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African Journal of Agricultural Research

Full Length Research Paper

Agriculture in sub-Sahara Africa developing countries and the role of government: Economic perspectives

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Recent agricultural and economic growth has been impressive in sub Saharan Africa (SSA), and explained in part by decades of donor investments. Sustaining recent progress will hence require a fundamental reshaping of SSA host country government policy priorities, which traditionally underinvest in agricultural research. This article investigates country-specific factors that explain government's tendencies towards policy bias across three important policy dimensions: cash versus food crops, imports versus exports, and agriculture versus non-agriculture sectors. Policy bias was measured using rates of assistance indices across the three policy dimensions based on panel data, from 26 years (1955-2011) and across 26 SSA countries. Results indicate that overall policy orientation of SSA governments are biased against agriculture, but within the specific policy dimensions there was a significant bias towards cash over food crops and exports over imports. The result also shows the level of government assistance in resource rich countries decreased as rural population share increased above 57%.

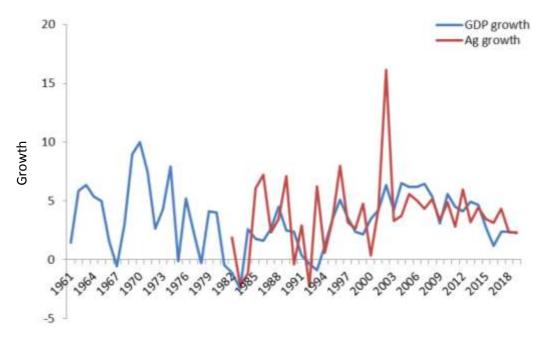**Key words:** Agriculture assistance, sub Saharan Africa, policy bias, trade bias index.

INTRODUCTION

Recent agricultural and economic growth has been impressive in sub Saharan Africa (SSA) (FAO, 2016). Many SSA countries have experienced rapid economic growth over the last decade (Robin, 2011; World Bank 2013, 2017; Shimeles et al., 2018). On average, SSA GDP growth rate averaged 5.0% from 2004 to 2013 and outpaced prior economic performance over previous decades. Overall SSA economic growth was higher than global economic growth during the same period. African agricultural growth increased steadily from averages of

2.4 and 2.7% in the 1980 and 1990's to 3.3% since 2000, exceeding economic growth throughout most of the period (Figure 1).

The recent agricultural growth in SSA's economic growth cannot be sustained without corresponding agricultural growth and poverty reduction in rural areas. The view of agriculture as the main economic engine in developing countries has been well established in the development literature (Ranis and Fei, 1961; Gardner, 2005; Pingali, 2007; Self and Grabowski, 2007; Pandey

Figure 1. Sub Saharan African countries' GDP and Agricultural Growth Rate during 1961-2020.
Source: World Bank 2020.

and Kumari, 2021; Seok and Moon, 2021; Ligon and Sadoulet, 2018; Dorosh and Thurlow, 2018; Mogues et al., 2012). Agriculture's catalyst in economic development is particularly effective in SSA where large rural populations of smallholder farms persist and development is in its infancy (Schultz, 1964; Rosegrant and Hazell, 2000). Agricultural-led growth has been more effective in reducing poverty as shown by case studies in Ethiopia, Ghana, Rwanda, Uganda, and Zambia (Mellor et al., 2001; Diao et al., 2007; Christiaensen et al., 2010; DenJanvry and Sadoulet, 2010; Mogues et al., 2012; Maruyma et al., 2018; Ligon and Sadoulet, 2018; Dorosh and Thurlow, 2018; Bekun and Akadiri, 2019). Other research has documented its positive effect on rural economies though multiplier effects (Haggblade et al., 1991), achieving shared growth (Ravallion and Chen, 2003; Kraay, 2006), and as a supplier of raw materials and other input in non-agricultural sectors (Johnston and Mellor, 1961).

Other encouraging trends include the potential for African agriculture to feed its fast growing population (Van Ittersum et al., 2016; Elrys et al., 2020). The critical role of agricultural development in response to population pressure was put forth in the seminal work of Boserup (1965), where technological change is argued to have the capacity to overcome constraints on land and labor, sufficient to feed growing populations. Over the past decade, African agricultural growth has, on average, increased faster than its population as development has more successfully enabled producers to better utilize natural resources, particularly water available throughout SSA (FAO, 2016). Nigeria, for example, is moving closer towards once again being a net exporter of agricultural commodities (Robin, 2011; IMF, 2017). Recent studies provide cautious optimism that SSA can introduce rapid technological change, e.g. through a shift towards intensification including improved crop varieties and greater use of fertilizers, and satisfy growing food needs over the next few decades (Circa, 2050) without substantial increases in current import levels (Seck et al., 2016; Van Ittersum et al., 2016; Fan, 2020).

African growth in agriculture is explained in part by donor investments over the past couple of decades (Lowder, 2012; Pernechele et al., 2021). Stakeholders have forged a renewed commitment to invest in African agricultural sectors, including governments, non-governmental organizations (NGO) and the private sector (Franklin and Oehmke, 2019; Mangeni, 2019). Their general goal is to transform agriculture from a development challenge, mired in traditional farming, to a technologically and innovative based engine driving economic growth, while alleviating poverty, hunger, and food imports (Lowder, 2012; UN, 2012; Shimeles et al., 2018; Sakho-Jimbira and Hathie, 2020). Such aspirational goals envision an African Green Revolution, fostering new levels of productivity coupled with an emerging view of agriculture as a leading driver of economic growth rather than as a lagging, backwards sector (Quiñones et al., 1997; World Bank, 2007; Martin-Guay et al., 2018; Ariga et al., 2019; Clay and Zimmerer, 2020). Most private sector investment is foreign direct investment, such as China, as well as other developed countries which have invested in SSA for financial returns rather than political or philanthropic motives (Awadhi et al.,

2022; Verkhovets and Karaoğuz, 2022). FDI reached 32 billion US dollars across SSA in 2019 with even larger investments of 46 billion US dollars in 2020 (UNCTAD, 2021).

Promoting and investing in agriculture will require a fundamental reshaping of SSA host country government priorities which undervalue and underinvest in agricultural research (Fan and Breisinger, 2011). Donor investment has continued to be necessary to fill in the gaps left by inadequate support for agriculture provided by SSA governments (Pernechele et al., 2021). Even when compared with developing countries in other parts of the world, SSA governments' investment in agriculture, in terms of budgetary outlays, is small. Over the past few decades (1980-2005), African spending on agriculture represented 6 to 7% of total national budgets, while in Asia allocations were twice as large, ranging between 6 and 15% (IFPRI, 2009). During the more recent upturn in economic and agricultural output (2004-2018), SSA funding for food agriculture increased in many countries, averaging 6% of national government budgetary expenditures, but to continue to fall short of benchmarks established for example by the 10% goal of Maputo convention (Pernechele et al., 2021). Investment gaps have typically been filled by international donors but after decades of investments with disappointing returns "donor fatigue" has become a reality (Gossel, 2018). Misuse and misappropriation of donor funding is substantial, including large proportions of donor funding that remains unspent, averaging 42% according to Pernechele et al. (2021). Although SSA governments have been more responsive to investing in agriculture, many maintain a bias against agriculture, even where development has proceeded rapidly. Ghana, for example, has had a downward trend in publically funded agricultural investments over the recent past despite experiencing some of the most dramatic economic progress throughout SSA (Pernechele et al., 2021).

Political concerns and the concentration of wealth into elite factions are powerful incentives that are likely to continue to draw governments away from adequately investing in agriculture. Studies have found that SSA governments not only underinvest in agriculture, but often discriminate against agriculture and rural populations. Research on the interaction between government policy and its corresponding effects on the structure and performance of the agricultural sector is well documented. In investigations toward what causes some nations to prosper while others fail, Ehui and Okike (2008) conclude that in general, government is primarily responsible for positioning agriculture into its optimal role in the development agenda. Most researchers argue that political institutions largely determine the level of governmental support and assistance to agriculture, including to smallholder farmers (Olson, 1971; Ehuli and Okike, 2008; Bates, 2007; Bates and Block, 2009). Their argument is based on the logic of Olson's (1971)

collective action which suggests that: "compared to small groups, large groups will face high costs when trying to organize and therefore the incentive for group action diminishes as group size increases in a sense that large groups are less capable of acting in their common interest than small groups". In their investigation of political economy of agricultural trade protection in SSA, Bates (2007) and Bates and Block (2009) argue that there is a tendency for governments in countries with sizeable farming populations, and where agriculture is the primary economic activity, to enact policies biased against agriculture. Governments in countries so structured tend to impose heavy implicit taxes on agriculture, often directly on producers at the farm-gate. Bates (2007) and Bates and Block (2009) conclude that government policies, and bias toward agriculture, will tend to increase in proportion to "the rural dwellers share of population". Other factors can mitigate the rural population effect, including the nature of the political party system and extent of democracy within its corresponding institutional and governing frameworks.

After critically reviewing foreign development assistance projects to Africa (1995-2004), Acemoglu and Robinson (2012) also argue that institutions play the most influential role in successful agriculture development and leading a country out of poverty by paving road towards prosperity. They identify institutions along a continuum from politically extractive to economically inclusive, with the former relying on farm taxation rather than agriculture development to finance government and generate economic growth at the national level. Inclusive economic institutions are more conducive to economic growth than extractive political ones by enforcing property rights, creating a level economic playing field between rural and urban sectors, and encouraging investments in new technology and skills (Acemoglu and Robinson, 2012).

A substantial proportion of smallholder farmers in SSA remain trapped in poverty without access to financing and other tools to increase their productivity and profitability despite recent gains in agricultural and economic development (Robin, 2011). Binswanger-Mkhize and McCalla (2009) and Nwachukwu and Ezeh (2007) both cite over 70% of Africa's poor people live in rural areas and depend on agriculture for a large share of their income and according to the World Bank (2010), 48% of Africa's population lives in extreme poverty, on $1.25 a day. Collectively, smallholders represent the most important force in SSA agriculture, responsible for 90% of agricultural production. Rural infrastructure continues to be poorly developed making it difficult for agricultural producers to access more lucrative urban and international markets. Therefore, it is necessary to implement comprehensive economic and social development programs targeting poverty alleviation in rural areas by enabling producers with the inputs, technology, and knowledge they require to increase farm productivity. Such programs are particularly important

since a substantial proportion of national assets are in rural areas in addition to agricultural land including natural and mineral resources (Nwachukwe et al., 2007; World Bank, 2010).

Trade policy, including establishing exchange rates and tariff levels, also plays a determining role in whether agriculture is being taxed or subsidized by government policy. African countries have tended to adopt policies that favor the interests of urban areas, such as cheap food policies, that target poverty by reducing food expenditures among the urban poor who typically spend a large portion of their income on food (Bates and Bock, 2009). Urban populations are by design much more spatially concentrated than rural communities and in the African context are typically less populated. Urban consumers thus hold a relative advantage as political lobbyists in countries with a large rural agricultural population (Bates and Block, 2009). African agricultural production is for the most part dependent on smallholder producers whose political influence is often difficult to mobilize (Bates and Bock, 2009). Alternatively, governments have tended to tax agricultural exports, e.g., "cash crops" such cotton. Taxing exports can often generate substantial government revenue, and when properly implemented, can be an important engine of economic growth, e.g. export of Kenyan horticulture to European markets, fish and seafood in Chile, etc. (Schurman, 1996; Barrett et al., 1999). Concerns arise, however, when taxation is excessive and revenue is improperly utilized, e.g. cotton in West Africa (Bassett, 1996; Delpeuch, 2009). Consequently, in countries with large farm populations, agriculture remains a less effective political group compared to competing interests from urban elites as reflected in policy that subsidizes urban groups while extracting from rural areas (Bates and Block, 2009).

The mining and extraction of natural resources has also been identified as an influential factor on agricultural policy. Countries heavily dependent on exports are likely to suffer from the resource curse paradox whereby countries become dependent on a single commodity "monoculture" such as oil that crowds out other sectors such as service and manufacturing (Gokmenoglu et al., 2016; Sertoglu et al., 2017). Efforts to explain the paradox are numerous as discussed in Gokmenoglu et al. (2016) including inadequate investment (Atkinson and Hamilton, 2003), poor development of human capital (Bravo-Ortega and De Gregorio, 2005), weak institutions and the inability to make efficient use of natural resources (Leite and Weidmann, 1999; Sarr et al., 2011; Wright et al., 1999; Wright and Czclusta, 2004), and overall poor governance including corruption, political instability, and risk of internal strife (Judge et al., 2011; Tornell and Lane, 1998; Collier and Hoeffler, 2005). Bourguignon and Verdier (2000) similarly argue that governments of resource rich countries tend to exhibit less support for agriculture since the mining and extraction of natural resources concentrates political and economic power into elite factions. Such concentration inhibits the distribution of political power towards the middle and lower classes, typically in rural areas, and thwarts adoption of broader growth-promoting policies. Export driven economies are also highly prone to price volatility, particularly the co-integration of agricultural and oil prices that leave lower income households food insecure during periods of oil shocks (Sertoglu et al., 2017; Gokmenoglu et al., 2021). Isham et al. (2003) add that resource wealth worsens the quality of institutions because it allows governments to avoid accountability and resist modernization. Bates and Block (2009) and Bates and Block (2011) counter, however, that governments of resource rich countries tend to enact policies that favor producers of both food and cash crops. They argue that governments of resource rich countries, specifically in Africa, have tended to protect staple food crops by raising the level of domestic prices above those prevailing in world markets while taxing cash crops (Bates and Block, 2009).

Economic growth and development can also influence agricultural policy. Bates et al. (2013) discovered that political reform in Africa increased economic growth, as measured by GDP, and was also strongly related to the change of total factor productivity at the micro level. Anderson and Bruckner (2012) found that changes in agricultural prices and support programs negatively affected SSA real GDP per capita during the period 1960-2005. Geography and location have also been identified as factors influencing agricultural policy. Ndulu et al. (2007) argue that landlocked countries are more likely to provide favorable policy towards agriculture, e.g., through trade policy, than coastal countries. Using arable land share as a proxy for the overall importance of agriculture to a country's agriculture, Bates and Block (2009) show that protecting staple food crops has had a positive effect on agricultural policy and outcomes.

Drawing from the examples of the Asian Green Revolution, strong government support and interventions, through the development and introduction of new technology and investments in infrastructure, were crucial in ensuring the modernization of agriculture and rural farm poverty alleviation in Asia (Diao et al., 2007). The purpose of this article is hence to investigate whether SSA countries have provided necessary support for agriculture, including during recent periods of economic growth and agriculture development, or alternatively have maintained biased policies towards agriculture. Specifically, this paper explains patterns of government assistance to farmers across 20 SSA countries, considering empirical factors such as rural/urban population share, real GDP per capita, arable land share, natural resource endowment, arable land share, and location. Results and findings enable the following policy questions to be addressed: (1) Was SSA government support for agriculture affected by the recent spurt in economic development? (2) Do SSA governments

become more inclined to support rural population as development occurs in agriculture and rural population declines? (3) Is government support influenced by farmers producing either cash or food crops? (4) Does agricultural support vary depending on the rural/urban share of the population? (5) Has African support for agriculture remained too low, and could further growth be possible with more appropriate levels of support for agriculture?

This article contributes to the literature by identifying factors affecting the type and nature of government assistance. Many studies were limited in their scope to one or two indices of government assistance measures (Bates and Blocks, 2011). Others provided only indices without rigorously identifying which factors significantly affected government assistance to farmers (Anderson and Valenzuela, 2013). This study employed panel data over an extended time period, across a wide range of SSA countries, and a comprehensive set of explanatory variables providing a more comprehensive understanding of government assistance to agriculture.

THEORY AND HYPOTHESES

This paper focuses on the role SSA governments can play in aspiring to transform subsistence agriculture to a more productive, and profitable, technologically based agriculture. To empirically assess government's role in agricultural policy, a range of price support indices are correlated to measures of SSA agricultural development, e.g., smallholder farm welfare, to identify the nature of government food and trade policy and assistance to the rural sector. Price support to agriculture can be either supportive or extractive and can take several forms. Often, price support mechanisms are manifested as part of broader political and economic policy measures and can be difficult to decipher. A common agricultural subsidy is direct input distribution, that is, subsidies. Such government backed market interventions have targeted market imperfections, e.g. missing credit markets, through subsidies that help cash-constrained farmers find solutions to better manage risk, ease liquidity constraints, and strengthen supply chains (Rapsomanikis, 2009). Such "market-smart" subsidies tend to better facilitate linkages to private markets by stimulating product demand through improved quality and more attention to consumer preferences and by encouraging new market entrants, including smallholder farmers (Banful, 2010).

Government interventions into markets, and related policy measures, alter supply and demand channels and typically distort agricultural prices. The following provides an economic framework of the mechanisms SSA countries have often used in taxing exportable goods, e.g. cotton, cocoa, and coffee. In the cotton market equilibrium framework, D is the global cotton demand and under the small country assumption demand is highly elastic, that is, the supply from a single country has only a minimal effect on price (Figure 2). The supply curve S is the domestic supply generated by the aggregate production of the country's cotton producers. Governments have monopsony control over the purchase of cotton and are the sole exporters of cotton to world markets. Without market interventions, producers supply quantity Q at price P with a total economic surplus given by the combined area of the triangles = A + B + C (Figure 2).

Let a government decide to tax cotton to generate revenue with a unit tax of t implemented by a fixed pricing scheme in which the government retains monopsony control on the purchase of cotton

from producers (Figure 2). Under this type of monopsony, the tax t is deducted from producer's revenue when cotton is purchased by the government, resulting in an added cost to producers. Cotton supply thus shifts upwardly by the amount t shifting market equilibrium from point E to E_1 (Figure 2). Establishing this new equilibrium increases cotton price from P to P_1 and decreases market supply from Q to Q_1 (Figure 2). Governments capture a tax-rent equal to area A, the rectangle $P_1E_2P_2E_2$ (Figure 2). The rent is calculated as $t \times Q_1$, that is, the tax rate multiplied by the quantity supplied following the tax (Figure 2). The overall effect of the tax is negative, however, on both consumers and producers. Consumer surplus is reduced by the area B, due to both a loss in quantity purchased, $Q-Q_1$, as well as the increased cotton price, P_1-P (Figure 2). Likewise producer surplus is reduced by the area C, due to producers receiving a lower price for their cotton, $P-P_2$, and having a reduced marketed quantity sold, $Q-Q_1$ (Figure 2). To counteract the tax's negative effects on supply, governments typically simultaneously provide subsidies on input markets such as fertilizer, seed, chemicals, etc. Subsidies shift the supply curve downward and to the right, reducing somewhat the negative effects of the tax (Varian, 2010). Studies have found, however, that subsidies only partially redistribute gains back to consumers and producers (studies form my cotton papers).

Procedure

Government interventions often have complicated effects on markets, affecting both consumers and producers and often in confounding ways, which makes it difficult to isolate their net effect (Lerner, 1936; Baliño et al., 2019). A government imposed tax on cotton, for example, results in farmers receiving a lower cotton price while consumers pay a correspondingly higher price for cotton based goods. One practical approach to measure government's effect of policy actions on market outcomes, that is, potential distortion and bias, is to compare prices with and without agricultural market policy interventions using nominal rate of government protection (NRP) concepts (Balassa, 1965; Bhagwati, 1971; Corden, 1971, 1997; Harberger, 1971; Anderson et al., 2008). NRP compares commodity prices received by the producer at the farm-gate to a basis price, typically a global price. This calculation requires determining the transportation and other transaction costs incurred from shipping goods from the farm gate to port of embarkation, including freight on board (FOB) costs. If NRP is positive, then agricultural policy maintains a positive bias on that commodity, incentivizing producers to expand output. Negative values of NRP work in the opposite direction, creating a policy bias against the commodity, discouraging producers to reach economically efficient output levels, resulting in reduced output. In practical terms, negative NRP act as an implicit tax on the commodity, reducing producer's profit, and hampering development efforts. NRP is greatly influenced by trade policy, that is, export oriented policy will create mechanisms to artificially raise producer price resulting in positive NRP values. Where government support outside of establishing pricing mechanisms and structures is minimal, and farm-gate prices are the main revenue signal perceived by producers when developing production plans, NRP is an adequate means for measuring incentives and disincentives from policy initiatives.

In the more general setting, however, producers base their production planning on a more complex nexus of incentives and disincentives, including direct and indirect subsidies, direct payments, taxes, tariffs, fees established by environmental, safety, and phytosanitary protocols, ecosystem payments, and agricultural R&D investments (Baliño et al., 2019). To incorporate a more complete set of incentives, the NRA (nominal rate of assistance) measure was developed. NRA hence reaches beyond farm-gate prices to include the entire nexus of incentives and disincentives
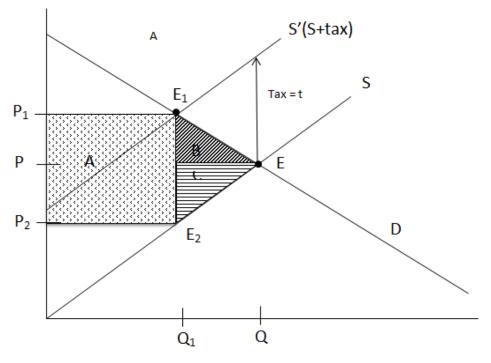
Figure 2. Effect of tax on cotton market supply and demand.
Source: Authors' Report

paid and received, creating a more complete and accurate measure of agricultural policy bias. NRA is calculated using the farm gate and global prices as in the NRA, with adjustments made from each payment or receipt. While global trade pacts have strongly discouraged subsidies and transfer payments, in many countries government have maintained subsidies and transfers through various means, often resulting in commodities with high values of NRA.

The total effect of government assistance on the agricultural sector will in general include effects from other sectors as well, particularly manufacturing and industrial (Baliño et al., 2019). To account for the more general setting, in which agriculture is just one of the economic sectors affecting prices, Anderson et al. (2008) generated the relative rate of assistance (RRA) index:

$$RRA = \left[\frac{1+NRA_{ag}^x}{1+NRA_{non-ag}^x} - 1 \right] \qquad (1)$$

where NRA_{ag}^x is the nominal rate of government assistance to agricultural (ag) exportable goods (x), and NRA_{non-ag}^x is the nominal rate of government assistance to non-agricultural (non-ag) exportable goods (x) and is calculated in analogous manner to NRA_{ag}^x but in other sectors such as industrial and manufacturing. The same nexus of incentives and disincentives are included when calculating, e.g. taxes, tariffs, subsides, tariffs, etc. To determine a single RRA measure for a country, a weighted average of NRA_{ag}^x and NRA_{non-ag}^x measures for each commodity and sector is calculated. The weighted average is calculated using the value of each commodity, ag and non-ag, using its border price as the weight, which is then multiplied by the commodity's share of total

production, and then summed across all commodities. Detailed calculations of RRA and NRA measures are provided and discussed in Anderson and Valenzuela (2013) and Baliño et al. (2019) for a large number of SSA countries. Positive RRA values imply that government assistant to agriculture is favorable, that is, non-biased, incentivizing producers to expand production.

Two corollary indices are developed based on RRA to obtain further insight into potential policy bias. The cash-food bias index (CFBI) measures government level of assistance to farmers by assessing whether producers of either cash or food crops benefit the most from government policies. In SSA countries, food crops grown for domestic consumption include roots (tubers) and cereals, e.g. cassava, yams, sorghum, maize, and millet. Cash crops are grown primarily for commercial purposes and are typically exported. Notable examples of cash crops include cotton, cocoa, and oil palm. It has long been debated whether a government should assist food or cash crops. Some argued that cash crops are important to generate foreign revenue that can be invested in manufacturing and industrial sectors to boost economic development. Others argue that food crops are more important for self-sufficiency in regions where poverty and mal-nutrition prevails (Darkoh and Ould-Mey, 1992; Winters et al., 2004; Harrison, 2006). Often it hence remains a dilemma for governments to choose which types of policies to implement. CFBI measures how products of cash crops are assisted through government pricing policies relative to products of food crops (Anderson et al., 2008):

$$CFBI = \left[\frac{1+NRA_{cashcrops}}{1+NRA_{foodcrops}} - 1 \right] \qquad (2)$$

where $NRA_{cashcrops}$ refers to the nominal rate of assistance to cash crops and $NRA_{foodcrops}$ is the nominal rate of assistance

to food crops. Positive CFBI values imply that government assistant to cash crops is favorable while simultaneously biased against food crops.

The trade-bias index (TBI) captures the relative support given to agriculture versus non-agriculture tradable goods (Anderson et al., 2008; Bates and Block, 2009; bates and Block, 2011). The TBI utilizes the price of exportable versus importable goods to assess whether a government has an anti-trade bias within agricultures. If government assistance to imports is more favorable than exports, then more resources will be available to imports (ceteris paribus). The TBI is calculated as follows:

$$TBI = \left[\frac{1 + NRA_{ag_x}}{1 + NRA_{ag_m}} - 1 \right]$$
(3)

where $NRAag_x$ is the nominal rate of assistance to agricultural exportables and $NRAag_m$ is the nominal rate of assistance to agricultural importable. Positive TBI values imply that government assistant towards exportable crops is favorable, that is, non-biased against agriculture exports.

Econometric models were constructed to assess the nature of government policy support to agriculture. The three rates of assistance indices, RRA, CFBI, and TBI, were analyzed as dependent variables, that proxies, to the level of assistance provided to agriculture. All three measures (RRA, TBI, and CFBI) are based on government's nominal rate of assistance to

agriculture (NRA) as measured using the approach outlined in Anderson et al. (2008).

The three regression models for NRA, CFBI, and TBI include the same set of independent variables that were chosen based on a literature review-discussed in the introduction section-that identified them as potentially having significant explanatory power. The independent variables included natural resource endowment (Bourguignon and Verdier, 2000; Isham et al., 2003; Manning et al., 2006; Bates and Block, 2009), location (Ndulu et al., 2007), share of rural population (Bates and Block, 2011), GDP (Bates et al., 2013; Anderson and Bruckner, 2012), and share of arable land (Bates and Block, 2011). Country and time are control variables that enter as fixed effects in the model.

Because the data are an unbalanced panel of observations across time (year) and cross section (country), correlation between independent variables and error terms can occur. The model was hence constructed as a panel data model that explicitly considers autocorrelation (across time) and correlation (across space) between the unobserved heterogeneity among the countries. A panel data model can be constructed as a random or a fixed effects model. A fixed effect model is chosen since it allows correlation between independent variables and error. To remove autocorrelation, time and country specific variables are included (Greene, 2012).

The representative model for each of the three regression models follows a similar approach to Bates and Block (2011) where assistance measures are regressed with country specific independent variables using ordinary least squares. The three individual models for NRA, CFBI, and TBI are packaged in a general framework as follows:

$$y_{it} = \alpha + \delta_1 Resource\ rich_i + \delta_2 Landlocked_i + \delta_3 Rural\ population\ share_{it} + \delta_4 (Resource\ rich * Rural\ population\ share)_{it} + X_{it}\beta + Country_i + Year_t + \varepsilon_{it},$$
(4)

where y_{it} is our dependent variable depicting government level of assistance to farmers for country i in year t through the three policy indicators defined earlier: RRA, CFBI, and TBI; *Resource rich* is a dummy variable for resource rich-countries; *Landlocked* is a dummy variable for landlocked countries, *Rural population share* is the share of a country's population living in rural areas; X stands for the independent variables such as real GDP per capita, arable land share in country i in year t, *Country_i* is a country specific fixed effect term that captures unobserved time invariant, $Year_t$ is a time specific fixed effect term that captures unobserved country invariant, δ_1 through δ_4 are regression parameter estimates, and ε_{it} is the error term associated with country i in year t.

Using these outcomes as the background of their decision-making process policy makers in developing countries particularly in SSA countries may advocate for a transformation of the agricultural sector with an emphasis on improving farmers' wellbeing.

Data

The dependent variables (RRA, CFBI and TBI) measures were calculated by Anderson and Valenzuela (2013) for twenty SSA countries over the period 1955 through 2011 and are summarized in Table 1 (World Bank, 2017). The twenty SSA countries included

in the Anderson and Valenzuela (2013) data are Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Mali. Mozambique, Nigeria, Senegal, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

Independent variables were taken from the World Bank Development Indicators database including: resource rich country, landlocked country, rural population share, GDP, and arable land share (World Bank, 2017). A 'resource rich country' is defined by the International Monetary Fund (IMF) as having exports of non-renewable natural resources (e.g. oil, minerals, and metals) accounting for more than 25% of the value of the country's total exports. IMF has classified 20 countries in sub-Saharan Africa as being resource rich. This classification was based on data from 2005 to 2010, and included seven countries from our dataset: Cameroon, Mali, Nigeria, South Africa, Tanzania, Zambia, and Zimbabwe. Landlocked countries lack direct access to seaborne trade and include five countries in our data: Burkina Faso, Ethiopia, Mali, Zambia, and Zimbabwe. Rural population and arable land shares are measured as continuous variables in the range from 0 to 100. The independent variable data was collected to coincide with the time period (1955-2011) and location (20 SSA countries). The panel data consists of 1,320 possible observations (66 years × 20 countries) but due to missing data, primarily from the dependent variables, the total number was reduced to 505 usable observations.

Data summary

Table 2 provides the descriptive statistics of the dependent and independent variables used in the econometric models. On average, RRA was -0.278 during the period 1955-2011. The

Table 1. Definitions of dependent and independent variables used for regression estimation.

Variable type	Definition
Dependent	
RRA	Relative Rate of Assistance to farmers
CFBI	Cash Food Bias Index
TBI	Trade Bias Index
Independent	
Resource Rich Country	If Yes=1, if No=0
Landlocked Country	If Yes=1, if No=0
Rural Population Share (%)	Share of a Country's Population Living in Rural Areas
GDP($)	Real Gross Domestic Product per capita
Arable Land Share (%)	Share of arable land area (crops and pasture)
Country	Index for country
Year	Index for year

Source: Authors Report

negative sign indicates that SSA countries have adopted biased policies towards agriculture and farming in general. Government assistance to agriculture has resulted in unfavorable outcomes for agriculture compared to those that would have been achieved under free market conditions according to the methodology and assistance metrics used by Anderson et al. (2008). For example, China, though not included in our study, had biased agricultural policies until 1995 after which it adopted reform measures that shifted a substantial portion of its agriculture to the private sector. By 2005, China's RRA was close to zero, indicating it implemented balanced policies between agriculture and non-agriculture. Subsequently, China's economic growth increased over the period 1995-2005, suggesting that its growth was at least in part due to a positive shift in agricultural policy. Similar shifts in agricultural policy and beneficial outcomes have been enacted in other Asian countries including Japan, Taiwan, and Korea.

Cash food bias index averaged -0.210 over the study period (1995-2011), indicating that SSA governments included in our sample have implemented policies favoring the production of food crops over cash crops. This outcome tends to confirm the logic of collective action that argues urban dwellers have sufficient political power to influence government policies in their favor by artificially lowering the cost of food (Bates and Block, 2009). Such bias is beneficial for urban and food-deficit households, particularly in SSA countries where food expenditures are typically the largest share of household disposable income. For Africa as a whole, the consumption of these foods' accounts for a large part of agricultural output and is projected to double by 2025 with USD 50 billion added to demand (Manning et al., 2006). For the future, however, with adequate support food deficits can be a potential for Africa's farming population if domestic production can be increased to meet projected demands for cereals, roots and tubers, and meat. This will likely require a substantial reorientation of agriculture from subsistence to market based planning and organization to provide the necessary growth to reach the tremendous number of Africa's rural poor (Manning et al., 2006).

The trade bias index is negative, implying that on average African governments have adopted policies that can be viewed as favoring agricultural imports over exports. In particular, USDA (2013)'s trade report supports our result that as exports to SSA countries from US increased above 5% from 2002 to 2012, food imports to SSA increased likewise.

Out of 505 observations compiled, 25% of them relate to countries in our data that are resource rich while approximately 30% of them relate to countries that are landlocked. These results reflect that in general the SSA countries in our study have limited natural resource endowments available to them and also lack seaport access. Out of 505 observations with information about the rural population share, on average 72% of the African population live in rural areas. According to Bate and Block (2011), although a large portion of the SSA population live in rural areas, they lack political power to influence policy. Government assistant hence leads to urban consumers whose voice is government is louder and more effective in lobbying government policy towards cheap food policies. When looking at the gross domestic product per capita on average out of 505 observations, our sample of African countries has a GDP per capita of 1,411 dollars and its logarithm value for easy interpretation after estimating is 7.25. Although GDP level in these countries has increased in recent years, it is very low level compared to developed countries, e.g. above $12,000 in 2015, or high-income countries, e.g. are above U.S $40,000 in 2015. Regarding the arable land share variable, our sample data of SSA countries has an average proportion of arable land of 11% (Table 2). This share of arable land of 11% is typical of countries throughout the world, including developed countries.

EMPIRICAL RESULTS

Equation 4 was estimated using SAS 9.4 software platform's "PROC REG" command statement for all three of the policy assistance (bias) measures: RRA, CFBI, and TBI (SAS 2021). Model specification was analyzed using a Hausman test to determine whether it fit best as either a random or fixed effect model. The null hypothesis of the Hausman test, which tests whether correlation of the independent variables and error terms are zero, was rejected (P<0.05) in all three of the models. Based on the Hausman test, the fixed effect model was deemed the most appropriate for each model. Table 3 presents the results of the corresponding fixed effect model for the

Table 2. Summary statistics of variables.

Variable	Definition	No. of obs.	Mean	Std. dev.	Min.	Max.
RRA	Relative Rate of Assistance	505	-0.278	0.317	-0.946	1.295
CFBI	Cash Food Bias Index	505	-0.210	0.397	-0.927	2.216
TBI	Trade Bias Index		-0.296	0.402	-0.971	1.419
Resource Rich Country	If Yes=1, if No=0	505	0.250	0.433	0	1.000
Landlocked Country	If Yes=1, if No=0	505	0.297	0.457	0	1.000
Rural Pop. Share (%)	Share of a country's population living in rural areas	505	72.238	12.214	41.660	95.160
Log GDP (log $)	Real Gross Domestic Product per capita	505	7.252	0.633	5.805	9.087
Arable Land Share (%)	Share of land area that is arable under permanent crops, and under permanent pastures (World Bank)	505	10.758	7.973	2.660	33.488
Country	Sub-Saharan African countries	20	-	-	-	-
Year	1955 to 2011	57	-	-	-	-

Source: Anderson and Valenzuela (2013).

Table 3. Fixed effect models of government assistance to agriculture to farmers.

Variable	Model 1 (RRA)		Model 2 (CFBI)		Model 3 (TBI)	
	Parameter Estimate	Std. Dev.	Parameter Estimate	Std. Dev.	Parameter Estimate	Std. Dev.
Intercept	-0.550	0.510	-1.420**	0.640	-1.220*	0.780
Resource Rich Country	-0.910***	0.200	0.760***	0.270	1.370***	0.330
Landlocked Country	0.010	0.080	-0.060	0.110	0.230*	0.160
Rural Population Share	-0.004	0.003	0.003	0.004	0.002	0.005
Resource Rich Country*Rural Population Share (%)	0.016***	0.003	-0.008**	0.004	-0.02***	0.004
GDP (logarithm $)	0.125**	0.050	0.099*	0.060	0.080	0.070
Arable Land Share (%)	-0.004	0.007	0.025***	0.007	0.008	0.007
No. of Obs.	505					

[1]Country and year fixed effect terms are significant at 1% level. [2]*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.
Source: Author's calculations.

CFBI, and TBI.

RRA model

The RRA regression model was found to have three significant variables, including two highly significant variables (P<0.01) and the third significant at the 5% level (P<0.05) (Table 3). The Resource Rich Country variable three alternative regression equations explaining RRA, had the greatest explanatory power as it was highly significant (P<0.01) as both a linear term and when included as an interactive term with the Rural Population Share variable. As a linear term, a country's resource endowment, as indicated by Variable implies that *ceteris paribus* a percentage increase in Rural Population Share variable

increased RAA by an average of 0.016. Since the effect of Resource Rich Country had different signs when included as either a linear or interactive term, its overall effect on RRA needs to be calculated by summing its individual marginal effects from its linear and interactive terms. When calculated at Rural Population Share's mean value of 72.24%, the marginal effect of a resource rich country on RRA is 0.246, indicating that the overall (marginal) effect of the Resource Rich Country variable was positive on RRA, suggesting that country's well-endowed with natural resources, and an average rural population share, provided policy support to agriculture during the study period. The marginal effect becomes negative, however, when the share of the population living in rural areas was above 56.9%, implying that "resource rich" governments in countries with smaller rural population shares enacted policy that was biased towards agriculture and favored non-agricultural sectors. The results suggest that the arguments of Bates and Block (2009), that is, urban elites have greater political power, are weakened in countries with a strong natural base since agriculture policy increased in proportion to rural population share. This could be explained by resource rich countries having greater incentives to protect their natural resource base and to maintain the viability of its rural communities. Urban political power becomes realized, however, when rural population shares fall below 56.9% where urban elites are bale to influence government's policy against agriculture and towards non-agricultural sectors, providing empirical support for Bates and Block (2009).

A country's GDP positively affected government assistance to the agricultural sector, with a coefficient estimated equal to 0.13 and statistically significant (P<0.05). The marginal effect of GDP on RRA is 0.0172, indicating that a 1% increase in GDP corresponds to a 0.0172 increase in CFBI. The significant and positive effect of GDP result is similar to Manning et al. (2006) argument that agricultural support can be growth promoting. Our findings differ, however, from Bates and Block (2011) who argue that SSA countries tend to under invest in agriculture and did not identify any important role of GDP in agricultural investment. In particularly, SSA countries have experienced fast growing economic development after the beginning of this century, and for the most part SSA countries have increased investments to agriculture as GDP grew. This fact supports our result that GDP has significantly influenced assistance to agriculture while Bates and Block (2011) analysis. The discrepancy could be explained since our results were obtained from a different study period and countries whereas Bates and Block (2011) study included fewer years (1955-2004) and contained non-SSA countries.

The remaining three variables, Landlocked Country and Arable Land Share and intercept, did not have a significant effect (P>0.10) on RRA (Table 3). The weak explanatory power of the Landlocked Country suggests that government policy is not dictated by geography, and even countries without access to navigable pots can overcome such constraints through economic development and that the human dimension of organizing political capital are stronger determinants of policy as indicated by the highly significant GDP and Rural Population Shares. Likewise, a countries distribution of farming communities, that is, Arable Land Share, also has significant effect on policy compared to economic growth and population demographics.

Cash food bias index (CFBI) model

The CFBI regression model identified five significant variables, including two highly significant variables (P<0.01) and the remaining three significant at the 5% level (P<0.05) (Table 3). The Resource Rich Country variable had significant explanatory power as both a linear term and when included as an interactive term with the Rural Population Share variable. As a linear term, a country's resource endowment, as indicated by the Resource Rich Country variable, had a highly significant, positive effect of 0.76 (P<0.01) on CFBI and as an interaction term with Rural Population Share had a significant, negative (P<0.01) effect of -0.008 on CFBI (Table 3). The marginal effect of the interaction variable implies that *ceteris paribus* a percentage increase in Rural Population Share variable decreased CFBI by an average of 0.008 for resource rich countries. Since the parameter estimates of Resource Rich Country had different signs when included as either a linear or interaction term, its overall effect on CFBI needs to be calculated by summing Resource Rich Country's individual marginal effects from both its linear and interactive terms. When calculated at Rural Population Share's mean value of 72.24%, the overall marginal effect of a resource rich country on CFBI is 0.182, indicating that the Resource Rich Country variable had a positive effect on CFBI, suggesting that country's well-endowed with natural resources, and an average rural population share, provided policy support to cash crops during the study period. The marginal effect becomes negative, however, when the share of the population living in rural areas reaches beyond 95.0%, implying that "resource rich" governments generally favor supporting cash crops since rural population shares have not and are not ever likely to reach such high rates as 95.0%. The findings of our model differ from Bates and Block (2009) who found that resource rich countries tended to protect food crops over cash crops. This difference could be explained by our model's result being contingent on the share of rural population. Our model does agree with Bates and Block (2009) for countries with extremely large rural population shares of 95.0%. It is likely that the typical errors associate with our regression model have overstated the role of high rural population shares in explaining the cash crop bias. Our model hence implies

that resource rich countries with substantial rural population shares provide policy support that favor food crops over cash crops. This reflects the priority placed on feeding large rural populations to provide food security rather than economic growth and wealth generation.

A country's GDP had a significant (P<0.10) and positive effect on CFBI with a parameter estimate of 0.099 (Table 3). The marginal effect of GDP, calculated at the mean value of ln(GDP), indicates that for every percentage increase in GDP, CFBI increases by 0.0137 (Tables 2 and 3). According to our model results, governments in countries with greater economic development and higher corresponding GDP implemented policies that favored producers of cash crops over producers of food crops. The significant, positive role of GDP on investing in cash crops is encouraging since it suggests that a SSA countries increase their economic development, they are more willing to invest in commercial aspects of agriculture that can provide an economic engine of continued growth. This finding is consistent with Bourguignon and Verdier (2000) and Isham et al. (2003) who argue that wealthier countries tend to favor cash crops over food crops and essentially provide a precautionary tale for situations where governments have focused on commercial farming at the expense of meeting domestic needs. Caution is required especially in countries where food production is marginal, in which case policy should be redirected to food crops to assure food security.

The proportion of arable land of land area arable had a significant and positive effect (P<0.01). Its marginal effect implies that for every percentage increase in arable land, the government level of assistance to producers of cash crops as measured by CFBI increased by 0.025. This implies a bias against producers of food crops in countries with abundant arable land, which is somewhat paradoxical. Moreover, Bates and Block (2009) found that arable land was positively related to policy orientation of government toward agriculture.

TBI model

The third regression model explains the TBI, which compares the level of government assistance provided to producers of agricultural exports relative to imports. The Resource Rich Country variable had a highly significant (P<0.01) on TBI as both a linear and interaction term with Rural Population Share (Table 3). As a linear term, the Resource Rich Country variable had positive effect of 1.37 on TBI and as an interaction term with Rural Population Share its effect was negative, with a parameter estimate of -0.02 (Table 3). The marginal effect of the interaction variable implies that *ceteris paribus* a percentage increase in Rural Population Share variable reduced TBI by an average of -0.02. Since the effect of Resource Rich Country had different signs when included as either a linear or interactive term, its overall effect on TBI needs to be calculated by summing its individual marginal effects from its linear and interactive terms. When calculated at Rural Population Share's mean value of 72.24%, the marginal effect of a resource rich country on RRA is calculated as -0.075, indicating that the overall (marginal) effect of the Resource Rich Country variable was negative on RRA. The regression results suggest that countries well-endowed with natural resources, and an average rural population share, provided policy artificially high levels of policy support to producers of agricultural imports, rather than exports, during the study period. The marginal effect becomes positive, however, when the share of the population living in rural areas falls below 66.5.9%, implying that "resource rich" governments in countries with smaller rural population shares enacted policy that are biased towards agricultural exports and consequently against imports.

Our regression results for the interactive effect of Resource Rich Country and Rural Population Share contrast that of Robin (2011) who found that resource rich countries tended to enact policies that are biased against producers of agricultural exports as the rural population share decreased. The differences could be explained by the different countries included in both studies. Our results, moreover, can be equally rationalized since many SSA countries with large rural population shares have struggled to produce adequate staple food crops, which are hence deemed as imports in these types of countries. In efforts to reduce imports, countries facing large staple food imports would be incentivized to provide additional support, including at artificially high levels, to producers of staple food crops to reduce imports. This is particularly true since food imports reduce country's scarce foreign currency reserves.

The landlocked variable had a significant (P<0.05) and positive effect according to model results (Table 3). The results hence suggest that governments in landlocked countries enacted policies that favored producers of agricultural exports over imports. Our result is consistent with Ndulu et al. (2007) who also found that landlocked countries were likely to show less bias against domestic agriculture, that is, supporting producers of agricultural exports to reduce the need for importing food. Such policies are considered appropriate provided that the support of export crops, which are typically cash crops such as cotton, tropical fruits, or coffee, do not displace the production of domestic staple food crops in countries where food security remains a pressing issue. The remaining three variables did not have a significant effect on TBI including GDP, Arable land Share, and did not have any significant effect on the assistance government provides to agriculture as measured by TBI (Table 3).

DISCUSSION ACROSS THE RRA, CFBI, AND TBI MODELS

The comparison of three regression results suggests that

resource rich countries oriented their agricultural policies with a bias against domestic agriculture compared to non-agricultural sector, but within agricultural support was provided for domestic producers. This is an encouraging results since results imply that exports were favored over imports and policy support was also provided for food crops over cash crops. In some situations, however, the support of exports could be considered as a bias towards agriculture in countries where exports are primarily extractive in nature, e.g. oil and minerals, rather than agricultural commodities such as cotton, tropical fruits, and coffee. To accomplish export oriented policy, food prices are typically artificially suppressed to support non-agricultural industries and to maintain low food prices in urban areas. The long-term effect of maintaining artificially low food prices leads to overvalued currencies and financial insolvency, which in many countries resulted in structural adjustment to remedy macroeconomic ills.

It is important to also highlight model implications for countries without access to substantial natural resources, countries with Resource Rich Country = 0. Model results suggest for non-resource rich countries, policy was biased against agriculture (RRA), cash crops (CFBI), and exports (TBI). While it is difficult to generalize non-resource countries should principal be more oriented and towards investing in agriculture since income from other sources including natural resource extraction and manufacturing are infeasible. Our findings are inconsistent with expectations since regression results indicate that non-resource rich countries held a bias against agriculture, while favoring cash over crops and imports over exports. This confirms concerns of the donor community that SSA countries have underinvested in agriculture, presumably relying on external assistance to make up gaps. Moreover, underinvesting in agriculture is equally troubling since t leads to policies favoring imports to reduce imported food costs, and the incentives to invest in cash crops even in situations where they crowd out food crops and result in even higher levels of food imports. In these situations, donors need to work with governments to find ways to shift polies encouraging agricultural production and placing highest priority on assuring food security. Governments find it politically expedient to support food crops over cash crops for maintain their large farming populations (significant in CFBI).

Landlocked countries' government implemented neutral policies for agricultural (insignificant in RRA and CFBI) over non agriculture, and cash crops over food crops with slightly export orientated policies (weakly significant in TBI). GDP had significant, positive effects only on both RRA and CFBI but not TBI. Since the SSA countries included in our sample were considered as low income countries throughout the entire period, economic growth provided incentives to favor agriculture and cash crops although economic growth has likely not been strong

enough to have influence on trade policy. Over time, however, GDP might be positive effect on TBI as government investments become better positioned to make investments in export-driven enterprises and ventures. Arable land share only influenced CFBI but not RRA and TBI. This is an expected result. As share of arable land is large, the country encourages planting more cash crops than food crops. However large share of arable land did not influence TBI and RRA because of each country has unique situation such as whether they resource rich, land locked, or some different historical economic developments that represent overall of its country's agricultural environment.

Conclusion

SSA countries have experienced rapid economic and agricultural growth over the past two decades, reversing the stagnation that most countries experienced since independence. As economies have prospered, policy makers have become interested in how the recent growth has affected agricultural policy. This research analyzed whether key factors are able to explain government policy assistance to agriculture in SSA African countries. Government policy indicators were measured by the relative rate of assistance to agriculture (RRA), the cash food bias index (CFBI), and the trade bias index (TBI).

In this paper, our working hypothesis considered government assistance to farmers as being primarily by the rural/urban population share. While our hypothesis was supported by the econometric results, the strongest factor was found to be the Resource Rich Country variable who favored non-agricultural sectors over agriculture, producers of cash crops over producers of food crops, and producers of agricultural exports over producers of agricultural imports. Our results suggest that whether countries have natural resources or not, they have implemented agriculture policies differently across SSA. The proportion of people in rural areas affected government assistant to farmer in all three of the models through an interaction term with the resource rich variable. However, it affected the model when included in the interaction variable with resource rich countries and became statistically significant at 99% confidence level for the Relative Rate of Assistance (RRA) model and Trade Bias Index (TBI) model, and statistically significant at 95% confidence level for the Cash Food Bias (CFBI) index model. When a country was a resource rich, the government tended to enact policies that benefit the agricultural sector only as the number of people living in rural areas increases. Analogously, producers of cash crops tended to benefit from government policies in resource rich countries as the number of people living in rural area increased. Results from the TBI found that government policies in resource rich countries tended to be biased against producers of agricultural exports, thus

providing more supports to producers of agricultural imports as the proportion of people living in rural areas increased.

However, the policies that SSA countries have implemented were found by our model results depend on a variety of other parameters including whether a country is resource rich, landlocked, or has a sizable arable land share. Our results are generally consistent with results from prior studies (Bourguignon and Verdier, 2000; Isham et al., 2003; Manning et al., 2006; Bates and Block, 2009; Ndulu et al., 2007; Anderson and Bruckner, 2012; Bates and Block, 2011; Bates et al., 2013). We were unable to confirm previous report regarding landlocked countries being less biased against agriculture. In fact, that variable turned out to be statistically not significant in all the models except for the TBI where it was statistically significant at 90% confidence level. It reflects those landlocked countries tended to enact policies favoring producers of agricultural exports over producers of agricultural imports. As expected, a country's GDP) positively influenced the assistance government provides to agriculture. In both models of RRA as well as CFBI, the GDP estimated enters positively showing that agriculture over non-agricultural sectors, and producers of cash crops over producers of food crops benefit from government assistance as a country's GDP increased. Surprisingly, we were unable to confirm the effect of arable land share on government's assistance to agriculture. Its parameter estimate turned out to be statistically significant only for the Cash Food Bias index model and it shows that government policies tend to be biased against producers of cash crops as the size of arable land share increases.

Across all three models, we conclude that each index had different significant variables. Government assistance to farmers might be different in terms of specific policies. And if they were all significant in three models, the signs of coefficient of those variables had opposite signs such as that the variable of resource rich country was all significant, but it is negative in RRA, positive in CFBI and TBI. This shows that overall attitudes of SSA governments were anti agriculture (negative sign of RRA), but in specific sectors among agriculture such as food production (CFBI) and trade policy (TBI), their attitude changed that they favored cash crop over food crops and also favored exports over imports, hence suggesting export-oriented agricultural policies. This is one of our important findings.

POLICY RECOMMENDATIONS

The results imply that for countries reliant on resource exports policy needs to be redirected towards agricultural sector, with an emphasis on food crops for domestic markets. This policy reshaping is critical to meet the challenges of rapid population growth and the burgeoning demand from rising incomes. This transformation to Africa's Green Revolution will require new types of assistance to farmers, who need to be equipped to forge new levels of agricultural productivity. The introduction of new agricultural technology needs to proceed rapidly, including bundled technology that proved so successful in the Asian and Latin American green revolutions, e.g. improved seed varieties, intensive use of fertilizer(s), and where available irrigation. Breeding should give priority to developing drought-tolerant crop varieties as well and complementary technologies to maximize soil water use efficiency (Kanu et al., 2014). The water efficient maize for Africa (WEMA) maize breeding program had developed improved genetic lines and where politically and socially tenable, genetically modified maize varieties crops are likely to become more widely available and adopted.

Africa's Green Revolution will also require the development of strong rural financial network to allow financing of new technologies and to provide African farmers with improved marketing channels to provide price stabilization and similar opportunities available in developed countries. Credit constraints and often the complete absence of lending opportunities has historically been a primary hindrance to the adoption of improved cropping systems in SSA. Financial institutions will need to be created in a flexible manner to serve the unique needs of the SSA smallholder, e.g. lack of collateral, high levels of risk, and limited experience with formal borrowing. The financing sector will likely need to include crop insurance and similar mechanisms to protect producers and lenders from adverse production outcomes, due to weather, pest outbreaks, and market collapse. This will be particularly important in the marginal rain-fed production areas.

Governments need to continue to invest in extension with a repurposing on efforts to promote Green Revolution technology. A critical component will be to enhance the human capital of smallholder farmers through both on-farm and online education and training to increase their capacity to make best use of improved production systems. Today's availability of the internet and cell phone technology can be especially useful to maintain close contact between extension agents and the smallholder communities. With the development of appropriate web based tools, extension services can also provide applications to assist smallholders in managing crop inventories, marketing, drought monitoring, pest and disease movements, and promoting best farming practices. Training needs to be inclusive, with an emphasis on both gender and youth. Traditional farming has discouraged Africa's youth whom often immigrate to more urban areas in search of better opportunities. Improved farming and increased profitability in agriculture can retain more of Africa's youth in rural areas and even attract urban emigres to return.

The development of new agricultural technology will

require greater levels of partnership between the public and private sectors. Given the existing human capital and technological capacity of Africa's national agricultural research centers, creating the needed innovations will require in most instances partnering with global agricultural companies to gain access to the advances in fields such as genetic and molecular engineering, artificial intelligence, robotics, etc. Recent examples of these types of arrangements could be facilitated include the WEMA project and the development of GM cotton in countries such as Burkina Faso. In both cases, technology was provided by the private sector and adapted to local conditions primarily by local agricultural institutions. Developing partnerships will likely require third party mediation, such as donors, to assure both sides concern's over issues such as intellectual property rights, establishing patents, benefit sharing, and a litany of legal issues. Attracting private partners and associated FDI will demand SSA government increase their transparency. In particular, SSA government will need to strengthen their institutional frameworks, e.g. legal, property rights, social justice, to increase FDI inflows.

The critical role of resource endowments on agricultural policy bias found in our study further highlights the need for those countries to diversify their economy away from their limits as a resource "monoculture". The overall aim would be to diversify the economy by building up new sectors that would be less reliant on commodities such as oil to minimize effects from market volatility and price shocks. While developing agriculture would assist the poor during periods of market volatility, in the case of oil, agriculture's dependence on oil prices is unlikely to provide necessary relief. Complementary exchange policies need to be put in place to minimize market volatility and large food price spikes since global agricultural prices are determined principally by outcomes in the oil and foreign currency markets (Nazlioglu and Soytas, 2012; Zhang et al., 2010; Zhang and Reed, 2008)

The significant effect of land locked countries instill a policy bias towards imports rather than establishing food security through domestic production is likely caused by inadequate infrastructure. Sub-Saharan Africa's failing infrastructure, primarily roads but often electricity, water, and communications, results in prohibitively high transaction costs and inefficient marketing channels in rural areas. Greater investments in rural infrastructure would reduce costs everywhere along the value chain, from input provision at the farm gate to retail sales in urban marketing centers, creating enhanced incentives and improved prospects for domestic producers to increase output and provide a greater share of national food needs. Physical infrastructure such as roads have substantial multiplier effects and can packaged with other strategic and planning goals, reducing the overall cost to the agricultural sector. In particular, developing SSA's hydrologic infrastructure through improved irrigation would reduce its reliance on rain-fed agriculture and improve its capabilities in mitigating impacts of climate change.

FUTURE RESEARCH

Understanding the role of government in developing agriculture policy is a complex task. While the price support approach used in this paper provides insight into how policy bias can be measured based on market outcomes, more research is needed to assess how policy bias could be measured across different outcomes such as food production, resources usage, and food nutritional measures. Additional research could be used to expand the policy dimensions beyond the three used in our paper, e.g. how policy is potentially biased with respect to gender, socioeconomic status, ethnicity, etc. The role of the private sector in agriculture policy, and how it can influence government attitudes towards shaping policy across rival investment opportunities, should also be explored.

Our data was based on assistance measures develop from a previous study that included observations only until 2011. It is recommended that the research community pool resources and extend the measure unto the present to allow for a more contemporaneous analysis. Doing so would also address data constraints and related data issues such as paucity and opacity that continue to challenge research in developing countries. Models and planning tools that advise policymakers are only as functional as the data used in their construction, and given the general lack of data quality and quantity; efforts should be made to provide more resources for data collection. In particular, this would require not only data on government expenditures on agriculture, but more importantly a further refinement of where investments were made. Proving policy researchers with comprehensive databases of government expenditures would greatly improve their capacity to assess the appropriateness of expenditures across the dimensions and scope of modern day agriculture planning as addressed in this paper, that is, ag versus non-ag sectors, imports versus exports, and food versus cash crops.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interest.

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