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Investment in agricultural productivity vs rural commercialization: which way to rapid poverty reduction in Ethiopia?

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Abstract: Developing countries identify a set of strategic objectives to promote agricultural production, and assure food security and reduced level of poverty. Two of these objectives are (i) sustainable increase in agricultural productivity, and (ii) accelerated agricultural commercialization. Each of these objectives is backed-up by a long-list of priority investment areas. However, most of these countries cannot satisfy the financial and technical requirements to execute both of the strategic objectives and all of these investment areas. In light of this, taking the case of Ethiopia as an example, this study employs an economy-wide model and assesses the relative efficiency of alternative investment options on agricultural performance and poverty reduction. Results show that the policy instruments cause significantly different production and welfare responses. Productivity enhancing interventions such as input subsidy and irrigation provision have superior welfare consequences, while policies aimed at small holder commercialization have the least effect.

Key words: investment prioritization, agricultural policies, economy-wide model, Ethiopia

1. Introduction

Arguably, agricultural productivity is the lowest in Africa (Diao, *et al*., 2012), and many identify considerable opportunities to accelerate agricultural growth, thereby promoting rural development and reducing poverty. Likewise, subsistence farming, characterized by low production and productivity, dominates most developing countries. At the global level, peasant farm households account for no less than a quarter of the world's population (Mendola, 2007). This should be considerably higher in Africa and other developing regions of the world. Moreover, semi-subsistence farming contributes about 90 percent of agricultural output in sub-Saharan Africa (Torero, 2011) and 75 percent of total agricultural production in East Africa (Salami *et al*., 2010); all these suggesting a huge potential for improving marketability and commercializing Africa's agriculture.

Rural development is perceived by many as a key to sustainably reduce poverty in agriculture dependent low-income economies (Diao *et al*. 2009). In most cases, developing countries, typically those in sub-Sharan Africa (SSA), have identified a set of strategic objectives to promote agricultural production, and assure food security and reduced level of poverty. Two of these objectives are (i) sustainable increase in agricultural productivity, and (ii) accelerated agricultural commercialization (MoARD, 2010; Laurent, 2014). Each of the objectives is backed-up by a set of priority investment

areas. Among the long list of investment areas identified in countries documents related to improving agricultural productivity are irrigation development, skill development of farmers, input and production subsidy (including seed and fertilizer supply), and R&D related to crop and livestock. Likewise, countries policies incorporate market information system, infrastructure development, and agricultural credit among potential investment areas to promote farmers commercialization and their integration to markets.

However, most of these countries cannot satisfy the financial and technical requirements to execute both of the strategic objectives and all of the investment areas (Pauw and Thurlow, 2014) indicated above, calling for a robust analysis on the welfare and food security implications of the strategic objectives and the accompanying investment areas such that governments can properly gear their attention to those investment options that can bring about greater food security and reduced poverty.

In light of this, this study assesses the relative roles of alternative investment options thereby comparing the food security and poverty implications of a predetermined amount/level of investment. To this end, this study employs an economy-wide model that measures the direct and indirect effects of alternative rural investment plans. The study incorporates various information extracted from project planning and sector studies. Such analyses can benefit development efforts of national governments and development agents by allowing them make informed decisions on investment and project priorities.

2. The agriculture expenditure - economic growth and agricultural performance nexus

The relationship between public expenditure and economic growth has been extensively examined in the theoretical and empirical literature, although the link remains inconclusive. The theoretical development on this relationship dates back to Wagner (1883) and Keynes (1936) (cited in Singh and Sahni, 1984; and others). The theoretical elaborations revolve around the causality of the relationship. The Wagner point of view stressed that the size of public expenditure is a result of income levels, where richer countries are more likely to allocate more money for public spending due to increased effective demand. On the other hand, those on the Keynesian perspective established that public expenditure is rather a discretionary tool adopted by governments to reverse economic slowdowns and achieve targeted objectives.

Like the theoretical development, there emerges a large volume of empirical literature on the relationship between public expenditure and economic growth, with mixed results on the link (Singh and Sahni, 1984; Barro, 1991; Abizadeh and Yousefi, 1998; Oyinlola and Akinnibosun, 2013). While some such as Singh and Sahni (1984) and Barro (1991) observed no support for increased public spending on economic growth, the majority of the literature including Abizadeh and Yousefi (1998) and Oyinlola and Akinnibosun (2013) support the Keynesian notion that public spending can be strategically used to promote sectoral and overall GDP.

In most developing countries where poverty alleviation is a key socio-economic challenge, the agricultural sector is still the backbone of the economy. There is an inherent desire in these countries to understand how and to what extent public expenditure to agriculture is related to the sector's performance. However, focusing specifically on public expenditure on agriculture, Ihugba *et al*. (2013) and Uger (2013) could not see a clear relationship between public spending on agriculture and economic growth. Specifically, Ihugba *et al*. (2013) and Uger (2013) empirically analyzed the

relationship between Nigerian government expenditure on the agricultural sector and its contribution to economic growth and observed a very weak causality between the two.

On the other hand, a large majority of the studies confirm the pro-growth and pro-poor nature of public expenditure on agriculture at various contexts. For example, investigating the role of public expenditure on agricultural on the performance of the agricultural sector in India, Selvaraj (1993) found that government expenditure to agriculture is of vital importance for the growth of the sector. Using the case of Vietnam, Fan *et al*. (2004) observed the growth stimulating role of government spending on agriculture. There are similar evidences from some African economies. Chidinma and Kemisola (2012) studied public expenditure in support of agriculture and observed significant and positive effect on growth. Likewise, using district- and regional-level public expenditure data and household-level production data, Benin *et al*. (2008) and Benin *et al*. (2009), respectively, witnessed on the case of Malawi and Ghana that provision of various public goods and services in agriculture and allied sectors (education, health, and rural roads) have substantial impact on agricultural productivity.

Some cross-county and regional analyses also suggest the importance of scaling up expenditure to agriculture. Examining nine economies in Latin America, Elias (1985) identified pro-growth nature of agricultural expenditure by the government, especially when irrigation, and research and extension have the highest share of the expenditure. Based on a cross-country analysis of 44 developing African, Asian, and Latin American countries, Fan and Rao (2003) also showed an overall strong contribution of government expenditure on agriculture to agricultural growth. In addition, they observed that rural centered expenditures such as rural infrastructure, social security, and education have positive growth-promoting effects among the countries they studied.

Not all studies identified positive nexus between public expenditure on agriculture and agricultural performance. For example, Ani *et al*. (2014) investigated the issue on Benue State of Nigeria and their analysis indicates a negative contribution to agricultural production, suggesting that it is not only the size but adequate monitoring and evaluation mechanisms are desirable to ensure increased agricultural productivity.

In addition, the link between government agricultural expenditure and growth depends on the nature of the expenditure. There is evidence (Benin *et al*., 2008; Fan and Rao, 2003; Fan *et al*., 2004) that rapid gains in agriculture would result from increased government investments on agricultural research, education, and rural infrastructures, although this could be contextual and need to be studied given each country's realities. The composition of capital and current expenditure should also be put in perspective as that seems to affect the outcomes of public expenditures. Nasiru (2012) observed on the case of Nigeria that while government capital expenditure causes economic growth, there was no observable causal relationship between current government expenditure and economic growth. Studying 30 developing countries over a period of 10 years, Bose *et al*., (2007) suggest that increasing the share of government capital expenditure in GDP is desirable for economic growth, while the role of current expenditure is insignificant. In contrast to these, using panel data for a set of developing countries, Devarajan *et al*. (1996) and Ghosh and Gregorious (2008) show that current (capital) spending has positive (negative) and significant effects on the growth rate, contrary to commonly held views.

As a result of the overall pro-growth nature of public investment on agriculture and the prominence of the agricultural sector in most developing economies, few policy makers and development agents consider public expenditure on agriculture as a strategic tool for poverty reduction. However, there is limited knowledge on how to allocate and prioritize scarce public funds and invest on agriculture and rural development. As a result, countries tend to execute development projects on ad hoc basis.

3. Public expenditure on agriculture and rural development in Ethiopia

Analysis of Ethiopia's recent growth performance (World Bank, 2013) shows that public investment has played key part and its share has increased fast to reach one of the highest levels in the world. Monitoring and Analyzing Food and Agricultural Policies (MAFAP) program of Food and Agriculture Organization (FAO) has been tracking public capital expenditure on the food and agricultural sector in Ethiopia (see in FAO, 2014). The record shows that actual total public capital expenditure has increased by an average rate of 33.9% per year from 2007 to 2013. Consistent to this, public expenditure in support of agriculture and rural development surged by a rate of 27.9% yearly. Although this growth rate is slower by about 6 percentage points from the overall public capital expenditure, given the sheer size of agriculture in the country, budget allocated to agriculture is encouraging compared to some other African economies.[1] What is disappointing, however, is declining share of government budget allocated for agriculture from about 25.0% in 2007 to only 13.5% in 2013. Despite the decline, the share still remains well above the 10 percent threshold of the Maputo target (FAO, 2014).

Empirical findings (such as Fan and co-authors; Devarajan *et al*., 1996) reveal that the composition of public spending determines the short and long-term impacts of the expenditures on rural development and poverty alleviation. In terms of the composition of public expenditure in support of the agricultural sector, almost 30% of the public support to the sector goes to agriculture-supportive policies such as in the development of rural infrastructure (rural roads and energy) and rural health and education (Figure 1). Of agriculture-supporting expenditures, rural infrastructure development (including rural roads) share 34.0%, showing the strong weight given to rural health and education in the country's rural development plans.

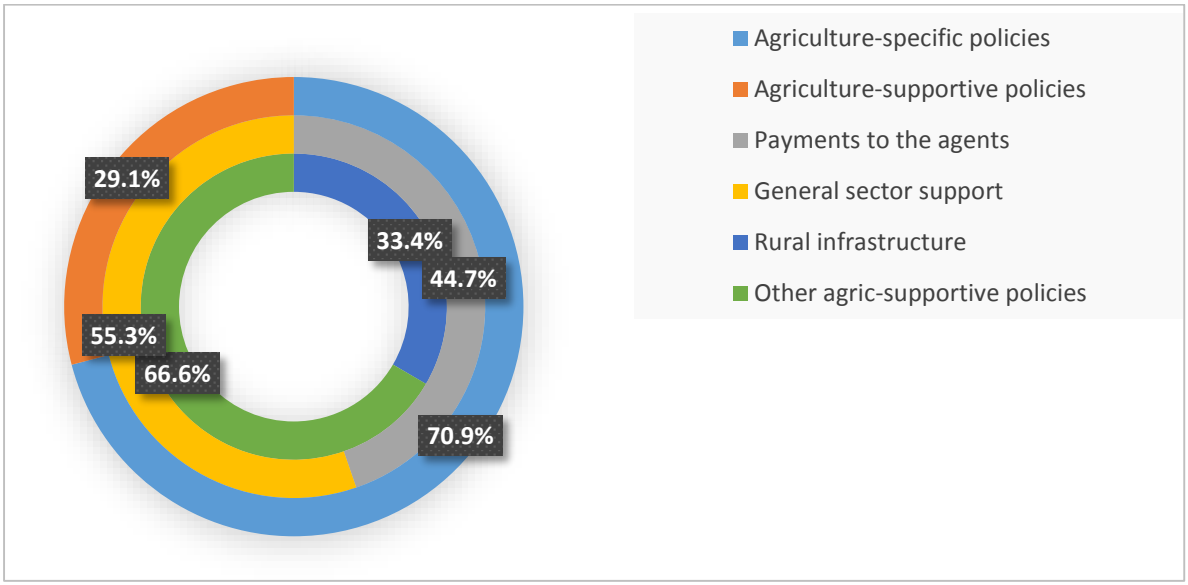
The lion's share (70%) of the expenditures has so far been allocated to agriculture specific policies such as support to agents in the agricultural sector (including producers and consumers) and general sector support involving agricultural research and extension. Support to agents in the agricultural sector reaches 45.0% of agriculture-specific expenditures, while activities such as research and extension consume 55.0% of funds in this class of expenditure. Support to consumers as food aid and cash transfers are the main components of support to agents in the sector (with a share of 54.8%), while producers receive payments as output and (mainly) input (seeds, irrigation, and on-farm irrigation) *subsidies* accounting for 34.6% of total support to agents. The remaining is taken up by other expenditure classes within support to agents in the agricultural sector.

Donor support has been an important and integral part of government budget in Ethiopia. Specifically, the role of aid and donor funding in public expenditure (capital) in support of agriculture in Ethiopia has been high and increasing. For the past 10 years, more than 60.0% of total capital expenditure in support of food and agriculture has come from donors in the form of aid, the share of

[1] The share of public budget allocated to agriculture is 2.7, 4.1, and 5.1% of total budget in Kenya, Tanzania, and Uganda, respectively. See MAFAP database. It averages 13.5% for Ethiopia.

which has increased in 2011-12 to more than 80.0%. There are differences in fund sources among agriculture-specific and agriculture-support expenditure classes. The share of donor funds is slightly bigger for agriculture-sportive polices such as rural services and rural infrastructure. Although the government contributed less than 40.0% of the funds to agriculture-specific investments, it contributed a very high share of the payments to producers (80.0%) as opposed to the payments to consumers (24.0%).

Figure 1: Public expenditure in support of agriculture in Ethiopia



Source: Own compilation based on FAO (2014)

4. Data and method of analysis

4.1. Method of analysis

This study adapts a modified version (Aragie, 2014) of an economy-wide computable general equilibrium (CGE) model called STAGE (McDonald, 2007). This model is particularly tailored to economic analysis in developing countries such as those in Africa. Specifically, it is an economy-wide model which accounts for some salient features of the rural economy such as production for own consumption by explicitly modelling households as joint producers and consumers (i.e., the presence of home production for home consumption), and defining labor supply at the household level such that labor supply by a household to own consumption activities is constrained to own labor endowment. These modifications were desirable to better portray the production and consumption systems in peasant economies, such as Ethiopia.

Specifically, production follows multi-level nested structure where household and non-household enterprises aim at maximizing profit. All activities are generally assumed to use nested constant elasticity of substitution (CES) technology, but different activities may have different values of substitution elasticity. Specifically, the production nesting structure in the STAGE model discussed in McDonald (2007) is modified to account for the production nesting structure considered appropriate for the kind of economies this study focuses on. Note that labor use by household enterprises for producing for own consumption is constrained by the household's own labor endowment and this condition is imposed in the labor market equilibrium condition. Also, at the lowest strata of the production nest, physical land is combined with irrigation to form land-irrigation aggregate. This

aggregate input is then aggregated with fertilizer to form land-irrigation-fertilizer input which is used in the agricultural sector. This way of aggregating land, irrigation and fertilizer across different stages helps capture the different rate of substitution among the inputs; it helps to account the close substitutability between land and irrigation in efficiency levels.

Consumers' behavior is defined by a two-stage consumption nesting such that households demand for commodities reflects the source of commodities as defined in the social accounting matrix (SAM) (see below). At the bottom of the consumption nest is a CES demand system where pair of notionally identical home produced and marketed commodities are combined to provide aggregate consumption of the commodity. Consumers decide on the optimal combination of these two types of commodities based on their relative prices subject to the imperfect substitution elasticity defined effectively as part of the CES function. The choice of CES at this stage of the nest does the purpose as semi-subsistence households will not be worried about the source of the commodities (i.e., home produced *teff* or marketed *teff*) in fulfilling their subsistence levels of consumption. At the top of the nest, consumers maximize their utility from the consumption of a set of combined commodities (from the lower nest) subject to their budget constraints and the linear expenditure demand systems (LES) derived from Stone-Geary utility function. LES demand systems split subsistence consumption, which is still a dominant phenomenon in low-income countries, from discretionary consumption where the amount of household budget on discretionary demand is a residual component of total household consumption budget and committed expenditure on subsistence demand. The subsistence and discretionary consumption expenditure is decided over the composite of own account and market commodities generated in the lower nest of the consumption tree.

4.2. Data for analysis

This study is based on a recently estimated SAM for a typical agrarian African economy, Ethiopia (Aragie, 2014), which has several salient features: i) it splits commodities into own account and marketed counterparts, and ii) it incorporates households as producing units in the activities account separating them from activities by incorporated non-household enterprises thereby properly reflecting the consumption and production structures of semi-subsistence economies. The SAM is constructed in conformity to the recommendations of the System of National Accounts (SNA) that 'in situations where there is a significant amount of consumption represented by own account production, it would be useful to record the distinction between consumption expenditure by households on home production for home consumption commodities from commodities purchased in the market place' (ISWGNA, 2009, paragraph 14:65). Hence, the SAM explicitly differentiates consumption of home produced commodities from marketed commodities by recognizing the role of households as producing units. There are a total of 39 commodities of which 15 are home production for home consumption, with corresponding number of marketed counterparts, and 9 are solely supplied by the market such as public services and industrial goods. Margin services are also separated into trade and transport margins.

There is extensive representation of activity account owing to the fact that households are now explicitly recognized in the SAM as producing units. As a result the SAM includes 57 activity accounts of which 35 are multiproduct household activities while 12 are purely non-agricultural. There are also 35 representative household groups where each regional state in the country is represented by rural, other urban and big urban households. Rural households are further classified by four agro-ecological zones: moisture sufficient and drought prone highlands, and moisture sufficient and

drought prone lowlands. In addition, the SAM provides a detailed account of factors of production. There are a total of 88 factors where about two-third are labor types classified into five skill types for each administrative region in the country. Apart from these relevant extensions, the SAM also has other institutional accounts including accounts for enterprises, the government, investment-saving and the rest of the world (RoW).

4.3. Simulation design

Using a modified version (Aragie, 2014) of STAGE (McDonald, 2007), the essence of which is briefly described above, we analyze the effects of five agricultural policies on a typical African economy. Three of the policy interventions: irrigation development, production subsidy, and input subsidy, are instruments intended to achieve improved agricultural productivity. The other two policy simulations are targeted at insuring rural commercialization and agricultural transformation by supporting market development. In a low-income economy context, market information and infrastructural development refer to public-good investments, such as rural rood developments, that can lower transaction costs for remote households and facilitates access to markets. In particular, these policies aim at improving rural infrastructure which would ultimately cut per-unit margin services (*reduction in margin services*) and the size of commodities used to provide margin services (*margin service provision efficiency*). We are interested primarily in the ability of each policy to increase agricultural performance and the welfare of rural households, and how cost effective each policy is in terms of raising the welfare of the targeted population for every money spent on the policy. For ease of comparison of the effects of these policy options, we consider same level of public budget. In particular, we assume that the government plans to invest an amount equal to 5% (which is roughly about $1 billion) of the country's GDP in 2010.

Identifying a feasible source of fund is crucial as this also has relevant distributional implications. Three funding sources are considered for evaluating the relative efficiency of these policies on income and poverty. First, we assume that the government reallocates its expenditure away from non-productive consumption and towards these new policy options. We then consider the possibility that the government will be able to raise the additional funds equivalent to 5% of GDP using income tax replacement. The choice of the specific tax instrument depends on the ability of the country to raise the required level of funds. As informality still prevails in the country, we assume that the government will eventually develop the capacity to expand the income tax base. Lastly, and more close to the current trend in source of funds flowing towards agriculture (see section 3), we assume that the government is financing the expenditures using donor aids. The macroeconomic effects of these alternative funding sources will clearly be divers.

Irrigation development: Despite the huge potential in Ethiopia, only 6.8% of the total land under cultivation and less that 15% of the potential is irrigated (Mitik and Engida, 2013; Hagos *et al*., 2010). The government has recognized the role of irrigation for sustainable farming and poverty reduction; hence there are several project plans on the pipeline. A recent study by Hagos *et al*. (2010) to measure/quantify the contribution of the irrigation sector to the country's agricultural and overall GDP observed that irrigation input accounts for about 4 and 2% of agricultural GDP and overall GDP, respectively. Accordingly, a 2010 SAM for Ethiopia has been re-estimated to account for this information. Once this is done, the next question is how to link these funds to a possible level of irrigation development/expansion. We base ourselves on unit cost estimates from the literature. Calculation from Foster and Morella (2010) shows that large scale irrigation schemes in Ethiopia

require a $1953 investment per hectare, while small scale schemes cost $3590 per hectare, averaging about $2771 per hectare. Five percent of GDP which is about $1 billion can finance 360,880 hectares of land. This amounts to a 58% increase in irrigation input as the current level of irrigated land in the country is about 625,819 hectares (Hagos *et al*., 2010).[2]

Production subsidy: The production subsidy policy measure, as implemented here, provides the farmer a mark-up on the average price per unit of composite output it produces. These subsidies are proportional to the level of output, providing incentives to increase production. However, as a consumer, the farm household buys the target commodity from the market on the market price. We could also examine the production subsidy by imposing such a subsidy on different classes of agricultural commodities: food crops, cash crops and livestock. Since farm households are assumed not to consume considerable amount of cash crops, the effects on these households and the rural economy would be different under a cash crop production subsidy from a food crop production subsidy. However, farm households are treated in the data as multi-product activities producing composite commodities with the assumption of identical cost structures across specific commodities they produce. As in the case of irrigation development, a fund amounting to 5% of national GDP is considered available to finance the production subsidy package.

Input subsidy: The use of modern agricultural inputs is fundamental during the green revolution that swept through Asia and Latin America in the ’60s and ’70s. However, to date, the use of agricultural inputs remains very low in SSA in general, including Ethiopia. As a result, the government of Ethiopia has been financing input marketing systems, in which farmers were supplied with agricultural inputs at controlled and subsidized prices, and often on heavily subsidized credit. Hence, the input subsidy policy option enables farms buy subsidized intermediate inputs, i.e., at prices lower than the market price. In the experiments, a fund equivalent to 5% of national GDP is assumed to be allocated equi-proportionally to subsidize two strategic inputs of fertilizer and irrigation. The effect of this policy differs from the output subsidy as producers are forced to consume more of these two inputs in relation to others. Under production subsidy, farmers are free to optimally allocate inputs, given their market prices, such that they respond to the production incentive.

Rural infrastructure development: Trade and transport margins are high in Ethiopia averaging 10% of commodity demand (Aragie, 2014). We specifically target the quantity of margins used per unit of domestic demand and the quantity of commodity used to produce a unit of margin services, where the latter is an indication of efficiency improvement in marketing provision. The literature on cost of rural roads is used to link the budget to road density and then to improvement in marketing margins. Road development plans in Ethiopia’s Plan for Accelerated and Sustained Development to End Poverty (PASDEP): 2005-10 (MoFED, 2006) are used to compute the level of road network expansion that can be achieved with this level of investment. Over the five years, the government planned to invest about Birr 38.9 billion (which is 90% of the total road investment) on rural roads, which was expected to expand rural road density by 21 percentage points as of 2010 from 33.2 in 2005. PASDEP assumes that 95% of this investment is capital investment, while the remaining is recurrent expenditure. This ratio is used to allocate the new expenditure on rural infrastructure as capital and recurrent expenditure. Given these figures, a budget equal to 5% of GDP (which amounts

[2] Apart from the impact on agricultural production and productivity, this will also have noticeable distributional implications as only 15.7% of irrigated land and 10% of non-irrigated land income is distributed to poor rural households (Mitik and Engida, 2013).

to Birr 15 billion) could expand rural road density by 8%. An estimate on rural infrastructure-marketing (trade and transport) margin link from Schürenberg-Frosch (2014) on African countries shows elasticity of 0.19 for the agricultural sector and 0.15 for the non-agricultural sector. Taking the elasticity values from Schürenberg-Frosch (2014), the new investment can reduce trade and transport margin in the agricultural sector by 1.5% (8%*0.19) and in the non-agricultural sector by 1.2% (8%*0.15). These values are used for experiment purposes.

4.4. Model closure and market clearing conditions

A small country assumption is imposed with regard to the relationship the country has with the rest of the world; i.e., the country is price taker in the import and export market. We carry out a simplified assumption on the factor market. Factors of production are assumed to be fully employed. However, this assumption does not mean that factors are actually fully employed, but only that the transition from state of unemployment to employment, and vice-versa, is limited. Allowing for unemployment will not significantly affect the comparative efficiency of the expenditure items, which is the purpose of this analysis. In relation to the behaviors of saving and investment, investment driven saving is assumed where the saving rate is allowed to respond to changes in investment demand. As it is difficult for a small open economy to raise the required amount of foreign savings, fixed external balance is considered, where the exchange rate endogenously adjusts to clear the external balance. Further, the government is assumed to maintain the base level internal balance by allowing for its consumption expenditure freely adjust. This later assumption is also crucial for the simulation design as i) public reallocation of funds is considered as one source of funds; and ii) public financing of irrigation and rural road projects is exogenously linked to government saving.

5. Effects of agricultural policies

5.1. Macroeconomic effect

Irrespective of financing sources, investments in rural infrastructure (roads) and production subsidy lead to strong depreciation of the local currency, with the least impact coming from the input subsidy measure (Table 1). As expected, the exchange rate effect is more pronounced when the projects are financed by donors in the form of aid. The inflow of foreign currency in the form of donor aid contributes to the strong depreciation of the Birr. These policies also have heterogeneous impacts on government income and expenditures. While production and input subsidies resulted in strong drops in government income if the financing source is budget reallocation, investment in rural roads and irrigation development results in marked increase in these incomes as donor funds are used. Government income rises considerably when income tax is raised to finance the investments.

The choice of financing sources considerably shape how government expenditure changes. Obviously, reallocation of budget from consumption expenditure to capital investment results in strong drop in government expenditure. However, the use of donor funds dampen this effect on government expenditure as the declines are only one-third. These expenditures remain slightly above the base levels when the government raises fresh funds from direct income taxes. Notice that government capital investment increases substantially in response to investments on rural infrastructure and irrigation. Finally, the macroeconomic impacts of these agricultural policies are summarized on the GDP effects. Input subsidy, followed by irrigation development, results in stronger increase in GDP irrespective of the financing sources, while production subsidy remains less effective in this regard.

Table 1: Macroeconomic effects (%)

	Base (billion LCU)	Margin efficiency	Per unit margins	Production subsidy	Input subsidy	Irrigation develop't
Budget reallocation						
Exchange rate	1.00	-2.68	-2.68	-2.77	-0.77	-2.03
Tax Revenue	36.42	-6.32	-6.28	-9.34	11.40	-0.57
Activity tax	0.00	-	-	_-inf	-	-
Input tax	0.00	-	-	-	_-inf	-
Gov't income	51.00	-3.06	-3.06	-32.86	-29.30	-1.94
Exchange rate	44.58	-35.17	-35.16	-37.59	-33.51	-33.88
Gov't saving	6.42	220.00	220.00	0.00	0.00	220.00
GDP	376.17	1.24	1.26	1.19	2.54	2.04
Donor fund/aid						
Exchange rate	1.00	-3.83	-3.83	-3.94	-1.98	-3.15
Tax Revenue	36.42	-0.97	-0.93	-3.81	17.48	5.56
Activity tax	0.00	-	-	_-inf	-	-
Input tax	0.00	-	-	-	_-inf	-
Gov't income	51.00	17.67	17.68	-12.11	-8.05	19.09
Gov't expenditure	44.58	-11.45	-11.44	-13.85	-9.21	-9.83
Gov't saving	6.42	220.00	220.00	0.00	0.00	220.00
GDP	376.17	1.42	1.45	1.39	2.80	2.30
Tax replacement						
Exchange rate	1.00	-0.53	-0.52	-0.47	1.20	0.12
Tax Revenue	36.42	199.50	199.60	210.06	214.94	202.17
Activity tax	0.00	-	-	_-inf	-	-
Input tax	0.00	-	-	-	_-inf	-
Gov't income	51.00	27.79	27.80	0.05	1.19	28.48
Gov't expenditure	44.58	0.12	0.14	0.05	1.36	0.92
Gov't saving	6.42	220.00	220.00	0.00	0.00	220.00
GDP	376.17	0.40	0.42	0.31	1.82	1.41

Source: Own compilation based on model results

5.2. Production effect

Input subsidy is superior in terms of the effect on both agricultural and overall production, followed by irrigation development under all funding modalities (Table 2). It is, however, surprising to observe that these agricultural policies cause non-agricultural production to increase more rapidly compared to the surge in agricultural production, specifically when the government is assumed to reallocate its use of funds. The output effect of the policies is stronger when budget reallocation is used as a source of finance, while increasing income tax to finance the policies is less effective in relative terms. Although the production of both marketed and non-marketed agricultural output is likely to increase in all cases, non-marketed output tend to increase strongly even when rural infrastructure is allowed to improve. Despite the joint increase in market supply, this observation reveals the established semi-subsistent nature of production in the country. The two more productive policy interventions, i.e., input subsidy and irrigation development are more likely to result in greater increase in marketed production vis-à-vis production for own use. The agricultural policies examined can also allow a greater share of the expansion in non-agricultural production to flow to markets outside the household.

Table 2: Production effects (%)

		Margin efficiency	Per unit margins	Production subsidy	Input subsidy	Irrigation develop't
Budget reallocation						
Staple food	Non-marketed	2.59	2.59	4.40	5.18	3.66
	Marketed	2.09	2.10	2.63	5.27	3.48
	All staples	2.26	2.27	3.25	5.24	3.55
Cash crops	Non-marketed	2.33	2.32	4.21	4.79	3.22
	Marketed	1.04	1.08	2.62	11.28	4.33
	All cash crops	1.66	1.67	3.38	8.18	3.80
Other agriculture	Non-marketed	2.81	2.79	4.49	5.59	3.73
	Marketed	-0.38	-0.37	0.33	6.02	2.48
	All other agriculture	0.31	0.31	1.23	5.93	2.75
Non-agriculture	Non-marketed	0.50	0.50	2.92	5.06	2.21
	Marketed	2.18	2.19	0.98	6.80	3.82
	All non-agriculture	2.06	2.07	1.12	6.68	3.70
Total production		1.83	1.84	1.87	6.27	3.52
Agriculture	Non-marketed	2.59	2.58	4.39	5.19	3.59
	Marketed	1.11	1.13	1.82	6.16	3.22
	All agriculture	1.59	1.60	2.66	5.84	3.34
Donor fund/aid						
Staple food	Non-marketed	2.26	2.26	4.09	4.87	3.41
	Marketed	2.17	2.19	2.73	5.40	3.67
	All staples	2.20	2.21	3.20	5.22	3.58
Cash crops	Non-marketed	2.01	2.00	3.90	4.48	2.96
	Marketed	0.28	0.32	1.81	10.20	3.70
	All cash crops	1.11	1.12	2.81	7.47	3.34
Other agriculture	Non-marketed	2.20	2.19	3.88	4.99	3.18
	Marketed	-1.10	-1.10	-0.41	5.27	1.89
	All other agriculture	-0.39	-0.39	0.52	5.21	2.17
Non-agriculture	Non-marketed	0.10	0.10	2.52	4.66	1.91
	Marketed	1.31	1.32	0.16	6.05	3.16
	All non-agriculture	1.22	1.23	0.33	5.95	3.07
Total production		1.25	1.25	1.31	5.74	3.09
Agriculture	Non- marketed	2.20	2.20	4.01	4.82	3.27
	Marketed	0.82	0.84	1.53	5.85	3.05
	All agriculture	1.27	1.28	2.34	5.51	3.12
Tax replacement						
Staple food	Non-marketed	0.96	0.97	2.65	3.55	2.25
	Marketed	0.07	0.08	0.48	3.24	1.73
	All staples	0.38	0.39	1.24	3.35	1.91
Cash crops	Non-marketed	0.90	0.89	2.68	3.40	1.98
	Marketed	0.06	0.10	1.68	11.01	4.19
	All cash crops	0.46	0.48	2.16	7.38	3.13
Other agriculture	Non-marketed	0.99	0.97	2.49	3.77	2.10
	Marketed	-0.39	-0.39	0.34	6.04	2.87
	All other agriculture	-0.09	-0.10	0.80	5.55	2.71
Non-agriculture	Non-marketed	0.51	0.51	2.93	5.04	2.48
	Marketed	-0.02	-0.01	-1.25	4.76	2.14
	All non-agriculture	0.02	0.03	-0.95	4.78	2.16
Total production		0.13	0.14	0.12	4.67	2.24
Agriculture	Non-marketed	0.96	0.95	2.63	3.56	2.17
	Marketed	-0.10	-0.08	0.55	5.03	2.39
	All agriculture	0.25	0.25	1.23	4.55	2.32

Source: Own compilation based on model results

5.3. Consumption effect

Change in consumption provides a closer indication on how these agricultural policies could affect the welfare of households, while standard welfare analysis is provided later. The consumption effect is stronger for the input subsidy and irrigation development options although production subsidy can still provide considerable surge in consumption (Table 3). In all cases, under all funding sources, market consumption increases more than the increase in own account consumption. Furthermore, the agricultural policies results in bigger expansions in the consumption of non-agricultural commodities more than the growth in agricultural commodities. This is largely because prices of non-agricultural commodities decline in the former set of simulations, while prices of agricultural commodities increase.

Despite this overall picture, results are heterogeneous across households. Rural households experience stronger increases in agricultural and non-agricultural consumption under all agricultural policies whether the policies are financed by diverting public funds or by raising the income tax rate. Gains exceed for urban households as the government considers financing investments on rural roads and irrigation. Raising the income tax rate to finance these policies is exceptionally costly for urban households, resulting in a more than 6% drop in consumption as these households are the main contributors of income tax. These households also tend to lose marked declines in consumption when production subsidy is considered.

Table 3: Consumption effects (%)

			Margin efficiency	Per unit margins	Production subsidy	Input subsidy	Irrigation develop't
Budget reallocation							
Rural	Agriculture	Non-marketed	2.62	2.62	3.83	5.25	3.63
		Marketed	4.18	4.21	6.78	8.09	5.36
		All agriculture	3.42	3.44	5.34	6.71	4.52
	Non-agriculture	Non-marketed	0.22	0.22	1.71	5.16	2.06
		Marketed	5.90	5.93	7.82	7.21	6.25
		All non-agriculture	5.06	5.08	6.92	6.91	5.63
	All		4.11	4.12	6.00	6.79	4.98
Urban	Agriculture	Non-marketed	1.16	1.13	-4.03	-0.59	1.66
		Marketed	2.28	2.28	-1.73	2.70	3.51
		All agriculture	2.27	2.28	-1.74	2.69	3.50
	Non-agriculture	Non-marketed	-1.73	-1.76	-5.55	1.63	0.37
		Marketed	5.07	5.07	-0.10	2.02	5.23
		All non-agriculture	5.04	5.04	-0.13	2.02	5.20
	All		3.89	3.89	-0.80	2.30	4.50
Overall effect			4.05	4.07	4.33	5.69	4.86
Donor fund/aid							
Rural	Agriculture	Non-marketed	2.22	3.43	4.87	3.30	2.22
		Marketed	3.60	6.18	7.50	4.82	3.60
		All agriculture	2.93	4.84	6.22	4.08	2.93
	Non-agriculture	Non-marketed	-0.19	1.29	4.74	1.75	-0.19
		Marketed	5.25	7.17	6.60	5.62	5.25
		All non-agriculture	4.44	6.30	6.32	5.04	4.44
	All		3.56	5.45	6.26	4.48	3.56
Urban	Agriculture	Non-marketed	1.22	-3.98	-0.49	1.81	1.22
		Marketed	2.25	-1.77	2.68	3.58	2.25
		All agriculture	2.24	-1.78	2.67	3.58	2.24
	Non-agriculture	Non-marketed	-1.60	-5.43	1.78	0.68	-1.60
		Marketed	5.00	-0.16	1.98	5.21	5.00
		All non-agriculture	4.96	-0.19	1.98	5.19	4.96
	All		3.83	-0.85	2.27	4.52	3.83
Overall effect			3.61	3.63	3.90	5.28	4.49
Tax replacement							
Rural	Agriculture	Non-marketed	1.07	1.07	2.14	3.70	2.29
		Marketed	3.24	3.27	5.68	7.19	4.69
		All agriculture	2.19	2.20	3.96	5.50	3.52
	Non-agriculture	Non-marketed	0.74	0.74	2.24	5.63	2.83
		Marketed	2.78	2.80	4.34	4.22	3.35
		All non-agriculture	2.48	2.50	4.03	4.43	3.28
	All		2.31	2.32	3.99	5.05	3.42
Urban	Agriculture	Non-marketed	-8.06	-8.09	-13.48	-9.51	-7.31
		Marketed	-6.41	-6.40	-10.81	-5.95	-4.87
		All agriculture	-6.41	-6.41	-10.82	-5.97	-4.88
	Non-agriculture	Non-marketed	-8.23	-8.26	-12.19	-4.88	-5.79
		Marketed	-6.61	-6.61	-11.92	-8.81	-6.01
		All non-agriculture	-6.62	-6.62	-11.93	-8.79	-6.01
	All		-6.53	-6.53	-11.47	-7.62	-5.54
Overall effect			0.13	0.15	0.19	1.93	1.22

Source: Own compilation based on model results

5.4. Welfare effect

As reported in Table 4, rural households benefit strongly under all funding modalities, showing the possible poverty reduction roles of these expenditure items on agriculture as a huge proportion of the population still resides in rural areas where poverty is more widespread. At national level, input subsidy has the strongest effect on welfare followed by production subsidy. These expenditure items increase overall welfare by up to 6.4%. Investment options that intend to improve rural infrastructure, i.e., improvement in efficiency of margin services production and reduction in per-unit margins requirement, have the least effect on welfare although there is a gain of up to 4.2%. The size of the welfare gain increases from income tax to donor funds and to public budget reallocation. This rank in welfare effects across funding sources mirrors the effects on production (see Table 2). At household group level, while input subsidy is superior for rural households, urban households are more likely to be better-off if the government allocates the funds to irrigation development projects since this expenditure item results in stronger gins in income to these households.

Table: Welfare effects (%)

	Margin efficiency	Per unit margins	Production subsidy	Input subsidy	Irrigation develop't
Budget reallocation					
Drought prone highland	5.17	5.19	6.40	4.60	5.68
Drought prone lowland	6.16	6.17	5.91	6.99	6.77
Moist highland	3.91	3.92	6.15	7.68	4.87
Moist lowland	3.35	3.37	4.60	6.24	4.43
Rural all	4.26	4.28	6.17	6.89	5.11
Urban all	3.98	3.99	-0.06	3.60	4.62
All households	4.21	4.23	5.18	6.37	5.03
Donor fund/aid					
Drought prone highland	4.50	4.52	5.75	4.00	5.05
Drought prone lowland	4.57	4.58	4.30	5.57	5.23
Moist highland	3.42	3.44	5.68	7.22	4.45
Moist lowland	2.87	2.88	4.10	5.71	4.01
Rural all	3.70	3.72	5.63	6.37	4.61
Urban all	3.96	3.96	-0.08	3.61	4.67
All households	3.74	3.76	4.72	5.93	4.62
Tax replacement					
Drought prone highland	2.90	2.92	3.84	2.40	3.61
Drought prone lowland	4.81	4.82	4.09	5.81	5.64
Moist highland	2.11	2.12	4.17	5.94	3.32
Moist lowland	2.93	2.95	4.00	5.73	4.25
Rural all	2.39	2.41	4.08	5.09	3.47
Urban all	-5.72	-5.71	-10.05	-5.71	-4.70
All households	1.09	1.11	1.82	3.36	2.17

Source: Own compilation based on model results

6. Conclusions

Most countries, especially those in the developing world, identify a set of strategic objectives to promote agricultural production, assure food security, and reduce the level of poverty. Two of these objectives are (i) sustainable increase in agricultural productivity, and (ii) accelerated agricultural commercialization. Each of these objectives is backed-up by a long-list of priority investment areas.

However, these countries are constrained by the size of financial and technical resources required to execute both of the strategic objectives and all of these investment areas. In light of this, this study assesses the relative roles of alternative investment options thereby comparing the food security and poverty implications of a predetermined amount of investment. In particular, taking the case of Ethiopia, this study employs an economy-wide model to investigate and compare the agricultural growth and poverty reduction effects of alternative agricultural policies aimed at improving rural productivity and commercialization. The following conclusions can be drawn from the results:

- Overall, these policies can have positive and strong production, consumption, and welfare implications. The benefits are specifically higher for rural households, revealing the poverty alleviation effects.
- A comparison of the relative efficiency of the policies reveals that support to farmers in the form of input subsidy is the most effective among the five policy options in improving household (private) welfare, followed by irrigation and output subsidy. This indicates that, in a supply constrained economy of Ethiopia, focus on agricultural production and productivity enhancing activities is more rewarding (at least in the short-run) than efforts that would help link farmers to markets.
- Of the alternative sources of financing the expenditure items examined, reallocation of public funds away from non-productive public consumption towards the policies examined results in superior outcomes across all indicators of economic performance. However, budget reallocation option could be challenged by issue of fiscal sustainability since public budget on other expenditure items severely declines.

The following summary conclusion can be drown from the above observations. While input subsidy can be considered as a quick and short-run instrument for achieving rapid agricultural growth and poverty reduction, the long-run solution for poverty reduction is likely to lie on increased irrigation development as this spending item can also help reduce the risk of crop failure in this era of increased weather uncertainty and climate change. The study provides an interesting insight on rural investment prioritization in Ethiopia, and this same approach can be replicated to prioritize sector-oriented investment on other developing countries.

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