RETURNS TO PUBLIC AGRICULTURAL SPENDING IN THE COCOA AND NONCOCOA SUBSECTORS OF GHANA

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ABSTRACT

Using public expenditure and agricultural production data on Ghana from 1961 to 2012, this paper assesses the returns to public spending in the agricultural sector, taking into consideration expenditures on agriculture as a whole and then separately for expenditures in the cocoa versus the noncocoa subsectors. Different regression methods and related diagnostic tests are used to address potential endogeneity of agricultural expenditure, cross-subsector dependence of the production function error terms, and within-subsector serial correlation of the error terms. The estimated elasticities are then used to calculate the rate of return to expenditures in the sector as a whole and within the two subsectors.

The elasticity of land productivity with respect to total agricultural expenditure is estimated at 0.33–0.34. For the noncocoa subsector, the estimated elasticity is 0.66–0.81. And in the cocoa subsector, it is 0.36–0.43. The returns to total agricultural expenditure are estimated at 82–84 percent for the aggregate analysis. For the disaggregated sectorial analysis, the returns to expenditure in the noncocoa subsector are estimated at 437–524 percent, whereas the returns to expenditure in the cocoa subsector are estimated at 11–14 percent. Implications are discussed for raising overall productivity of expenditure in the sector, as well as for further studies.

Keywords: agricultural expenditure, cocoa, Ghana, rate of return

JEL Codes: C20, H50, Q10

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1. INTRODUCTION

This paper examines past patterns of government spending on agriculture in Ghana, and how that spending has impacted on agricultural productivity growth. The scope and rigor of the analysis is constrained by the available data, and only partial insights are possible. The paper is structured as follows. The next section examines trends in public agriculture spending over the period 1961-2012, and disaggregates that spending into the cocoa and noncocoa sectors. While Ghana's allocation of its total expenditure to agriculture is similar to that of many other Africa countries, the lion's share of that spending has gone into the cocoa subsector, while the noncocoa subsector, which includes all the country's food staples, has been about as neglected as elsewhere. The subsequent sections deals with econometric analyses that estimate the impact of public spending on agricultural productivity growth, and provide some useful insights into the marginal returns to public investments in the cocoa and noncocoa subsectors. This is followed by our concluding section.

2. TRENDS IN PUBLIC AGRICULTURE SPENDING, 1961-2012

2.1 Data Sources

Data on public agriculture expenditure in Ghana were compiled from various national and international sources from 1961 to 2012 for the agriculture sector as a whole, and separately for the cocoa and noncocoa subsectors (Table 1). The noncocoa subsector includes noncocoa crops (including food staples), livestock, forestry, and fishery. The cocoa subsector is managed exclusively by the Ghana Cocoa Board. Data on total government expenditure, which, by subtracting agricultural expenditure, is used to calculate nonagricultural expenditure, were also obtained from the above sources. Agricultural production data were compiled from FAOStat, and disaggregated for the cocoa and noncocoa subsectors. The supplementary table in the annex shows details of how the annual expenditure data were compiled, including the sources for each data point.

Table 1: Data sources for public spending and agricultural output, 1961-2012

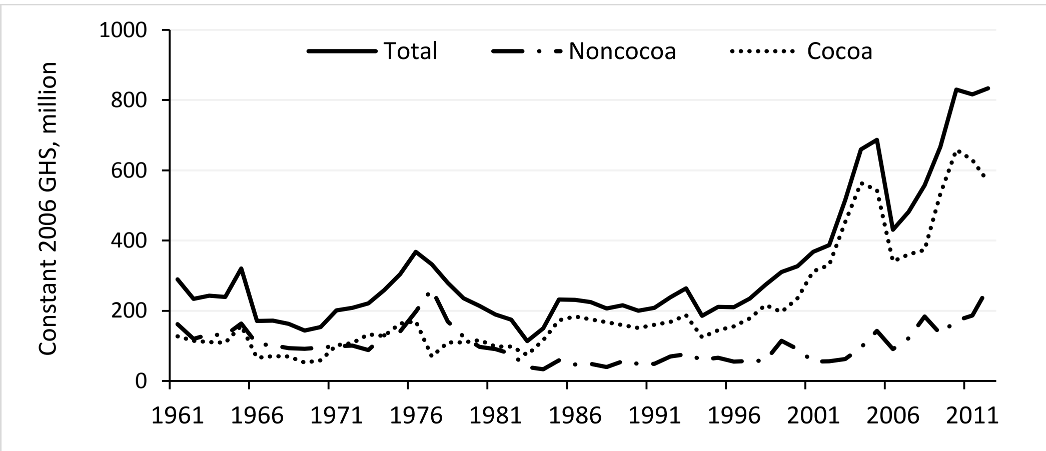
Variable	Description/Disaggregation	Data sources
Total expenditure (*TE*)	Total government expenditure in constant 2006 GHS, million, disaggregated into recurrent and capital expenditures	Stryker (1990), IMF (1998, 2000, 2005), Kolavalli et al. (2012), MOFA (2013), GCB (2013), CAGD (2011, 2013, 2014), IFPRI
Agricultural public	Government expenditure on agriculture in constant 2006 GHS, million, disaggregated into:	

expenditure (*agEXP*)	• Cocoa subsector • Noncocoa subsector (noncocoa crops, livestock, forestry, fishery)	(2015), World Bank (2015)
Agricultural output per hectare (*Y*)	Gross output in constant 2004-2006 GHS divided by agricultural area (including arable land, permanent crops, permanent meadows and pastures, forest area, and inland water), disaggregated into: • Cocoa subsector • Noncocoa subsector	FAO (2016)

2.2 Trends in Public Agriculture Expenditure and Output per Hectare

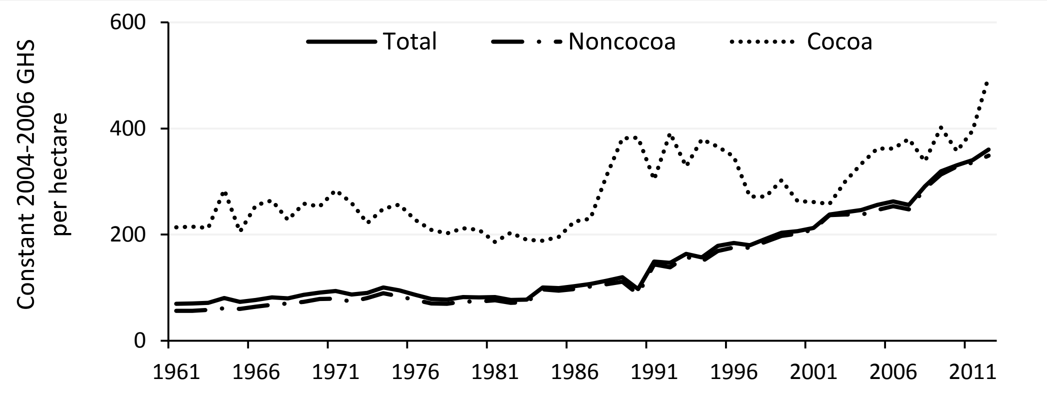
Trends in agricultural public expenditure and gross agricultural output per hectare of agricultural land are shown in Figures 1 and 2, respectively, and Table 2. There have been considerable fluctuations in public spending over the years, driven by changing governments and their policy agendas, but very little upward trend until the 1990s after the policy reforms. Government spending on the cocoa subsector has far exceeded government spending on the noncocoa subsector, a gap that has widened since the 1990s. Average land productivity has grown slowly but steadily over the years, but despite the spending bias towards the cocoa subsector, nearly all the increase in total land productivity has arisen from the noncocoa subsector.

Figure 1: Agricultural public expenditure in Ghana by subsector, 1961–2012



Source: Author's illustration based on compiled data (see Table 1 and Annex).
Note: GHS = Ghanaian cedi.

Figure 2: Agricultural output per hectare by subsector in Ghana, 1961–2012



Source: Author's illustration based on FAO (2016).
Note: GHS = Ghanaian cedi.

To better understand these trends and fluctuations in public expenditure, it is useful to relate them to the underlying agricultural policies of successive governments. Major influential factors include the following:

- Until 1990, there was direct agricultural production by the government through state farms and cooperatives.
- Subsidization of farm production stopped in 1990 and returned in 2007.
- Implementation of policies and strategies was mostly through projects until the 1990s and then through programs and sector-wide approaches afterward.
- Government and public spending was decentralized, including the enactment of the Local Government Law in 1988, establishment of the District Assembly Common Fund in 1993, and implementation of direct district budgeting and execution starting in 2012.
- Agricultural public expenditure reviews were conducted in 1977, 1998, 2006, and 2012.
- The country signed the CAADP compact in 2009.

Table 2 summarizes the trends in public expenditure and land productivity by sub-periods that correspond to successive governments, beginning in 1958. A short summary of the agricultural policies of each period follows.

Table 2: Agricultural expenditure and output per hectare by subsector in Ghana, 1961–2012

Indicator	1961–1965	1966–1971	1972–1979	1980–1981	1982–1992	1993–2000	2001–2008	2009–2012
Agriculture expenditure, growth rate (%)								

Total	2.3	1.0	3.6	–11.3	4.2	6.1	4.3	6.7
Cocoa	3.8	3.9	–3.0	–15.6	5.9	6.4	1.0	1.5
Noncocoa	1.0	-1.4	9.0	–6.1	1.1	4.9	17.8	23.7
Agriculture expenditure (% of output)								
Total	17.4	9.5	15.3	11.8	8.8	6.5	9.4	10.8
Cocoa	30.1	19.1	40.7	45.3	70.9	53.9	76.5	90.3
Noncocoa	12.7	7.0	10.1	6.4	2.5	2.0	2.1	2.9
Agriculture output per hectare, growth rate (%)								
Total	2.4	4.2	-2.4	0.8	5.9	3.8	3.5	3.9
Cocoa	3.1	3.4	-6.0	-11.1	5.8	6.9	10.0	7.7
Noncocoa	2.1	4.5	-1.8	2.8	5.8	4.1	3.2	3.6

Source: Author's calculation based on compiled data (see Tables 5.1 and 5A).

1958 to 1966

The post-Independence policies of the Convention People's Party government led by Dr. Kwame Nkrumah extended from 1951 to 1966, and were dictated by the overall economic development agenda of rapid industrialization, which was primarily financed by taxing agriculture. An Agricultural Development Corporation (ADC) was established to promote the production of export crops (mainly cocoa) for foreign exchange earnings and production of industrial crops (mainly rubber, sugar cane, oil palm, and cotton) to feed the ambitious local factories that were being set up. As such, the bulk of agriculture expenditure was allocated to ADC and spent on input subsidies (imports of fertilizers, other chemicals, tractors, and implements) and on distribution and marketing of produce. Following the ADC's forced closure in 1962, due to its accumulated large debts and unsuccessful large-scale production and marketing activities, state farms and cooperatives were established to take over ADC's projects and the ministry's stations. Price controls, input and credit subsidies, and obligatory credit allocations continued to be used to support the heavy state involvement in agricultural production, distribution, and marketing (Stryker 1990; Dappah 1995). At the time of Nkrumah government's overthrow in 1966, there were 105 state farms (42 of them were inherited from ADC) cultivating about 22,396 hectares, with 62 percent under permanent crops (mainly rubber, oil palm, sugar cane, cotton, coconut, banana, and kola nut) and the remaining 38 percent under food crops (mainly maize and rice) (Austin and Luckham 1975). As Table 2 shows, agriculture expenditure in 1961–1965 grew at an annual average rate of 2.3 percent, with expenditures on cocoa growing faster (3.8 percent) than combined expenditures on the noncocoa subsector (1.0 percent). The amount spent as a share of the respective subsector's agricultural output was much higher for cocoa (30.1 percent) than for noncocoa (12.7 percent). Growth in the land productivity for the agricultural sector as a whole averaged 2.4 percent year, with growth in the noncocoa subsector (2.1 percent) being lower compared with the growth in the cocoa subsector (3.1 percent).

1966 to 1971

This era was governed by the National Liberation Council military government under Lieutenant General Joseph Arthur Ankrah and Lieutenant General Akwasi Afrifa (1966–1969), followed by the second republic under Doctor Kofi Busia and the Progress Party (1969–1972). The main strategy of the National Liberation Council government that had significant bearing on the level of agriculture expenditure and how it was allocated was in trying to ward off the domestic crisis (mainly, high food prices and low producer prices) and to pay off the large debts amassed by the previous government (Austin and Luckham 1975). Doing so involved stimulating more agricultural primary exports (cocoa and timber) and cutting back on direct state involvement in agricultural production. For example, between the 1966 coup d'état and May 1968, the producer price of cocoa was doubled, no new state farms were established, and some state farms and factories were closed or sold off. This trend continued into the Busia-led government. Although there was marked structural change in the rest of the economy (especially nationalism and promotion or takeover of businesses by Ghanaians), agricultural policy and finance mostly continued as before—that is, promote production of cocoa for export, promote industrial crops to feed factories, import and subsidize fertilizer and capital for production of these crops, and import food to feed the urban consumers.

The biased support to large-scale farms or farmers is reflected in the lending practices to the sector by banks that were obligated to provide agricultural loans. The banks typically gave loans to those farms operating 20–1,000 acres of farmland and producing industrial crops or engaged in agro-industry (Austin and Luckham 1975). As Table 2 shows, agriculture expenditure during this era grew at an average rate of 1.0 percent per year, with expenditures on cocoa growing much faster (3.9 percent) than combined expenditures on the noncocoa subsector (–1.4 percent). Here too, the amount spent as a share of the respective subsector's agricultural output was more than twice as high for cocoa (19.1 percent) as it was for noncocoa (7.0 percent). Growth in land productivity for the agricultural sector as a whole averaged 4.2 percent per year, which was dominated by growth in the noncocoa subsector (4.5 percent), as compared with growth in the cocoa subsector (3.4 percent).

1972 to 1979

Promotion of private large-scale agricultural production was enhanced following the second coup d'état and rule of the country by the National Redemption Council military government under General Ignatius Acheampong (1972–1975) and the Supreme Military Council government under Lieutenant General Frederick Akuffo (1975–1979). It was during this era that the first agricultural-specific initiatives were launched—Operation Feed Yourself, which aimed to help reduce food imports, and Operation Feed Your Industries, which aimed to continue providing raw materials to feed local factories. During these years, fertilizer subsidies were substantial, and bank loans to large-scale operators increased rapidly (Quartey-Papafio 1977). Although small-scale farmers were not directly supported under these policies and interventions, they seem to have had easy access to fertilizer and seed, which contributed favorably to their well-being (Wiemers 2015). In general, the economic development agenda of rapid import-substitution industrialization continued.

As Table 2 shows, agriculture expenditure in 1972–1979 grew at an average rate of 3.6 percent year, with expenditures on cocoa experiencing a declining growth rate (–3.0 percent) and combined expenditures on the noncocoa subsector rising rapidly (9.0 percent). Still, the amount spent as a share of the respective subsector's agricultural output was much higher for cocoa (40.7 percent) than for noncocoa (10.1 percent). There was a declining trend in land productivity for the entire agricultural sector, which averaged –2.4 percent per year, with the decline in the noncocoa subsector (–1.8 percent) being lower than in the cocoa subsector (–6.0 percent).

1979 to 1981

Following another coup d'état in June 1979 came the brief military government of the Armed Forces Revolutionary Council, led by Flight Lieutenant Jerry John Rawlings from June to September 1979, and then the third republic, led by the government of the People's National Party under Doctor Hilla Limann from September 1979 to December 1981. Dr. Limann's government launched a two-year program, Action Programme for Agricultural Production, 1980–1981 (Andah 1980). As Table 2 shows, there was negative growth in most indicators during this relatively short period, likely reflecting the widely acclaimed economic mismanagement of the government prior to the coup d'état. The amount spent as a share of the respective subsector's agricultural output continued to be much higher for cocoa (45.3 percent) than for noncocoa (6.4 percent).

1982 to 2000

Jerry Rawlings came back to power, first through another coup d'état under the government of the Provisional National Defence Council from the eve of 1982 until 1993, and then through the ballot box, ushering in the fourth republic under the National Democratic Congress government until January 2001. This roughly 20-year period is known for the Structural Adjustment Program, which is locally called the Economic Recovery Program. In addition, numerous agricultural sector–specific plans, strategies, projects, or programs were launched. As expected with the structural adjustment, there was substantial cutback in government spending in general, and agricultural input subsidies were stopped in 1990. Overall agriculture expenditure grew at an average rate of 4.2 percent in 1982–1992 and 6.1 percent in 1993–2000, with expenditures on the cocoa subsector growing faster than combined expenditures on the noncocoa subsector. As Table 2 shows, the amount spent as the share of the respective subsector's agricultural output continued to be much higher for the cocoa subsector than for the noncocoa subsector.

With the launch of the Local Government Law, the decentralization policy, and institution of the District Assembly Common Fund, direct spending and accounting of expenditures at lower levels increased, likely increasing the targeting of expenditures for agricultural and rural development (Mogues and Benin 2012). Comparative growth in land productivity was mixed, however; whereas it was equal (5.8 percent per year) in the cocoa and noncocoa subsectors in 1982–1992, it was higher for the cocoa subsector (6.9 percent per year) than for the noncocoa subsector (4.1 percent percent) in 1993–2000.

2001 to 2008

With the National Patriotic Party, led by John Agyekum Kufuor, coming into power in January 2001, there was a shift from project-based agricultural development to program-based and sectorwide approaches. Some of the most influential approaches on the sector were the Presidential Special Initiatives, the Agricultural Services Subsector Investment Program, and the Food and Agricultural Sector Development Policy, among others. It was during this era that CAADP, the Africa-wide, agriculture-led development initiative, was launched in the continent, though Ghana did not officially complete and sign its national compact until 2009. The CAADP raised the profile of agricultural expenditures and influenced the definition and accounting of agriculture expenditure (the debate of which continues today).

In 2007, the government announced that it would reintroduce agricultural input subsidies (fertilizer, block farms, mechanization, and buffer stock) and then went on to spend an average of GHS 7.9 million each year in 2007 and 2008 to implement it (Benin et al. 2013). Direct spending at subnational levels continued. As Table 2 shows, at the national level, agriculture expenditure during this era grew at an average rate of 4.3 percent per year, with growth in expenditure on the cocoa subsector being almost stagnant (1.0 percent) compared with growth in expenditure on the noncocoa subsector (17.8 percent). The amount spent as a share of the respective subsector's agricultural output continued to be much higher for cocoa than for noncocoa. For example, the share of expenditure on cocoa as a share of the subsector's agricultural output was 76.5 percent, compared with only 2.1 percent for the noncocoa subsector. Growth in land productivity for the entire agricultural sector averaged 3.5 percent per year, with the average growth being lower in the noncocoa subsector (3.2 percent), compared with growth in the cocoa subsector (10.0 percent).

<u>2009 to 2012</u>

Since January 2009, the National Democratic Congress has been the ruling government in Ghana—first under Professor John Evans Atta Mills (2009–2012) and then John Dramani Mahama (2012–present). Some of the key policies, programs, and projects undertaken during this era include the Ghana Commercial Agriculture Project and the Soil, Land, and Water Management Project. Direct spending at subnational levels continued. In 2012, the composite budgeting system was introduced for all 216 metropolitan, municipal, and district assemblies[1] to effect fiscal decentralization of the 1988 Local Government Law, in which all decentralized functions of government are directly managed by the assemblies at the respective levels of government.

Agricultural input subsidies also remained strong. The overall trends in agriculture expenditure at the national level are similar to trends seen in the preceding periods analyzed. For example, agriculture expenditure during 2009-2012 grew at an average rate of 6.7 percent per year, with expenditure on cocoa barely growing (1.5 percent), as compared with combined expenditure on the noncocoa subsector (23.7 percent). The share of expenditure on cocoa as a share of the subsector's agricultural output was 90.3 percent per year, compared with only 2.9 percent per year for the noncocoa subsector. Growth in land productivity for the entire agricultural sector was 3.9 percent, with growth in the cocoa subsector (7.7 percent) outperforming growth in the noncocoa subsector (3.6 percent).

[1] These include 6 metropolitan assemblies, 49 municipal assemblies, and 161 district assemblies.

Overall trends from 1961 to 2012

To summarize, overall agricultural policy and expenditure have favored the cocoa subsector. Between 1961 and 2012, the periods over which the data used here are available, agricultural expenditure on the cocoa subsector grew at an average rate of 3.7 percent per year, compared with –0.3 percent for the noncocoa subsector. The share of expenditures on the cocoa subsector as a share of the subsector's agricultural output was 57.6 percent per year, compared to only 3.7 percent per year for the noncocoa subsector. The annual average growth rate in land productivity for the entire agricultural sector averaged 3.3 percent per year, driven by growth in the noncocoa subsector (3.7 percent), as compared with growth in the cocoa subsector (1.0 percent).

In terms of fulfilling its Maputo Declaration target of allocating at least 10 percent of total government spending to agriculture, Ghana has failed to meet this requirement, amidst several reports that show otherwise following confusion on differentiating mostly expenditures of the government sector and those of public corporations such as the Ghana Cocoa Board (Benin 2014). Considering only expenditures of the general government sector (i.e. expenditures on the noncocoa subsector as shown in Table 2), the share of government expenditure on agriculture as a share of total government expenditure amounts to only 2.1 percent during 2001-2008 and 2.8 percent during 2009-2012. This is low even by African standards (Benin and Yu 2013), especially as it includes all the country's food staples. When expenditures of the Ghana Cocoa Board are included as part of public expenditures on agriculture, and expenditures of other public corporations are included as part of total public expenditure, Benin (2014) estimates the share to be about 3.8-5.3 percent, which still falls short of the 10 percent Maputo Declaration target.

3. PRODUCTIVITY IMPACTS RATES OF RETURN: CONCEPTUAL FRAMEWORK AND EMPIRICAL MODELS

Two key questions arise from our analysis of past patterns of public spending on agriculture. First, though a relatively small share of total spending has been allocated to agriculture since 1958, has this been money well spent? We would like to know the average economic rate of return to that spending. Second, given that the lion's share of government spending has gone to the cocoa subsector, has the non-cocoa sector been unduly neglected? To answer this question we would like separate estimates of the rates of return for the cocoa and noncocoa subsectors.

3.1 Conceptual framework

The analysis in both papers is based on a conceptual framework that sees government spending as contributing to a stock of public capital in rural areas, and this stock contributes to agricultural productivity growth. This growth linkage can arise through various channels:

- Technology-advancing productivity effects, which typically derive from the yield-enhancing technologies of public expenditure in agricultural R&D
- Human capital–enhancing productivity effects, which typically derive from public expenditure in agricultural education, extension, and information, which all help raise the knowledge and skills of farmers and those engaged in agricultural production (Schultz 1982)
- Transaction cost–reducing productivity effects, which derive from public expenditure on infrastructure (such as storage facilities, market information, and feeder roads) in the agricultural sector, which in turn contributes to improved access to input and output markets and thus reduces the cost of agricultural inputs and technologies (Sadoulet and de Janvry 1995)
- Crowding-in productivity effects, which is a second-order effect in which the increase in public capital induces an increase in private investment in agricultural production and along agricultural value chains.

In addition to the various channels through which productivity effects of public agriculture expenditure may materialize, the literature also shows that the effects are not the same for all types of expenditure. Also, the effects often materialize with a lag rather than contemporaneously.

These various effects can be captured in a model in which agricultural productivity is specified as a function of the stocks of both government and private capital in agriculture, as well as the use of resources like land, labor, and modern inputs, and other exogenous factors like rainfall. The stocks of government and private capital depend, respectively, on accumulated public and private spending over time, with relevant time lag structures and depreciation rates. The stocks of public capital can also be disaggregated by type of spending. A second set of equations specifies that the stock of private capital and the use of other resources (land, labor, and modern inputs) is a function of the stock of public capital, along with other variables such as prices, policies, terms of trade, infrastructure, access to financial and technical services, access to input and output markets, land pressure, etc.

The literature on public investment analysis shows that the public spending decision, too, may be endogenous, since the amount spent or invested on a sector or activity may depend on the performance of the sector or returns to investment in the activity. So is the notion that growth in public capital is an endogenous process, that is, an outcome of growth in income rather than only a cause of it. As such, it is good practice to add a third equation to explain the level of government spending each year, typically using variables on political processes and institutional arrangements. When estimating the model, allowance must also be made for other variables that could be endogenous to the model or which are serially correlated over time. This modeling approach is well established in the literature (e.g., Aschauer 1989; Barro 1990, Thirtle et al. 2003, Fan 2008).

3.2 Relative returns to public spending in the cocoa and noncocoa subsectors

The model

Using national data for the period 1961-2012, we estimate a variant of the previously stated model for Ghana's agricultural sector as a whole, and then separately for the cocoa and noncocoa subsectors. The model is a reduced-form, single equation that is specified as follows:

$$Y_{st} = f(agEXP_{st}, STK_{st}, \boldsymbol{Z1}_{st}, \boldsymbol{Z2}_t), \tag{1}$$

where *Y* is the value of gross agricultural output per hectare; *agEXP* is public agriculture expenditure; *agSTK* is public agriculture capital stock; and ***Z1*** and ***Z2*** are vectors of exogenous factors affecting agricultural output and use of inputs such as public nonagriculture expenditure, policies, institutions, infrastructure, prices, etc., differentiating those that are subsector specific (***Z1***, as related to some policies and institutions for example) and those that are not (***Z2***, such as land pressure, climate and agroecology).

Endogeneity of public agriculture expenditure is dealt with by using instrumental variables (IV) and two-stage least squares (2SLS), where the first-stage equation is specified as follows:

$$agEXP_{st} = h(agSTK_{st}, \boldsymbol{Z1}_{st}, \boldsymbol{Z2}_t, Z3_t), \tag{2}$$

where Z3 represents the instrument or variables that broadly speaking affect *agEXP* but not *Y*. All the variables used in the estimation are observed with the exception of the public agriculture capital stock, $agSTK$, which was constructed using the following capital formation approach:

$$agSTK_{st} = I_{st} + (1-\delta)agSTK_{st-1}, \tag{3a}$$

$$agSTK_{s,1961} = \frac{I_{s,1961}}{(\delta+r)} \tag{3b}$$

Where I is the gross capital formation, δ is the depreciation rate, r is the real interest rate, and the initial capital stock, $agSTK_{1961}$, is estimated using the procedure of Kohli (1982). The annual values of I are based on the share of capital expenditure in total expenditure for the entire economy (compiled from the same sources of expenditure listed in Table 5.1), δ is compiled from (Knoema 2016), and r from the World Bank (2016). More discussion on the variables used in the estimation will come later.

From the estimation, the elasticity of agricultural output per hectare with respect to public agriculture expenditure (ϑ_s) can be obtained as:

$$\vartheta_s = \frac{\partial Y_s}{\partial agEXP_s} + \frac{\partial Y_s}{\partial agSTK_s} \tag{4}$$

where ∂ refers to the partial derivative. The elasticity is interpreted as the percentage change in agricultural output per hectare (Y) due to a 1 percent change in public agriculture expenditure ($agEXP$).

Rates of Return

With the estimated elasticities (ϑ_s), the ROR can be estimated as the discount rate (d) that equates the net present value of marginal productivities ($\hat{\vartheta}_s * \bar{Y}_s * \bar{A}_s$) over the relevant time horizon (that is, q = 0, 1, ..., N) to an initial public agriculture expenditure ($agEXP_{s0}$), equivalent to 1 percent of the annual average public agriculture expenditure in subsector s (or $0.01 * \overline{agEXP_s}$):

$$\sum_{q=0}^{N} \frac{\hat{\vartheta}_{st-q} * \bar{Y}_s * \bar{A}_s}{(1+d)^t} = agEXP_{s0}, \tag{5}$$

where Y is the annual average value of gross output per hectare in subsector s and $\bar{A}_s$ is the annual average agricultural land area in subsector s.

Empirical model

The empirical model estimated are reduced-form single equations that can be written as:

$$Y_t = a + \beta agEXP_t + \gamma agSTK_t + \boldsymbol{Z1}'_{st}\tau_s + \boldsymbol{Z2}'_t\pi + e_t \quad \text{(6a)}$$

$$Y_{st} = a_s + \beta_s agEXP_{st} + \gamma_s agSTK_{st} + \boldsymbol{Z1}'_{st}\tau_s + \boldsymbol{Z2}'_t\pi_s + e_{st}. \quad \text{(6b)}$$

where (6a) is for the agricultural sector as a whole and (6b) are disaggregated for the cocoa and noncocoa subsectors.

Table 3 presents descriptive statistics of the specific variables used in the econometric analysis from 1961 to 2012. Most variables are self-explanatory but a few explanations are in order. Nonagriculture public expenditure per capita (*nagEXPpc*) is used to capture overall budget constraint. Rainfall (*R*), obtained from HarvestChoice (2015). is used to capture the effect of weather shocks. Similarly, a dummy variable (FIRE82) is used to capture the shock of the widespread bush fire in 1982 that destroyed a substantial amount of the cocoa trees at the time. As such this could be considered a mostly cocoa-specific shock. The general evolution of policies, institutions, infrastructure etc. is measured using another time dummy variable, *POLINST*, representing the level at specific time periods: 1961–1971 = 0 (as the baseline following independence), 1972–1982 = 1 (period after the first agriculture-sector specific strategy embodied in the operation feed yourself), 1983–1990 = 2 (economic recovery program), 1991–1999 = 3 (for complete pullout of the direct government involvement in production, stoppage of subsidies, etc.), and 2000-2012 = 4 (for PRSP, CAADP, reintroduction of subsidies, etc.). Another dummy variable is included to represent the type of ruling government (*GOVTYP*: 1 = military in 1966–1969, 1972–1979, 1982–1992; 0, otherwise). To capture the capacity of the government to implement policies in the sector, *CAPAC* is the number of years the same minister of agriculture was in position. We use both a continuous variable measured in years and qualitative variable with three levels. This may be considered a noncocoa subsector variable, as the COCOBOD is managed by a chief executive and board that are under the ministry of finance. Another noncocoa specific variable is measured by the dummy variable for the three years following the year (1977, 1997, 2006, and 2012) in which an agriculture public expenditure review was undertaken (*agPER*). For the instruments to predict government agriculture expenditure, *agEXP*, three variables were tried: a) an indication of whether budget allocations for agriculture were influenced by establishment of the District Assembly Common Fund, measured by a dummy variable representing the years the fund was established (*DACF*: 1994-2012 = 1, and 0 otherwise); b) an indication of whether budget allocations for agriculture were influenced by decentralization of extension by incorporation of the district agricultural development units into the District Assembly (*DADU*: 1997-2012 = 1, and 0 otherwise); and c) an indication of whether budget allocations for agriculture are fixed relative to the allocations to other sectors, which is measured by the share of agricultural expenditure in total expenditure (*SHAEXP*), disaggregated for the cocoa and noncoca subsectors.

Table 3: Description and summary statistics of variables, 1961–2012 annual average

Variable	Mean	Standard error
Gross agricultural output, 2004-2006 GHS/ha (*Y*)		
Total agriculture	149.01	11.63
Noncoca subsector	140.64	11.87
Cocoa subsector	282.43	10.05
Agricultural expenditure, million 2006 GHS (*agEXP*)[a]		
Total agriculture	315.00	25.58
Noncoca subsector	103.98	7.43
Cocoa subsector	211.02	22.25
Agricultural capital stock, million 2006 GHS (*agSTK*)[a]		
Total agriculture	1452.06	73.59
Noncoca subsector	644.21	8.81
Cocoa subsector	807.85	68.22
Nonagricultural expenditure, 2006 GHS per capita (*nagEXPpc*)	162.34	9.42
Rainfall, mm (*R*)	98.66	1.86
1982 bush fire, 1961-1981 = 0, 1982–2012 = 1 (*FIRE82*)	0.60	0.01
General policies and institutions, cf.: 1961–1971 = 0 (*POLINST*)		
1972–1982 = 1	0.21	0.06
1983–1990 = 2	0.15	0.05
1991–1999 = 3	0.17	0.05
2000–2012 = 4	0.25	0.06
Type of government, 1 = military, 0 otherwise (*GOVTYP*)	0.44	0.07
Capacity of government, years with same agriculture minister (*CAPAC*)		
Number of years, continuous (*CAPAC1*)	3.10	0.22
Number of years, cf: 1 year = 0 (*CAPAC2*)		
2 or 3 years = 1	0.25	0.06
More than 3 years = 2	0.50	0.07
Three years following agriculture expenditure review, 1978-1980, 1998-2000, 2007-2009 = 1; 0 otherwise (ag*PER*)	0.17	0.05
Instruments (*Z3*)		
District assembly common fund , 1961-1993 = 0, 1994–2012 = 1 (*DACF*)	0.36	0.07
Decentralization of extension, 1961-1996 = 0, 1997–2012 = 1 (*DADU*)	0.31	0.06
Share of agricultural expenditure in total expenditure (*SHAEXP*)		
Total agriculture	0.13	0.01
Noncoca subsector	0.05	0.00
Cocoa subsector	0.08	0.00
Variables used in calculating public capital stock and rate of return		
Capital expenditure, % of total expenditure	22.48	1.85
Fixed capital depreciation rate, % (δ)	3.06	0.00
Real interest rate, % (*r*)	-9.04	2.56
Agricultural land area, million hectares (*A*)		
Total agriculture	20.78	0.03
Noncoca subsector	19.48	0.08
Cocoa subsector	1.29	0.06

Source: Author’s calculation based on various data sources (see Table 1 and the annex for details).
Notes: cf. = compared with.

Equations 6a and 6b were estimated using instrumental variables and two-stage least squares (IV-2SLS), where the validity of the instruments and endogeneity of *agPER* were tested using several statistical tests.[2] To generate greater confidence in the results, we also estimated the equations using ordinary least squares (OLS) for 6a and seemingly unrelated regression (SUR) methods (Zellner 1962; Zellner and Huang 1962) for 6b, considering nested subsets of explanatory variables to assess sensitivity of the estimates to different variables. Here too, various tests were used to check for independence of the error term over time (or autocorrelation) in 6a and 6b as well as for independence of the error term across equations in 6b.[3] In all cases (IV-2SLS, OLS, and SUR), we estimated robust standard errors to adjust for possible misspecification in the IV-2SLS and SUR estimation (Wooldridge 2013) and the Newey-West standard errors for the OLS estimation (Newey and West 1987). Because the robust specifications typically tend to result in larger standard errors and lower statistical significance of the estimated parameters, which we find to be true with the estimates obtained here, we attach greater confidence to the parameter estimates that are statistically significant at the 10 percent level or lower. Nevertheless, we report the statistical significance of the estimated parameters with both regular and robust specifications of the standard errors. All continuous variables are transformed by natural logarithm so that their estimated coefficients are interpreted directly as elasticities. Then, the elasticity of agricultural output per hectare with respect to public agriculture expenditure is obtained as: $\vartheta_s = \hat{\beta}_s + \hat{\gamma}_s$.

4. REULTS OF PRODUCTIVITY IMPACTS AND RATES OF RETURN

Results of the IV-2SLS are presented in Tables 4 (first stage) and 5 (second stage), followed by the OLS results in Table 6, and the SUR results in Table 7. In the OLS and SUR estimation, we also estimate a basic model that includes only $agEXP_t$ and $agSTK_t$ as the determinants. Where it is applicable in each table, the results are presented for different specifications of the standard errors.

Instruments and first-stage IV-2SLS regression results

With respect to the IV-2SLS, all three potential instruments (*DACF*, *DADU*, and *SHAEXP*) were tried in the estimation, but the *DACF* performed best in terms of meeting the two IV requirements of being correlated with expenditure ($agEXP_t$) and not agricultural output per

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[2] These include partial *R*-squared statistics from the first-stage regression to test for weak instruments (Bound, Jaeger, and Baker 1995) and the Durbin score and Wu-Hausman tests of endogeneity (Durbin 1954; Wu 1974; Hausman 1978).
[3] First-order serial correlation was tested for using Durbin's alternative test for autocorrelation (Durbin 1970) and higher-order serial correlation using the Breusch-Godfrey Lagrange multiplier (LM) test for autocorrelation (Breusch 1978; Godfrey 1978). Cross-equation independence of the error terms was tested for using the Breusch-Pagan test (Breusch and Pagan 1980).

hectare (Y_t). The IV tests shown in Table 4 confirm that the *DACF* instrument, is not weak and that the first-stage equation is adequately identified. The test of exogeneity of $agEXP_t$ is not rejected, implying that it is in fact exogenous in the model specification adopted in this paper. Together, these findings indicate that the impact of agricultural public spending can also be consistently estimated with the OLS and SUR techniques. The negative effect of *DACF* on $agEXP_t$ suggests that the amounts spent on the agricultural sector, total and for each subsector, has declines since the establishment of the DACF in 1994. With respect to the other variables, the periods under military government rule (*GOVTYP*) are associated with lower agricultural expenditures. Other variables with statistically significant coefficients are nonagricultural expenditure per capita (*nagEXPpc*) and periods following an agricultural public expenditure review (*agPER*), both of which have a positive effect. The statistical significant positive signs on the policy and institutional variable (*POLINST*) suggest that agricultural expenditures have increased over time relative to the base of 1961–1971, except in the noncocoa subsector.

Table 4: First-stage results of instrumental-variables, two-stage least squares regression of agricultural expenditure in Ghana, 1961–2012

Variable	Total agriculture		Noncocoa subsector		Cocoa subsector	
agSTK	0.995	***	2.760	***	0.642	***
nagEXPpc	0.794	***	1.127	***	0.717	***
Y_{t-1}	-0.157		-0.484	*	-0.411	*
Rainfall	0.278		-0.155		0.599	**
FIRE82	0.199		0.429	*	0.379	
GOVTYP	-0.207	**	-0.145		-0.342	***
POLINST						
1972–1982=1	0.497	***	0.024		0.582	***
1983–1990=2	0.583	**	-0.419		0.856	***
1991–1999=3	0.420	*	-0.384		0.695	**
2000–2012=4	0.882	***	-0.458		1.194	***
CAPAC1			-0.064	**		
CAPAC2						
2 or 3 years=1	0.041					
>3 years=2	-0.098					
agPER			0.389	***		
$agEXP_{t-1}$ (cocoa)			0.536	***		
$agEXP_{t-1}$ (noncocoa)					-0.054	
Instrument (*Z*3)						
DACF	-0.809	***	-0.902	***	-0.912	***
Intercept	-6.235	***	-18.155	***	-3.283	**
Model statistics						
F-statistic	35.08	***	25.38	***	40.31	***
R-squared	0.925		0.908		0.927	
IV tests						
$agEXP_t$ is exogenous						
Durbin score χ^2 statistic	2.297	0.13	2.116	0.15	1.811	0.18
Wu-Hausman *F*-statistic	1.698	0.20	1.515	0.23	1.362	0.25

Instrument is weak						
F-statistic	21.50	***	19.88	***	20.57	***

Source: Author's representation based on model results. See Table 5B.1 for detail description of variables. Notes: Dependent variable is agricultural expenditure ($agEXP_t$). Blank cell = not applicable. All continuous variables are transformed by natural logarithm. IV tests: $agEXP_t$ is exogenous = test that agricultural expenditure can be treated as exogenous; and instrument is weak = test that the first-stage reduced-form equation is weakly identified. *, **, and *** represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively. For IV tests, *p*-value is reported where test is not statistically significant.

Productivity impacts of agricultural public expenditure

Because of failure to reject exogeneity of $agEXP_t$, we use the IV-2SLS, OLS, and SUR results to form a range of the estimated impact.[4] Thus, the elasticity of total land productivity with respect to total agricultural expenditure is estimated at 0.33–0.34, which means that a 1 percent increase in total agricultural expenditure is associated with a 0.33–0.34 percent increase in total agricultural output per hectare or total land productivity. For the noncocoa subsector, the estimated elasticity is 0.66–0.81. And in the cocoa subsector, it is 0.36–0.43.

Influence of other factors on agricultural productivity

As the table of results show, the sign and statistical significance of the variables are very much consistent across the different model specifications and estimation techniques used. The most important variables across the board are: the lag of productivity (Y_{t-1})—positive everywhere, suggesting lower productivity compared with levels achieved in prior years; rainfall—positive for total agriculture and noncocoa subsector, but negative or insignificant for cocoa subsector; and state of policy and institutions (*POLINST*)—higher productivity compared to base year of 1961–71 for total agriculture and noncocoa subsector, but negative or insignificant for cocoa subsector. Other variables of importance for a specific subsector include: capacity (*CAPAC*1), which weakly positive for noncocoa; military government rule (*GOVTYP*), which weakly positive for cocoa; and nonagricultural expenditure per capita (*nagEXPpc*), which is weakly positive for cocoa and noncocoa in the SUR estimation only.

Table 5: Second-stage results of instrumental-variables, two-stage least squares regression of impact of agricultural expenditure on agricultural output per hectare in Ghana, 1961–2012

Variable	Total agriculture			Noncocoa subsector			Cocoa subsector		
$agEXP_t$	0.043			0.016			0.152		
$agSTK_t$	0.298	**	rr	0.646	**	rr	0.274	**	rrr
Total elasticity[‡]	0.341	***	rrr	0.663	***	rrr	0.427	***	rrr
nagEXPpc	0.052			0.046			0.075		

[4] The Durbin alternative and Breusch-Godfrey test results show that serial correlation is not a problem in the full model, which means the robust and Newey-West standard errors are not necessary, though we still maintain to report them. Same with the Breusch-Pagan test of independence across the two subsectors. And so we do not use the estimates of the base model to from the range.

$Y_{t\text{-}1}$	0.417	***	rrr	0.533	***	rrr	0.574	***	rrr
Rainfall	0.150	*		0.278	***	rrr	-0.287	*	rr
FIRE82	-0.016			-0.029			0.047		
GOVTYP	0.003			-0.003			0.087	*	
POLINST									
1972–1982=1	-0.010			0.021			-0.216	***	rr
1983–1990=2	0.164	*	rr	0.230	**	rrr	-0.227		r
1991–1999=3	0.424	***	rrr	0.553	***	rrr	-0.244		r
2000–2012=4	0.455	***	rrr	0.666	***	rrr	-0.493	**	rrr
CAPAC1				0.013	*	r			
CAPAC2									
2 or 3 years=1	-0.010								
>3 years=2	0.011								
agPER				-0.009					
$agEXP_{t\text{-}1}$ (cocoa)							-0.049		
$agEXP_{t\text{-}1}$ (noncocoa)				-0.055					
Intercept	-0.699			-3.551	**	rr	1.160		
Model statistics									
Wald or *F*-statistic	3340.4	***	rrr	4195.9	***	rrr	200.2	***	rrr
R-squared	0.985			0.988			0.793		

Source: Author's representation based on model results. See Table 5B.1 for detail description of variables.
Notes: Dependent variable is agricultural output per hectare (Y_t). Blank cell = not applicable. All continuous variables are transformed by natural logarithm. ‡ Total elasticity is obtained by summing elasticities with respect to $agEXP_t$ and $agSTK_t$. *, **, and *** represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively. r, rr, and rrr represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively, for robust standard errors.

Table 6: Ordinary least squares regression results of the impact of agricultural expenditure on agricultural output per hectare in Ghana, 1961–2012

Variable	Total agriculture		Noncocoa subsector		Cocoa subsector	
	Base model	Full model	Base model	Full model	Base model	Full model
$agEXP_t$	0.171	-0.058	-0.059	-0.070	0.006	0.026
$agSTK_t$	1.252 *** rrr nnn	0.391 *** rrr nnn	1.807 ** rr n	0.885 *** rrr nnn	0.350 *** rrr nnn	0.334 ** rrr nnn
Total elasticity‡	1.424 *** rrr nnn	0.333 *** rrr nnn	1.749 ** rr	0.814 *** rrr nnn	0.356 *** rrr nnn	0.360 ** rrr nnn
nagEXPpc		0.094		0.108		0.121 *
Y_{t-1}		0.401 *** rr nn		0.488 *** rrr nnn		0.568 *** rrr nnn
Rainfall		0.176 *		0.264 *** rrr nn		-0.220
FIRE82		-0.024		-0.024		0.064
GOVTYP		-0.006		-0.003		0.067
POLINST						
1972–1982=1		0.020		0.010		-0.159 ** r nn
1983–1990=2		0.200 ** rr nnn		0.176 * rr nn		-0.138
1991–1999=3		0.436 *** rr nnn		0.502 *** rr nnn		-0.203
2000–2012=4		0.497 *** rrr nnn		0.594 *** rrr nnn		-0.391 * rr nn
CAPAC1				0.012 n		
CAPAC2						
2 or 3 years=1		0.000				
>3 years=2		0.023				
agPER				0.016		
$agEXP_{t-1}$ (cocoa)						-0.057
$agEXP_{t-1}$ (noncocoa)				-0.008		
Intercept	-5.151 *** rrr nnn	-1.078 r n	-6.635	-4.935 *** rrr nnn	3.284 *** rrr nnn	0.894
Model statistics						
Wald or *F*-statistic	82.90 *** rrr nnn	200.9 *** rrr nnn	2.590 * r n	227.6 *** rrr nnn	23.23 *** rrr nnn	13.15 *** rrr nnn
R-squared	0.763	0.986	0.096	0.989	0.487	0.806
Tests of serial correlation						
Durbin alternative *F*-statistic	300.1 ***	0.699 0.40	1160.1 ***	1.108 0.29	47.40 ***	0.131 0.72
Breusch-Godfrey *F*-statistic	44.83 ***	0.972 0.34	49.93 ***	1.564 0.21	25.84 ***	0.180 0.67

Source: Author's representation based on model results. See Table 5B.1 for detail description of variables.
Notes: Dependent variable is agricultural output per hectare (Y_t). Blank cell = not applicable. All continuous variables are transformed by natural logarithm. ‡ Total elasticity is obtained by summing elasticities with respect to $agEXP_t$ and $agSTK_t$. *, **, and *** represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively. r, rr, and rrr represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively, for robust standard errors. n, nn, and nnn represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively, for Newey-West standard errors. For tests of serial correlation, *p*-value is reported where test is not statistically significant.

Table 7: Seemingly unrelated regression estimates of the impact of sectorial agricultural expenditure on sectorial agricultural output per hectare in Ghana, 1961–2012

Variable	Base model				Full model			
	Noncocoa subsector		Cocoa subsector		Noncocoa subsector		Cocoa subsector	
$agEXP_t$	-0.087		-0.129	*	-0.073		0.025	
$agSTK_t$	2.055	***	0.264	**	0.868	***	0.348	***
Total elasticity‡	1.968	***	0.134	**	0.796	***	0.373	***
nagEXPpc					0.102	*	0.122	**
Y_{t-1}					0.501	***	0.560	***
Rainfall					0.263	***	-0.226	
FIRE82					-0.028		0.058	
GOVTYP					-0.003		0.067	
POLINST								
1972–1982=1					0.006		-0.160	**
1983–1990=2					0.166	*	-0.143	
1991–1999=3					0.491	***	-0.207	
2000–2012=4					0.579	***	-0.400	**
CAPAC1					0.013	*		
agPER					0.018			
$agEXP_{t-1}$ (cocoa)							-0.066	
$agEXP_{t-1}$ (noncocoa)					-0.006			
Intercept	-8.107	**	4.547	***	-4.849	***	0.918	
Model statistics								
Wald χ^2 statistic	11.160	***	7.400	**	4510.5	***	211.82	***
R-squared	0.094		0.224		0.989		0.806	
Test of independence								
Breusch-Pagan χ^2 statistic	25.230	***	25.230	***	0.272	0.602	0.272	0.602

Source: Author's representation based on model results. See Table 5B.1 for detail description of variables.
Notes: Dependent variable is agricultural output per hectare (Y_t). Blank cell = not applicable. All continuous variables are transformed by natural logarithm. ‡ Total elasticity is obtained by summing elasticities with respect to $agEXP_t$ and $agSTK_t$. *, **, and *** represent statistical significance at the 0.1, 0.5, and 0.01 probability level, respectively. For test of independence, *p*-value is reported where test is not statistically significant.

Rates of return to public agricultural spending

The results in Table 8 show that returns to total agricultural expenditure are estimated at 82–84 percent for the aggregate analysis. For the disaggregated sectorial analysis, the returns to expenditure in the noncocoa subsector are estimated at 437–524 percent, whereas the returns to expenditure in the cocoa subsector are estimated at 11–14 percent.

Table 8: Rates of return to agricultural public spending in Ghana, 1961–2012

Variable	Elasticity		Annual average				ROR (%)	
	Low	High	Expenditure (million GHS)	Output per ha (GHS)	Area (million ha)	Expenditure (% of output)	Low	High
Total agriculture	0.33	0.34	315.00	149.01	20.78	10.17	82	84
Noncocoa	0.66	0.81	103.98	140.64	19.48	3.80	437	524
Cocoa	0.36	0.43	211.02	282.43	1.29	57.92	11	14

Source: Author's calculation based on model results.
Notes: GHS = Ghanaian cedi in 2006 constant prices.

Results of the aggregate analysis mask the large differences between the two subsectors, which are driven by both the relative elasticity and the relative expenditure–to–output ratio in the different subsectors. Although the estimated elasticities are about 2 times higher in the noncocoa subsector than in the cocoa subsector, the expenditure–to–output ratio in the cocoa subsector is about 15 times higher than in the noncocoa subsector. As such, the relative higher returns to expenditure in the noncocoa subsector are not surprising. Together, these findings indicate that overall productivity of and returns to total agricultural expenditure can be improved by reallocating some of the expenditure resources intended for the cocoa subsector to the noncocoa subsector. Although it may be difficult to reallocate existing resources that have already been committed, it seems prudent to consider this in future budget allocations or when additional resources for the sector become available. That the cocoa subsector is a major foreign exchange could complicate this policy implication. However, the noncocoa subsector also earns foreign exchange, particularly from exports of horticultural and industrial crops and timber from forestry. Furthermore, foreign exchange is used to import food, some of which could be saved by increasing productivity of local foods. As such, the key policy issue is the extent to which foreign exchange from cocoa exports that is lost due to the reallocation of expenditures is outweighed by the gain in noncocoa foreign exchange and the cost saving from reduced food import, as a result of a decrease in productivity in the cocoa sunbsector and an increase in productivity in the noncocoa subsector. This is an empirical issue that is beyond the scope of this paper. Further disaggregation and analysis of expenditures in the noncocoa subsector into for example export and food subgroups is needed, in addition to disaggregated data on foreign exchange earnings and food imports.

5. CONCLUSIONS AND IMPLICATIONS

The Government's public spending on agriculture has fallen short of 10% of its total expenditure in most years since 1961. In recent times, the share has been lower than 5 percent per year on average, which is low by African standards, and in terms of fulfilling its Maputo Declaration target. Furthermore, most of this spending has been in the cocoa subsector, and when that is netted out, the spending share for the non-cocoa subsector was only 2.1 percent during 2001-2008 and 2.8 percent during 2009-2012. This is low even by African standards, especially as it includes food staples. Perhaps one reason for this low share is that the tax on cocoa exports sustains a lot of the spending in the cocoa subsector.

The high share going to cocoa seems unwarranted given that between 1961 and 2012, the annual average growth rate in land productivity was 3.7 percent per year in the noncocoa subsector as compared with 1.0 percent per year in the cocoa subsector. Also, the estimated rate of return to public expenditure in the noncocoa subsector is 437–524 percent, compared to 11–14 percent for the cocoa sector. Some rebalancing of spending between the two sectors seems advisable, as expenditures on the cocoa subsector as a share of the subsector's agricultural output was 57.6 percent per year, compared to only 3.7 percent per year for the noncocoa subsector. In 2007 the government launched several subsidy programs to help grow the noncocoa subsector. These programs cover fertilizer, improved seeds, and mechanization, as well as a price support program. The cost of these programs was initially modest at GHS7.5 million per year in 2007 and 2008, but had escalated to 25 percent of MOFA's budget in 2010, and seems likely to increase to about half MOFA's budget by 2020. Unfortunately, the available evidence does not show these programs to be generating the full benefits that were expected, and there is need to reevaluate them to ascertain whether this is the best way to spend available pubic resources to promote agricultural growth.

Because different types of spending have different impacts, disaggregated analysis of the impacts of different kinds of agricultural spending, for example R&D or irrigation versus other kinds of agricultural spending, is needed.

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ANNEX

Data sources on public expenditures in Ghana, 1961-2012

Year	Total government expenditure		Agriculture expenditure (million GHS)		Deflator[4]	Agriculture expenditure data sources (N=noncocoa, C=cocoa)
	Million GHS[1]	Capital (%)[2]	Noncocoa subsector	Cocoa subsector[3]	2006=100	
1961	0.023	39.1	0.0028	0.0022	0.0017	Stryker (1990)
1962	0.025	40.7	0.0021	0.0020	0.0017	Stryker (1990)
1963	0.027	39.3	0.0025	0.0021	0.0019	Stryker (1990)
1964	0.033	38.8	0.0027	0.0022	0.0020	Stryker (1990)
1965	0.036	39.2	0.0039	0.0038	0.0024	Stryker (1990)
1966	0.027	24.2	0.0027	0.0017	0.0026	Stryker (1990)
1967	0.031	22.0	0.0025	0.0018	0.0025	Stryker (1990)
1968	0.037	18.3	0.0026	0.0020	0.0028	Stryker (1990)
1969	0.044	19.0	0.0029	0.0016	0.0031	Stryker (1990)
1970	0.047	23.0	0.0030	0.0019	0.0032	Stryker (1990)
1971	0.050	20.6	0.0034	0.0034	0.0034	Stryker (1990)
1972	0.054	17.9	0.0039	0.0042	0.0039	Stryker (1990)
1973	0.077	22.1	0.0042	0.0062	0.0047	Stryker (1990)
1974	0.114	25.2	0.0076	0.0075	0.0059	Stryker (1990)
1975	0.150	29.5	0.0107	0.0124	0.0076	Stryker (1990)
1976	0.200	31.9	0.0192	0.0165	0.0097	Stryker (1990)
1977	0.306	22.7	0.0426	0.0114	0.0163	Stryker (1990)
1978	0.374	20.3	0.0476	0.0311	0.0282	Stryker (1990)
1979	0.409	16.9	0.0490	0.0427	0.0389	Stryker (1990)
1980	0.467	10.5	0.0570	0.0685	0.0588	N=IFPRI (2015), C=Stryker (1990)
1981	0.772	14.8	0.0940	0.1015	0.1032	N=IFPRI (2015), C=Stryker (1990)
1982	0.953	8.7	0.1020	0.1290	0.1320	N=IFPRI (2015), C=Stryker (1990)
1983	1.476	8.1	0.1171	0.2178	0.2944	N=IFPRI (2015), C=Stryker (1990)
1984	2.669	12.6	0.1320	0.4641	0.3984	N=IFPRI (2015), C=Stryker (1990)
1985	4.576	13.1	0.2830	0.8321	0.4807	N=IFPRI (2015), C=Stryker (1990)
1986	7.066	11.9	0.3200	1.2524	0.6811	N=IFPRI (2015), C=Stryker (1990)
1987	10.213	19.7	0.4630	1.6651	0.9481	N=IFPRI (2015), C=linear interpolation
1988	14.390	19.4	0.5000	2.1168	1.2648	N=IFPRI (2015), C=linear interpolation
1989	19.647	21.9	0.9140	2.5817	1.6227	N=IFPRI (2015), C=linear interpolation
1990	25.447	20.9	1.0438	3.2105	2.1284	N=IFPRI (2015), C=IMF (1998)
1991	34.026	20.8	1.2378	4.0886	2.5550	N=IFPRI (2015), C=IMF (1998)
1992	49.881	24.1	1.9815	4.7814	2.8399	N=IFPRI (2015), C=IMF (2000)
1993	81.353	19.1	2.8449	7.0119	3.7418	N=IFPRI (2015), C=IMF (2000)
1994	177.231	25.8	2.9427	6.0667	4.8691	N=CAGD (2001), C=IMF (2000)
1997	464.865	18.2	6.5785	20.7430	11.6350	N=CAGD (2001), C=IMF (2000)
1998	560.744	18.6	7.8291	29.5062	13.6186	N=CAGD (2001), C=IMF (2000)
1999	656.622	27.9	17.7458	30.4868	15.5213	N=CAGD (2001), C=IMF (2000)
2000	752.500	36.9	17.9186	46.5510	19.7477	N=CAGD (2001), C=IMF (2005)
2001	1,199.760	51.6	14.7664	83.0808	26.6235	N=MOFA (2013), C=Kolavalli et al. (2012)
2002	1,277.780	43.4	18.3890	107.9965	32.6985	N=MOFA (2013), C=Kolavalli et al. (2012)
2003	1,880.200	48.4	26.3825	190.3620	42.0845	N=MOFA (2013), C=Kolavalli et al. (2012)
2004	2,603.466	53.5	45.7670	271.3823	48.1237	N=MOFA (2013), C=Kolavalli et al. (2012)
2005	3,070.353	48.9	78.9841	300.8731	55.3247	N=MOFA (2013), C=Kolavalli et al. (2012)
2006	4,056.891	31.5	90.6267	340.0949	100.0000	N=MOFA (2013), C=Kolavalli et al. (2012)
2007	5,661.918	41.3	141.4683	418.8755	116.2760	N=MOFA (2013), C=Kolavalli et al. (2012)
2008	7,407.220	43.4	256.6725	521.9458	139.7663	N=MOFA (2013), C=Kolavalli et al. (2012)
2009	8,869.230	53.9	220.6086	872.2741	163.8475	N=MOFA (2013), C=Kolavalli et al. (2012)
2010	12,173.835	44.1	327.9592	1,257.9316	191.0390	N=MOFA (2013), C=Kolavalli et al. (2012)
2011	13,829.000	38.2	406.5289	1,368.8934	217.6239	N=MOFA (2013), C=GCB (2013)
2012	22,675.000	15.8	667.0152	1,423.1870	250.7148	N=CAGD (2013), C=GCB (2013)

Notes: Expenditure data prior to 2007 were mostly in the old currency units (GHC), which were divided by 10,000 to obtain the new currency equivalent (GHS).

[1] Data series on total government expenditure were compiled from three sources: 1961–1979 from Stryker (1990), 1980–2010 from IFPRI (2015), and 2011–2012 from CAGD (2014). These expenditures do not include expenditures on cocoa that were incurred by the Ghana Cocoa Board, which is an autonomous public corporation. In the analysis therefore, we add the expenditures on cocoa to total government expenditure to obtain total public expenditure.

[2] Data series on total capital expenditures were compiled from two sources: 1961–1979 from Stryker (1990) and 1980–2012 from various issues of government finance statistics issued by the Controller of Accountant General's Department (CAGD).

[3] Expenditures on the cocoa were reported for financial years from October to September. We use the last year in the financial year as the calendar year to compile the data (e.g. 1978 for 1977/1978).

[4] Data series on the deflator is calculated by dividing GDP in current GHS by GDP in constant 2006 GHS, which were obtained from the World Bank (2015).