestry	0.204	-0.409	0.225	-0.388
Fishery	-0.145	-0.789	-0.083	-0.727
Mining	-0.105	-0.136	-0.090	-0.122
Food	0.478	-0.579	0.557	-0.501
Other industries	-0.362	-0.289	-0.356	-0.283
Electricity and water	0.696	0.820	0.647	0.769
Construction	1.418	2.595	1.256	2.434
Trading	0.047	-0.013	0.050	-0.010
Hotel,Rest	-0.395	-0.093	-0.430	-0.129
Transport	0.465	0.239	0.452	0.225
Financial	0.307	0.181	0.291	0.165
Service to firms	-0.482	0.166	-0.566	0.081
Public services	1.546	2.794	1.381	2.625

Fig. 3. Value added (% in 2031).

Source: The authors.

cashew nut sectors - their share in agricultural employment is about 60% (Guinea-Bissau, 2015).

The fall in forestry and mining productions is because such sectors' investment elasticities, ε_i , are low. In the case of the millet and cashew sectors, the labor-intensive activities, we observed that, although the relative prices of millet and cashew nut rise with trade liberalization, their production reduced sharply because the return on investment in the millet and cashew nut sectors are lower among the agricultural sectors, disfavoring the allocation of investment to those sectors. Especially as the composition of domestic inputs in the composite good for cashew nut production is more significant than imported inputs, the imported input price fall was insufficient to reduce the cost of production, burdening investable funds in the sector. In general, the results of scenarios 1 and 3 do not suggest any structural changes because the agricultural sectors' share of added value and labor is still more significant than in non-agricultural sectors.

In scenarios 2 and 4, directing investments from agriculture to non-agricultural sectors created labor outflow to the formers. The construction and food processing industries absorbed most of the available labor force because its growth, driven by the investment shock, increased the requirement of factors, especially low-skilled labor. Thus, the structural change was brought by the increase in the volume of investment in non-agricultural sectors, whose returns are growing. In Guinea-Bissau, these sectors, however, are less productive than some agricultural sectors, such as cashew nuts. Therefore, the structural change occurred with the labor reallocation from more productive to less productive sectors, that is, a labor-pull structural transformation.

McMillan and Rodrik (2011) found a similar pattern of structural transformation in several developing countries in Africa and Latin America. This result corroborates also Bustos, Garber, and Potenticelli (2020)'s work. They found evidence that induced agricultural productivity provides savings not reinvested in the sectors that received initial investments but in other sectors, such as manufacturing. We found that the impulse generated by investment in infrastructure (i.e., in the construction sector) generated resources for the government and firms, which reinvested part of their revenue in other manufacturing and service sectors.

Fig. 4 depicts the implications of these funding strategies on household income. It shows changes in percentage points of each household income in the last period of the simulation. Scenarios 1 and 3 imply an increase in household income in rural and urban settings regardless of the individual ex-ante economic conditions, although the poor have benefited the most. Most income gains for the poor are due to increased income from work, while improvements in income for the non-poor are explained by growth in capital income. The source of the difference in gains between the poor and the rich, in favor of the former, is that the labor income of the poor grew more than the capital income earnings of the non-poor. Social transfer income has also contributed to an increase in the poorer disposable income over time. Conversely, in scenarios 2 and 4, only unskilled workers benefited in increased income due to the increased demand in construction and transport-intensive sectors for unskilled labor. The poor rural household is the most affected. The loss of income for these groups of households occurred because the labor incomes have decreased: production fell, which contributed to lowering unskilled labor demand.

The difference between the result of the debt versus tax funding mechanism is fundamentally due to the impact of each measure on transfers and the capital income gain. In the debt-based financing scheme, there is a more significant transfer of income from private agents to households in the form of social transfers, benefiting the poor the most. Meanwhile, tax financing burdened firm investment

Household group	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Rural household 1	6.161	1.445	6.256	1.536
Rural household 2	3.377	-0.379	3.496	-0.264
Rural household 3	2.763	-0.782	2.887	-0.661
Rural household 4	2.545	-0.924	2.672	-0.802
Rural household 5	2.321	-1.071	2.449	-0.947
Rural household 6	2.206	-1.147	2.335	-1.021
Urban household 1	6.401	1.698	6.497	1.791
Urban household 2	3.413	-0.232	3.537	-0.112
Urban household 3	2.738	-0.669	2.868	-0.542
Urban household 4	2.497	-0.824	2.629	-0.696
Urban household 5	2.248	-0.985	2.382	-0.854
Urban household 6	2.120	-1.068	2.256	-0.936

Fig. 4. Household income (% in 2031).

Source: The authors.

revenue and reduced firm investment and profitability, lowering social transfers and capital income to households. The difference in the results of these scenarios would be even more significant if not for the fact that public debt needs to be paid back out of future taxes. The payment of future taxes to the government by private agents slightly reduced disposable income, although it is still greater than disposable income obtained by the tax-based policy. Moreover, we also observe that the reduction in future financing needs is due to the strengthening of public finances resulting from the payment of future taxes by agents, creating an environment conducive to investments in the country.

We also find that industries where incomes are increasing demand unskilled labor, which favors job opportunities for the unskilled poorest of the rural and urban poor in these industries. The improvement in income among the poorest in rural and urban environments favored demand for domestic products, especially food, further increasing employment and production in these sectors. Rising domestic production positively affected the growth in the number of exported products (intensive margin) and in the volume of exported goods (extensive margin); i.e., there are trade gains in favor of manufacturing sectors at the expense of terms of trade losses against agricultural sectors. For instance, although the country is historically a net importer of food goods, economic opening financed by the deficit increased food production enough for the domestic market so that it exports about 0.96% of food goods. Also, transport services exports have increased by about 0.25% relative to the BAU scenario.

The income outcomes influenced the consumption behavior of each household group (Fig. 5). Strategies 1 and 3 increased household consumption in rural and urban settings, but the consumption of the poor grows more than that of the non-poor in all social configurations. Families consume more due to the income effect: an increase in the labor income generates an improvement in the purchasing power, contributing to an increase in aggregate consumption. In these scenarios, the price effect had little effect because the variation of the consumer price index over time was positive (see Fig. A.3 in the Appendix). In scenarios 2 and 4, however, only the consumption of poor rural and urban households was positively impacted. The increase in labor income and the negative variation in the consumer price index explained most of the gains in household consumption from implementing these strategies.

Thus, the economic growth resulting from the increase in total production favored poverty reduction as the incomes-and consumption-of the rural poor and poor of urban areas rose. Increased consumption by the poor partly reflected pent-up demand. Increased income and product supply in the domestic market now allow the poorest to access goods they could not afford in the BAU scenario.

The result that the poor benefit more than the non-poor, both in terms of income and consumption, has critical distributional implications. Fig. 6 shows the trajectories of income inequality, measured by the Gini index for each combination scenario and year. Income inequality rose in strategies 1, 3, and 4. In scenarios 1 and 3, the increase in income inequality is significant at the beginning of the period but then decreases. This result is because the ex-post improvement in the income of poor households at the beginning of the period was not enough to offset the ex-ante income gap between the non-poor and the poor. Furthermore, at the beginning of the period, the capital income gains of the non-poor were growing as much as the labor income gains of the poor, contributing to maintaining the initial income inequality. Conversely, in scenario 4, income inequality grows, stabilizes most of the time, then decreases drastically, due to the poor's income improvement, but also due to the price effect because the stability of the consumer price index contributed to maintaining the positive variation of disposable income.

The extent to which trade reforms affect structural change in developing countries such as Guinea-Bissau may depend on development measures to support the economic impacts of such reforms, both at the macro and sectoral and at the household level. There are significant political implications of our findings that must be highlighted.

Developing countries may not enjoy the same opening effects as their developed peers. In these countries, several internal blocks are linked, for example, to the low supply of physical infrastructure, which contributes to increasing transaction costs (Hoekman and Nicita, 2011), which is why trade facilitating is essential to boost growth and sectoral production (Dennis and Shepherd, 2011). Thus,

Household group	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Rural household 1	4.356	1.888	4.378	1.912
Rural household 2	1.619	0.056	1.667	0.105
Rural household 3	1.015	-0.348	1.069	-0.294
Rural household 4	0.801	-0.491	0.858	-0.435
Rural household 5	0.580	-0.639	0.639	-0.581
Rural household 6	0.467	-0.715	0.527	-0.655
Urban household 1	4.591	2.142	4.615	2.167
Urban household 2	1.654	0.204	1.708	0.257
Urban household 3	0.990	-0.235	1.050	-0.175
Urban household 4	0.753	-0.391	0.816	-0.329
Urban household 5	0.508	-0.552	0.573	-0.488
Urban household 6	0.383	-0.635	0.449	-0.570

Fig. 5. Household consumption (% in 2031).

Source: The authors. Note: Fig. 5 shows changes in percentage points of each household consumption.

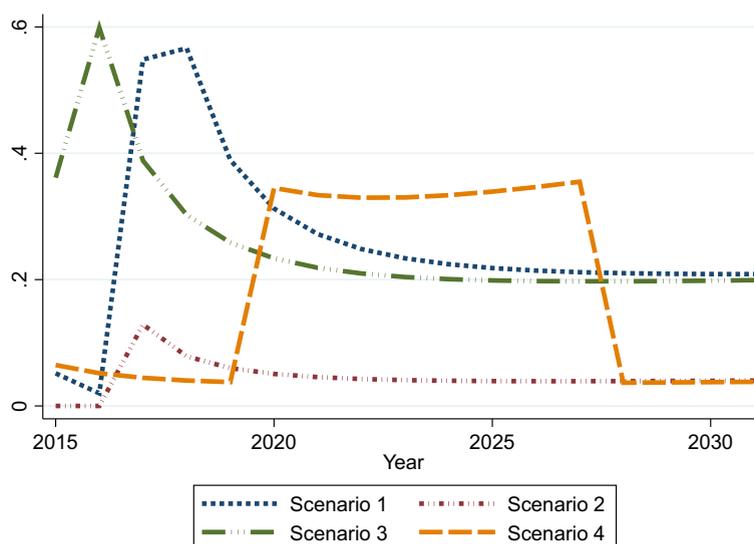


Fig. 6. Dynamic trajectory of income inequality (2015–2031).

Source: The authors.

trade openness may be necessary for the developing world's socioeconomic progress because of its impacts on wage improvements, economic efficiency, and geopolitical benefits of economic integration. However, it may be insufficient for developing countries to achieve development goals, such as those linked to poverty relief (Jackson, 2015).

As mentioned in Section 2, we laid a trade liberalization support structure from the Guinean government's infrastructure incentive development policy in 2015. Like several extant works such as Vanduzai and Chitiga (2017) and Savard (2010), we find that public investment in infrastructure generates positive externalities at the level of economic activity. Intuitively, the initial boost impact reduction of increased imports on GDP is offset by improvements in other macroeconomic aggregates, such as aggregate investment and consumption.

In terms of funding capacity, the government may resort to debit to finance the initial investment package due to the scarcity of resources. However, as the economy grows, the transfers from private agents to the government also increase. Since the gains of transferred resources, but also from the income of the invested capital, is higher than the initial loss caused by trade reform through cuts in tariff rates, the total government income grows from one period to the next. Increased government revenue over time contributed to a rise in investable funds for the government. As a result, the need to make new loans or scale the tax rate on firms' income to finance new investments reduces as government total income rises.

These results have enormous political implications. Guinea-Bissau is a top-20 recipient of loans to finance poverty reduction policies (OECD, 2020), including supporting the first National Strategy for Poverty Reduction (I NSPR) in 2005, oriented to social development (i.e., extreme poverty alleviation in the short term). The I NSPR was reinforced in 2011 by II NSPR, but now to improve the provision of infrastructure services. Likewise, part of the resources destined to finance the current infrastructure construction program come from external resources through a financing agreement between the government of Guinea-Bissau and international creditors in Geneva in 2015 (see Guinea-Bissau, 2015). Therefore, the long-term cost of this funding to the country can be high, in addition to the fact that there is no guarantee that these funds will be fully allocated to the initial purpose. In addition, the world economy fluctuations due, for example, to Covid-19 can hinder the inflow of external resources to developing countries, compromising the execution of large investment projects. In fact, according to the Organisation for Economic Co-operation and Development - OECD (2020), although the levels and trends of external financing had reduced before Covid-19, the current context led to a decrease of about 700 billion of funds available to developing economies in 2020 relative to 2019. Thus, the findings that government revenue is positively affected in both scenarios may be an essential way for development programs in this country to be less dependent on the availability of external resources.

Regarding impacts at the sectoral level, this study did not model the implications of current policy on the diversification of the economy. However, manufacturing sectors (such as the food industry) and services grow in their share of added value, implying a reduction in the economy's dependence on the performance of the agricultural sector. Furthermore, as the participation of the financial sector in the total product grows, the reinvestment of the gains in this sector can be essential for the financial sector development in this country. The government and private actors could use domestic loans to finance development measures and investments in other vital sectors.

As in Bustos et al. (2020)'s work, we find that the reinvestment of resources by firms in non-agricultural sectors has generated the reallocation of workers due to increasing job opportunities outside of agriculture. This result signals the potential of the current development strategies to kick on structural change in Guinea-Bissa. Like Boccanfuso et al. (2014), the results change across proposed scenarios, suggesting that the financing scheme may matter for the design of development measures in countries that face scarcity of

resources, seeking alternatives to promote economic growth, sectoral production, and population standard of living improvements.

Finally, the main objective of trade reforms in Guinea-Bissau has been to promote economic efficiency and productivity improvement capable of reducing poverty as they create decent job opportunities and improve household income gains and consumption (see [Guinea-Bissau, 2010](#)). However, the effects of these measures are still not well documented. The partitioning of households into various types and by social configuration allowed us to shed light on micro-level implications of current development programs, which may be an indispensable guide for future development policies aimed at reducing poverty, taking into account the heterogeneities of households in this country.

4. Limitation and future works

The present study may have some limitations that need to be addressed by future studies. First, development options are not unique, and government can resort to other measures to promote production, poverty reduction, and structural change. For instance, some studies (e.g., [Bustos et al., 2020](#); [Gollin et al., 2021](#)) suggest that improved agricultural productivity investments can provoke structural transformation. Guinea-Bissau has a comparative advantage in the agricultural sector - although our findings have suggested a significant loss of agriculture's share of value-added.

Therefore, future work could explore how the externalities of improved agricultural productivity can lead to labor savings in agriculture and its implications for structural transformation. Second, methodologically, a regional CGE model may be compelling. There are different degrees of economic integration across regions in Guinea-Bissau, so impacts are expected to differ significantly between regions. As the present model is national, we are still determining to what extent some households in different regions would absorb the impacts. Furthermore, the industry may produce more varieties of products in an open economy scenario ([Betts et al., 2017](#)). Future work could also explore the implications of trade reform on structural change with multi-product industries producing varieties of goods.

5. Conclusions

This study analyzed the relationship between trade reforms supported by infrastructure investment and economic outcomes in Guinea-Bissau using a dynamic recursive CGE model. Import tax rate reductions have lowered import prices and increased imports, positively affecting GDP since, as the price of the composite good fell, the production costs also fell, contributing to an increase in demand for private investment. The positive externalities associated with public infrastructure investments improve economic activity, positively impacting growth. The agent's transfers to the government and capital income gains had reduced financial needs even before the program was completed, which offset the government's revenue loss from tariff cuts.

The financing scheme plays a vital role in the sectoral results obtained. We found that funding infrastructure investment through debt only positively impacts the added value of most agricultural sectors, regardless of whether the import tariff reform is partial or complete. However, when debt and taxes are combined to offset government revenue losses and increase funding for infrastructure investment, firms shift scarce investable resources to higher-return manufacturing and service sectors. There was an outflow of agricultural workers to these sectors. Scenarios 1 and 3 imply increased household income and consumption in urban and rural areas. However, the more significant variation in the income of the poor relative to their non-poor counterparts was not enough to compensate for the initial earnings gap. As a result, income inequality increased at the beginning of the period but decreased as the labor income of the poor grew more than the gains from capital income by the non-poor. In scenarios 2 and 4, only the rural and urban non-poor benefited in income and consumption gains, reflecting the pattern of structural change observed in this country, where workers have moved from higher productive sectors to less productive ones.

One of the main development challenges in Guinea-Bissau concerns how to potentiate the effects of trade openness since this country is still ranked at the bottom in several economic development indicators. Past development programs were conceived but subsequently failed due to limited financial resources. External funds have varied according to the external situation, while domestic financial institutions are precarious. We suggest that surrounding this shortage of funding is for the government to redirect available funds to productive investments. Investment in infrastructure may reduce transaction costs and make the private business environment more favorable. However, how the government finances this investment should be an essential matter. Indeed, relative price changes through trade reform affect domestic agents differently. For instance, it is natural to expect that the government's income reduction due to the tariff rate cut will affect the poor who depend on government transfers. An infrastructure financing scheme must therefore take into account the distributive aspects. We found that increasing the scale of taxes on firms' income contributes to reducing income inequality. However, these development options for this country are not unique. Various strategies to promote structural change and poverty reduction can be devised, including directly promoting agricultural productivity and using natural resource revenues to support public and private investments in several key sectors. Thus, this study can be a first step toward finding several complementary studies to analyze feasible development promotion strategies for this country.

Declaration of Competing Interest

There is no conflict of interest related to this paper.

Data availability

Data will be shared upon request.

Appendix

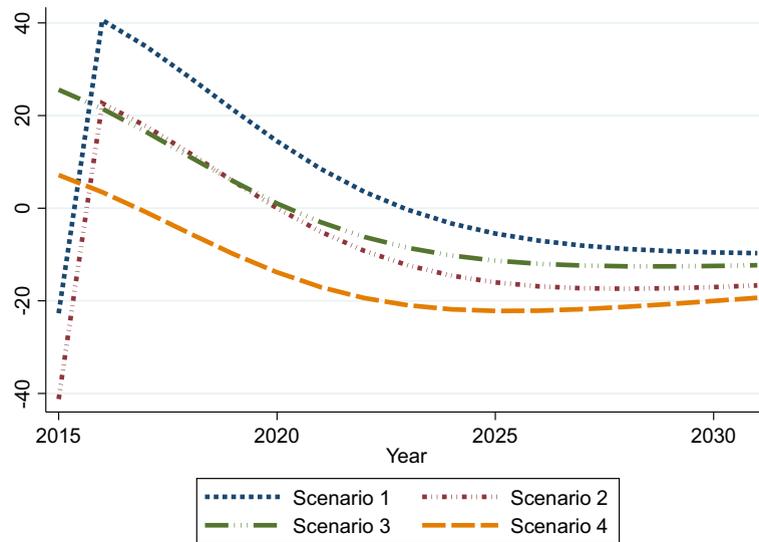


Fig. A.1. Public deficit.
Source: The authors.

Sector	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Millet	-10.767	-4.658	-10.617	-4.517
Sorghum	0.799	-0.426	0.840	-0.384
Maize	0.835	-0.401	0.876	-0.358
Rice	0.815	-0.539	0.862	-0.491
Fonio	0.760	-0.411	0.799	-0.371
Cotton	0.789	-0.445	0.829	-0.404
Other agr,	0.760	-0.625	0.810	-0.574
Cashew nut	-0.850	0.262	-0.905	0.207
Breeding	0.445	-0.498	0.480	-0.462
Forestry	0.701	-0.260	0.729	-0.230
Fishery	0.837	-0.615	0.899	-0.553
Mining	-0.139	-0.186	-0.122	-0.169
Food	1.510	-0.210	1.534	-0.187
Other industries	0.547	0.062	0.566	0.082
Electricity and water	1.842	1.475	1.811	1.444
Construction	2.053	3.056	2.000	3.006
Trading	0.640	0.197	0.656	0.213
Hotel,Rest	0.111	0.103	0.129	0.122
Transport	1.210	0.602	1.206	0.598
Financial	0.976	0.463	0.978	0.465
Service to firms	-0.007	0.432	-0.017	0.422
Public services	-0.852	0.780	-0.940	0.691

Fig. A.2. Industry demand for composite labor (% in 2031).

Source: The authors.

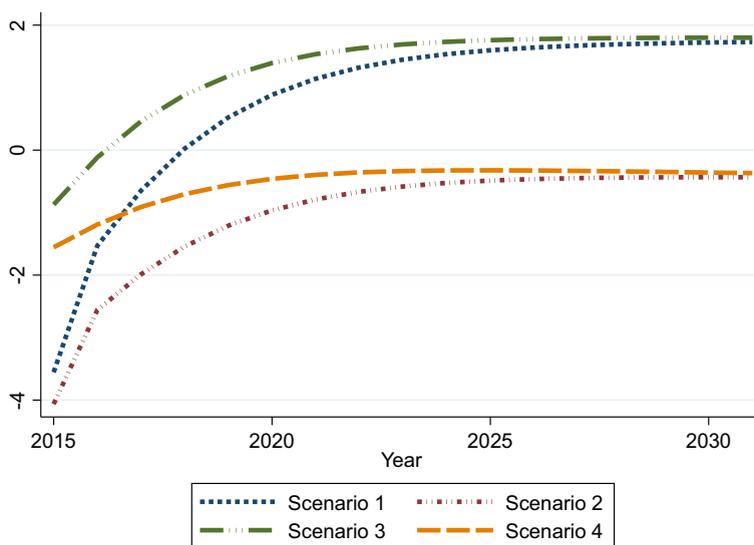


Fig. A.3. Consumer price index.

Source: The authors.

Table A
Behavioral parameters.

	HR1	HR2	HR3	HR4	HR5	HR6	HU1	HU2	HU3	HU4	HU5	HU6
Frisch	-1,2	-1,3	-1,4	-1,5	-1,6	-1,7	-1,4	-1,6	-1,7	-1,8	-1,9	-2
MIL	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
SORG	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
MAIZE	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
RICE	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
FONIO	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
COTTON	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
OTHAGR	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
CASHEW	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
BHUNT	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
FORESTRY	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
FISHERY	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
MININ	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
FOODP	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
OTHIND	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
ELEWAT	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
CONST	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
TRREP	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
HREST	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
TRANSP	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
FINANCE	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
FIRMSEV	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5
ADM	2	1,6	1,2	0,7	0,4	0,1	1,01	1,4	1,8	2	2,2	2,5

Source: The authors.

Appendix B – Production technology

Fig. B illustrates the structure of production technology that shows the different levels of optimization during the production process of the domestic firms. At the top level, intermediate inputs and value added are combined in fixed shares to produce the sectoral output of each productive activity. The strictly complementarity 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.

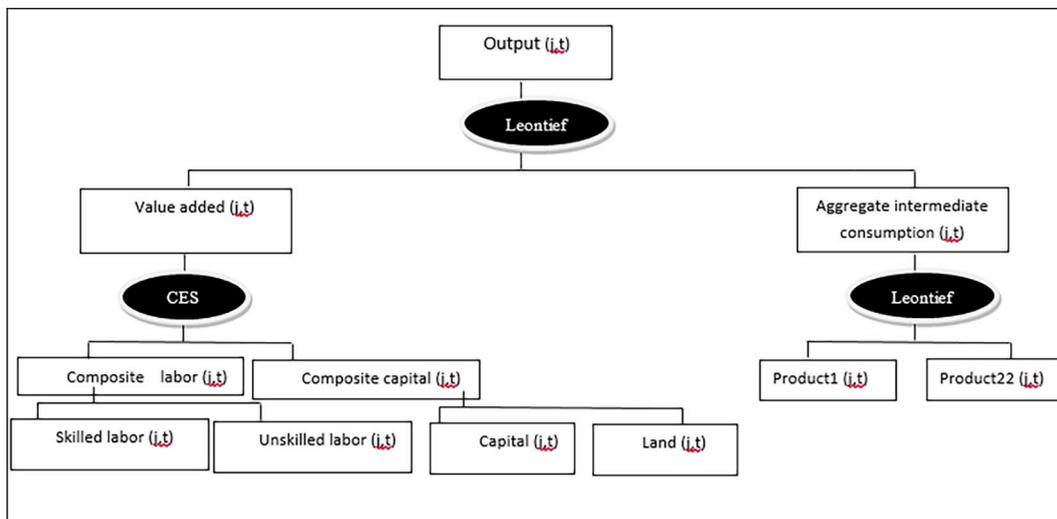


Fig. B. Nested structure of production technology of the model.

Source: The authors.

Appendix C. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ememar.2023.101027>.

References

- Abizadeh, S., Pandey, M., 2009. Trade openness, structural change and total factor productivity. *Int. Econ. J.* 23 (4), 545–559. <https://doi.org/10.1080/10168730903372273>.
- Alcalá, F., Ciccone, A., 2004. Trade and productivity. *Q. J. Econ.* 119 (2), 613–646. <https://doi.org/10.1162/0033553041382139>.
- Alvarez, F., Lucas, R.E., 2007. General equilibrium analysis of the Eaton–Kortum model of international trade. *J. Monet. Econ.* 54 (6), 1726–1768. <https://doi.org/10.1016/j.jmoneco.2006.07.006>.
- Anderson, J., van Wincoop, E., 2004. Trade costs. *J. Econ. Lit.* 42 (3), 691–751. <https://doi.org/10.1257/0022051042177649>.
- Armington, P.A., 1969. A theory of demand for products distinguished by place of production. *IMF Staff. Pap.* 16 (1), 159–178. <https://doi.org/10.2307/3866403>.
- Arndt, C., Benfica, R., Tarp, F., Thurlow, J., Uaiene, R., 2010. Biofuels, poverty, and growth: a computable general equilibrium analysis of Mozambique. *Environ. Dev. Econ.* 15 (01), 81–105. <https://doi.org/10.1017/S1355770X09990027>.
- Betts, C., Giri, R., Verma, R., 2017. Trade, reform, and structural transformation in South Korea. *IMF Econ. Rev.* 65 (1), 745–779. <https://doi.org/10.1057/s41308-017-0031-7>.
- Boccanfuso, D., Joanis, M., Richard, P., avar, L., 2014. A comparative analysis of funding schemes for public infrastructure spending in Quebec. *Applied Economics* 46 (2), 1–12. <https://doi.org/10.1080/00036846.2014.909576>.
- Bureau, J.C., Fulponi, L., Salvatici, L., 2000. Comparing EU and US trade liberalization under the Uruguay round agreement on agriculture. *Eur. Rev. Agric. Econ.* 27 (3), 259–280. <https://doi.org/10.1093/erae/27.3.259>.
- Cabral, J.F., 2015. Social Accounting Matrix for Guinea Bissau. AGRODEP Data Report, n.05. International Food Policy Research Institute (IFPRI), Washington, DC. Available on: <http://www.agrodep.org/dataset/2007-social-accounting-matrix-sam-guinea-bissau>. Available on:
- Cateia, J.C., Savard, L., Freitas, C.A., 2022. Economic impacts of infrastructure investment with different funding mechanisms: evidence from Guinea-Bissau. *Cogent Econ. Finance* 10 (1), 1–16. <https://doi.org/10.1080/23322039.2022.2101226>.
- Bustos, P., Caprettini, B., Ponticelli, J., 2016. Agricultural productivity and structural transformation: Evidence from Brazil. *American Economic Review* 106 (6), 1320–1365. <https://doi.org/10.1257/aer.20131061>.
- Bustos, P., Garber, G., Ponticelli, J., 2020. Capital accumulation and structural transformation. *Quart. J. Econ.* 135 (2), 1037–1094. <https://doi.org/10.1093/qje/qjz044>.
- Cateia, J.V., Bittencourt, M.V.L., Carvalho, T.S., Savard, L., 2023. Funding schemes for infrastructure investment and poverty alleviation in Africa: evidence from Guinea-Bissau. *J. Int. Dev.* <https://doi.org/10.1002/jid.3737>.
- Christiaensen, L., Martin, W., 2018. Agriculture, structural transformation and poverty reduction: eight new insights. *World Dev.* 109, 413–416. <https://doi.org/10.1016/j.worlddev.2018.05.027>.
- Costantini, V., Sforna, G., 2020. A dynamic CGE model for jointly accounting ageing population, automation and environmental tax reform. European Union as a case study. *Econ. Model.* 87, 280–306. <https://doi.org/10.1016/j.econmod.2019.08.004>.
- Cutrini, E., 2019. Economic integration, structural change, and uneven development in the European Union. *Struct. Chang. Econ. Dyn.* 50, 102–113. <https://doi.org/10.1016/j.strueco.2019.06.007>.
- De Loecker, J., Goldberg, P.K., Khandelwal, A.K., Pavcnik, N., 2016. Prices, markups, and trade reform. *Econometrica* 84 (2), 445–510. <https://doi.org/10.3982/ecta11042>.
- Decaluwé, B., Lemelin, A., Robichaud, V., Maisonnave, H., 2012. PEP-1-t: The PEP standard single-country, recursive dynamic CGE model. Version 2.1.
- Dennis, A., Shepherd, B., 2011. Trade Facilitation and Export Diversification. *The World Economy* 34 (1), 101–122. <https://doi.org/10.1111/j.1467-9701.2010.01303.x>.
- Diao, X., Thurlow, J., 2012. A recursive dynamic computable general equilibrium model. In: Diao, X., Thurlow, J., Benin, S., Fan, S. Chapter (Eds.), *Strategies and Priorities for African Agriculture: Economywide Perspectives from Country Studies*, 2, pp. 17–50.
- Duarte, M., Restuccia, D., 2010. The role of the structural transformation in aggregate productivity. *Q. J. Econ.* 125 (1), 129–173.
- Eaton, J., Kortum, S., 2002. Technology, Geography, and Trade. *Econometrica* 70 (5), 1741–1779. <https://doi.org/10.1111/1468-0262.00352>.
- Echevarria, C., 2008. International trade and the sectoral composition of production. *Rev. Econ. Dyn.* 11 (1), 192–206. <https://doi.org/10.1016/j.red.2007.06.004>.
- Estache, A., Perrault, J.-F., Savard, L., 2012. The impact of infrastructure spending in Sub-Saharan Africa: A CGE modeling approach. *Economics Research International* 2012 (18), 1–18. <https://doi.org/10.1155/2012/875287>.
- Ferreira, P.C., Trejos, A., 2011. Gains from trade and measured total factor productivity. *Rev. Econ. Dyn.* 14 (3), 496–510. <https://doi.org/10.1016/j.red.2011.01.001>.
- Freire-González, J., Ho, M.S., 2019. Carbon taxes and the double dividend hypothesis in a recursive-dynamic CGE model for Spain. *Econ. Syst. Res.* 31 (2), 267–284. <https://doi.org/10.1080/09535314.2019.1568969>.
- Frisch, R., 1959. A complete scheme for computing all direct and cross demand elasticities in a model with many sectors. *Econometrica* 27 (2), 177–196. <https://doi.org/10.2307/1909441>.
- Fugile, K., 2017. R&D capital, R&D spillovers, and productivity growth in world agriculture. *Appl. Econ. Perspect. Policy* 40 (3), 421–444. <https://doi.org/10.1093/aep/pxp045>.
- Goedeme, T., Collado, D., 2016. The EU convergence machine at work. To the benefit of the EU's poorest citizens? *J. Common Mark. Stud.* 54 (5), 1142–1158. <https://doi.org/10.1111/jcms.12382>.
- Gollin, D., Hansen, C.W., Wingender, A.M., 2021. Two blades of grass: The impact of the green revolution. *J. Polit. Econ.* 129 (8), 2344–2384. <https://doi.org/10.1086/714444>.
- Gollin, D., Parente, S., Rogerson, R., 2002. The role of agriculture in development. *Am. Econ. Rev.* 92 (2), 160–164. <https://doi.org/10.1257/000282802320189177>.
- Gräbner, C., Heimberger, P., Kapeller, J., Schütz, B., 2020. Structural change in times of increasing openness: assessing path dependency in European economic integration. *J. Evol. Econ.* 30, 1467–1495. <https://doi.org/10.1007/s00191-019-00639-6>.
- Guinea-Bissau, 2010. Para além de Castanha de Cajú: Diversificação através do comércio. World Bank Document No.59562, Guinea-Bissau. Available on: <https://documents1.worldbank.org/curated/fr/314531468034873380/pdf/595620ESW0PORT1Main0Report01PUBLIC1.pdf>. World Bank Document No.59562, Guinea-Bissau. Available on:
- Guinea-Bissau, 2015. Plan Strategique et Operationnel 2015-2020 «Terra Ranka » Document II. Rapport Final 1–198.
- Hoekman, B., Nicita, A., 2011. Trade policy, trade costs, and developing country trade. *World Dev.* 39 (12), 2069–2079. <https://doi.org/10.1016/j.worlddev.2011.05.013>.
- ILO, 2019. International Labor Organization Database. Available at: <http://www.ilo.org>. Accessed on: Sept. 2020.
- International Food Policy Research Institute (IFPRI), 2007. Social Accounting Matrix for Guinea Bissau. Available on: <http://www.agrodep.org/dataset/2007-social-accounting-matrix-sam-guinea-bissau>.
- Jackson, S., 2015. Growth and Development: Why Openness to Trade is Necessary but not Sufficient. World Bank. <https://blogs.worldbank.org/trade/growth-and-development-why-openness-trade-necessary-not-sufficient>.
- Kokovin, S., Molchanov, P., Bykadorov, L., 2022. Increasing returns, monopolistic competition, and international trade: revisiting gains from trade. *J. Int. Econ.* 137, 103595. <https://doi.org/10.1016/j.jinteco.2022.103595>.
- Krugman, P., 1979. Increasing returns, monopolistic competition, and international trade. *J. Int. Econ.* 9 (4), 469–479. [https://doi.org/10.1016/0022-1996\(79\)90017-5](https://doi.org/10.1016/0022-1996(79)90017-5).
- Krugman, P., 1981. Intraindustry specialization and the gains from trade. *J. Polit. Econ.* 89 (5), 959–973. <https://doi.org/10.1086/261015>.
- Kuznets, S.S., 1966. *Modern Economic Growth: Rate, Structure, and Spread*. Yale University Press, New Haven, CT.
- Lewis, W.A., 1954. Economic development with unlimited supplies of labour. *Manch. Sch.* 22 (2), 139–191. <https://doi.org/10.1111/j.1467-9957.1954.tb00021.x>.
- Lewis, W.A., 1980. The slowing down of the engine of growth. *Am. Econ. Rev.* 70 (3), 555–564.

- Lin, L., Mackenzie, V., Piesse, J., Thirtle, C., 2001. Agricultural Productivity and Poverty in Developing Countries. Extensions to DFID Report No.7946, pp. 1–33.
- Malefane, M.R., Odhiambo, N.M., 2018. Impact of trade openness on economic growth: empirical evidence from South Africa. *Int. Econ.* 71 (4), 387–416.
- Männasoo, K., Hein, H., Ruubel, R., 2018. The contributions of human capital, R&D spending and convergence to total factor productivity growth. *Reg. Stud.* 52 (12), 1598–1611. <https://doi.org/10.1080/00343404.2018.1445848>.
- Matsuyama, K., 2008. Structural change. In: *The New Palgrave Dictionary of Economics*, 2. https://doi.org/10.1057/978-1-349-95121-5_1775-2.
- McMillan, M.S., Rodrik, D., 2011. *Globalization, Structural Change and Productivity Growth* (NBER Working Paper Series No. 17143). NBER, Cambridge, MA.
- Ngai, L.R., Pissarides, C.A., 2007. Structural change in a multisector model of growth. *Am. Econ. Rev.* 97 (1), 429–443. <https://doi.org/10.1257/aer.97.1.429>.
- OECD, 2020. Aid Database. Available on: <https://www.oecd.org/development/idsonline.htm>.
- Organisation for Economic Co-operation and Development - OECD, 2020. The Impact of the Coronavirus (COVID-19) Crisis on Development Finance. Available on: [https://read.oecd-ilibrary.org/view/?ref=134_134569-xn1go1i113&title=The-impact-of-the-coronavirus-\(COVID-19\)-crisis-on-development-finance](https://read.oecd-ilibrary.org/view/?ref=134_134569-xn1go1i113&title=The-impact-of-the-coronavirus-(COVID-19)-crisis-on-development-finance).
- Pavcnik, N., 2002. Trade liberalization, exit, and productivity improvements: evidence from Chilean plants. *Rev. Econ. Stud.* 69 (1) <https://doi.org/10.1111/1467-937X.00205>, 245–27.
- Rivera-Batiz, L.A., Romer, P.A., 1991. International trade with endogenous technological change. *E. Econ. Rev.* 35 (4), 971–1001. [https://doi.org/10.1016/0014-2921\(91\)90048-N](https://doi.org/10.1016/0014-2921(91)90048-N).
- Sakyi, D., Villaverde, J., Maza, A., 2015. Trade openness, income levels, and economic growth: the case of developing countries, 1970–2009. *J. Int. Trade Econ. Dev.* 24 (6), 860–882. <https://doi.org/10.1080/09638199.2014.971422>.
- Sangare, S., Maisonnave, H., 2018. Mining and petroleum boom and public spending policies in Niger: A dynamic computable general equilibrium analysis. *Environment and Development Economics* 23 (5), 580–590. <https://doi.org/10.1017/S1355770X18000104>.
- Savard, L., 2010. Scaling up infrastructure spending in the Philippines: a top-down bottom up micro-simulation approach. *International Journal of Microsimulation* 3, 43–59. <https://doi.org/10.34196/IJM.00024>.
- Tangermann, S., 2016. Multilateral rules for agriculture: From GATT to WTO. In: Josling, T., Meilke, K.D. (Eds.), *Handbook of International Food and Agricultural Policies, Volume III: International Trade Rules for Food and Agricultural Products*. World Scientific, pp. 74–116.
- Teignier, M., 2014. The role of trade in structural transformation. *J. Dev. Econ.* 130, 45–65. <https://doi.org/10.1016/j.jdeveco.2017.09.002>.
- Uy, T., Yi, K.-M., Zhang, J., 2013. Structural change in an open economy. *J. Monet. Econ.* 60 (6), 667–682. <https://doi.org/10.1016/j.jmoneco.2013.06.002>.
- Vanduzai, M., Chitiga, M., 2017. Growth and employment impacts of public economic infrastructure investment in South Africa: a dynamic CGE analysis. *J. Econ. Financ. Sci.* 10 (2), 235–252. <https://doi.org/10.4102/jef.v10i2.15>.
- WITS, 2020. World Integrated Trade Solution. Trade database. Available on: <https://wits.worldbank.org/>. Available on:
- World Bank, 2020. World Bank Development Indicators. Available on: <https://databank.worldbank.org/source/world-development-indicators>. Available on: