Effects of Agricultural Public Investments on Economic Growth and Households' Welfare in Benin: An Applied General Equilibrium Analysis

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Abstract

Investments in the agricultural sector have been a concern for decades amongst policy makers in developing countries and particularly in Sub-Saharan Africa. The rationale was that countries' dependence on imported food products invalidated their quest to achieve food sovereignty. Conditions for agrarian changes, R&D's dynamics and subsequent total factor productivity were they met? This study analyses the multiplier effects of productivity improvement through agricultural investments on the country's various sectors and on household welfare. Applying the CGE model and using Benin SAM 2013, three simulations were carried out considering the key agricultural sectors of the Government Action Program 2016-2021. The current results highlight the positive distributional effects of public agricultural investments. Also, these effects in line with consumption gain and welfare increase have been more pronounced in rural rather than urban areas. It is therefore instructive to note that public policies for investment in the agricultural sector would be more favorable to rural dwellers than urban. More than political speeches that call citizens for a drift from urban areas to rural, in particular to the agricultural sector, massive public investments in the agricultural sector would lead to urban poverty that would trigger urban-rural migration.

Keywords: agricultural investments, agricultural productivity, computable equilibrium general model, households' welfare, Benin.

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1. Background

As agriculture remains the economic drive of the rural Africa, promoting economic transformation in Africa will depend largely on stimulating agricultural growth (Jambo 2017). In this perspective, Benin has experienced different schemes of social policy management since the country got independent in 1960 in order to alleviate poverty via accelerated and sustained economic growth. The implementation of each government five-year plan kept the food production increasing in spite of climate change harmful effects on the agricultural sector (FOASTAT 2019). Governments have started since 2006 and particularly from 2016 to implement a set of policies to encourage farmers to increase crop production through public investments such as agricultural subsidies, agricultural R&D, extension and support services, and irrigation systems. The literature reveals that agricultural public investments represent one of the direct and effective tools for enabling sustainable economic growth in developing countries (Fan et al. 2008; Ngene et al. 2012; Bahta et al. 2014). In this sense, agriculture development plays a primordial role in favor of economic growth, poverty reduction and food and nutrition security improvement (Benin et al., 2008). Considering the different effects of agricultural sector, Greyling (2012) claimed that the place of agriculture goes way beyond its direct effect on rural incomes as it has both backward linkages on the supply side and forward linkages on the manufacturing side. Thus, the link between agriculture and the other sectors was shown higher in developing countries and it results of demand and supply effects (Ndhleve et al. 2017).

In spite of the agriculture importance, Benin is confronted by crop yield losses on the one hand (Hounnou et al. 2019a) and demographic pressure with continuous annual growth rate by 3.52%, on the other hand. This situation could lead to an imbalance between supply and demand of agricultural products. Confronted by limited resources, development agents have to allocate the resources among sectors and sub-sectors efficiently (Thurlow et al. 2008). Thus, governments spent in sectors to get multiplier effects. In developing countries, due to market failure, agricultural investments are oriented to input subsidies and price support programs to improve households' welfare and economy-wide growth (Diao et al. 2010). It becomes critical to understand the inter-linkages among sub-agricultural sectors, on the one hand, and between agriculture and the rest of the economy, on the other hand. In fact, one can ask about effective and the effects of public investments in agriculture even when there are many theories about its influence on economic growth (Greyling 2012). Many studies across the world strongly concur that rural economic growth and widespread poverty reduction require increased production in agriculture (Bahta et al. 2014; Ivanic and Martin 2017; Mgeni et al. 2019a).

In addition, African countries are concerned about the food security issue, which could be addressed by increasing food production (Jambo 2017). Therefore, making the agricultural sector a priority is essential to eradicate poverty given that 78% of the poor in sub-Saharan Africa depend on agriculture (Diao et al. 2010). This sector is estimated to employ nearly two thirds of the labor force and to provide the livelihood for the majority of the rural poor (Ngene et al. 2012).

Based on forward and backward effects, all sectors have to be considered together in purpose of the entire economy effect analysis of agricultural productivity improvement even if agriculture is the driving force of Beninese economy and employs more than 70% of the population (MAEP 2018). In 1960, the agricultural sector represented more than 46% of the economy, and this value fall down more than half (20%) in 2017 (World Bank 2018). Nonetheless, agriculture continues to be the main drive in poverty reduction. Furthermore, the fact that

the sector represents less than quarter of the economy does not provide the true illustration of the agriculture's effect on the national economy as this excludes the multiplier effects (Greyling 2012). Other arguments supporting public agricultural investments arise in climate change framework which appears as climate change effects adaptive strategies. What are the projected effects if public agricultural investments proceed as predicted in national plan 2016-2021? Are these projected effects consistent with the development goals? Could greater or better distributed outcomes and effects be obtained from public agricultural investment plan in Benin?

The relationship between public investments and agricultural TFP is through the development of public capital (Benin et al., 2008). Increase in the stock of public capital would increase the productivity of all factors of agricultural production leading to higher agricultural wages and incomes and improved well-being. In these ways, public investments could also encourage private capital investments in agricultural and non-agricultural development. On the other side, the development of the non-agricultural rural sector could have multiplier effects if it provides new market opportunities for farmers and creates non-agricultural employment. The latter is particularly important for absorbing surplus labor and other factors of production that would result from increased of agricultural TFP (Benin et al., 2008).

Despite its importance, agricultural productivity growth in sub-Saharan Africa is reported to remain very low and is mainly due to the low level of agricultural investments (Jambo 2017). What made the economy of this region more dependent on imports and food aid. Comparatively, during the Green Revolution in Asia, agricultural investments are estimated at 15% of total investments (IFPRI, 2013). Unlike in Africa, during the same period, agricultural investment is estimated to be around 5%, which is lower than the investments required for growth (Benin et al. 2008). Meanwhile, the effects of public agricultural investments (R&D, extension, land management, supervision or training, irrigation, etc.) on growth, income and welfare have been addressed in several theories, methods and empirical studies (Pardey and Beddow 2013; Kristkova et al. 2016). According to these authors, (i) the links between agricultural investments and household welfare are multiple; (ii) the effects could be direct and/or indirect, and (iii) the effects could be studied at different scales (micro, meso and macro). However, the improvement of total factor productivity (TFP) is achieved through the increase in the productivity of all factors of production, which in turn affects agricultural remuneration and poverty reduction. In the same line, Gollin and Rogerson (2014) stressed that TFP in agriculture is positively correlated with overall growth and particularly the poverty alleviation.

The theories related to public investment and productivity are twofold (Coker et al. 2019). On the one hand, the first foregrounds on government responsibility such as justification and effectivity of public spending is based on classical, neoclassical and Keynesian theories. On the other hand, the second dimension treating the resource allocation decision and policymakers' roles is driven from allocation, stabilization and distribution theories. To sum up, CGE modelling is based on neoclassical general equilibrium theory, specifically the theory of optimization. This theory is used to analyze the market economies and depicts the strategy of all markets equilibrium without any actions in that sense. It is driven from Adam Smith's (1776) publishing on free market price system and the general equilibrium theory of the competitive market economy (Walras 1874). Over the past few decades, the CGE model has been widely applied to assess the effects of public investments on the economy because of its ability to identify the direct and indirect effects of the economic system and to reduce the bias of the partial equilibrium model or the econometric method. The CGE model would establish numerical models of all supply-demand relationships in an economy (Bezabih et al. 2010). In developed and some

developing countries, several studies have analyzed the effects of investments using the CGE model. Bahta et al. (2014) analyzed the role of agriculture in the welfare, income distribution and economic development of Free State Province in South Africa. Beyene and Engida (2016) used the CGE model to address public investment in irrigation, training, growth and poverty reduction in Ethiopia. Using the same method, Boulanger et al. (2018) assessed policy options to support the growth and transformation strategy of the agricultural sector in Kenya. In South Africa, Ndhleve et al. (2017) also used the CGE model to analyze public agricultural investment and poverty in the Eastern Cape Province. In sum, Gollin and Rogerson (2014) inferred that the CGE model helps to examine country economies and policy decisions. However, few studies have examined the effects of public agricultural investment on the Beninese economy and household welfare using the CGE model.

After categorizing households following their living area, poverty level and farming practices, this paper develops a CGE model to analyze ex ante differential effects of public agricultural investments on their welfare and its effects on the entire economy. The rest of the paper is structured in 4 sections. Section 2 presents the CGE model for Benin and its database while section 3 provides contain of the different scenarios simulated. Then, results of effects of public agricultural investments on economy-wide are discussed in section 4. Finally, section 5 capsulizes the results and deduces the policy implications.

2. Methods

2.1 Computable general equilibrium model for Benin

The CGE model for Benin was developed to capture the offsets and synergies resulting from the acceleration of growth in the various flagship agricultural sectors, as well as the economic links between the agricultural sector and other sectors of the economy. Because this study focuses on flagship agricultural sectors, non-agricultural sectors are aggregated into one account called "non-agricultural sector". It includes mining, construction, manufacturing and service sectors (transportation, trade, finance, accommodation and food services, etc.). The agricultural sectors examined are maize, cassava, rice, pineapple, cashew nut and cotton. The other agricultural sectors are grouped under the terms "other agri-food sectors" and "other export sectors". The CGE model also identifies the livestock, forestry and hunting, and fishing sectors.

In addition, the paper examines the households' profit from TFP improvement. The literature suggests that household welfare is analyzed using consumer surplus (CS) or the equivalent variation (EV) or the compensating variation (CV). In this study, the concept of EV as it was employed by Hounnou et al. (2019b) is adopted. The equivalent variation is the willingness to pay which measures the maximal amount to pay to prevent the inflation in price and it requires the price and quantity levels of the initial situation. When EV is positive, it implies welfare improvement, while it is negative, EV indicates welfare deterioration. Thus, households' expenditures or incomes are considered to capture welfare and its increase corresponds to welfare improvement while its decrease denotes welfare deterioration.

2.2 Data used

The database used for this CGE model comes from the Social Accounting Matrix (SAM). The parameters and variables of the CGE model are calibrated according to the SAM which would represent the balance of the structure of the Beninese economy. The 2013 Benin SAM has been disaggregated into 13 production sectors and

13 product accounts. In order to identify the effect on households, the household account was also disaggregated. Based on the survey for the Global Analysis of Vulnerability and Food Security (AGVSA) realized in 2013, urban households are grouped into poor and non-poor urban households. In addition to the level of poverty, rural households are grouped according to the main occupation, the agricultural practice or not of the heads of households. Rural households are then segmented into 4 subgroups: poor agricultural households; non-poor agricultural households; poor non-agricultural households and non-poor non-agricultural households. The concept of household refers to one of the economy-wide institutions. It represents an institution which consumes commodities produced by activities or firms so as to maximize its utility. The household earns income by providing its endowments of labors, capital or land for firms. Data of AGVSA 2013 were used due to the corresponding year with that of SAM and the issue of data availability from national statistical institute. As for the factors of production, the model considered labor, capital and land. The labor is divided into skilled and unskilled labor. The other accounts included in the model are the government, savings and investment account and the rest of the world. In addition to the SAM data, some additional data are required to calibrate the model. These are the elasticities. As there are no empirical estimates of elasticities in Benin, they are all derived from a CGE model of the Ghanaian economy from Issahaku's (2015) work. This choice is based on a certain similarity between the two countries in terms of their economic structures and their agent behaviors.

Thus, the model can be used to simulate the effects of external shocks, changes in economic policies or changes in economic structure. There are two types of CGE models: the static model that simulates medium-term economic effects while the dynamic model simulates long-term economic effects (Bezabih et al. 2010). In the static CGE model, it is assumed that firms and households would adapt to change by adjusting their production and consumption behavior. The solution to numerical simulation shows the effects after this adjustment, but before it has had time to have longer-term effects, such as on capital stocks (savings and investment). In a dynamic model, these long-term effects are also included, as well as other expected changes, such as changes in population structure and education levels. The analytical framework adopted for the CGE model is the one developed by the International Food Policy Research Institute (Lofgren et *al.* 2002). At least two reasons justify the rationale of using a static model instead of a dynamic one. First of all, total productivity improvements are set in the target year and no provision is made for their sequencing in the planning period of 5 years. Secondly, sequencing productivity improvement is very tricky as soon as various components of policy reforms have divergent effects on productivity in the agricultural sector. This last argument was acknowledged by various authors who, on the one hand, claimed that public agricultural investments are oriented towards the functioning of sectoral administrations rather than the agricultural sector (Sossou 2015); and on the other hand, emphasized that institutional reforms negatively affect agricultural productivity during the early years (Kiani et *al.* 2008).

2.3 Description of the scenarios

Agricultural investments through the use of improved technologies in agricultural production increase yields to their potential productivity (Mgeni et al. 2019a). Such an increase in productivity, which would increase production and, ultimately, household income, could lead to a sustainable improvement in household welfare, a reduction in unemployment and other social concerns (Pothen and Welsch 2019). These hypotheses would raise the question: what are the multiplier effects in an economy when a sector such as agriculture experiences an increase in productivity? Therefore, the methodology used in this study considers public investments in the

agricultural sector as a strategy to improve the TFP. Thus, production would gradually increase according to the sectors with an increase of 70, 35, 85, 11, 44 and 51% respectively in the cotton, pineapple, cashew nut, maize, cassava and rice sectors (PAG 2017). Three scenarios are simulated: (i) TFP improvement in maize rice and cassava sectors named TFP in staple crops, (ii) TFP improvement in pineapple, cashew nut and cotton sectors named TFP in cash crops, and (iii) the combination of the first two scenarios named TFP in staple and cash crops. Therefore, the model was first calibrated with the SAM. Subsequently, a counterfactual simulation was carried out, assuming that agricultural investments and thus gradual technological progress took place following government intervention to support Beninese producers to benefit from the best production conditions. In general, the parameters in the equations of the CGE model describe the agents' behavior in terms of production technology as well as the structure of consumption and markets. Thus, the increases in the above-mentioned different production rates were introduced through the production efficiency parameter in Leontief's aggregate production function, assuming an increase in the production of the flagship sectors of the PAG.

$$ALPHAVA_{ia} = ALPHAVA_{i} \times (1 + a)$$

Where:

$ALPHAVA_{ia}$ is the parameter of production efficiency after public agricultural investments,

$ALPHAVA_{i}$ is the initial production efficiency parameter,

a is the percentage change in the efficiency parameter.

Therefore, the percentage changes in the macroeconomic baseline variables considered for this study are compared with the counterfactual simulation predicted by the model (Mgeni *et al.* 2019b). It is expected that the feedback effects of the shock will be observable not only in the sub-sectors, but also in other sectors of the economy. It is hypothesized that the transmission of the shock, thus triggering an increase in the production of agricultural sectors, would lead to an increase in the domestic supply of agricultural products. Increased supply, in turn, would lead to lower prices for agricultural products in local markets where consumers would buy more of these cheap local products. At the same time, suppliers would be motivated to supply export markets due to the increase in export prices compared to local markets. In addition, the increase in demand for local products would lead to a decrease in imports of products.

An increase in production is also expected to have an impact on the income of economic agents (households, governments and the rest of the world). Households would depend on labor, return on capital, and transfers from government and the rest of the world. Consequently, the improvement of TFP in agricultural sectors would lead to an increase in demand for labor and capital, which would lead to an increase in household income. Government revenues are expected to increase due to increased collection of direct and indirect (sales) taxes, production taxes, import taxes, export taxes and other corporate taxes. Increasing the incomes of these economic agents would lead to an increase in savings, which could then stimulate investment, not only in the agricultural sector, but also in other sectors of the economy.

3. Results and discussion

3.1. Effects of public agricultural investments on local production

The model results, illustrated in Table 1, generally predict an increase in local production in all sectors for all of the simulations. Specifically, TFP improvement in staple crops increases the value of the crops promoted by 20.26%, 63.71% and 6.69%, respectively for maize, rice and cassava. The model's prediction indicates that TFP improvement in staple crop sectors would positively affect the value of all other agricultural sectors and the strongest variation is obtained in cashew nut sector (21.22%). With regard to TFP improvement in cash crops: pineapple, cashew nut and cotton, the model predicts that the increases in the values of these sectors are 4.89%, 8.99% and 6.07%, respectively. Apart from the direct effects, TFP improvement in cash crops would lead to an increase, but insignificant in the production values of other sectors of the economy such as the rice sector (0.98%), the maize sector (0.83%) and the other cash crop sectors (0.70%) (Table 1). From the point of view of the combined staple and cash crop sectors, the model indicates that TFP improvement through public agricultural investments under the PAG would generate a sharp increase in the rice sector (74.82%), followed by the maize sector (16.81%) and the cassava sector (5.01%). Also, the model predicts that TFP improvement would negatively affects cashew nut product (-80%) if anything is adjusted to control that. The service sectors have also increased. The increase in the value of services (trade and non-agricultural products) would indicate that interventions affecting local agricultural production would subsequently increase the supply of raw materials for the industrial sector. This implies that improving the productivity of flagship agricultural sectors would in turn stimulate the production of other agricultural products and promote the supply of raw materials for the agri-food industries. Similar results have been obtained from other studies (Lectard and Rougier 2018). These authors supported the thesis that an increase in agricultural production would positively affect industrialization. It would also provide raw materials for industry and food for industrial employees.

Additionally, the findings of inhibitory effects in the cashew nut sector could be explained by the fact that increasing production in one sector would require more factors of production, such as labor, by causing a shortage of factors of production in the other sectors. Similarly, households could opt for these sectors which, because of a larger investment in one of them, would lead to a disinterest in the others. By analogy, the upstream effect of agricultural productivity would lead to the reallocation of factors of production to agri-food and services industries, causing a decline in production in non-food industries and services (Mgeni et al. 2019a).

Table 1. Percentage change in production according to simulations (% of baseline)

Products	TFP in staple crops	TFP in Cash crops	TFP in staple and cash crops
Maize	20.26	0.83	16.81
Rice	63.71	0.98	74.82
Cassava	6.69	0.23	5.01
Pineapple	0.55	4.89	3.30
Other staple crop	1.93	0.62	2.63
Cotton	0.44	6.07	3.80
Cashew-nut	24.22	8.99	-80.00
Other cash crop	4.48	0.70	3.73
Breeding	1.41	0.42	2.35
Hunting and forestry	1.06	0.36	2.31
Fishing	0.94	0.32	1.78
Trade	1.31	0.37	1.50
Nonagricultural product	0.32	0.14	0.78

Source: Calculated from the 2017 PAG and Benin's CGE model

3.2 Effects of public agricultural investments on Gross Domestic Product

In terms of gross domestic product (GDP), the results show that wealth creation is higher in the staple crops' simulation than that in the other crop sectors (Table 2). The variation in GDP in real terms is around 1.38% and 0.32% for the promotion of the staple crop and cash crop sectors, respectively. The average variation in GDP in real terms is around 1.36% for all sectors combined. These findings are similar to those of Coker et al. (2019) in Nigeria where crops TFP improvement affects GDP growth by 1.4%. The Table 2 also shows that staple crop TFP improvement significantly increases absorption within the economy (1.22%). It appears that the effects of public agricultural investments on economic growth are still low and could not be compared to the effects obtained during the Asian Green Revolution (IFPRI, 2013). The result suggests that an increase of expenditure on goods and services influences the welfare and the country's economic growth. Indeed, the public agricultural investments of the PAG (2016-2021) would match the recommendation of the Maputo Declaration, unlike Acclassato's (2016) observations on successive periods from 2001 to 2016. However, those investments could be directed to administrative functioning of the agricultural sector rather than the targeted projects (Sossou 2015). In the same vein, Kiani et al. (2008) reported counterproductive negative effects of agricultural investments on productivity during the early stage of institutional reforms in Pakistan. For efficient and positive public agricultural investments on economic growth, it is necessary, on the one hand, to direct these investments towards agricultural productivity and, on the other hand, to restructure sectorial administrations in order to get "development administrations".

Table 2: Effect of agricultural TFP on demand side real GDP variables (% of baseline)

Macro-variable	TFP in staple crops	TFP in Cash crops	TFP in staple and cash crops
Absorption	1.22	0.28	1.20
Consumption	1.75	0.40	1.74
Exports	1.64	0.55	0.75
Imports	1.05	0.35	0.48
GDP at market price	1.38	0.32	1.37
Net indirect taxes	0.87	0.27	0.85
GDP at factor cost	1.50	0.33	1.54

Source: Calculated from the 2017 PAG and Benin's CGE model

3.3 Effects of public agricultural investments on local commodity prices

Table 3 shows the impact of the model's projection for the effects of public agricultural investments on local commodity prices. For the first two simulations, the model predicts that individual TFP improvement in staple crops and cash crops would lead to lower prices on the local market. The significant drop in prices in first simulation concerns rice (-28.80%), cassava (-27.90%) and maize (8.58%) while pineapple (-24.44%) and cotton (-18.21%) are those concerned in second simulation. It is also noticed that in the first simulation, the model indicates an increase in the prices of cotton (0.17%), cashew nut (0.15%), trade (1.79%) and non-agricultural product (0.97). For the last simulation, the model predicts lower prices, not only for products in the flagship sectors, but also for other agricultural products. This implies that the improvement in production would result to an increase in the supply of all local agricultural products. The increase in local production of other products would lead to lower prices, which would consequently lead to an increase in demand for local products. These results corroborate those of previous studies that predicted a price decline in the study on policy options to support the growth of Kenyan agriculture (Boulanger et al. 2018) and the study on reducing dependence on edible oil imported into Tanzania (Mgeni et al. 2019a). The price decrease observed in this study could be linked to the increase in agricultural production and therefore its supply. Dissimilarly, the price increase in first simulation would be that TFP improvement in staple crops would have a negative effect on the production level of the other sectors and the decrease in their production would cause an increase in prices.

Table 3. Variation in prices of local products on the local market (% of baseline)

Product	TFP in staple crops	TFP in Cash crops	TFP in staple and cash crops
Maize	-8.58	-0.44	-10.46
Rice	-28.80	-0.41	-45.30
Cassava	-27.90	-0.46	-26.22
Pineapple	-0.52	-24.44	-22.84
Other staple crop	-0.42	-0.43	-2.49
Cotton	0.17	-18.21	-16.15
Cashew nut	0.15	-0.20	4.92
Other cash crop	-0.33	-0.43	-2.43
Breeding	-0.60	-0.34	-2.16
Hunting and forestry	-0.38	-0.36	-2.05
Fishing	-0.08	-0.29	-1.56
Trade	1.79	0.38	2.06
Nonagricultural products	0.97	0.11	1.31

Source: Calculated from the 2017 PAG and Benin's CGE model

3.4 Effects of public agricultural investments on the sale of local products

The model results show an increase of all the single sector products either agricultural or nonagricultural sector in the first two simulations (Table 4). For the promoted staple crops in the first simulation, rice (63.71%) and cassava (6.69%) vary as the same percentage in production variation while maize (5.73%) is different. It is clear that cassava and rice are produced and consumed domestically. In general, the model forecasts an increase in sales of local products, particularly for rice (74.82%), maize (5.41%), cassava (5.01%), and other export products (3.73%). The results also indicate the decrease of cashew nut product on local market. Firstly, this increase in sales of agricultural products would be due to an increase in local production and a decrease in prices on the local market. These results confirm those of studies conducted in Tanzania (Mgeni et al. 2019b), Burkina Faso (Zidouemba and Gerard 2018) and Kenya (Boulanger et al. 2018). Those authors indicated in their work that an increase in commodity sales in the local market is the result of an increase in production. In addition, as mentioned in previous sessions, prices of imported products would be relatively higher than those of locally produced basic goods. This would increase consumers' real income, which means that they could acquire more commodities locally produced at low prices, thus increasing the demand for sales of local products. In addition, the increase in sales of industrial products and services would be linked to the availability of income from households, due to the decline in commodity prices (Mgeni et al. 2019a). Firstly, public agricultural investments could facilitate food availability at the country level. Secondly, the decline in domestic sales of some products in favor of the promoted sectors could be due to the substitution effects between products (Ntombela et al. 2017).

Table 4. Variation in the quantities of local products on the local market (% of baseline)

Products	TFP in staple crops	TFP in Cash crops	TFP in staple and cash crops
Maize	5.73	0.34	5.41
Rice	63.71	0.98	74.82
Cassava	6.69	0.23	5.01
Pineapple	0.50	2.42	2.31
Other staple crop	1.76	0.54	1.95
Cotton	0.37	0.17	0.91
Cashew nut	0.84	0.28	-0.80
Other cash crop	4.48	0.70	3.73
Breeding	1.33	0.39	2.08
Hunting and forestry	0.70	0.23	1.19
Fishing	0.94	0.32	1.78
Trade	1.31	0.37	1.50
Nonagricultural product	0.48	0.18	0.82

Source: Calculated from the 2017 PAG and Benin's CGE model

3.5 Effects of public agricultural investments on imported and exported products

The disaggregation of imports and exports is important for projection setting. On the one hand, for this research, the model predicts 41.84%, 0.46% and 64.07% decreases in rice imports, respectively for TFP improvement in staple food crops, cash crops and both simulations altogether (Table 5). Similarly, for other agricultural products, imports are projected to fall. However, the model results indicate an increase in imports of industrial products (1.02%). This means that public investments in the agricultural sector which improve TFP would reduce imports, either of the products of the promoted sectors or of other products of the non-promoted agricultural sectors. As a result of the increased supply of local products, importers would turn to less abundant products, i.e. products whose local supply is insufficient to meet local demand (Mgeni et al. 2019a). The rationale that could support the increase of industrial sector would lie in the fact that industrial products are not local and also in the fact that household income has improved. Public agricultural investments aim at boosting the agricultural sector and promoting local agricultural products, which in the long term should lead to a reduction in foreign currency investments (import dependence) for food products. In the developing countries, literature shows that the increase in local commodity production not only meets direct consumer demand, but also provides agri-food and extractive companies with raw materials (Ivanic and Martin 2018). As a result, increasing local production would allow commodities processing industries to achieve economies of scale in terms of quality, variety and quantity, thus reducing the welfare losses that would result from lower imports. Similarly, promoting the production of local commodities to support the expansion of agro-industries would be an appropriate strategy for the industrialization of agriculture dependent countries (Mufuruki et al. 2017). These results suggest that public agricultural investments would reduce the country's dependence on food imports.

Table 5. Variation in the quantities of imported and exported products (% of baseline)

Product	TFP in staple crops	TFP in Cash crops	TFP in staple and cash crops
	Imports		
Rice	-41.84	-0.46	-64.07
Other staple crop	-1.57	-0.81	-7.85
Breeding	-1.87	-0.54	-6.62
Fishing	-0.88	-0.46	-4.82
Nonagricultural product	1.35	0.38	1.02
	Exports		
Maize	70.41	2.61	58.94
Pineapple	4.44	187.55	89.49
Other staple crop	5.11	2.03	15.28
Cotton	2.06	118.81	66.11
Cashew nut	26.96	10.03	-122.72
Breeding	4.92	1.40	13.59
Hunting and forestry	4.71	1.73	13.86
Nonagricultural products	-0.45	-0.03	0.61

Source: Calculated from the 2017 PAG and Benin's CGE model

On the other hand, the model results for TFP improvement in staple food and cash crops predict upward changes in exports, except for nonagricultural sector. For example, the first simulation shows an increase in the quantity of maize exported by 70.41% and of cashew nut exported by 26.96% compared to the baseline situation (Table 5). Overall, the investment model in the agricultural sector predicts an increase in exports of all agricultural products, with significant variations in pineapple (89.49%), cotton (66.11%) and maize (58.94%). This increase in agricultural exports would be supported by an increase in their production. The increase in the domestic supply of agricultural products would result in lower prices on the local market relative to the export price. Relatively high export prices would imply that it is more profitable for traders to sell on the export market, so suppliers would move towards export markets. This finding is consistent with studies that have shown that whenever the supply of local commodities increases in one sector of the economy, it would be expected that, in the short term, exports in other sectors, particularly in the industrial sector, would decline due to the imbalance between local supply and demand (Ivanic and Martin 2018; Mgeni et al. 2019a). Similarly, in the medium term, when local demand is met by local commodities, the surplus in the industrial and service sectors could also be exported in exchange for the import of capital and technology that could contribute to industrialization and overall economic welfare (Samouel and Aram 2016). The effects of these public agricultural investments would boost exports and earn valuable foreign currencies.

3.6 Effects of public agricultural investments on household income and equivalent variation

For an analysis of the effects of improved agricultural production on different population groups, households are disaggregated into six groups. Table 6 shows the percentage changes in household incomes across the different simulations. The model results of Agricultural TFP improvement show an increase in income for all household categories considered in this research. This result is in line with the results of a study in Botswana that found that the 5% increase in factor productivity in the agricultural sector led to a 0.6% increase in household incomes in both rural and urban areas (Tlhalefang and Mangadi 2012). The simulations also show that the variation in income is greater among rural households and particularly among nonagricultural households. One possible reason for the increase in the incomes of these groups would be related to their high dependence on unskilled labor income, whose demand would increase as a result of government-initiated agricultural investments, which would lead to an increase in production in the various flagship sectors of the agriculture (Mgeni et al. 2019a). This result would imply that government support for flagship agricultural sectors motivates producers to increase their production, which in turn is translated into higher household incomes. It is also due to the value chain adopted in agricultural sector in developing countries where downstream actors would be able to benefit more from the gains of the TFP improvement and related service activities such as marketing, processing, transportation and probably the middlemen (Coker et al. 2019). Based on a multi-regional CGE model in India, Naranpanawa and Arora (2014) pointed out that increasing agricultural enterprise production would lead to higher incomes for rural agricultural households. In addition, the results show that investments in the agricultural sector through the improvement of the TFP would lead to an overall increase in income for all categories of households. Studies argue that interventions in the agricultural sector, where developing countries have a comparative advantage, are essential to increase incomes and improve the livelihood of poor rural and urban households (Lectard and Rougier 2018). Thus, interventions to increase production could help the government to reduce income inequalities among the Beninese population.

In regards to equivalent variation, only rural agricultural non-poor households are negatively affected by TFP improvement in agriculture. As a result, investments in cash crop sectors have insignificant effects on the level of welfare of agricultural households. Moreover, Table 5 shows that rural households experience a significant improvement in welfare compared to urban households in TFP improvement in agriculture. Overall, the results show a general improvement in household welfare, if the investment program is oriented towards agricultural productivity (Mgeni et al., 2019a). The various studies on welfare and poverty reduction have not addressed household aspects in general and the urban-rural gap in particular (Bahta et al. 2014; Beyene and Engida 2016). Depending on Benin's economic structure, massive public agricultural investments would benefit rural households in general more than urban households.

Table 6. Change in household income and equivalent variation according to simulations (% of baseline)

Household categories	TFP in staple crops	TFP in Cash crops	TFP in staple and cash crops
Income			
Rural agricultural poor	0.07	0.19	1.26
Rural agricultural non poor	0.09	0.19	1.20
Rural nonagricultural poor	0.82	0.12	0.32
Rural nonagricultural non poor	1.27	0.30	1.28
Urban poor	1.26	0.30	1.31
Urban non poor	1.88	0.54	2.49
Equivalent variation			
Rural agricultural poor	2.30	-	1.70
Rural agricultural non poor	0.90	-	-0.20
Rural nonagricultural poor	2.90	0.20	3.10
Rural nonagricultural non poor	1.80	0.40	2.00
Urban poor	1.30	0.40	1.30
Urban non poor	1.90	0.60	2.40
Whole of the household	1.70	0.40	1.70

Source: Calculated from the 2017 PAG and Benin's CGE model

4. Conclusion and policy implications

The initiatives of the Beninese government's action program aim at reducing the country's dependence on imports of basic food products through the promotion and stimulation of national agricultural production. This paper assessed the effects of public agricultural investments by improving the total factor productivity. A computable general equilibrium model was implemented to capture the multiplier effects of agricultural sector interventions on economic growth and improved household welfare. The results show that increasing agricultural production would affect national agricultural production in both promoted and non-promoted sectors, and would improve household welfare. Specifically, the model predicts that investments would stimulate the supply of local agricultural products, leading to lower prices. This price reduction would lead to a welfare gain in terms of consumer surplus. Thus, interventions aimed at increasing production would encourage local producers to offer more agricultural products, which imply that such interventions in the agricultural sector could reduce import dependence, thus improving the country's food availability and accessibility. Provided with adequate raw materials from the agricultural sector, local companies could achieve economies of scale. The increase in household incomes indicates that interventions in the agricultural sector would lead to the use of more factors of production, including labor, to meet the demand for local commodities. Welfare gains are also the results of improved incomes for different categories of households. On this basis, public agricultural investments in Benin are desirable and should be encouraged to take advantage of the comparative advantage of the Benin's agriculture. For the initiatives to be effective, the government could work in synergy with development partners whose actions are focused on improving agricultural productivity in rural areas. Finally, to achieve the objectives

assigned to Benin's agricultural sector, investments must be real and benefit the beneficiaries, namely farmers. This will foster a favorable business environment.

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