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Impact of Fertilizer Price Subsidy on Agricultural Growth in Togo

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Abstract

Fertilizer subsidy policy remains a major plank of inputs policies in Africa. Its objective is to improve agricultural productivity and reduce poverty among farmers. This article examines the impact of fertilizer prices subsidy on agricultural growth in Togo. The Autoregressive distributed lag (ARDL) modelling approach is used to analyse both short and long run impacts of fertilizer subsidy on agricultural growth. Using data from national and international sources over the period 1985 to 2016, the results show that, the impact of fertilizer price subsidy on agricultural growth is limited. The price subsidy did not significantly enhance agricultural growth neither in the short nor in the long run. Moreover, the results highlight the fact that factors, which play a major role in agricultural growth are expenditure, arable land and labour force. To improve the efficiency of fertilizer subsidy, the government should drop price subsidy policy at global level and experience alternative options, which would facilitate fertilizer access to poorer and more marginal farmers.

Keywords: price subsidy, fertilizer, agricultural growth, ARDL model

1. Introduction

Debate over subsidizing agricultural inputs is divided between two schools of thought. The first one, which is of Keynesian vision and described as “push subsidy”, is a policy that supports the intensive use of inputs thanks to an incentive through subsidy policy. The second, of a liberal view, is in controversy to the first. It is qualified as “Price-pull” because it is based on an increase of agricultural products’ prices followed by a reduction or even a removal of subsidies on inputs (Holden, 2019; Yovo, 2017).

Among subsidies’ benefits generally highlighted, is the idea that promoting affordable fertilizer use could “incentivize” farmers to adopt new technologies, allowing them to additional investment, and lead to more efficient, accessible combinations of inputs. This efficiency effect, also referred to as a “crowd-in” effect, is synonymous with greater productivity (Mason & Jayne, 2012). Additional arguments relate to possibility of overcoming imperfect markets for farmers, such as credit market or insurance market as well the possibility to correct negative externalities(Weibigue, 2021).

However, controversial arguments are related to the extent to which income generated by a price reduction is spent on agricultural activity. Farmers facing financial constraints in their daily subsistence are very likely to direct any monetary gains brought about by subsidies to their final consumption instead of to acquiring additional acres of land or new technology. This disincentive to invest in farming is known as “crowding-out” effect and results in no direct impact on production (Weibigue, 2021). Moreover, other controversial arguments are related to high fiscal and administrative costs of subsidy management, possibility of leakage to commercial market and neighboring countries where price relations have not changed, and diversion of commercial purchases by farmers who would otherwise pay the full price (Gautam, 2015). Fertilizer subsidy programs in Africa also tended to have adverse side effects, contributing to corruption and state paternalism, often hindering development of commercial input distribution systems (Jayne et al., 2018).

Similarly, controversy developed in theoretical arguments is highlighted in empirical studies. In fact, if some studies found a positive effect of fertilizers subsidy on productivity (Basurto et al., 2020; Iddrisu et al., 2020; Martey et al., 2014; Mason et al., 2020; Minviel & Latruffe, 2017; Ricker-Gilbert et al., 2013; Sibande et al., 2017; Wossen et al., 2017), others found no or negative effect (Armas et al., 2010; Fan, 2008; López & Galinato, 2007).

This debate on agricultural input subsidy policies in Sub-Saharan Africa (SSA) is far from being settled and remains relevant. Despite this controversy, agricultural input subsidies are increasingly popular with farmers and political leaders who are aware of electoral weight of the practice (Dorward & Morrison, 2015; Holden, 2019). A general trend across Africa's south of Sahara has been observed, where governments spend around US $ 2 billion annually on fertilizer subsidy programs (Ricker-Gilbert et al., 2013). According to Theriault et al. (2018), the share of agricultural budget allocated to the fertilizer subsidy program has steadily increased over the last decade in sub-Saharan Africa, from less than 10% in 2008 to around 25% in 2014.

One of the main reasons for state intervention in agricultural input market in sub-Saharan Africa (SSA) is failure of the input market (Klette et al., 2000). The recent revival of interest in subsidizing agricultural inputs to alleviate market failures stems from the concern to increase agricultural productivity, a prerequisite for meeting the needs of an ever-growing population (Morris et al., 2007; Pender et al., 2004). These subsidies are also motivated, not only by the commitment made in Maputo in 2003 by African leaders to devote at least 10% of their national budget to agriculture to achieve agricultural growth for at least 6%, but also, and above all through the "Abuja Declaration" of 2006, in which many African governments pledged to significantly re-launch input subsidy programs with the aim at increasing fertilizer use and agricultural productivity through Africa (Jayne et al., 2016, 2018).

In Togo, the will of the government to fight against the risks of food insecurity has resulted in an active and very interventionist role of the State in the agricultural input market, especially that of inorganic fertilizers. Fertiliser subsidies account for an increasing share of agricultural sector expenditure. Thus, an analysis of the economic composition of public spending on agriculture reveals a significant share of input subsidies, with a preponderant share of fertiliser subsidies. Between 2002 and 2011, these subsidies increased tenfold, from US $0.5 million to US $5 million, with a peak of US $9 million corresponding to 30% of the expenditure of the ministry in charge of agriculture in 2009 (Yovo, 2016). It is estimated that over the period 2005-2010, the selling price of fertilisers to farmers corresponded to an average subsidy of about 35-40% of the real cost of import and distribution except in 2009 when it reached 50% due to the sharp increase in the price of fertilisers on international markets (MAEH, 2012).

Despite the large share of fertilizer subsidy expenditure in the budget allocated to agriculture, its impact on agricultural growth is hardly perceptible. For example, during 2002-2011 Agricultural GDP grew for less than 5% whereas subsidies as share of public agricultural expenditure increased for more than 100%. At Nationwide, the level of fertiliser use remains very low, with an average of 12 kg/ha of nutrients in 2018 (Food and Agriculture Organization of the United Nations, 2020; World Bank, 2020), which is well below the target of 50 kg/ha set by African governments through the Comprehensive Africa Agriculture Development Programme.

In order to contribute to the debate on the controversies among economists about the effect of subsidies on agricultural growth, this article focuses on the specific case of Togo and tries to examine the following questions: should Togolese government continue to support farmers by reducing the fertilizer price or should it remove the universal subsidy policy? Has the subsidy policy implemented by Togolese government since 1980 to 2016 been translated into agricultural GDP growth? To answer to these queries, the paper assesses the effect of subsidized chemical fertilizer prices on agricultural growth in Togo. This article is of major interest for policy makers and development partners insofar as it enables to appreciate the effectiveness of fertilizer price subsidies for new policies purpose for Africa in general and for Togo in particular. The value added of this article is that, contrarily to the previous studies, which examined the impact of fertilizer subsidy on agricultural productivity, production or incomes at household level, the current work focuses on fertilizer price subsidy at macroeconomic level.

The rest of the article is organized as follows. Section 2 provides an overview of fertilizer subsidy policy in Togo. Section 3 briefly reviews the literature on the relationship between input subsidies and development of agricultural economy. Section 4 describes the research methodology. Section 5 presents and discusses the results. A conclusion and implications for agricultural policies end the article.

2. Overview on Fertilizer Subsidy Policy in Togo

Since 1970, as in most countries of sub-Saharan Africa, Togolese government has intervened in the agricultural inputs market by subsidizing the price of fertilizers with the objective to encourage the intensification of agriculture. The principle is that by fixing the price of fertilizers at a level lower than the market price, the producer should increase fertilizer consumption.

Figure 1 shows that Togo has a long tradition of subsidy. In the 1980s, the subsidy rate was still at relatively high levels (80%). The price of a kilo of fertilizer, which in 1980 was US $ 0.4 on the international market, was less than US $ 0.1 in Togo, i.e. a subsidy of more than 80%. The analysis of Figure 1 highlights three major periods in the evolution of subsidy policy.

The period from 1980 to 1993 which corresponded to the decline phase of the subsidy: During this period, the subsidy fell from 80% to 0%. This drastic decrease in the rate of the subsidy is due to the implementation of structural adjustment programs which involved disengagement of the state from the production domain with the removal of subsidies. The period from 1993 to 2002 was marked by the lowest rate of subsidy. This is the consequence of the drying up of public finances due to the suspension of cooperation with the EU. The period from 2002 to 2018 is characterized by a seesaw evolution of the subsidies. It is marked by several episodes, in particular the resurgence of subsidy in 2008 in response of food crisis.

During the third period, the rate of subsidy varied significantly depending on the selling price and the fluctuations in purchase price of fertilizers on world markets over time (see Figure 1). The average subsidy rate has been 27% over the past ten years (2008-2018). However, this situation conceals disparities: in 2009, for example, this rate reached 49% of the cost price (MAEH, 2012). In that year, fertilizer prices on the international market had risen sharply and sales prices remained at US $ 16 per 50 kg bag (World Bank & International Monetary Fund, 2014). On the other hand, the subsidy rate fell in 2010, 2014, 2016 and 2017. The 2016/2017 agricultural season marked the start of the reform of the subsidy system, allowing moving from universal subsidy to innovative-targeted subsidy system to vulnerable farmers. This reform resulted not only in decrease of the subsidy rate but also in the number of beneficiaries.

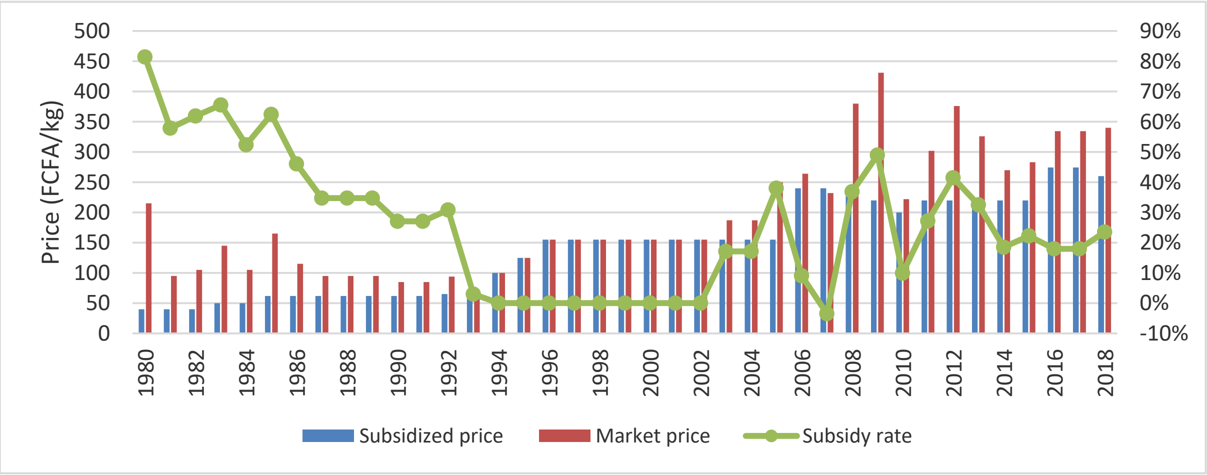

Figure 1. Evolution of fertilizer market price, subsidy price and subsidy rate in Togo from 1980 to 2018

Source: Data from MAEH, 2012; MAPAH, 2020

Figure2 highlights the evolution of the consumption of the quantity of fertilizers used per hectare in Togo over the period from 1970 to 2020. It appears that despite the drop in the level of the subsidy, the intensity has increased over time, nevertheless, the quantity used remained very low. It peaked at 13 kg/ha in 2019. This quantity is well below the recommended standard in Africa (50 Kg/ha) which itself is far below the average for Latin America and the Caribbean (140 kg/ha in 2016), Asia (330 kg/ha in 2016), Europe (236 kg/ha in 2016) (World Bank, 2020).

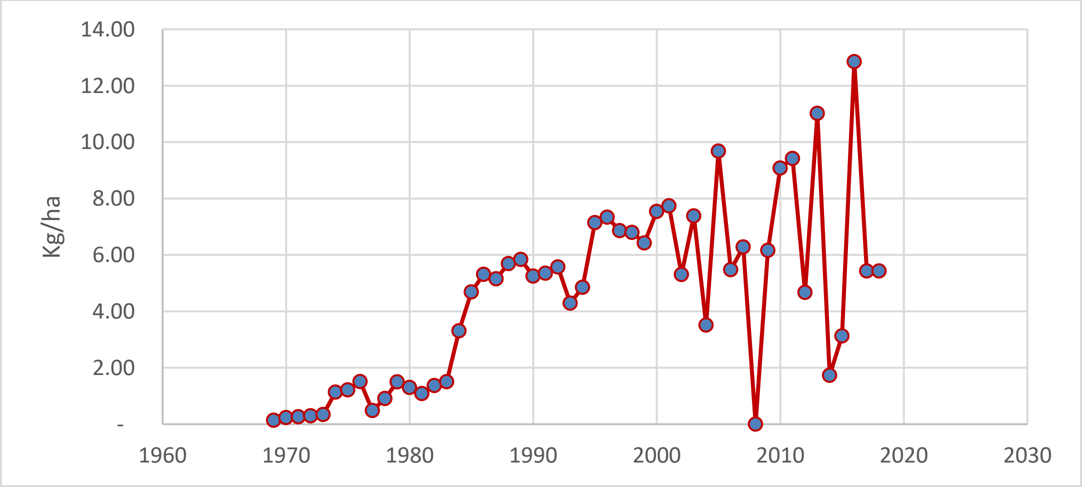

Figure 2. Evolution of fertilizer use intensity (kg/ha) in Togo from 1970 to 2020

Source: Data from FAOSTAT and WDI

Figure 3 provides an overview of the comparative evolution of agricultural growth and the share of subsidies in the agricultural budget over the period 1985-2018. The examination of this figure does not allow us to draw a clear conclusion about the effect of the fertiliser price subsidy policy on the agricultural GDP growth rate. The analysis shows that the subsidy and the agricultural GDP have experienced an almost contrasted evolution. This seems to indicate a marginal effect of the subsidy on agricultural GDP growth.

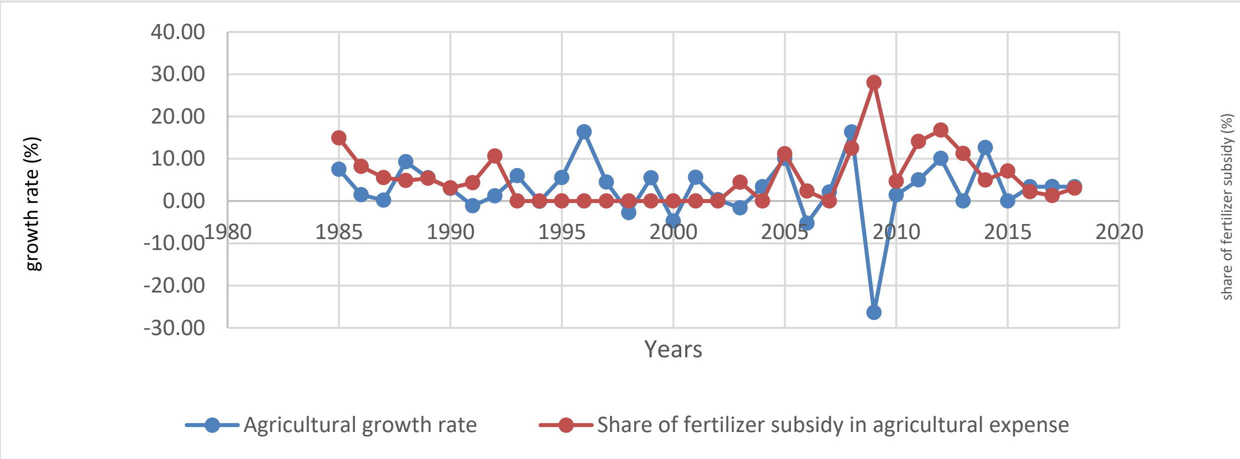

Figure 3. Comparative evolution of the agricultural growth rate and the share of fertilizer subsidy in the agricultural budget

Source: Data from MAEH, 2012; MAPAH, 2020

3. Brief Literature Review

Agricultural input subsidy policy has been the subject of several theories and empirical studies in the developing world since their introduction around 60 years ago in several Asian countries as part of the Asian Green Revolution (Holden, 2019). In contrast to the theories of free trade and free market, which objective is to limit distortions, there are schools of thought emphasizing the need to support agriculture because of its particularity (Ariga & Jayne, 2009; Crawford et al., 2005; Druilhe & Barreiro-Hurlé, 2012; Kato & Greeley, 2016; Krueger, 1990).

In theory, by reducing costs, input subsidies should increase farm profitability by reducing farmers' financial constraints, thereby encouraging adoption of modern inputs to boost production through increased productivity (Fan et al., 2008; Jayne et al., 2013). Various disadvantages of input subsidies have been reported in the literature such as high fiscal and administrative costs, leakage to commercial fertilizer market and to neighbouring countries, crowding out effects of commercial fertilizer demand (Morris et al., 2007).

Empirical research devoted to this subject is as divergent as the theory. Morris *et al.* (2007) conducted an extensive review of alternative policies such as fertilizer subsidies to improve fertilizer use in Africa. They noticed that in every region of the world, intensification of crop-based agriculture has been associated with a sharp increase in the use of chemical fertilizer. Jayne & Rashid (2013) synthesize data on input subsidy programs in sub-Saharan Africa. They compare the pros and cons of returning to subsidies versus other spending on agricultural research and infrastructure development. For the latter, the weight of the evidence indicates that the costs of the subsidy programs generally outweigh their benefits and at least a partial reallocation of expenditures from fertilizer subsidies to R&D and infrastructure would provide higher returns to agricultural growth and poverty reduction. Iddrisu *et al.* (2020) using a computable general equilibrium model, analysed implication of the fertilizer subsidy program on income growth, productivity and employment in Ghana. The results indicate that the fertilizer subsidy program has improved GDP growth and productivity, particularly in the main agricultural sectors and the agro-food industry. Specifically, compared to business as usual scenario, implementation of the fertilizer subsidy program in 2017 improved productivity of maize, sorghum and rice value chains by around 8.3%, 4.5%, and 3. 8%, respectively. They also observed significant positive effects on the value added of food industry, indicating the presence of a link with agriculture. Based on these findings, they recommended that the fertilizer subsidy program be implemented and, if possible, extended beyond its intended implementation period. Ferrouki et *al.* (2021) in a similar study examined the effect of subsidies on agricultural growth in Algeria with a multiple linear regression model. They have succeeded in showing that support for agricultural production, in particular subsidies, has a positive effect on agricultural value added. Tsiboe *et al.* (2021) using matching methods, estimated the treatment effect of fertilizer subsidy program on a cross-sectional sample of 5,923 cereal households drawn from a population-based survey dataset for 2012/13 and 2016/17. Results showed that cereal yield enhancement attributable to subsidy program was 24.5%. Additionally, the effect disaggregated by type of cereal showed that farmers cultivating maize benefited the most. These findings support the ability of subsidy program to improve productivity. Weibigue (2021) using the stochastic frontier approach to compute the efficiency scores, analyzed the impact of fertilizer subsidies on productivity of farmers in the Senegal River Valley. The results obtained from survey data collected from 125 households indicate that fertilizer subsidy programs have significantly improved rice productivity. This result is consistent with the finding of Seck (2017) who used "data envelopment analysis" and an endogenous treatment-regression model that accounts for potential endogeneity and self-selectivity issues for the same data in Senegal. Ricker-Gilbert et al. (2013) uses a double-hurdle model with panel data from Malawi to investigate how fertilizer subsidies affect farmer demand for commercial fertilizer. The article controls for potential endogeneity caused by nonrandom targeting of fertilizer subsidy recipients. Results show that on average 1 additional kilogram of subsidized fertilizer crowds out 0.22 kg of commercial fertilizer, but crowding out ranges from 0.18 among the poorest farmers to 0.30 among relatively non-poor farmers. This indicates that targeting fertilizer subsidies to the rural poor is likely to maximize the contribution of the subsidy program to total fertilizer use. Several other studies have found significant positive effects (Mason et al., 2016; Minviel & Latruffe, 2017; Sibande et al., 2017).

Contrarily to the studies cited above, Warr & Yusuf (2014) simulated an increase of 27.8 percentage in the fertilizer price subsidy in Indonesia and found a reduction of 0.33 percent in GDP. Numerous other studies have shown that the impact on agricultural growth of an untargeted input subsidy is much lower than an investment of the same level aimed at providing public goods such as rural infrastructure, research, education, etc. (Ariga & Jayne, 2009). Fan *et al*. (2008) argue that subsidies compete directly with longer-term investments in roads, education, and agricultural research & development and thereby undermine long-term growth and poverty reduction. Subsidies are therefore considered as an inefficient way to support long-term agricultural production by several authors (Crawford et al., 2005; Dorward & Morrison, 2015; López & Galinato, 2007).

All in all, and from a methodological point of view, the works reviewed used various methods of analysis, in particular the computable general equilibrium model, the simple linear regression model, the efficiencies scores, the matching methods, the data envelopment analysis and the double-hurdle model. None of the studies used the ARDL model with macroeconomic approach. This model is an innovative approach in assessing the effect of fertilizer subsidy on agricultural growth.

4. Methodological Approach

4.1 Theoretical Framework

The Solow model is considered to be the reference for modern growth models. The basis of Solow's model is the Cobb-Douglas type production function. However, according to Barro (1990), the endogenous growth models are more useful for understanding the drivers of growth. Building on the work of Barro (1990), the growth is a function of public expenditures used for capital endowment (K) and labour (L). The starting production function is written as follows:

$$Q_t = A_t K_t^{\alpha} L_t^{\beta} \tag{1}$$

Where Q_t denotes the aggregate output of the agricultural sector at time t, A_t, K_t and L_t denote the total factor productivity (TFP), capital stock and labour stock at time t, respectively. Linearizing by the logarithm of the production function, equation (1) can be rewritten as follows:

$$lnQ_t = lnA_t + \alpha lnK_t + \beta lnL_t \tag{2}$$

4.2 Specification of the Model

The specification of the model starts from equation (2). Following Lopez and Galinato (2007), agricultural growth is a function of the primary factors of production (K), the volume of labour (L), the area of land used (Z) and the productivity index (A). According to Barro (1990), the impact of government spending on output growth eventually is transmitted through the total factor productivity (A). Therefore, we assume that total factor productivity (TFP) is a function of government policies and other exogenous factors including market prices (P), the non-agricultural sector performance (Y). According to Lopèz & Galinato (2007), government policies can be subdivided into three components: trade policies (T), public expenditure policies (E), and the subsidy policy (S). As a factor affecting the agricultural productivity, we add environmental and natural factors such as rainfall (CL). Thus, we model total factor productivity as follows:

$$A_t = f(E_t, S_t, Y_t, T_t, P_t, CL_t) \tag{3}$$

Equation (3) can be expressed explicitly as follows:

$$A_t = E_t^{\beta_1} S_t^{\beta_2} Y_t^{\beta_3} T_t^{\beta_4} P_t^{\beta_5} CL_t^{\beta_6} \tag{4}$$

Combining equations (1) and (4), we obtain:

$$Q_t = E_t^{\beta_1} S_t^{\beta_2} Y_t^{\beta_3} T_t^{\beta_4} P_t^{\beta_5} CL_t^{\beta_6} Z_t^{\beta_7} K_t^{8} L_t^{\beta_9} \quad (5)$$

By linearizing equation (5) and adding a constant, an error term and a Dummy variable D which stands for the food security crisis occurred in 2008, we obtain an estimable explicit econometric model, as follows:

$$LnQ_t = \beta_0 + \beta_1 lnE_t + \beta_2 lnS_t + \beta_3 lnY_t + \beta_4 lnT_t + \beta_5 lnP_t + \beta_6 lnCL_t + \beta_7 lnZ_t + \beta_8 lnK_t + \beta_9 lnL_t + \beta_{10} D\_2008 + \varepsilon_t \quad (6)$$

4.3 Definition and Justification of the Variables

Q which is the dependent variable stands for Agricultural Gross Domestic Product (AGDP) per capita in real term. This aggregate is the standard used to calculate the growth rate in the literature. E(+) is the amount of agricultural expenditure to agricultural GDP with expected positive sign (Barro, 1991; López & Galinato, 2007). E includes expenditure in irrigation, research, extension, and rural infrastructure. S (+/-) represents the amount of fertilizer subsidies to AGDP. Its effect can be positive or negative (Armas et al., 2010; López & Galinato, 2007). Y (+) is the share of non-agriculture GDP used as a proxy for non-agriculture sector performance and generally correlated with agricultural performance (López & Galinato, 2007). T (+) represents the index of trade openness which corresponds to the ratio of agricultural trade (X+M) to agricultural GDP. It is a standard index which effect on growth is often positive in the literature (Fosu & Magnus, 2006). P (+/-) is the real price index of agricultural products. This index stands for inflation. According to López-Villavicencio and Mignon (2011), there is a threshold level of inflation beyond which the impact would be negative and positive if below. CL (+/-) represents the annual rainfall used to capture the effect of climate. Here also, the literature showed the threshold effect of rainfall. Z (+) is the area of sown land, this variable positively affects the growth because Togolese agriculture being extensive, an increase in agricultural land is likely to influence positively the growth of agricultural output. K(+) is the volume of assets owned, i.e. the stock of capital. Due to the non-availability of this variable, K is proxy by Z. L (+) is the agricultural labour. It is the share of agricultural labour in the total of labour force. Apart from land, labour is the main production factor used in Togolese agriculture. So, the expected effect is positive. D_2008 (-) which stands for a dummy variable is included in the model to capture the adverse effect of the 2008 food crisis. β_0 is a constant parameter and ε is the white noise. It is important to note that, the agricultural labour and cultivated land variables are used as proxy for private inputs in order to capture possible complementarity effects between private and public assets (Armas et al., 2010).

4.4 Model Estimation Method

The Autoregressive Distributed Lag (ARDL) model of Pesaran et al (2001) is applied in this study. The ARDL model approach is advantageous because it can be used when the variables are integrated of different orders (I (0) or I (1)) (Pesaran et al., 2001). Another advantage is that it gives better estimates with small sample sizes, as this is the case for our sample (32 observations). However, variables should be tested for the unit root to ensure that they are not integrated of order greater than 1 ((Udoh, 2011). The general form of the ARDL (p, q) model is as follows:

$$Y_t = \varphi + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=0}^{q} b_j X_{t-j} + e_t \ldots \quad (7)$$

Where Y_t is the dependent variable and the independent variables X_t can be purely integrated of order I(0) or I(1); a_i and b_j are coefficients; φ is the constant; p, q are optimal shift orders; e_t is a vector of error terms (white noise). Thus, the ARDL model can be specified in the following form by proposing to capture the short-term and long-term effects of explanatory variables on the independent variable:

$$\Delta Q_t = a_o + \sum_{i=1}^{p} a_{1i}\Delta Q_{t-i} + \sum_{i=0}^{q} a_{2i}\Delta E_{t-i} + \sum_{i=0}^{q} a_{3i}\Delta S_{t-i} + \sum_{i=0}^{q} a_{4i}\Delta T_{t-i} + \sum_{i=0}^{q} a_{5i}\Delta K_{t-i} + \sum_{i=0}^{q} a_{6i}\Delta L_{t-i} + \sum_{i=0}^{q} a_{7i}\Delta Y_{t-i} + \sum_{i=0}^{q} a_{8i}\Delta P^*{}_{t-i} + \sum_{i=0}^{q} a_{9i}\Delta CL_{t-i} + +b_1 Q_{t-1} + b_2 E_{t-1} + b_3 S_{t-1} + b_4 T_{t-1} + b_5 K_{t-1} + b_6 L_{t-1} + b_7 Y_{t-1} + b_8 P^*{}_{t-1} + b_9 CL_{t-1} + b_{10} D + e_t \quad (8)$$

With Δ, first difference operator; a_o, the constant; a_i, short-term effects; b_i, the long-term dynamics of the model; e_t, error term (white noise).

According to Fosu and Magnus (2006), the ARDL approach begins by conducting a test for the existence of cointegration. According to econometric literature, several tests of cointegration exist namely Engle & Granger (1987), Johansen (1991), Johansen and Juselius (1990), and Pesaran et *al*. (2001). The Engle and Granger (1987) cointegration test is only valid for two integrated variables of the same order (i.e. order of integration = 1), so it is less efficient for multivariate cases (Kuma, 2018). Although Johansen's test solves this problem based on error-correction autoregressive vector modelling (VECM), it also requires that all the variables be integrated of the same order, what is not always the case. With several integrated variables of different orders (I(0), I(1)), one can use the cointegration test of Pesaran et *al.* (2001) called "bounds test for cointegration".

This cointegration test was carried out to verify the existence or not of a long-term relationship. The test procedure is such that the Fisher values obtained must be compared to the critical values (limits) simulated for several cases and different thresholds by Pesaran et *al* (2001). Thus, the calculated statistics are then compared to the values given by Pesaran et al (2001). The critical values of the lower bound assume that the variables are integrated of order zero (i.e. I(0)), while the upper critical values assume that the explanatory variables are integrated of order one (I(1)).

If the calculated F-statistic is less than the lower bound, the null hypothesis is accepted. If it is between the lower limit and the upper limit, no decision can be made as to the long-term relationship, in which case the result is considered inconclusive. Finally, if it is greater than the upper bound, the null hypothesis of the absence of cointegration is rejected in favour of the presence of a long-term relationship between the variables.

The null and alternative hypotheses tested are as follows:

$$H_0: b_1 = b_2 = b_3 = b_4 = b_5 = b_6 = b_7 = b_8 = b_9 \text{ : Existence of a cointegrating relationship}$$

$$H_1: b_1 \neq b_2 \neq b_3 \neq b_4 \neq b_5 \neq b_6 \neq b_7 \neq b_8 \neq b_9 \text{ : Absence of a cointegrating relationship}$$

As with any dynamic model, the information criteria (Akaike-AIC, Shwarz-SIC) are used to determine the optimal offsets (p, q) of the ARDL model.

After establishing the existence of a long-term cointegrating relationship, an error-correction model can help to confirm whether or not there is cointegration between variables. This model is specified as follows:

$$\Delta Q_t = a_o + \sum_{i=1}^{p} a_{1i}\Delta Q_{t-i} + \sum_{i=0}^{q} a_{2i}\Delta E_{t-i} + \sum_{i=0}^{q} a_{3i}\,\Delta S_{t-i} + \sum_{i=0}^{q} a_{4i}\Delta T_{t-i} + \sum_{i=0}^{q} a_{5i}\Delta K_{t-i} + \sum_{i=0}^{q} a_{6i}\Delta L_{t-i} + \sum_{i=0}^{q} a_{7i}\Delta Y_{t-i} + \sum_{i=0}^{q} a_{8i}\Delta {P^*}_{t-i} + \sum_{i=0}^{q} a_{9i}\Delta CL_{t-i} + b_{10}D + \theta ECM_{t-1} + e_t \quad (9)$$

Where θ represents the speed of adjustment.

4.5 Data: Nature and Sources

The data used are annual time series covering 32 years, i.e. from 1985 to 2016. The data come from various sources: the Ministry of Agriculture, the National Meteorology, FAO and Word Bank. The table1 below provides information on the variables used.

Table 1. definition of variables and sources of data

Variables	Definitions	Unit of measure	Sources of data
AGDP	Agricultural Gross Domestic Product per capita real	USD	FAO (FAOSTAT)
E	Agricultural expenditure	% AGDP	World Bank (WDI)
S	Fertilizer subsidies	%AGDP	Ministry of agriculture
Y	Non-agriculture GDP	%GDP	World Bank (WDI)
T	Trade openness index of agricultural products	% AGDP	World Bank (WDI)
P	Price index of agricultural products	% Annual	World Bank (WDI)
CL	Annual average rainfall	mm	National Meteorology
K	Share of cultivated land	% Total arable land	World Bank
L	share of agricultural labour	% Active population	World Bank (WDI)

Source: Authors

4.6 Descriptive Statistics

The descriptive statistics of the variables used in the model are summarized in table 2. From the analysis of these results, it appears that during the period of the study, the real agricultural Gross domestic product (AGDP) per capita of the country was on average US $ 141.64, and the maximum at US $ 243 in 2008. The lowest AGDP (US $ 78.89) was recorded in 2009 following the global food crisis. The variable E, represents the amount of agricultural expenditure on public goods related to AGDP. It averages 2.04 with its highest level being 3.11 in 2017. This was achieved thanks to the massive investments made under the National Agricultural Investment and Food Security Program (PNIASA). Agricultural expenditure on public goods reached its minimum (1.28) in 1993, as a result of the break in international cooperation. The amount of fertilizers subsidy to AGDP is on average 0.27 and varies between 0.12 and 0.51 over the period of analysis. The highest value corresponds to the year 2009 because of the increase in the price of fertilizers on the international market. The variable Non-agricultural GDP (Y) which reflects the conditions prevailing in sectors other than agriculture is calculated as a share of GDP. It averages 0.60 over the period of analysis. It runs between a minimum of 0.56 to a maximum of 0.67. The trade openness index (T) corresponds to the ratio of trade (exports + imports) of agricultural products to agricultural GDP. Over the period, the average indicator is 0.47 with a peak (1.85) in 1985 and the minimum value in 2013 corresponding to 0.188. The real price index of agricultural products (P) is on average 59.82% over the study period with a maximum of 112.19% in 2018 and 25.95% in 1993. The annual rainfall is used to capture the effect of the climate (CL) and represents on average over the study period 1162.24 mm with a maximum level of 1341.03 mm in 1991 and a minimum of 900.59 mm in 2001. The share of cultivated land (K) is the proxy of the volume of assets owned by farmers. It represents the area of sown land. Over the analysis period, the area sown is on average 63.75% of arable land. The maximum area sown is 70.78% and the minimum 56.81%. The share of agricultural labour (L) varied between 33 and 55% over the study period. The mean labour force represents 46.75% of the active population.

Table 2. Descriptive statistics of the model variables

variables	Obs	Mean	Std dev	Min	Max
Agricultural Gross Domestic Product (AGDP)	32	141.64	37.79	78.89	243
Agricultural expenditure (E)	32	2.04	3.44	1.28	3.31
Fertilizer subsidies (S)	32	0.32	0.43	0.12	0.51
Share of non-agricultural GDP (Y)	32	0.60	0.18	0.56	0.67
Trade openness index (T)	32	0.47	0.28	0.19	1.55
Price index of agricultural products (P)	32	59.82	27.28	25.95	112.19
Annual average rainfall (CL)	32	1162.24	113.40	900.59	1341.03
share of agricultural land (K)	32	63.75	4.61	56.81	70.78
share of agricultural labour (L)	32	46.75	5.60	33.10	55.55
Dummy food Crisis of 2008	32	0.25	0.04	0	1

Source: Authors' estimate, 2022

5. Results and Discussion

This section analyses and discusses econometric results of fertilizer price subsidy impact on agricultural growth in Togo. To do this, validation tests of the ARDL model are presented first, and then the results followed by discussion.

5.1 Statistical Validation Tests of the Model

5.1.1 Unit Root Test

From table 3, unit root tests for stationarity conducted for the variables indicated that five variables were integrated of order one [I (1)] and five others variables are stationary in level. The series being integrated at different orders, the cointegration test of Engle and Granger and that of Johansen are inefficient. This makes the cointegration test at the bounds appropriate (Pesaran et al., 2001). Two steps must be followed to apply Pesaran cointgration test: First of all, determine the optimal model then use Fisher's test to test cointegration between series.

Table 3. Result of Augmented Dickey-Fuller (ADF) stationarity tests

Variables	**ADF p-value in level**	**ADF p-value in first difference**	**Integration order**
Agricultural Gross Domestic Product (Q)	0.00	-	I(0)
Agricultural expenditure (E)	0.97	0.00	I(1)
Fertilizer subsidies (S)	0.02	-	I(0)
Share of non-agricultural (Y)	0.00	-	I(0)
Trade openness index (T)	0.00	-	I(0)
Price index of agricultural products (P)	0.99	0.00	I(1)
Annual average rainfall (CL)	0.00	-	I(0)
share of agricultural land (K)	0.76	0.00	I(1)
share of agricultural labour (L)	0.10	0.02	I(1)

Source: Authors' estimate, 2022

5.1.2 Optimal Model and Diagnostic Tests of the Estimated ARDL Model

The Akaike Information Criterion (AIC) was used to select the optimal ARDL model that offers statistically significant results with the fewest parameters. The observation of graph 1 indicates that ARDL model (1, 1, 2, 2, 2, 0, 2, 0, 1) is the most optimal among the 20 models presented, because it offers the smallest value of the AIC.

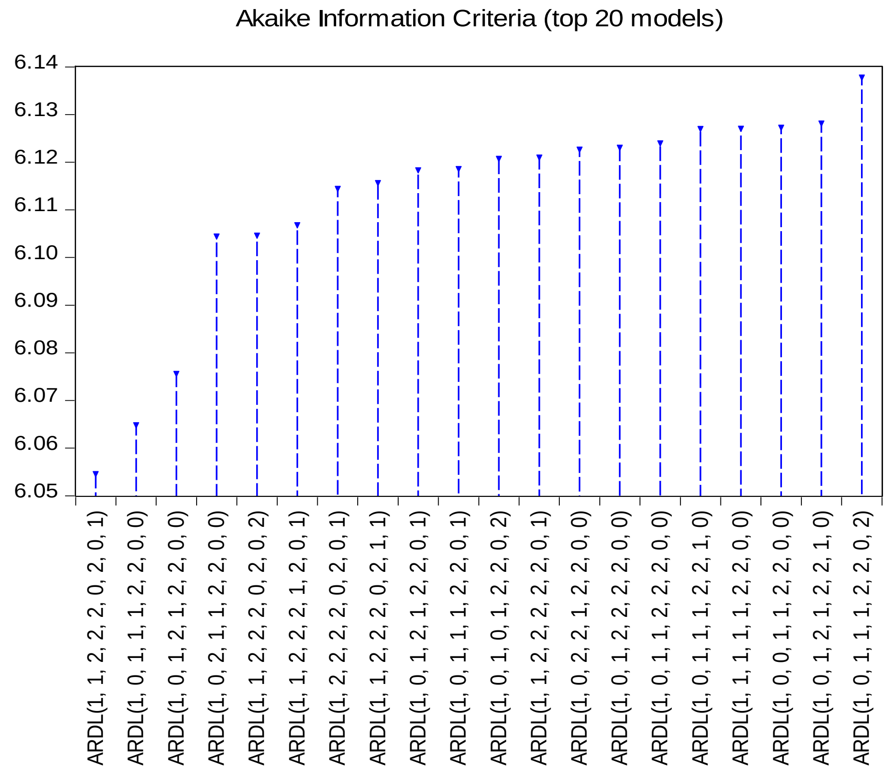

Figure 4. Akaike Information Criteria (AIC)

Source: Authors' estimate, 2022

Moreover, with regard to diagnostic tests of the estimated ARDL model, we note the absence of autocorrelation of the errors, there is no heteroscedasticity, that there is normality of the errors and the model was relatively well specified (see Table 4). The null hypothesis is therefore accepted for all these tests, validating the model statistically. The cumulative sum and the cumulative sums of the squares of the recursive residuals of the model also indicate the stability of the coefficients over the period of analysis (Figure 4). The estimated ARDL (1, 1, 2, 2, 2, 0, 2, 0, 1) model is globally well specified and explains the dynamics of growth rate of agricultural GDP in Togo over the period from 1985 to 2016.

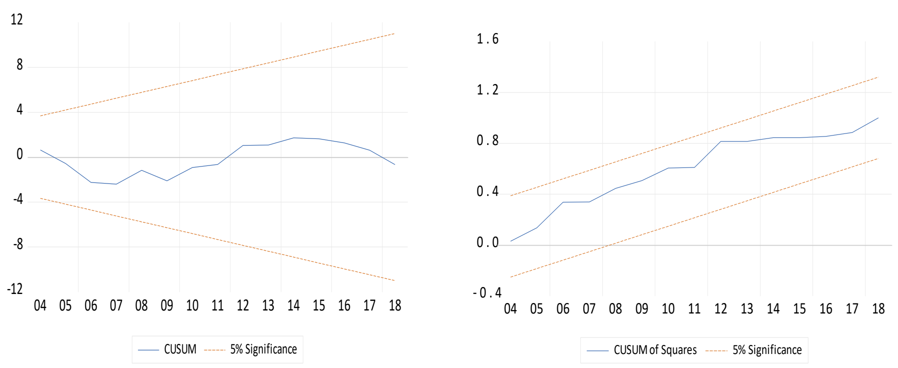

Figure 4. Plot of CUSUM and CUSUMQ for the stability of model coefficients

Table 1. Estimated ARDL model diagnostic test results

Assumptions	Test	Values (probability)
Autocorrelation	Breusch-Godfrey	2.26 (0.14)
Heteroscedasticity	Breusch-Pagan-Godfrey	0.70 (0.76)
	Arch-test	0.27 (0.61)
Normality	Jarque-Bera	1.35 (0.51)
Specification	Ramsey (Fisher)	4.52 (0.05)

Source: Authors' estimate, 2022

5.1.3 Bounds Cointegration Tests

The results of the bounds cointegration tests show that there is a cointegration relationship between the series under study. The value of the calculated F statistic is greater than that of the upper bound, which enables us to estimate the long-term effects of the independent variables on the dependent variable (Table 5). Indeed, Table 5 shows that the calculated F statistic (6.077) is greater than the upper bound critical value (3.5) at the 5% threshold. Even better, at the 1% threshold, the calculated F statistic is also greater than the upper bound critical value (4.26). Thus, the null hypotheses of no cointegration are rejected in favour of the existence of long-term cointegrating relationships.

Table 5. Results of the cointegration test

Variables	LnE, LnS, LnY, LnCL, LnP, LnT, LnK, lnL D_2008	
F-statistic	6.08	
Critical threshold	**Lower bound**	**Upper bound**
1%	2.96	4.26
5%	2.32	3.50
10%	2.03	3.13

Source: Authors' estimate, 2022

5.2 Result of the ARDL Model Estimation

5.2.1 Short Run Results

The results from Table 6, show that the equilibrium correction coefficient (ECM) estimated (-0.70) is highly significant and has the correct sign. This implies a high speed of adjustment to equilibrium after a shock. Approximately 70% of disequilibria from the previous year shock converge back to the long run equilibrium in the current year.

According to short run dynamic presented in table 6, fertilizer price subsidies have no significant impact on agricultural growth in the short run. Conversely, agricultural expenditure (in irrigation, research, extension, and rural infrastructure) has a positive impact on agricultural GDP growth in the short run. This impact lasts more than one year. Additionally, the global food crisis that Togo experienced in 2008 had a positive effect on agricultural growth. This unexpected result can be explained by the resurgence of fertilizer subsidy in 2008 in response of food crisis. The result is supported by the stylized facts which show AGDP growth in 2008 followed by a decline in 2009 (Figure 2).

Other variables such as rainfall, agricultural commodity price index, arable land, labour force exert a significant positive effect in the short run. The remaining variables, non-agricultural sector performance and trade openness have no significant impact on agricultural GDP growth in the short term.

Table 6. Estimation results of the short-term coefficients of the error correction model

Dependent variable: D(LnQ)			
Variables	**Coefficients**	**t-statistics**	**p-value**
D(LnQ(-1))	-0.35***	-11.20	0.00
D(LnE)	0.39***	6.12	0.01
D(LnE(-1))	0.55***	10.26	0.00
D(LnS)	0.07	1.52	0.13
D(LnS(-1)	0.27	1.32	0.17
D(LnY)	1.04	0.09	0.93
D(LnY (-1)	1.24	0.18	0.43
D(LnT)	-1.14	1.54	0.24
D(LnT (-1)	-0.11	1.51	0.25
D(LnP)	1.09***	8.63	0.00
D(LnCL)	0.20***	15.16	0.00
D(LnCL (-1)	1.56	0.43	0.41
D(LnK)	5.21***	18.94	0.00
D(LnL)	1.76***	7.68	0.00
D(LnL (-1)	0.043	0.76	0.39
D_2008	0.31**	2.23	0.04
ECM (-1)	-0.70***	-31.83	0.00
R-square	0.90		
Adjusted R-square	0.87		
Stat Durbin-Watson	2.19		
F-statistics	23.44		
Prob (Statistics-F)	0.00		
***: significant at 5%; ***: significant at 1%*			

Source: Authors' estimate, 2022

5.2.2 Long Run Results

The estimated coefficients show long-run response of agricultural GDP growth to the various regressors. From the results of Table 7, it appears that, fertilizer subsidies have a positive but non-significant impact on agricultural GDP growth in the long-run, as is the case in the short-term result. However, public agricultural expenditure has a positive and significant impact on agricultural growth in the long-run. A 1% increase in agricultural expenditure (irrigation, research, extension, and rural infrastructure) leads to approximately 0.49% increase in agricultural GDP growth. Similarly, other variables such as rainfall, area sown and labour force have positive and significant long run impact on agricultural GDP growth. The remaining variables; non-agricultural GDP, agricultural commodity price index, trade openness and 2008 food crisis seem to exert no significant effect on agricultural grow in the long run.

Table 7. Estimation results of the long-term coefficients of the ARDL model

Dependent variable: LnQ			
Variables	**Coefficients**	**t-statistics**	**p-value**
LnE	**0.49*** **	**3.02**	**0.00**
LnS	0.26	0.53	0.63
LnY	0.23	1.31	0.37
LnT	-0.35	-1.13	0.34
LnP	-0.88	-1.15	0.39
LnCL	**0.44****	**2.39**	**0.02**
LnK	**1.58*** **	**2.65**	**0.01**
LnL	**0.40*** **	**2.86**	**0.01**
D_2008	-0.52	-1.05	0.26
R-square	0.86		
Adjusted R-square	0.77		
Stat Durbin-Watson	2.12		
F-statistics	88.05		
Prob (Statistics-F)	0.00		

***: significant at 5%; ***: significant at 1%*

Source: Authors' estimate, 2022

6. Discussion

Estimation of ARDL model shows that fertilizer price subsidy does not significantly impact agricultural growth in the short run and in the long run. This result contradicts Ferrouki et al (2021) Tsiboe et al. (2021), Weibigue (2021) and Iddrisu et al. (2020) but corroborates Crawford et al.(2005); Dorward & Morrison (2015); López & Galinato (2007). In contrast, agricultural expenditure has a significant positive impact on growth both in the long and short term. This implies that agricultural expenditure (in research, extension, rural infrastructure etc) generates a higher return on investment than fertilizer subsidy (Armas et al., 2010; López & Galinato, 2007).

The poor performance of subsidy spending is not counterintuitive. As highlight by stylized facts, the subsidy rate fell over time and the purchasing power of farmers dropped drastically. Even though, fertilizers are subsidized, farmer’s purchasing power did not allow them to purchase fertilizers. Consequently, farmer’s fertilizers consumptions were very low (Yovo, 2017).

Another reason is the crowding out effects of subsidies (Crawford et al., 2005 ; Dorward & Morrison, 2015 ; Jayne et al., 2013). Indeed, subsidies not only crowd out private investment in the agricultural sector, but more importantly compete with investment in other public goods (infrastructure, rural roads, irrigation etc.) for financial and non-financial resources in government budget. Many economists agree that the opportunity cost of subsidies in terms of productive public goods such as infrastructure, research and technology transfer is often high. Ineffectiveness of price subsidies can be also explained by price difference between Togo and neighboring countries which causes leakage of subsidized fertilizers outside the country.

Finally, discrepancy between our results and those of previous authors, most of whom obtained significant positive effects, may be related to difference in terms of approach used. Our work focused on macroeconomic data. Previous works have used household data.

7. Conclusion and Agricultural Policy Implications

In Togo, as elsewhere in SSA countries, governments have often used subsidies as a means of encouraging the use of agricultural inputs in order to achieve agricultural growth, food security and poverty reduction goals. This article assessed the impact of fertilizer price subsidy on agricultural growth in Togo during 1985 to 2016. Results from ARDL model reveal that fertilizer subsidy did not significantly enhanced agricultural growth neither in short run nor in long run. Conversely, agricultural expenditure (research, extension and rural infrastructures) positively and significantly affects agricultural growth both in the short run and long run. In addition, we find that other variables such as arable land and labour force also play a major role in agricultural GDP growth.

In view of the above findings, it is important to formulate subsidy policy likely to impact agricultural growth in Togo. To improve the efficiency of fertilizer subsidy, the government should drop price subsidy policy at global level for “target subsidy” which would facilitate fertilizer access to poorer and more marginal farmers. It is also important to take actions to prevent leakage of subsidized fertilizers to neighbouring countries.

One limitation of this study is the small sample size. For further research, result can be improved if the data are spatially disaggregated, e.g., at the regional or prefectural level, in order to increase the sample size. For this purpose, the researcher will need to determine quantity of fertilizer consumed by region or by prefecture during the study period. These data may be available in reports of the ministry of agriculture.

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