EFFECTS OF FARMER'S MANAGEMENT ON FOOD SECURITY IN CEMAC

By

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DECLARATION

I, DENE DIONADJI ESPOIR, declare that this is my original research work and it has not been submitted in any other university.

DENE DIONADJI ESPOIR

Signature ……

Date …… /……. /……..

APPROVAL

This is to certify that the present research project entitled "**Effects of Farmer's Management on Food Security in CEMAC**" was conducted under my guidance and supervision.

Supervisor Dr. NYABYENDA Radjab

Date: …../ ……/ …..

Signature ……..

DEDICATION

I dedicate this work to my parents and to relatives.

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Achieving a thesis is a long, painful, but always rewarding job. If this research was able to succeed, it is thanks to the support of several people whom I would like to thank.

First of all, I want to give thanks to Almighty God for giving me the strength, the patience and the courage to see this work through to the end;

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DENE DIONADJI ESPOIR

PRELIMINARY

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

FA : Food Accessibility

FA : Food Availability

ASS : Sub-Saharan Africa

CEMAC : Economic and Monetary Community of Central Africa

AS : Agricultural Supervision

FAO : Food and Agriculture Organization of the United Nations

GDPAH : Gross Domestic Agricultural Product per capita

IFPRI : International Food Policy Research Institute

RDO : Rural Development Objectives

SDG : Sustainable Development Goals

ASE : Agricultural Supervision Expenditure

OMD : Millennium Development Goals

AP : Agricultural Production

PAJIA Support project for the renovation and development of vocational training for the supervision of farmers

WFP : World Food Program

DC : Developing Countries

NARS : National Agricultural Research System

NGO : Non-Governmental Organization

ABSTRACT

This study consists of analyzing the effect of Farmer Supervision on food security in the CEMAC zone, with regard to the persistence of the phenomenon of food insecurity which undermines for a panel of three countries (Cameroon, Chad and Gabon) for the period 2000 to 2018. This study investigates the validity of the hypothesis through panel data analysis. Using a panel ARDL model and following the models used by Nubukpo (2007),Guru and Hadjimichael (1996),Gurgand (1994),we find that in the short and long term that the agricultural supervision is positively related to the growth of agriculture production and agricultural income. It also emerges from the estimation of the linear model that a shock on the agricultural supervision has an effect not only on agricultural production but also on all the others variables. Indeed, the coefficients of these two variables are statistically significant at level. The coefficients associated with the agricultural supervision and agricultural production is positive and significant at the 5% level.

The government of the three countries (Cameroon, Chad and Gabon) must take and strengthen economic policy measures in order to properly supervise farmers.

Key Words: Supervision of Farmers, Food Security, Food Availability, Food Accessibility, Panel data and econometric techniques, CEMAC.

CHAPTER 1 INTRODUCTION TO THE STUDY

1. Background of the study

Food security means having, at all times, both physical and economic access to sufficient food to meet dietary needs for a productive and healthy life. A family is food secure when its members do not live in hunger or fear of hunger. Food insecurity is often rooted in poverty and has long-term impacts on the ability of families, communities and countries to develop and prosper. Prolonged undernourishment stunts growth, slows cognitive development and increases susceptibility to illness.

Today, more than 800 million people across the globe go to bed hungry every night, most of them smallholder farmers who depend on agriculture to make a living and feed their families. Despite an explosion in the growth of urban slums over the last decade, nearly 75 percent of poor people in developing countries live in rural areas. Growth in the agriculture sector -- from farm to fork -- has been shown to be at least twice as effective in reducing poverty as growth in other sectors.

Agriculture has always appeared in the discourse of political authorities as the priority sector of the economy.

The CEMAC zone is landlocked, it is an area plagued by food insecurity. The agricultural sector of CEMAC is confronted with enormous constraints: an agricultural population in sharp decline in favor of a progressive and accentuated urbanization, a food production which does not manage to meet the needs of the populations, thus creating a situation of increasingly serious food insecurity in the most disadvantaged sections of the population.

In the CEMAC zone, as in the other sub-regions of Sub-Saharan Africa, the problem of food security arises both in terms of the quantitative availability of products and in terms of the

qualitative availability of food consumed and internal flow between different regions and between different strata of society.

In view of the importance attached to agricultural activity, however, the observer cannot help but notice a general stagnation in the country's agricultural performance (Ondoa, 2006).

Agriculture is the cornerstone of economic development and the fight against food insecurity in CEMAC. It mobilizes an impressive workforce and generates considerable income for farmers (Ondoa, 2006).

Indeed, in its broadest sense, agriculture refers to all work transforming the natural environment for the production of plants and animals useful to man. In addition to the cultivation of plants, this also includes breeding, fishing and hunting.

From an economic point of view, agriculture represents a sector of activity, an income-generating activity based on land use, animal husbandry and so on. As such, it contributes to reducing food insecurity (FAO, 2011).

It is a sector of activity with a specific character for a country's economy; it meets the most important human need: food (FAO, 2011).

Indeed, agriculture in its broad sense refers to all work transforming the natural environment for the production of useful plants and animals. Sufficient to eradicate hunger, it is then necessary to undertake its management (Losch, 2008). This then consists of the action of surrounding a cadre of trained and to humans. In addition therefore to the cultivation of plants, specialized in the field, includes farming, fishing and hunting activities.

From an economic point of view, agriculture represents a sector of activity, an income-generating activity from land exploitation, animal cultivation, etc.

However, although the regions of Eastern and Southern Africa have made efforts in this direction, the rate of undernourished people continues to increase. Despite the efforts made in Central Africa, progress remains barely perceptible, and there is an almost double increase in the number of undernourished people. The sub region therefore still lags behind global and regional trends.

Agriculture is the main sector of the economy of the CEMAC countries. This sector covers the subsistence and income needs of a large rural population. It employs about 64% of the area's workforce and contributes 25% to the gross domestic product of the sub-region, although this varies greatly from one state to another. However, it provides only about 15% of export earnings due to the relatively large weight of oil exports produced in the four out of six CEMAC countries. This contribution is just as variable from one country to another. The share of imports of agricultural products in total imports is around 16%.

In terms of food security, the CEMAC countries have been unable in recent decades to ensure an increase in agriculture and food availability for their populations. The community continues to face situations of food crisis, conflicts, and natural disasters that hamper its economic development. The performance of the agricultural sector has remained insufficient to face the multiple challenges facing the promotion of local markets, the conquest of new export markets, etc.

It is a sector of activity with a specific character for the economy of a country; it responds to the most important care of human beings: food (FAO, 2011).

For this purpose, the expression "farmer" from the Latin "agricultor" designates a person whose activity aims to cultivate the soil. In order to produce in sufficient quantity to eradicate hunger, it is then necessary to undertake its supervision (Losch, 2008).

This then consists in the action of surrounding a framework of personnel trained and specialized in the field.

The concept of management naturally derives from the word framework, which designates an area determined by limits, a structure that manages and surrounds a salaried employee exercising management functions or requiring a higher level of qualification.

Therefore, the word “management” designates an activity of directing, controlling or monitoring a person, a group, an organization or a sector of activities.

We can retain from these definitions that the concept of “supervision” is an activity of direction and control of a group for which one is responsible. Those responsible for this activity are supervisors while the beneficiary group of individuals is referred to as the supervisor.

Speaking of an agricultural supervisor, he is in fact the person who is permanently in the field with the farmer for his training. This is what others call: the base agent.

Therefore, the agricultural supervisor is one of the essential components of agricultural development organizations.

In connection with the rural world, the supervisors exert an influence on the producers by the transmission of knowledge, knowledge with a view to developing cultures. It is support-advice and technical assistance offered to them by the supervisors who share with them the concern of agricultural yields.

In order to perform these roles better, supervisors must have the means and be motivated to do so, because they have to work with adults, most of whom are illiterate. It takes a lot of patience and leadership to value them.

Framing is also "the action of maintaining and guiding the impulses of others along a path laid out by others (by hierarchical superiors or by institutional bodies, laws, etc.) and seeking not to overstep the margins (too much)" (Garant and Letor , 2014). This is why they believe that the success of this action relies on "an important rhetorical task of constructing and negotiating meaning, the main tool of which is the spoken word: defining, indicating and negotiating the meaning of work, i.e. giving it meaning and direction, and dealing with the forces at play".

It is clear from the foregoing that management must be imbued with leadership.

It emerges from all the foregoing that the framework must be imbued with leadership and in this sense, one can evoke "the notions of management and management which the directors and managers are called upon to demonstrate" (Garant and Letor 2014) (Garant and Letor , 2014).

Technical support in the agricultural field then integrates all these notions and aims to support the development of modern agriculture by offering all the necessary support services, whether technical and technological, material or educational, to farmers.

The agricultural framework particularly covers: rainfed farming techniques; aid for improving soil fertility in order to increase agricultural yields (soil defense and restoration); modernization of crops in rotation (cereals, legumes, etc.); the training and professional organization of producers; the organization of credit; distribution of inputs; renewal and maintenance of seed equipment; seed production; product collection and marketing.

That said, agricultural supervisors must have the skills, means and intellectual resources necessary to fulfill the very important functions of management, control, negotiation, training and motivation, which sum up supervision with a view to mobilizing farmers to more productivity.

We also start from the observation of the scarcity of local agricultural products on the markets of Central Africa and in the shopping basket. The cost of local food available, the cost is extremely high and does not put it within the reach of the masses. The African market is cluttered with a multitude of imported food products whose quality is sometimes questionable. As a result, the concept of food self-sufficiency rings in the ears of populations in Central Africa like a fable, then they are lived in fears of scarcity, shortages and soaring prices of food products on the market.

Food habits are increasingly outward looking to the detriment of African food cultures. This situation is not without consequence on the economies of the States of the region which, not only see their populations exposed to the tensions of the international markets, but also the latter adopt extroverted food habits according to their incomes. Without however forgetting the rate of poverty and unemployment which undermine societies, leading to a situation of malnutrition and undernourishment in many households. Faced with this ongoing food crisis in Central Africa, several strategies have obviously been designed to put an end to this nutritional endemic that is food insecurity, but the results are still mixed.

This state of affairs has therefore prompted us to take a close look at this situation and the attempts to implement solutions to get out of it. Our work is therefore entitled: The effects of farmer supervisors on food security in the CEMAC zone.

2. Problem statement

Central Africa has for many years been subject to difficulties in meeting the growing demand for food due to a multiplicity of factors such as rampant urbanization, lack of interest in agriculture by young populations, lack of means available for crop maintenance, the growing infertility of the soil due to its poor use, the change in the eating habits of the populations, who are increasingly oriented towards imported products, climate change which influences

the weather and agricultural seasons and causes a reduction in productivity. In view of this situation, we think it is time that the talk of the alleged great importance of the agricultural sector is translated into action.

It has become commonplace to affirm that agriculture is a major determinant in the fight against food and nutritional insecurity. In this case, it should therefore be given more serious attention than in the past. This bold orientation calls for the establishment of mechanisms that will boost agricultural yield and the creation of agro-pastoral industries. It is indeed regrettable to note that, despite the prospects and mechanisms for combating undernourishment in the world, the undeniable agricultural potential of Central Africa, for example, does not remove it from the list of regions where poverty reigns. food insecurity in the world in general and in Africa in particular.

If global agricultural issues have long been polarized around artisanal-type farms to a more technical, entrepreneurial model, questions of trade openness, the hunger riots of 2007-2008 reminded us that questions of food insecurity, poverty and starvation more economical, with significant yields in the main agricultural production sectors. It resulted in the creation of subsequent added values, were major and urgent challenges for agriculture.

Thus, for many defenders, the supervision of farmers is based on groups or professional organizations of farmers with a view to carrying out agricultural renovation based on the modernization and intensification of production. This is a development model that has been very beneficial for European countries, especially France, during post-war reconstruction thanks to American aid.

In the same vein, (Alchancho, states that with the acquisition of the first tractors under the Marshall Plan, France launched the modernization of its agriculture with the corollary, 2012)

states that with the acquisition of the first tractors under the Marshall Plan, France launched the modernization of its agriculture with the corollary, until 1960, of the specialization of farms, the expansion of surface areas and the intensification of agricultural extension to enable farmers to align themselves with technical standards conducive to more efficient agriculture.

The orientation law of agriculture in 1962 (Loi Pisani) emphasizes the development of family farms, the promotion of agriculture and the taking into account of the points of view of the peasants. This one has thus enabled the transition from small-scale farms to an entrepreneurial model, more technical, more economical, with substantial yields in the main agricultural production sectors. This resulted in the creation of subsequent added values, leading to the development of the agri-food industry and mass distribution (Alchancho, This resulted in the creation of subsequent added values, leading to the development of the agri-food industry and mass distribution, 2012).This process of professionalization and development of farmers has also led to the creation of peasant movements likely to put pressure on the government to safeguard the achievements.

Binswanger (2001), Stringer and Pingali (2004), (Kydd et al. , 2002) emphasize the potential of agriculture and argue for support for its development within a market-oriented economic framework.

Arguments in favor of agriculture-led growth and improved food security highlight the direct impact that more efficient agriculture can have on the living conditions of the poor as well as its effects on economic activity in general.

Several elements suggest that a dynamic and prosperous agriculture promotes, to a large extent, employment and non-agricultural incomes in rural areas. Empirical studies conducted

in SSA, cited in (Haggblade, Hazellet Brown, 2018), estimate the multiplier effect of agriculture on non-agricultural income in rural areas at 1.5.

(Badouin , 2006) already proposed that traditional society should be replaced by "a system of agricultural economy based on other behaviors". Binswanger (2001), (Stringer and Pingali , 2004) Kyddetal food derived from agriculture highlight the direct impact that is hampered by resistance. We find ourselves in the presence of a conflict between economic systems that must be harmoniously articulated in order to ensure the transition.

Thereby, <<the decision to promote peasant agriculture must be based on a certain number of technical and economic support structures: extension, marketing, credit, animation and cooperation…>> (Badouin, 1965). The green revolution the cooperative movement, community development, rural development, etc., had become the leitmotif of agricultural orientation policies.

On the other hand, (Smith , 2017) saw an imperfect division of labor in this sector. However, he underlined its complementarity with the manufacturing sector. The future will seem at first to prove him right, on the first point: the world will be built through industry, then the development of services, the role of agriculture being simply that of supplying, or even not slowing down, these more dynamic sectors.

The spies of development economics, in particular Lewis (1954) and some of its heirs to school of ‘dualism’ will give agriculture a role initially central, but which will quickly become ambiguous: that of an activity concealing mass unemployment in a subsistence economy.

(Lewis , 2018)deduces zero productivity and the opportunity to employ this disguised unemployment, the ‘surplus’ labor, in capitalist sectors with positive marginal productivity.

In other words, does Farmer Training contribute to reducing food insecurity in the CEMAC zone?

This is the reason why this study was conducted.

3. Research Objectives

3.1 Main objective

The food insecurity in the CEMAC zone has been studied, as mentioned above, many times before, with varying results. The main objective of this research is to identify the impact of farmers on food security in the CEMAC zone.

3.2 Specific objectives

The specific objectives of this study are the following:

1) To assess the effects of farmers management on food security in the CEMAC zone.
2) To analyze the impact of farmers management on food security in CEMAC.
3) To find out the effects of the supervision of farmers on food insecurity in the CEMAC zone.

5. Scope of the study

This study is in the field of economics. It focuses on the effects of farmer’s management on food security in CEMAC and covers a panel of three countries (Cameroon, chad and Gabon).

6. Significance of the study

This study has enabled to the researcher, to policy makers, to ULK, to others researchers .

7.1. Researchers

In this work it is a question of carrying out an analytical reading of the food insecurity situation and the control strategies developed in Central Africa. Review the strategies for combating food insecurity in Central Africa through the various policies that contribute to food security. But more specifically, we went in search of the causes of the existence and prevalence of food insecurity in the sub-region by digging into time and history, in order to have an orientation on the future prospects. prescribe. This will be done through a quantitative (the results in the form of numerical data) and qualitative (the different agricultural mechanisms put in place for food diversity) analysis of the data collected. This analysis, which has two aspects, both qualitative and quantitative, seems to us to be the most suitable for this field of study because, not only does it make it possible to evaluate agricultural productivity in Central Africa on the basis of the CAPs, but also to assess the proportion of efforts to combat undernourishment in Central Africa. In doing so, the analysis of the sectorial policies of the region in the area of agriculture, makes it possible to bring some solutions to the problem.

7.2 Economic interest

The development of the agricultural sector was an important pillar for the (radical) economic development of the states of the region. By strengthening agricultural strategies and policies, yields were highly likely to be increased. This increase in agricultural productivity would initially make it possible to limit imports of agricultural products, which would reduce the outflow of money. Secondly, the creation of processing industries would open the field of employment, would attract foreign investment, which would have an impact on the balance of payments. The construction of product flow paths would allow food products to be redistributed. In addition, this would strengthen the private and informal sector, the latter

being up to now the most profitable in African economies. It was essential that the populations know how to take themselves in hand, stop freezing on the trades of the bureaucracy. The modernization of agriculture in Africa in general and in Central Africa in particular could increase its field of interest by improving agricultural policies, as was the case in China. Likewise, it would help to ensure that the population devotes itself to agricultural trades, which would contribute to opening up the possible fields of self-employment which was very essential for Africa where the States are no longer able to employ.

7.3 Political interest

Access to food products was of crucial political importance in view of the harmful consequences that could result from an increased scarcity of foodstuffs accompanied by a severe inflation of the prices of basic products. Food crises were sometimes at the origin of social riots, which could be used by the opposition to overthrow a government. This state of affairs places, alongside sovereignty, food security as a central issue of governance. In addition, as the neo-functionalist conceives, politics was at the heart of the construction of any integrating and/or development project or program.

7.4 Social Interest

The social interest of this study lies in the ability of populations to eat healthy, balanced and sufficiently. It was important for the populations of Central Africa to have food sovereignty. This concept created and supported by the international peasant movement "La Via Campesina", is understood as "the right of populations, communities and countries to define their own food, agricultural, territorial policy as well as work and fisheries, which must be ecologically, socially, economically and culturally adapted to each specificity. Food sovereignty includes a real right to food and food production, which means that all people

have the right to healthy food, culturally and nutritionally appropriate, as well as food production resources and the ability to ensure their survival and that of their society.

To this end, the accent must be placed on the crops that are part of the food habits of the populations of Central Africa, as we said above, that these are roots (cassava, potatoes, taro), cereals (millet, sorghum, wheat, maize etc.) Besides this we could add cash crops such as cotton, cocoa, coffee. But their production must not encroach on the cultivation of the most consumed products, as China has done with the strengthening of rice cultivation to the detriment of cotton. ensure their survival and that of their society. To this end, the accent must be placed on the crops that are part of the food habits of the populations of Central Africa, as we said above, that these are roots (cassava, potatoes, taro), cereals (millet, sorghum, wheat, maize etc.)

8. Definitions of key concepts

We review the definition of management, farmer, agricultural management, food security, food availability, accessibility of foodstuffs, panel ARDL Approach.

- **Framing**

The concept of management naturally derives from the word framework, which designates an area determined by limits, a structure that manages and surrounds a salaried employee exercising management functions or requiring a higher level of qualification. Thus, the word "management" designates an activity of directing, controlling or monitoring a person, a group, an organization or a sector of activities. It is also the entire staff who carry out this management, control or monitoring activity.

We can retain from these definitions that the concept "management" is an activity of direction and control of a group for which one has responsibility.

Garant and Letor (2014) believe that the framework associated with leadership<<both refer to actions of orientation, regulation and coordination in the organization. They refer to an influence exerted by certain actors on others in order to achieve the objectives set by an organization >>.

- **Farmer**

Expression "farmer" from the Latin "agricultor" designates a person whose activity aims at cultivating the soil. In order to produce in sufficient quantity to eradicate hunger, it is then necessary to undertake its supervision (Losch, 2008). This then consists in the action of surrounding a framework of personnel trained and specialized in the field.

Technical supervision in the agricultural field then integrates all these notions and aims to support the development of modern agriculture by offering all the necessary support services, whether technical and technological, material, communicational or educational, to farmers.

- **Agricultural supervision**

Agricultural supervision particularly opens up: rainfed cultivation techniques; aid for improving soil fertility in order to increase agricultural yields (soil defense and restoration); the modernization of crops in rotation (cereals, legumes, etc.); the training and professional organization of producers; the organization of credit; distribution of inputs; renewal and maintenance of seed equipment; seed production; product collection and marketing.

- **Food safety**

The Committee on Food Security (CSA) defines food security as the "physical, social and economic opportunity (for all people at all times) to obtain sufficient, safe and nutritious food to satisfy food needs and preferences to lead a healthy and active life", according to the CSA, "food security exists when all human beings have, at all times, physical and economic access

to sufficient, healthy and nutritious food for them. meeting their energy needs and food preferences for a healthy and active life (CSA, 2006).

- **Food availability**

This is the availability of food in sufficient quantity and of an appropriate quality, the supply of which is ensured by national production or imports (including food aid). This means that in a country, a region, a locality, food products are physically available in sufficient quantity to ensure the food security of its inhabitants. The origin of these foods can be either local, national or imported from abroad. This therefore implies a whole marketing system that connects producers (local, national, from the rest of the world) with local consumers.

- **Food accessibility**

These are factors that allow everyone, regardless of their socioeconomic or physical condition, to access a grocery store or any other place offering food. Accessibility includes both the dimensions of geographic proximity, the cost of food, and the cognitive and physical abilities required to obtain food. Geographical access to a grocery store is considered low beyond a distance of one kilometer in urban areas and sixteen kilometers in rural areas.

Panel ARDL Approach: is an intermediate estimator that allows the short term parameters to differ between groups while imposing equality of the long term coefficients between groups.

CHAPTER 2 : LITERATURE REVIEW

The importance of a sound agricultural policy has been recognized from the very earliest times in all cultures. In the 6th century BC (Jesus Christ), in China, Lao Tseu wrote:<<Nothing is more important than agriculture to govern peoples and serve Heaven>>. Furthermore, he blamed the rulers who neglected the agricultural sector: The imperial palaces are superb, but the countryside is left fallow and the granaries are empty.

The field of study of this dissertation is limited to the CEMAC space in Central Africa. CEMAC is a sub-regional group of six countries including Cameroon, RCA, Equatorial Guinea, Gabon, Chad and Congo-Brazzaville. As part of this work, we will limit ourselves to three countries of the CEMAC Zone, namely: Gabon, Cameroon and Chad.

In this chapter, we will see the theories and models (1), we review the theoretical (2) and empirical (3) foundations of the effect of farmer supervision on food security.

We present in this part, the theories and models of agricultural development.

2.1 Theories and models

2.1.1 The theories

We present here the model of (Coxhead et al. , 2002) who analyzes the various factors explaining the relative decline of agriculture.

a.1) The surplus theory: the reservoir of agricultural labor as fuel for economic growth.

- **The foundations of theory**

This theory is based on the work of Lewis (2016) inspired by classical political economy. In the long term, the accumulation of capital depends on the share of profit in relation to wages

and ground rent. When this share increases the accumulation accelerates, and the country develops.

Lewis (2016) proposes a thesis in which the employment of surplus agricultural labor makes it possible to generate increasing profits.

Procedures for transferring the surplus to industry

The agricultural transition is based on structural factors affecting demand. Improving agricultural productivity allows a reduction in agricultural production costs, which translates into a reduction in relative agricultural prices. Indeed, according to Engel's law, the income elasticity of the demand for food products being lower than the improvement in productivity in agriculture benefits industry: the drop in agricultural prices is not entirely absorbed by an equivalent increase in demand for agricultural products, which is transferred to industrial products.

a.2) Enrichments of the surplus theory

The labor surplus theory is based on two strong assumptions:

- This surplus induces wage stability as long as this surplus is not absorbed;

-The marginal productivity of labor is zero in the traditional sectors;

These assumptions are open to criticism. The very hypothesis of surplus labor is undermined in certain regions (particularly in Sub-Saharan Africa) where the seasonality of agricultural work causes slack periods, which are not always periods of underemployment. Indeed, labor must be available for periods of high activity. This surplus could rather be considered as a real reservoir of labor for intense periods (harvests.).

The agriculture/industry and urban/rural link deserved to be updated: rural activities are not only agricultural, as evidenced by the Asian experiences of rural industrialization, particularly in India and China.

2.1.2 Models

In this part, we present some theoretical models of agricultural growth.

b.1) Theoretical model of traditional agricultural growth

The traditional agricultural production function. Agricultural production (Y) is a function of the factors of production: land (S), labor (N) and production capital (K), i.e. the means of production used to implement value the land and to produce.

We can conveniently schematize this function by writing:

$Y=f(S, N, K)$ (1)

By dividing by N it comes: $Y/N=f(S/N, 1, K/N)$ $Y=Nf(S/N, 1, K/N)$

Taking into account the conditions defined above, N is practically constant: in the simplest situations each of the workers is provided with the essential tools (spade and sickle) for his activity.

The traditional agricultural production function can conveniently be written

As follows: $Y=N_{\varphi}(S/N)$ (2)

Production depends on the number of workers (N) and is a function of the area available per worker.

The production available for human consumption is equal to the total production, after deducting the withdrawals necessary for the continuity and expansion of the production process in relation to population growth. Producers seek to satisfy their subsistence needs as a

minimum: each worker must provide for his own food and that of the inactive members of his family.

If cs is the subsistence consumption per person, and n is the dependent population per worker, the subsistence production per worker (PS) must be at least equal to:

$$Ps=cs(1+n).$$

♦ Law of non-proportional returns.

Agronomic experimentation shows that when one factor of production is varied, the others remaining constant (ceteris paribus), production does not increase proportionally. The law of non-proportional returns has a general meaning and applies in particular when the varying factor is work.

♦ Population and livelihoods.

In fact, in 1798 Malthus formulated his famous principle according to which, under the conditions of the Western economy of his time, the population rose faster than production.

♦ Pre-Malthusian economy.

Many authors have mentioned the communal character of traditional societies, which means that each person's consumption is not proportional to their production.

In traditional economies, real consumption may rise above necessary subsistence consumption, but the "wisdom" of traditional populations leads them to stockpile, because production remains highly dependent on natural conditions, Harvests are fluctuating and, for lack of stocks, this economy risks being subjected to cyclical famines (poor harvests).

♦ Malthusian economics.

Under the conditions of the traditional economy, very close to natural conditions, the actual agricultural production (Yr) is very fluctuating compared to the trend production (Yt).

In the period of the pre-Malthusian economy, cyclical famines can occur, if stocks are not constituted or if several successive years of bad harvests have absorbed them.

b.2) Magali model (2007)

Magali is an econometric model of French agriculture designed to make medium-term projections and variants. It explains the supply of 27 agricultural products, intermediate consumption and operating costs, to arrive at agricultural income.

It also makes it possible to represent the structural evolution of the sector through the agricultural population and investment. The highlights of the long-term evolution of the French agricultural sector are well known. The 1970s marked a considerable slowdown in growth: fall in investments, slowdown in per capita income, and fall in the overall RBA since 1977. Some attribute this slowdown to the crisis, aggravated by a series of climatic accidents, others to an inadequacy of the development model of French agriculture to the needs of the market. In dynamic simulation on the past, the MAGALI model can attempt to disentangle these various effects.

These simulations should show that MAGALI is designed above all to inform agricultural policy decisions, in particular through the control variables of prices (which remain exogenous).

♦ Model equations

The type of specification suggested by this overall diagram has sometimes had to be adapted. But it has been successfully tested in many cases, especially when it has been possible to use

regional data to clarify the role of structural constraints, which remains difficult to assess from simple time series. Estimates were made using econometric methods.

♦ Structures

We distinguish :

- Land: the change in utilized agricultural area (UAA) is considered exogenous;
- Capital in building and equipment: gross fixed capital formation depends on the price of labor and capital, agricultural value added in value, and a cash flow variable: the envelope of subsidized loans available.

  The distribution between building and equipment is then a function of the relative prices of the two goods, but also of the orientation of production through variables representing the respective added values of animal and plant production.

- Work: specifications in terms of price could not be maintained in this case.

  Employment is therefore explained by the volume of production and by the stock of building and material capital which replaces labor. In addition, for each of the three job categories (farm managers, family helpers, employees), an analysis of regional data made it possible to construct a variable that synthesizes the effect of production orientation. Although relatively weak compared to the mechanism of substitution of capital for labor, this effect is significant and plays differently on each category.

All in all, the structure block thus confirms the idea of an interaction between structures and prices. But the stock of factors available depends above all on general macroeconomic conditions:

- Technical progress and evolution of relative costs;

- Which determine the rate of substitution of capital for labor.

2.2. Review of the theoretical literature

In this part, we review the existing literature on food security, the modernization of agriculture, peasant organization as well as the evolution of support provided to agricultural producers.

- **Food security issues**

The history of Central Africa reveals that the food situation that prevails today was not always like this, but began to deteriorate from 1994. If today Central Africa faces such a dilemma in the food field it is because of a certain number of reasons and events which have followed one another during its history.

2.2.1 Agricultural production in the sub-region.

In terms of agricultural production in the CEMAC zone, Cameroon plays a major role. Agriculture is dominated in the region by small producers with the exception of Cameroon where there are commercial farms. Aspects of agriculture such as the level of production, type and variety of products, production systems, self-sufficiency and nutrition, and the sector's contribution to GDP, the countries of the region are heterogeneous. However, there are common characteristics, the main one being that agricultural production is generally insufficient both in terms of volume and variety to meet consumer needs. These countries are therefore partially or totally dependent on imports to meet consumer needs.

- Cameroon, producing more than its counterparts, is less threatened by the critical situation of food insecurity which prevails in the region. It even ranks higher in the polls for self-sufficiency, although there are discrepancies between districts, Cameroon has fewer undernourished people (23%) while the average is by 53%. The main agricultural products are plantains, tomatoes, cassava, cocoa, coffee, pineapples, beef, chicken, eggs, avocados, cassava, etc. Cameroon also produces

cereals, vegetables, cotton and sugar. Progress in the agricultural sector has been recorded there since 1999.

- With just 1.7 million inhabitants, Gabon is a sparsely populated, highly urbanized country located between Cameroon and Congo on the Gulf of Guinea.

The agricultural sector is dominated by small family farms, of which there are an estimated 70,000. They are mainly run by older people, and it is estimated that their average size in 2012 was just 0.20 ha. Agricultural production is insufficient to cover the country's food needs, forcing the country to import an estimated 60% of basic foodstuffs, particularly cereals and meat products.

The Gabonese agricultural sector includes food crops, rubber, and palm oil and employs around 20 percent of the population. However, the sector’s contribution to GDP was only five percent in 2017. Gabon relies heavily on food imports, which account for the majority of domestic food consumption. Imported foodstuffs come mainly from France, South Africa, and Cameroon. Gabon has 22 million hectares of forest, one million hectares of arable agriculturalland, and over 800 kilometers of coastline. Gabon has a growing class of entrepreneurs producing export-ready foodstuffs including dried fruit and jams, spices, and palm oil. Gabon, for its part, although having only 5% of its population suffering from malnutrition, is 60% dependent on food exports. The main crops are plantains, game, sweet potatoes, cash crops like rubber, sugar and bananas. Cocoa and coffee production has declined considerably since the 1970s.

- In 2020, approximately 80% of Chad's labor force was employed in the agricultural sector. This sector of the economy accounts for 52.3% of the GDP, as of 2017. With the exception of cotton production, some small-scale sugar cane production, and a portion of the peanut crop, Chad's agriculture consists of subsistence food production.

The East Sudanian savanna, which accounts for about 10% of the total land area, contains the nation's most fertile croplands. Settled agricultural communities growing a wide variety of food crops are its main features. Fishing is important in the rivers, and families raise goats, chickens, and, in some cases, oxen for plowing. In 1983 about 72% of all land under cultivation in Chad was in the East Sudanian savanna. Chad mainly produces livestock products, groundnuts, cereals made up of millet, sorghum, rice, corn. There is also the cultivation of cotton. Despite its massive cereal production, Chad suffers from a chronic cereal deficit.

2.2.2 Peasant organization et evolution of support provided to agricultural producers

Here we explain the mode of peasant organization and the evolution of support provided to agricultural producers.

b.1) Mode of peasant organization

Efficiency and the performance of any work result from its mode of organization, its distribution among the main stakeholders. The rural world in Africa does not entirely obey this rule of social division of labor. This conditions small-scale production and limits the achievement of food self-sufficiency due to rapid population growth. In Cameroon, agriculture is still organic for the most part, it is purely family. Peasant agriculture is intended for subsistence. Jean (1993) described the traditional society as one which “is characterized by a simple economy, a subsistence economy. It is organized on the basis of small, relatively autonomous restricted groups. Social organization is dominated by kinship”.

The traditional peasant does not see his work as a profession, but as a social institution to be fulfilled. He then relies on the other members (women and children in this case), excluding any idea of recruiting labor to expand his production.

In "traditional family model of farming, the question of work was considered natural, implicit, but not explicit or organized" (Leupe, 2013). The organization of work integrating administrative functions (staff management for example) calls into question the professional identity of the farmer because office activities are not part of the traditional activities of the farmer (Boissier, 2016). This situation explains why it is still difficult for traditional African farmers to break away from this production model in order to meet ever-increasing demand caused by population growth, although it is necessary to have the means of production, still inaccessible to some. Cameroonian agriculture is then based on the work of small farmers still using rudimentary means and very few inputs. Their individual labor is barely enough to solve their subsistence problems.

It must be understanding that most farmers are illiterate or school dropouts. They enter this trade without any basic technical training. Meanwhile, the majority of agronomists and rural development workers graduating from universities and training schools prefer laboratory, office or administrative work.

The role of support and guidance services is crucial for the development of the entrepreneurial spirit by encouraging producers to create and develop agricultural cooperatives and professional organizations in rural areas. These structures ensure the economic and social functions of the main agricultural sectors following the withdrawal of the State in the early 1990s.

Since then, it is clear that there can be no sustained development without the structuring of activities in rural areas, without the participation of farmers whose work is recognized as vital for the economy in Africa. This requires making farmers' organizations responsible for the proper organization of agricultural work. The objective would be that farmers must now produce to sell. “This openness to the market will have to result in the development of

specific skills mastered by farmers to deal with other economic operators and development partners: agriculture becomes a profession" (Achancho, 2012). Gold, the reality is such that when the agricultural sector was liberalized, many economic operators got involved in the sectors to exploit the peasants without taking their interests into account. This led to a disorganization of the market leading to a strong impoverishment of the peasant masses. The consequence is therefore a drop in motivation and the abandonment of cash crops, the main sources of foreign exchange.

Also, must we recognize that the agricultural sector does not receive a significant share of public investment, which does not promote the development of rural areas faced with exodus.

Some productors have understood what is at stake and are seeking funding for their activities from the Local Agricultural Credit and Mutual Fund Centers (CLCAM) which require excessive guarantees. The Cameroonian government also supports farmers through its microcredit program for the poorest. And mainly, growth sectors benefit from special support funds. However, the weakness of the credits does not allow the producers to achieve their objectives, because some end up indebted.

Efforts remain to be done for the mechanization and financing of large-scale agriculture, all of which would make it possible to increase production.

b.2) Evolution of support for agricultural producers and difficulties

The support provided has Two peasants have been structured and institutionalized over time. (Gouton, 2015)was able to distinguish four important periods in the conception and implementation of advice in the field of agriculture.

First of all, from colonization to the first years after independence, new production methods were put in place to supply French agri-food industries with tropical products. Thus, from 1904 to 1930, research centers sponsored by corresponding institutes in France were set up

with the aim of creating technologies to support the production objectives defined by the administration (oil palm, food crops, coffee, peanuts and coconut palms). These methods were disseminated under duress (quotas of agricultural products to be supplied, chores, etc.) (Gouton, These methods were disseminated under duress (quotas of agricultural products to be supplied, chores, etc.) , 2015).

Then, after independence, and more specifically from 1960 to 1975, intervention companies were created or approved for each of the sectors: oil palm, cotton, peanuts, rice and tobacco. These regional companies were well structured to better supervise the producers. The results obtained with this approach were generally good, as the conditions were favorable (Gouton, 2015).

In the third period, popularization was institutionalized with the creation in 1975 of Regional Action Centers for Rural Development (CARDER). Their mission was to provide comprehensive support to rural producers.

It consisted of:

- ✓ The supply of agricultural inputs and veterinary products;
- ✓ Credit to farmers' organizations for inputs and animal traction equipment;
- ✓ The supply of selected seeds;
- ✓ The supply of seedlings;
- ✓ The marketing of agricultural products (industrial as well as food);
- ✓ Research and development;
- ✓ Extension;
- ✓ Support farmers' organizations (Gouton, 2015).

Finally, it should be noted take that the limitations of the institutionalized extension approach through the CARDERs gave rise to new reflections which led to the design of the so-called management advice approach.

This approach has had positive effects with regard to cash management, the choice of crops and labor, but it seems too restrictive to the economic and financial aspects of the farm and does not take sufficient account improving production techniques. The management advice recommended at the start has therefore strongly evolved towards an approach whose entry point into the farm still remains the control of the economic and financial aspects, but which now takes into account the needs of producers in terms of advice. technology and new technologies (Gouton, 2015).

Nowadays, a new approach is implemented. This is the so-called “agricultural advisory” approach. It more or less combines the old approaches in a global support strategy for the farmer who is put ahead in decision-making and the conduct of activities. Advisors put themselves in a position to exchange knowledge, demonstrate, train and contribute innovations to support informed decisions by the farmer or professional agricultural organizations.

Cameroon has agricultural services whose role is to supervise producers on the basis of new techniques and technologies in the field of agriculture.

Non-market services provide technical assistance to rural producers, whether stockbreeders or farmers. “Extension should enable producers to adopt new techniques and technologies with the aim of enabling them to increase their yield and thus improve their income” (Achancho, 2012). But the difficulties of these structures hinder their performance. The following factors underlie the poor management performance, although some things have improved in the meantime:

-The incompetence of development officers in the field (lack of concrete experience, non-existent ongoing training, technical recipes learned by heart);

-The inadequacies of the system for disseminating technical topics;

-The environment economic not facilitating the adoption of themes (Lack of supply, marketing difficulties, etc.);

-Technical standards incompatible with the characteristics of the production units (excessive economic risks, excessive labor consumption, etc.) (Beaudoux, 2018).

In a poor State without mineral resources, the weakness of budgetary allocations constitutes a limit for the implementation of political orientations in agricultural matters, especially in terms of extension, the poor relation of agricultural "Extension is a difficult activity to manage and administer for a government. Farmers have multiple needs and meeting them is a complex task (Benor et al. , 2014). Without consistent resources, extension services manage as best they can support programs for producers. They are confronted with the insufficiency of personnel and means and rolling stock to intervene in the often landlocked countryside. Road infrastructure leaves much to be desired, especially in the rainy season. This situation leads to the demotivation of extension agents who already do not have a good salary situation. They function in routine, which blunts their eagerness to go into the field, if not to repeat the same techniques that the peasants are already supposed to master.

While the quest for innovation must be permanent, it should be noted that the transfer of knowledge within the framework of cooperation with universities and agricultural research institutes is not always systematic. The extension agents are insufficiently trained, the technical messages are inconsistent, because they are disconnected from the local reality. The nature of the topics addressed corresponds more to Western models than to the real concerns

of rural populations, who consider administrations or organizations as surveillance units that they avoid as much as possible (Idoux and Beau, 2017).

It should be noted that due to poverty and declining income, farmers have different needs, the prior satisfaction of which could offer chances of success to extension actions. These primary security and subsistence needs often distance them through sordid practices from the concerns displayed by the supervisory staff, which are to improve their productivity.

Farmers' organizations relay the knowledge received from their peers, but they are experiencing changes that make their missions difficult. They are cooperatives, groups or development associations at the village level, unions or interest groups. They are often formed on the initiative of the administrative authorities with the help of supervisory staff.

For the government, these structures are channels of information and training for producers with a view to strengthening their professional capacities. Above all, it is a matter of providing them with technical and organizational support that enables them to develop and achieve their mission (Mukantagwera, 2011).

Based on a study carried out in Guinea, a non-exhaustive inventory of the various functions fulfilled by farmers' organizations was carried out (knowing that the same organization can fulfill several functions). It is:

- Environmental management (space management, land management);

-Equipment management (mills, shellers);

-Collective production (collective field);

- Supply (framework for the inventory of needs, group purchasing, and credit management);

-Common storage (seed granary, cereal bank);

- Joint work (work exchange groups);

- Financing (integrated credit systems with other activities, specialized credit institutions);

-Commercialization;

- Advice to producers (Beaudoux and Forget,2017).

Despite the potential of farmers' organizations, it is clear that the State is unable to provide the necessary support for them to fulfill these functions. Lacking financial resources and an organizational system capable of self-management for several reasons, they are left to fend for themselves or sometimes serve as a sounding board for a few projects and political propaganda. These organizations which should be real instruments of development are characterized by the lack of entrepreneurial spirit of their members, the low capacity to develop shaky projects, the lack of financing or the impossibility of having access to credits for cause guarantees not available (Mukantagwera, 2011).

Finally, it should be noted that serious organizational problems arise in the sense of regrouping farmers. Indeed, often lacking enlightened and honest leaders, these structures are subject to poor management, which paralyzes the participation of members in activities, who no longer find it in their interest to cooperate. This situation engenders crises that most often lead peasant organizations to dislocation. Extension services still need to make a great deal of effort in monitoring the management of farmers' organizations in order to truly ensure their contribution to improving their living conditions and increasing agricultural production.

2.2.3 Institutions fighting food insecurity

♦ FAO

The Food and Agriculture Organization of the United Nations is an organization specialized in the United Nations, founded in 1945 in Quebec. Its headquarters are in Rome, at the

PalazzoFAO,since1951.Since June15,2013, the FAO has 197 members, including 194 member countries one member organization (the European Union) and two associate members(Faroe Islands and Tokelau). Its overriding objective is "To help build a world free from hunger», his logotype is "Fiat panis" (a Latin expression meaning "there was bread for everyone").

Mission and activities

-Provide technical assistance to developing countries.

-Providing information and harmonizing standards in the fields of agriculture, forestry and fisheries, notably through its publications (e.g. periodic reports on agriculture, fisheries and forestry), and its databases.

-Advise governments and provide them with a forum for multilateral debate.

-Organize neutral forums between states to discuss the main issues relating to agriculture, food and food safety.

-In collaboration with the WHO, the FAO is developing the Codex alimentarius international food standardization system. They jointly joint FAO/WHO Expert Committee on Food Additives (JECFA).

-Secretariat and maintenance of the Freshwater Resources Management System (FIRMS).

-Raise awareness of chronic hunger issues around the world, for example, through the One Million Hungry project.

FAO was relieved of part of its initial mandate following the creation of the WFP and IFAD.WFP, on the one hand, and IFAD, on the other, both registered organizations in Rome.

By as a result, food aid is no longer part of its primary remit. The FAO does not provide food aid; this task has been entrusted to the World Food Program (WFP).

♦ World Food Program

Created in 1961, WFP works for a world where every man, woman and child has permanent access to enough food to lead an active and healthy life. To achieve this goal, WFP works alongside its partner agencies in the United States:

-The Food and Agriculture Organization of the United Nations (FAO) and the international Fund for Agricultural Development (IFAD);

-As well as governments and NGO partners. Every year, WFP feeds more than 80 million people in nearly 80 countries.

Approximately 11,500 people work for the WFP, most of them in highly-rewarded very remote locations, in direct contact with the most disadvantaged and undernourished populations.

Mission

WFP responds to the challenges through relief, rehabilitation and development that support basic education and the enrolment of school enrolment; promoting food security and rural development; and improving the nutritional status of children and pregnant and lactating women.

♦ IFAD

FIDA (International Fund for Agricultural Development,)is a specialized institution of the United Nations system. It was founded in December 1977 in the wake of the World Food in Rome in 1974.

IFAD is a development aid bank whose mission is to provide financial support as a donor and organizer, in the agricultural and rural development in developing and transition countries. Its mission is to fight hunger, malnutrition and poverty by improving farming means and techniques, and by creating and modernizing agricultural and commercial in rural areas, in particular through microfinance projects.

IFAD is particularly keen to carry out projects in collaboration with, among others with the World Bank, UNDP, WFP and FAO.

IFAD, like other international organizations, has been accused of being politically dominated by donor countries, exerting on their behalf strategic influence on the economy of developing countries, and to subordinate its aid to the beneficiaries' adherence to a productivity approach and at the expense of the national interest in certain sectors of the economy. However, it does have the advantage of working within a relatively strict and transparent framework that limits the abuse of tied aid, which is harder to avoid in bilateral in bilateral development aid relationships.

2.3 Empirical review

This part presents the view of other researchers on the current research topic.

2.3.1 The agricultural industry and the evolution of agricultural income

The literature has shown the frequent multiplicity of agricultural activities in developing countries ((DeJanvry and Sadoulet , Carton de Grammont and Losch , 2010).The total income of agricultural households is the sum of an agricultural income (which depends on the productivity of agricultural labor) and a non-agricultural income. The increase in a non-agricultural income can also be a lever for increasing their total income. Some of this non-

agricultural income may come from wages, self-employment, social transfers, agricultural subsidies or remittances.

For an agricultural household at the moment, we can write:

Total income (i;t)=Agricultural income (i;t)+Non-agricultural income (i;t)

In other words, by simply formalizing:

$Ri^{TOTAL}(t)=Ri^{A}(t)+Ri^{NA}(t)$

However, in a market economy, the level of income (agricultural or non-agricultural) is mechanically indexed to that of labor productivity (agricultural or non-agricultural).

We can therefore write:

$Ri^{A}(t)=\alpha_{A}.Pi^{A}(t)/Wi^{A}(t)$ and $Ri^{A}(t)=\alpha_{NA}.Pi^{NA}(t)/Wi^{NA}(t)$ Where:

Pi^{A} and Pi^{NA} are agricultural and non-agricultural gross value added generated by the working quantities $Wi^{A}(t)$ and $Wi^{NA}(t)$ allowed by the agricultural management, i for agricultural and non-agricultural activities; α_{A} and α_{NA} for the coefficients used to convert labor productivity into monetary income.

The α.P/W ratios can be thought of as partial productivities of agricultural and non-agricultural labor. The α coefficients could obviously be indicated in detail, but for the sake of simplification and since this is not our purpose here, we won't add to the notation. Using the decomposition factorial presented above, we can write the equation describing the total income of the agricultural house holding i:

$Ri^{TOTAL}(t)=Ri^{A}(t)+Ri^{NA}(t)= \alpha_{A}.Pi^{A}(t).Si^{A}(t)/Si^{A}(t).Wi^{A}(t)+ \alpha_{NA}.Pi^{NA}/ Wi^{NA}$

Where Si^A is the agricultural area worked. This last equation shows the dependence of total income on agricultural gross value added, non-agricultural gross value added, agricultural area worked and he amount of work allocated to agricultural and non-agricultural activities.

We recall the following constraint: the total quantity of work available to the unit is also finite.

So: $Wi^{TOTAL}=Wi^A+Wi^{NA}$

After standardization, this can be written as:

$1=Wi^A+Wi^{NA}$

We can also include social transfers T in non-agricultural income:

$Ri^{TOTAL}(t)=Ri^A(t)+Ri^{NA}(t)=\alpha_A.Pi^A(t).Si^A(t)/Si^A(t).Wi^A(t)+\alpha_{NA}.Pi^{NA}(t)/(1-Wi^{NA}(t))+Ti(t)$

This last formula, constructed for an agricultural household but equally valid for a country, allows the following discussion. For a farming family, the arrival of the youngest members of the family as farm workers, if not accompanied by an increase in farm production, will, ceteris paribus, reduce the "average" farm income, i.e. the "number of hectares per farm worker". This is a very common situation in developing countries. The reform also shows that markets related to agriculture are very important for total income.

Indeed:

-the way the agricultural land market functions will have an impact on the choices made to grow more land per unit of agricultural work: colonize (clear), buy or buy new land to expand.

-similarly, the greater or lesser degree of functionality and dynamism of non-agricultural labor markets will have an impact on the choices made by unit-owners with regard to the allocation of labor to agricultural and non-agricultural activities. -Finally, the added agricultural value produced per unit of land, i.e. the particle productivity of the land, depends on markets such as those for agricultural inputs (fertilizers, herbicides), credit (investments such as greenhouses, irrigation equipment) and, to a certain extent, technical knowledge (training courses that are more or less accessible and paid for by farmers). What adaptation strategies do farming households implement in a demo-economic context of declining trend in the "area worked per farm asset"? Two behaviors are usually taken into account: seeking to increase the productivity of the land and/or farm income.

2.3.2 Agricultural framework and evolution of economic productivity

Theoretical arguments and historical data have revealed the existence of a close link between investments made in agriculture and economic productivity. But it took the end of the 1980s for economists to begin to develop quantitative measures of this link by constructing macro econometric models.

The study by analyzed three types of agricultural export (manual cultivation, animal traction and motorized cultivation). This study concludes that by combining the labor force and manual equipment, we can go from an export 3.5 times greater at the origin to exports which become 5 times greater with animal traction and 101 times greater. with animal traction combined with small motorization.

In Burkina-Faso, (Zerbo, 2020) established production budgets for 41 farms (21 in animal traction and 20 in motorized cultivation) and considered the net margins per hectare, per worker and per household (at the official price and at the market price) of cotton, maize and

sorghum. Overall, the results are better in animal-drawn cultivation than in motorized cultivation.

According to these authors, according to projections made by the National Long-Term Prospective Study in the experimental phase for Benin in 2025, food production needs would grow by 6% per year. They will only be satisfied if operators improve their technique and means of production.

(Chantaigner, 2018) gives for Indonesia the motives for tractor use (owners and tenants). The improvement of working conditions, less tedious and faster work such as manual labor and animal traction take much longer, operating costs become relatively high, insufficient manpower and animals of related to the time of soil preparation, social prestige.

The use of the tractor allows the farmer to stand out from traditional working methods. (Dovring, 2018)attests that to a certain extent, mechanization can allow rapid tillage, but that this scheme does not hold where there is a surplus of labor. It also emphasizes that mechanical energy can play a great role, even in low-income countries, for soil preparation (cleaning, deep plowing) and that the importance to be given to this form of energy will be all the more only if the unproductive seasons are too long so that draft animals constitute a higher burden.

Mechanization is therefore presented as an expensive technology that often requires significant foreign exchange (Meiiden, 2018). In sub-Saharan Africa, the investment required for the acquisition of plows represents the equivalent of 2.4 to 2.7 times the average manual cash income of farmers (Pingali et al, 2018). The investment becomes increasingly high because of the cost of imported materials due to currency devaluations (Bigot and Raymond, 2019).

Many low-income farmers can rarely afford the equipment (Meiiden, 2018). But there are difficulties in guaranteeing the repayment of the loan and the high repayment rate of the latter (Le Thiee, 2016).

Economists have always accorded an important place to agriculture for economic growth.

For Lewis (2015), agriculture participates in the formation of capital, releases low-productivity labor to supply other sectors, in particular industry, by constituting a market for industrial products that provides foreign currency to finance Gillis imports. (1990) estimate that agriculture, because of its profit potential, attracts foreign direct investment creating jobs and opening up new investment niches for the benefit of local entrepreneurs for an increase in local production.

According to the (the World Bank , 2008), agriculture contributes to development as an economic activity, a means of subsistence and a provider of environmental services, which makes it a unique instrument of development. This is confirmed by a study conducted by (Patrick Guillaumont , 2013), based on the work of (Barro and Sala-i-Martin , 2012), which concludes that only environmental conditions (through the agricultural sector) have a significant impact on the growth in production in the Sahel. However, like any economic sector, the agricultural sector needs financing for a better contribution to growth. Indeed, financial resources largely condition access to inputs and equipment necessary for the adoption of an intensive production system.

However, the literature reveals a weakness of financing in agriculture in many developing countries. (FAO, notes underinvestment in agriculture over the past decade in many developing countries, 2016) Notes underinvestment in agriculture over the past decade in many developing countries. It finds that a large share of public spending on agriculture goes

to subsidies, so that there are few public resources left for creating new infrastructure or for other growth-enhancing spending.

In the case of Burkina, subsidies are rather ad hoc and rare and agricultural expenditure is mainly intended to pay the salaries of civil servants and to cover the operating expenses of the administrations in charge of agriculture (Zonon, 2008).

According to FAO (2016) experts, due to insufficient funding, many government agricultural support services function poorly, rural roads are impassable for much of the year, agricultural machinery is unusable and irrigation schemes are in poor condition, while erosion, deforestation and salinization continue to accelerate, at an ever faster pace. It is also noted that, since the mid-1980s, official development assistance for agriculture has fallen significantly (FAO, 1990).

Several studies carried out in Burkina show that the level of efficiency of producers is very low. (Zonon and Kabore , 2016) estimate the level of efficiency of Burkinabe producers at around 40%; which means that producers could increase their production by 60% if their technical efficiency improved.

In the literature, education is the factor most cited by authors as an explanatory factor of the level of efficiency of producers (Zunon, 2003). However, there is no global consensus regarding the impact of investing in education on farmer productivity. (Gurgand, 2007) finds that education has a zero or even negative return in agriculture in Côte d'Ivoire. In the case of Burkina, Zunon (2003) shows literacy has a significant impact on the level of efficiency of farmers.

However, education alone does not systematically increase the performance level of producers; education policies must be followed by policies for equipping producers or policies for transmitting more modern techniques.

A study conducted by CAPES in 2008 on market gardening shows that lower yields reflect either an insufficient mastery of production techniques, or a drop in seed quality, or both. The study recommends a vision of production techniques, a strengthening of training and support for producers and agricultural technicians on technical production itineraries. The work of (Fadonougbo and Koba , 2008) in Benin, relating to the effects of infrastructure on economic growth showed that a 1% increase in investments in the report increases domestic production by 0.33%.

Similarly, studies by (Mèdéhouénou and Sènou , 2011) in Benin show that investments in long-term education infrastructure have a greater influence on agricultural speculation than on transport and health.

2.3.3 Empirical analysis for central and West Africa

We discuss here the state of research on leadership in rural areas as well as agricultural development and the socio-economic situation of the area.

State of research on supervision in the rural environment

Few studies have specifically addressed the supervision of actors in the rural world.

However, related themes such as extension, advisory support, cooperative development and farmer training have been the subject of reflection by some researchers.

(Grimard, 2018)Studied the performance of peasant management structures within a Sahelian rural development organization (ODR) in Mali.

The ODRs were created in all West African countries to facilitate public intervention in the 1970s in the agricultural sector. These structures which carried the hopes of the development of production in rural areas experienced failures after a few years. He worked to elucidate “certain problems at the level of the supervisor-farmer junction and to seek what can lead to

an improvement in these reciprocal relations, which improvement can undoubtedly promote increased performance of the entire system of management frame."

Thus, vulnerability perceived as the individual's inability to adapt results from the fact that the individual fails to convert his potentialities into capabilities.

The theme "supervision" has been extensively developed in the pedagogical and distance learning environment. On this subject, researchers agree on the fact that it is about "learning support services", which bring together human and technological resources supporting the learner in his approach (Drion, 2010). However, (Bernatchez, 2000)stands out from these authors by defining, in the pedagogical framework, supervision activities:<<as the implementation of a set of communication and exchange activities, technological means and human resources that allow free collaborative interactions between learners, co-learners and tutors to meet support needs throughout a self-directed distance learning process>>.

This definition attaches importance to the collaborative interactions between the supervisor and the supervisor and the supervisors among themselves, with a view to empowering the learner. This offers a good prism for rural extension activities Badouin (2016) already considered activities of "extension, marketing, credit, animation, cooperation, etc.". He considers that "extension constitutes at the same time as the centerpiece of the agricultural supervision, the technical aspect of the latter". It must be supplemented by "the economic framework". The success of extension should be noted by the increase in harvest tonnage. This researcher has highlighted the important role of agricultural research institutions and universities in what he calls.

Beaudoux (2016) considers that "extension programs must take into account production systems and agrarian structures in their technical, economic and social components as well as the relations of agriculture with the environment". Modern agriculture certainly reduces

hunger and poverty in these socioeconomic aspects, but it generates ecological problems through the intensive use of inputs (chemical fertilizers, pesticides).

Drion (2014) studied the general principles on which agricultural extension should be based, drawing on models from sub-Saharan Africa. He showed the preponderant role of popularization in the development of cotton production in Zaire before independence. He believed that these spectacular results stemmed from the convergence of interests between the colonial government and the private sector.

This researcher has also shown that "the place of extension in the development of the cotton sector in French-speaking Africa depends on the degree of integration of these sectors". If the sector was able to succeed in Mali, it is because the Malian textile development company took charge of all the functions from production to marketing. However, in many countries, integration is limited to production functions and industrial operations. Thus the functions of stabilization and marketing are ensured by State companies other than the cotton companies. This was the case in Côte d'Ivoire, Cameroon, the Central African Republic, Senegal9Drion, 1994).

However, Drion (2014) recognizes that Burkina Faso was exceptional, because the integration of functions was partial. "These are rural development organizations distinct from the cotton companies which ensure the functions of production, distribution of inputs and marketing".

Mukantagwera (2011) showed in his research that the training and education of farmers allows the development and survival of their cooperative and therefore contributes to the improvement of production. She pointed out that "the low use of agricultural inputs and imperfections in the hydro-agricultural facilities do not allow rice farmers to maximize the yields of their farms" (Mukantagwera, 2011). She believes that this fact stems from training

gaps, despite the felt needs, which affect the yields of the cooperative studied. The lack of professionalism of the leaders, the lack of equipment and the lack of resources noted in his research denote a lack of supervision which is provided mainly by public services and partner organizations.

According to the authors, coaching activities are based on exchanges and interactions between supervisor and supervisor in order to achieve the latter's autonomy and achieve the common goal. It borrows managerial knowledge for its efficiency of result. Modern management recommends believing in the abilities of employees by putting them in a good position for work, which makes it possible to optimize performance. This is not yet rooted in managerial practices in underdeveloped countries where people still believe in the miracles of the mechanistic organization of work based on bureaucracy and a system of dominance.

2.4 Research gap

Of the more than one hundred studies we have consulted on the subject of agricultural supervision, there are very few that deal directly with the effect of farmers management on food security in CEMAC. These studies are all limited to the relationship between agriculture and growth in order to draw conclusions about the evolution of food security. At this level, for the World Bank, growth is a necessary but not sufficient condition for reducing food insecurity, since management can contribute to food insecurity reduction or, more generally, to a direct improvement in well-being, other than through the growth channel.

Four studies have examined the relationship between the agricultural sector and Gross Domestic Product (GDP), recognized as a good measure of the level of agricultural production.

The analysis of the cointegration between agricultural productivity and food availability is based on the ARDL model of (Pesaran et al. 2001). They conclude that the supervision of

farmers improves agricultural productivity. Economic progress, in a given country, inevitably has the consequence of reducing agriculture's share of employment and GDP (De Janvry et al. 2009.). (Timmer ,Cervantes and Brooks, 2019) ,This is primarily due to the fact that the elasticity of demand relative to time is greater in the case of non-agricultural services.

Thus, as incomes rise, consumers increase their consumption of manufactured goods and services more than their consumption of food products.

The authors believe that the links between agriculture and the reduction of poverty are based on the action of four "transmission mechanisms":

- The direct impact of improved agricultural performance on rural incomes;
- Consequences of lower food prices for the poor in rural and urban areas;
- The contribution of agriculture to growth and the creation of economic outlets from this sector;
- The fundamental role of agriculture in stimulating and sustaining economic transition, when this sector ceases to occupy the leading position in a country (and in supporting the poor) and gives way to more varied processing and service activities. If so, the ability to reduce food insecurity in the future, by relying on these mechanisms, will depend on the extent to which agricultural productivity can be increased where it is most needed.

2.5 Conceptual framework

In order to ensure clarity of this study, the researcher developed the following conceptual framework which helps to understand the effects of farmer management on food security in CEMAC through independent, dependent and intervening variables as shown in the below figure 1.

-Cultivated area

The land factor is the total amount of land allocated to agriculture. This factor is considered in the modelling, given that agriculture in Cameroon is extensive and therefore the growth of agricultural land is likely to influence the growth of agricultural output.

In general, production is considered to increase with cultivated area. It is given in square kilometers of land agricultural.

-Secondary school enrolment rate

Education is an important factor in improving labor productivity. It will be taken into account here by the share of the population with secondary education. Given that, on average, farmers are educated at primary level, an increase in the share of the population with secondary education may reflect an improvement in the level of education of the rural population, and therefore of farmers.

In the CEMAC context, improved education levels are reflected in a loss of interest in the agricultural sector, which in turn reduces the agricultural workforce and hence the volume of production. In the literature, education is the factor most cited by authors as explaining producers' level of efficiency (Zonon, In the literature, education is the factor most cited by authors as explaining producers' level of efficiency, 2013). However, there is no global consensus on the impact of investment in education on farmers' productivity. Gurgand (2017) finds that education has a zero or even negative return in agriculture in Côte d'Ivoire. This is given by the percentage of secondary school enrolment.

The variable has a positive sign.

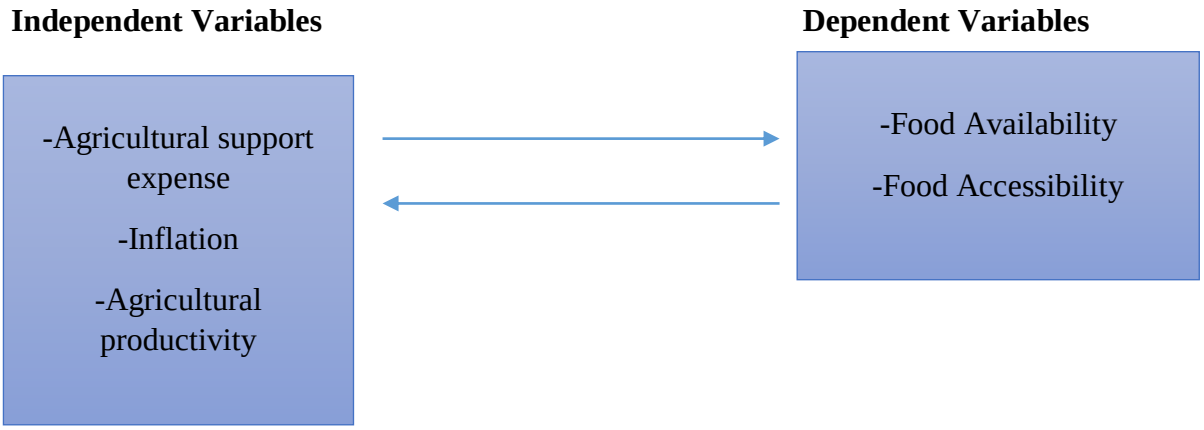


Figure 1: Conceptual framework

As above observed, in the box of independent variables, there are Agricultural support expense, Inflation , Agricultural productivity ,and in the box intervening variables there are Cultivated area, Corruption control, Population growth rate, Secondary school enrollment rate, Armed conflict , as key engine for farmer management on food security in CEMAC zone.

So, all findings from this research are going to be the fruit of all these variables.

2.6 Conclusion

At the end of this chapter where it was a question of analyzing the theoretical and empirical foundations of the supervision of farmers on the reduction of food insecurity, it appears that the agricultural supervision is a means of development of agriculture whose results are very advantageous in the context of food security. It is practiced in both southern and northern countries. Farmers are supervised in most countries by the state and through national and international institutions. Sub-Saharan Africa is one of the main regions suffering from food insecurity. It does not seem to favor economic growth in sub-Saharan Africa. The impact of the supervision carried out is insignificant.

CHAPTER 3 RESEARCH METHODOLOGY

This chapter is devoted to the methodological approach; we will specify the specification of the basic model, the data used as well as the methods and techniques of econometric estimation.

3.1. The population of the study

Study population refers to the people, things, and events from which the research sample was drawn. The population of this research is a sample of three countries (Chad, Gabon, Cameroon) of the CEMAC zone whose data are available and the data used come from the various secondary sources which are: WDI, FAOSTAT, and the two data armed conflict and natural disaster that we have constructed (these are the dummy variables, to construct: in the case of Chad, if Chad has experienced a war, we note 1 and if Chad has not experienced a war, we note 0). These data are 2000-2018, 57 Observations in total. We did not do questionnaires not sampling to say that we did not use raw or primary data. We used secondary data.

3.2. Data collection techniques and tools

This research is made up of the annually data of agricultural support expense, agricultural production, and other variables used to test the effect of farmer's management on food security for three countries of the CEMAC zone from 2000 to 2018. Based on the availability of data over the period and because the use of a wide coverage is essential in order to enhance the reliability of the data used for estimation as well as reliability and consistency of the results, the research uses panel data for those countries. The selected countries in the CEMAC zone are: Cameroon, Gabon, and Chad.

In our study, we have used secondary data sourced from World Development Indicators (WDI),Food and Agriculture Organization Corporate Statistical Database (FAOSTAT). The

websites for the World Bank were consulted for documentations including reports, economic reviews and different publications relatives to the research. And these variables are numerical data that can be evaluated using statistical techniques. The method was used by the researcher to investigate the effects of farmer's management on food security in CEMAC.

3.3. Data process

Panel Data

1) The main interest to use panel data is the group and not the individual units in the group, which means that very little information is lost by taking the panel perspective.

2)The use of panel rather than time series data not only increases the total number of observations and their variation but also reduces the noise coming from the individual time series.

3) Best suited where data availability is an issue particularly for developing countries where short time spans for variables are rampant, often insufficient for fitting time series regressions.

4) There is heterogeneity (differences) among units in the panel.

5) Panel estimation techniques take this heterogeneity into account by allowing for subject specific variables.

6) Suited for studying dynamic changes due to repeated cross-sectional observations.

The study made use of econometric analysis with broad panel data. The reason why we choose to use panel data is that they present several advantages. In most of African (and other developing countries) it is difficult to get data for a long period (more than 30 years). Panel data allow us to considerably increase the sample size. And by studying repeated cross-section observations, panel data are better suited to study the dynamics of change. These two reasons are the ones that motivated us the most to use panel data in this study. (GUJARATI,

2014) But not only that, many criticisms have been leveled at studies that have attempted to explain the effects of farmer's management with time series.

ARDL panel could be used as a model estimation method. Using annual data from secondary source, we used statistical tools such as regression equations to analyze the data and reach conclusions. The software Stata 12 and Eviews 10 are used to estimate the coefficient values of explanatory variables used in the regression model.

3.4 Hypothesis

Hypotheses are the tentative answers to be tested using econometric and statistical methods. The current research was conducted based on the following hypotheses.

H0: The supervision of farmers has a positive effect on the availability of foodstuffs in the CEMAC Zone from 2000 - 2018.

H1: The supervision of farmers has a negative effect on the availability of foodstuffs in the CEMAC Zone from 2000 -2018.

These hypotheses were tested using the ARDL modeling. The ARDL were used to find the long-run effect between dependent variable and independent variable.

Debates around the supervision of farmers have occupied a very important place in major international summits and have constituted a major theme for development objectives.

Few studies have specifically addressed the supervision of farmers. However, related themes such as extension, advisory support, cooperative development and farmer training have been the subject of reflection by some researchers.

Grimard (1989) studied the performance of peasant management structures within a Sahelian rural development organization (ODR) in Mali.

Bourou and Havard (2010) state that in agriculture, services refer to market activities (supply of inputs and equipment, loans, veterinary care, various certifications) and non-market activities (extension, advice, training). They can be directed towards the production of a product or towards the support of a process (case of the organization of farmers). Moreover, the theme "supervision" has been extensively developed in the teaching and distance learning environment.

However, Bernatchez (2000) stands out from these authors by defining, within the pedagogical framework, supervision activities:<<as the implementation of a set of communication and exchange activities, technological means and human resources that allow free collaborative interactions between learners, co-learners and tutors to meet support needs throughout a self-directed distance learning process>>. This definition gives importance to collaborative interactions between the supervisor and frames it between them, with a view to empowering the learner. This offers a good prism for the rural extension activities that Badouin (1965) already considered as activities of "extension, marketing, credit, animation, cooperation, etc."

Badouin (1965) considers that "extension constitutes at the same time as the centerpiece of agricultural supervision, the technical aspect of the latter". It must be supplemented by "the economic framework".

Drion (2014) studied the general principles on which agricultural extension should be based, drawing on models from sub-Saharan Africa. He showed the preponderant role of popularization in the development of cotton production in Zaire before independence. He believed that these spectacular results stemmed from the convergence of interests between the colonial government and the private sector.

On the other hand, Beaudoux (2017) considers that “extension programs must take into account production systems and agrarian structures in their technical, economic and social components as well as the relations of agriculture with the environment”.

In view of all the above, we can formulate the following hypothesis:

The impact of farmer management on the evolution of agricultural production has emerged as one of the variables explaining the evolution of agricultural production in developing countries such as Cameroon, Gabon and Chad. In this study, the evolution of the farm management dependency has a positive and significant influence on the evolution of agricultural production and farm income, which is an indicator of the well-being of the population. This research has shown that the training and education of farmers enables the development and survival of their cooperatives, and thus contributes to the improvement of production.

For a long time, agriculture suffered from a tenacious negative presupposition, but quite understandable, because it was based on the "natural slope" of historical facts. Indeed, the decline in the share of agriculture in growth, to the benefit of industry and then the tertiary sector, is a finding of rare regularity in the history of development. This was the case for the first industrial revolutions, starting with England in the 18th century, as for China or India in the 20th century. The major currents of thought that have historically influenced the various development policies in the world often have in common the fact of translating this "structural transition" into a form of agricultural inferiority. Thereby:

The vision of Quesnay, for whom agriculture was the only activity that really produced wealth and "created the virtue of peoples and the strength of States" (Weulersse, 2013)did not dominate.

Lewis (2015) deduced zero productivity and the opportunity to employ this disguised unemployment, the “surplus” of labor, in capitalist sectors with positive marginal productivity.

As for the defenders of the framework, they refute these arguments, judging them to be exaggerated.

Thus, (Richards , 2015)presents three periods that have marked the history of African rural development and agricultural supervision, based on examples taken from the Anglo-Saxon world (Nigeria, Sierra Leone).

(Rôling, 2015)also provides a very informative overview of extension in general. It shows how a change in intervention policy, organizational method or supervision method changes the behavior of the target populations.

(Rist, 2014) proposes a point of view aimed at methods of strengthening supervision: increasing the number of supervisors in the same area, for example.

Richards (2015) insists on the knowledge of popular knowledge. Rôling (2015) proposes the AKIS (Agricultural Knowledge and Information System) method for listing this knowledge. (Bayart, 2019) offers it a "bottom-up" approach, drawing inspiration from De Certeau's book (1990) which itself shows that the people are endowed with a certain number of resources which are in fact "arts of do" strategic or tactical.

Addressing rural sociology of the young independent African states, (Badouin, 2015) presented the difficulties of structuring the activities of supervising the peasants with a view to the modernization of traditional agriculture.

In view of this work, it follows that the development of the agricultural sector requires the promotion of farmers' organizations and the support services that go with it by setting up a support-advice and support system centered on the objectives. from production.

Indeed, the question of the supervision of farmers remains unresolved between the various authors.

3.5. Model specification

In order to achieve our objective, the study made use of econometric analysis with broad panel data to which we will apply the ARDL panel. In this model, the lagged dependent variable is considered as the control variable. This method solves the problem of endogeneity of the dependent variable.

Most of the models estimated in the empirical literature on the framing effect have the general form of the model (Ghura and Hadjimicheal., 2016). Nubukpo (2007) drew on the work of Ghura and Hadjimichael (2016) and Gurgand (2016) on real GDP growth in African countries.

Hence the model is written:

- $Log(DA)=\beta0 + \beta1Log(DEA)+ \beta2SC + \beta3CC + \beta4TCP + \beta5TSC+\beta6DN+ \varepsilon i$
- $AA = \beta0 + \beta1Log(DEA) + \beta2CA + \beta3INFA +\beta4PA + \varepsilon i$

Where (DEA) is Agricultural Support Expense, (SC) Cultivated Area, (CC) Corruption Control, (TCP) Population Growth Rate, (TSC) Secondary School Enrollment Rate, (DN) Natural Disaster and (DA) Availability Food is the variable to be explained. The second model has five variables to explain, namely: Agricultural Support Expense (DEA), (CA) Armed Conflict, (INFA) Inflation, (AP) Agricultural Productivity, (AA) food accessibility.

$\beta0$ is the constant;

ε is error term;

β1 β2 β3 β4 ……. B6 are the regression coefficients associated with each of the variables.

a) **The choice of variables**

In order to test the hypotheses, formulated below, in order to develop a basic panel model for this work, we used the variables for which the data are available on the basis.

a.1. The variables to explain

The research has explained two variables in this thesis.

- For the first model, we have:

a.1.1. Food availability

It is the availability of food in sufficient quantity and of an appropriate quality, the supply of which is ensured by national production or imports (including food aid). Food Avaibility is expressed in calorific value. Indeed, any increase in labor productivity increases Food Avaibility more than proportionally. This can be explained by the positive effect of improved technical efficiency or technological progress on production. For the measurement of the Food Availability variable, we used FAO data which is calculated in FAOSTAT. FAO calculates every year for each country by estimating how much food is available, by determining what proportion of the population may not have access to the food they need. To calculate Food Availability, FAO used the volume of cereal production.

a.1.2. Food accessibility

It is the set of factors allowing everyone, regardless of their socio-economic or physical condition, to access a grocery store or any other place offering food. Accessibility includes both the dimensions of geographic proximity, the cost of food, and the cognitive and physical abilities required to obtain food. Geographical access to a grocery store is considered low beyond a distance of one kilometer in urban areas and sixteen kilometers in rural areas. For the measurement of the Food Accessibility variable, we used FAO data which is calculated in

FAOSTAT. To calculate Food Accessibility, FAO took into account the purchasing power of individuals.

a.2. The variables of interest in the two models

These two models have the same variable of interest which is the Expenditure on Agricultural Supervision (DEA).

The Agricultural Supervision Expenditure: this is the budget devoted to the supervision of agriculture. The spending on agriculture is the proxy of agriculture supervision. In general, the budget devoted to the supervision of agriculture is taken into account in the budget of agriculture, so when we give the budget of the Ministry of Agriculture, this also incorporates the budget to supervise farmers. It is given in billion CFA; its expected sign is positive.

3.6. Methods of data analysis

3.6.1 Model estimation method

In recent years, there has been a surge of interest in dynamic panel data models, in which the number of time series observations, T, is relatively large and of the same order of magnitude as the number of groups, N. Such panels are common in cross-country analyses. The long-run effects and the speed of adjustment to the long run are the parameters of interest in most applications of this type.

Suppose that given data on time periods, t = 1,2, ... ,T, and groups, i = 1,2, ... , N, we wish to estimate an ARDL(p, q, q, ... , q) model,

$$y_{it} = \sum_{j=1}^{p} \delta_i \, y_{i,t-j} + \sum_{j=0}^{q} \beta_{ij}' \, X_{i,t-j} + \varphi_i + e_{it} \qquad (1)$$

Where y_{it} is the dependent variable, $(X_{it}')'$ is k*1 vector that are allowed to be purely I(0) or I(1) or cointegrated, δ_{ij} is the coefficient of the lagged dependent variable called scalars; β_{ij} are k*1 coefficient vectors; φ_i is the unit-specific fixed effects; i = 1,2, ... , N; t = 1,2, ... ,T; p,q are optimal lag orders; e_{it} is the error term.

The re-parameterized ARDL (p,q,q,…q) error correction model is specified as:

$$\Delta y_{it} = \theta_i[y_{i,t-1} - \lambda_i' X_{i,t}] + \sum_{j=1}^{p-1} \xi_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \beta_{ij}' X_{i,t-j} + \varphi_i + e_{it} \qquad (2)$$

Notes:

- θ_i= -(1-δ_i), group-specific speed of adjustment coefficient (expected that θ_i <0)
- λ_i'= vector of long run relationships
- ECT=$[y_{i,t-1} - \lambda_i' X_{i,t}]$, the error correction term
- ξ_{ij}, β_{ij}' are the short-run dynamic coefficients

3.6.2 Preliminoly test

3.6.2.1 Panel unit root

Before proceeding to cointegration techniques, we need to verify that all variables are integrated with the same order. In doing so, we have used the first generation test of the panel unit root of Im et al. (2023, hereinafter IPS) and the second generation test of the panel unit root of Pesaran (2005). These tests are less restrictive and more powerful than the tests developed by (Levin and Lin , 2013), Levin et al. (2012) and Breitung (2012), which do not allow for heterogeneity in the autoregressive coefficient. The tests proposed by IPS permit solving Levin and Lin's serial correlation problem by assuming heterogeneity between units in a dynamic panel framework.

The basic equation for the panel unit root tests for IPS is as follows:

$$\Delta y_{i,t} = \alpha_i + \rho_i y_{i,t-1} + \sum_{j=1}^{p} \emptyset_{ij} \Delta y_{i,t-j} + e_{i,t}\ ; \qquad i = 1,2,\ldots..,N; t = 1,2,\ldots.,T \qquad (1)$$

Where $y_{i,t}$ stands for each variable under consideration in our model, α_i is the individual fixed effect and p is selected to make the residuals uncorrelated over time. The null hypothesis is that $\rho_i = 0$ for all i versus the alternative hypothesis, which is that $\rho_i < 0$ for some i=1,….,N_1 and $\rho_i = 0$ for i=N_1 + 1,…,N.

The IPS statistic is based on averaging individual augmented Dickey-Fuller (hereinafter ADF) statistics and can be written as follows:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{iT} \qquad (2)$$

Where t_{iT} is the ADF t-statistic for country i based on the country-specific ADF regression, as in Eq. (1). The statistic has $\bar{t}$ been shown to be normally distributed under H0, and the critical values for given values of N and T are provided in Im et al. (2003).

3.6.2.2 Stationarity test

Before proceeding with the estimation of the model, it is advisable to ensure the stationarity of the observed series, because when the variables are not stationary, the estimation of the coefficients by the pooled mean group and the usual F-Fischer and t-Student are not valid. Economic series are not stationary by nature. The values obtained at each date are not always derived from the same probability law. It is necessary to stationarize the non-stationary series to avoid the risk of spurious regressions.

There are a number of tests for detecting instability or series: since graphical methods are unreliable, we will have to resort to more rigorous tests such as: the Dickey-Fuller(ADF) unit root usual test, which may be simple or increased, the test ADF consists in testing the null hypothesis "unit root or non stationarity is present "against the alternative hypothesis "stationary processis present". By formulating these hypotheses mathematically we have:

H0:δ=

H1:δ<1,βo≠0

The decision rule (accept or reject the null hypothesis) consists in comparing the calculated absolute value of the Dickey-Fuller Augmented (ADF)statistic with the absolute value of McKinnon's(1973) read critical value(CV).

3.6.3 Diagnostic tests

3.6.3.1 Cointegration test

Cointegration analysis helps to clearly identify the true relationship between variables by looking for the existence of a cointegrating vector and eliminating its effect if any. When the series are not stationary in level, there is presumption of cointegrations which are verified by the ARDL were used in this thesis.

3.6.3.2 Pooled mean group estimators

On the one hand, Loayza and Ranciere contend that standard static panel models such as pooled OLS, fixed effects, or random effects do not allow for the distinction of short- and long-run relationships among variables.(Simões, 2011) Furthermore, Campos and Kinoshita [claim that when some repressors are endogenous, as we will see in our particular sample, the parameters can be biased Focusing on dynamic panel models, Arellano and Bond's GMM-difference estimator and Arellano and Bover's GMM-system estimator are very useful when the sample has a large number of countries relative to the time period, which is not our case.(Pesaran, Pesaran, Shin, & Smith, 1999)

Furthermore, the GMM is more concerned with short-run dynamics. Taking these shortcomings into account, the panel autoregressive distributed lag (ARDL) technique appears to be a very successful method for overcoming these drawbacks. According to Pesaran and Shin, one of the main advantages of this methodology is that it can be used when variables have different orders of integration, or when they are I(0), I(1), or a combination of the two.(Martorano, Sanfilippo, & Haraguchi, 2017)

The Mean Group (MG) estimator, the Pooled Mean Group (PMG) estimator, and the Dynamic Fixed Effects (DFE) estimator can all be used to estimate the Panel ARDL Approach. The Pesaran et al. PMG considers long-term slope parameters to be homogeneous across countries, but short-run coefficients to be heterogeneous. Pesaran and Smith's MG

allows for country-specificity in both the short and long term. This procedure, in particular, estimates individual regressions for each country before computing unweighted means.

The DFE is very similar to the PMG, but it also limits not only the long-run coefficients but also the short-run coefficients to being equal across countries. To distinguish between the PMG, MG, and DFE, we use the Hausman test to see if there are any significant differences between these estimators. It is well known that PMG and MG are both consistent; however, under the assumption of long-term homogeneity, PMG is more efficient. As a result, we test the null hypothesis that the difference between PMG and MG is not significant, as well as the hypothesis that the difference between PMG and DFE is the most appropriate. (Rafindadi, 2013)

Two estimation methods are often used to estimate panel data models. The first (mean group estimator) consists of averaging separate estimates for each group in the panel. According to (Pesaran and Smith , 2015), this estimator provides consistent estimates of the parameter's averages. (Pirotte, 2019)also shows that the mean group estimator provides efficient long-run estimators for a large sample size. It allows the parameters to be freely independent across groups and does not consider potential homogeneity between groups. The second method is the usual panel method (random or fixed effects and GMM methods). These models force the parameters to be identical across countries and could lead to inconsistent and misleading long-term coefficients, a possible problem that is exacerbated when the period is long. (Pesaran et al. , 2015) proposed an intermediate estimator that allows the short-term parameters to differ between groups while imposing equality of the long-term coefficients between countries. One advantage of the PMG is that it can allow the short-run dynamic specification to differ from country to country while making the long-run coefficients constrained to be the same.

3.6.3.3 Goodness of fit of the model

The quality of the regression R^2 measures the proportion (percentage) of the total variation of the variable to be explained by the regression model. The coefficient of determination R2 is a summary measure that indicates how well the sample regression line fits the data. However, it should be noted that the R^2 increases with the explanatory variable. Its value is between 0 and 1. It takes the value 0 when no explanatory variable explains the variable to be explained and takes the value 1 if 100 percent of the explanatory variables explain the variable to be explained.

3.6.3.4 Mean group

(Pesaran, Shin and Smith , 2015)suggest Mean Group (MG) model in order to resolve the bias due to heterogeneous slopes in dynamic panels, the MG estimator on the other hand, provides the long-run parameters for the panel through making an average of the long-run parameters from ARDL models for individual countries. For instance, if the ARDL model follows

The Above equations reveal how the model estimates separate regressions for each country and calculate the coefficients as unweight mean of the estimated coefficients for the individual countries. This does not impose any restriction. It allows for all coefficients to vary and be heterogeneous in the long-run and short-run. However, the necessary condition for the consistently and validity of this approach is to have a sufficiently large time-series dimension of the data.

e) Dynamic Fixed Effect

The dynamic FE estimator is remarkably similar to Pooled mean group estimator, however; it confines the coefficient of the co-integrating vector to be equal across all panels in the long run. The FE models further restricts the speed of adjustment coefficient and the short-run

coefficient to be equal. Dynamic fixed effect model allows panel-specific intercepts. DFE also calculate the standard error while making allowance of intragroup correlation. As discussed in Baltagi, et al. (2000), E models are subject to a simultaneous equation bias from the endogeneity between the error term and the lagged dependent variable. The Hausman test can be easily performed to measure the extent of this endogeneity.

3.7. Restrictions

The CEMAC zone is made up of six countries: Chad, Cameroon, Gabon, Equatorial Guinea, Congo and the Central African Republic, but given the unavailability of certain data, the research has limited herself to the three countries in the CEMAC zone; Chad, Cameroon and Gabon from 2000 to 2018.

3.8 Conclusion

In this chapter, the methodological approach that was uses to estimate the models specified in this thesis. The results obtained will allow us to confirm or invalidate the research hypotheses. The logical continuation consists in carrying out the econometric tests, presenting and interpreting all the results obtained from the Stata 12 and EVIEWS 10 software.

CHAPTER 4 RESULTS AND INTERPRETATION

The evaluation of the influence of the supervision of farmers on food security in the CEMAC countries is our objective in this chapter. The econometric models developed in chapter III will allow us to achieve this goal. To this end, the following hypotheses must be confirmed or invalidated at the end of this study:

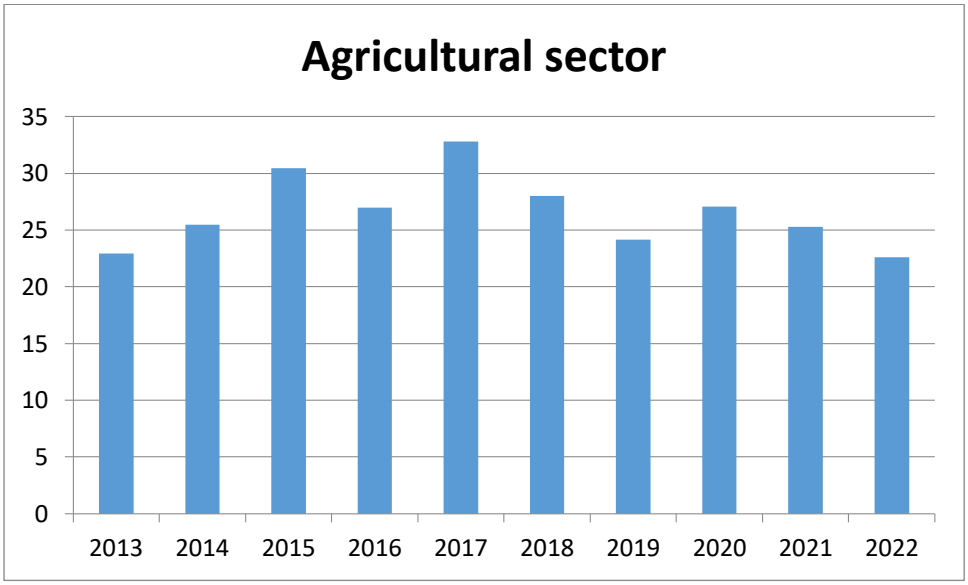
H0: The supervision of farmers has a positive effect on the availability of foodstuffs in the CEMAC Zone from 2000 - 2018.

H1: The supervision of farmers has a negative effect on the availability of foodstuffs in the CEMAC Zone from 2000 -2018.

4.1 The CEMAC countries have different economies based on the below Sectoral trends

-Chad Economic profile 2013-2022

a) Chad agricultural sector trend analysis



Source: Researcher's plot using Excel, 2023

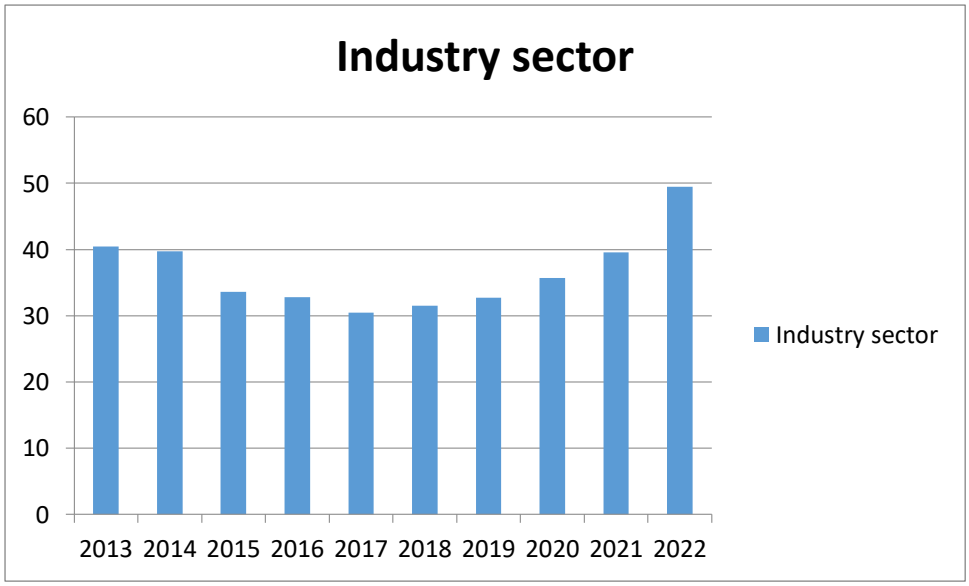
Agriculture is the most important source of income in Chad. It accounts for almost a quarter of gross domestic product (GDP) and employs around 80% of the working population. It thus

makes an essential contribution to the country's economic development, but its potential is not fully exploited.

Agricultural value increased from 2013 to 2017, then began to decline from 2018 to 2022. Only 6% of arable land is used. There are many reasons for this: in addition to factors such as unmanageable climatic variations, soil exhaustion, plant pests and inadequate water management, there is the particular difficulty of very limited access to agricultural inputs, such as seeds.

High-quality seeds are one of the most important factors in boosting agricultural production. They can both improve the population's self-sufficiency and generate income. However, Chad's poorly organized and structured seed sector only partially meets the demand for seeds.

b)Chad industrial sector trend

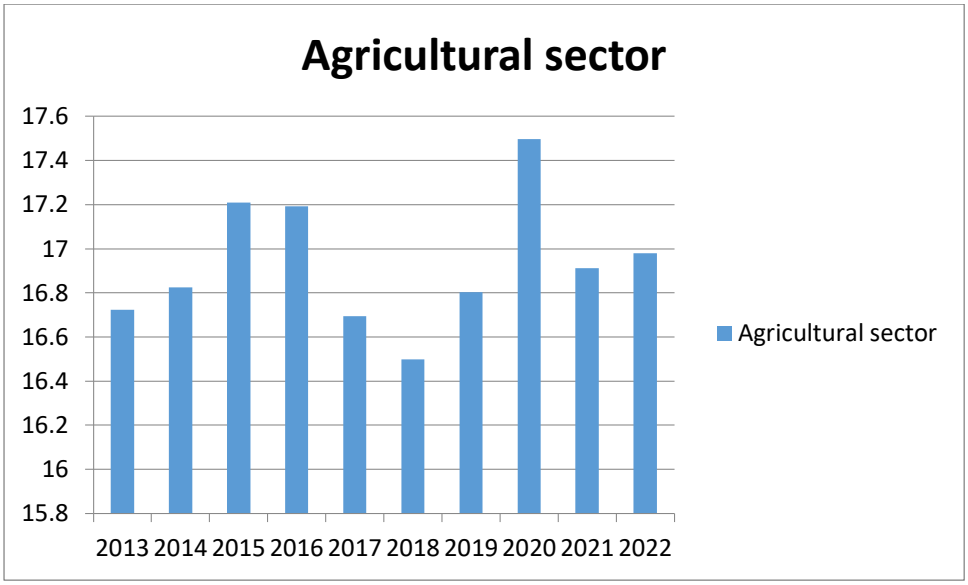


Source: Researcher's plot using Excel, 2023

The industrial sector was booming in 2022, and we can see that the development of the industrial sector is well on the way if all the conventions and guidelines issued are respected to the letter. A country potentially rich in agriculture and livestock plays a negligible role in the process of creating wealth and employment. Chad's industrial sector is made up of several processing units, ranging from agriculture, livestock breeding and fishing to hydrocarbons.

-Cameroon Economic profile 2000-2022

a) Cameroon agricultural sector trend analysis



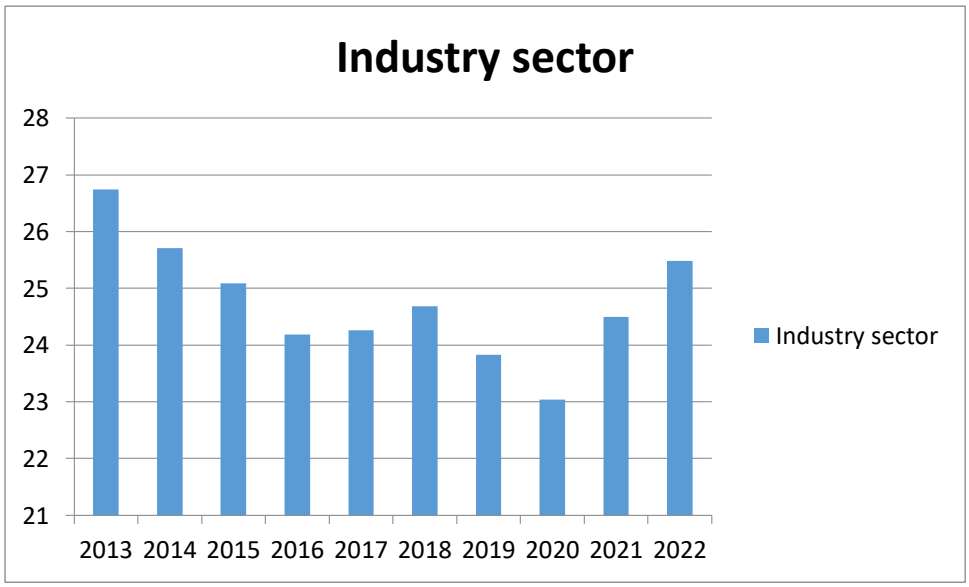
Source: Researcher's plot using Excel, 2023

Cameroon's agriculture was the country's main source of growth and foreign exchange until 1978, when oil production took off. Agriculture accounted for 44% of GDP in 2004, declining to 16.7% in 2013, 17.5% in 2020 and 16.9% in 2021. Agricultural activity and productivity in the sector declined during the oil boom of the 1980s. In Cameroon, around 90% of rural households are invested in the agricultural sector in one way or another. This may explain why this sector employs around 60% of the population and accounts for more than half of the country's non-oil export revenues.

Agriculture was the main occupation for 62% of Cameroon's working population in 2012, although only around 15.4% of land is arable. This low percentage is due to poor arable land management policies and the almost universal isolation of arable areas. Indeed, very few roads link the countryside to the major cities, which has a major economic impact, given that the regions likely to be farmed are not connected to markets. However, despite these shortcomings (which are gradually being resolved), Cameroon enjoys a dynamic agricultural sector that not only achieves over 80% self-sufficiency in food, but also stimulates exports of

consumer products to landlocked neighboring countries (Chad and the Central African Republic), as well as those that do not produce enough food, such as Gabon and Equatorial Guinea.

b) Cameroon industrial sector trend analysis



Source: Researcher's plot using Excel, 2023

Cameroon's industrial development faces major problems both internally and in relation to the external market. Internally, the country suffers from market failure due to the low purchasing power of the local population and the high cost of manufactured goods in Cameroon. We can see that the industrial sector in Cameroon has dropped from 2014 to 2022. This can be explained by several obstacles that hinder the development of industries in Cameroon. These include

1-Domestic market problems

Not only do Cameroonians have very low purchasing power, but locally-produced manufactured goods also have high prices due to costly investment, which does not favor local industries.

2-Lack of capital

To invest in industry, you need to save, and to do so, you need sufficient income. However, over 60% of the Cameroonian population has difficulty meeting its basic needs. Those with substantial means prefer to invest in real estate, which is certainly more profitable in both the short and long term.

3-Lack of a highly qualified workforce

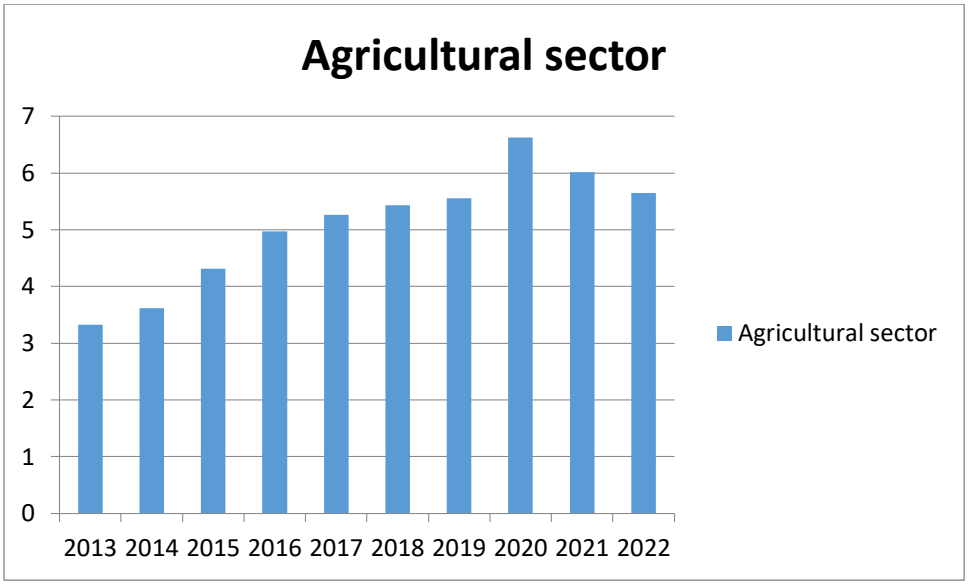
Cameroon has an abundant workforce. But it is either unskilled or poorly trained. There is, however, a highly-qualified workforce, but it is under-employed or misused, i.e. it is placed in situations where it does not perform the functions for which it was trained. This inconvenience drives private employers or the State to resort to foreign expertise, which is nevertheless more expensive.

4-Government action

Government action is inadequate or inappropriate. Indeed, many industries have gone bankrupt in Cameroon, either because they were poorly conceived (e.g. Cellucam), or because they are run by incompetent, selfish and greedy people. There are also the obstacles of taxes and red tape, which discourage both domestic and foreign investors.

-Gabon Economic profile 2000-2022

a)Gabon agricultural sector trend analysis

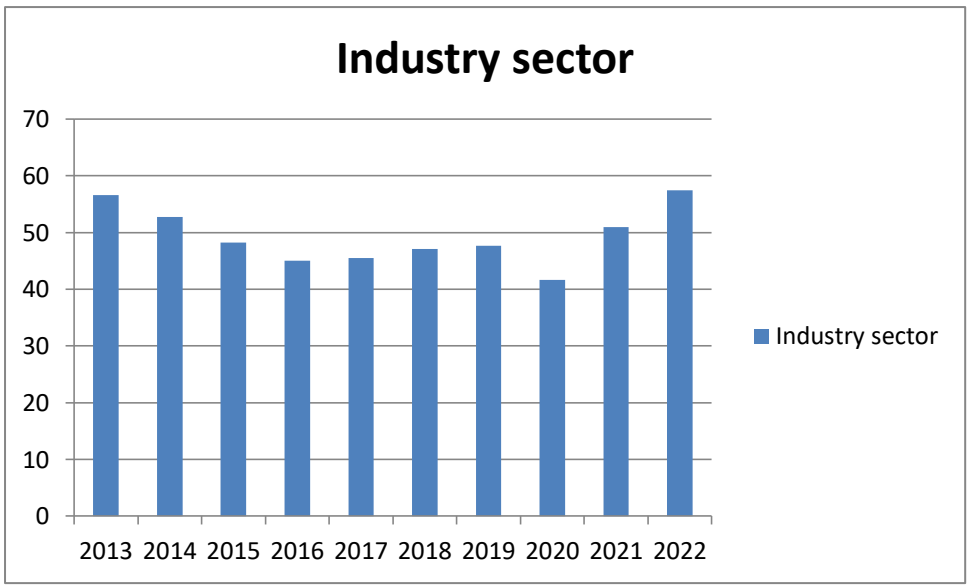


Source: Researcher's plot using Excel, 2023

We can see that investment in the agricultural sector in 2013 was too low, until it picked up again in 2020, before falling back in 2022. The agricultural sector is one of the main contributors to the country's GDP, after the oil industry, which also plays an important role in the Gabonese economy. It is estimated that 1.9% of Gabon's surface area is cultivated, and agriculture accounts for 8% of the country's total GDP.

The Gabonese government supports efforts to diversify and increase agricultural production, and has set up a number of demonstration farms. Although Gabon's agriculture sector has considerable potential, given its natural assets; it contributes only marginally, along with the fishing sector, to wealth creation. As a result, Gabon's agricultural sector is highly dependent on external supplies of foodstuffs.

b) Gabon industrial sector trend analysis



Source: Researcher's plot using Excel, 2023

Investment in the industrial sector is low from 2015 to 2021, with an increase in 2022. Gabon's main industries are oil, minerals (mainly manganese) and wood. The government plans to develop Gabon's industrial sector and improve its national infrastructure. Although export restrictions persist on raw timber, the industry is developing in the manufacture of furniture and plywood products.

4.2 Trend analysis

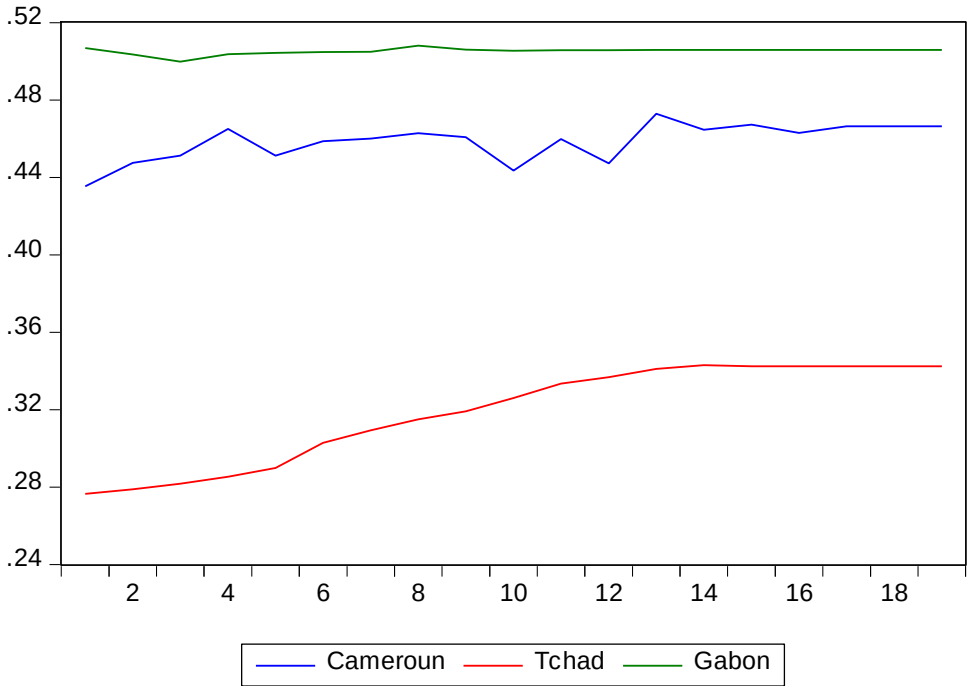


Figure 4.2: Agricultural Supervision Expenditure

Source: Researcher's plot using Eviews, 2023.

Cameroon has experienced an increase in expenditure devoted to the supervision of farmers but slowly, on the other hand, Chad has experienced a jagged evolution of the budgets devoted to the supervision of farmers and Gabon has experienced stability in this area.

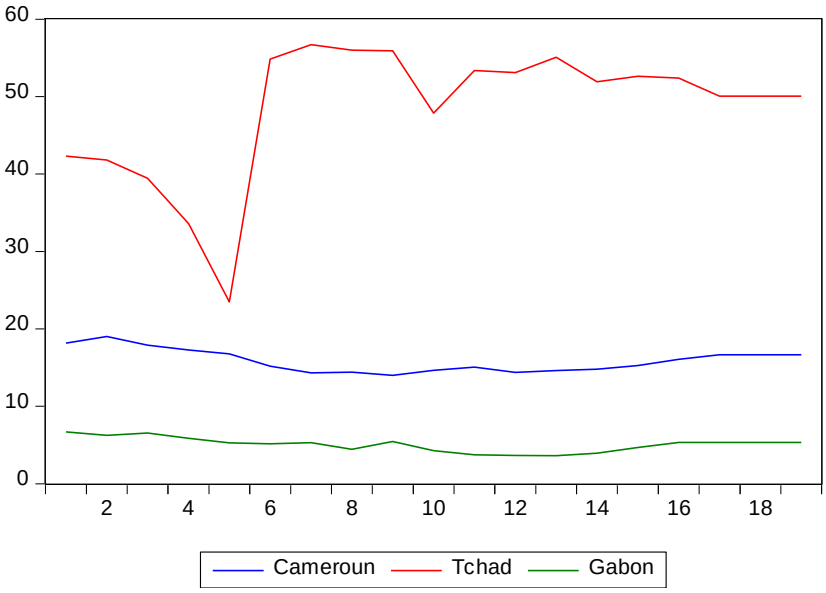


Figure 4.3: Evolution of Food Accessibility in the countries of the CEMAC area

Source: Researcher's plot using Eviews, 2023

On the graph, we see that Gabon and Cameroon experienced stable access to food, while Chad experienced a drastic drop in food accessibility during the period from 2000 to 2006, for compared to 2007 until today, we see an exponential increase in the level of access to food.

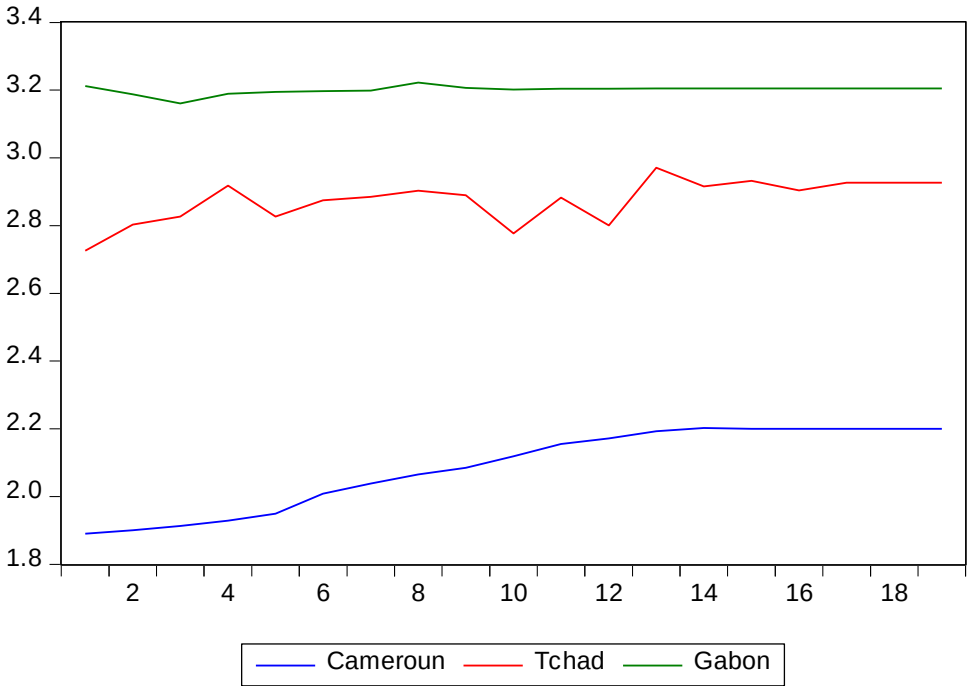


Figure 4.4: Evolution of Food Availability in the countries of the CEMAC zone

Source: Researcher's plot using Eviews, 2023.

Food availability has experienced a slow evolution in Cameroon, on the other hand in Chad it has experienced an ups and downs evolution during this same period and Gabon has experienced a stagnation of food availability

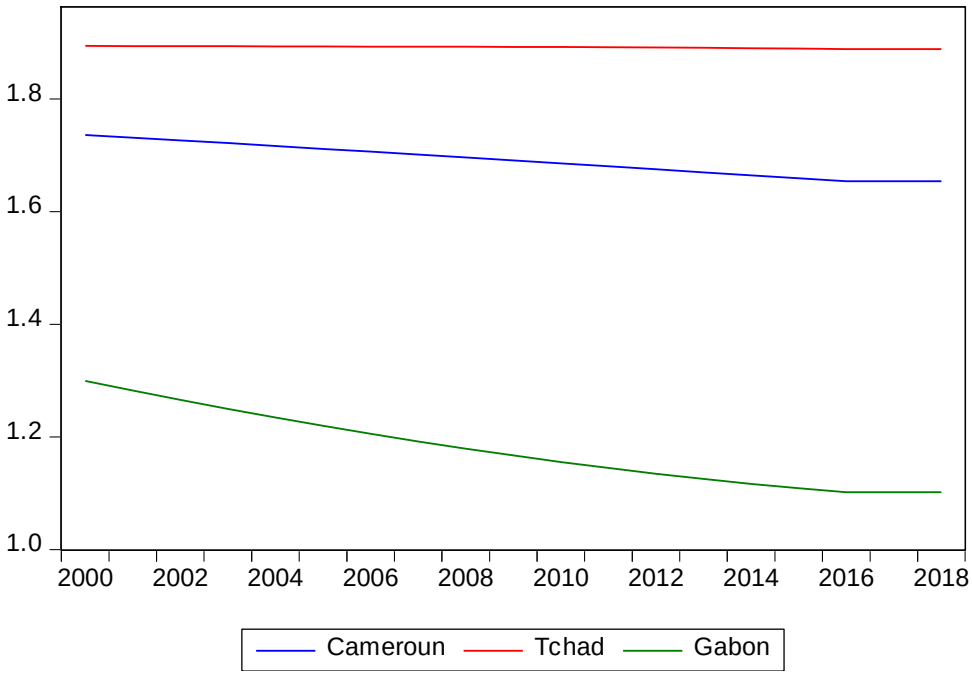


Figure 4.5: Agricultural Production

Source: Researcher's plot using Eviews, 2023

Generally speaking, in the study area, agricultural production is declining and is believed to be slow. This is due to the health and security crisis situation in the area. Gabon and Chad have experienced the 2019 security crisis, so we are seeing a decline in agricultural production in the CEMAC area due to the security crisis linked to the power of political demonstrations.

4.3 Effect of farmers' supervision improves food availability

In this section, it is a question of carrying out the regression of the first model and presenting its results, then of interpreting these results and finally of giving the implications of economic policies.

4.3.1. Tests and results of the econometric model estimates

a.1 Descriptive statistics, stationarity test and cointegration test

Descriptive stastistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LogDA	57	2.720132	0.4787692	1.890365	3.221936
LogDEA	57	0.4273848	0.0815358	0.2765457	0.5081169
SC	57	25.06285	10.30081	14.492	39.65613
CC	57	8.368421	3.35214	1	14
TCP	57	531.5217	754.4409	2.535052	1667
TSC	57	25.98483	18.25598	2.496043	48.27931
DN	57	0.2105263	0.4113064	0	1

Source: Researcher's computation using Stata, 2023

Stationarity test

The researcher performed the Im, Pesaran and Shin test to test the stationarity of the study variables. This test is similar to the ADF test. The result of this test is summarized in the table (Appendix 2).

From the table, it emerges that the variables of the first econometric model do not have the same order of integration. It can therefore be seen that the variables: food availability, agricultural supervision expenditure,population growth rate and natural disaster are stationary at level, i.e. integrated into the order 0. On the other hand, the variable: the cultivated area, corruption control, secondary school enrollment rate integrated into order 1.

Variables	In level		In difference		Integration order
	Statistical values	Probability	Statistical values	probability	
Log(DA)	-1.48203	0.0692			I (0)
Log(DEA)	-1.53700	0.0621			I(0)
CS	0.01209	0.5048	-4.66000	0.0000	I(1)
CC	0.07039	0.5281	-2.37520	0.0088	I(1)
TCP	-2.62975	0.0043			I (0)
TSC	-0.60311	0.2732	-2.05570	0.0199	I (1)
DN	-2.72412	0.0032			I (0)

Source: Researcher's computation using Eviews, 2023

- **Panel Data Cointegration Test**

The cointegration test that we would perform is the Kao test. This test has for null hypothesis the absence of cointegration. As part of this analysis, this test gives us a statistical value of-3.301924 with a probability of 0.0005. Thus, as the probability is less than 5%, we therefore conclude that the different stationary variables in first difference are cointegrated. However, the preliminary tests that we carried out beforehand would allow us to estimate the econometric model by the OLS method without risk of estimation bias (Cf Appendix 3).

4.3.2 Hausman test and first model estimation results

b.1) Hausman test

For any panel model, the question that researchers usually face is the choice between the fixed-effects model and the random-effects model. The Hausman test therefore allows us to answer this question. After performing this test if we obtain a probability greater than 5%, we choose the random effects model but otherwise we choose the fixed effects model. The results of this test are shown in the following table:

Table 4.1: Results of the Hausman test of the first model

Hausman test

```
hausman fixed random

                 ---- Coefficients ----
             |      (b)           (B)             (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------------
      LogDEA |    5.324427     5.154031        .1703965        .0804532
          SC |   -.0191584     .0057219       -.0248803        .0065608
          CC |    -.001913    -.0026024        .0006894               .
         TCP |     .000291     .0001825        .0001085        .0000689
         TSC |    .0057675     .0027761        .0029914        .0003791
          DN |   -.0004078    -.0025836        .0021758               .
------------------------------------------------------------------------------

           chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)

                   =       29.20

         Prob>chi2 =      0.0001
```

Source: Researcher's computation using stata,2023

The result of the probability of the Hausman test is least than 5%. So it is the fixed effects model that is better suited to the data of the study.

b.2) Generalized Method of Moments

Generalized Method of Moments (GMM) is an estimation procedure that allows econometric models especially in panel data to be specified while avoiding often unwanted or unnecessary assumptions, such as specifying a particular distribution for the errors.

Assume the (linear) regression model with an endogenous regressor:

Where: $y = X' ß + u$

y and u are N x 1 vectors; ß is a K x 1 vector of unknown parameters;

X is a N × K matrix of explanatory variables

Because of the assumption of endogeneity, we assume a matrix Z that is N x L Where, L > K

The Z matrix is assumed to comprise a set of variables that are highly correlated with X but orthogonal to u (i.e., a set of valid instruments).

Table 4.2 :Panel Generalized Method of Moments

Dependent Variable: LOG_DA_
Method: Panel Generalized Method of Moments
Date: 10/25/23 Time: 10:16
Sample (adjusted): 2001 2018
Periods included: 18
Cross-sections included: 3
Total panel (balanced) observations: 54
2SLS instrument weighting matrix
Instrument specification: C LOG_DEA_(-1) CC(-1) SC(-1) TCP(-1) TSC(-1) DN(-1)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_DEA_	5.146857	0.180144	28.57082	0.0000
CC	-0.005372	0.001039	-5.168907	0.0000
SC	0.009265	0.001752	5.287952	0.0000
TCP	0.000300	3.75E-05	8.006654	0.0000
TSC	0.006835	0.000431	15.85978	0.0000
DN	-0.013281	0.012237	-1.085305	0.2832

R-squared	0.999529	Mean dependent var	2.726288
Adjusted R-squared	0.999480	S.D. dependent var	0.473914
S.E. of regression	0.010810	Sum squared resid	0.005609
Durbin-Watson stat	1.623980	J-statistic	4.066682
Instrument rank	7	Prob(J-statistic)	0.043737

Source: Researcher's computation using Eviews, 2023

The results correspond to the generalized method of moment estimator and therefore we will have an estimate which will have non-self-correlated error terms

b.3) Results of the estimation of the first model

The results of the estimation of the effect of the supervision of farmers on the availability of foodstuffs in the CEMAC countries are summarized in the following table:

Table 4.2: Panel ARDL regression result of the first model

The Panel ARDL results, taking into account the PMG, FE, and DFE estimations.

	First model		
	Long term		Short term
Variable	Pmg	Fe	Dfe
LOG_DEA	0.812 (854025.5)***	3.971 (0.040) ***	0.795 (1.248) ***
SC	0.721 (29486.96)***	0.636 (0.014) ***	0.630 (0.000) ***
TCP	0.446 (81476.67) **	0.616 (0.159) ***	0.703 (3.865) ***
TSC	0.032 (3997.858)***	0.047 (0.007) **	0.131 (6.871) ***
DN	-0.413 (167802.4)***	-2.055 (0.377) ***	-0.767 (0.000) **
CC	0.154 (37954.91) **	0.124 (0.022) ***	0.548 (0.000) *
C		0.645 (0.354)	

Source: Researcher's computation using Stata, 2023

*** p<0.01, ** p<0.05, * p<0.1.(i) under the null hypothesis, PMG is more efficient estimation than FE. (ii) PMG is more efficient estimation than DFE under the null hypothesis.

c) INTERPRETATIONS OF RESULTS

The coefficients associated with these two variables are, among others:

Long term

- ❖ The coefficient associated with the agricultural supervision expenditure variable is positive and significant at the 5% level. A 1% increase in DEA results in an increase 0.812 of Food Availability.
- ❖ The coefficient associated with the cultivated area variable is negative and significant at the 5% level. A one percent increase in the SC variable a increase in 0.721 of food availability. It is an important indicator of the level of agricultural production in a country.It is an important indicator of the level of agricultural development in a country.
- ❖ The coefficient associated with the natural disaster variable is negative and significant at the 5% level. A one percent increase in the DN variable leads to a decrease in -0.413of food availability.
- ❖ The coefficient associated with the "secondary school enrollment rate" variable has the sign economically expected (positive) and is significant at the 5% level. This relationship could be explained by the fact that framing in Cameroon,Gabon and Chad has helped to sustain the elements that contribute to the improvement in this rate.On the other hand, an increase in this rate on the other hand, leads to a drop in the agricultural workforce and therefore to a drop in agricultural production.Framework has certainly contributed to the construction of educational and health infrastructure, leading to an improvement in education indicators.

- **Hausman test:**the probability of the Hausman test is 0.0001. This value is least than 5%. So it is the fixed effects model that is better suited to the data of the study.

Short term

- ❖ The coefficient associated with the agricultural supervision expenditure variable is positive and significant at the 5% level. A 1% increase in DEA results in an increase of 0.795 of Food Availability.

❖ The coefficient associated with the cultivated area variable is positive and significant at the 5% level. A one percent increase in the SC variable increase in 0.630 of food availability. It is an important indicator of the level of agricultural production in a country.It is an important indicator of the level of agricultural development in a country.

The coefficient associated with the "secondary school enrollment rate" variable has the sign economically expected (positive) and is significant at the 5% level.

The positive sign of the agricultural supervision expenditure coefficient as well as its significance confirm the first hypothesis according to which:

H0: The supervision of farmers has a positif effect on the availability of foodstuffs in the CEMAC Zone.

4.4 Effect of farmers' supervision improves food accessibility

4.4.1 Tests and results of the econometric model estimates

a.1. Descriptive statistics, stationarity test and cointegration test

Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
AA	57	23.13591	19.27674	3.626463	56.71846
LogDEA	57	0.4273848	0.0815358	0.2765457	0.5081169
CA	57	0.1403509	0.3504383	0	1
INFA	57	3.970224	0.4287058	3.345962	4.42867
PA	57	1.587053	0.3058802	1.101541	1.894111

Source: Researcher's computation using Stata, 2023

- **Stationarity test**

As part of this work, we performed the Im, Pesaran and Shin test to test the stationarity of our variables. This test is similar to the ADF test. The unit root test result is therefore summarized (Appendix 11).

From the table, it appears that the variables of our first econometric model have the same order of integration. We therefore see the variables: Food accessibility; Agricultural Supervision Expenditure, inflation, agricultural productivity are stationary at level; CA is stationary at 1st difference .

Variables	In level		**In difference**		**Integration order**
	Statistical value	**Probability**	**Statistical value**	**Probability**	
AA	-1.27162	0.1018			I(0)
Log (DEA)	-1.53700	0.0621			I(0)
CA	0.0621	0.5857	-1.62357	0.0522	I(1)
INFA	-1.91747	0.027			I(0)
PA	-1.81807	0.0035			I(0)

Source: Researcher's computation using Eviews, 2023

- **Panel Data Cointegration Test**

The cointegration test that we will perform is the Kao test. In our case this test gives us a statistical value of-2.934234and the probability is 0. 0017.So as the probability is strictly at 5%. We therefore conclude that the different stationary variables in first difference are cointegrated (Appendix 12).

a.2. Hausman test and estimation results of our first model

- **Hausman test**

After performing this test if we obtain a probability greater than 5%, we choose the random effects model but otherwise we choose the fixed effects model. So it's the effects model that is better suited to the study data. The results of this test are shown in the following table:

Table 4.3: Results of the Hausman test of the second model

```
hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
      LogDEA |    103.9493     31.29493        72.65437        60.35758
          CA |    4.639331     4.147558        .4917727        .3223798
        INFA |    17.41915     26.83773       -9.418582        8.259988
          PA |     42.6513     70.50702       -27.85571        15.86482
------------------------------------------------------------------------------
chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                           =        3.08
                 Prob>chi2 =      0.5452
```

Source: Researcher's computation using stata,2023

The results of the probability of the Hausman test are 0.5452. This value is strictly greater than 5%. So it is the random effects model that is best suited to the study data.

a.3) Generalized method of the moments

Generalized Method of Moments (GMM) is an estimation procedure that allows econometric models especially in panel data to be specified while avoiding often unwanted or unnecessary assumptions, such as specifying a particular distribution for the errors.

Assume the (linear) regression model with an endogenous regressor:

Where: $y = X' ß + u$

y and u are N x 1 vectors; ß is a K x 1 vector of unknown parameters;

X is a N × K matrix of explanatory variables

Because of the assumption of endogeneity, we assume a matrix Z that is N x L Where, L > K

The Z matrix is assumed to comprise a set of variables that are highly correlated with X but orthogonal to u (i.e., a set of valid instruments).

Table 4.4: Panel Generalized Method of Moments

Dependent Variable: AA
Method: Panel Generalized Method of Moments
Date: 10/26/23 Time: 06:38
Sample (adjusted): 2001 2018
Periods included: 18
Cross-sections included: 3
Total panel (balanced) observations: 54
2SLS instrument weighting matrix
Instrument specification: C LOG_DEA_(-1) CA(-1) INFA(-1) PA(-1)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG_DEA_	2.569827	0.575493	4.465436	0.0000
CA	-0.008510	0.134476	-0.063280	0.9498
INFA	0.153410	0.025133	6.103846	0.0000
PA	0.529244	0.098606	5.367248	0.0000

R-squared	0.909175	Mean dependent var	1.188599
Adjusted R-squared	0.903726	S.D. dependent var	0.414285
S.E. of regression	0.128545	Sum squared resid	0.826189
Durbin-Watson stat	0.354597	J-statistic	35.35115
Instrument rank	5	Prob(J-statistic)	0.000000

Source: Researcher's computation using Eviews, 2023

The results correspond to the generalized method of moment estimator and therefore we will have an estimate which will have non-self-correlated error terms

b) Results of the estimation of the second model

The results of the estimation of the effect of socio-political instability on FDI flows entering CEMAC countries are summarized in the following table:

Table 4.4: Panel ARDL estimation result of the second model

	Second model		
	Long term		Short term
Variable	Pmg	Fe	Dfe
LOG_DEA_	0.901 (584025.5)***	0.921 (1.404) ***	0.756 (0.035) **
CA	-0.853 (23386.96)***	-0.531 (1.214) *	-0.416 (0.478) ***
INFA	-0.879 (51276.60)***	-0.727 (3.300) **	-0.603 (6.867) ***
PA	0.612 (1077.812)**	0.518 (1.177) ***	0.235 (2.170) *
C		-1.078 (1.604)	

Source : Researcher's computation using Eviews,2023

*** p<0.01, ** p<0.05, * p<0.1.(i) under the null hypothesis, PMG is more efficient estimation than FE. (ii) PMG is more efficient estimation than DFE under the null hypothesis.

c) INTERPRETATIONS OF RESULTS

According to our empirical results:

Long term

- **Agricultural supervision expenditure:** the coefficient associated with the "Agricultural supervision expenditure" variable is positive and is significant at the 5% level. However, this variable has the economically expected sign. However, a 1% increase in the DEA variable leads to an increase in 0.901 food accessibility. The long-term preponderance of the impact of farmer management on the evolution of agricultural production is highlighted in the work of Mukantagwera (2011), where farmer support expenditure (FSE) is one of the variables among the variables that explain the evolution of agricultural production in developing countries such as Cameroon, Gabon and Chad. In this study, the evolution of agricultural has a positive and significant influence on the evolution of agricultural agricultural production and income, which is an indicator of the well-being of the population. The research has shown that training and education of farmers enable the development and sustainability of their cooperative, and contribute to improved production. The analysis of the cointegration between agricultural productivity productivity and food availability is based on the ARDL model (Pesaranetal, 2012), which concludes that farmer supervision improves productivity.
- **Conflict Army (CA):** the coefficient associated with the variable CA has a negative and significant sign; However, a 1% increase in the CA variable leads to an increase in 0.853 food accessibility;
- **The inflation rate:** the coefficient associated with the INFA variable has a negative and significant sign. However, a 1% increase in the INFA variable leads to an increase in 0.879 food accessibility;

- **Agricultural Production (% GDP):** the coefficient associated with the agricultural production variable has a positive and significant sign. However, an increase of one point in the PA variable leads to an increase in 0.612 food accessibility;

Short term

- **Agricultural supervision expenditure:** the coefficient associated with the "Agricultural supervision expenditure" variable is positive and is significant at the 5% level. However, this variable has the economically expected sign. However, a 1% increase in the DEA variable leads to an increase in 0.756 food accessibility.
- **Conflict Army (CA):** the coefficient associated with the variable CA has a negative and significant sign; However, a 1% increase in the CA variable leads to an decrease 0.416 in food accessibility;
- **The inflation rate:** the coefficient associated with the INFA variable has a negative and significant sign. However, a 1% increase in the INFA variable leads to an decrease in 0.603 food accessibility;
- **Agricultural Production (% GDP):** the coefficient associated with the agricultural production variable has a positive and significant sign. However, an increase of one point in the PA variable leads to an increase in 0.235 food accessibility;

Hence we are led to accept our second hypothesis H0:

H0: The supervision of farmers improves the accessibility of foodstuffs in the CEMAC Zone.

4.5 Discussion of results

The aim of this work is to examine the effects of farmer training on food security in the CEMAC zone. Achieving this objective was facilitated by the use of statistical analysis of data relating to food availability and food accessibility of foodstuffs. The long-term preponderance of the impact of farmer management Mukantagwera(2011) , where farmer

support expenditure (FSE) is one of the variables explaining the evolution of AP in developing countries such as Cameroon, Chad and Gabon. In this study, the evolution of FSE has a positive and significant influence on the evolution of agricultural production and agricultural income, which is an indicator of well-being.

In this study, the evolution of Agricultural Management Expenditure has a positive and significant influence on the evolution of Agricultural Production and Agricultural Income, which is an indicator of the population's well-being. In her research, she showed that training and education of farmers enable the development and survival of their cooperatives, and thus contribute to improved production. The analysis of cointegration between agricultural productivity and food availability is based on the ARDL model (Pesaranetal.,2012), which concludes that farmer coaching improves agricultural productivity. Following this analysis, we came to the conclusion that farmer coaching has a positive influence on food security in the CEMAC. In other words, the adoption and implementation of a common agricultural policy in the CEMAC countries will make it possible to overcome problems linked to hunger and increase the level of food security through an increase in the budget allocated to supporting food production in the countries concerned.

From an economic point of view, the validity of the models is assessed by considering the signs of the variables releaved by the estimation. Overall, the models are consistent from the point of view of economic theory. In fact, almost all the variables are consistent with the economically expected signs. The models are therefore validated from an economic point of view. Additionally, all the variables differently influence the effect of farmer’s management in the region. This result is part of the theoretical framework that we have established and that explains it.

With a coefficient of determination of around 99% and 96%, and the probability of Fisher statistic for goodness of fit, the different variables of the model account for their ability to explain the phenomenon under study. This means that 99% and 96% of variations in PA and REA respectively are explained by the variables retained in the two models.

The overall goodness-of-fit tests corroborate the results given by the coefficients of determination. They show that the models are significant overall.

Probability (F-statistic) is below the 5% threshold and regressions are of good quality at the 5% threshold.

The autocorrelation test showed us that there is an autocorrelation problem, to correct the autocorrelation problem; we will use the generalized least squares method by doing the weighted regression. The results correspond to the generalized least squares estimator and therefore we will have an estimate which will have non-self-correlated error terms.

In this way, issues relating to the availability and accessibility of food products are being addressed in the Economic and Monetary Community of Central Africa.

4.6 Conclusion

In this chapter, it was a question of doing the regressions of the two models of analyzing and interpreting the results obtained on the Eviews 10 and Stata 12 software. And in difference. Out of seven variables, four were stationary at the level, ie integrated at order 0. Following the various econometric tests, the residuals of the two models were stationary and normal. So we concluded that there were error-correction models. Variables were 5% significant in the long-term and short-term relationship. These are: farmer management expenses, cultivated area, labor, etc. agricultural labor force, agricultural exports, household final which influence agricultural production and income of the local population over the long term. Government efficiency influences farm income only in the short term.

CHAPTER 5: CONCLUSIONS, AND RECOMMENDATIONS

5.1. Conclusions

The role played by the supervision of farmers (EA) in the process of growth and development of a country no longer needs to be demonstrated today. Indeed, one arrives at a logic according to which, the effectiveness of the EA is an important factor of the economic growth. The establishment of a quality institutional fabric for better planning of AE is therefore essential. Choosing to support farmers in a country or region whose institutional structures are already strengthened and consolidated is a crucial factor for its effectiveness.

The supervision of farmers is the action of surrounding, by specialists (trained and specialized individual), farmers, the majority of whom are made up of illiterate adults. Understanding between these different actors (supervisors and supervisors) then turns out to be very difficult.

The Framework farmers contribute to reducing food insecurity in the CEMAC zone?

This is the question to which this study should provide an answer.

For a better orientation of this work, we initially made the tour of the literature, then in a second time, we passed to an empirical verification of the hypotheses formulated from the literature. We therefore adopted a hypothetical-deductive approach.

After an empirical verification of our hypotheses using econometric tools, we obtained results whose interpretations enabled us to identify economic policy recommendations.

Model estimates and statistical tests give the following results:

The Fisher tests made it possible to deduce that the models are globally significant; therefore, there are indeed exogenous variables in the established models which contribute to the explanation of the dependent variables;

The analysis of the signs and coefficients associated with each variable has been made and shows that the EA positively influences the reduction of food insecurity;

Thus, the governments of the three countries, namely: Cameroon, Chad and Gabon, must take and strengthen economic policy measures in order to properly supervise farmers.

And finally, given the incompleteness of data on the variables considered in the models, we only took into account 57 observations (study covering the period 2000-2018). Therefore, our results can be improved if we increase the number of observations.

FUTURE AREAS OF RESEARCH

Given the limitations presented above and the existing literature on this subject, it appears that many authors have had to explore the link between Farmer Supervision and good governance. That said, these patterns will be explored in our future research. In addition, in order to make the work more interesting, we could extend the research to the entire CEMAC zone or even sub-Saharan Africa while considering a microeconomic study.

5.2 Recommendation

Proposing avenues for economic policy recommendations is not as easy. However, we are going to propose some which find their justification in the results obtained. The major role played by economic and social policies is indisputable. The purpose of economic policies is to define economic objectives and implement the means necessary to achieve them, through the creation of stable jobs and various allocations to populations that improve their well-being.

Social policies, for their part, propose the provision of and access to public goods and services (health, education, food, etc.).

absence and/or the inadequacy of these public services causes a brake on economic and social development. To lead a country to development, taking into account the supervision of farmers therefore appears to be an essential necessity in the process of eradicating insecurity in the CEMAC zone.

Indeed, the various steps undertaken in this work have made it possible to affirm that the supervision of farmers positively and significantly affects the volume of agricultural production, thus the supervision of farmers contributes to the improvement of agricultural production in the CEMAC zone. As a result, the supervision of farmers contributes to the fight against food insecurity in the CEMAC zone, that is to say that the supervision of farmers can be used as a means to raise the level of well-being of the population of three countries of the CEMAC zone (Cameroon, Chad and Gabon).

In view of the role that the supervision of farmers in the CEMAC zone can play, some recommendations are necessary to amplify its action in the fight against poverty:

Set up an observatory for monitoring and evaluating the supervision of farmers in the CEMAC zone. This observatory will be competent to decide on the allocation of the budget allocated to agricultural supervision;

To reinforce the capacity (materials, training of executives, financial incentives) of all institutions involved in the process of supervising farmers, in order to ensure working conditions for convincing results;

To reinforce the effectiveness of the government to enable the supervision to reach the real beneficiaries and also to motivate the various actors intervening in the supervision process.

Investing in agriculture: African states had pledged to provide 10% of their budget to agriculture. This figure has not yet been reached. However, the problems in the agricultural

sector are numerous, in particular the high cost of fertilizers and other inputs, the insufficiency of the means of conditioning, in particular for food crops.

Carry out agrarian reform: Land is a crucial production factor in agricultural activity. The allocation of cultivable land must be made in favor of those who have the capacity to develop it and the rights of landowners must be better protected.

Control structures must be created to control the effective execution of the works ordered by the authorities and to verify the effectiveness of the supervision hired in order to prevent part of the population from appropriating the resources allocated to them. These recommendations could partly respond to the two concerns raised by the supervision of farmers in general: that of the motivation of the supervision actors and that of the quality of the agricultural supervision institutions.

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APPENDICES

ANNEXE MEMO

Appendix 1: Statistique descriptive

```
. summarize LogDA LogDEA SC  CC TCP TSC DN

    Variable |       Obs        Mean    Std. Dev.       Min        Max
-------------+--------------------------------------------------------
       LogDA |        57    2.720132    .4787692   1.890365   3.221936
      LogDEA |        57    .4273848    .0815358   .2765457   .5081169
          SC |        57    25.06285    10.30081     14.492   39.65613
          CC |        57    8.368421     3.35214          1         14
         TCP |        57    531.5217    754.4409   2.535052       1667
-------------+--------------------------------------------------------
         TSC |        57    25.98483    18.25598   2.496043   48.27931
          DN |        57    .2105263    .4113064          0          1
```

Source: Researcher's computation using Stata, 2023

Appendix 2 : Results of the stationarity tests of the variables of the equation of the first model

Variables	**In level**		**In difference**		**Integration order**
	Statistical values	**Probability**	**Statistical values**	**probability**	
Log(DA)	-1.48203	0.0692			I (0)
Log(DEA)	-1.53700	0.0621			I(0)
CS	0.01209	0.5048	-4.66000	0.0000	I(1)
CC	0.07039	0.5281	-2.37520	0.0088	I(1)
TCP	-2.62975	0.0043			I (0)
TSC	-0.60311	0.2732	-2.05570	0.0199	I (1)
DN	-2.72412	0.0032			I (0)

Source: Researcher's computation using Eviews, 2023

Appendix 3 : Test de Cointegration

Kao Residual Cointegration Test
Series: LOG_DA_ LOG_DEA_ SC CC TCP TSC DN
Date: 09/12/23 Time: 07:59
Sample: 2000 2018
Included observations: 57
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-3.301924	0.0005
Residual variance	2.04E-05	
HAC variance	1.76E-05	

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID)
Method: Least Squares
Date: 09/12/23 Time: 07:59
Sample (adjusted): 2002 2018
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.568931	0.178146	-3.193626	0.0025
D(RESID(-1))	-0.391066	0.125423	-3.117980	0.0030

R-squared	0.556381	Mean dependent var	0.000103
Adjusted R-squared	0.547328	S.D. dependent var	0.009270
S.E. of regression	0.006237	Akaike info criterion	-7.278153
Sum squared resid	0.001906	Schwarz criterion	-7.202395
Log likelihood	187.5929	Hannan-Quinn criter.	-7.249204
Durbin-Watson stat	1.864164		

Source: Researcher's computation using Eviews, 2023

Appendix 4: Test de Hausman

```
hausman fixed random
```

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
LogDEA	5.324427	5.154031	.1703965	.0804532
SC	-.0191584	.0057219	-.0248803	.0065608
CC	-.001913	-.0026024	.0006894	.
TCP	.000291	.0001825	.0001085	.0000689
TSC	.0057675	.0027761	.0029914	.0003791
DN	-.0004078	-.0025836	.0021758	.

```
chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)

        =       29.20

Prob>chi2 =      0.0001
```

Source: Research's computation using Stata, 2023

SECOND MODEL

Appendix 5 : Statistique descriptive

```
summarize AA LogDEA CA INFA  PA
```

Variable	Obs	Mean	Std. Dev.	Min	Max
AA	57	23.13591	19.27674	3.626463	56.71846
LogDEA	57	.4273848	.0815358	.2765457	.5081169
CA	57	.1403509	.3504383	0	1
INFA	57	3.970224	.4287058	3.345962	4.42867
PA	57	1.587053	.3058802	1.101541	1.894111

Source: Researcher's computation using Stata,2023

TEST DE STATIONNARITE

Appendix 6: Result of the stationarity of the residuals of the second model

Variables	In level		**In difference**		**Integration order**
	Statistical value	**probability**	**Statistical value**	**Probability**	
AA	-1.27162	0.1018			I(0)
Log (DEA)	-1.53700	0.0621			I(0)
CA	0.0621	0.5857	-1.62357	0.0522	I(1)
INFA	-0.75771	0.2243	-2.45691	0.0070	I(1)
PA	0.62802	0.7350	3.32191	0.9996	

Source: Researcher's computation using Eviews, 2023

Appendix 7: Test de cointegration

Kao Residual Cointegration Test
Series: AA LOG_DEA_ CA INFA PA
Date: 09/12/23 Time: 08:03
Sample: 2000 2018
Included observations: 57
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

	t-Statistic	Prob.
ADF	-3.035198	0.0012
Residual variance	17.30760	
HAC variance	4.513061	

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID)
Method: Least Squares
Date: 09/12/23 Time: 08:03
Sample (adjusted): 2002 2018
Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID(-1)	-0.994629	0.151638	-6.559232	0.0000
D(RESID(-1))	0.386245	0.126950	3.042489	0.0038

R-squared	0.471880	Mean dependent var	-0.116919
Adjusted R-squared	0.461102	S.D. dependent var	4.401120
S.E. of regression	3.230847	Akaike info criterion	5.221792
Sum squared resid	511.4802	Schwarz criterion	5.297550
Log likelihood	-131.1557	Hannan-Quinn criter.	5.250741
Durbin-Watson stat	2.212453		

Source : Researcher's computation using Eviews,2023

Appendix 8: Test de hausman

```
hausman fixed random
```

```
                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
      LogDEA |    103.9493     31.29493        72.65437        60.35758
          CA |    4.639331     4.147558        .4917727        .3223798
        INFA |    17.41915     26.83773       -9.418582        8.259988
          PA |     42.6513     70.50702       -27.85571        15.86482
------------------------------------------------------------------------------

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        3.08
                Prob>chi2 =      0.5452
```

Source: Researcher's computation using Stata,2023

Appendix 9: Data for first model

1	Pays	Codes	Années	Log(DA)	Log(DEA)	SC	CC	TCP	TSC	DN
2	TCHAD	1	2000	2.7253398	0.435420661	38.619759	1	3.6711345	22.10113	0
3	TCHAD	1	2001	2.8025685	0.447556236	38.858005	3	3.7692464	23.292311	0
4	TCHAD	1	2002	2.8266578	0.451273234	38.699174	3	3.8349758	24.855671	0
5	TCHAD	1	2003	2.917663	0.465035132	38.77859	3	3.8306411	24.25176	0
6	TCHAD	1	2004	2.8268519	0.451303064	38.77859	5	3.7442073	24.755989	0
7	TCHAD	1	2005	2.8750034	0.458638356	39.334498	6	3.6102931	25.534679	0
8	TCHAD	1	2006	2.8846821	0.46009796	39.29479	6	3.4616646	26.209869	0
9	TCHAD	1	2007	2.9027098	0.462803621	39.176461	9	3.3414054	30.755239	0
10	TCHAD	1	2008	2.8894138	0.460809737	39.176461	9	3.2696664	28.97094	0
11	TCHAD	1	2009	2.776919	0.443563212	39.179638	9	3.2598261	29.00713	0
12	TCHAD	1	2010	2.8824107	0.459755859	39.338469	9	3.2873092	29.49234	0
13	TCHAD	1	2011	2.8007171	0.44726924	39.656131	9	3.3213794	30.19792	1
14	TCHAD	1	2012	2.9707187	0.472861531	39.656131	9	3.3330089	31.128691	1
15	TCHAD	1	2013	2.9152943	0.464682401	39.656131	9	3.3166752	31.128691	1
16	TCHAD	1	2014	2.9323215	0.467211589	39.656131	10	3.2647064	31.128691	0
17	TCHAD	1	2015	2.9041202	0.46301459	39.656131	10	3.1909403	31.128691	0
18	TCHAD	1	2016	2.9267025	0.466378578	39.656131	10	3.1140924	31.128691	1
19	TCHAD	1	2017	2.9267025	0.466378578	39.656131	10	3.1140924	31.128691	0
20	TCHAD	1	2018	2.9267025	0.466378578	39.656131	10	3.1140924	31.128691	0
21	CAMEROUN	2	2000	1.8903651	0.276545696	19.377631	3	2.535052	46.660961	0
22	CAMEROUN	2	2001	1.9002032	0.278800048	19.377631	5	2.5703666	46.12915	0
23	CAMEROUN	2	2002	1.9130187	0.281719212	19.377631	5	2.6009051	46.12915	0
24	CAMEROUN	2	2003	1.9291123	0.2853575	19.377631	5	2.6317654	46.512711	0
25	CAMEROUN	2	2004	1.9489995	0.289811717	19.483404	7	2.6605715	44.70042	0
26	CAMEROUN	2	2005	2.0081316	0.302792162	19.489751	8	2.6861165	44.702728	0
27	CAMEROUN	2	2006	2.0381829	0.309243146	19.489751	9	2.7111636	44.893879	0
28	CAMEROUN	2	2007	2.0654677	0.315018402	19.489751	11	2.7323792	44.009159	0
29	CAMEROUN	2	2008	2.085005	0.319107101	19.595524	12	2.7432612	45.455688	0
30	CAMEROUN	2	2009	2.1185623	0.326041242	19.701297	12	2.7416385	47.172421	0
31	CAMEROUN	2	2010	2.155336	0.33351499	20.519981	12	2.7306902	47.172421	0
32	CAMEROUN	2	2011	2.1716387	0.336787574	20.625754	12	2.7165869	47.812698	1
33	CAMEROUN	2	2012	2.1929297	0.341024705	20.625754	14	2.7015959	47.979488	1
34	CAMEROUN	2	2013	2.202679	0.34295121	20.625754	14	2.6831629	48.120838	1
35	CAMEROUN	2	2014	2.1997552	0.342374349	20.625754	14	2.6618761	48.162369	0
36	CAMEROUN	2	2015	2.1997552	0.342374349	20.625754	14	2.6385361	48.279308	0
37	CAMEROUN	2	2016	2.1997552	0.342374349	20.625754	14	2.6135851	48.279308	1
38	CAMEROUN	2	2017	2.1997552	0.342374349	20.625754	14	2.6135851	48.279308	0
39	CAMEROUN	2	2018	2.1997552	0.342374349	20.625754	14	2.6135851	48.279308	0
40	GABON	3	2000	3.2122675	0.506811708	16.303	3	1630.3	2.4960433	0
41	GABON	3	2001	3.1878872	0.503502943	15.413	5	1541.3	2.4977024	0
42	GABON	3	2002	3.1611283	0.499842126	14.492	5	1449.2	2.5151247	0
43	GABON	3	2003	3.1894903	0.503721288	15.47	5	1547	2.5729764	0
44	GABON	3	2004	3.1945143	0.504404842	15.65	5	1565	2.6787857	0
45	GABON	3	2005	3.1968667	0.504724534	15.735	6	1573.5	2.8130763	0
46	GABON	3	2006	3.1986296	0.504963952	15.799	6	1579.9	2.9298753	0
47	GABON	3	2007	3.2219356	0.508116855	16.67	8	1667	3.0233005	0
48	GABON	3	2008	3.2067449	0.506064419	16.097	8	1609.7	3.1214815	0
49	GABON	3	2009	3.2020522	0.505428403	15.924	8	1592.4	3.2241243	0
50	GABON	3	2010	3.2037941	0.505664603	15.988	7	1598.8	3.3133862	0
51	GABON	3	2011	3.2040657	0.505701412	15.998	7	1599.8	3.4097219	1
52	GABON	3	2012	3.2052585	0.505863062	16.042	7	1604.2	3.4582148	1
53	GABON	3	2013	3.2051773	0.505852057	16.039	9	1603.9	3.3832276	1
54	GABON	3	2014	3.205069	0.505837379	16.035	10	1603.5	3.1652929	0
55	GABON	3	2015	3.2051502	0.505848388	16.038	9	1603.8	2.8621819	0
56	GABON	3	2016	3.2052044	0.505855725	16.04	10	1604	2.5378086	1
57	GABON	3	2017	3.2052044	0.505855725	16.04	10	1604	2.5378086	0
58	GABON	3	2018	3.2052044	0.505855725	16.04	10	1604	2.5378086	0

Source: world bank, FAOSTAT, Ministry of each country

Appendix 10: Data for second model

1	pays	codes	années	AA	Log(DEA)	CA	INFA	PA
2	Cameroun	1	2000	18.169151	0.4354207	0	3.3459615	1.7360617
3	Cameroun	1	2001	19.010919	0.4475562	0	3.3535316	1.7312744
4	Cameroun	1	2002	17.887262	0.4512732	0	3.3586961	1.7264175
5	Cameroun	1	2003	17.287568	0.4650351	0	3.3651134	1.7214973
6	Cameroun	1	2004	16.77166	0.4513031	0	3.3723596	1.7165042
7	Cameroun	1	2005	15.170814	0.4586384	0	3.3798492	1.7114613
8	Cameroun	1	2006	14.327044	0.460098	0	3.3873898	1.7063507
9	Cameroun	1	2007	14.405157	0.4628036	0	3.3949767	1.7012138
10	Cameroun	1	2008	13.998539	0.4608097	0	3.4019173	1.696033
11	Cameroun	1	2009	14.641897	0.4435632	1	3.4084096	1.6908338
12	Cameroun	1	2010	15.065761	0.4597559	0	3.4149733	1.6855984
13	Cameroun	1	2011	14.379617	0.4472692	0	3.423082	1.6803446
14	Cameroun	1	2012	14.624536	0.4728615	0	3.4253712	1.6750723
15	Cameroun	1	2013	14.786332	0.4646824	0	3.4268365	1.6697816
16	Cameroun	1	2014	15.263974	0.4672116	0	3.4268365	1.6644633
17	Cameroun	1	2015	16.051709	0.4630146	0	3.4287825	1.6591458
18	Cameroun	1	2016	16.663443	0.4663786	0	3.4303976	1.6538105
19	Cameroun	1	2017	16.663443	0.4663786	0	3.4324883	1.6538105
20	Cameroun	1	2018	16.663443	0.4663786	0	3.4324883	1.6538105
21	TCHAD	2	2000	42.314197	0.2765457	0	3.9096497	1.8941111
22	TCHAD	2	2001	41.810332	0.2788	0	3.9261051	1.8939281
23	TCHAD	2	2002	39.443272	0.2817192	0	3.8143298	1.8937507
24	TCHAD	2	2003	33.596906	0.2853575	1	3.8895698	1.8935676
25	TCHAD	2	2004	23.469747	0.2898117	0	4.0686002	1.8933844
26	TCHAD	2	2005	54.844593	0.3027922	1	4.1670938	1.8932012
27	TCHAD	2	2006	56.718465	0.3092431	1	4.1906741	1.8930179
28	TCHAD	2	2007	56.002246	0.3150184	1	4.2354636	1.8928289
29	TCHAD	2	2008	55.916647	0.3191071	1	4.2536914	1.8926455
30	TCHAD	2	2009	47.855472	0.3260412	1	4.2257087	1.8924619
31	TCHAD	2	2010	53.372547	0.333515	1	4.3467998	1.8921892
32	TCHAD	2	2011	53.109027	0.3367876	0	4.3798491	1.8918273
33	TCHAD	2	2012	55.088262	0.3410247	0	4.3911302	1.8913758
34	TCHAD	2	2013	51.916837	0.3429512	0	4.4036918	1.8908289
35	TCHAD	2	2014	52.62102	0.3423743	0	4.3298666	1.8901918
36	TCHAD	2	2015	52.385551	0.3423743	0	4.3703724	1.8894642
37	TCHAD	2	2016	50.056029	0.3423743	0	4.334511	1.88864
38	TCHAD	2	2017	50.056029	0.3423743	0	4.3092748	1.88864
39	TCHAD	2	2018	50.056029	0.3423743	0	4.3092748	1.88864
40	GABON	3	2000	6.6930476	0.5068117	0	4.0811405	1.2992457
41	GABON	3	2001	6.2484331	0.5035029	0	4.0748823	1.2821688
42	GABON	3	2002	6.5360886	0.4998421	0	4.0876571	1.2656431
43	GABON	3	2003	5.8628742	0.5037213	0	4.1432829	1.2496874
44	GABON	3	2004	5.2763078	0.5044048	0	4.2294519	1.2343401
45	GABON	3	2005	5.1534739	0.5047245	0	4.3826737	1.2195583
46	GABON	3	2006	5.3008784	0.504964	0	4.3432699	1.2054209
47	GABON	3	2007	4.4545772	0.5081169	0	4.3336228	1.1919259
48	GABON	3	2008	5.4644318	0.5060644	0	4.3457938	1.179092
49	GABON	3	2009	4.276198	0.5054284	0	4.2571035	1.1669331
50	GABON	3	2010	3.7373893	0.5056646	0	4.3338422	1.1554271
51	GABON	3	2011	3.6551578	0.5057014	0	4.4130725	1.1446676
52	GABON	3	2012	3.6264629	0.5058631	0	4.4267031	1.1345914
53	GABON	3	2013	3.9493715	0.5058521	0	4.4286695	1.1252209
54	GABON	3	2014	4.6761547	0.5058374	0	4.4032506	1.1166077
55	GABON	3	2015	5.3426384	0.5058484	0	4.393262	1.1087003
56	GABON	3	2016	5.3426384	0.5058557	0	4.3983216	1.1015409
57	GABON	3	2017	5.3426384	0.5058557	0	4.3808289	1.1015409
58	GABON	3	2018	5.3426384	0.5058557	0	4.3808289	1.1015409