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2012

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Abstract: According to the Food and Agriculture Organization (FAO), the development of subsistence agriculture is the best way to assure food security in developing countries. The objective of this study fits into this logic in that it analyzes the impact of subsistence farming to food security in Cameroon. Data from the FAO and the World Bank over the period 1961-2007 were used to formulate a cointegration model between food availability and subsistence framing index based on the ARDL (Autoregressive Distributed Lag) procedure. Firstly, the analysis shows that the long-run elasticity of subsistence farming index is 0.38, higher than in short-run (0.27). This result confirms the positive impact of subsistence farming on food security in short-run and long-run. Secondly, the trend is significant and positive, meaning that structural variables such as market functioning, the development of road and market infrastructures etc., positively impact on food security in Cameroon. However, population growth reduces food availability, a factor that could obscure the positive impact of subsistence farming. Therefore it would be necessary to consider a scenario in which the subsistence farming growth rate is higher than the population growth rate.
[AMBAGNA Jean Joël ; KANE Gilles Quentin, OYEKALE, Abayomi Samuel **Subsistence Farming and Food Security in Cameroon: A Macroeconomic Approach.** *Life Sci J* 2012;9(4):3949-3954]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 589

Keywords: Food Security, subsistence farming, ARDL model, Cameroon.

1. Introduction

Food security is a major and growing challenge in developing countries mostly in sub-Saharan Africa. Even if it is clear that agricultural development remains a strategic option for achieving food security in sub-Saharan Africa, it should be noted that agricultural policies were hitherto focused on cash crops. Subsistence farming then has been under estimated. In the case of Cameroon, for example, agricultural subsidies and aid were focused on export crops such as cocoa, coffee and cotton. However, subsistence farming is likely to affect quickly and significantly the household nutrition. Literature review demonstrated that several studies on African economics are also in line with this vision.

The role of subsistence food production in improving food security was highlighted by Aliber and Hart (2009) and Baipheti and Jacobs (2009) in a case study of South Africa. Thus, it is necessary to support subsistence production to curb food insecurity in both rural and urban areas. This requires an increase in supply and a decrease in dependence on the market. In fact, subsistence farming products can directly be consumed by households. In the under-industrialized economies, subsistence food production can be transformed locally contrary to the export crops which require further processing. Therefore, increasing food production will reduce importation and improve the trade balance even more than the net importing countries mostly import subsistence farming products. Besides, reduce food imports also reduces the risk of international food prices volatility transmission to the domestic economy.

According to the third Cameroonian household survey (ECAM III), majority of farming households engaged in subsistence farming which is the main source of household income (INS[1], 2008). Then, when the output prices are stable, ceteris paribus, any increase in subsistence farming production will raise farm income (Kidane & al., 2006). However, these incomes provide access to other food which they cannot grow cheaply (vegetable oils, milk ...). Thus, farm household food security increase when their subsistence farming production is growing to help to provide other kind food that they do not cultivate themselves. Therefore, subsistence agriculture can play an important role in reducing household vulnerability to food insecurity by improving welfare and reducing the effect of inflation (Baipheti & Jacobs, 2009).

The aim of this study is to analyze the impact of subsistence farming production on food security in Cameroon. It has both a positive and methodological interest. On the positive side, few

[1] National Institute of Statistics

scientific studies have addressed the impact of the subsistence farming sector in food security in sub Saharan Africa. Concerning the methodological level, the use of new techniques of cointegration can be interesting. Theoretical clarification of ideas being indissolubly linked to the analysis of facts; we choose a theoretical and empirical approach in order to achieve our goals. Thus, theoretical bases justifying the role of agricultural production for food security are presented before assessing the effect of subsistence farming production on food availability in Cameroon.

2. Methodology

Data sources

The data used is derived from FAO (Food and Agriculture Organization) and The World Bank. The variables are derived from the economic literature on the determinants of food security. All data series are annual and cover the period of 1961-2007.

Theoretical framework

The agricultural production as a determinant of food security finds its anchor in the theory of self-reliant development focused on protectionism, particularly in the "Boserupian" and "Malthusian" theories.

Boserupian theory and food security

According to the "Boserupian" theory, the national economy itself generates the food availabilities necessary to ensure national food security. In fact, the high density of the population is helpful for intensification of the agricultural production and improvement of the food resources. The growing urban markets translate into effective demand which impact producers create conditions for intensification of production systems. According to authors, the increase in production occurs through adaptation techniques; subject letting the markets reveal the real prices which express the relative scarcity of the factors of production and the products.

Malthusian theory and food security

According to the "Malthusian" theory, growth of food products is less rapid than the population growth, and then population pressure leads to increasing food dependency and leads to a regulation of the population either by famines, or migrations and wars.

The increase in the rural population led to increased pressure on resources particularly a land. This pressure involves a fall of the fertility of land which leads to a reduction in crop yields and thus a decrease in agricultural production available in long run causing famines somehow restore the balance between population and the capacities to produce of considered spaces.

In the modern version of "neo-Malthusian" thesis famine is replaced by migration when there is desequilibrium between the capacity to produce of a city and the needs for the population. In the Malthusian approach therefore, the growth rate of the food products must be necessary greater than the population growth rate to ensure the national food security.

ARDL Model

This study aims to analyze the impact of subsistence farming production on food availability using ARDL (Autoregressive distributed lag) model due to Pesaran, Shin and Smith (2001).

The equation for long-run equilibrium of the model is as follows:

$$fs_t = \pi_0 + \pi_1 ipv_t + \pi_2 pib_t + \pi_3 pop_t + \pi_4 T + \varepsilon_t \quad (1)$$

π_i : Long-run elasticities.

The variables are essentially taken from the literature and they are presented in the following table:

Table 1: Description of variables use in the ARDL model

Variables	Comments
Food availability (fs)	The food availability measure the average calorific contribution per capita during one year
Index of subsistence farming production (ipv)	The index of subsistence farming production is calculated using the value of subsistence farming production given by World Bank
per capita gross domestic product (GDP)	GDP is used here as an approximation of national income
growth rate of population (pop)	The growth rate of population captures the effect of population growth on food security
Trend (T)	The trend captured the effect of other variables which are not including in the model specification (the development of road and market infrastructures, the governance…

Reduced form of ARDL model

For the empirical analysis of a long-run relationship and dynamic interactions between the variables, we use the ARDL cointegration procedure according to to Pesaran, Shin and Smith (2001). We could adopt a standard approach by implementing the usual tests of unit roots and cointegration (Dickey-Fuller, Phillips-Perron, ...). However, it is recognized that the standard unit root tests to determine the order of integration in time series suffer from many disadvantages. The main disadvantage of these tests is their low power (Schwert, 1989, Cochrane, 1991; Blough, 1992). Our study uses new econometric techniques able to estimate both the short-run and long-run dynamics.

The procedure called "bounds test" is adopted for three main reasons:

- Firstly, it is a simple procedure. In contrast to other techniques of multivariate cointegration (Johansen, Juselius), it allows the estimation of the cointegrating relationship by using the ordinary least squares (OLS) method.
- Secondly, it does not require a prior unit root test on variables in contrast to other techniques such as Johansen. While other methods of cointegration analysis require that all regressors are of the same order of integration, the ARDL approach offers the possibility of using mixed regressors. This new test procedure is valid whatever the distribution of variables are I (1)[2], I (0)[3] or a combination of 2. It also allows capturing both the short-run and long-run dynamics in cointegration analysis.
- Thirdly, this approach is statistically more appropriate to analyze the cointegration relationships in small samples, whereas the Johansen cointegration method requires large samples to be valid.

The "bounds test" procedure arises as follows:
Given the error correction model below:

$$\Delta fs_t = \beta_0 + \sum_{j=1}^{q_1} \beta_{1j}\Delta fs_{t-j} + \sum_{j=0}^{q_2} \beta_{2j}\Delta ipv_{t-j} + \sum_{j=0}^{q_3} \beta_{3j}\Delta pib_{t-j} + \sum_{j=0}^{q_4} \beta_{4j}\Delta pop_{t-j} + \delta_1 fs_{t-1} + \delta_2 ipv_{t-1} + \delta_3 pib_{t-1} + \delta_4 pop_{t-1} + \alpha T + \varepsilon_t \quad (2)$$

δ_i : Long-run multipliers.

β_{ij} : Short-run dynamics.

The "bounds test" procedure

The first step of the ARDL approach is to estimate equation (2) by OLS to test the existence of a long-run relationship between the variables.

$$\begin{cases} H0 : \delta_i = 0 \\ H1 : \delta_i \neq 0 \end{cases}$$

The test procedure is to calculate F-statistics under the null hypothesis of no cointegration and compare them with the critical values tabulated by the authors. Two critical values were calculated by the authors, corresponding to the "terminal" zones of acceptance and rejection of the test. The lower bound assumes that all the regressors are I (0), whereas the upper limit them as I (1). If the value of F-statistics is outside the interval, the hypothesis of a relationship level (in case I (0)) or cointegrating relationship (in case I (1)) between the variables cannot be rejected. Then the estimation can be performed regardless the order of integration of the series. On the other hand if the test statistics fall inside the interval, the test is undetermined.

In order to extend the cointegration test of the coefficient of error correction term due to Banerjee Doladi and Mestre (1998), the authors have developed a second version of the test based on the t of student of the error correction term in the equation (2). The procedure is identical to the F-test. This test is useful when the F-test is undetermined. It is presented as follows:

$$\begin{cases} H0 : \delta_1 = 0 \\ H1 : \delta_1 \neq 0 \end{cases}$$

In the second step, when the cointegration between the variables is, the model is specified as follows:

$$fs_t = \pi_0 + \sum_{j=1}^{p_1} \pi_{1j} fs_{t-j} + \sum_{j=0}^{p_2} \pi_{2j} ipv_{t-j} + \sum_{j=0}^{p_3} \pi_{3j} pib_{t-j} + \sum_{j=0}^{p_4} \pi_{4j} pop_{t-j} + \alpha T + \varepsilon_t \quad (3)$$

The optimal lag of each variable is determined using the Akaike information criterion.
In the third step, the short-run dynamics is obtained by estimating an error correction model associated with long-run model. The specification is as follows:

$$\Delta fs_t = \mu + \sum_{j=1}^{q_1} \beta_{1j}\Delta fs_{t-j} + \sum_{j=0}^{q_2} \beta_{2j}\Delta ipv_{t-j} + \sum_{j=0}^{q_3} \beta_{3j}\Delta pib_{t-j} + \sum_{j=0}^{q_4} \beta_{4j}\Delta pop_{t-j} + \alpha T + \gamma ecm_{t-1} + \varepsilon_t \quad (4)$$

Where

β_{ij} : Coefficients associated with the short-run dynamics

γ : Speed adjustment to long-run equilibrium

ecm : Error correction term

3. Results and discussion

Firstly we present the results of cointegration test and secondly result of short-and long-run of impact of subsistence farming production on food availability.

The "bounds test" Results

Applied to Equation 2, the test procedures provide:

$$\Delta fs_t = \beta_0 + \beta_1\Delta fs_{t-1} + \beta_2\Delta ipv_t + \sum_{j=0}^{1} \beta_{3j}\Delta pib_{t-j} + \sum_{j=0}^{3} \beta_{4j}\Delta pop_{t-j} + \delta_1 fs_{t-1} + \delta_2 ipv_{t-1} + \delta_3 pib_{t-1} + \delta_4 pop_{t-1} + \alpha T + \varepsilon_t \quad (5)$$

For the F-test:

$$\begin{cases} H0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0 \\ H1 : \delta_1 \neq 0, \delta_2 \neq 0, \delta_3 \neq 0, \delta_4 \neq 0 \end{cases}$$

For the t-test: $\begin{cases} H0 : \delta_1 = 0 \\ H1 : \delta_1 \neq 0 \end{cases}$

The values of F (.) and t (.) test statistics are given in the following table:

[2] Order of integration is one. The first difference of this time series should be stationary.
[3] Stationary times series.

Table 2: Test-statistics

	Value of test-statistics	critical values at 5%	
		I(0)	I(1)
$F(fs_t / ipv_t, pib_t, pop_t, T)$	5.98	4.01	5.07
$t(fs_t / ipv_t, pib_t, pop_t, T)$	-4.66	-3.41	-4.16

The value of the two tests (Fisher and Student) are outside the interval (more than critical value in absolute), therefore the assumption of cointegration can be accepted (table 2). The equation can be estimated assuming that all the series are I (1) without testing them individually.

Impact of subsistence farming production on food availability

According to Pesaran, Shin and Smith (2001), the equation is estimated with the appropriate number of lags. Using the Akaike criterion, an ARDL (1, 1, 1, 0) model has been chosen:

$$\log fs_t = \pi_0 + \pi_1 \log fs_{t-1} + \pi_2 \log ipv_t + \pi_3 \log ipv_{t-1} + \pi_4 \log pib_t + \pi_5 \log pib_{t-1} + \pi_6 \log pop_t + \pi_7 T + \varepsilon_t \qquad (6)$$

In this equation inclusions of various lag variables describe the process dynamics of the variables before equilibrium. Thus, it corresponds to a short-run representation of ARDL model. The estimation results are given in Table 3.

Table 3: Short-run elasticity

Variable	Coefficient	t-Statistic	Prob.
$\log fs_{t-1}$	0.433340	3.502824	0.0012
$\log ipv_t$	0.339321	4.783837***	0.0000
$\log ipv_{t-1}$	-0.091801	-1.086699**	0.2840
$\log pop_t$	-1.259807	-3.639982***	0.0008
$\log pib_t$	0.052445	1.090663	0.2823
$\log pib_{t-1}$	-0.051238	-1.010568	0.3186
T	0.029235	3.039759***	0.0043
π_0	26.28213	4.058901***	0.0002
Adjusted R-squared	0.893232		
Durbin-Watson stat	2.327644		
F-statistic	54.78191		
Prob(F-statistic)	0.00000		

*, **, *** denote statistical significance at the usual confidence levels.

In general, the short-run elasticities are consistent with those expected. Any increase in 1% of the index of subsistence farming production leads to increased food availability from 0.33%. This result confirms the positive impact of subsistence farming production on food security, although this effect is limited (the elasticity remains lower than 1). This can also be explained by the insufficiency of support for subsistence farming production and the population growth (elasticity is greater than 1 in absolute value). Consequently, boosting subsistence farming production by massive funding of crops such as rice, wheat or maize (which are main cereals imported and consumed in Cameroon) and tubers, is necessary.

In the short run, GDP has no effect on food availability. This can be explained by a poor redistribution of the growth effect between different sectors of the economy. In fact, the growth does not improve food security if it is directed towards the productive sectors. Kidane and al. (2006) have also shown that the growth has effect on poverty only if it is directed towards city where the poor live and the goods they consume. Similarly, it will have effect on food security only if it is directly towards food security and to the most consumed food.

In addition, the results suggest that the trend is significant. This could mean that structural variables such as the development of road and markets infrastructure, and other uncontrollable factors positively affect food security in Cameroon. Therefore it is important to improve the quality of institution and governance. Better alimentary governance is needed to support the consolidation of food security in Cameroon.

The long-run impacts concern the value of variables in equilibrium. Thus, the long-run elasticity is derived as follow:

$$\log fs_t = \pi_0^* + \pi_1^* \log ipv_t + \pi_2^* \log pib_t + \pi_3^* \log pop_t + \pi_4^* T + \varepsilon_t \qquad (7)$$

$$where \quad \pi_0^* = \frac{\pi_0}{1-\pi_1} \quad \pi_1^* = \frac{\pi_2}{1-\pi_1} \quad \pi_2^* = \frac{\pi_3}{1-\pi_1} \quad \pi_3^* = \frac{\pi_4+\pi_5}{1-\pi_1} \quad \pi_4^* = \frac{\pi_6}{1-\pi_1}$$

The elasticity of food availability related to subsistence farming production index is:

$$\theta = \pi_1^* = \frac{\pi_2}{1-\pi_1}$$

Table 4: Long-run elasticities

Variable	Coefficient	t-statistics
log ipv	0.387645	5.5115900***
log pop	-2.183850	-7.733133***
log pib	0.023913	1.366760
T	0.051258	5.720542***

*, **, *** denote statistical significance at the usual confidence levels.

The hypothesis of cointegration is accepted; then an error correction model can be specified.

Table 5: Error correction model

Variable	Coefficient	t-Statistic	Prob.
$ecm(-1)$	-0.598938	-4.753210	0.0000
$\Delta \log ipv_t$	0.343986	6.139329	0.00
$\Delta \log pib_t$	0.071873	1.696759	0.0971
$\Delta \log pop_t$	-0.267243	-2.517625	0.0157

$$ecm = \log fs - 0.38 \log ipv_t + 2.18 \log pop_t - 0.02 \log pib_t - 0.05T$$

The error correction term is negative and significant, indicating those food availability and subsistence farming production indexes are cointegrated. Shocks that affect food availability are absorbed at a rate of 59.89%.

The long-run elasticity of subsistence farming production index (0.38) is higher than in short-run (0.33) (Table 4). This result confirms the positive impact of subsistence farming production on food security in the long-run. However, the population growth reduces the food availabilities what could obscure the positive impact of the subsistence farming production. Therefore it would be necessary to consider a scenario in which the subsistence farming production growth is always higher than the population growth.

Due to the fact that resources are scarce and limited; a special emphasis should be placed on the efficiency in the use of agricultural input. Then the marginal productivity of labor must be greater than the marginal consumption in order to transform the population growth as engine of the agricultural intensification according to the Boserupian approach. Moreover improvement in market functioning in rural and urban area can help agricultural production in exceed to reach to the markets in deficit. This would allow an increase in farm household income and also the stability of food prices. Indeed, in Cameroon in as much as rural infrastructure and rural institution are missing, crops are generally wasted. Therefore, development of infrastructure such as road and markets must be part of sustainable agricultural policies in order to improve the effect of agricultural production on food security.

Overall, the results confirm the positive impact of food production on food availability either in the short-run or in the long-run. Thus food security is improved. However, increasing the subsistence farming production could not be the only one solution to achieving food security, if it is not accompanied by a better markets functioning, development of road infrastructure, and good governance in order to improve the purchasing power of households who are net buyers of food.

4. Conclusion

The objective of this paper was to show the impact of subsistence farming production on food security in Cameroon. The theoretical literature suggests that in general food production must improve food security. Although the controversies opinions, in many cases subsistence farming production positively affect food security in macro level.

These general results are confirmed in the specific case of Cameroon and conform to those Baipheti and Jacobs (2009) and Aliber and Hart (2009). Indeed, we show that the elasticity of food availability compared to the subsistence farming production index is 0.27 and 0.38 in the short-run and long-run respectively. This confirms the positive impact of subsistence farming production on food security in the short-run and long-run. Therefore it seems to be necessary to finance subsistence farming production. However to be efficient these measures must be accompanied by other structural measures such as development of market and rural infrastructure, the quality of food governance

In addition, ppopulation growth negatively affects food security in Cameroon. Then the subsistence farming production growth must be greater than the population growth to avoid the Malthusian scenario. In a context of climate change, the focus should be on efficiency use of agricultural inputs to improve farm income.

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11/11/2012