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RESEARCH ARTICLE

The effects of public and private investments on food security in Cameroon

Votsoma Philémon[1*], Vangvaidi Albert[2], Pene Zongabiro Nina Pelagie[3], Mohamadou Oumarou[1], Ndouyang Balguessam Bruno[1], Mohamadou Sani[1], Bilkissou Hadjara[1], Kaltoumi Raihanatou[1], Fatal Esperance[1], Abdoulaye Assana[1]

[1]Faculty of Economics and Management, University of Garoua, P.O.Box : 346, FSEG, Garoua, Cameroon
[2]Faculty of Economics and Management, University of Maroua, P.O.Box : 46, FSEG, Maroua, Cameroun
[3]Faculty of Economics and Management, University of Ngaoundere, P.O.Box : 454, FSEG, Ngaoundère, Cameroon

Corresponding Author: Votsoma Philémon. Email: philemonvotsoma@yahoo.fr
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Abstract
This paper aims to analyse the effects of public as well as private investments on food security in Cameroon. The study, used data from 1988 to 2020 and Generalized Least Squares method for estimation. The results revealed that (i) public investment reduce effect on food security while (ii) private investment has a positive effect on food security. Therefore, the study suggests to Cameroonian government to direct public policies towards investments in agricultural sector in order to boost food production, food availability and food accessibility in the country.

Keywords: Investments; food security; public sector; private sector; Generalized Least Squares method

Introduction

An increase in the rate of food insecurity in the world is still a hot topic. The rate of food insecurity in the world has evolved over time. As of 2019, nearly 750 million people, or one in ten people worldwide, have experienced food insecurity (Food and Agriculture Organization (FAO), 2020). According to the report entitled 'The State of Food Security and Nutrition in the World 2020', almost 690 million people, or 8.9% of the world's population suffer from hunger. While the fight against hunger is stagnating, the COVID-19 pandemic is intensifying global vulnerabilities and food shortages. In addition, the world's population has increased thanks to a rise in the birth rate and improvements in the quality of human health care. In fact, the increase in population growth rate is a factor that boost demand for food on global level. However, despite a favourable outlook for global food supply, food prices increase and high transportation costs increase the cost of imported food. Therefore, many countries experienced inflation in retail food price. Labour shortages and the rise in the price of fertilisers and agricultural inputs are also other cause of increase in food prices. In the United Nations Development Programme's Human Development Report (UNDP, 2019), Cameroon's Human Development Index (HDI) was 0.563, placing the county in the 153rd out of 189 poorest countries. This HDI value places Cameroon in the 'medium human

development' category. Let notice that the socio-political crises, has deteriorated food insecurity in Cameroon from 12.8 % in 2019 to 20.5% in 2020. The distribution of food insecurity among regions in Cameroon are as follows: 40% in the North-West, 30.7% in the West, 22.1% in Adamaoua, 24.8% in the Far North (Ministry of Agriculture and Rural Development, 2020, World Food Program (WFP), 2020, and FAO, 2020). Tough the country has enormous potential for sufficient food availability, it faces a number of humanitarian, security and health crises that compromise food security (FAO, 2021). Climate change, limited access to food, and poverty linked to economic shocks and inequality are factors of food insecurity. In addition, mainly terrorism (Boko Haram in Far North), socio-political crisis in North-West and South -West regions, the increase of migrants from central Africa Country in the East region are other causes of food insecurity. Food security in Cameroon is also affect by speculation. In fact, the country is identified as the main producer of agricultural crop products in Central Africa, meanwhile, Daka, Wang and Hu (2021) identified Cameroon as the breadbasket of Central Africa. Thus, producer and retailers choose to sale their products to neighbouring countries (Gabon, Equatorial Guinea, Chad, Central African Republic) where market price is higher than the one applies on local market, leading to shortage in local markets. Yet, the agricultural sector in Cameroon remains underdeveloped due to the inadequacies of investment in agricultural sector. The part of Cameroonian government budget allocate to agricultural sector is 4.5% of the government total of annual expenditure (National Statistics, 2019). Despite the engagement took in The Maputo Declaration in July 2003, where Heads of African States agreed to allocate at least 10% of their budgets to develop agricultural sector in order to achieve agricultural growth at 6% (New Partnership for Africa's Development, Mbaku, 2004). The country has not respected this engagement, for instance in 2021 just 1.86% of budget was allocate to agricultural sector (National statistics, 2021). With respect to current debate on the link between investment and food security in the world, the authors propose to participate to this debate trough this paper entitle: the effect of public and private investment on food security in Cameroon. The study aims to assess the effects of both public and private investment on food security in Cameroon through this main question: what is the link between investment and food security? To answer this question, two assumptions was made: firstly, the effect of public investment on food security and secondly, the effect of private investment on food security.

To answer this question, we will use two assumptions: firstly, the effect of public investment on food security and secondly, the effect of private investment on food security. This paper is structure as follows: section two presents literature review on the relationship that actually exist between different types of investments and food security, methodology of the study is in section three, while the main results and their interpretations are presented in section four, finally the study is concludes with main recommendations towards the publics authorities in Cameroon.

Literature Review

The agricultural policy of Cameroon was defined in the five -year plans from 1975 to 1986 and aims to increase agricultural production in order to achieve food security. However, the increase in agricultural productivity is linked to the increase of investment in agricultural sector. For instance, the joint statement on global food security issued by the G8 meeting held in Aquila (Italy) in June 2009 recognises that, the combination of chronic under-investment in agriculture and economic instability are two mains causes of persistent food insecurity. Thus, both public and private investment in the agricultural sector can play an important role in ensuring food security for the population. Investment in agriculture appear as a most important and effective strategy for reducing food insecurity in rural areas, where the majority of the world's poorest people live (World Bank, 2007 and FAO, 2012). Since the investment needed to develop an agricultural value chain plays an important

role in reducing food security, consequently investment in agricultural sector have had a positive impact in many countries.

Public investment and food security

Review of global literature on the link between public investment and food security

Agricultural value chains have often increased the availability and quality of food, if they focus on a diversity of crops consumed locally, and have also contributed to increase food production (Bishwajit and Yaya (2024), Cleaver, 2013; Rutherford et al., 2016; Kaplan et al., 2016). In this perspective, public spending can be directed towards subsidising agricultural projects (Daka, Wang and Hu, 2021). The subsiding of agricultural input is generally intended to increase productivity through better access to fertilisers. Thereby contributing to a rise in producers' income (lower production costs) and a fall in consumer prices (increased supply) (Kazukauskas, et al., 2014; Jayne et al., 2018; Solaymani et al., 2019). In this vein, Kanter et al, (2015) have shown that input subsidy policies are likely to lead an increase in agricultural production, which later provides additional income to farmers, enabling them to purchase foodstuffs that can improve the nutritional status of the household. Therefore, the financing of agricultural activities is also crucial to ensuring food security. The financing of agriculture makes a significant contribution to agricultural production. While strengthening and diversifying agricultural financing promotes the development of food markets (Ibrahima Thiam and Malick, 2020). Meanwhile, the financing of agricultural sector in Cameroon shows that there is a positive relationship over time between agricultural financing and food security (Biligil, 2017). Public investment in agriculture is necessary to reduce food insecurity (World Food Program, 2020 and World Bank, 2017). As food prices likely to rise, investment in the agricultural sector has become more essential for guaranteeing food security around the world. As a result, investment in research and development, physical infrastructure, and communications technologies contribute to improve the availability and access to food (Kristova et al.,2017; Heisey and Fuglie, 2018). Thus, spending on research and development as well as on support services of agriculture contribute to food security by promoting food systems that guarantee basic diets (Shankar, Chunk and Frank, 2017). It has also noted that investment in education has a positive effect on the population's food security. It promotes agricultural productivity, the higher the level of education of the farming population, the higher will be the agricultural productivity. In this vein, Mengoub (2018) in her paper entitled 'Agricultural investment in Africa: a low level… many opportunities', shows that investment in education is seen as an effective means of increasing agricultural productivity gains. This improvement in agricultural productivity increases the availability of foodstuffs.

Despite many policies adopted by various government across the world, the agricultural sector still faces limited investment that is view as main factor of food insecurity. Meanwhile, food security has become main objective of agricultural policy for every country. Thus, investment is recognized as a key variable mainly in rural areas where it has been identified as an essential element of the fight against poverty and food insecurity (, World Bank, 2007; Barret et al., 2010; De Janvry and Sadoulet, 2010). In this line, Alston et al., (2009) show that agricultural investment from farmers or from the public sector to increase productivity at farm level can also improve the availability of food on the market and exert downward pressure on prices, making food affordable to consumers. Public investment in the agricultural sector should therefore have a positive impact on food security and poverty. Increase in public investment in agricultural sector expected to have a positive impact on food security, not only in rural areas but also in urban areas, as the fall in prices resulting from growth in

production will satisfy both rural and urban populations (Burchi, Scarlato and d'Agostino, 2018; Timmer, 2000; FAO,2012).

Review of synthetic literature on the link between public investment and food security

According to Douillet and Girard (2013), agricultural production depends not only on the soil and climate, but also on the technologies available, farming practices and public policies that directly or indirectly affect farmer's activities, through their general or specific economic orientation. These authors highlight the importance of state intervention in the agricultural sector through public investment and the quality of the institutions that promote agricultural development. Though agriculture remains a main pillar of development in many developing countries, over time its contribution to Gross Domestic Product (GDP) has declined in many parts of the world, partly due to low investment and the neglect of this key sector in favour of manufacturing industries (Forum for Agricultural Research in Africa (FARA), 2006). Investment in agricultural sector is divided into economic and social infrastructure. Public investment in agricultural research, road, electrification and education generates high returns in terms of agricultural growth and poverty reduction, that are highly complementary to private investment. State funding of agricultural activities plays an important role in food security. In fact, agricultural financing makes significant contribution to production, strengthening and diversifying agricultural activities, thus promotes the development of food markets The funding of agricultural projects or granting subsidies to farmers increase the availability of foodstuffs trough the increasing of agricultural productivity (Ibrahima, Thiam et Malick, 2020).
In this same vein, Biligil (2017) analysed the impact of public funding of the agricultural sector on the growth of agricultural products in Cameroon. The results show a positive relationship over time with public spending allocated to the agricultural sector. The growth of agricultural production has contributed to the reduction of food insecurity among local population. Thus, public investment in agricultural sector has a positive impact on food security. Public investment in education mainly in vocational training in agriculture, improve farmers skills who are more effective and efficient in practising modern technics of farming (Mengoub,2018). Public spending to support food prices mainly towards price support and aid for farmers has a positive effect on food security. For instance, Kaya and Erden (2008) in their paper concluded that development aid devoted to agricultural sector and growth have a positive relationship. Therefore, the level of food prices is a key determinant of food security. In fact, when prices are low, people are able to buy and vary their diet more. However, Timmer (2010) argued that, the volatility of food prices is evidence of the existence of food crises due to dynamic public policies to support the production or consumption of food and non-agricultural products. Investment in agricultural sector can also reduce the vulnerability of food supply to shocks, thereby improving the stability of consumption. On the supply side, a period of high prices leads the government to encourage research and investment in order to increase agricultural production. Public and private sectors can invest in the construction of food storage and other infrastructure to ensure supply. However, the period of low prices reduces the interests of governments, resulting in a decline in public support.

Private investment and food security

Review of global literature on the link between private investment and food security

The World Bank (2007) recommends to governments to ease the pressure on national food security by attracting Foreign Direct Investment (FDI) in order to solve chronic problems of low investment in agricultural sector.

However, a negative effect of Foreign Direct Investment in major developing countries were noticed. FDI has led to an increase in the rate of food insecurity, due to foreign investors seeking to maximise their interests by exploiting the resources of developing countries (Bjornlund, Bjornlund and Rooyen, 2022). For instance, World Bank (2004) noted earlier that FDI flows into agriculture tend to be highly volatile. Agriculture is land-based activities, and land is owned by major local elites who concentrated benefits from FDI. In this same line, Alfaro (2003) and Aykut and Sayet (2007) have shown in cross-country empirical analysis that FDI in primary agriculture hurt economic growth in developing countries. FDI in agricultural sector has led to environmental problems. In this line, Clapp (2003) in his studies noted that governments in developing countries have followed foreign agricultural policies that favour the use of chemical-dependent technologies due to the involvement of multinational firms in agricultural projects. Multinational firms, use high-intensity pesticides and fertilisers that replaced natural crop rotation and organic fertilisers (Altieri, 2000 and Jorgenson, 2007). In some cases, foreign investors in developing countries use substances that are banned in developed countries for environmental norms (Magdof et al.,2000 and Shiva and Bedi, 2002). The pollution of water sources poisoned farmland and later force the migration or the abandonment of subsistence farms by local producers. In addition, the use of chemical fertilisers can be the cause of certain diseases in developing countries. Therefore, private investment can act as a brake on the development of poor countries (Mihalache and Li, 2011).

Studies of the effects of FDI on food security in developing countries show that energy consumption was negatively related to FDI in agricultural sector in both short and long term (Djogoto, 2022). In fact, some social conflict arises mainly the large-scale of land acquisitions by foreign firms that lack transparency in land transfers and the absence of consultation with local stakeholders. In addition, land transfers involve the displacement of local small holders and the loss of grazing land for nomadic pastoralists that later lead to food insecurity in local population due to the export of crops produce by foreign firms. Moreover, there are concerns on the highly mechanised production methods from foreign firms, that limited job creation and increase the rate unemployment of local population (Hallam, 2011). Despite, the negative effects stresses in the preview paragraph, FDI in agricultural sector have positive effects on food security. For instance, subsidising high-productivity agriculture increases the quantity of food available. In this line, Frimpong and Oteng (2008) have noted the diverse importance of FDI for host countries including: the influx of foreign capital increases the supply of funds for investments, thereby promoting capital formation, and the direct contribution to the food security of local population. Multinational firms have also helped to set up restaurants and large supermarket where consumers can find wide variety of foodstuff at competitive prices. As a result, the population is food-secure. In this same vein, Aloui and Maktouf (2024) found out in the studying the impact of FDI and political stability of food security in SSA found out that FDI positively impact food security in the region.

Review of synthetic literature on the link between private investment and food security

Skoet, Kostas and Deuss (2004), argued that growth, poverty reduction and food security, particularly in the poorest countries, depend on investment and rural economic activities. The low level of investment in agricultural sector in major developing countries is reflected in low productivity and stagnant production. Despite the priority given to agriculture, many developed countries are facing limited financial capacities to invest in agriculture in developing countries. While, developing countries have limited access to bank loans from commercial bank and microfinance, meanwhile these countries turn to FDI. FDI in agricultural sector is an historical phenomenon since colonial period where large firms were established to import technical equipment and export raw materials and crops product to support European industries. Thus, private investment has important effect on food security, including the exploiting of fertile and irrigable land took from local

population. In the same line, Corporations (2009) stresses that the technological contributions of multinational firms have been limited due to difficult transfer and diffusion of technologies to small farmers. In fact, the advantages of technologies and productions from FDI is near zero, if the crops produce are entirely export to investor countries. In addition, multinational firms paid very low wages to local population unenabled them to meet their food requirements and encouraged the move of rural population to the cities, thereby the reduction of agricultural workforce and the increase in food prices in the cities (Reardon et al., 2003). A model will be an important tool for analysing the impact of national investment on food security in Cameroon.

Empirical review of models on the effects of investment on food security

Major analysis of the effect of investment on food security use different models. For instance, Zidouemba and Gerard (2015) in their paper entitle: 'investment and food security in Burkina Faso' used Computable General Equilibrium (CGE) model to analyse the effect of public investment in agriculture in Burkina Faso. While, Ibrahima Thiam and Malick (2020) in their paper entitle 'empirical links between agricultural financing and food security in Senegal' used multiple regression model inspired by Kpodar (2006) for analysis. While Aloui and Maktouf (2024) used General Moment Method to the impact of FDI and political stability of food security in SSA. Among various models, this study uses multiple linear regression model and the error correction model for analysis. Expliquez pourquoi?

The above literature stresses the effect of both public and private investment on food security. All authors agreed on the fact that public and private investments have a certain effect on food security, however the effect can be negative or positive. Some studies highlight the factors that cause food insecurity, some factors are identify on individual (social) level while other are on national and/or regional level (political, economic, cultural). Literature also, stress variables that affect food security, including: climate change, natural resources, land, financing, education, health, political conflicts, government policies, physical infrastructures, ect. In addition, major studies on food security are done on regional level or in cross countries studies, few studies are done on a single country due to a difficulty to constitute a strong database over a long period of time. However, this study overcome this challenge by focusing on Cameroon context and shed light on how both public and private investments and various variables could significantly affect food security in the country.

Methodology

Multiple regression model

Based on the assumption that financing of agricultural sector contributes significantly to food security. Ibrahim, Thiam, and Malick (2020), used the multiple regression model to analyse the linkages between agricultural financing and agricultural production in Senegal. These authors model is based on the models of Kpodar (2006) and Jeanneney and Kpodar (2011). Both models present the impact of financial development on poverty.

The theoretical model can write as follow:

$$log(PSA_t) = a_0 + a_1 \log(FIA_t) + a_2 \log(VAA_t) + AX \quad (1)$$

Where, *PSA* is the prevalence of undernutrition, *FIA* is agricultural financing consisting of bank credit, *VAA* is agricultural value added and *X* is a set of control variable (with elasticity A), food availability in kilocalories

(*DISK*), gross national income per capita (*RNB_H*) and outstanding loans from microfinance institutions (*C_IMF*), t is the period index.
The theoretical model can be rewrite as follow:

$$\log(PSA_t) = a_1 \log(FIA_t) + a_2 \log(\mathrm{VA}A_t) + a_3 \log(VANA_t) + a_4 \log(POP_t) + a_5(DISK)_t + a_6 \log(RNB\_H_t) + a_7 \log(C\_IMF_t) + C + E_t. \quad (2)$$

The prevalence of undernutrition (PSA) represents the level of food security in a country that is capable of capturing the population with insufficient access to adequate, regular and nutritional food for an active and healthy life. *Agricultural financing (FIA)*: is made up of short-term financing (FCT_t),medium-term financing(FMT_t), and long-term financing(FLT_t), so, $FIA_t = FCT_t + FMT_t + FLT_t$.*Agricultural Value Added (VAA)* is an indicator that informs the agricultural entrepreneur about his ability to pay labour and capital factors. *Non-agricultural value added (VANA*), it is part of the agricultural value chain. *Food availability in Kilo calorie (DISK):* is the daily per capita food energy availability that corresponds to the available food for consumption during the reference period. Gross National *Income per capita (RNB_H)* is the sum of value added produced by all residents plus all tax revenues. *Population (POP)* is the number of people or inhabitants to be fed during a given period. The outstanding credit of MFIs (C_IMF) is an indicator to measure the financing of MFIs intended for the client.

Error Correction model

The model specification is based on the approach used by Nupuko (2007), adapted from the models of Ojo and Oshikoya (1995), Ghura and Hadjimicheal (1996) and Tenou (1999) on real GDP growth in African countries. The model considers the two channels of public expenditures' effects on the growth of agricultural sector. The formulation links production and factors that may influence growth of agricultural sector. These are direct and indirect factors. The direct factors are labour, private capital, land and agricultural public expenditures. Indirect factors are general public goods such as electricity and education.
The general specification of model can be written as follow:

$$Prod = f(DPA, Lab, Land, Priv, Elec, Edu) \quad (3)$$

Where, Prod is agricultural production, DPA: Public Expenditure on Agriculture, Lab: Labour, Land: Land, Priv: Private capital, Elec: Electricity, Educ: Education.

The equation can be written as follow:

$$\triangle InProd = a_1 \triangle DPA + a_2 Lab + a_3 \triangle InLand + a_4 \triangle InPriv + a_5 \triangle InEdu + a_6 \triangle InElec + a_7 \triangle InProd + a_8 \triangle DPA_{-1} + a_9 Lab_{-1} + a_{10} \triangle InLand_{-1} + a_{11} \triangle InPriv_{-1} + a_{12} InEduc + a_{13} InElec_{-1} \quad (4)$$

In this expression, $\triangle$ is the derivative factor with respect to time. The coefficients $a_i$are the elasticities.
The coefficients a_1 *to* a_6 characterize short-term dynamic while the coefficients a_8 to a_{13} allow the long-term equilibrium behaviour of the growth rate of agricultural production to be derived and the coefficient a_7 is the error correction coefficient.

Model specification

The model of this study is based on the models of Kpodar (2006) and Jeanneney and Kpodar (2008). The originality of these models is a relationship between Cobb-Douglas function and agricultural production and its explanatory factors. In fact, this type of function was used by Barro and Salai-Martin (2004) and Guillaumont (2004). Mundlak et al., (2002) also used this type of function for a determinant analysis of agricultural growth in Indonesia, the Philippines and Thailand.
The model of equation is in the following form:

$PIB_t = f(X_{1t}, X_{2t}, X_{3t}, \ldots . X_{nt})$. (5)

The equation can be rewrite as follow:

$$PIB_t = X_{1t}, X_{2t}, X_{3t}, \ldots X_{nt}. \quad (6)$$

PIB_t is the agricultural domestic product, is a function of agricultural production.
X_{nt} represent the variables explaining the rate of food insecurity at a given time t.
The equation in logarithmic form is as follows:

$Log(PIB_t) = a_0 + a_1 logX_{1t} + a_2 logX_{2t} + \cdots\ a_n X_{nt} + E_t$. (7)

In the context of the effect of national investment on food security in Cameroon, several variables explain food insecurity measured by agricultural gross domestic product. The main variables explaining agricultural production are (i) public and private investments. The variables of the model are: public investment (Ipa_t), private investment measured by foreign direct investment *(Ide)*, electricity *(Elec)*, rural population (Pop_t) ,gross domestic product (Pib_t), inflation (Inf_t), agricultural land (Ter).
The model for the analysis is as follows:

$Log(TIA) = a_0 + a_1 \log(Ipa_t) + a_2 \log(Ide_t) + a_3 logEle_t + a_4 \log Pop_t + a_5 logPib_t + a_6 logInf_t + a_7 logTer_t + E_t$ (8)

where a_0 is a model constant $\boldsymbol{E_t}$ is the error term, a_i represent the coefficients of the variables of the model.

Description of variables of the model

Seven variables were selected to explain the rate of food insecurity in Cameroon.

Dependent or explained variables

The rate of food insecurity at a time t (TIA_t): it represents a situation where all people have sustainable physical, social and economics access to sufficient and nutritional food that meets their need and dietary preference. In this study, the value added of agricultural production proxy by gross domestic product it used as dependent variable.

Independent or explanatory variables

Public investment expenditure (Ipa_t) expenditure by the state to promote a country's socio-economic development. Public investment in agriculture is used to acquire durable goods and services for uses as means of production. Public investment is gross fixed capital formation (GFCF) by general government. The choice of this variable is justified by its effectiveness in increasing agricultural production. Figure 1 represent public investment in agricultural sector in Cameroon.

Figure 1: public investment in agricultural sector in Cameroon

Source: authors' own elaboration from Stata 14.0

Public investment in agricultural sector in Cameroon is periodic and not stationary. There is a succession of growth and decline over time. From 1988 to 1992, public investment fell to the lowest level. From 1992, public investment will grow and vary moderately until the 2020s.

Private investment measured by foreign direct investment *(Ide),*

These are net investment inflows to acquire a lasting stake in a sector operating in an economy other than that of the investor. The choice of this variable is justified by the fact that FDI uses much of the agricultural land in developing countries for its activities.

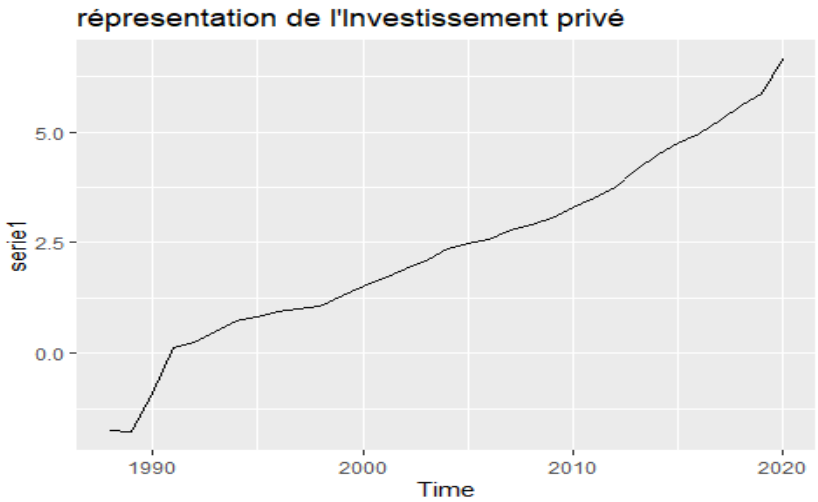

Figure 2: private investment in agricultural sector

Source: authors' own elaboration from Stata 14.0

FDI has increase year to year from 1990 up to 2020 period.

Electricity *(Elec),* is considered to be public infrastructure that helps to open up rural areas and improve conditions for farming. Electricity encourages the development and the establishment of agri-food industries in rural areas. The figure 3 represents the rural population has access to electricity service.

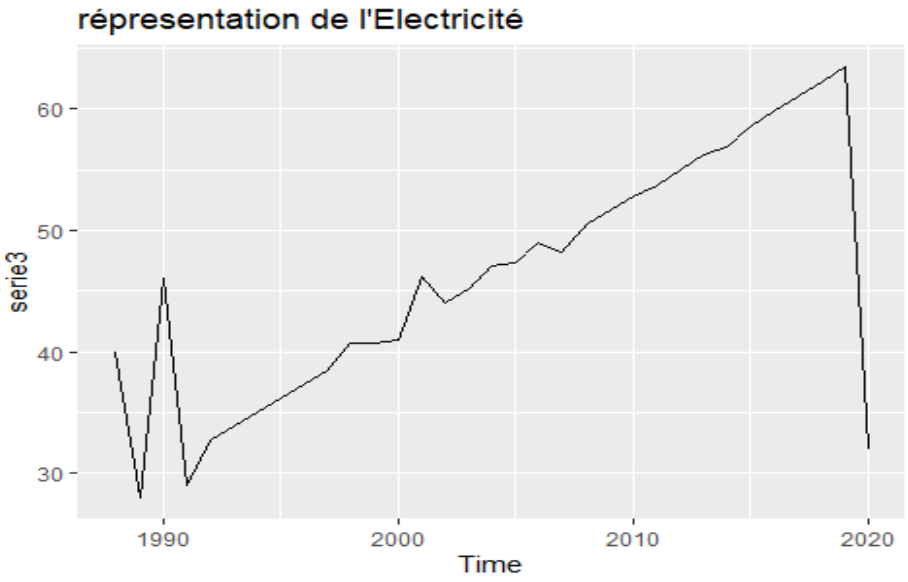

Figure 3: Electricity distribution
Source: Authors' own elaboration from Stata 14.0

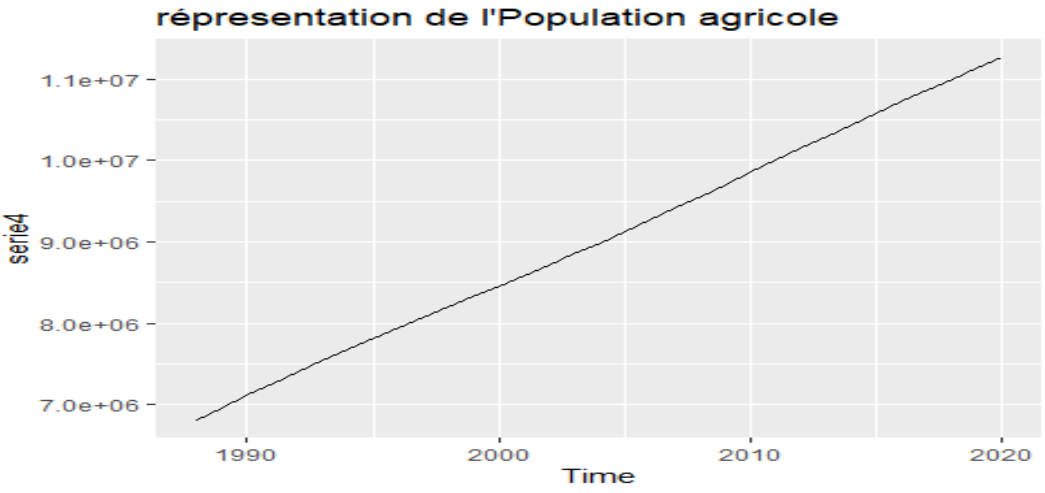

Figure 4: agricultural population in Cameroon
Source: Authors' own elaboration from Stata 14.0
The curve representing agricultural population is increasing and linear over the period from 1990 to 2020. This growth in the agricultural population may be due to an increase in the birth rate in rural areas.

This curve representing access to electricity in Cameroon, from 1988 to 1991, the series is periodic and from 1991 public investment in electricity increases more and more. show us that Cameroon is multiplying its efforts to offer a significant quantity of electricity to its population. From 2019 the curve declines sharply indicating a

drop in public investment in the electricity sector in Cameroon. Rural population (Pop_t) represents all the people living in rural areas who are part of farming households. It refers to people living in rural areas as defined by the national statistics institution. The interest of choosing this variable is to see the impact of the increase in the rural population on the rate of food security. The evolution of agricultural population in Cameroon is represents in figure 4.

Agricultural Gross Domestic Product (Pib_t) is an indicator that quantifies the total value of annual wealth production by economic agents in a given territory, while the agricultural gross domestic product represents the aggregate of production value, it is annual wealth created by the agricultural sector in a given country. Figure 5 present the evolution of the agricultural gross domestic product in Cameroon.

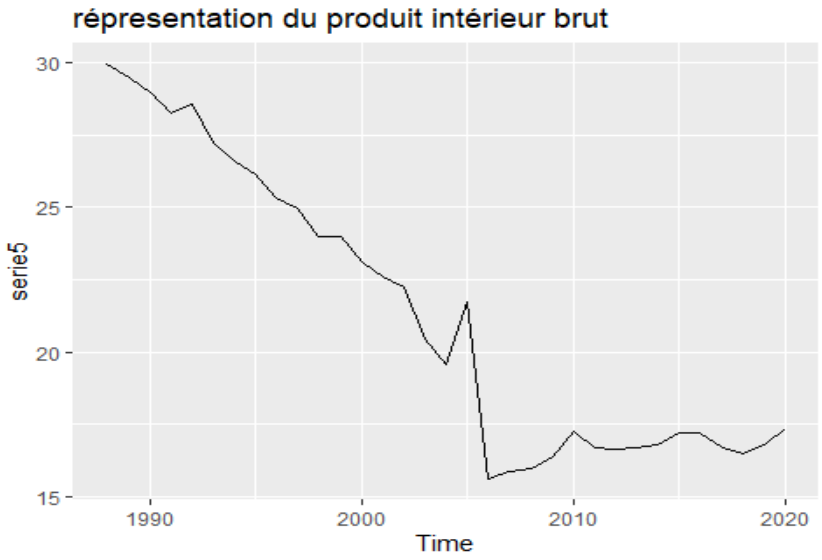

Figure 5: agricultural population in Cameroon
Source: Authors' own elaboration from Stata 14.0

The curve of agricultural gross domestic product in Cameroon decreasing over the period from 1988 to 2020. This decline can be explained from the decrease in marginal labour productivity of the agricultural sector. It may be also to the decline in public investment, draining of natural resources and the infertility of agricultural land.

Inflation (Inf_t): is a loss of purchasing power of money, resulting in a general and sustained increase in the prices of goods and services. Inflation as measured from the consumer price index reflects changes in the cost of a basket of goods and services purchased by the average consumer. The inflation was chosen as variable because the rise in prices influences consumption power. Figure 6 presents the variation in the prices of consumer goods in Cameroon.

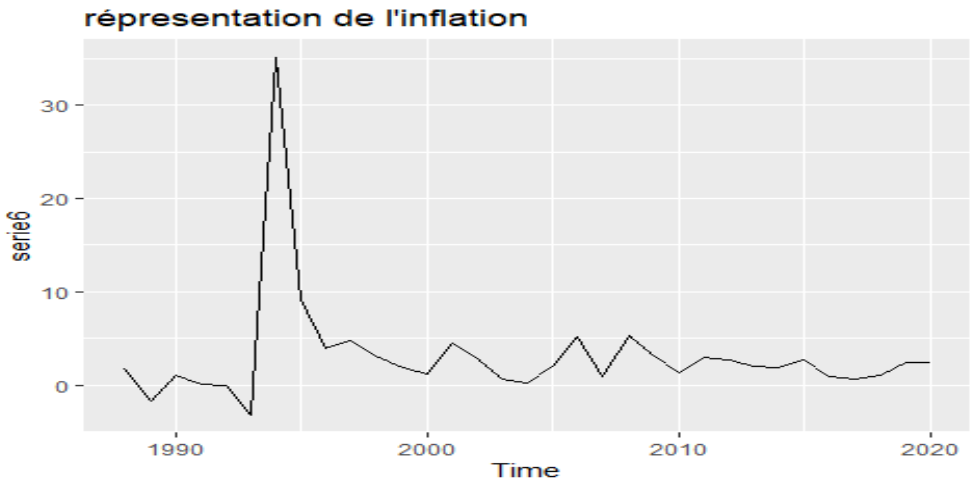

Figure 6: Inflation in Cameroon
Source: Authors' own elaboration from Stata 14.0

Figure 6 shows that inflation is not stable. A consumer prices evolves from a minimum and negative value to reach a maximum value in 1992. From 1992, the curve decreases and the stabilise between 0 and 5 until 2020.

Agricultural land (Ter), is a part of land that is arable and permanently cultivated or grazed. Arable land includes land defines by the FAO as land for temporary crops, temporary land for reaping or grazing, land where vegetable gardens are grown and temporary land set aside. Figure 7 presents agricultural land in hectares in Cameroon.

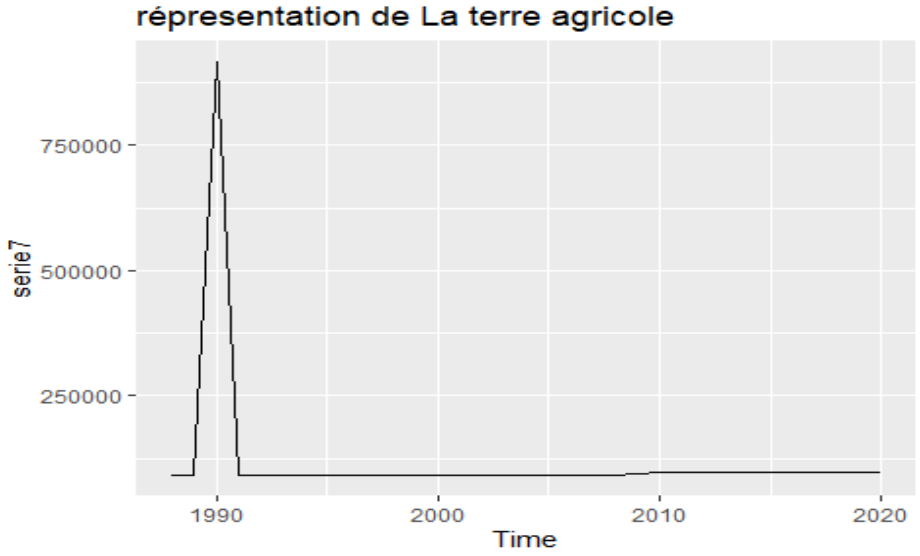

Figure 7: Agricultural Land in Cameroon
Source: Authors' own elaboration from Stata 14.0

Figure 7 highlights that, the surface of agricultural land in Cameroon has remained stable over time, though there was an exponential increase over a short period of one year before falling to in a minimum value by 2020.

Results and discussions

Descriptive statistics test

Table 1. Descriptive statistics of the variables

Variables	Obs.	Average	Standard Deviation	Min.	Max
Agricultural gross domestic product	33	5,806245	1319075	5,525321	6,215273
Inflation	30	16,76927	1.180574	12,98454	19,41165
Agricultural land	27	11,1802	1.336653	7,972011	12,82858
Direct agricultural investment	29	15,91068	1.43013	12,38236	17,75597
Agricultural population	33	18,96968	42943	18,45742	21,07685
Public investment	29	6,729237	2814199	6,143799	7,102718
Electricity	27	3,632012	1.479305	1,479305	5,189085

Source: Authors' own elaboration from Stata 14.0

Overall comments that can be made from table 1 is that variables relating to gross domestic product (131907), public investment (2814199) and agricultural population (42943) have the largest standard deviations, this means a great variability or volatility of these variables. Conversely, variables such as agricultural land (1, 3366) and access to electricity (1.4793) have a higher standard deviation, that means they are less variable or volatile.

Stationarity test for variables

A time series is said to be stationary weak, if its statistical properties do not vary over time (expectations and variances). In this study, to test the stationarity of variables, the augmented Dickey Fuller test was used. This test allows to highlight the stationary or non-stationary character of a time series by determining a deterministic or stochastic trend (Bourbonnais,2006). The Dickey-fuller test allows to test the stationarity of a series with for hypothesis zero (the series is not stationary) against and alternative hypothesis (the series is stationary) at the error threshold of 5%. The decision rule (accept or reject null hypothesis) consists of comparing the absolute value of the Augmented Dickey-Fuller statistic (ADF) with the absolute value of Mc Kinnon's (1973) critical value (CV) read.

Table 2. Results of stationary test on the variables

Variables	Dickey-Fuller statistical values	P-values at 5% critical threshold	Integration order
Public investment	-6,303	-2,994	I (1)
Foreign Direct Investment	-7,268	-3	I (1)
Electricity	-7,053	-3,00	I (1)
Agricultural population	-10,727	-2,980	I (0)
Inflation	-8,100	-2,983	I (1)
Agricultural gross domestic product	-3,998	-2,980	I (0)
Agricultural land	-6,900	-3,00	I (1)

Source: Authors' own elaboration from Stata 14.0

Table 2 presents the results of the stationarity tests for the variables of the model. It can be noticed that variables in the econometric model are not stationary at any level. These values are augmented Dickey-Fuller statistical values where I (0) represents the order of integration of the level test and I (1) the order of integration of the first difference test. Thus, the variables, agricultural gross domestic product and agricultural population are integrated at level and are therefore stationary that means that the means, variances and covariances do not depend on time. The other variables: agricultural land, inflation, foreign direct investment, public investment and electricity are stationary in first difference. The variables have different integration orders, meanwhile they are integrated at different levels so the co-integration test will be performed to see the co-integration between these variables.

Johannsen co-integration test between variables

The co-integration test is to examine how two or more non-stationary time series can be tested, to verify whether the combined value of these series is stationary. Table 3 presents the results of Johannsen co-integration test. Results from table 3 shows that the trace statistical values are greater that the critical values at the 5% threshold. Therefore, the null hypothesis of co-integration between variables is accepted.

Correlation test on series

In the analysis of our series, it is necessary to see the correlation that exists between the variables of the model. Table 4 presents the correlation test result.

Model validation tests

Jarque-Bera test is used to check the normality of statistical distribution. Normality exists when the Jarque-statistical value is less than 5.99 or when its probability is greater than the 5% threshold. Table 5 present the results of Jarque-Bera test.
The Jarque-Bera test of normality gives a probability of 0.00 less than 5%, it can be concluded that values are not well distributed or do not follow the normal law (normal distribution).

Breush-Godfrey test, allows to check whether the errors are auto-correlated or not. There is autocorrelation if statistical value calculated in absolute value is less than the unit. Table 6 present the result of Breush-Godfrey test.

Table 3. Results of Johannsen co-integration test.

Rank	Trace statistics	P-value at 5%
0	33,824	0, 1
1	6,618	0,634

Source: Authors' own elaboration from Stata 14.0

Table 4. the correlation test result

	Inflation	Agricultural land	Foreign direct investment	Agricultural population	Agricultural gross domestic product	Public investment	Electricity
Inflation	1.0000						
Agricultural land	-0.4978	1.0000					
Foreign direct investment	-0.5082	0.9983	1.0000				
Agricultural population	-0.4217	0.5421	0.5887	1.0000			
Agricultural gross domestic product	-0.0390	-0.0005	-0.0218	-0.1266	1.0000		
Public investment	-0.4337	0.5468	0.5937	0.9974	-0.1627	1.0000	
Electricity	-0.5152	0.9953	0.9992	0.6182	-0.0330	0.6237	1.0000

Source: Authors' own elaboration from Stata 14.0

The results from table 4 shows that the dependent variable (agricultural gross domestic product) is not correlated with its explanatory variables.

Table 5. Result of normality test of Jarque-Bera

Equations	Df	Statistical values	Prob
agricultural gross domestic product	2	68,265	0000
Set	2	68,265	0000

Source: Authors' own elaboration from Stata 14.0

Table 6. Breush-Godfrey test

Observation	Statistical value	Probability
1	2,444	0,1323

Source: Authors' own elaboration from Stata 14.0

The result of the Breush-Godfrey test gives us a statistical value in absolute terms that is greater than unity, so we can conclude that the errors are not correlated.

Ramses test, allows to see whether the model suffers from the omission of one or more relevant variables. The test consists of testing the null hypothesis that the model is well specified (probability greater than 5%) against the alternative hypothesis that the model is not well specified (probability less than 5%). Table 7 present the result of Ramses test.

Table 7. Result of Ramses test

Missing observation	Chi-2	Df	Prob > Chi-2
1	6,1	1	0,004

Source: Authors' own elaboration from Stata 14.0

Table 7 present the probability of 0.04 which is less than the value of 0.05, this means the linear model is not correctly specified.

Cusum and Cusum squares stability test, this test enables to check the stability of the estimated model. There is stability if the curves do not leave the corridor. Figure 8 present the result of Cusum test.

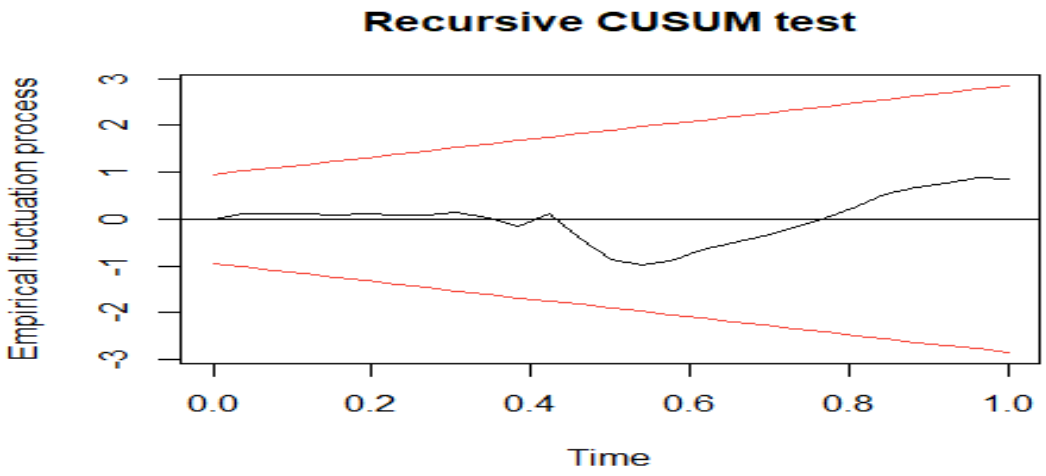

Figure 8: Cusum test
Source: Authors' own elaboration from Stata 14.0

Figure 8 shows that the curve associated with this test does not cut through the corridor (in red). The conclusion is that the model is therefore stable at 5% threshold.

Final results, interpretations and discussions

Public investment and food security

The summary of the results of the estimate model is gives in table 8.
The overall comments that can be made from table 8 are as follows: the estimate model gives a probability associated with Fisher statistic of 0.0077. As this gives a lower probability than the 5% significance level, we can conclude that the model is globally significant. A coefficient of determination of the model is equal to 0.39 (R^2 = 0.39) this shows that 39% of the variability of gross domestic product is explained by agricultural population and public investment. The results of individual significance tests by the probabilities associated with the Student statistic show that the variable public investment and the agricultural population are significant at 10% significance level.

Table 8. Results of the estimated model 1

Variables	Coefficient	Standard Deviation	Statistical values	P- value
Agricultural population	1,187814	682194	1,74	0,095
Public investment	-0,9226278	4636124	-1,99	0,059
Inflation	0,059	0111875	-1,17	-1,17
Constant	-10.26126	9.902853	-1,04	0,311
Probabilité > F	*R-carré*		*R-carré ajusté*	
0.0077	*0.3977*		*0.3192*	

Source: Authors' own elaboration from Stata 14.0

Public investment (IPA): appears with a negative sign, this means it is negatively correlated with the agricultural gross domestic product. It is also significant at 10% level, meaning that an increase of one unit in public investment results in a 0.9226 reduction in the value of agricultural domestic product. The reduction in agricultural value added (in gross domestic product), following an increase in public investment can be explained by the fact that not all investment is favourable for the development of the agricultural sector. Increase in public spending on long-term investments such as economic and social infrastructure do not have a direct impact on agricultural production. The increase in government spending may be due to tax increases that have negative effects on farmers' incomes. These results are different from the results of Biligil (2017) when studying public spending and agricultural growth in Cameroon, find out that an increase in public spending in the agricultural sector is followed by an increase in agricultural production.Rural population (Pop): the coefficient associated with the agricultural population variable has a positive sign. This variable is significant at 10% level. However, an increase of one unit in the rural agricultural population will lead to an increase of 1.187 in agricultural gross domestic product. An increase in the highly active population is a labour force. The quality of care and training of farmers determines the level of agricultural production. The more educated and healthier the agricultural population, the more productive it will be and consequently an increase in agricultural value added (Mengoub,2018).Inflation on consumption goods, the coefficient associated with inflation variable is positive but not significant in the model.

Foreign Direct Investment and food security

The summary of the results of the estimation 2 is gives in table 9

Table 9. Results of the estimation 2

Variables	Coefficient	Standard Deviation	Statistical values	P- value
Agricultural Land	-0,209	0,400	-0,23	0,000
Foreign direct investment	0,202	0,348	5,82	0,000
Inflation	-0,003	0,24	0,24	0,815
Constant	4,847	357	13,55	0,000
Probability > F	R^2		$R^{2\ adjusted}$	
0,0001	*0,650*		*0,6000*	

Source: Authors' own elaboration from Stata 14.0

The results of estimation 2 from table 9 show that a probability associated with the Fisher statistic is 0.0001, this probability is below the 1% significance level, therefore the model is globally significant. The variables foreign direct investment, agricultural land and inflation are globally significant at 1% significance level. In this model the coefficient of determination R^2 shows 64% of the variability of gross domestic product is explained by foreign direct investment and agricultural land.

Agricultural land: the coefficient associated with the agricultural land variable has a negative sign, but significant at 1% significance level. Therefore, an increase of one unit of agricultural land will lead to a decrease of 0.20 in agricultural value added (agricultural domestic product). This reduction in added value may be due to poor use of the land by farmers. Many factors can explain this situation: the renting of arable and irrigable by industrial firms, the lack of financial means to practice extensive agriculture on a large area of agricultural land, the scarcity of arable land (farmers are not able to access arable land) therefore reduce agricultural value (Corporations, 2009).

Foreign Direct Investment (FDI): is positively correlated with agricultural gross domestic product at the 1% significance level. The entry of one unit of FDI in Cameroon will increase gross domestic product by 0.20. this result is in line with Ibrahim, Thiam, and Malick (2020), who found out that FDI positively impact agricultural sector. The increase in agricultural value added is the outcome of the benefits of FDI inflows into agricultural sector through various channels including: technology transfer mainly new techniques in agricultural practices that enable local population to practice extensive and highly profitable agriculture, building infrastructure that directly or indirectly supports the development of agricultural activities and financing (Zidouemba and Gerard, 2015). In fact, foreign investors are intervening in agricultural sector in Cameroon through the financing of different agricultural projects from various ministries.

Inflation: this variable is negatively correlated with agricultural value added but is not significant in the model.

Conclusion

This paper aims to access the effects of both public and private investment on food security in Cameroon. Literature review highlights that food security for the population is an objective pursued by several institutions and government. The study used multiple regression model and error correction model to stress the relationship between both public and private investment on food security. The different estimations show the significant effect of both investment on food security. Public investment appears to have a negative effect on food security while private investment proxy by Foreign Direct Investment (FDI) have a positive effect on food security. The argument for these controversial results, is that an increase in government spending may be due to tax increases that have negative effects on farmers' incomes and the fact that not all government investment is favourable to agricultural sector. The positive effect of Foreign Direct Investment is mainly explained by the involvement of foreign investors mainly Non-Governmental Organisations (NGOs) in the financing of various agricultural project from different ministries in Cameroon. Thus, to ensure food security in Cameroon, particular attention needs to be paid to rural areas, where the majority of poor live. The government therefore can invest in the construction of social and economic infrastructures mainly road and communications infrastructures in order to enable farmers to obtain accurate information on supply and demand and easily access to local and national markets in order to deliver their agricultural products. Government of Cameroon can ensure vocational training

of Cameroonian youth that represent the major of active population through the creation of training schools for agricultural practices and natural resources transformation that are important factors for food security of the Cameroonian population. Finally, Cameroonian government can ensure that policies, laws and regulations that govern agricultural investment mainly land management are basic conditions for modern agriculture and ensure social peace.

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