Charlotte FONTAN SERS

Mazhar MUGHAL

Pau Business School

From Maputo to Malabo: Public Agricultural Spending and Food Security in Africa

Abstract

This study examines the role government spending on agriculture has played in enhancing Africa's state of food security during the past 25 years. We study this relationship by controlling for various economic, demographic, institutional, climatic and geographical factors that influence food insecurity in Africa.

We find little evidence of significant beneficial effects of public agricultural spending on food security as a whole. However, food security has improved in countries which spend high proportions of their budgets on agriculture. The commitment by African government in the Maputo Declaration to allocate 10% of public spending to agriculture therefore appears to be pertinent.

JEL Classifications : 011, 055, Q18

Keywords : public agricultural spending, food security, Africa

1. Introduction

At the 2003 African Union summit in Maputo, Mozambique, African leaders adopted the Comprehensive Africa Agriculture Development Programme (CAADP). The initiative was aimed at promoting agricultural growth, reducing poverty and improving food security in the continent (AU 2003). African countries' heads of states committed to invest at least 10% of the total government expenditures in the agriculture sector within five years. This level of investment was deemed necessary to achieve an average 6% annual agricultural growth rate in order to attain the Millennium Development Goal (MDG) of eradicating extreme hunger

and poverty by 2015[1]. This commitment was reaffirmed in the 2014 Malabo Declaration on Accelerated Agricultural Growth And Transformation for Shared Prosperity And Improved Livelihoods adopted at the African Union summit at Malabo, Equatorial Guinea. The declaration committed to ending hunger and halving poverty in the continent through inclusive agricultural growth by 2025 (AU, 2014).

Fourteen years since the Maputo declaration, significant progress has been made in allocating higher public funds to agriculture. 11 African countries managed to allocate 10% or more of their budgets to agriculture in any year since 2005, while Ethiopia, Kenya, Mozambique and Sierra Leone achieved 6% agricultural growth in most of these years (World Bank, 2015). Progress has also been made in reducing hunger from the continent, even though a quarter of Sub-Saharan Africa's population is still considered undernourished (FAO, 2015).

What then is the relationship between public agricultural expenditure and the extent of food insecurity in Africa?

Country studies such as Aidoo et al. (2013), Gezimu Gebre (2012), Matchaya and Chilonda (2012), Magana-Lemus et al. (2016), Muche et al (2014) and Zakari et al. (2014) have examined the relationship in the context of various African countries.

On the macroeconomic level, FAO suggests public spending allocated to agriculture to be one of the key factors for success in reducing undernourishment and poverty, particularly in the rural areas (FAO, 2012; FAO, IFAD, WFP, 2015). According to FAO, hunger is more prevalent in countries where public agricultural expenditure per worker is lower (FAO, 2012 p. 6).

63% of the population of SubSaharan African countries lives in rural areas and depends to a large extent on agriculture (World Bank, 2015). Moreover, around 80% of farms in Africa are smaller than 2 hectares (Lowder et al., 2015). These small farms often rely on primitive

[1] For details on United Nations Millennium Development Goals, see : http://www.un.org/millenniumgoals/

cultivation technology to produce cereals and cash crops, and lack access to better seeds, inputs and insurance against natural catastrophes and crop failures. Food security is thus a constant concern. Public investment on agriculture therefore has a major scope for alleviating rural poverty and improving food security.

In this study, we examine the role government spending on agriculture has played in enhancing Africa's level of food security in the past quarter of a century. We study this relationship by analyzing available data for African countries using a panoply of empirical specifications and controlling for various economic, demographic, institutional, climatic and geographical factors that influence the state of food security. We examine the temporal dimension of this relationship as well as the effect of the size of public spending. We explore various aspects of food security and check whether spending on research and development follows the same patterns as the overall public spending allocated to agriculture.

We find little evidence of a significant overall beneficial effect of public agricultural spending on food security in Africa. However, food security has improved in countries and regions which spend high proportions of their budgets on agriculture. Spending on agricultural research and development too has shown a useful impact on Africa’s food security. The results of the study are robust to use of an array of empirical specifications and econometric techniques.

The remainder of the article is organized as follows:

Section 2 presents the trends in African countries’ government expenditures allocated to agriculture and describes the food security situation in the continent. The empirical model and the data and methodology employed are presented in Section 3, followed by the discussion of results in Section 4. Conclusions and policy implications are given in the last section.

2. Public spending on agriculture and food security in Africa

2.1. Public Spending on Agriculture

Throughout the 1980s and the 90s, agriculture remained a low-priority item in the policy agenda of most African countries, as focus was mainly on economic reforms and liberalization of the industrial, finance and other service sectors (Yu et al., 2015). Policy rhetoric shifted during the 2000s with realization of agriculture's potential for leading economic growth and poverty alleviation in Africa. Even though public spending on agriculture remains minor compared with on farm investments (Lowder et al., 2015), efforts have since been made to raise agricultural productivity through increased government expenditure accompanied by private sector investments and development assistance from international donors.

Regions all over the continent devised joint strategies for promoting agricultural growth through collaboration in information sharing, improvements in physical infrastructure, and research and development (R&D). Examples in this regard are the Common Agricultural Policy for Economic Community of Central African States, the Agricultural Policy of the West African Economic Community (ECOWAP), and the Food and Nutrition strategy (2015-2025) for Southern African Development Community. Implementation of the ECOWAP Agricultural Policy adopted in 2005 by the West African Economic Community, the ECOWAS is based on the Regional Agricultural Investment Programme, the RAIP (ECOWAS, 2008). The program comprises of four components, the first of which is the «Promotion of strategic projects for food security and food sovereignty"[2]. Accordingly, all countries have defined their national agricultural investment plans with a strong focus on improving food security (FAO, 2015)[3].

---

[2] See for details : http://www.ecowas.int/ecowas-sectors/agriculture/

[3] For Senegal for instance, see ftp://ftp.fao.org/tc/tca/CAADP%20TT/CAADP%20Implementation/CAADP%20Post-

Agricultural spending by African governments has improved substantially in absolute terms. However, the spending still remains inadequate relative to the total expenditure (Table 1). African countries allocate an average of 6% of their annual budgets to agriculture, a share far below the 10% target set at Maputo, and only a fifth of the African countries have reached the 10% expenditure share target in any year since 2003. Although some countries such as Niger, Burkina Faso, Ethiopia, Malawi and Mali regularly allocated 10% or more of their budgets to agriculture, populous countries like Nigeria, Cameroon and Democratic Republic of the Congo could not regularly allocate even 5% of government funds to agriculture. In similar manner, little clear upward trend can be seen in expenditure shares by region, and regional averages have remained below 10% during the entire 1990 – 2014 period (Table 1). Likewise, while real per capita public spending on agriculture grew seven-fold in East Asia and the Pacific and four-fold in South Asia, expenditures fell by 25% in Africa south of the Sahara.

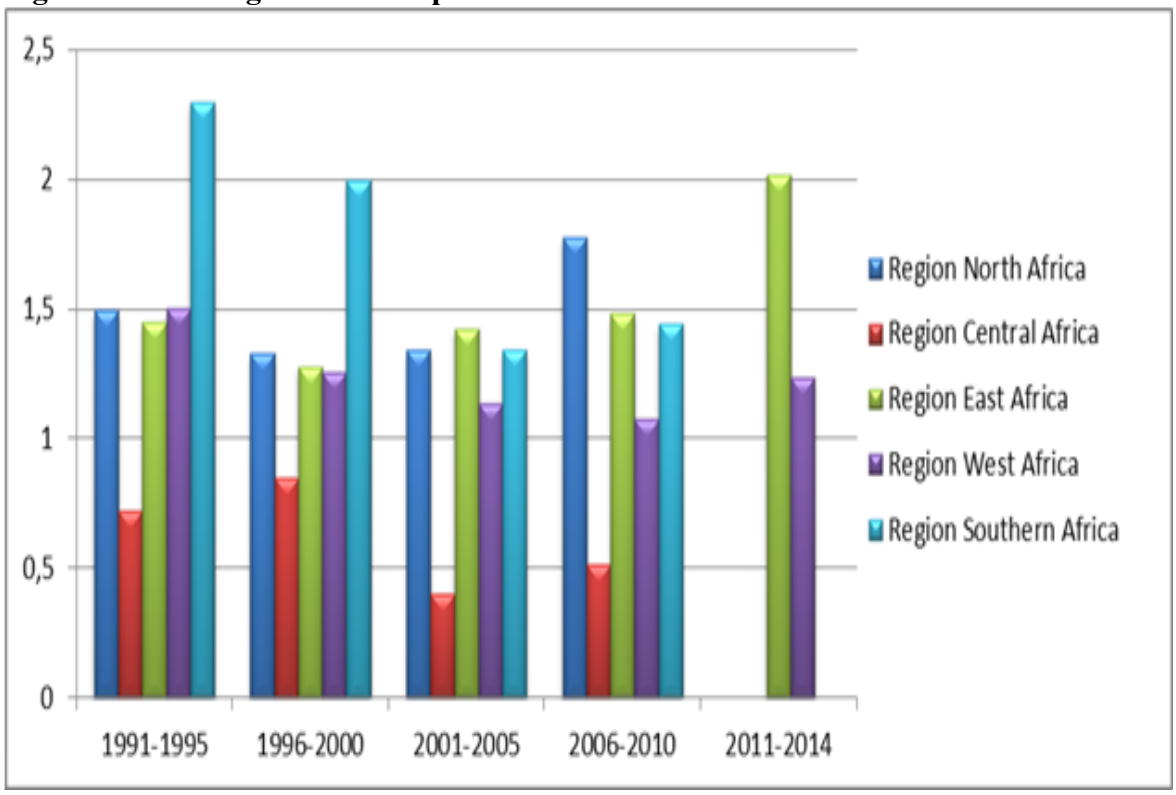
Table 1. Public agricultural expenditures as a share of total spending (%) 1990 – 2014

Subregion	1991-1995	1996-2000	2001-2005	2006-2010	2011-2014
North Africa	5,01	5,52	5,08	3,71	_
Central Africa	1,65	4,09	1,08	1,88	_
East Africa	5,82	5,26	5,73	7,72	5,24
West Africa	9,14	7,91	7,05	8,91	_
Southern Africa	6,31	5,1	3,57	3,01	_

Source : SPEED Database (IFPRI, 2015)

Compact/Investment%20Plans/National%20Agricultural%20Investment%20Plans/Senegal%20CAADP%20Post-Compact%20Agricultural%20Sector%20Investment%20Plan.pdf

Figure 1. Public agricultural expenditures as a share of GDP 1990-2014



Source : SPEED Database (IFPRI, 2015)

Relative to GDP, spending on agriculture fell in several subregions of Africa during the 1990s but picked up since the 2000s (figure 1). During the first five years since the launch of CAADP (2003-2008), expenditures grew by a healthy 7.7% per year at an average (IFPRI, 2015). Growth in agricultural spending halted during the following five years (2008-2013) averaging a dismal 1.3% per year. Reasons for this slow growth include the spike in food prices during 2007 and drying up of international aid and private investments in the wake of the 2008 global financial crisis.

The best pace of progress was seen in the region of West Africa where public spending grew four-folds to reach 9.7% of total spending in 2010. In 2003, this region had the lowest investment rates of all African regions. Barring countries in this region, few African countries have yet achieved agricultural production levels reached in the 1960s (Badiane et al., 2015).

Although the continent as a whole saw the longest period of agricultural growth since independence and agricultural growth in several countries occasionally reached double digits,

the performance of many countries has remained weak. Growth has often been volatile and episodes of negative growth have also been reported. At the subregional level, only East Africa registered a healthy growth in spending relative to GDP in the 2008 to 2014 period, while West Africa even suffered a decline in agricultural GDP. To that extent, the objectives of Maputo accord have still not been attained for many African countries. Besides, the relationship between agricultural value added growth rate and aggregate public agricultural expenditures is found to be insignificant or negative for all regions of Africa except for East Africa (Benin and Yu, 2013).

2.2. State of food insecurity in Africa

Food security is said to exist when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life (FAO, 1996). The phenomenon integrates four dimensions namely stability, access to food, availability of nutritionally adequate food and the biological utilization of food, which are calculated using indicators such as average value of food production, road density, evolution of cereal import dependency ratio, and prevalence of anemia among children under five years of age.

Today, SubSaharan Africa and South Asia are the world's two main remaining concentrations of food insecurity. In contrast to Western Asia, Latin America and the Caribbean, progress in combating hunger has been slow in these two regions (FAO, IFAD, WFP, 2015). Prevalence rates of undernourishment in SubSaharan Africa still approach 21% at an average (FAO et al. 2017), whereas in North Africa, the rates are close to 8%.

Table 2. Undernourishment Trends in Africa

Sub Region	Number of undernourished (million)		Change (%)	Undernourishment prevalence (%)	
	1990-92	2014-16		1990-92	2014-16
North Africa	6	4.3	-28,30%	< 5%	< 5%
East Africa	103.9	124.2	19.6%	47.2%	31.5%
Central Africa	24.2	58.9	143.7%	33.5%	41.3%
Southern Africa	3.1	3.2	2.3%	7.2%	5.2%
West Africa	44.6	33.7	-24.5%	24.2%	9.6%

Source : (FAO, IFAD, WFP, 2015)

Every fourth undernourished human being in the world comes from Africa south of the Sahara (FAO et al. 2017). The number of malnourished people in the continent has grown from 179 million in the 1999-2001 period to over 205 million in the 2014-16 period. All the five regions in Africa have seen an absolute increase in the number of malnourished people during the period.

Table 2 shows the numbers and proportion of undernourished population for various sub regions of Africa for the 1999-2001 and 2014-16 periods. Eastern and Central Africa still suffer from widespread undernourishment with prevalence rates of 32 and 24.8% respectively.

In West Africa, improvement in diet quality has accompanied increase in calorie consumption (Me-Nsope and Staatz, 2015). Per capita availability of roots and tubers and fruits and vegetables has increased, as has the consumption of animal proteins even though consumption of the latter still remains low by world standards. Part of this diet improvement has come from imported food items such as chicken, Irish potatoes as well as rice. Whereas rice production in West Africa increased from 6.4 million tons in 1992 to over 12 million tons in 2011, imports tripled to almost 10 million from an initial 3.5 million tons in 1992.

Africa's average Import Dependency ratio rose from 25.2% in 1990-92 to 42% in 2011-2013. This sharp increase is in part due to the emergence of African middle class with diversified taste for food. Another reason is the national policies during the later part of the twentieth century which favoured cultivation of cash crops for exports at the cost of food and cereals.

3. Model, methodology and data

3.1. Model

As discussed in the previous section, food security is a multi-dimensional phenomenon, and its different dimensions may therefore be difficult to take into account. Few studies have empirically examined factors that determine the level of food security on the macroeconomic level. In their 2015 report on the state of food security, Food and Agricultural Organization of the United Nations suggest inclusive growth, social protection in the rural areas, well functioning markets, good governance, price stability, agricultural productivity, and small farmer income to be among important factors that help alleviate undernourishment in a country (FAO, IFAD, WFP, 2015). Economic growth which enhances access to food, assets and resources, particularly for the poor and women and allows them to realize their potential, has great impact on food security. Growth, while a necessary condition for progress in poverty and hunger reduction especially in the face of an expanding population, is not sufficient if it does not improve the lives of the poor (FAO, IFAD, WFP, 2015). The FAO study shows that the relationship between GDP growth and food security is positive for developing countries as a whole. This association weakens as the country grows richer.

Inflation too has a strong influence on food security. Food accounts for a proportionally higher share of poor households' budgets, and sudden and large increases in food prices hurt them more (Bora et al., 2010).

Demographic factors too affect food security. Slowing population growth rates and falling infant and child mortality helps improve food security situation.

The availability and access to food could be undermined in the aftermath of weather or climatic shock such as crop failure, famine, food or water shortage.

In this study, we control for these drivers of food security in order to gauge the relationship between public agricultural spending and food security in Africa. We also control for the

continent's spatial dispersion. Africa's five geographical regions: North, Centre, West, East and South differ widely in demographic, climatic, topographical and economic characteristics and thereby present varying food security scenario. In our model, Central Africa is taken as the base region among the five African subregions.

Our baseline model is given as:

$$\text{Undernutrition\_prevalence}_{i,t} = f(\text{agrexptotal}_{i,t}, \text{gdpgrowth}_{i,t}, \text{inflation}_{i,t}, \text{mortality}_{i,t}, \text{naturalhazard}_{i,t}, \text{northafrica}_{t}, \text{eastafrica}_{t}, \text{westafrica}_{t}, \text{southernafrica}_{t}) \quad (1)$$

where 'i' represents the corresponding African country and 't' the year of the observation. The proportion of population suffering from undernutrition is taken as the main food security indicator.

3.2. Methodology

The study proceeds in the following steps:

In the first step, the baseline model is estimated using random and fixed-effect panel data techniques. The random-effects model is found to be more appropriate. The model is estimated using different indicators of public agricultural spending: share of agricultural expenditures in the total government budget (the default indicator), logged amount of public agricultural spending, public agricultural spending as a proportion of GDP, per capita public spending on agriculture, public agricultural spending relative to rural population, and public agricultural spending per land area.

In the second step, we focus on the time dimension by alternately using one, two, three, four and five-year lagged values of public agricultural spending.

In Step 3, we examine the impact of public agricultural spending on various aspects of food security namely availability, access, stability and biological utilization. The indicators corresponding to the four aspects include average dietary energy supply adequacy, domestic

food price index, domestic food price volatility, and prevalence of stunting among under 5 children.

In Step 4, we consider a crucial subcategory of public expenditures on agriculture, namely research and development (R&D). Indicators alternately used in place of the default indicator include logged amount of agricultural R&D spending, share of agricultural R&D in the country's agricultural GDP, per capita spending on agricultural R&D and the number of scientists per 1000 farmers. The first of these indicators is also estimated with lags of one, five and ten years to account for delayed impact of R&D spending on the country's food security.

In step 5, we take into account possible size effect of public spending by alternately limiting the dataset to above median, above mean, top quartile and top decile countries in the public agricultural spending distribution. We also look for possible regional variation.

As a next step, we account for certain important events by introducing event time dummies and look for their interaction with the public spending indicator. The variables include a dummy for the Maputo declaration, a dummy for the year that the corresponding country began participation in the CAADP, and a dummy for the onset of the 2007 – 2008 world food crisis. Public agricultural spending is alternatively interacted with the Maputo, CAADP and food crisis dummies. The first two interactions account for the change in public funds allocated to agriculture after signing the Maputo declaration and participating in the CAADP respectively. The third interaction takes into account lower budgets allocated to agriculture by African governments during the food crisis, possibly due to the public funds being diverted towards social programmes meant for subsidizing domestic food prices.

In step 7, we alternately include six indicators of institutional quality to account for factors such as political stability and absence of violence or terrorism, rule of law, government effectiveness, control of corruption, regulatory environment and accountability.

Elements of favourable investment environment such as good governance, macroeconomic stability, transparent and stable trade policies, effective market institutions and respect for property rights help create an enabling environment for agriculture (FAO, 2012, p.14). FAO (2015) reports that countries such as Benin, Cabo Verde, Ethiopia, Rwanda and South Africa which have made major strides in achieving MDG targets also have improved governance and tackled corruption. A strong association between food security and institutional factors can thus be expected.

In step 8, we try additional models by alternately including various additional socioeconomic and demographic indicators.

The association between public agricultural spending and food security may vary across countries depending on the importance of the agricultural sector in those countries. For example, producers of oil and other natural resources can guarantee their populations' food security in spite of a small role of agriculture in the national output.

Urbanization is a major demographic change taking place in Africa. This has the potential to substantially change the levels of undernutrition in developing countries as rural households engaged in subsistant farming often become food deficient after migrating to urban slums.

Another factor examined is the domesic food production whose fluctuations can significantly affect vulnerable segments of the population.

Health and sanitation conditions may play a significant role in improving households' nutrition situation (DeWalt, 1993; Headey, 2012). Enhancements in the share of population having access to improved sanitation reflects better hygienic conditions and greater safety from preventable diseases which helps ameliorate nutritional adequacy.

The public agricultural spending – food security relationship may evolve with the progress of a country's level of development and its economic size. To capture this effect, we carry out

alternative specifications of the baseline model by replacing GDP growth rate with per capita output and the country's GDP.

Finally, we estimate the baseline model by employing alternative empirical strategies. We include time and country effects. Arellano and Bond estimater is also employed to address endogeneity and autocorrelation issues. In addition, we estimate a model based on three-year averages of the baseline specification to counter data variability across countries owing to the the sample's unbalanced nature. We also try instrumenting public agricultural spending with quantity of fertilizers, number of tractors and per capita arable land. The three are found to be weak instruments.

3.3. Data

The study covers the period from 1991 to 2014. Estimations are carried out on a useable dataset of 621 observations at the maximum for 37 panels. Table A-1 in the appendix presents summary statistics of the selected variables. The definitions and sources of these variables are given in Table 3.

Table 3. Data description

4. Findings

4.1. Public agricultural spending and food security – the relationship

Table 4 Columns 1 and 2 show fixed- and random-effect panel estimations of the baseline model. The relationship between the share of agricultural expenditures in the total government spending and the prevalence of undernourishment in Africa is found to be insignificant. There is some possibility that this insignificant relationship may be limited to a particular indicator of public spending. To check for this possibility, we carry out the

estimations by substituting the indicator for public agricultural expenditure by other relevant indicators, namely the amount of public agricultural spending, public agricultural spending to GDP ratio, per capita public agricultural spending, public agricultural spending per rural population and public agricultural spending per surface area. Results (given in Columns 3 to 7 corroborate the initial findings. The association between public agricultural spending and food insecurity remains invariably insignificant.

Table 4. Food security and public agricultural spending indicators

4.2. Public agricultural spending and food security – temporal dimension

Table 5 Columns 1 to 5 show estimations with public agricultural spending respectively lagged by one, two, three, four and five years.

The association of all the five lags with undernutrition prevalence is found to be statistically insignificant, suggesting that time horizon of public spending apparently does not play a significant role in improving food security in Africa.

Table 5. Food security and lagged public agricultural spending

4.3. Public agricultural spending and food security – Availability, access, stability, and utilization aspects

Table 6. Food security aspects and public agricultural spending

Is the insignificant relationship between food security and public spending on agriculture seen across various aspects of food security or is the relationship limited to a particular dimension? We seek answer to this question by regressing indicators that refer to specific aspects of food

security. Table 6 shows estimations using average dietary energy supply, food price index, domestic food price volatility and percentage of under 5 children who are stunted as dependent variables. These indicators account for the four aspects of food security, namely availability, access, stability and biological utilization. The coefficient for public agricultural spending retains its lack of significance in three out of four estimations. Only the association with average dietary energy supply adequacy is significant with a counter-intuitive negative sign, implying that greater share of public budget allocated to agriculture is associated with poorer food availability. This effect may owe to higher agricultural budget coming at the cost of more direct food assistance measures.

The association with average dietary energy supply adequacy turns insignificant when the amount of public agricultural expenditures is used instead of their share in the total government spending (result not shown).

4.4. Public expenditure on agriculture and food security – R&D spending

We examine the relationship between food security and public spending on agricultural research and development by considering four indicators of agricultural R&D: amount of agricultural budget allocated to R&D, R&D spending on agriculture as a share of agricultural GDP, per capita R&D spending, and the number of scientists per 1000 farmers (Table 7 Columns 1 – 4).

Three out of four R&D indicators show no significant association with undernutrition prevalence. However the amount of R&D expenditures shows a strong significant association. A 1% increase in agricultural R&D spending is associated with a 0.21% fall in undernutrition. This beneficial effect on food security is also visible after one and five years of the R&D spending (Columns 5 – 6). The relationship disappears after a gap of ten years (Column 7).

Table 7. Food security and R&D expenditures

4.5. Public agricultural spending and food security – Size effect

Next we examine whether the insignificant relationship between food security and public spending on agriculture is applicable on all countries regardless of the size of their budgetary allocations. Countries such as Burkina Faso, Ethiopia, Malawi and Mali allocated substantially high proportion of their annual budgets to agriculture.

Table 8 reports estimations pertaining to countries in the above median, above mean, top quartile and top decile part of the spending distribution. The relationship is found to be significant and negative in all the four cases. Besides, this size effects seems to grow with the proportion of public spending assigned to agriculture.

Region-wise estimations (shown in Table 9) corroborate this finding. The relationship is found to be significantly negative for North Africa and West Africa, two out of the three regions of the continent which allocate a high share of budget to agriculture. The relationship is insignificant for the two laggard regions of Southern and Central Africa.

Table 8. Food security and public agricultural spending – Size effect

Table 9. Food security and public agricultural spending – Regional variation

4.6. Public agricultural spending and food security – events and interactions

It may just be that the food security – public agricultural spending relationship became significant after signing the Maputo declaration or since the countries began participating in the Comprehensive Africa Agriculture Development Programme (CAADP). The relationship may also have suffered during the 2007-2008 food crisis that led to food shortage in a number of countries. Table 10 Columns 1 to 3 report models including dummy variables for these

three events. Inclusion of these variables does not change the lack of significance of the food security – public agricultural spending relationship. The spending – event interaction variables shown in Table 10 Columns 4 to 6 are likewise insignificant.

Table 10. Food security and public agricultural spending- Events and interactions

4.7. Public agricultural spending and food security – the role of institutions

Table 11 reports estimations including six indicators of institutional quality: political stability, rule of law, government effectiveness, control of corruption, regulatory environment, and accountability. These indicators mostly show an intuitive negative association with undernourishment. Only two of these relationships, however, is found to be significant.

Besides, the relationship between public agricultural spending and food security observed so far remains unchanged.

Table 11. Food security and public agricultural spending – Institutional factors

4.8. Public agricultural spending and food security – additional controls

Table 12 reports model specifications including a number of socioeconomic and demographic control variables. Estimations reported in Column 1 and 2 allow for the size of agriculture in the domestic economy and the proportion of population living in rural areas. Estimations shown in Columns 3 and 4 take into account domestic food production and proportion of population having access to improved sanitation facilities respectively. Finally, columns 5 and 6 give specifications with per capita output and GDP replacing the country's GDP growth.

The association between public spending on agriculture and undernutrition invariably remains insignificant regardless of the level of significance of the control variables included.

Table 12. Food security and public agricultural spending – Additional controls

4.9. Public agricultural spending and food security – Alternative models

The relationship between food security and public expenditure on agriculture has so far been consistently found to be insignificant. In the following, we carry out various estimations to test the robustness of this finding. We run models to tackle possible issues of heteroscedasticity, serial autocorrelation and endogeneity.

Table 13 Column 1 shows model including time-fixed effects while Column 2 shows estimates including country-fixed effects. Column 3 shows estimation including both time- and country-fixed effects, while Column 4 shows Arellano and Bond estimation.

In all of these models, the lack of significance of the relationship of interest remains intact.

Table 13. Food security and public agricultural spending – alternative models

5. Discussion and concluding remarks

Africa is the world's biggest battleground in the fight against hunger. African governments and the international donor community have realized the importance of taking steps to end hunger and ensure the right to food to the continent's population. Public spending on agriculture is one of these measures. In this study, we examined the association of expenditures on agriculture by African countries during the past quarter of a century with the progress in combating food insecurity. We employed a number of econometric techniques and carried out a large array of estimations. We fail to find an overall significant beneficial role of these expenditures in the evolution of Africa's overall food security situation. We can be reasonably sure that this lack of significance is not a statistical artifact arising from empirical

methodology or an econometric quirk. Moreover, there does not seem to be a time lag beyond which the association with food insecurity turns significant.

This notwithstanding, we find a significant size effect of public agricultural spending. Countries which spend above average share of their budget on agriculture are found to be able to improve their food security relatively better. We find similar results on the regional level.

This suggests that for the majority of African countries, public spending on agriculture over the past quarter of a century has remained below the levels which would allow a diminution of undernutrition. The recommendation to allocate 10% of government spending to agriculture therefore appears to be pertinent.

We also find evidence for some beneficial effect of R&D spending on agriculture on Africa's food security situation. This highlights the need for better directing the spending towards expenditure items that can reach the segments of population the most in need. In Africa south of the Sahara, R&D has received more than a 40 per cent increase in government funding during the past decade (IFPRI, 2015). The 2015 FAO, African Development Bank Group, ECOWAS report arguments in favour of steering government spending towards R&D and the provision of other public goods (e.g. road network, access to water and electricity) rather than subsidizing or supporting private goods (e.g. agricultural equipment, seeds, fertilizers and other inputs). The mantra is "more public goods fewer subsidies" (FAO, ADBG, ECOWAS, 2015). Better targeting of public spending is therefore as important as focusing on increasing existing expenditures.

Here a caveat must be mentioned : the transparency, reliability and quality of data on agricultural expenditures in Africa leaves much to be desired. Mogues et al. (2015) term the public spending statistics a 'Black box'. According to the Open Budget Index from the International Budget Partnership [4], African countries such as Niger, Egypt, Chad and

[4] For detail, see http://survey.internationalbudget.org/#rankings.

Equatorial Guinea are among the least transparent in the world in terms of budget declarations. Besides, African countries employ a variety of classifications of agricultural spending (Benin and Yu, 2013), which makes comparative analysis cumbersome. Results obtained from the data made available by the SPEED database of IFPRI used in this study should therefore be interpreted with caution.

References

African Union. (2003). African Union Declaration on Agriculture and Food Security in Africa. Assembly/AU/Decl.4-11 (II).

African Union. (2014). African Union summit 2014, Decisions, declarations and resolution in Malabo.

Aidoo, R., Mensah, J. O., & Tuffour, T. (2013). Determinants of household food security in the sekyere-afram plains district of ghana. *European Scientific Journal, ESJ*, *9*(21). Retrieved from https://eujournal.org/index.php/esj/article/view/1488

Badiane, O., Collins, J., Diao, X., & Ulimwengu, John M. (2015). Economic recovery in Africa and its determinants. In *Beyond a Middle Income Africa: Transforming African Economies for Sustained Growth with Rising Employment and Incomes*. Washington DC: International Food Policy Research Institute (IFPRI).

Bora, Saswati, Ceccacci, Iride, Delgado, Christophe, & Townsend, Robert. (2010). Food security and conflict. World Development Report background papers.

De Walt, KM. (1993). Nutrition and the commercialization of agriculture: ten years later. *36*, 1407–1416.

ECOWAS. (2008). *Regional Agricultural Policy for West Africa "Make agriculture the lever of regional integration"*,12p.

EM-DAT. (2015). The CRED/OFDA International Disaster Database. Université catholique de Louvain-Brussels-Belgium.

FAO. (1996). *Rome Declaration on World Food Security and World Food Summit Plan of Action* (World Food Summit 13–17 November 1996). Rome: FAO.

FAO. (2012). *The State of Food and Agriculture: Investing in Agriculture for a better future*. Rome: FAO.

FAO. (2015). *Regional Overview of Food Insecurity in Africa, African Food Security Prospects Brighter Than Ever*. Rome: FAO.

FAO, African Development Bank Group, & ECOWAS. (2015). *Agricultural growth in West Africa : market and policy drivers*, 406p. Rome.

FAO, IFAD, UNICEF, WFP and WHO. (2017). *The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security,* 132p. Rome: FAO.

FAO, IFAD, & WFP. (2015). *The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress*, 62p. Rome: FAO.

Gezimu Gebre, G. (2012). Determinants of Food Insecurity among Households in Addis Ababa City, Ethiopia. *Interdisciplinary Description of Complex Systems*, *10*(2), 159–173. https://doi.org/10.7906/indecs.10.2.9

Headey, D. D. (2013). Developmental Drivers of Nutritional Change: A Cross-Country Analysis. *World Development*, *42*(Supplement C), 76–88. https://doi.org/10.1016/j.worlddev.2012.07.002

IFPRI. (2015). The Statistics on public expenditure for economic development database. International Food Policy Research Institute, Washington DC.

Lowder, S., Carisma, B., & Skoet, J. (2015). *Who Invests How Much in Agriculture in Low- and Middle-Income Countries? An Empirical Review* (SSRN Scholarly Paper No. ID 2637352). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2637352

Magaña-Lemus, D., Ishdorj, A., Rosson, C. P., & Lara-Álvarez, J. (2016). Determinants of household food insecurity in Mexico. *Agricultural and Food Economics*, *4*, 10. https://doi.org/10.1186/s40100-016-0054-9

MATCHAYA, Greenwell C, & CHILONDA, Pius. (2012). Estimating effects of constraints on food security in malawi: policy lessons from regressions quantiles. *Applied Econometrics and International Development*, *12*(2).

Me-Nsope, N., & Staatz, J. (2015). *Changes in Per Capita Food Availability in West Africa: Implications for Agricultural Market Development* (Food Security Collaborative Policy Briefs No. 212910). Michigan State University, Department of Agricultural, Food, and Resource Economics. Retrieved from https://econpapers.repec.org/paper/agsmidcpb/212910.htm

Mogues, T., Caceres, L., Fernandez, F., & Mariam B. Umarji. (2015). Reconstructing public expenditure data: Use of classification systems to better measure public spending in agriculture — a Mozambique case study | IFPRI. Retrieved November 28, 2017, from http://www.ifpri.org/publication/reconstructing-public-expenditure-data-use-classification-systems-better-measure-public

Muche, Mequanent, Endalew, Birara, & Koricho, Tesfalem. (2014). Determinants of Household Food Security among Southwest Ethiopia Rural Households. *Food Science and Technology*, *2*(7), 93–100.

World Bank. (2015). World Development Indicators.

Yu, B., Fan, S., & Magalhães, E. (2015). *Trends and Composition of Public Expenditures: A Global and Regional Perspective* (SSRN Scholarly Paper No. ID 2637328). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2637328

Zakari, S., Ying, L., & Song, B. (2014). Factors Influencing Household Food Security in West Africa: The Case of Southern Niger. *Sustainability*, *6*(3), 1191–1202. https://doi.org/10.3390/su6031191

Table 3. Data description

Variable	Definition	Source
undernourishment	Prevalence of undernourishment (%) (3-year average)	FAOSTAT
agrexptot	Percentage of agriculture in total government spending	IFPRI SPEED database
ag_us	Agriculture expenditure in 2005 usd (in billion)	IFPRI SPEED database
agrexpgdp	Public agricultural spending to GDP	IFPRI SPEED database
agrexppop	Public agricultural spending per population	IFPRI SPEED database
agrexprural	Public agricultural spending per rural population	IFPRI SPEED database
agrexparea	public agricultural spending to land area	IFPRI SPEED database
gdpgrowth	Growth of GDP (constant 2005 US $)	World Bank national accounts data, and OECD National Accounts data files.
inflation	Inflation, consumer prices (annual %)	International Monetary Fund, International Financial Statistics and data files.
Mortality	Mortality rate, under-5 (per 1,000 live births)	UNICEF, WHO, World Bank, UN DESA Population Division
natural__hazard	Number of disasters associated with food shortage, crop failure or famine	Emdat
Average Dietary Energy Supply Adequacy	Average Dietary Energy Supply Adequacy (ADESA) : %/ DImension of Food security for AVAILABILITY	FAOSTAT
Food price index	Domestic food price index/ Dimension of Food Security for ACCESS	FAOSTAT
Domestic food price volatility	Domestic Food price volatility / Dimension of Food Security for STABILITY	FAOSTAT
Percentage of children under 5 years of age who are stunted.	Prevalence of child stunting / Dimension of Food Security for STABILITY	World Bank
agrirespending	Agricultural Research Expenditure. Spending, total (million constant 2011 US $ dollars)	ASTI
agrirepcapita	Agricultural Research Expenditure per capita	ASTI
agrirepagrgdp	Agricultural Research Expenditure as a share of Agricultural GDP	ASTI
agrirepfarmers	Researchers, total (FTEs per 100,000 farmers)	ASTI

agrgdp	Agricultural value added as a share of GDP	World Bank national accounts data, and OECD National Accounts data files.
gdppercapita	GDP per capita (constant 2005 USD)	World Bank national accounts data, and OECD National Accounts data files.
rural_population_share	Proportion of total population living in rural areas	World Bank World Development Indicators database
foodproductionindex	Food Production Index	FAOSTAT
Sanitation	Access to improved sanitation facilities refers to the percentage of the population using improved sanitation facilities.	WHO/UNICEF
political_stability	Reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism. Estimate ranges from approximately -2.5 (weak) to 2.5 (strong)	World Bank World Development Indicators database
gov_effectiveness	Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	World Bank World Development Indicators database
rule_of_law	Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	World Bank World Development Indicators database

Table 4. Food security and public agricultural spending indicators

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	under_nourishment	under_nourishment	under_nourishment	under_nourishment	under_nourishment	under_nourishment	under_nourishment
VARIABLES							
agrexptot	0.0353	0.0381					
	(0.0576)	(0.0580)					
lnag_us			-0.123				
			(0.338)				
agrexpgdp				0.0615			
				(0.277)			
agrexppop					-0.0242		
					(0.0334)		
agrexprural						-0.00989	
						(0.0153)	
agrexparea							-1.90e-05
							(1.30e-05)
gdpgrowth	-0.132***	-0.135***	-0.139***	-0.140***	-0.140***	-0.141***	-0.142***
	(0.0471)	(0.0471)	(0.0428)	(0.0428)	(0.0428)	(0.0428)	(0.0436)
inflation	0.000508**	0.000508**	0.000387*	0.000405*	0.000402*	0.000403*	0.000405*
	(0.000231)	(0.000231)	(0.000216)	(0.000210)	(0.000210)	(0.000210)	(0.000214)
mortality	0.0998***	0.102***	0.0951***	0.0964***	0.0949***	0.0951***	0.0947***
	(0.00802)	(0.00816)	(0.00902)	(0.00855)	(0.00867)	(0.00866)	(0.00867)
natural_hazard	-1.117	-1.049	-0.142	-0.156	-0.173	-0.168	-0.178
	(0.810)	(0.812)	(0.765)	(0.765)	(0.765)	(0.765)	(0.777)
northafrica	-21.83***		-20.84***	-21.22***	-20.70***	-20.65***	-21.74***
	(6.537)		(7.330)	(7.305)	(7.329)	(7.361)	(7.419)
eastafrica	1.718		0.783	0.566	0.772	0.696	1.383
	(5.942)		(6.430)	(6.450)	(6.445)	(6.457)	(6.090)
westafrica	-16.25***		-14.56**	-14.64**	-14.50**	-14.53**	-14.52***
	(5.308)		(5.852)	(5.884)	(5.877)	(5.890)	(5.534)
southernafrica	-6.687		-5.937	-6.179	-5.619	-5.779	-6.044
	(5.525)		(6.166)	(6.183)	(6.210)	(6.208)	(5.813)
Constant	23.79***	12.89***	25.72***	23.46***	23.77***	23.73***	23.75***
	(4.744)	(1.126)	(8.011)	(5.289)	(5.290)	(5.299)	(4.994)
Observations	618	618	593	593	593	593	577
R-squared		0.273					
Number of id	35	35	37	37	37	37	36

Note:

Columns 1 and 2 show random- and fixed-effects specifications of the baseline model.

Columns 3 - 7 show estimations alternately using the amount of public agricultural spending in log, public agricultural spending to GDP, per capita public agricultural spending,public agricultural spending per rural population and public agricultural spending to land area instead of % share of agriculture in total public spending.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 5. Food security and lagged public agricultural spending

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**under_nourishment**	**under_nourishment**	**under_nourishment**	**under_nourishment**	**under_nourishment**
L.agrexptot	0.0383				
	(0.0566)				
L2.agrexptot		0.0340			
		(0.0559)			
L3.agrexptot			0.0303		
			(0.0522)		
L4.agrexptot				0.0230	
				(0.0502)	
L5.agrexptot					0.0196
					(0.0487)
gdpgrowth	-0.110**	-0.0707	-0.0174	-0.0347	-0.0586
	(0.0443)	(0.0451)	(0.0447)	(0.0436)	(0.0419)
inflation	0.000534**	0.000561**	0.00785***	0.00734***	0.00632***
	(0.000227)	(0.000223)	(0.00102)	(0.000975)	(0.00107)
mortality	0.101***	0.103***	0.0988***	0.0970***	0.0960***
	(0.00767)	(0.00741)	(0.00708)	(0.00697)	(0.00699)
natural_hazard	-1.092	-0.561	-0.107	0.0238	0.423
	(0.783)	(0.750)	(0.687)	(0.656)	(0.632)
northafrica	-21.15***	-20.52***	-20.38***	-19.93***	-19.32***
	(6.316)	(6.044)	(5.929)	(5.972)	(6.215)
eastafrica	2.197	2.433	2.511	3.086	3.716
	(5.744)	(5.497)	(5.393)	(5.436)	(5.660)
westafrica	-16.11***	-15.99***	-15.84***	-15.44***	-14.95***
	(5.130)	(4.907)	(4.815)	(4.851)	(5.050)
southernafrica	-6.298	-6.110	-5.481	-5.024	-4.419
	(5.339)	(5.108)	(4.953)	(4.982)	(5.183)
Constant	23.14***	22.43***	22.29***	22.09***	21.71***
	(4.578)	(4.380)	(4.289)	(4.313)	(4.477)
Observations	621	620	603	580	556
Number of id	35	35	36	36	36

Note:

Columns 1 - 5 respectively show public agricultural spending as a proportion of total government spending lagged 1, 2, 3, 4 and 5 times.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 6. Food security aspects and public agricultural spending

VARIABLES	(1) Average Dietary Energy Supply Adequacy	(2) Food Price Index	(3) Domestic food price volatility.	4 Percentage of children under 5 years of age who are stunted
agrexptot	-0.179***	2.519	0.171	-0.184
	(0.0491)	(5.268)	(0.139)	(0.116)
gdpgrowth	0.0791**	-17.36***	0.0692	-0.202
	(0.0370)	(4.301)	(0.115)	(0.124)
inflation	-0.00475***	-12.20***	0.263***	0.00515***
	(0.000882)	(0.795)	(0.0202)	(0.00138)
mortality	-0.115***	-3.134***	-0.00694	0.0809***
	(0.00632)	(0.741)	(0.0195)	(0.0159)
natural_hazard	0.672	-27.75	-4.565***	4.447***
	(0.627)	(46.67)	(1.214)	(1.542)
Constant	123.7***	735.6***	11.50***	30.03***
	(0.873)	(91.27)	(2.399)	(2.387)
Observations	602	330	296	142
R-squared	0.454	0.473	0.406	0.376
Number of id	34	31	27	34

Note:

Columns 1 to 4 show estimations using average dietary energy supply adequacy, food price index, domestic food price volatility, and percentage of children under 5 years of age who are stunted as dependent variable respectively.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 7. Food security and R&D expenditures

VARIABLES	(1) under_nourishment	(2) under_nourishment	(3) under_nourishment	(4) under_nourishment	(5) under_nourishment	(6) under_nourishment	(7) under_nourishment
lnagrirespending	-3.533***						
	(0.681)						
agrirepagrgdp		-0.728					
		(0.453)					
agrirepcapita			-0.256				
			(0.219)				
agrirepfarmers				-0.0220			
				(0.0139)			
L.lnagrirespending					-2.955***		
					(0.658)		
L5.lnagrirespending						-2.001***	
						(0.602)	
L10.lnagrirespending							-0.738
							(0.566)
gdpgrowth	0.0222	0.0207	0.0209	0.0245	-0.00163	0.00997	-0.0286
	(0.0529)	(0.0565)	(0.0544)	(0.0547)	(0.0507)	(0.0499)	(0.0416)
inflation	-0.0554***	-0.0677***	-0.0608***	-0.0606***	-0.0409***	-0.0290	0.000698
	(0.0151)	(0.0162)	(0.0155)	(0.0156)	(0.0150)	(0.0324)	(0.0327)
mortality	0.0994***	0.106***	0.103***	0.100***	0.0971***	0.0886***	0.0949***
	(0.00827)	(0.00905)	(0.00849)	(0.00850)	(0.00786)	(0.00686)	(0.00761)
natural_hazard	0.487	1.230	0.822	0.861	0.0804	0.747	0.584
	(0.677)	(0.794)	(0.691)	(0.696)	(0.617)	(0.514)	(0.436)
northafrica	-17.24*	-18.53*	-18.39*	-18.79**	-17.41*	-14.90	-12.19
	(10.08)	(10.58)	(10.31)	(9.284)	(9.891)	(11.36)	(13.52)
eastafrica	10.10*	5.631	5.461	5.484	9.215*	10.31	11.49
	(5.509)	(5.894)	(5.559)	(5.014)	(5.399)	(6.890)	(9.054)
westafrica	-7.655	-11.34**	-9.808**	-9.949**	-8.187*	-6.772	-4.750
	(4.853)	(5.180)	(4.943)	(4.462)	(4.759)	(6.369)	(8.494)
southernafrica	3.214	2.504	0.301	-0.283	2.998	6.593	10.56
	(5.224)	(5.744)	(5.331)	(4.781)	(5.115)	(6.738)	(8.745)
Constant	23.80***	17.54***	17.96***	18.25***	23.07***	18.40***	11.65
	(4.439)	(4.509)	(4.387)	(3.996)	(4.347)	(5.853)	(7.833)
Observations	497	455	497	498	502	439	304
Number of id	36	31	36	36	36	32	28

Note:

Column 1 shows results for estimation including the log of the amount of R&D spending.

Column 2 shows results for estimation including R&D as a share of GDP.

Column 3 shows results for estimation including per capita R&D spending.

Column 4 shows results for estimation including the number of scientists per 1000 farmers.

Columns 5 - 7 show results for estimation including 1, 5 and 10 lags of the lagged amount of R&D spending respectively.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 8. Food security and public agricultural spending – Size effect

	(1)	(2)	(3)	(4)
VARIABLES	**under_nourishment**	**under_nourishment**	**under_nourishment**	**under_nourishment**
agrexptot	-0.186***	-0.288***	-0.357***	-0.361***
	(0.0545)	(0.0546)	(0.0608)	(0.115)
gdpgrowth	0.0887	0.0903	0.102	-0.0231
	(0.0594)	(0.0658)	(0.0738)	(0.122)
inflation	-0.0333*	-0.0509***	-0.0673***	-0.0688
	(0.0171)	(0.0171)	(0.0184)	(0.0638)
mortality	0.123***	0.131***	0.141***	0.151***
	(0.00787)	(0.00798)	(0.00897)	(0.0153)
natural_hazard	-2.254***	-2.288***	-1.223	-1.871
	(0.791)	(0.816)	(0.930)	(1.561)
northafrica	-25.06***	-30.11***	-31.02***	
	(6.776)	(9.591)	(11.48)	
eastafrica	-1.616	-6.699	-7.057	-4.939
	(6.214)	(7.898)	(8.051)	(10.49)
westafrica	-23.59***	-29.10***	-31.16***	-35.04***
	(5.871)	(7.579)	(7.646)	(9.790)
southernafrica	-7.277	-10.96	-14.77*	-16.24*
	(6.069)	(7.880)	(8.031)	(9.820)
Constant	26.07***	31.47***	33.30***	34.12***
	(5.272)	(7.040)	(7.062)	(9.792)
Observations	339	251	175	71
Number of id	29	25	21	11

Note:
Columns 1 and 2 show models including countries with above median
and above mean public agricultural spending to total spending rates respectively.
Columns 3 and 4 show models pertaining to top 25% and 10% countries in

Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Table 9. Food security and public agricultural spending Regional variation

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**under_nourishment**	**under_nourishment**	**under_nourishment**	**under_nourishment**	**under_nourishment**
agrexptot	-0.362***	-0.153**	0.275	1.467***	0.104
	(0.0600)	(0.0688)	(0.196)	(0.282)	(0.140)
gdpgrowth	-0.0229	-0.0340	-0.212*	-0.0612	-0.244
	(0.0413)	(0.0508)	(0.121)	(0.284)	(0.159)
inflation	-0.0208	-0.0673**	0.00707***	-0.263**	1.54e-05
	(0.0236)	(0.0265)	(0.00153)	(0.106)	(0.000242)
mortality	0.0104	0.122***	0.0786***	0.126***	0.106***
	(0.00804)	(0.00988)	(0.0237)	(0.0319)	(0.0316)
natural_hazard		-0.0804	0.382	-2.767	-1.991
		(1.059)	(2.066)	(2.590)	(3.981)
Constant	7.477***	5.877*	18.01***	16.68***	23.28***
	(0.508)	(3.227)	(4.526)	(5.054)	(4.750)
Observations	74	228	162	95	59
Number of id	4	12	9	6	4

Note:

Columns 1 to 5 show estimations pertaining to North Africa, West Africa, Southern Africa, East Africa and Central Africa respectively.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 10. Food security and public agricultural spending- Events and interactions

VARIABLES	(1) under_nourishment	(2) under_nourishment	(3) under_nourishment	(4) under_nourishment	(5) under_nourishment	(6) under_nourishment
agrexptot	0.0297	0.0344	0.0370	0.0316	0.0398	0.0498
	(0.0571)	(0.0577)	(0.0577)	(0.0617)	(0.0578)	(0.0594)
gdpgrowth	-0.115**	-0.133***	-0.130***	-0.115**	-0.134***	-0.130***
	(0.0468)	(0.0471)	(0.0472)	(0.0469)	(0.0471)	(0.0474)
inflation	0.000496**	0.000512**	0.000509**	0.000498**	0.000514**	0.000516**
	(0.000229)	(0.000231)	(0.000231)	(0.000230)	(0.000231)	(0.000232)
mortality	0.0755***	0.0972***	0.0987***	0.0751***	0.0961***	0.0971***
	(0.0106)	(0.00936)	(0.00823)	(0.0115)	(0.00943)	(0.00838)
natural_hazard	-1.034	-1.106	-1.145	-1.031	-1.032	-1.236
	(0.802)	(0.810)	(0.811)	(0.804)	(0.812)	(0.818)
northafrica	-24.10***	-22.10***	-21.94***	-24.14***	-22.20***	-22.12***
	(6.677)	(6.650)	(6.658)	(6.641)	(6.779)	(6.401)
eastafrica	1.387	1.741	1.708	1.381	1.698	1.656
	(6.042)	(6.029)	(6.051)	(5.997)	(6.146)	(5.813)
westafrica	-15.87***	-16.19***	-16.23***	-15.87***	-16.20***	-16.26***
	(5.398)	(5.387)	(5.405)	(5.357)	(5.492)	(5.192)
southernafrica	-6.790	-6.736	-6.685	-6.798	-6.763	-6.731
	(5.618)	(5.607)	(5.626)	(5.576)	(5.716)	(5.405)
maputo	-2.232***			-2.197***		
	(0.640)			(0.766)		
caadp		-0.501			0.848	
		(0.915)			(1.579)	
foodcrisis			-0.484			0.307
			(0.766)			(1.145)
maputo#agrexptot				-0.00826		
				(0.0995)		
caadp#agrexptot					-0.219	
					(0.209)	
foodcrisis#agrexptot						-0.131
						(0.141)
Constant	27.82***	24.19***	23.97***	27.86***	24.31***	24.14***
	(4.953)	(4.864)	(4.834)	(4.946)	(4.953)	(4.659)
Observations	618	618	618	618	618	618
Number of id	35	35	35	35	35	35

Note:

Column 1 shows estimation with Maputo declaration dummy.

Column 2 shows estimation with participation in CAADP.

Column 3 shows esimation including the 2007-2008 food crisis dummy.

Columns 4 - 6 show estimations including public agricultural spending share interacted with the maputo declaration, participation in the CAADP and food crisis dummies respectively.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table 11. Food security and public agricultural spending – Institutional factors

VARIABLES	(1) under_nourishment	(2) under_nourishment	(3) under_nourishment	(4) under_nourishment	(5) under_nourishment	(6) under_nourishment
agrexptot	0.0289	0.0319	0.0294	0.0304	-0.0246	0.0272
	(0.0580)	(0.0578)	(0.0580)	(0.0583)	(0.0567)	(0.0582)
gdpgrowth	-0.0242	-0.0211	-0.0250	-0.0270	-0.00781	-0.0160
	(0.0465)	(0.0462)	(0.0464)	(0.0466)	(0.0445)	(0.0465)
inflation	0.00633***	0.00617***	0.00637***	0.00637***	0.00579***	0.00655***
	(0.00101)	(0.00102)	(0.00101)	(0.00101)	(0.000975)	(0.00102)
mortality	0.0984***	0.0993***	0.0991***	0.0994***	0.0971***	0.0956***
	(0.00914)	(0.00878)	(0.00884)	(0.00937)	(0.00849)	(0.00895)
natural_hazard	-0.786	-0.849	-0.765	-0.765	-0.676	-0.864
	(0.710)	(0.711)	(0.708)	(0.715)	(0.682)	(0.712)
northafrica	-19.41***	-18.84***	-19.21***	-19.63***	-13.96**	-17.01***
	(6.165)	(6.473)	(6.225)	(6.000)	(5.972)	(5.749)
eastafrica	4.063	4.368	4.093	3.786	8.479	5.839
	(5.625)	(5.893)	(5.661)	(5.432)	(5.427)	(5.199)
westafrica	-14.58***	-14.20***	-14.68***	-14.97***	-10.73**	-13.48***
	(5.040)	(5.268)	(5.036)	(4.844)	(4.828)	(4.590)
southernafrica	-5.301	-4.642	-5.364	-5.810	0.461	-3.319
	(5.259)	(5.532)	(5.286)	(5.126)	(5.084)	(4.865)
political_stability	-0.302					
	(0.890)					
gov_effectiveness		-0.545				
		(0.588)				
rule_of_law			-0.227			
			(0.983)			
control_of_corruption				0.209		
				(1.260)		
regulatory_quality					-6.403***	
					(1.156)	
voice_accountability						-2.362*
						(1.208)
Constant	21.24***	20.61***	21.24***	21.77***	14.12***	18.83***
	(4.582)	(4.805)	(4.654)	(4.544)	(4.527)	(4.381)
Observations	399	399	399	399	399	399
Number of id	35	35	35	35	35	35

Note

Columns 1 to 6 show esimations alternately including six institutional variables: political stability and absence of violence, government effectiveness, rule of law, control of corruption, regulatory quality, and voice. and accountability

*** p<0.01, ** p<0.05, * p<0.1

Table 12. Food security and public agricultural spending – Additional controls

	(1)	(2)	(3)	(4)	(5)	(6)
	under_nourishment	under_nourishment	under_nourishment	under_nourishment	under_nourishment	under_nourishment
VARIABLES						
agrexptot	0.0381	0.00264	0.0596	-0.0253	0.00952	-0.00670
	(0.0589)	(0.0571)	(0.0508)	(0.0546)	(0.0570)	(0.0558)
gdpgrowth	-0.160***	-0.121***	-0.0593	-0.0951**		
	(0.0529)	(0.0461)	(0.0420)	(0.0440)		
inflation	0.000516**	0.000424*	0.000763***	0.000366*	0.000593***	0.000555**
	(0.000237)	(0.000226)	(0.000204)	(0.000215)	(0.000228)	(0.000222)
mortality	0.106***	0.0708***	-0.0127	0.0667***	0.0835***	0.0607***
	(0.00926)	(0.00986)	(0.0112)	(0.00899)	(0.00877)	(0.00971)
natural_hazard	-0.878	-0.995	-1.540**	-0.467	-1.215	-0.960
	(0.825)	(0.794)	(0.714)	(0.759)	(0.798)	(0.780)
northafrica			-33.76***		-15.53**	-11.12
			(6.498)		(6.670)	(6.842)
eastafrica			-0.709		-3.496	2.710
			(5.856)		(6.038)	(6.080)
westafrica			-16.06***		-17.48***	-18.60***
			(5.230)		(5.327)	(5.436)
southernafrica			-7.996		-1.883	-5.487
			(5.444)		(5.633)	(5.656)
agrgdp	-0.0222					
	(0.0532)					
ruralpopshare		51.03***				
		(9.615)				
foodproductionindex			-0.180***			
			(0.0141)			
sanitation				-0.616***		
				(0.0707)		
lngdp_per_capita					-6.878***	
					(1.358)	
lngdp						-6.533***
						(0.903)
Constant	12.78***	-16.03***	55.58***	37.35***	69.87***	175.9***
	(1.486)	(5.561)	(5.264)	(3.070)	(10.41)	(21.69)
Observations	603	618	616	607	618	618
R-squared	0.279	0.307		0.375		
Number of id	34	35	35	35	35	35

Note

Columns 1 to 4 show esimations including agricultural value added as a share of GDP, the proportion of population living in rural areas, food production index, and the proportion of population with access to improved sanitation facilities respectively.

Columns 5 and 6 show estimations with GDP growth rate replaced by per capita GDP and the amount of GDP respectively.

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 13. Food security and public agricultural spending – alternative models

	1	2	3	4
VARIABLES	**under_nourishment**	**under_nourishment**	**under_nourishment**	**under_nourishment**
agrexptot	0.00384	0.0381	0.00219	0.0151
	(0.0597)	(0.0580)	(0.0588)	(0.00936)
gdpgrowth	-0.122**	-0.135***	-0.135***	-0.0317***
	(0.0512)	(0.0471)	(0.0496)	(0.00562)
inflation	0.000450*	0.000508**	0.000441*	5.14e-05*
	(0.000241)	(0.000231)	(0.000234)	(3.01e-05)
mortality	0.0550***	0.102***	0.0525***	0.0201***
	(0.0122)	(0.00816)	(0.0128)	(0.00153)
natural_hazard	-0.817	-1.049	-0.780	0.126
	(0.853)	(0.812)	(0.832)	(0.101)
northafrica	-25.93***	-15.92***	-21.30***	0
	(4.657)	(2.129)	(2.375)	(0)
eastafrica	1.118	1.638	0.0566	0
	(4.147)	(1.907)	(1.929)	(0)
westafrica	-15.53***	-2.605	-4.169**	0
	(3.701)	(1.853)	(1.873)	(0)
southernafrica	-6.892*	9.551***	9.185***	0
	(3.849)	(1.856)	(1.854)	(0)
L.under_nourishment				0.844***
				(0.00786)
Constant	31.45***	19.97***	29.33***	1.086***
	(3.954)	(1.908)	(2.962)	(0.180)
Observations	618	618	618	557
Number of id	35	35	35	35

Note:

Columns 1 and 2 show models including time and country effects respectively.

Fixed effects not shown to conserve space.

Column 3 shows model including both time and country effects. Fixed effects not shown to conserve space.

Column 4 shows Arellano and Bond estimation for the baseline specification.

Standard errors in parentheses.

*** p<0.01, ** p<0.05, * p<0.1.

Table A-1. Summary Statistics

VARIABLES	N	mean	sd	min	max
under_nourishment	1,075	25.31	15.38	5	76.80
agrexptot	719	5.638	5.429	2.28e-05	45.68
ag_us	655	0.174	0.270	3.12e-10	2.170
agrexpgdp	655	1.357	1.325	5.82e-09	9.393
agrexppop	655	14.15	18.88	2.45e-08	116.2
agrexprural	655	26.16	40.02	3.69e-08	231.7
agrexparea	639	13,786	48,478	8.05e-06	554,053
gdpgrowth	1,064	4.099	6.760	-50.25	106.3
inflation	972	55.59	796.9	-11.69	23,773
mortality	1,296	114.2	58.66	13.80	321.9
Average Dietary Energy Supply Adequacy	1,056	108.5	15.87	69	152
Food Price Index	620	242.6	525.0	0.100	8,600
Domestic food price volatility.	576	12.60	9.431	1.600	89.80
percentage of children under 5 years of age who are stunted	255	37.19	11.25	7.9	69.6
agrirespending	593	31.43	61.10	0.100	467.8
agrirepcapita	533	2.349	3.049	0.0616	17.50
agrirepagrgdp	541	0.996	1.045	0.100	7.400
agrirepfarmers	606	19.68	46.92	1.883	342.5
agrgdp	994	25.08	15.28	2.032	65.97
ruralpopshare	1,075	0.610	0.164	0.133	0.945
foodproductionindex	1,031	94.14	25.09	38.79	213.4
sanitation	1,245	36.34	25.98	2.600	98.40
political_stability	673	-0.581	0.682	-2.039	1.025
gov_effectiveness	673	-0.483	0.860	-2.995	1.186
rule_of_law	672	-0.552	0.559	-2.057	1.250