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Strategic Public Spending

Scenarios and Lessons for Ghana

Emerta Aragie

Marco Artavia

Karl Pauw

Development Strategy and Governance Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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AUTHORS

Emerta Aragie (e.aragie@cgiar.org) is an Associate Research Fellow in the Development Strategy and Governance Division (DSDG) of the International Food Policy Research Institute (IFPRI), Washington, DC.

Marco Artavia (marco.artaviaoreamuno@fao.org) is an Economist in the Monitoring and Analyzing Food and Agricultural Policies (MAFAP) program of the Food and Agriculture Organization (FAO), Rome, Italy.

Karl Pauw (k.pauw@cgiar.org) is a Senior Research Fellow in the Ghana Strategy Support Program (GSSP) of the International Food Policy Research Institute (IFPRI), Accra, Ghana.

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ABSTRACT

Growth in Ghana during the last decade has not translated into meaningful benefits for rural households who experienced an increase in poverty in recent years. This reflects, among other factors, the relatively weak performance of the agricultural sector and its general lack of competitiveness. The government has identified agriculture as the backbone of its development strategy and is committed to address the numerous challenges faced by the sector. However, it is likely to encounter fiscal constraints in a post-development assistance era. It is therefore crucial to understand the trade-offs associated with alternative spending strategies. In this study we develop an economywide modeling framework for analyzing returns to public spending in support of agriculture. The model is used to evaluate the effect of compositional shifts in spending given marginal returns to different areas of investment. Our analysis focuses especially on extension services and input subsidies as two important components of the government's agricultural development strategy. The objective of the study is to advise policymakers on which spending strategy is the most likely to contribute to government's development goals, such as poverty reduction or economic growth. We find that a doubling of the share of agriculture in total public budget would accelerate agricultural growth to somewhere between 7.6% and 8.6% against the business-as-usual scenario of about 3.5%. The level of growth achieved depends on the types of policies that are favored. In the examples presented here, we show that an input subsidy-oriented spending strategy may yield significant benefits in the short run (1–5 years), and especially in an expansionary fiscal environment, but investments in effective extensive services are more sustainable and rewarding in the medium- to longer-run (6–10 years), especially when public resources are more constrained. These results demonstrate why short-term political goals might result in policy choices that are suboptimal from a longer-term development perspective.

Keywords: public agricultural investments, input subsidies, extension, Ghana

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1 INTRODUCTION

Ghana's economy has been growing at 7.2% per annum during 2007–2017 (MoF, 2018b), around three times the population growth rate of 2.3% (World Bank, 2018a). Growth in the non-agricultural sectors was especially robust, averaging 8.3%, and fueled mostly by rapid growth in the crude oil and gas sector that became operational in 2011. Agricultural growth, however, lagged growth in the rest of the economy, with the sector expanding at only 4.3% per annum over the same period. This reflects, among other things, low levels of technology adoption in the sector and a general lack of competitiveness in regional and global markets (ISSER, 2017), which some have explicitly linked to the low level of public investment in agriculture (Benin & Tiburcio, 2018). Concerns have also been raised about the future competitiveness of the sector in the face of possible Dutch Disease (World Bank, 2018b).

The agriculture/non-agriculture growth differential has contributed to a rapid structural shift in Ghana's economy: whereas agriculture contributed one-third of the gross domestic product (GDP) in the early 2000s, its share today is less than one-fifth (MoF, 2018b). Despite its declining economic importance, the agricultural sector still employs half the overall workforce and accounts for 70% of rural employment (World Bank, 2018b). Rural employment, in turn, is currently as high as 49% of total employment (GSS, 2016). As such, the agricultural sector remains vital to the welfare of rural households, many of whom are poor. Somewhat disconcertingly, recent official estimates reveal an increase in rural poverty from 37.9% to 39.5% between 2012/13 and 2016/17 (GSS, 2018a), with particularly sharp increases in Ghana's northern regions. While on the one hand this illustrates the important connection between the structure of growth and welfare outcomes in developing countries, it also raises questions about the effectiveness of government- and donor-funded rural development strategies in Ghana, which have explicitly targeted the northern regions.

In recognition of the development challenges that plague rural Ghana, the current government has identified agricultural development as the backbone of its development strategy (McDonnel, 2018). Substantial financial commitments have been made, primarily through two prominent policy interventions. The first is the Planting for Food and Jobs (PFJ) initiative, which aims to expand access to productivity-enhancing farm input subsidies, develop agroprocessing activities, and create jobs in, *inter alia*, maize, rice, soybean, sorghum, cassava, and several vegetable value chains over the 2017–2021 implementation period (MoFA, 2017b). The second is the Infrastructure for Poverty Eradication Program (IPEP), which addresses the infrastructure investment deficit—estimated at around US$30 billion (MoF, 2018a)—in areas such as transport, water and sanitation, and energy. PFJ and IPEP are ambitious programs: with a proposed average annual budget of GH¢ 765 million (or US$ 160 million), PFJ spending is set to be double the Ministry of Food and Agriculture (MoFA) budget of 2017; likewise, under IPEP, government pledged to disburse GH¢ 1.3 billion (or US$ 270 million) annually, equivalent to 30% of the government's total capital expenditure budget of 2017.

Whether or not spending targets are reached remains to be seen, but the commitment to prioritize agriculture and increase public spending in agriculture and rural development is commendable for several reasons. First, as noted earlier, agricultural growth has lagged growth in other sectors, which has arguably contributed to weak poverty outcomes in recent years. Investing in agriculture remains an important pro-poor development strategy (Diao, et al., 2010), even in a middle-income country such as Ghana. Second, public agricultural expenditure in Ghana has been far below the target of the Comprehensive African Agricultural Development Program (CAADP) of allocating at least 10% of total budgetary resources to the sector. Depending on whether narrow or expanded accounting definitions used, estimated agricultural expenditure shares are either in the 1–3% range (FAO, 2014; CAGD, 2016) or the 4–6% range (MoFA, 2017a; World Bank, 2017).

Third, Ghana was deemed to be "not on track" as measured against the African Union's African Agricultural Transformation Scorecard (AATS). The scorecard includes indicators related to the share of government expenditure dedicated to agriculture (as above) and progress made towards reducing hunger and poverty, increasing intra-regional trade, and enhancing resilience to climate variability (AU, 2018). This has led to MoFA agreeing to an "action plan" in August 2018 to address shortcomings. Finally, Ghana's government budget has in recent years been heavily biased towards recurrent expenditure at the expense of capital expenditure (MoF, 2018b). This is true both for the national budget and the agricultural sector budget and has contributed to the significant infrastructure deficit that now exists in the country. A recommitment to infrastructural spending will likely bode well for the agricultural sector's transformation and increased competitiveness in domestic, regional and global markets.

While spending commitments are substantial, Ghana tax collection rates are low compared to that in other lower middle-income African countries (Asiedu, et al., 2017). In addition to that, the current government of Ghana has outlined the vision of "Ghana Beyond Aid" in which it sees Ghana being able to finance its development agenda without recourse to foreign assistance. As development partners respond by reducing direct support for program implementation, the government may face significant fiscal constraints. This is especially true for agriculture where the recent trend of rising donor-funded shares in agricultural investments—i.e., from 40 to 60% during 2006–2011 (World Bank, 2017)—is likely to be reversed. Policymakers in the agricultural sector may therefore increasingly be faced with trade-offs, which requires better targeting of expenditures towards high-yielding investments.

Within this context we analyze the returns to public spending in and for agriculture in an economywide setting. We develop a modeling framework to evaluate the effect of compositional shifts in agricultural spending given information or assumptions about the marginal returns to two key types of spending—extension services and input subsidies—while controlling for others, such as investments in irrigation infrastructure and rural roads. Although scenarios are hypothetical, the tool and the results generated can aid policymakers in formulating a spending strategy geared towards achieving government development goals, be they poverty reduction, food and nutrition security, or economic growth targets.

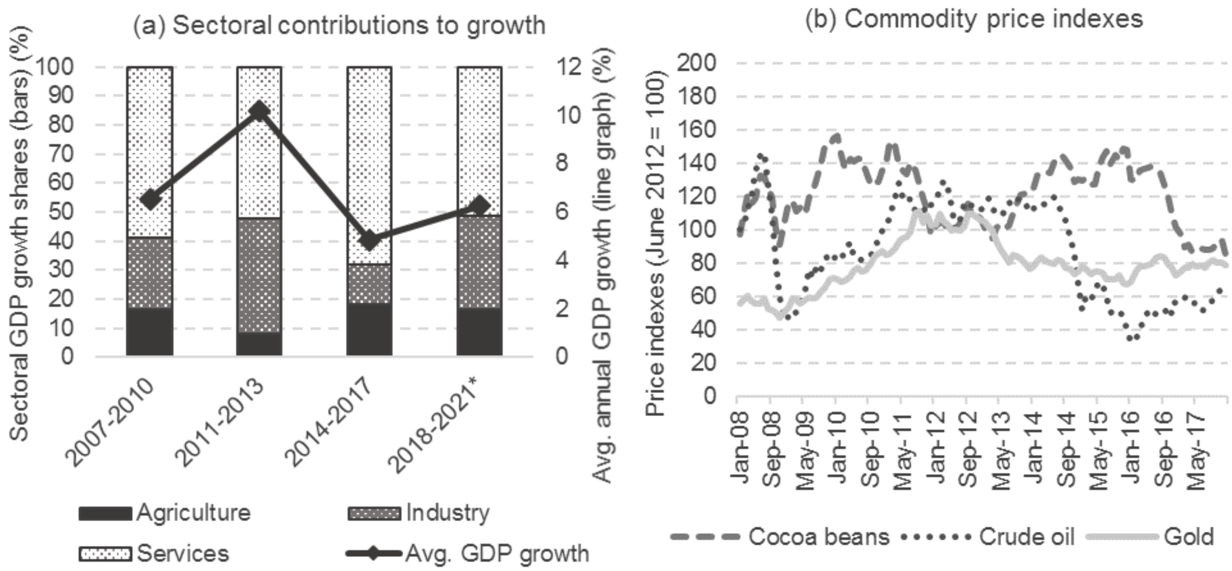
The rest of the paper is organized as follows. Section 2 provides background information on Ghana's economic performance, public spending trends, and socio-economic outcomes; Section 3 introduces the modeling framework; Section 4 presents the simulation design and discusses results; and, finally, Section 5 draws brief conclusions and makes recommendations for policy and further analysis.

2 GHANA ECONOMIC CONTEXT

2.1 Macroeconomic performance

The International Monetary Fund (IMF), among other institutions, projects Ghana's GDP growth rate will exceed 8% in 2018, one of the highest in the world (McDonnel, 2018). This is largely due to a strong recovery in oil prices, one of Ghana's important export commodities. This follows a decade of relatively volatile year-on-year growth, with Ghana's economic performance closely tied to global commodity markets swings. Growth averaged 6.5% during 2007–2010, exceeded 10% during 2011–2013 when the country began extracting oil and prices were at record highs, and slowed down again to under 4.8% during 2014–2017 (GSS, 2017b) as both oil and gold prices declined sharply and the oil sector encountered production challenges. The government's own growth forecast is somewhat more conservatively estimated at 6.2% for the period 2018–2021 (MoF, 2018b) (see Figure 2.1, panel a).

Figure 2.1. Growth trends and outlook (2007-2021) and global commodity price trends (2008-2017)



Source: Panel (a) is constructed from GSS (2017b) and MoF (2018b). Panel (b) is based on World Bank (2018) commodity price data. Notes: The average 2018–2021 growth rate (*) in panel (a) is a forecasted rate. Indexes in panel (b) are constructed with mid period data of June 2012 set equal to 100. The underlying price index for crude oil is a constructed average of Brent, Dubai and WTI prices, quoted in USD per barrel ($/bbl), while cocoa prices are in USD per kilogram ($/kg) and gold prices in USD per troy ounce ($/oz).

The bars in Figure 2.1 (panel a) show how the structure of growth evolved in Ghana. Although the services sector was the most important driver of growth during 2007–2017 with an average growth share of 53.7%, the industrial sector also emerged as an important contributor with 31.6%. However, the industrial sector's contribution to growth fluctuated significantly over time; for example, during the commodity boom of 2011–2013 it contributed 39.6%, but this share dropped to only 13.7% when global commodity prices—especially crude oil—slumped during 2014–2017 (Figure 2.1, panel b). Crude oil and gold accounted for two-thirds of Ghana's merchandise export revenues during 2011–2013 (UN Comtrade, 2017), which explains why the domestic impact of the global commodity price declines were so significant. With the recent recovery in global commodity markets the industrial sector's contribution to growth is expected to increase again to around one-third during 2018–2021.

Agriculture's share of GDP declined gradually from around one-quarter to one-fifth over the period 2007–2017. This is arguably a natural trend for a transitioning economy. However, at an average of 4.3% per annum, agricultural GDP growth was only about half the growth achieved in non-agricultural sectors.

This has meant that agriculture's contribution to growth, which averaged 13.7% over the period, has been disproportionately low relative to the sector's size. Agriculture's growth share has also been volatile, ranging from 7.9% during 2011–2013 to 18.3% during 2014–2017 (see Figure 2.1, panel a). This is partly explained by volatility in the agricultural growth rate, which ranged from –2% to 7%, and also by volatility in the rate of growth in non-agricultural sectors, although average growth in those sectors was much higher. Volatile growth in the agricultural sector raises concerns about the sector's resilience in the face of volatile global markets, macroeconomic instability, changing weather patterns, and outbreak of disease.

The relatively weak and volatile agricultural performance has been linked to low levels of technology adoption, with low productivity considered the major cause of low earnings and underemployment in rural areas (ISSER, 2017; World Bank, 2018b). Diao et al. (2017) furthermore find that economic transformation, which has been associated with rural households rapidly moving into nonfarm employment opportunities, has not been associated with agricultural intensification in Ghana as was the case in many other transitioning economies during the Green Revolution. Despite the sector's declining economic importance, slow agricultural growth is a concern from a welfare standpoint considering that almost half the workforce is employed in agriculture. It also has implications for consumers. The World Bank (2018) notes that while Ghana has the potential to be a net food exporter, low agricultural productivity has instead undermined its food security and the food import bill has been rising. Food products accounted for almost one-fifth of total imports in recent years, with staple grains alone representing 5%. Food demand in urban areas is projected to increase fourfold over the next two decades (World Bank, 2017), which may further increase the country's reliance on food imports, unless significant transformation of the agricultural sector can be achieved. With respect to cereals, the country is in short supply of particularly rice and millet due to high and rising national demand (MoFA, 2017d). Imports of processed foods are four times higher than processed food exports (GSS, ISSER and IFPRI, 2017).

Within each of the main sectors, only a handful of subsectors dominate. Between 2007 and 2017, the crops subsector accounted for 81.5% of the change in agricultural GDP; the petroleum (crude oil and gas) and the construction subsectors accounted for 48.3% and 31.4% of the change in industrial GDP, respectively; and the information and communication subsector accounted for 30.4% of the change in services GDP. At national level, these four largest subsectors accounted for over half the change in national GDP over the period. The implication is that a shock to any of these subsectors could have significant knock-on effects for the whole economy, as was evident with the oil price shock of 2014–2017. The lack of economic diversification, especially within the manufacturing sector, poses a significant threat to Ghana's economic stability and prospects for sustainable transformation. Addressing this should be a policy priority (ISSER, 2017; World Bank, 2018b).

While average GDP growth for the decade has been a respectable 7.2%, the slowdown in 2014–2017 was cause for concern. Rather than blaming oil prices alone, Younger (2016) believes the "recession" was kickstarted when public foreign borrowing increased sharply in 2012 to finance a ballooning public wage bill as government gave in to wage demands at the time of an anticipated windfall from oil exports. This contributed to large successive exchange rate depreciations, fueled by the slump in global commodity market prices, such that by December 2016 the Ghanaian cedi had lost two-thirds of its January 2010 value. The exchange rate depreciation, combined with rising government expenditure, contributed to double-digit inflation during the recessionary period: inflation first breached 10% at the end of 2012 and rose gradually to peak at over 18% in the first quarter of 2016 (GSS, 2017a). It was only by early 2018 that the year-on-year inflation rate dropped below 10% again, which is the upper bound of the government's inflation target range (8 ± 2%) (World Bank, 2018b).

2.2 Socioeconomic outcomes

Volatility in both the level and structure of growth in Ghana, combined with record-high levels of inflation, has had important socio-economic implications. Although average GDP growth has been three times higher than Ghana's population growth rate of 2.3% per annum (World Bank, 2018a), recent poverty statistics suggest that gains were not evenly distributed (GSS, 2018b). While poverty declined sharply from 31.9% in 2005/06 to 24.2% 2012/13, the combination of slower growth and a weaker poverty-growth elasticity—this measures the extent to which growth trickles down to the poor—has meant only a small further reduction in national poverty to 23.4% in 2016/17 (see Table 2.1). Likewise, whereas extreme poverty (defined as people living below the national poverty line of GH¢792 per year) almost halved between 2005/06 and 2012/13, from 16.5% to 8.4%, it only fell marginally to 8.2% in 2016/17. Most disconcerting, however, is the fact that rural poverty *increased* from 37.9 to 39.5% during 2012/13 and 2016/17. This was especially due to the sharp rise in rural poverty in the northern savannah zone: more than two-thirds of rural inhabitants in the savannah zone are now poor compared to 55.0% in 2012/13. This has come about despite government and development partners concentrating their development efforts in the north, which brings into question the effectiveness of development initiatives.

Table 2.1. Official poverty headcount rates in Ghana, by region (2005/06 to 2016/17)

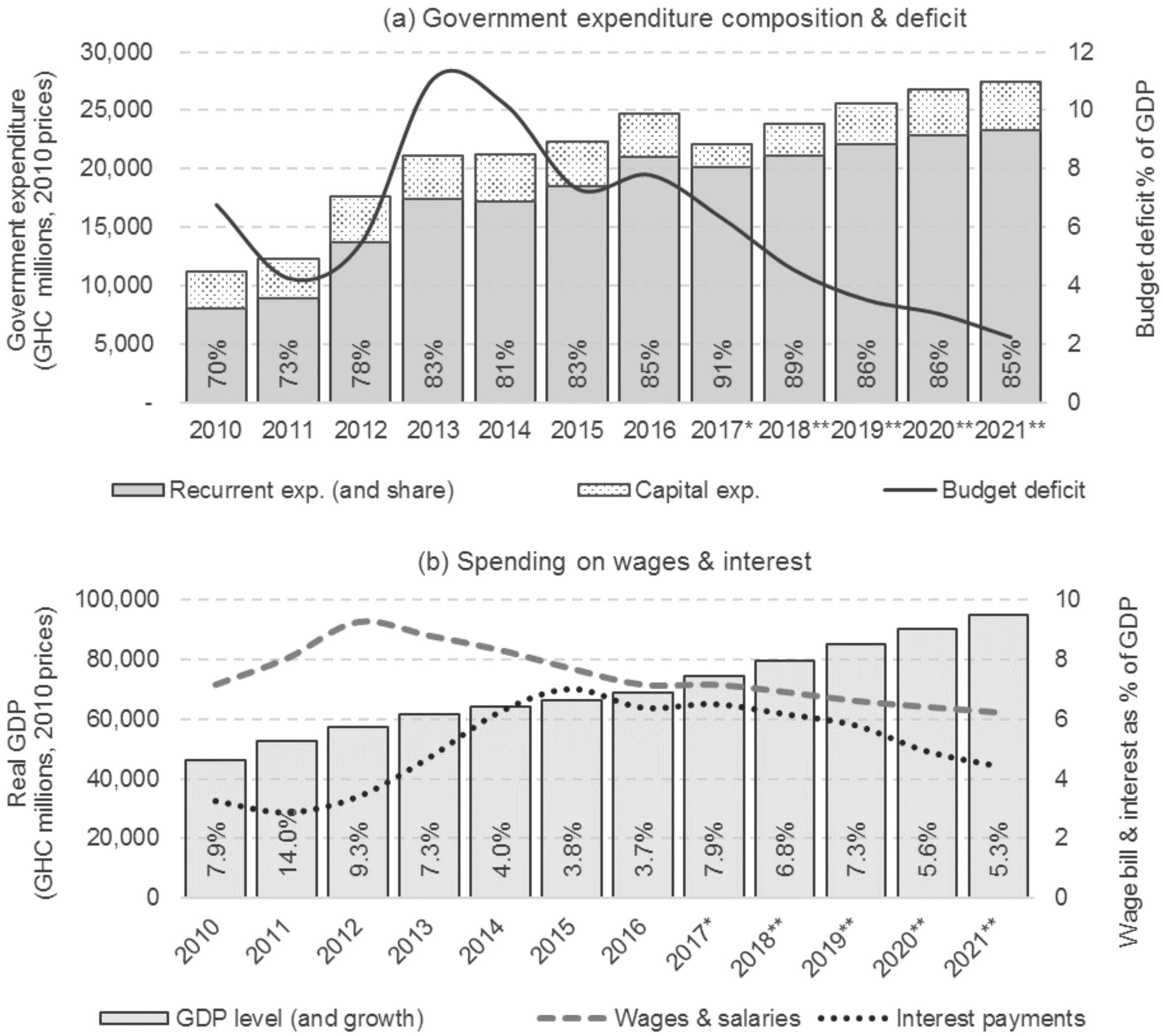
	Poverty				Extreme poverty			
	2005/06	2012/13	2016/17	Trend	2005/06	2012/13	2016/17	Trend
National	31.9	24.2	23.4		16.5	8.4	8.2	
Urban	12.4	10.6	7.8		5.1	1.9	1.0	
Greater Accra	12.0	3.5	2.0		4.5	0.5	0.0	
Urban Coastal	6.4	10.1	8.3		1.1	2.0	0.9	
Urban Forest	8.7	9.9	6.1		2.8	1.8	0.3	
Urban Savannah	30.1	26.4	24.9		16.9	4.6	5.4	
Rural	43.7	37.9	39.5		23.4	15.0	15.6	
Rural Coastal	27.2	30.3	29.9		9.6	9.4	6.9	
Rural Forest	33.1	27.9	24.1		12.6	7.8	4.3	
Rural Savannah	64.2	55.0	67.7		42.9	27.3	36.1	

Source: GSS (2018a).

2.3 Public expenditure trends

Government expenditure jumped sharply in real terms between 2012 and 2013 shortly after crude oil export revenues started flowing into the economy. Spending continued to grow rapidly until 2016 (Figure 2.2, panel a). Virtually all the growth in spending was accounted for by recurrent expenditure growth, such that its share in the national budget rose from 70% to 91% between 2010 and 2017. Much of the growth in recurrent expenditure was due to higher public wages and interest spending, which as a share of GDP peaked in 2012 and 2015, respectively (panel b). Since government neither had the anticipated fiscal space (i.e., from oil revenues) to finance these recurrent expenditures nor the political inclination to roll back wage offers, recurrent spending growth ultimately came at the expense of capital expenditure. The medium-term budget estimates (MoF, 2018b) suggest that the recurrent expenditure share will decline again, but not nearly at the pace it increased in previous years. Also evident from Figure 2.2 (panel a) is the sharp increase in the budget deficit (expressed as a share of GDP) during 2011–2013 due to the combined effect of spending increases and a slowdown in GDP growth. The budget deficit has gradually declined since then but is only predicted to drop below 5% again in 2018. However, as the World Bank (2018b) warns, this downward trend may be difficult to sustain as government comes under pressure to follow through on election promises, particularly as Ghana enters a new election cycle. The Ghana experience demonstrates the legacy effect of high levels of public borrowing and resulting interest spending, as well as the difficulty in reducing public wage bills.

Figure 2.2. Government expenditure trends (2010–2017) and medium-term plans (2018-2021)



Source: MoF (2018b). Notes: Percentages displayed in the bars in Panel (a) represent recurrent expenditure as a share of the total budget. Reported expenditures are either actual outturns (2010–2016), provisional outturns 2017 (*), or budgeted (2018–2021) (**).

As Ghana enters a renewed phase of rapid growth, the government has an opportunity to address several structural and socioeconomic challenges through adopting a public expenditure strategy geared towards encouraging economic diversification and reducing poverty and inequality. Increased diversification is critical in part because the extractive industry is capital-intensive and cannot absorb the growing workforce fast enough. Also, while substantial revenues will be earned in the next few years, oil revenues are expected to peak by 2023 and cease by 2036 (World Bank, 2018b). A successful diversification strategy will require government steers clear from the fiscal ill-discipline that has led to major infrastructure deficits—estimated to be in the region of US$30 billion (MoF, 2018a)—in areas such as transport, water and sanitation, and energy infrastructure. Infrastructure investments are crucial for fostering a business climate more conducive to the efficient allocation of productive resources across firms and sectors (Gelb, et al., 2014) and alleviate the worst effects of the resource curse or Dutch Disease in Ghana (Breisinger, et al., 2009; World Bank, 2018b).

2.4 Agricultural and rural development spending

At the 23rd African Union (AU) Assembly in Malabo in 2014 African heads of state adopted the *Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods* (AU, 2014). This reaffirmed AU member countries' commitment to the Comprehensive African Agricultural Development Program (CAADP) launched a decade earlier, which highlights the important role agriculture has in driving development and reducing poverty. Among the seven broad commitments made, heads of state agreed to continue to dedicate at least 10% of government expenditure to agriculture, actively reduce hunger and poverty, boost intra-regional trade, and enhance resilience to climate variability. In line with Ghana's CAADP commitment, agricultural development is central to the current government's development strategy for the country, with flagship initiatives such as the Planting for Food and Jobs (PFJ) and the Infrastructure for Poverty Eradication Program (IPEP) standing out. The Ministry of Food and Agriculture (MoFA) is also finalizing its new Ghana Agricultural Investment Plan (GhAIP) 2018–2021, which builds on the earlier Medium-Term Agriculture Sector Investment Plans (METASIP I and II), while a new Food and Agriculture Sector Development Policy (FASDEP III) will be developed in 2019 to replace the earlier FASDEP I (2002) and II (2007). The flagship initiatives and the forthcoming investment plan and agricultural policy all emphasize increased agricultural productivity, agroprocessing capacity, and marketing as central to a modern food system that can effectively compete with imports and supply a rapidly urbanizing population.

Despite high-level commitments, a composite scoring system developed for the AU African Agricultural Transformation Scorecard (AATS) in January 2018 (AU, 2018) revealed that only 20 of the 47 members were on track to achieve their commitments by 2025. The 10% agricultural spending commitment, which has become synonymous with CAADP, has been even more difficult to achieve, with only 10 countries reaching this goal. Ghana is one of the countries considered to be "not on track" measured by its composite score. The country's agricultural budget allocation has also remained well below target, irrespective of the accounting methods followed. There are no hard and fast rules for estimating agricultural expenditure shares, although AU member countries are advised to follow certain guidelines (AU-NEPAD, 2015). MoFA's own method deviates from the AU guideline in that expenditures by the Ghana Cocoa Board (COCOBOD), a parastatal, are included in its estimates of agricultural spending in the most recent Agricultural Public Expenditure Revue (AgPER "Lite") (MoFA, 2017a). The AgPER yields expenditure shares of 5.8% to 7.6% for the period 2012–2015 (budgeted shares were slightly higher), which some consider to be an overestimate (Benin & Tiburcio, 2018).

By contrast, Ghana's Controller of the Accountant General's Department (CAGD, 2016) follows AU guidelines and estimates agricultural expenditure shares ranging from a high of 1.7% in 2012 but dropping steadily to only 0.5% in 2015. Estimates produced by the Monitoring and Analyzing Food and Agricultural Policies (MAFAP) program of the Food and Agriculture Organization (FAO) are somewhere in the middle, declining from 3.7% to 1.9% over the period 2006–2012 (FAO, 2014). The MAFAP method includes both agriculture-specific expenditure (i.e., transfers where agriculture is the principal beneficiary) and agriculture-supportive expenditure (i.e., transfers that have a strong and indirect influence on agricultural sector development), and so despite taking a broad view of what constitutes agricultural expenditure, their estimated expenditure shares are still well below the AgPER estimates.

Irrespective of accounting methods followed, there appears to be consensus that Ghana's agricultural expenditure levels have not only remained well below the CAADP target, but that they are also in decline. Benin and Tiburcio (2018) explain that low agricultural spending may reflect a perception among policymakers that investing in agriculture is not growth-enhancing. Large differences in planned and actual expenditures may also reflect a reverse causality between sectoral growth and budget appropriations. This could imply that higher agricultural expenditure is a *consequence* of growth rather than the other way around. However, when testing the relationship econometrically, Benin and Tiburcio (2018) conclude that the more likely direction of causality in Ghana is that public agricultural expenditure growth *causes* agricultural GDP growth; moreover, they find that there is a significant lag effect of agricultural spending on growth of up to eight years. This means that not only are productivity and growth effects of public investments positive, but they may also take time to fully manifest and/or have longer-lasting effects.

As Akroyd and Smith (2007) rightly point out, while the commitment to spend 10% on agriculture is laudable, it ignores the fact that the quality of spending is far more important than overall levels of spending. While it is hard to ascertain the quality of agricultural service delivery, it is useful to consider the composition of expenditure as a proxy of quality, especially given our knowledge of returns to different types of expenditure. Both the MAFAP (2006–2012) and AgPER (2012–2015) studies note steady declines in certain types of expenditures. For example, over the earlier period, MAFAP finds that agriculture-specific expenditures increased relative to agriculture-supportive expenditures, with a substantial increase in fertilizer subsidies driving this trend. At the same time, spending on agricultural research and knowledge transfer activities decreased sharply (FAO, 2014). This trend continued in the latter period, with reported declines in research and development (R&D) expenditures and extension spending (MoFA, 2017a). The World Bank (2017), in turn, finds that most agricultural spending finances routine operating expenses, leaving a very modest balance for productivity-enhancing investments.

These spending trends are cause for concern given differences in the returns to spending that strengthen the sector's capacity to grow (i.e., physical capital infrastructure or farmers' knowledge) compared to those that are fully consumed in the same period (e.g., production or input subsidies) (Benin & Tiburcio, 2018). While the latter may have short-term benefits, investments in infrastructure, research and farmers' knowledge are typically associated with higher returns as measured by productivity and growth in the long term in developing countries (Mogues, et al., 2015). This also true in Ghana (Benin, et al., 2012) because of the nature of the impact pathways through which investments impact productivity. For example, investment impact pathways can be technology-advancing, e.g., in instances where research and development spending contribute to technology adoption in the private sector; they can be human capital-enhancing, e.g., in the sense that spending on extension or education or health raises farmers' knowledge and/or labor productivity; they can be transaction cost-reducing, e.g., in the case where infrastructure investments reduce trade and transport margins; and, lastly, they can have a crowding-in effect on private capital, e.g., through the creation of an enabling business environment that is more conducive to private sector participation.

In summary, despite the high-level commitments made, and despite evidence about positive and long-term returns to agricultural spending, public agricultural expenditure in Ghana has remained low and appears to have declined in recent years. There are also concerns about the quality of spending, with an increased emphasis on fertilizer subsidies and administrative expenditures at the expense of spending on R&D, extension and infrastructure. As government reprioritizes agriculture, spending in the sector is anticipated to increase again, but, there are legitimate concerns about quality of spending. This warrants closer inspection; hence, in the remainder of this paper we develop a model framework to demonstrate the likely ways in which different packages of agriculture-specific or agriculture-supportive spending might impact on growth and poverty outcomes in Ghana, in both the short- and long-run. The aim is to guide policymakers in their prioritization of agricultural spending and better understand the trade-offs in the short and longer term.

3 MODEL FRAMEWORK

3.1 Linking agricultural spending to productivity outcomes

Total factor productivity parameters in general equilibrium models are calibrated based on observed relationships between factor inputs and output quantities. These remain constant unless shocked exogenously as a simulation exercise. While there have been numerous studies linking public expenditure to agricultural productivity growth, very few general equilibrium analyses have made the link between public spending and total factor productivity endogenous. In this study we adapt the approach piloted by Pauw & Thurlow (2015) and Aragie et al. (2018) in Uganda, and Benfica et al. (2018) in Mozambique to link public expenditure in areas such as rural roads, irrigation, input subsidies, and extension services to expected productivity changes within agricultural subsectors. By modeling this within an economywide context, the model can account for the spillover effects of productivity growth in a targeted sector on other sectors via inter-industry linkages; measure socioeconomic and welfare outcomes associated with public investments; be used to consider outcomes in combination with external shocks such as changes in world prices; and measure the implications of increased spending on government savings or taxation levels in the economy.

Before discussing the functioning of the economywide model itself, we first introduce the investment module used to "endogenize" the link between public spending and total factor productivity. Assume a simplified production function in equation [1] where Q_t is output at time t, α_t is total factor productivity (TFP), L_t is labor, N_t is land and K_t is capital input.

$$Q_t = \alpha_t F(L_t, N_t, K_t) \qquad [1]$$

The public expenditure literature shows that performance of the agricultural sector depends not only on agriculture-specific public spending (such as on inputs, irrigation, or agricultural extension), but also on spending in related areas such as rural roads (also called agriculture-supportive expenditure). Equation [2] accounts for these expenditure classes and links them to the time and activity-specific productivity parameter, α_t.

$$\frac{\dot{\alpha}_t}{\alpha_{t-1}} = \beta_0 + \beta_s \frac{\dot{S}_t}{S_{t-1}} + \beta_e \frac{\dot{E}_t}{E_{t-1}} + \beta_i \frac{\dot{I}_t}{I_{t-1}} + \beta_r \frac{\dot{R}_t}{R_{t-1}} \qquad [2]$$

In the above equation the raised dot above a variable indicates its derivative with respect to time t, i.e., the ratio $\dot{\alpha}_t / \alpha_{t-1}$ denotes the percentage change in α_t from time t–1 to t. S_t denotes the share of farm land using modern farm inputs (such as chemical fertilizers), E_t is the share of rural farm households receiving extension services, I_t is the share of cultivated farm land under irrigation, and R_t is a measure of rural road density (measured as kilometer road per 100 square kilometer of area). Growth in all these factors are expected to raise agricultural productivity. The parameter β_s is the marginal productivity effect of an increase in farm land using modern agricultural inputs. Similarly, β_e, β_i and β_r are marginal effects of changes in extension, irrigation and rural road coverage on agricultural productivity, respectively. S_t, E_t, I_t and R_t are all dependent on the level and trends of both public and private expenditures on inputs, extension, irrigation and rural roads, respectively. Our focus is only on public expenditure in this analysis, i.e., private expenditure is assumed to remain constant. Productivity is also a function of fixed time trend rate of technical change β_0, mapping past trends in Ghana.

The subsidy, extension, irrigation and road *outreach and stocks* at time t in the right-hand-side of equation [2] are computed using public expenditure, unit cost, demographic and land data. The farm land area covered by modern inputs financed by public expenditure ($SUBS_t$) and the intensity of fertilizer and input use (S_t) are determined by equations [3] and [4]:

$$SUBS_t = \frac{SUBS_t^e}{s} \qquad [3]$$

$$S_t = \frac{SUBS_t}{C_t} \quad [4]$$

Here $SUBS_t^e$ is public expenditure on input subsidy, s is the unit cost of covering a hectare of land, and C_t is the size of farm land at time t determined based on recent trends on farm land expansion in Ghana.

The additional coverage rates for extension, irrigation and rural roads are derived from the following expressions:

$$EXT_t = \frac{(1-m^e)EXT_t^e}{e} \quad [5]$$

$$IRR_t = \frac{(1-m^i)IRR_t^e}{i} \quad [6]$$

$$RRD_t = \frac{(1-m^r)RRD_t^e}{r} \quad [7]$$

where EXT_t^e, IRR_t^e and RRD_t^e are public expenditures on extension, irrigation and rural roads, respectively and e, i and r are corresponding costs of increasing these infrastructures by one unit. Unit costs are assumed to increase as coverage rates increase based on the assumption that the marginal cost of reaching an additional unit (e.g., household, hectare of land, etc.) increases as coverage rates increase (Biermann, 1998; Collier, et al., 2015). The parameter m^e is the share of spending on extension services devoted to maintaining the skills of already covered farm households, while m^i and m^r are the shares of irrigation and road spending, respectively, devoted to repairing and maintaining existing infrastructure. We assume that the maintenance expenditure restores the quality of existing farming knowledge or physical infrastructure.

We make an important distinction between stocks and flows. Subsidization of inputs is treated as a flow, i.e., the subsidized fertilizer is fully consumed in the year in which the expense is incurred, and as soon as spending on subsidies is suspended, the benefits are lost. By contrast, extension, irrigation and rural roads are considered stocks. Even if spending is suspended in year t, infrastructure will remain in place and farmers will still have the knowledge from previous years. Of course, stocks also depreciate over time as physical infrastructure deteriorates or knowledge becomes obsolete or is lost. Treating irrigation and road infrastructure as stocks is standard in infrastructure studies (Pauw & Thurlow, 2015; Benfica, et al., 2018; World Bank, 2010). However, treating extension as a stock is novel. The rationale, of course, is that the knowledge imparted through the extension system does not disappear once the service is discontinued (Kislev, 1971; Betz, 2009; Zhang, et al., 2015). Over time, however, farmers knowledge may become obsolete (e.g., as new technologies become available) and hence, as with physical stocks, knowledge stocks are also assumed to gradually depreciate unless it is continually maintained. Stocks of extension knowledge, irrigation and rural roads infrastructure at time t are derived following standard investment functions:

$$E_t = E_{t-1} + EXT_t \quad [8]$$

$$I_t = I_{t-1} + IRR_t \quad [9]$$

$$R_t = R_{t-1} + RRD_t \quad [10]$$

The stocks of extension (E_t), irrigation (I_t) and road infrastructure (R_t) at time t are the sum of stocks in the previous period plus the additional stock resulting from public spending, after fully maintaining the quality of previous capital by incurring maintenance costs.

Finally, the extension, irrigation and road capital stocks per farm household, cultivated area and total area, respectively, are generated from:

$$E_t H_t = E_{t-1} H_{t-1} + EXT_t \quad [11]$$

$$I_t C_t = I_{t-1} C_{t-1} + IRR_t \quad [12]$$

$$R_tA = R_{t-1}A + RRD_t \quad [13]$$

where H_t and A are the size of farm households and total land area in Ghana, respectively, and C_t is the size of farm land at time *t* as defined above. In the recursive-dynamic model employed, we allow for changes in *C* and *H* based on their respective growth rates, while *A* is fixed at the base level. Specifically, *C* and *H* are assumed to increase over time following historical trends, growing at fixed rates of 1.0% and 2.3% per year, respectively. The growth rate of rural households is assumed equal to the average population growth rate in the country (World Bank, 2018a), whereas growth in arable land is based on FAO (2018).

Calibration of parameter values such as elasticities, share parameters and unit costs is an important step in our analysis. Some parameter values are calculated directly using Ghanaian data, while others are based on econometric estimates from Ghanaian literature (where possible) or estimates obtained from similar contexts in other countries. In some instances, parameter values are also set based on informed assumptions. All parameter values are set to 2015 levels to be consistent with the general equilibrium model. In instances where values for 2015 are not explicitly reported or available, we impute these from other years using the best available information. These parameter values, combined with the simulated level and composition of agriculture expenditure, ultimately determine the impact of spending on agricultural productivity. Since the confidence interval around some of these parameter values might be wide, it is advisable to carry out series of sensitivity analyses to assess the robustness of results to higher or lower parameter values.

Table 3.1 reports the parameter values and initial values for variables. Baseline public expenditures on input subsidies amounted to GH¢138 million (World Bank, 2017a), total expenditure on rural roads amounted to GH¢292 million (MoF, 2016), and spending on extension and irrigation development are estimated at GH¢14 and GH¢ 38 million respectively (FAO, 2014). Maintenance cost ratios, defined as the share of annual spending required to maintain existing infrastructure, are important for determining growth in infrastructure or knowledge stocks. Drawing on the World Bank (2010) we assume maintenance cost ratios of 50.8% for irrigation and 43.3% for rural roads. The concept of maintenance is somewhat different in the case of extension. Kislev (1971) and Betz (2009) argue that the cost of providing extension services to farmers who had previously received extension is lower than the cost of visiting farmers for the first time. This might relate to the fact that follow-up visits are more likely shorter or perhaps take the form of joint sessions with groups of farmers as opposed to costlier individual, on-farm visits. Unfortunately, we do not have reliable estimates of extension maintenance cost ratios; therefore, following Aragie, Pauw and Thurlow (2018), we assume that as much as 75% of extension spending is used to serve existing clients, while the balance is available to reach new clients.

Service coverage is defined in terms of hectares (irrigation or subsidies), number of households (extension services), or kilometers (rural roads). The area of crop land that benefits from fertilizer subsidies is imputed using information on recommended fertilizer application rates (MoFA, 2017d) and total fertilizer use in Ghana (MoFA, 2017c), which yields coverage of 223,000 hectares. The World Bank (2010a) reports that 300,361 households receive extension services (*E*). The area under irrigation (*I*) is reported to be 39,712 hectares in 2015 (MoFA, 2017d), while the stock of rural roads (*R*) is estimated at 42,045 kilometers (km) by MRH (2017). Expressing coverage values as a percentage of total stock levels yields coverage rates, a useful indicator to track when analyzing model results. It is estimated that Ghana has around 6.4 million hectares of arable cropland (*C*), there are 2.5 million farm households (*H*), and the total land area (*A*) is 237,748 square kilometers (MoFA, 2016). Thus, for example, the extension coverage rate is 12.0% (of 2.5 million households) while the subsidy coverage rate is 3.5% (of 6.4 million hectares).

Unit cost values are also obtained from a variety of sources. Unit costs for fertilizer input use is computed as the ratio of the subsidy program expenditure reported by the World Bank (2017a) and the area of cropland reached by modern inputs (MoFA, 2017; MoFA, 2017c). Unit costs for extension provision are derived from Kolavalli et al. (2010) who report the costs per farm household visit. Irrigation unit costs are from FAO and IFC (2014), while rural road costs are based on Alexeeva et al. (2008).

Elasticity values (β_s, β_e, β_i and β_r) are all derived from impact evaluation studies. Our value for β_s (0.241) is from Appleton and Balihuta (1996) and was originally estimated for Uganda. The interpretation of this elasticity value is that for a 1% increase in coverage of input subsidies, productivity will increase by 0.241%. The value for β_e (0.189) is from Fan and Zhang (2008), also originally estimated for Uganda. Values for β_i (0.036) and β_r (0.110) are from Fan et al. (2000) and Benin et al. (2009), respectively, as estimated for India and Ghana. As can be seen, the flexibility of this approach lies in the fact that even when evaluation data is not explicitly available for the case study country, evaluations of similar interventions elsewhere can be used to specify potential effects in the case study country.

Table 3.1. Investment module: public expenditure parameters

Initial values	2015 Values	Unit	Source
Baseline expenditure			
$SUBS^e$	138,000,000	GH¢	World Bank (2017a)
EXT^e	13,900,000	GH¢	FAO (2014)
IRR^e	38,200,000	GH¢	FAO (2014)
RRD^e	292,430,000	GH¢	MoF (2016)
Maintenance cost (share)			
m^e	0.750	share	Assumed
m^i	0.508	share	World Bank (2010)
m^r	0.433	share	World Bank (2010)
Baseline stocks (coverage)			
S	223,000	hectares (ha)	MoFA (2017), MoFA (MoFA, 2017c)
E	300,361	households (hh)	World Bank (2010)
I	39,712	hectares (ha)	MoFA (2017d)
R	42,045	kilometer (km)	MRH (2017)
Baseline stocks (totals)			
C	6,421,450	hectares	MoFA (2016)
A	237,748	square km	MoFA (2016)
H	2,503,006	rural households	MoFA (2016)
Unit costs			
s	619	GH¢/ha	Calculated
e	418	GH¢/hh	Kolavalli et al (2010)
i	9,486	GH¢/ha	FAO and IFC (2014)
r	434,709	GH¢/km	Alexeeva et al. (2008)
Elasticities			
β_s	0.241	elasticity	Appleton and Balihuta (1996) (Uganda)
β_e	0.189	elasticity	Fan and Zhang (2008) (Uganda)
β_i	0.036	elasticity	Fan et al. (2000) (India)
β_r	0.110	elasticity	Benin *et al*. (2009) (Ghana)

Source: Authors compilation; sources as cited in table.

The targeting of interventions is an important consideration when setting up the investment module. Some policies, such as subsidy programs, may be designed to explicitly target priority agricultural sectors. Others, by nature of their design, may implicitly target or favor certain sectors over others. Irrigation programs, for example, are more likely to benefit crops that are typically irrigated. Lastly, investments in rural roads or other public goods are less likely to explicitly or implicitly favor a wider range of subsectors. Since the investment module is defined at subsector-level, it is possible to introduce such targeting assumptions by specifying which subsectors are affected by different types of public programs and which are excluded. Of course, it is also common practice for policies to target certain types of households. Unfortunately, the investment module is not currently designed to accommodate such targeting.

Input subsidy programs in Ghana have historically focused on fertilizers. More recently, the PFJ program has also introduced a seed subsidy component, but the fertilizer subsidy component remains the largest in terms of resource allocation. Although PFJ targets a wide range of crops, the policy is not prescriptive as to how subsidized fertilizer should be utilized, and hence those crops that are traditionally fertilized are most likely to benefit. The Ghana Agriculture Production Surveys (GAPS) (Osei-Akoto, et al., 2014) report inorganic nutrient application by crop. We assume input subsidies only benefit those subsectors where fertilizer is applied on at least 10% of cultivated land for that subsector. Our subsidy spending component therefore targets maize, rice, cocoa, and horticulture. Likewise, based on GAPS data, Osei-Akoto, et al. (2014) find that farmers who receive extension services are more likely to cultivate maize, rice, cocoa, and horticultural crops. These sectors are therefore assumed to be the beneficiaries of increased spending on extension. Lastly, irrigation is assumed to benefit primarily some cereals such as rice and commercial crops including sugar cane in addition to root crops and vegetables.

3.2 Computable general equilibrium (CGE) model

Changes in sector productivity estimated from the investment module are translated into economywide growth and socioeconomic outcomes using IFPRI's recursive-dynamic CGE model (Thurlow, 2004) customized for rural investment and policy analysis in Ghana. Production is defined by a multi-level nested structure, specified for each sector. Imperfect substitutability between primary factors of production (eight labor types, land and four types of capital) are governed by constant elasticity of substitution (CES) functions, while intermediate inputs are combined with aggregate value-added inputs in fixed proportion. Land and labor factors are mobile across activities, but the transition from one factor type to the other is limited. Factor supply grows over time in line with historical growth trends.

The model further adopts an Armington approach to modeling trade flows (Armington, 1969). Specifically, a CES function determines the substitutability between and the optimal mix of imported and domestically produced goods consumed locally, subject to relative prices of imports and locally produced goods. Likewise, a constant elasticity of transformation (CET) function determines the optimal allocation of domestically produced goods between domestic and export markets, again subject to relative prices in those markets. Based on Narayan (2012), relatively elastic CES and CET elasticities are assumed for traded goods.

Households receive income from employed factors of production as well as transfers from local or foreign sources. A portion of income is saved, while the remainder is allocated across tax payments, consumption expenditure and transfers to other agents. Consumption is modelled using a linear expenditure demand system (LES), which recognizes the prevalence of subsistence consumption among farm households in Ghana.

Government collects tax revenue in the form direct taxes on income and profits and indirect taxes on goods and services. It also provides government services and makes transfers to households. The difference between revenue and expenditure is government savings, which in Ghana was negative in the model base year, signifying a recurrent budget deficit (see Section 2.3). We select a government closure whereby a simulated increase in public expenditure will, ceteris paribus, lead to an increase in the deficit. Of course, we also assume that increased spending raises productivity in the economy, which will raise household and enterprise incomes and hence tax collections. The net effect on the deficit is therefore uncertain. At least one possible consequence of increased government debt is that it may crowd out private investments. However, with higher household and enterprise incomes we also expect an increase in private savings, which may counter such crowding-out effects. The external balance is maintained through a flexible exchange rate that adjusts to clear the capital account. We assume wages, land rental rates, and capital costs respond endogenously to ensure full employment of all factors of production

The model is solved over a ten-year period from 2015–2025. When analyzing the effects of alternative budget spending strategies, we distinguish between the short (2015-2020) and medium- to longer-run (2020-2025). Consistent with the budget closure, we exogenously increase public spending on a portfolio of agricultural investments such that the agricultural budget share stays constant in the baseline or is doubled by 2020 in scenarios assuming accelerated spending (i.e., from a base-level of 3.6% to 7.2%). The investment module described in the previous section determines the simulated changes in crop productivity levels, i.e., they are applied to the CGE model as exogenous shocks to determine the economywide effects.

Poverty estimates are obtained by linking a household-level microsimulation module to the CGE model following Arndt et al. (2012). Changes in real consumption spending observed at the representative household group level in the CGE model are passed down from the CGE model to household survey data (GSS, 2014) and the change in the poverty status of each household is recorded. We report poverty rates for rural and urban households, as well as at national level.

3.3 A social accounting matrix (SAM) for Ghana

For this study we calibrate the CGE model with the most recent official Social Accounting Matrix (SAM) for Ghana for the year 2015. The SAM was produced jointly by the GSS, the Institute of Statistical, Social and Economic Research (ISSER), and IFPRI (GSS, ISSER and IFPRI, 2017). The SAM is part of the Nexus Project, an IFPRI-led collaboration between international organizations, national statistical agencies and research institutions that aims to improve the quality of SAMs used for country-level CGE modeling by establishing common data standards, procedures and classification systems.

The 2015 Ghana SAM separates domestic production into 55 activities consistent with industry groups from the International Standard Industrial Classification (ISIC) system (Revision 4). National accounts data provide benchmark GDP estimates for 21 aggregated sectors, which are then further disaggregated using production and producer price data for crops and livestock, mining, and various manufacturing subsectors. Information on production technologies are obtained from the 2004 supply-use table (SUT) for Ghana. Activities and commodities have a one-to-one mapping. Once again, national accounts provide the benchmark GDP expenditure estimates for private and public consumption, investment demand, and exports and imports.

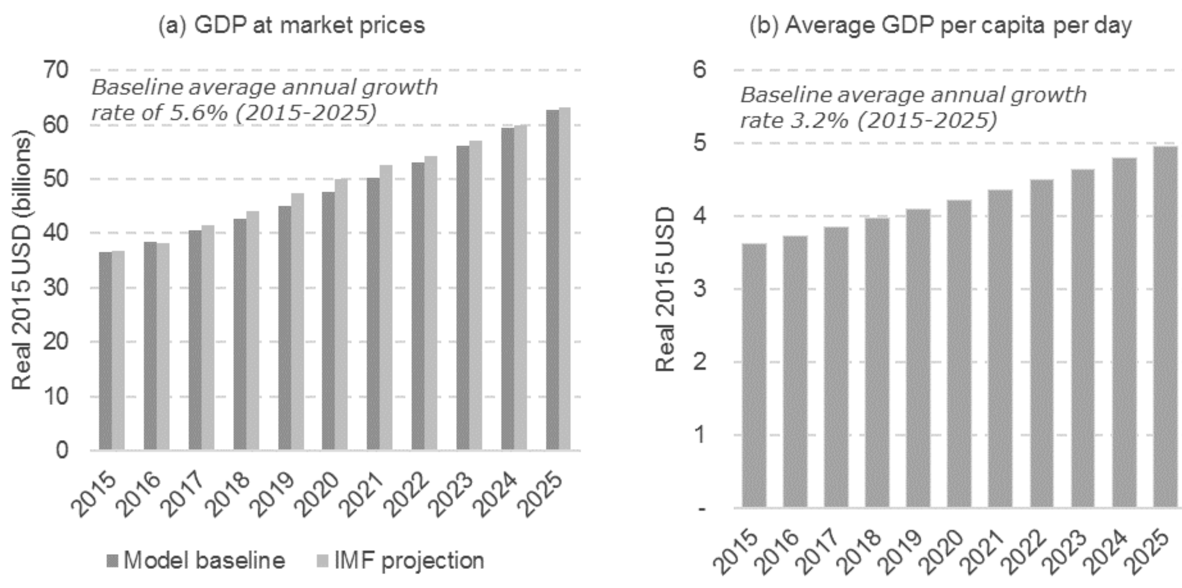
Factors of production include labor, land and capital, with labor further disaggregated across rural and urban areas and four education-based categories. SUT and household surveys provide information on aggregate sectoral value-added shares and their allocation across individual labor categories, respectively. The SAM also distinguishes capital stocks employed in crops, livestock, mining, and other subsectors. The SAM further includes 15 representative household groups, grouped into five expenditure quintiles and split into rural and urban households. Households consume either own-produced or marketed products, with income and expenditure patterns obtained from household survey data. Other domestic institutions include government and non-government enterprises. The data and a detailed technical is available on the GSS website.

4 RESULTS AND DISCUSSION

4.1 Construction of the model baseline

Standard practice in recursive-dynamic CGE modeling is to first create a baseline scenario to serve as the "business-as-usual" benchmark against which alternative development scenarios are evaluated. The baseline intends to depict the most plausible development trajectory of the economy under the existing set of policies and the assumption that growth, socioeconomic and public spending trends will continue along their historical paths. For our baseline we calibrate the CGE model to the GDP forecasts by the IMF (IMF, 2018) and population forecasts of the United Nations (2017). Figure 4.1 (panel a) compares the simulated GDP trend against the IMF forecast. As discussed in Section 2.1, GDP expanded at 4.8% during 2014–2017, and is expected to accelerate to 6.2% in near-term future (2018-2021). IMF forecasts are only available up to 2023, when the GDP growth rate is expected to slow down slightly to 5.1%. We calibrate our model to track that same level of growth also in 2024 and 2025.

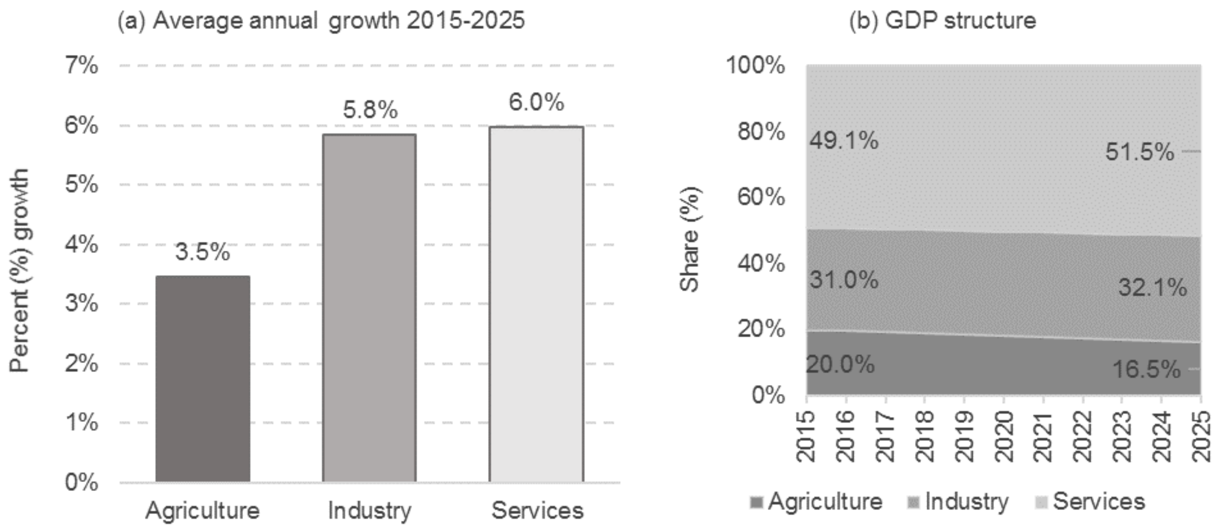
Figure 4.1. Baseline national GDP and GDP per capita per day (2015–2025)



Source: CGE model for Ghana and IMF (2018).

The simulated GDP growth rate averages 5.6% during 2015-2025. This is more than double the projected population growth of 2.3%, which results in a per capita GDP growth of 3.2% per year. As shown in Figure 4.1 (panel b) this equates to an increase in per capita GDP per day from US$ 3.60 to US$ 5.00 over the simulation period. Whether growth in average welfare translates into improved wellbeing for all Ghanaian households, and particularly the poor, depends on the structure of growth and how households across the income spectrum are linked to the real economy via product and factor markets. As discussed in Section 2.2, Ghana's recent growth experience has not been particularly pro-poor, especially for rural households. Consequently, we pay special attention to the structure of growth when calibrating the baseline. The baseline tracks historical sector-specific growth rates for agriculture, industry and services sectors (see Section 2.1), which, as shown in Figure 4.2 (panel a), implies simulated growth rates of 3.5%, 5.8% and 6.0% in these three sectors, respectively. This pattern of growth results in a continued decline in the share of agriculture in the economy, i.e., from 20.0% in 2015 to 16.5% by 2025 (panel b).

Figure 4.2. Baseline sectoral GDP and economic structure (2015–2025)

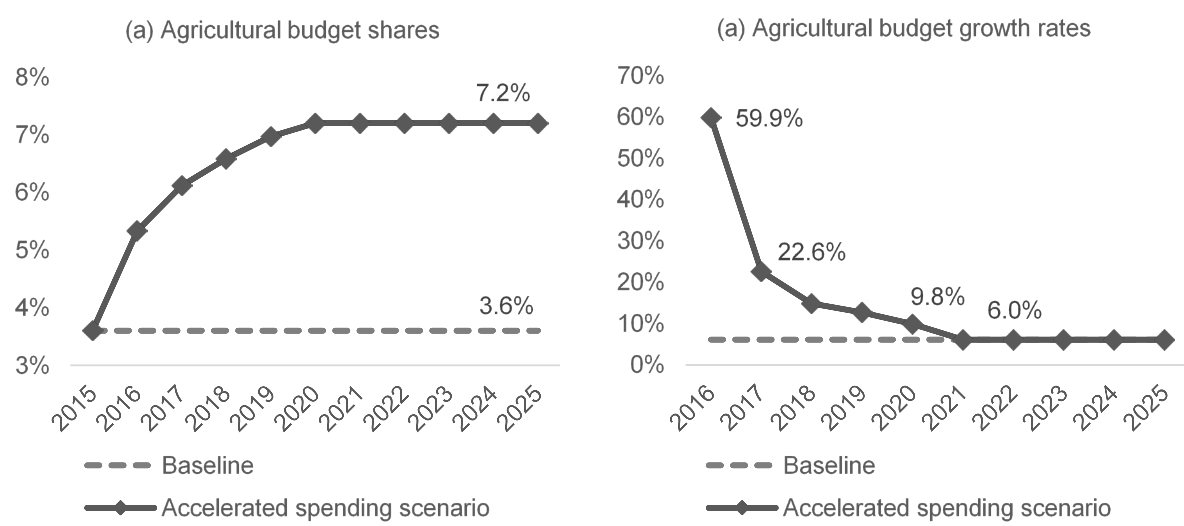


Source: CGE model for Ghana

4.2 Accelerated agricultural investment scenarios

The objective of the simulation exercise is to examine the impact of an increase in the agricultural budget share, defined as the share of agricultural-specific and agricultural-supportive expenditure, in the total government budget. Our own estimate of the agricultural budget share is 3.6% for 2015, which is within the range of estimates that have been reported for Ghana (see Section 2.4). The baseline scenario assumes that the agricultural budget share stays constant at 3.6% throughout 2015–2025. This is achieved by allowing both the agricultural budget and the non-agricultural budget to grow at a rate of 6% over the simulation period. As shown in Figure 4.4 further below, this equates to a growth in the baseline scenario agricultural budget from GH¢ 591 million in 2015 to GH¢ 1,062 million in 2025.

Figure 4.3. Simulated agricultural budget shares and budget spending growth rates (2015-2025)

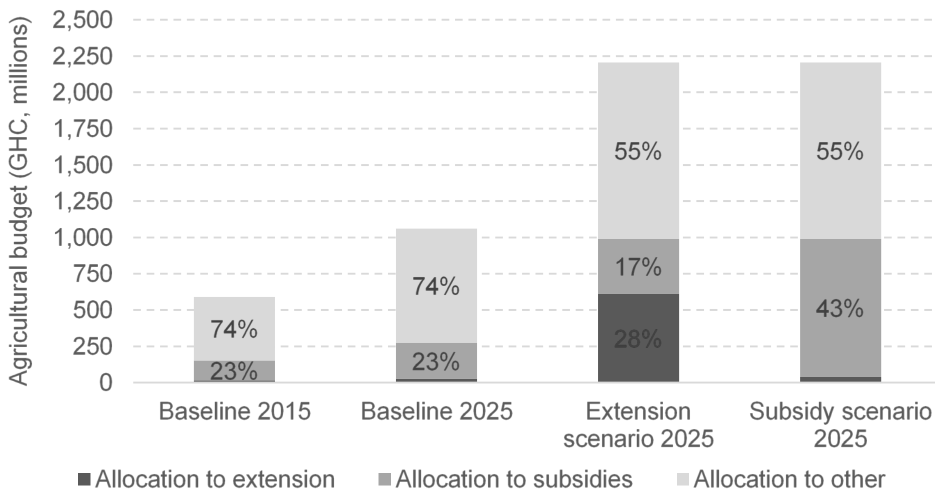


Source: CGE model for Ghana

Under the accelerated agricultural investment scenarios, we allow the agricultural budget share to increase to 7.2% by 2020, after which it stays at that level for the remainder of the simulation period (see Figure 4.3, panel a). Rather than reallocating the budget from non-agriculture to agriculture, the higher agricultural share is achieved by increasing the agricultural budget by the required amount, financed through higher government expenditure and flexible public saving rates. The non-agricultural budget growth rate is maintained at its baseline growth rate of 6% per annum. Also, we assume rapid growth in the agricultural budget in the early simulation years, with growth rates as high as 59.9% in 2016 and 22.6% in 2017. It levels off and stabilizes at 6.0% from 2021 onwards (panel b), i.e., once the target budget share is reached. In monetary terms, this means the agricultural budget reaches GH¢ 2,205 million by 2025, compared to GH¢ 1,062 million in the baseline (see Figure 4.4).

Apart from our interest in the impact of increased agricultural spending, we are also interested in understanding how the *composition* of spending shapes socioeconomic outcomes. We define several categories of expenditure, namely feeder roads, input subsidies, extension services, irrigation and other agricultural expenditure, consistent with the investment model introduced in Section 3.1. In the baseline scenario the agricultural budget share remains constant at 3.6%, while the composition of spending in the baseline is also kept relatively stable over time, resulting in a final allocation of public agricultural expenditure of 3% for extension services and 23% for input subsidies (see Figure 4.4). The remaining expenditure categories, including feeder roads, irrigation, and other infrastructural (grouped together here as “other” for simplicity reasons) attract 74% of funding.

Figure 4.4. Simulated agricultural budget composition under alternative scenarios (2015 and 2025)



Source: CGE model for Ghana

In the accelerated spending scenarios, the additional funding for agriculture is either oriented towards extension services or input subsidies. In the *extension scenario* we assume that half of the increase in the agricultural budget is allocated to extension services, while the other half is allocated to the other expenditure categories using baseline shares. Similarly, in the *subsidy scenario*, half of the increase in the agricultural budget is allocated to input subsidies. This results in significant shifts in the composition of the budget over the simulation period. Thus, in the extension scenario, the share of the agricultural budget allocated to extension reaches 28% in 2025, up from 3% in 2015, while in the subsidy scenario, the share of the agricultural budget allocated to input subsidies reaches 43% in 2025, up from 23% in 2015 (Figure 4.4).

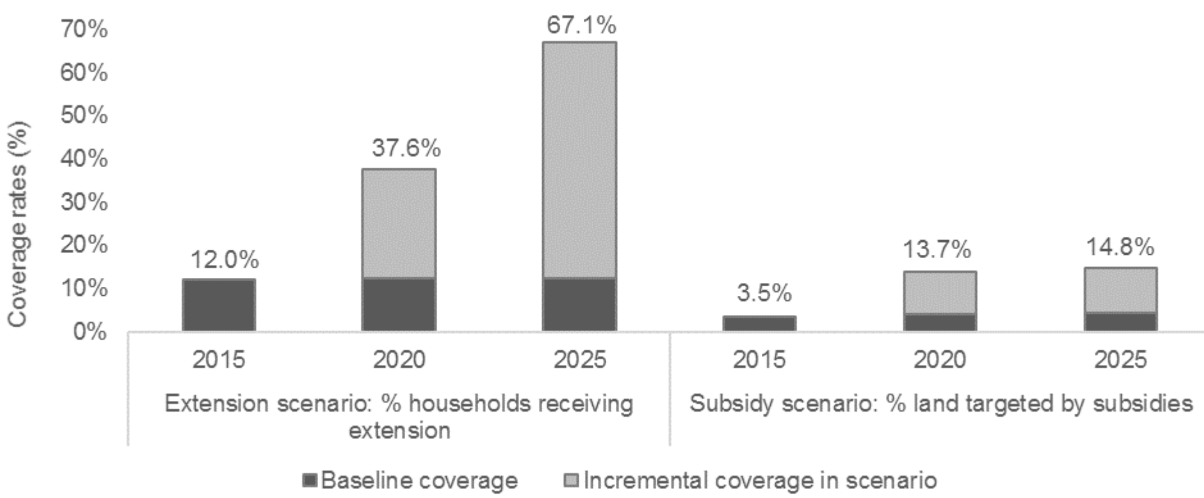
4.3 Results discussion

We organize the discussion of model results around four subtopics. We first consider the simulated impacts of increased spending under an extension-oriented or subsidy-oriented strategy on coverage (or access) rates for extension services and input subsidies. Expenditure trends and coverage rates of rural roads and irrigation are identical under both extension-oriented and subsidy-oriented scenarios since the proportion of the incremental budget allocated to them are unchanged across these two scenarios. We then present impacts at economic subsector level, focusing on the agricultural sector, followed by a brief discussion of key macroeconomic results. Finally, we consider the household-level income and poverty effects.

Coverage rates

The main purpose of the investment module introduced in Section 3.1 is to translate public agricultural expenditure into changes in agricultural productivity subject to the level and composition of spending across several expenditure categories. The coverage rate for extension services is the share of households that receive extension services, while for input subsidies it is defined as the share of cropland that benefits from input subsidies. Figure 4.5 summarizes the effects of increased spending on coverage rates under the extension and the subsidy scenarios. The dark sections of the bars show coverage rates in the baseline scenario in 2015, 2020 and 2025, while the lighter shaded sections show the *additional* coverage achieved with increased levels of spending in 2020 and 2025. Extension coverage in the baseline expands marginally from 12.0% in 2015 to 12.5% in 2025. In contrast, increased extension-oriented spending ensures that coverage rates are tripled in the first five years to reach 37.6% by 2020 and doubled in the next five years to reach 67.1% by 2025.

Figure 4.5. Changes in coverage rates: extension and subsidy scenarios (2015, 2020 and 2025)



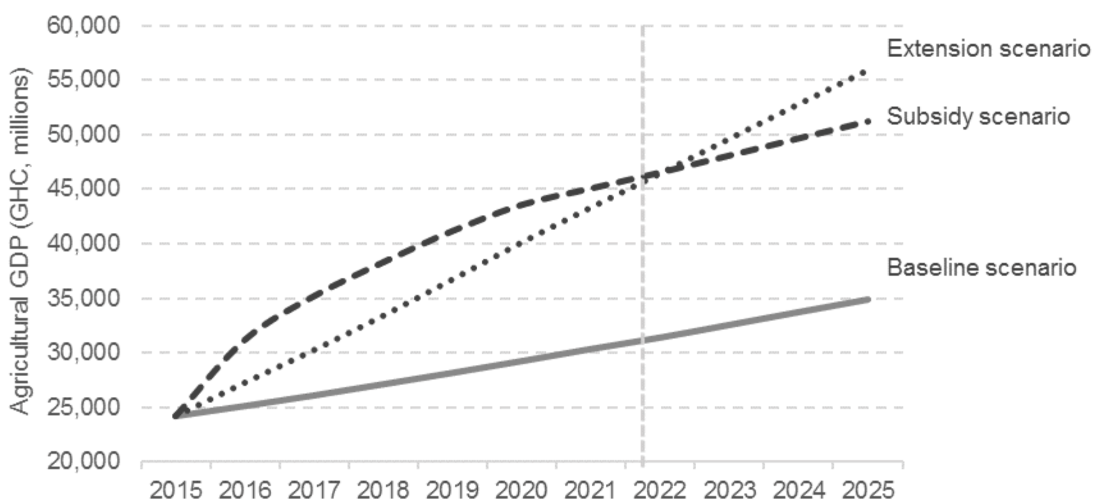
Source: CGE model for Ghana

Recall that the coverage rate for input subsidies is expressed as the share of cropland (not households) affected by input subsidies. Low fertilizer application rates in Ghana, estimated to be around 13.4 kilogram per hectare (Houssou, et al., 2017), and the fact that fertilizer is only applied intensively to some crops, explains the low apparent overall coverage rate (coverage rates expressed as a share of households will likely be higher). Under the baseline scenario, the subsidy coverage rate increases only marginally from 3.5% in 2015 to 4.3% in 2025. By contrast, under the accelerated spending scenario coverage increases rapidly to reach 13.7% by 2020. However, after that we see only a small further increase to 14.8% by 2025 as the subsidy rate slows down from 2020 onwards. Subsidy coverage rates therefore only increase rapidly during the initial rapid spending growth phase. Once budget growth slows down, a much larger share of the annual budget increase is used to continue financing subsidies for existing beneficiaries. By contrast, although spending on extension slows down, farmers already covered in the past retain part of the knowledge they accumulate, smoothly increasing extension coverage and sustaining the productivity effect. These observations are important for understanding the economic impacts under the alternative scenarios.

Sectoral output

Since our simulated policy interventions directly target the agricultural sector—and in some instances specific agricultural subsectors—we expect to see significant growth effects within agricultural subsectors. In the baseline, agricultural GDP grows at 3.5% per annum during 2015–2025, which is slightly higher than the anticipated (rural) population growth rate of 2.3% (see Table 4.1). Accelerated agricultural spending raises agricultural value-added GDP growth to 8.6% in the extension scenario and to 7.6% in the subsidy scenario over the period 2015–2025. Thus, for a given budget, extension outperforms input subsidies. However, this result depends on the timeframe of the analysis. As visually depicted in Figure 4.6, the subsidy scenario is associated with higher agricultural GDP levels (and average annual growth) compared to the extension scenario (12.4% versus 10.5%) during 2015–2020 when the agricultural budget expands rapidly. However, during 2020–2025, agricultural growth slows down significantly in the subsidy scenario when budget constraints prevent continued rapid expansion in the subsidy coverage rate, such that the extension scenario now outperforms the subsidy scenario with average growth rate of 6.7% compared to 3.1%. As the figure reveals, it is roughly in 2021 (or six years into the program) that outcomes under the extension-oriented scenario start yielding superior outcomes in terms of agricultural GDP levels.

Figure 4.6. Agricultural GDP levels (2015–2025)



Source: CGE model for Ghana

This result highlights an important sustainability challenge associated with subsidy programs. Output growth under subsidy programs is primarily associated with new beneficiaries being drawn into the program and moving from being low-yield producers using traditional inputs to high-yield producers using (subsidized) modern inputs. The hypothetical scenario modelled here assumes that budget constraints prevent continued rapid expansion of subsidy coverage, i.e., very few *new* beneficiaries can be added to the subsidy program each year when the budget is constrained. As long as the budget does not contract, existing beneficiaries will still receive the subsidy and will be able to maintain their crop yields, but existing beneficiaries will not be a source of output growth. Of course, if subsidy programs are effective at demonstrating to farmers the benefits of using modern inputs, some beneficiaries may be graduated from the program without the risk of their fertilizer application rates declining. The savings could then be used to enroll new beneficiaries on a rotating basis. In practice, however, this seldom happens; for example, in Tanzania only around one-third of input subsidy program beneficiaries continued to purchase fertilizer after graduating from the program there (World Bank, 2014).

As far as impacts at subsector-level are concerned (see Table 4.1), both the extension and subsidy scenarios are assumed to benefit a wide range of agricultural subsectors. As a result, we do not detect any significant differences in the *relative* subsector growth rates achieved under the extension and subsidy scenarios. Stronger agricultural growth has impacts on downstream sectors. Most significantly, compared to the baseline, average GDP growth in the agroprocessing sector accelerates by around two percentage points to 7.6% in the accelerated spending scenarios. This relates to the increased supply of lower-cost intermediate inputs from agricultural subsectors. Services sectors, which include the trade and transport sectors, expand marginally. The mining industry is negatively affected by the strong agricultural orientation in public spending. The overall effect on national GDP is positive: GDP at factor cost increases from 5.5% in the baseline to 6.5% in the extension scenario and 6.3% in the subsidy scenario.

Table 4.1. Sector-level effects: average annual real GDP (factor cost) growth rates (2015–2025)

	Baseline scenario				Accelerated spending: extension-oriented scenario				Accelerated spending: subsidy-oriented scenario			
	Initial GDP shares (%) 2015	Initial GDP level (GHC, millions) 2015	Average annual GDP growth, 2015-2025	Final GDP level (GHC, millions) 2025	Average annual GDP growth, 2015-2020	Average annual GDP growth, 2020-2025	Average annual GDP growth, 2015-2025	Final GDP level (GHC, millions) 2025	Average annual GDP growth, 2015-2020	Average annual GDP growth, 2020-2025	Average annual GDP growth, 2015-2025	Final GDP level (GHC, millions) 2025
Agriculture	20.0	24,178	3.5	34,081	10.5	6.7	8.6	55,011	12.4	3.1	7.6	50,436
Cereals	3.6	4,403	4.2	6,652	9.2	6.7	7.9	9,430	10.4	4.5	7.4	8,968
Roots & tubers	3.2	3,911	2.9	5,212	10.1	6.0	8.0	8,468	11.6	2.8	7.1	7,769
Pulses & oilseeds	1.5	1,830	4.3	2,794	10.0	8.5	9.3	4,439	11.3	6.7	9.0	4,324
Fruits & vegetables	5.1	6,231	3.3	8,613	15.8	7.9	11.8	18,958	19.3	1.5	10.0	16,231
Export crops	2.1	2,573	3.7	3,684	12.0	7.4	9.7	6,494	14.5	3.2	8.7	5,929
Livestock, for. & fishing	4.3	5,230	3.1	7,126	3.2	3.3	3.3	7,222	3.2	3.3	3.3	7,215
Industry	31.0	37,508	5.8	66,168	5.5	5.7	5.6	64,611	5.4	5.8	5.6	64,719
Mining	6.7	8,105	7.1	16,040	5.8	6.5	6.1	14,674	5.2	7.2	6.2	14,770
Manufacturing	5.5	6,658	5.9	11,793	6.0	6.5	6.2	12,183	6.0	6.6	6.3	12,235
Agroprocessing	*1.5*	*1,868*	*5.4*	*3,164*	*7.4*	*7.7*	*7.5*	*3,864*	*7.9*	*7.2*	*7.6*	*3,881*
Other manuf.	*4.0*	*4,790*	*6.1*	*8,628*	*5.4*	*5.9*	*5.7*	*8,319*	*5.2*	*6.2*	*5.7*	*8,354*
Other industry	18.8	22,745	5.4	38,336	5.2	5.2	5.2	37,755	5.3	5.1	5.2	37,714
Services	49.1	59,393	6.0	106,152	6.1	6.1	6.1	107,377	6.1	6.0	6.1	107,235
GDP at factor cost	**100.0**	**121,080**	**5.5**	**206,401**	**6.8**	**6.1**	**6.5**	**226,999**	**7.3**	**5.3**	**6.3**	**222,389**

Source: CGE model for Ghana

Macroeconomic results

Table 4.2 presents growth in real GDP at market prices and its various components. National GDP expands at an average rate of 5.6% in the baseline over the simulation period, with slightly lower growth in the first sub-period (2015–2020) than in the second (2015–2020). Structurally, growth in the GDP components are not markedly different in the two subperiods. We do, however, detect greater differences in the level and structure of growth in the two subperiods for the two accelerated growth scenarios. This relates to the more rapid growth in public agricultural expenditure in the first subperiod. Note that government consumption grows by 0.8 percentage points faster in the 2015-2020 period, both under the extension and subsidy scenarios, before matching the baseline growth rate reflecting a potential financial constraint the government could face even if it would remain committed to sustainably support agriculture.

Table 4.2. Macroeconomic effects: average annual real GDP growth rates (2015–2025)

	Baseline scenario			*Extension scenario*			*Subsidy scenario*		
	2015-2020	2020-2025	2015-2025	2015-2020	2020-2025	2015-2025	2015-2020	2020-2025	2015-2025
Domestic absorption	5.0	5.3	5.1	6.2	5.8	6.0	6.5	5.1	5.8
Private consumption (C)	4.7	5.3	5.0	6.6	6.1	6.4	7.1	5.0	6.1
Investment (I)	5.4	5.2	5.3	5.1	5.1	5.1	5.2	4.9	5.1
Government consumption (G)	6.0	6.0	6.0	6.8	6.0	6.4	6.8	6.0	6.4
Exports (X)	7.2	7.9	7.6	7.3	7.2	7.2	7.2	7.0	7.1
Imports (M)	5.8	6.8	6.3	5.9	6.1	6.0	5.8	6.0	5.9
GDP at market prices	5.5	5.7	5.6	6.7	6.2	6.4	7.1	5.4	6.3

Source: CGE model for Ghana

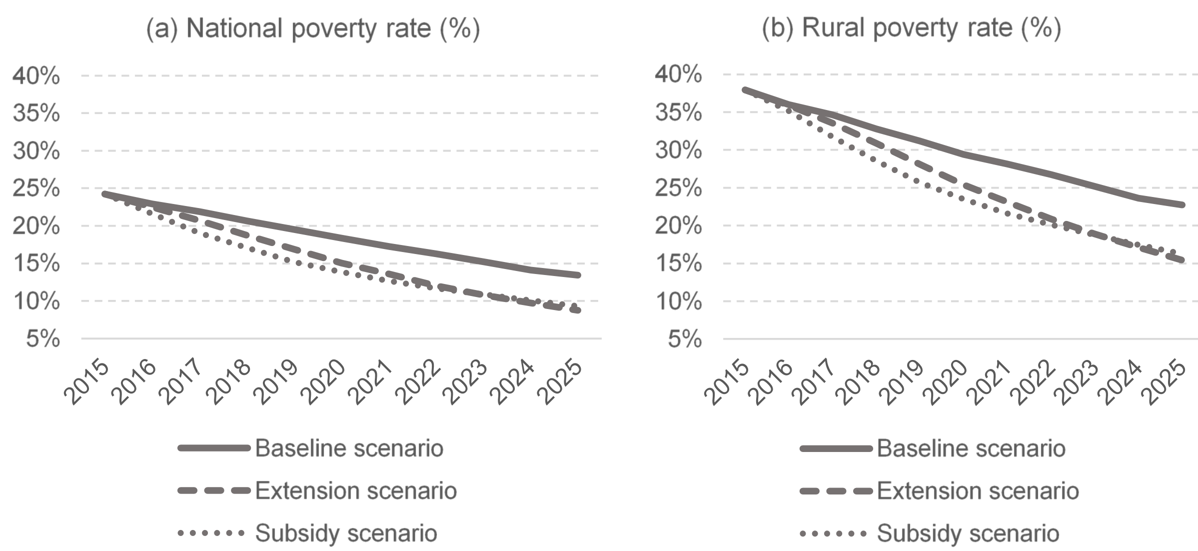
Domestic absorption, which is the sum of consumption expenditure, investment demand and government expenditure, provides a measure of aggregate domestic welfare. Here we notice slightly higher growth under the extension scenario (i.e., 6.0% compared to 5.8%), with the subsidy scenario yielding greater welfare benefits in the first subperiod and the extension scenarios in the second. Investment demand grows at roughly similar rates in the two accelerated growth scenarios. However, overall growth in investment is slightly lower than in the baseline since government saving declines as resources are diverted to finance increased government consumption consistent with the government closure adopted. The change in investment is smaller than that in government consumption since private savings increase modestly reducing the net effect on investments. This implies that the biggest driver of welfare differences between the subperiods and/or scenarios is the growth in private consumption, which is broadly indicative of household welfare effects, which we look more closely in the next subsection. International trade is impacted only slightly. A detailed discussion is beyond the scope of this analysis, suffice to say that a slight appreciation of the Ghanaian currency contributes to the marginal slowdown in export growth.

Household income and poverty

Table 4.3 presents changes in total household incomes (inclusive of factor returns and transfers), expressed in per capita terms. As direct beneficiaries of agricultural policies, rural farm households gain more from accelerated spending in agriculture than rural non-farm households, with income gains of 4.2% in the extension scenario and 4.0% in the subsidy scenario. Even greater income gains are enjoyed by poor rural households, who see their real incomes rise 4.5% and 4.2% in the extension and subsidy scenarios, respectively. This can be linked to the fact that food prices decline substantially due to increased agricultural productivity reinforcing the direct income effect as agriculture grows. In fact, prices of cereals, root crops and vegetables decline, on average, by 1.0% and 0.5% annually under the extension and subsidy scenarios, respectively. The urban poor also benefit as declining food prices transfer significant benefits to this group of households who spend a large share of their income on food. Out of all the subperiods, scenarios and household groups, the largest income gains are observed under the subsidy scenario in the shorter-term (2015–2020) for urban and rural poor households, who realize real income gains of up to 5.4% per annum. This best explains why input subsidy programs are politically popular, even though in the longer-term there might be concerns about their sustainability and these programs might be outperformed by those that prioritize more sustainable investments in agriculture.

The income results suggest that prioritization of agricultural interventions, in general, remain an effective measure in the fight against poverty, both in rural farm settings and poor urban settings. Figure 4.7 summarizes the key poverty results. In the baseline the simulated national poverty headcount rate declines from 24.2% in 2015 to 13.3% in 2025. Rural poverty also declines—albeit in relative terms not as rapidly—from 37.9% in 2015 to 22.8% in 2025. The relatively slower pace of rural poverty reduction can be linked to slower agricultural growth assumed for the baseline.

Figure 4.7. Poverty outcomes: national and rural poverty headcount rates (2015–2025)



Source: CGE model for Ghana

By contrast, in the accelerated spending scenarios, the rate of poverty reduction is significantly higher. By 2025 national poverty declines by more than half to reach 9.4% in the extension scenario or 10.0% in the subsidy scenario. The rate of poverty reduction is just as rapid among rural households, with rural poverty rates declining to 16.7% in the extension scenario and 17.8% in the subsidy scenario. To put these numbers in perspective, and within the context of the hypothetical scenarios presented here, Ghana may have an additional 1.3 million poor people by 2025 if it fails to follow through on its commitments to increase agricultural expenditure. Moreover, if government chooses to continue prioritizing input subsidies at the expense of extension services, it might reap political and socioeconomic benefits in the short term, but by 2025 this decision could imply an additional 230,000 people living in poverty.

Table 4.3. Household per capita income effects (2015–2025)

	Initial per capita income (2015)	Baseline scenario		Accelerated spending: Extension scenario				Accelerated spending: Subsidy scenario			
		Annual income growth, 2015-2025	Final income level (GHC) 2025	Annual income growth, 2015-2020	Annual income growth, 2020-2025	Annual income growth, 2015-2025	Final income level (GHC) 2025	Annual income growth, 2015-2020	Annual income growth, 2020-2025	Annual income growth, 2015-2025	Final income level (GHC) 2025
Rural households	2,485	2.8	3,276	3.8	4.1	4.0	3,662	4.5	3.1	3.8	3,596
Farm households	2,296	2.9	3,055	4.1	4.4	4.2	3,481	4.9	3.1	4.0	3,404
Quintile 1-2 ("poor")	*1,576*	*3.0*	*2,118*	*4.2*	*4.7*	*4.5*	*2,437*	*5.2*	*3.2*	*4.2*	*2,383*
Quintile 3-5 ("non-poor")	*2,930*	*2.8*	*3,881*	*4.0*	*4.3*	*4.2*	*4,401*	*4.8*	*3.0*	*3.9*	*4,304*
Non-farm households	2,994	2.6	3,871	3.2	3.4	3.3	4,148	3.4	3.1	3.2	4,112
Quintile 1-2 ("poor")	*1,392*	*2.7*	*1,810*	*2.7*	*3.6*	*3.1*	*1,893*	*2.9*	*3.4*	*3.1*	*1,896*
Quintile 3-5 ("non-poor")	*4,144*	*2.6*	*5,350*	*3.3*	*3.4*	*3.4*	*5,767*	*3.5*	*3.0*	*3.2*	*5,702*
Urban households	6,313	2.6	8,127	3.7	3.3	3.5	8,906	3.9	2.7	3.3	8,723
Quintile 1-2 ("poor")	*2,974*	*3.1*	*4,043*	*4.8*	*4.3*	*4.6*	*4,650*	*5.4*	*3.1*	*4.2*	*4,506*
Quintile 3-5 ("non-poor")	*6,920*	*2.5*	*8,869*	*3.6*	*3.3*	*3.4*	*9,679*	*3.8*	*2.6*	*3.2*	*9,489*
All households	**4,404**	**2.6**	**5,707**	**3.7**	**3.6**	**3.6**	**6,290**	**4.1**	**2.8**	**3.4**	**6,165**

Source: CGE model for Ghana

5 CONCLUSIONS AND POLICY RECOMMENDATIONS

This study examines how changes in the level and composition of public agricultural expenditure can affect socioeconomic outcomes in the short and medium term. The analysis is done in the context of Ghana, a lower-middle income country that has experienced robust economic growth over the past decade and is set to be one of the star performers globally this year as far as economic growth is concerned. However, Ghana has also faced several challenges. With its relatively undiversified economy, it has been vulnerable to global commodity market swings; it has faced trouble keeping inflation and interest rates at bay, in part because of excessive government debt used to finance recurrent rather than capital expenditure; and growth in its agricultural sector has lagged that in the rest of the economy, contributing to the recent increase in rural-urban inequality and rural poverty.

In recognition of these challenges the government of Ghana has identified agricultural development as the backbone of its development strategy, with substantial financial commitments to large programs such as the Planting for Food and Jobs (PFJ) initiative and the Infrastructure for Poverty Eradication Program (IPEP). While on paper these programs are designed to be broad-based and provide an extensive range of agricultural services or address infrastructural deficits, concerns remain about both the low budgetary allocation to agriculture in general and the quality of that spending. Ghana's agricultural budget share remains far below the 10% target to which African Union (AU) member states have committed, while agricultural budgetary allocations are heavily biased in favor of routine operating expenses and fertilizer subsidies at the expense of spending on agricultural research and knowledge transfer activities that tend to yield more sustainable benefits in the long run.

Against this background we examine the potential impact of both an increase in public agricultural expenditure as well as changes in the composition of agricultural spending in Ghana. We calibrate a recursive-dynamic Computable General Equilibrium (CGE) customized for rural investment and policy analysis to a 2015 Social Accounting Matrix (SAM) for Ghana. A novel feature of the model is the use of an investment module which translates public agricultural expenditure into agricultural productivity changes at subsector level. The model is calibrated using a combination of program evaluation data and information on government service delivery and project costs. In addition to a baseline scenario, which assumes a "business-as-usual" development trajectory under the existing set of policies and spending patterns, we define two hypothetical accelerated agricultural spending scenarios: an extension services-oriented scenario which prioritizes spending on extension services and leads to a five-fold increase in the share of households receiving extension services over the simulation period (2015–2025); and an input subsidy-oriented scenario which leads to a four-fold increase in the cropped area that benefits from the supply of subsidized farm inputs.

The simulations involve an exogenous increase in the budget allocation to agriculture such that the agricultural budget share doubles from 3.6% in 2015 to 7.2% by 2020 and is maintained at that level thereafter until the end of the simulation period in 2025. We therefore model a situation where, in the short run, agricultural spending increases rapidly, but in the medium- to longer-term budget constraints come into play and agricultural expenditure only grows at the same pace as non-agricultural spending. Apart from the direct effects on agricultural productivity and growth, the economywide model captures indirect production effects via inter-industry linkages and household welfare effects via product and factor markets. It is important to note that the simulated scenarios do not attempt to replicate actual programming; hence, results are not meant to be accurate forecasts, but are merely indicative of possible outcomes under a range of plausible scenarios and assumptions.

The results reveal that in the shorter-term (2015-2020), a subsidy-oriented spending program results in an average annual agricultural GDP growth of 12.4% and an average annual rural farm household income growth of 4.9%. Welfare benefits are also transferred to rural non-farm and urban households, mainly via factor and product markets (i.e., higher wages and lower prices), with recorded income gains of 3.4% and

3.9% respectively for these household groups. By contrast, the extension-oriented scenario leads to an average annual agricultural GDP growth of 10.5% and an average annual rural farm household income growth of 4.1%. The results are reversed in the longer-term (2020–2025). Now the extension scenario records higher average annual agricultural GDP growth than the subsidy scenario (i.e., 6.7% vs. 3.1%), while farm household income growth is also higher (i.e., 4.4% vs. 3.1%). The much stronger relative performance of the extension scenario in the latter period means the extension scenario also outperforms the subsidy scenario over the whole simulation period.

These results highlight a typical sustainability challenge of subsidy programs. Output growth under smallholder input subsidy programs is primarily associated with new beneficiaries being brought into the program and moving them from being low-yield producers using traditional inputs to high-yield producers using (subsidized) modern inputs. When budget constraints prevent continued expansion of subsidy coverage—a situation that is extremely likely to eventually occur—existing beneficiaries will be able to maintain high crop yields through continued access to modern inputs, but there will be no further *growth* in their yields or output, and no further growth originating from the conversion of low-yield farmers into high-yield farmers to expansion of the coverage rate.

The important difference between the subsidy scenario and the extension scenario is that under the latter we assume that it is an investment that builds human capital over time. Thus, even with constrained agricultural budget, available funds can still be used to maintain the skill levels of covered farmers at a reduced cost, while at the same time expanding service coverage. For this reason, investments in human capital are considered more sustainable than expenditures on input subsidies. While our study focused on extension, the principles are similar for other forms of investment such as infrastructure or research and development.

These results do not suggest that subsidy programs should be abandoned; on the contrary, there are many strong arguments in their favor. For one, they represent a useful tool for quickly raising yields and boosting growth, especially in settings where input use is low, and households are resource-constrained. However, there should be more emphasis on increasing the sustainability of these programs. For example, returns to investments in fertilizer subsidies can be raised through complementary support to farmers to raise fertilizer use efficiency (e.g., extension services focused on improving soil fertility, or policies to promote modern seed to be used in conjunction with fertilizer); or more can be done to ensure that farmers continue using fertilizer even when they graduate from subsidy programs. Subsidy programs should also not come at the expense of other important investments, such as in extension, research and development, or rural infrastructure, all of which tend to provide more sustainable returns in the longer term. The ideal is therefore to have a more balanced public investment portfolio.

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1201 Eye Street, NW
Washington, DC 20005 USA
Tel.: +1-202-862-5600
Fax: +1-202-862-5606
Email: ifpri@cgiar.org