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# IMPACT OF PUBLIC INVESTMENTS ON AGRICULTURAL GROWTH: THE ARDL MODEL APPROACH IN CAMEROON

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***Abstract***

*This paper analyses the impact of public investments on agricultural growth in Cameroon. The main objective is to examine the contribution of public investments on agricultural growth in Cameroon. The methodology used to achieve this objective is the ARDL model of Pesaran (2001). The data used are from the World Bank's World Development Indicators (WDI) and the United Nations Agriculture Fund's FAOSTAT from 1988 to 2018. Our results show that public investments are significant and positive in the long run on agricultural growth.*

***Keywords:*** *public investment, agricultural growth, ARDL, Cameroon.*

## Introduction

The agricultural sector has long been the poor relation of the economies of African countries in general, and particularly those of sub-Saharan Africa. Due to the numerous constraints, in this case the crises affecting the agricultural market, agriculture has resurfaced in global debates and is now at the forefront of the international scene. Heads of state, international organisations and civil society, prompted by the effects of climate change on agricultural production and the food crises of the last few decades, are now questioning the problems of agricultural production and productivity around the world.

The importance of agriculture in countries south of the Sahara is well known. Indeed, the agricultural sector employs more than half of the total working population (IMF, 2012) and provides livelihoods for small-scale farms representing nearly 80% of the total production units (Alliance for a Green Revolution in Africa, 2014). In addition, it generates about 30% of the Gross Domestic Product (GDP), and represents one of the main sources of foreign exchange, i.e. a rate of 40% in total (World Bank; 2008). An efficient and well-organised agriculture allows for diversification and an increase in agricultural production while ensuring an accumulation of capital capable of transferring to other sectors. The aim is to guarantee an adequate standard of living through the stabilisation of prices for basic agricultural products. Following this accumulation of wealth, the investment of the agricultural surplus in other sectors ultimately leads to an increase in demand, job creation and ultimately to an increase in income. Investing in agriculture is therefore a necessary condition for the development of countries.


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Such economic dominance of agriculture demonstrates the importance of agricultural development for economic growth and poverty reduction in developing countries. Moreover, although it is recognised that agricultural development becomes less important with economic development, it nevertheless provides an essential basis for economic growth in both the agricultural and non-agricultural sectors.

African agricultural production has increased quite significantly over the last two decades, eventually leading to an increase of three times the previous production. However, notwithstanding this increase, Africans continue to import agricultural products to meet the food needs of their population. There is even a deficit in the balance of trade. African countries are therefore moving from a surplus to a deficit situation. Faced with this situation, the increase in food prices, combined with the impact of climate change on agricultural production, African countries are no longer able to meet the food needs of their populations: they must develop an inclusive agriculture that will enable the populations to fight against poverty and ensure food security. This is possible through investment in the sector.

Investment in agriculture has always been an important instrument for economic growth and the fight against hunger. From ancient civilisations to the contemporary world, the thorny issue of agricultural growth to solve hunger has been a challenge for decades. In a world of wealth accumulation, technological advances and over-consumption, nearly 900 million people go to bed hungry every night, with 70% of them in the South. The international community and the States that once neglected agriculture for decades, both in official development assistance and in the budgets of the States concerned, are now vying with each other in announcing investments in this sector.

However, despite the emphasis placed on agricultural investment in recent years, public investment is declining in the countries of the South, and this has been pointed out by many actors. Thus, the share of spending on agriculture in the national budget of States fell between 1980 and 2000, except in Europe and Central Asia. It fell from an average of just under 7% in 1980 to 4% in 2007, as states focused on increasing public spending in sectors such as mining and energy (World Bank, 2008).

According to the financial resource flows to agriculture (2011), the situation is alarming for sub-Saharan African countries. Over the past decade, the share of agriculture in the national budget of these countries varies between 3 and 6%.

In a context of poverty and growing hunger, African countries recognised in 2003 in Mozambique the importance of agriculture through the Comprehensive Africa Agriculture Development Programme (CAADP). The Central African country of Cameroon is not to be outdone and is setting up a National Agricultural Investment Programme (NAIP), which aims to generate sustainable growth in the agricultural sector. In particular, it aims to ensure food sovereignty, food and nutritional security for the country's populations through modernisation and a balanced production system. Given Cameroon's agricultural potential, with a primary sector contributing to nearly 45% of GDP, a population growth rate of nearly 3%, 39.9% of the poor, 55% of whom live in rural areas, and with a worrying nutritional and food situation, public decision-makers are obliged to address this issue (SRHR, 2016).

Previous studies on this topic have focused on examining overall public spending on agricultural growth. As an improvement on previous studies, this paper assesses the impact of public investment on agricultural growth while incorporating potential variables that could explain this relationship, such as hectares per worker, farm population, CO2 emissions, life expectancy and education. In addition, studies on this topic have had other methodological approaches. Our study uses the pesaran cointegration test approach.

The development of this problem will be done in three parts, the first one will be devoted to the review of the literature. The second will be reserved for the presentation of the methodological approach. The third part will illustrate the results of the research.

## 1. Review of the literature

Empirical studies on the relationship between public investment and agricultural growth show firstly a causal relationship and secondly mixed results.

Inadequate infrastructure is one of the key bottlenecks to the successful use of agricultural research and technology, because it limits farmers' choices in terms of production choices and levels of agricultural output. If the infrastructure provides an enabling environment, the economic returns to research and technology are generally high.

Based on data from 44 developing countries in three regions (Africa, Asia and Latin America), Thirtle, Lin, and Piesse (2003) find high returns to agricultural research and technology. They find that Asia (12 countries) has the highest annual return (31%), followed by Africa (22%, 18 countries), and Latin America (6%; 13 countries). Annual rates of return were particularly high (40-50%) in Ethiopia, Morocco, Pakistan, the Philippines and Uganda. On the contrary, they were negative in Lesotho, Senegal, Sri Lanka, and Tanzania.

Fan, Zhang, Zhang (2002) and Fan, Zhang, and Rao (2004), find that public spending on agricultural research and technology has significantly improved agricultural production. They find marginal returns of 9.54 yuan per yuan spent in China (1997) and 12.1 shillings per shilling spent in Uganda (1992-99).

According to Mundlak (2000) cited by Cervantes-Godoy and Dewbre (2010), agricultural progress in modern times has been driven primarily by technical advances. Numerous empirical studies have confirmed that the social returns to public investment in agricultural research, extension and education are high. Indeed, investments in agricultural R&D, extension and education point to a steady increase in agricultural productivity. As a result, partial indicators of productivity such as output per unit area, output per head of livestock or output per agricultural worker are used to compare countries in terms of their agricultural performance at a given point in time.

Several econometric studies assess the effects of infrastructure (or stock) investment on agricultural output and productivity. Most of these studies find a positive and significant effect (Antle 1984; Binswanger, Khandker, and Rosenzweig 1993; Mundlak, Larson, and Butzer 2002; and Fan and Zhang 2004).

Fan and Zhang (2004) using dynamic generalized moments (GMM), investments in roads and irrigation contribute significantly to agricultural growth. Agricultural growth leads to a much larger demand effect for irrigation than for roads. This can be explained by the fact that irrigation is a sector-specific infrastructure and the associated demand is more directly influenced by agricultural growth, whereas the demand for roads depends on different factors (Fan and Zhang 2004). Fan, Hazell and Thorat (2000) found that public investment in rural roads is very positive for agricultural productivity growth in India.

Investment in roads also contributes significantly to agricultural growth as well as to the growth of the non-farm sector and the national economy (Fan, Zhang, and Zhang 2002; Fan and Chan-Kang 2005).

The quality of infrastructure is an important cause of the effects of infrastructure on agricultural growth and poverty reduction (Fan and Chan-Kang 2005). Measured per kilometre of new roads, the authors find that investment in high quality roads in China generates a return in total GDP that is almost 50% higher than investment in poor quality roads. The latter have the highest returns the effects of high quality roads are almost twice as large as those of low quality roads in urban areas. Moreover, if the effects are considered with the ratio of returns to costs (i.e. taking into account the cost of construction), high quality roads have lower returns per yuan than low quality roads in all areas and regions combined. In other words, the economic rate of return per yuan is higher for low quality roads than for high quality roads.

Although several studies have shown the positive and significant impact of public investment in infrastructure on value added and economic growth, there is some work that finds mixed effects and questions Aschauer's results (Aaron, 1990 and Tatom; Sturm and De Haan, 1995). Canning et al (1994), using data on road, rail, electricity and telecommunications infrastructure as public physical infrastructure, assessed their contribution to output growth in 98 countries during the years 1960-1985. The authors conclude that the effect of road and rail infrastructure on growth is mixed.

Egert et al (2009) used an exogenous growth model to assess the effect of public infrastructure (roads, railways, electricity and telecommunications) in 24 OECD countries on economic growth over the period 1960-2005. The authors show that although no effect of public infrastructure on growth was found, only electricity would have a significant effect with a coefficient of 0.17.

Using a VAR model and quarterly data for France, Germany, Italy and Spain over the period 1995 to 2011, Broyer and Gareis (2013) analyse the output elasticity of public infrastructure investment. This study shows that this investment has a greater impact on economic activity during a recession than during a stable macroeconomic situation (the weighted average of the respective elasticity is equal to 0.17).

Bom and Ligthart (2013) in their study on the productivity of public capital, analysed 578 estimates from 68 studies (including 31 on the US and 37 on the OECD) over the period 1983-2008 and concluded that the estimates are biased by specifications and econometric data. They find that there is an estimated short-run return elasticity of 0.083 and a long-run return elasticity of 0.122 when public capital is invested by states domestically.

Uzbay Pirili and Lenger (2012) highlighted the importance of public capital and social capital on regional development in Turkey. They start from the new view of regional development, according to which investments in improving human capital and social infrastructure are as important as investments in physical infrastructure, to show that the former investments are the necessary condition for physical infrastructure investments to be effective and beneficial. Indeed, these authors conclude that over the period 1987-2001, public physical infrastructure and social infrastructure have varying effects on growth in developed and developing provinces, depending on their levels of human development.

The effects of infrastructure investments on agricultural value added are not consensual. This is explained by the emergence of three currents. The first current shows that infrastructure investments contribute to increasing agricultural value added. The underlying explanations are that infrastructure, through the provision of intermediate goods and services, enters into the productive process at national, regional or international level. It therefore improves the use of other factors of production, thereby increasing overall factor productivity and reducing production costs. Indeed, transport infrastructure improves farmers' accessibility to markets, reduces transport costs, and increases the income level of farm households by opening up the agricultural sector. Infrastructure in developing countries (DCs) helps to reduce income inequalities (Calderon and Serven, 2004). Education infrastructure allows farm households to improve their level of education, which is favourable to the use of new agricultural techniques. It also helps to limit rural-urban migration and improve rural welfare and quality of life. Investment in infrastructure is a determining factor in the specialisation of farmers (and potential farmers) in rural areas in that it guarantees their access to basic services (health, education, drinking water, etc.); to modern inputs (machinery, selected seeds, fertilisers, pesticides, etc.); to markets (road infrastructure, telecommunications, etc.); and to training on technical itineraries through the R&D

body. Moreover, the lack of infrastructure, especially transport infrastructure, leads to a decline in trade and consequently to a decline in growth (Edward, 2006).

The second stream shows that infrastructure investments contribute to the deterioration of agricultural value added. The underlying explanations are: a high level of infrastructure (overinvestment in infrastructure) has an exclusive effect on private capital, which consequently leads to a fall in productivity and therefore growth. In other words, public capital crowds out private investment (Ngalebaye and Avouba, 2020) and thus reflects a non-complementarity between public capital and private investment; this confirms the results of the work of Gupta et al. (2002) on this issue in developing countries. Moreover, for most developing countries, public expenditure is financed by borrowing, which limits the impact of public investment on growth, since part of GDP is devoted to debt repayment (Dione, 2016; Bose et al., 2007). Similarly, public expenditure is financed domestically by tax revenues, which are mainly derived from taxes that constitute an obstacle to private investment. Indeed, high public investment implies higher taxes which could discourage private investment. Public capital stimulates economic growth provided that public consumption expenditure is reduced. Mupu (2021) argues that fiscal policy plays an important role in macroeconomic stability.

The third stream shows that there is no effect (Egert et al. (2009). Some authors believe that the effect of infrastructure investment depends on the degree of substitutability or complementarity between public capital and private investment (Gupta et al., 2002).

Moreover, the debate on infrastructure in most developing countries is confronted with a lack of empirical consensus on its economic and fiscal effects.

## 2. Methodology

To verify whether public investment has an impact on agricultural growth in Cameroon, we chose an autoregressive distributed lag model (ARDL) developed by Pesaran et al. (2001), due to its ability to estimate concomitantly the long and short term parameters of the model in order to avoid problems arising from non-stationary time series data. As for any dynamic model, we will use the information criteria (Akaike-AIC, and Shwarz-SIC) to determine the optimal lags (p, q) of the ARDL model.

In our study, we seek to capture the impact of public investment (GFCF: gross fixed capital formation) on agricultural growth (AVA: agricultural value added). To capture the impact of public investment on agricultural growth in Cameroon, we chose annual data of exogenous and endogenous variables covering the period 1988-2018. The choice of this sample is justified by the availability of data collected from the World Bank database. We draw inspiration from the model specified by Brahim and Bachta (2016) that examines public investment and agricultural growth. The model written and developed in the Cameroonian context is written as follows:

$$\mathbf{VAAGRI = c + FBCFA + CO2 + EVIH+EVIF + POPA + SUPT +ESEC +V_t}$$

With,

VAAGRI: Agricultural value added

FBCFA: Gross fixed agricultural capital formation

SUPT: Number of hectares per agricultural worker

POPA: Agricultural population

EVIH: Life expectancy of men

EVIF: Life expectancy of women

ESEC: Secondary education

CO2: CO2 emission

If we want to capture the short term and long term effects of the above explanatory variables on agricultural growth in Cameroon, the ARDL representation of this function will be :


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$$\Delta VAAGRI_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i}\, \Delta FBCFA_{t-1} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta CO2_{t-1} + \sum_{i=1}^{q} \alpha_{3i}\, \Delta EVIH_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, \Delta EVIF_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta POPA_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\, \Delta SUPT_{t-1} + \sum_{i=1}^{q} \alpha_{7i}\, \Delta ESEC_{t-1} + \beta_1 FBCFA_{t-1} + \beta_2 CO2_{t-1} + \beta_3 EVIH_{t-1} + \beta_4 EVIF_{t-1} + \beta_5 POPA_{t-1} + \beta_6 SUPT_{t-1} + \beta_7 ESEC_{t-1} + V_t$$

$\Delta$ : Operateur de difference première

## 3. Results

### 3.1 Stationarity tests

The main results of the ADF and PP unit root tests are carried out using the Eviews 10 software and presented in a table indicating the order of integration of the series as well as the associated p-values.

| | **In level** | | **In first difference** | | **Conclusion on the order of integration** |
|---|---|---|---|---|---|
| | ADF | PP | ADF | PP | |
| FBCFA | -3.8285 (0.0192) | 0.1152 (0.9654) | -5.3179 (0.0001) | -5.4283 (0.0000) | I(1) |
| CO2 | -3.054089 ( 0.0412) | -3.190690 ( 0.0305) | | | I(0) |
| SUP | -0.1095 (0.9443) | -0.3619 (0.9102) | -2.1998 (0.0276) | -5.8068 (0.0000) | I(1) |
| POPA | -4.6468 (0.0002) | -2.8464 (0.0557) | -2.4728 (0.1255) | -11.9234 (0.0001) | I(0) |
| ESEC | | | -4.427977 (0.0018) | -4.548186 (0.0014) | I(1) |
| VAAGRI | -3.2992 (0.0727) | -2.3948 (0.3799) | -5.2252 (0.0002) | -5.6749 (0.0000) | I(1) |
| EVIH | -2.0549 ( 0.04) | -3.2070 ( 0.03) | | | I(0) |
| EVIF | -4.7776 (0.0001) | -2.9764 (0.058) | | | I(0) |

*Source: Author based on Eviews 10*

This table shows that the series are not integrated of the same order. While some of them are stationary at level (I(0)), others are not (i.e. I(1)). The estimation method we consider in this case is the ARDL method.

### 3.2 Cointegration tests

**Table 2: Wald statistics**

| ARDL Model | AIC | SC | Log likelihood | F-test | Wald test |
|---|---|---|---|---|---|
| ARDL(2, 0,0, 0, 0, 0, 0,1) | **-9.334823** | **-9.010147** | **450.7367** | **8.048968** | **0.000000** |

*Source: Author based on Eviews 10*

Since the p-value is less than 5%, it can be concluded that there is a long-run relationship between agricultural value added, agricultural fixed capital formation, CO2, POPA, EVIH, EVIF, ESEC and SUPT.

After having detected the existence of a single long-term relationship between agricultural values added, agricultural fixed capital formation, CO2, POPA, EVIH, EVIF, ESEC and SUPT, the second step of the method consists of searching for the estimated short-term and long-term coefficients of the model for which the long-term equilibrium relationship is validated.

**Presentation of the short and long term equilibria**

**Table 3: Long-term equilibrium**

| **Variables** | **coefficients** | **t-statistic** | **P>[t]** |
|---|---|---|---|
| TERRE | 60.78227 | 2.349088 | 0.0312** |
| POPA | -0.072644 | -0.155195 | 0.8785 |
| FBCFA | 8.177891 | 4.124526 | 0.0007*** |
| EVIH | -1.362081 | -1.951158 | 0.0677* |
| EVIF | 1.059809 | 1.370212 | 0.1884 |
| ESEC | -0.013912 | -0.360702 | 0.7228 |
| CO2 | -2.542500 | -5.971663 | 0.0000*** |
| **R-squared** | 0.954515 | | |
| **F-statistic** | 66.68451 | | |
| **Observations** | 30 | | |

*Source: Author based on Eviews 10.***(**)(*) significance at 1%(5%)(10%)*

**Table 4: Short-term equilibrium**

| **Variables** | **coefficients** | **t-statistic** | **P>[t]** |
|---|---|---|---|
| **D(VAA(-1))** | **0.243944** | **4.942305** | **0.0001***** |
| **D(CO2)** | **-1.054544** | **-6.903857** | **0.0000***** |
| **CointEq(-1)** | **-1.537391** | **-21.65375** | **0.0000** |
| **R-squared** | 0.954515 | | |
| **F-statistic** | 66.68451 | | |
| **Observations** | 30 | | |

*Source: Author from Eviews 10.***(**)(*) significance at 1%(5%)(10%)*


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We find after estimation that:

- The coefficient of the error term cointEq(-1) considered as "the recall force", represents the speed of adjustment of the short term relationship towards the long term equilibrium which is indeed negative and significant at 1%, which thus confirms the existence of the long term relationship.

- At the global level, the model is significant with a high coefficient of determination R2 (0.954515). This coefficient shows that the goodness of fit of the model is quite good.

However, some hypothesis validation tests are necessary to verify not only the correct specification of the models but also the stability of the coefficients. In the first case, these are the error autocorrelation test, the residual normality test, the specification test and the heteroskedasticity test. In the second case, it is the stability test of the CUSUM parameters and the square of the CUSUM.

**Table 5: Summary of Diagnostic Tests**

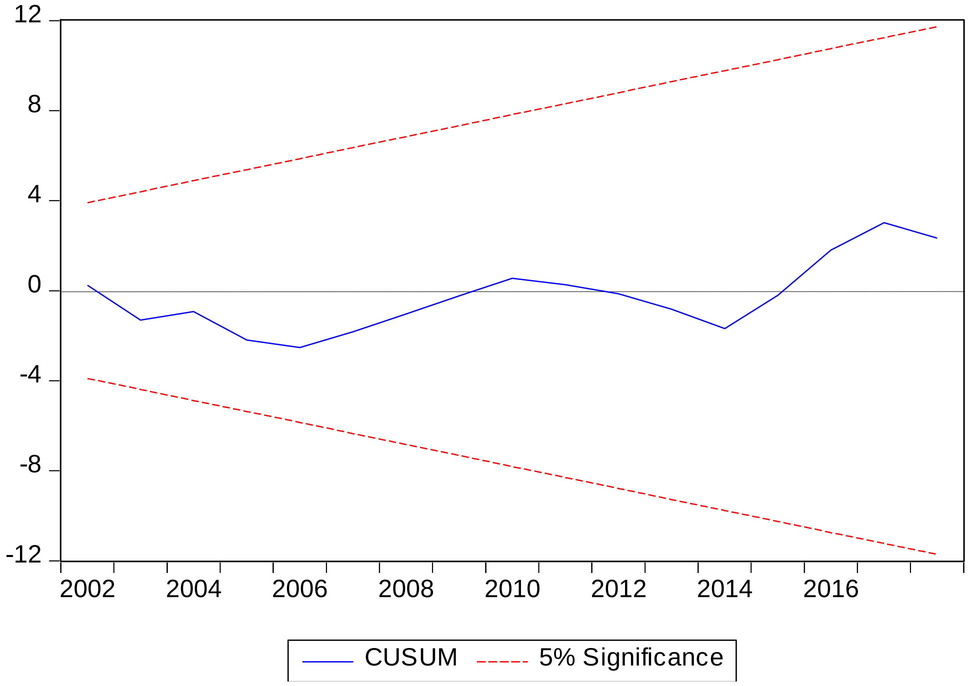
| **Intitulé** | **p-value** |
|---|---|
| **Test de Normalité de Jacque-béra** | 0.625041 |
| **Test d'autocorrélation de Breush Godfrey** | 0.3162 |
| **Test d'hétéroscédasticité de Breusch-Pagan** | 0.4870 |
| **Test de RESET** | 0.0765 |

*Source: Author from Eviews 10*

### Test of stability of the coefficients

In order to carry out our study, it is important to test whether the short term and long term relationships previously found are stable over the entire study period. To do this, we need to test the stability of the model parameters. The method we use here is based on the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) proposed by Brown et al.(1975).

**Figure 1: CUSUM test**




*Source: Author based on Eviews 10.*


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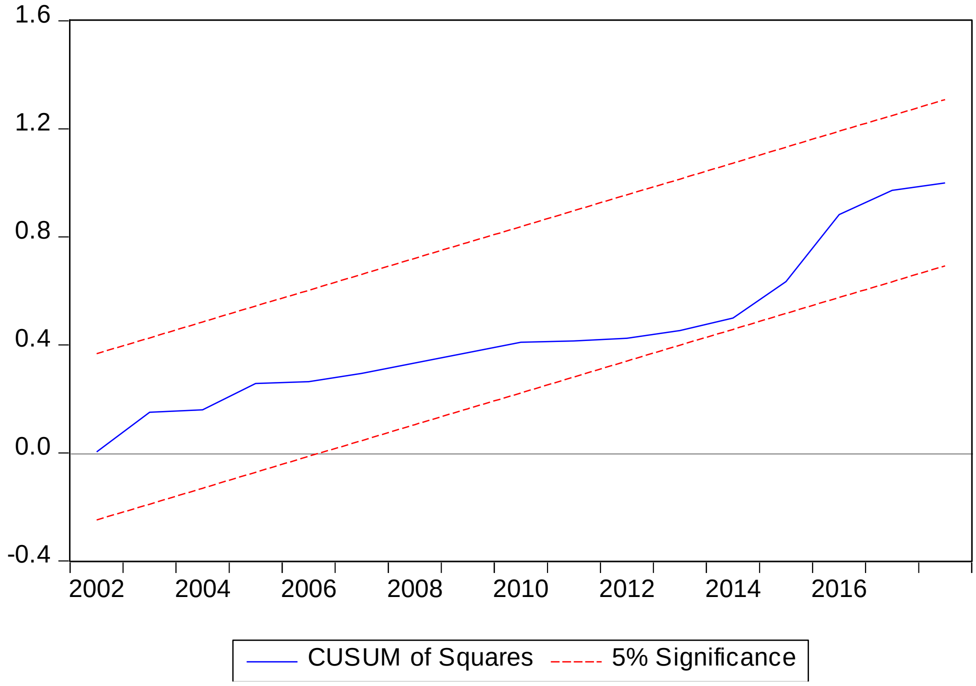
**Figure 2: CUSUM Squares test**




*Source: Author based on Eviews 10.*

After the diagnostic and stability tests have been carried out, we can move on to interpreting the results obtained from the study.

**4. Interpretation of the results**

In the following paragraphs we will interpret the different results we have obtained. We are interested in both the econometric and economic aspects of the analysis of the short-term dynamics and the long-term equilibrium.

The objective of this section is to verify the influence of public expenditure on the increase in agricultural production in Cameroon. Therefore, the validity of the variables is analysed through their statistical significance. In our study, the variables SUPT, FBCFA, EVIH and CO2 are statistically significant.

We interpret the short-term and long-term data in this way:

- SUPT

This variable is positive and significant in the long term. Thus, a 5% increase in area (SUPT) would increase VAAGRI by 60.78%. This result corroborates that of Jacquemot (2017) which shows the importance of land abundance for African agricultural production. Marwa and Mohamed (2016) confirm the result. They demonstrate in an analysis of the effect of public investments on agricultural growth in Tunisia that land capital is positively correlated with agricultural value added. It is out of phase with Bamba and Mouleye (2020) who analyse the effect of education on agricultural growth in the WAEMU zone from 1990 to 2018, and find that one of its control variables, namely land availability, has a negative coefficient and a high significance on agricultural growth.

- FBCFA

In the long run, this variable is positive and significant. Thus, a 1% increase in GFCFA would translate into an 8.17% increase in VAAGRI. This result was highlighted by Bamba and Mouleye (2020). In analysing the effect of education on agricultural growth in the UEMOA zone from 1990 to 2018, they find that public agricultural expenditure has a positive impact on agricultural growth. This result was also highlighted by Sow, Faye and Mendy (2020). These authors showed by studying the effects of rainfall on agricultural sub-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sector GDP in Senegal that agricultural investment has a positive impact on agricultural GDP. Marwa and Mohamed (2016) go further in an analysis of public investment on agricultural growth in Tunisia and also conclude the positive significance of these investments (captured by the "farmers' group effect") on agricultural growth.

- EVIH

This variable is negative and significant in the long run. Therefore, a 10% increase in HALE would decrease VAAGRI by -1.36%. This shows that the life expectancy of men is lower than that of women in Cameroon. In this country, it is 57.66 for men and 60.19 for women in 2018. This means that men will participate less in terms of life time in agriculture than women. This result was implemented by Bamba and Mouleye (2020) in the analysis of the effect of education on agricultural growth in the UEMOA zone from 1990 to 2018, showing that the HIA provides a negative contribution to agricultural growth.

- CO2 emission

This variable is negative and significant in both the long and short term. So, in the long run, any 1% increase in C02 emission would decrease VAAGRI by 2.5%. In the same vein, any 1% increase in CO2 emission in the short term would decrease VAAGRI by 1.054%. This result shows the very strong influence of climate on agriculture. Thus, the uncontrolled growth of greenhouse gas emissions has as a corollary the decrease of yields in the agricultural sector. Thus, in a study of 66 countries between 1971 and 2002, Dasgupta (2013) shows that climate change in general and CO2 emissions in particular have a negative impact on maize and rice production. In the same vein, Lobell et al. (2011) showed that due to climate change, maize and wheat production has decreased. Brown et al. (2010) concluded that the increase in temperature due to CO2 emissions is negatively affecting agricultural growth in 133 countries.

## Conclusion

This study was motivated by the desire to determine the long- and short-term impact of public investment on agricultural growth in Cameroon. To establish this relationship, we applied the ARDL methodology while drawing on the empirical model of Brahim and Bachta (2016) adapted to the Cameroonian context. Among the multiple results, land area is positive and significant, pointing to the presence of abundant land or availability for extensive agriculture in the country. The life expectancy of men is a negative and significant variable highlighting the lower life expectancy of men compared to women and the duration of men's agricultural activity in Cameroon. The emission of CO2, which represents a climatic dysfunction, is a negative and significant variable showing the impact of climate change on agricultural growth. In fine, the analysis of the selected model shows that public investment has a positive and significant impact on agricultural growth in Cameroon.

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