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Food Security Without Food Transfers?

A CGE Analysis for Ethiopia of the Different Food Security Impacts of Fertilizer Subsidies and Locally Sourced Food Transfers

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ABSTRACT

Both availability and access issues underpin Ethiopia's food security challenges. The country is mostly dependent on drought-exposed, rain fed agriculture, and high transaction costs inhibit trade in staples. Most of the population lives in rural areas where poverty is widespread and livelihoods vulnerable to shocks and poverty traps. This paper looks at different approaches to improve food security in Ethiopia. Specifically, it compares the impacts on the access and availability dimensions of policy-based fertilizer subsidies, targeting yield growth against one of additional food transfers, sourced from local markets. It also explores the possibility of combining the subsidies with a switch to local procurement of current food transfers. It first runs a micro simulation model based on empirically estimated yield functions to quantify the likely effects of additional fertilizer application on national yields, suggesting a rather modest response. It then simulates the policies of interest using the static IFPRI standard CGE model, calibrated for Ethiopia using the 2005/06 social accounting matrix of the Ethiopian Development Research Institute (EDRI).

Simulation results point in two directions. First, the food transfer policy is more effective at raising consumption of staples by the targeted rural poor. Second, the moderate yield growth induced by the subsidy shows economic multipliers, stronger effects on domestic supply and welfare gains accruing to all poor through increased factor incomes and decreased staple prices. Yield growth seems a promising avenue to pursue food security and, more generally, poverty reduction goals. Nevertheless, policies focusing on one dimension of the yield function alone, such as fertilizer subsidies, are unlikely to deliver the necessary improvement in yields. Food transfers may still be the most effective short- to mid-term answer to food access insecurity when high return agricultural productivity policies are not available and when internal resources can be used to bear policy costs, avoiding the exchange rate distortions associated with foreign financial assistance.

Keywords: food security, fertilizer subsidies, food transfers, local procurement, computable general equilibrium models, Ethiopia

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1. INTRODUCTION

Food security challenges are widespread in developing countries around the world. The understanding of these challenges among social scientists has indeed expanded a great deal in the past decades. A classical view which thought of food security primarily in terms of domestic availability was first enriched with an appreciation of the role of access and entitlement to food (Sen, 1981) and later complemented with the issues of utilization and micronutrients deficiency. Intra household distributional issues have also come to the fore (Dercon and Krishnan 2000).

Several policy responses have been devised to address identified dimensions of food insecurity. Arguably, the debate here is far from settled. Food transfers, for example, have been a prominent component in food security interventions but have come under criticism for a number of alleged disincentive effects leading to protracted dependency. These effects feature in general equilibrium policy simulations (Gelan 2007), but econometric tests often fail to find empirical evidence for them (Barrett and Maxwell 2005). Local procurement represents a recently proposed solution to disincentive effects resulting from depressed domestic prices that has yet to pass empirical tests of effectiveness.

Policies targeting agricultural productivity have also been proposed with a food security rationale, as farmers' welfare is enhanced by higher incomes and net consumers benefit from lower food prices (FAO 2010). Input subsidies, in particular, have attracted renewed attention following a recent Malawian experience (Minot and Benson 2009).

In this paper we use general equilibrium analysis to explore possible avenues to secure further food security gains in Ethiopia. Given the aggregate nature of our model, we focus on the dimensions of availability and access. In particular, we compare two policies: fertilizer subsidies and an extension of current food transfers, based on local procurement. We also explore the possibility of combining the subsidies with a switch to local procurement of current food transfers. The three policies are calibrated so that they result in equal demands for additional government expenditure. Furthermore, we use recent yield function estimates for Ethiopia to run a microsimulation model predicting the impact of higher fertilizer uptake on agricultural productivity. This enables us to study the subsidies in the context of yield responses currently applicable to Ethiopia. Model parameters are also calibrated so that household consumption response to the additional transfers and farmers demand response to the subsidies are realistic. Lastly, sensitivity analysis is performed for key assumptions.

Our contribution is threefold. First, we present the first general equilibrium analysis of locally procured food transfers for Ethiopia. In this sense, our work expands on Gelan's general equilibrium analysis comparing in-kind food aid and cash transfers (Gelan 2006). Second, we draw the general equilibrium conclusions to the recent debate on returns to fertilizer in Ethiopia (Asrat, Bizuneh and Seyoum Taffesse 2010; Dercon and Hill 2009). Given estimated yield responses, we find economic multipliers to an expansion in fertilizer uptake that is significant but not sufficient to match access gains under food transfers. Third, by comparing an agricultural productivity-based food security policy against an in-kind transfer policy, we generate a number of insights of general relevance. In particular, we identify and explore price and factor returns channels through which the policies impact incomes and access to food of various groups.

The rest of this paper is organized as follows. Section 2 reviews relevant literature on food transfers and fertilizer subsidies. Section 3 gives background information on Ethiopia, outlining current food security challenges, trends in food assistance and a number of stylized facts about fertilizer uptake, markets and rates of return. The general equilibrium model used is presented in Section 4, together with details of the specific policy simulations which are run. Section 5 presents the results and sensitivity analysis. Section 6 concludes.

2. LITERATURE REVIEW

Both fertilizer subsidies and food transfers have attracted substantial interest in the literature in recent years, albeit from different angles. Fertilizer subsidies are seen as a policy tool to increase agricultural productivity and encourage technological transformation in agrarian settings. Their merits in terms of achieving such productivity gains and their cost-effectiveness have been the subject of intense discussion. Food transfers, on the other hand, are seen as the standard response to food insecurity and have also recently been employed as part of safety net, asset protection programs (Barrett and Lentz forthcoming). The main focus of the analysis of the transfers is on their efficacy in raising household food consumption and on the disincentive effects they may create. In this literature review of the two policies, we briefly summarize some of the findings and arguments which are relevant for our analysis.

Fertilizer Subsidies

In Africa, average fertilizer use is very low even by developing-country standards: an average of 13 kilograms per hectare (kg/ha) of arable land in Africa versus 94 kg/ha in all developing countries. Micro evidence complements the macro picture documenting low adoption rates and a tendency for many farmers to stop using fertilizer after some years of adoption (Duflo, Kremer and Robinson 2008, Dercon and Christiaensen 2007, Tavneet forthcoming). In spite of low adoption rates, yield responses and economic returns to fertilizer use are often thought to be high. Duflo, Kremer, and Robinson, for example, experimentally document a mean seasonal return of 36 percent for Kenyan farmers using fertilizer in Busia District. This common wisdom of high, unexploited returns has recently been questioned by new evidence indicating high idiosyncratic heterogeneity in returns and negative economic returns at the bottom of the distribution (Zeitlin, Caria, Dzene, Jansky, Opoku, and Teal 2010; Tavneet forthcoming). Furthermore, Dercon and Hill (2009) in a recent paper on Ethiopia emphasize the complementarity of fertilizer with improved seeds varieties. They argue that in the case of Ethiopia available improved seeds offer yield gains of a smaller magnitude than *Green Revolution* seeds such as IR8 rice in India and leave little scope for further fertilizer induced gains in productivity (Dercon and Hill 2009).

Inorganic fertilizer in African countries is often an expensive imported commodity (Jayne, Govereh, Wanzala, and Demeke 2003). A case for fertilizer price subsidy therefore exists if returns to increased fertilizer use are believed to be high and some of the benefits from increased agricultural productivity are external to farmers or adoption is hampered by otherwise unaddressable market failures in credit, insurance, or domestic distribution markets.

After featuring as an almost ubiquitous element in Sub-Saharan Africa's agrarian policy in the 1970s (Bates, 1981) and following a subsequent roll-back phase, fertilizer subsidies are now a subject of renewed interest. A number of factors have contributed to this. First is the recent increase in maize harvest in Malawi, which is usually attributed, albeit controversially, to the government-sponsored fertilizer and seed program. Using a fixed effects estimator, Ricker-Gilbert, Jayne, and Black (2009) indeed find that the subsidy promoted adoption among a subset of farmers who did not use fertilizer before, generating high yield responses. Second, the Malawi famine of the 1990s and the global food crisis of 2007/08 further highlighted the importance of improving agricultural productivity (Minot and Benson 2009). Third is the positive, retrospective appraisal of the role of fertilizers subsidy in the Green Revolution in Asia.

However, fertilizer subsidies remain controversial. To the extent that subsidies are justified on the basis of domestic market failures elsewhere in the economy, say in credit or insurance markets, they remain a second best solution. Interventions directly aimed at correcting the relevant market failures should in principle be superior. Furthermore, a number of criticisms have emerged from the analysis of African countries' experience with the policy. Appropriation of subsidies from an élite of large-scale farmers was at the heart of some of the initial critiques (Bates 1981). Later retrospective appraisals pointed to the high cost and limited effectiveness of fertilizer subsidies in the 1970s and 1980s (Minot and Benson 2009). Furthermore, it is argued that subsidy schemes may undermine the formation of widespread private fertilizer distribution networks. Jayne, Govereh, Wanzala and Demeke (2003) compare the Kenyan, Zambian, and Ethiopian experiences. While evidence from Kenya and Zambia supports the theory that subsidies undermine private market development, in Ethiopia subsidy removals have actually resulted in greater government control over fertilizer pricing and distribution and the exit of prominent private actors from the market.

Food Transfers

Let us now turn to the literature on food transfers. Three issues are of interest here: the efficacy of transfers in increasing households' food consumption, the disincentives they may create, and the design issues.

First, food transfers have to a degree been shown effective in increasing households' food consumption. Contrary to what some may expect, though, the increase in food consumption that results from a transfer is almost always *smaller* than the amount of the transfer itself. Households are often able to sell some of the transferred amount in order to earn some cash income to be used for nonfood expenditure. Alternatively, households that rely on the market for food consumption may cut back on some of their original market purchases (Dorosh and Del Ninno 2002). The *additionality* of food transfers—that is, the increase in food consumption as a proportion of the food transfer— is hence almost always incomplete.

The food households receive is in effect a source of income, and such income is fungible for a number of purposes. Economic theory would hence predict that as long as the amount of the transfer is *inframarginal*—that is, smaller than what the household would normally buy from the market (Southworth, 1945)—then the food transferred simply replaces cash purchases of the same commodity. But a closer empirical assessment of this proposition suggests that this is not often the case. For instance, using a propensity score matching technique, Dorosh and Del Ninno (2002) find that the wheat consumption of Bangladeshi households increased by only 25 percent of the amount of small wheat transfers received after the severe floods of 1998.[1] Thus, the additionality of food transfers appears substantial but far from complete.

Second, a number of disincentive effects of food transfers have been alleged, with only some receiving empirical confirmation. Barrett (2006) provides a useful overview, distinguishing between disincentive effects that can be found at the micro, meso, and macro levels.

Micro-level effects include disincentives to poor household labor supply due to the income effects of the transfer or the work component of food-for-work programs. Household production of food can hence be reduced by the presence of a transfer program. Meso-level effects include effects on prices and community-level moral hazards for ensuring the continuation of the transfer program. Macro effects can take the form of displacement of commercial imports and of a *Dutch Disease* appreciation of the exchange rate.

As Barrett and Lentz argue, micro-level effects are often the result of the poor timing or targeting of food distributions and little sound empirical evidence has been produced that documents the existence of such effects (Barrett 2006; Lentz 2003). Abdulai, Barrett, and Hoddinott (2005) are an exception and empirically test the hypothesis of micro-level negative effects. Their results for Ethiopia fail to find significant effects of food aid on labor supply or farm investment once proper controls for household and village characteristics are included in the regression equation[2].

[1] On the other hand, the marginal propensity to consume wheat out of an increase in cash income was close to zero. Senaur and Young's (1986) tobit estimates similarly show that cash transfers were associated with a smaller increase in food consumption than food stamps of the same, infra-marginal value (Senaur and Young 1986). Cash and food transfers do not appear to have equivalent effects on households' food consumption. Hence, although cash transfers are increasingly considered as an appealing alternative, mainly due to the lower logistic costs involved in their distribution (Dorosh and Del Ninno, 2002; Del Ninno, 2000), food transfers appear superior from a food security perspective.

[2] They also use a vector-autoregressive regression model to check for the presence of disincentive effects to food production at the macro, national level and, again, do not find evidence for those.

Meso-level price effects, on the other hand, are often un-avoidable (Barrett and Maxwell 2005, Donovan et al. 1999). Food transfers that are not sourced from local markets will very often result in a decrease in food prices, as shown by Gelan (2007) within a general equilibrium framework for Ethiopia. A simple theoretical explanation for this comes from Engel's law. Food transfers introduce positive income shocks in households' budgets, thereby raising demand for all normal commodities. As we have seen above, this is behind the incomplete additionality of food transfers: households will often respond to the transfer by either selling some of the food or cutting back on market purchases. In-kind transfers sourced from international markets will thus create an increase in supply that is not fully met by an ensuing increase in demand, and thereby they will lower the price of the transferred commodity (Barrett 2006).

Third, the reliance of food aid agencies on food surpluses produced abroad is often blamed for the meso-level negative price effects of food aid. Consequently, design issues have now come to the fore and a shift to local procurement of food, that is, procurement "in the same country where the food is to be distributed" (WFP 2009) is gradually taking place.[3] In the words of Walker, Coulter, and Hodges (2005), local procurement "is widely believed to assist in the development of local agriculture and livelihoods in the source countries. It can also be expected to contribute to the development of more transparent and efficient domestic and regional grain marketing systems."

Although to date there has been little econometric analysis of the effects of such programs (Walker, Coulter and Hodges 2005), WFP (2006) provides an overview of qualitative case studies of local procurement. Two separate issues are explored. On the one hand, the cost-effectiveness of local procurement as opposed to traditional procurement modalities is defended (Clay and Benson 1990). On the other hand, a number of positive effects on local markets,[4] traders and producers are documented.[5] Lastly, Walker, Coulter and Hodges' (2005) qualitative case studies add a new concern to the debate by pointing at a negative role played by poorly timed WFP local purchases in increasing seasonal price volatility, with possible adverse effects on food security.

[3] The World Food Programme (WFP) estimates that in 2006 about 20 percent of global food aid flows were sourced through local procurement (WFP 2006). At the same time the percentage of WFP's food assistance that is locally procured has been trending upward, reaching a peak of 78 percent in 2008, with purchases spread over 73 developing countries (WFP 2009).

[4] Demand for blended and fortified food stimulated the growth of local food processing industries, while demand for staple food encouraged local market development through increased investment in storage infrastructure, improved business practices, and higher quality of food.

[5] Effects on producers and traders depend on the bidding system. Under competitive bids, "food aid grain sales are, for the main part, highly concentrated among a few suppliers, giving rise to concerns of price manipulation" (Walker, Coulter, and Hodges 2005). To avoid excessive concentration, groups of farmers are sometimes contracted directly. This has resulted in positive income effects and greater agricultural investment on the part of the contracted farmers, but it has proved costly for WFP in terms of higher prices paid, administrative costs, and risk of default (WFP 2006).

3. THE ETHIOPIAN CONTEXT

We briefly characterize the Ethiopian context in a number of key dimensions: food security, food transfers, fertilizer adoption, rates of return, and markets. The discussion highlights the persistence of food security challenges, the high levels of food transfers in the last decade and the relatively low levels of uptake and estimated yield response to fertilizer observed so far.

Food Security

Food security, in its most widely adopted conceptualization, depends on adequate availability, access, and utilization of food. With respect to the availability dimension, Demeke, Guta, and Ferede (2004) report a persistent food gap for Ethiopia, which is mostly met through food imports and food aid. Their projections—Table 2.3 in their paper—indicate a rising food gap during the period 2005–15, as agricultural growth is outpaced by rapid population growth. As these do not take into account the significant cereal growth achieved in the 2005–10 period (Dercon and Hill 2009), they may overestimate the worsening of the gap. Projections from the Growth and Transformation Plan also contradict the above forecast.

Closing the food gap is not itself in any way sufficient to ensure food security for all households. Food is often distributed unequally and some households may lack access to sufficient food. Comprehensive data on Ethiopian households' access to food is mainly available through the 2004/2005 Household Income and Consumption Expenditure (HICE). Using this dataset, Woldehanna, Hoddinott, and Dercon's (2008) paper on poverty and inequality trends reports a national headcount poverty rate of 38.7 percent. Although the paper documents remarkable progress in reducing headcount poverty over the period 1995/96–2004/05, the endpoint figure is still high. In particular, this figure aggregates a 39.3 percent poverty rate in rural Ethiopia and a 35.1 rate in urban areas and an even wider heterogeneity at the regional level—from a 48.5 percent rate in Tigray to a 27 percent rate in Harar. The poverty line used in the paper is "based on the cost of 2,200 kcal per day per adult food consumption with an allowance for essential nonfood consumption." Hence it essentially reflects a measure of food access—we can consider all households above the line as having sufficient access to food and most households below the line as having insufficient, insecure access.

Substantiating this point, a recent paper by Tafere and Seyoum Taffesse (2010) calculates household calorie consumption from the HICE and breaks it down in quintiles. Calorie consumption at the second quintile stands at 2,216, just above the cut-off, and consistent with a figure close to 38 percent of the population being below the cut-off. Furthermore, the bottom quintile consumption stands at 1,568 per day per adult—a worryingly low level of access to food for the bottom 20 percent of households (Tafere and Seyoum Taffesse 2010). Recent work from IFPRI's hunger index and Dorosh and Schmidt's (2009) regional disaggregation for Ethiopia also report estimates of calorie undernourishment in 2004/05 very close to the ones mentioned above.

More up-to-date data, although not nationally representative, comes from the 18 Ethiopian Rural Household Survey (EHRS) villages, which were re-surveyed in 2009. Tafere and Seyoum Taffesse (2010) report that in all but five of these villages calorie consumption per capita stood lower in 2009 than in 2004.

Food Transfers

Given widespread insufficient access to calories among Ethiopian households, coupled with a high incidence of severe drought and flood shocks, food transfers have been a recurrent measure adopted by the Government of Ethiopia to safeguard sufficient access to food among the population. Demeke, Guta, and Ferede (2004) report that "the size of food aid has increased, with significant ups and downs, from 239,000 metric tons in 1980 to 409,000 metric tons in 2001, representing an average growth rate of 2.5 percent per year." Food transfers have remained substantial in more recent years. In 2005, the year on which our simulations are based, food transfers amounted to 430,000 metric tons, which was significantly below the 605,000 metric tons of estimated requirement. Figures for distributed food assistance in following years are also high: 329,000 metric tons for 2006, 65,000 metric tons in 2007, 523,000 metric tons for 2008, and 670,000 in 2009.[6] Food transfers have thus been trending upward during the last decade. Most of this food is financed through foreign donations and is imported from abroad. WFP had initiated local procurement schemes in the mid 2000s, but these were halted during the food price crisis of 2008.

Fertilizer

Chemical fertilizer adoption significantly varies across crops in Ethiopia. While it is widely used in teff and wheat production, covering about 40 and 38 percent of plots respectively in 2004/05, it is used less extensively on maize and barley fields (Yu, Nin-Pratt, Funes, and Asrat 2010). Average application rates on cultivated land are low. Average application rates on fertilized land, though, compare more favorably with fertilizer use elsewhere and are reported to be about 0.78 quintal per hectare for teff, 1.02 for wheat, and 1.32 for maize in the same year of 2004/05 (Asrat, Bizuneh and Seyoum Taffesse 2010; Spielman, Kelemework and Alemu 2010).

Fertilizer prices are believed to be high and limiting adoption.[7] Croppenstedt, Dekeme, and Meschi (2003) indeed identify low value to cost ratios and lack of credit among a number of constraints to adoption and estimate a high price sensitivity of fertilizer demand. More recent work confirms the role of both credit and the relative prices with respect to output as determinants of fertilizer demand and points to the role of high transport costs and incomplete markets for credit and insurance as structural constraints for increased adoption and application (Zerfu and Larson, 2010).

While private sector participation in the fertilizer market has virtually disappeared in recent years,[8] marketing margins are reported to be similar to those of other African countries (Spielman, Kelemework, and Alemu 2010). This suggests that high international prices, and not domestic markets' oligopolistic structure, are the primary reason behind the high level of domestic fertilizer prices paid by farmers.[9]

Given relatively low fertilizer uptake rates and diminishing returns, it is surprising that recent microeconometric studies find low yield response to fertilizer application (Yu et al. 2010; Asrat, Bizuneh, and Seyoum Taffesse 2010). This may be partially explained by low levels of complementary input

[6] At the same time, estimated requirements were 508,000 metric tons in 2006, 208,000 metric tons in 2007, 845,000 metric tons in 2008, and 925,000 metric tons in 2009. Source: Disaster Prevention and Preparedness Commission (DPPC)- subsequently Disaster Risk Management and Food Security Sector (DRMFSS)- Humanitarian requirement reports, available online at the DRMFSS' website: www.dppc.gov.et.

[7] Asrat, Bizuneh, and Seyoum Taffesse (2010) report average fertilizer prices of 676 Birr per quintal in 2004/05.

[8] Between 1984 and 1993, the fertilizer market in Ethiopia was fully monopolized by the state where importation, distribution, and pricing were controlled by the state-owned agricultural input supply corporation (AISCO). With the issuance of the National Fertilizer Policy in 1993, however, a range of reforms were introduced toward liberalizing the fertilizer market in line with the country's broad development strategy of Agricultural Development-Led Industrialization and with donor requirements. The first set of reform introduced in 1993 ended state monopoly and allowed private-sector participation in the fertilizer market. In 1997/98 the market was further liberalized with the deregulation of the retail price and the withdrawal of fertilizer subsidies (Spielman, Kelemework and Alemu 2010).

The nature of major suppliers, from importers to retailers, has changed dramatically in the period following the reform. Private- sector participation was significant in the early years of the reform; by 1996 several private importers, 67 private wholesalers, and 2,300 retailers were operating with a significant share of the market. However, with the entry and increasing prominence of regional holding companies in the market since 1996, private companies rapidly exited: their share of imports went down to almost 0 in 1999 from a share of 33 percent in 1995. In 2000, private companies withdrew from the market and were totally replaced by regional holding companies with strong ties to regional government and alleged preferential treatment from the government for access to foreign currency. By 1996, regional holding companies accounted for about 67 percent of all fertilizer distributed in the country. In 2005, cooperative unions entered the market, which was followed by the subsequent withdrawal of holding companies in 2007 (Spielman, Kelemework, and Alemu 2010).

[9] Growing demand from developing countries and high oil prices are believed to be driving these recent international fertilizer price hikes (FAO 2008).

adoption and by widespread technical inefficiency.[10] Given estimated yield responses, value-to-cost ratios are low, and adoption of fertilizer, given current prices, may simply not be economical for a substantial proportion of farmers (Asrat, Bizuneh, and Seyoum Taffesse 2010).

[10] Although some improvement of efficiency has been registered over the period 1995–2009, "average level of farming efficiency for the surveyed farmers across all the years was 0.4, indicating that the farmer was less than one-half as efficient as those producing on the frontier" (Nisrane, Berhane, Asrat, Bizuneh, Seyoum Taffesse, and Hoddinott, 2010). According to the calculations of the authors, in 2009, this figure went up to 0.44, with peaks of 0.63 and 0.6 in Hararghe and Harussi/Bale zones, respectively.

4. THE CGE MODEL AND SIMULATIONS

Model and Data

This study uses IFPRI's standard static CGE model (Lofgren, Lee Harris and Robinson 2002). The model combines the abstract Walrasian general equilibrium with realistic economic data and simulates levels of supply, demand, and price that bear equilibrium across a specified set of markets. Accordingly, it is based on a set of simultaneous linear and nonlinear equations that define the behavior of economic agents, as well as the economic environment in which these agents operate, which is described by market equilibrium conditions and macroeconomic balances.

In the model a multistage production function is adopted. At the top level, value added and intermediate inputs and, at factor level, factors of production are combined by a Constant Elasticity of Substitution (CES) production function. Intermediate inputs are governed by Leontief's technology. In combining factors motivated by profit maximization, producers respond to changes in relative prices and are able to substitute among factors of production subject to constant returns to scale.

Furthermore, domestically sold and exported commodities are substituted through a constant elasticity of transformation (CET) function with an assumption of imperfect transformability between the two. Domestically produced commodities and imported commodities are substituted by the CES aggregation function, reflecting imperfect substitutability between imports and domestic output sold domestically (Armington, 1969). Each of the two specifications takes into account time or quality differences among its products.

Lastly, households' consumption demand is governed by a linear expenditure system (LES), derived from a Cobb-Douglas utility function. In the model, households are assumed to maximize their utility subject to their budget constraint.

Equilibrium in factor markets and macroeconomic balances is established through a number of closure rules.

Different factor markets reach equilibrium in different ways. Labor is assumed to be unemployed and mobile across sectors. Wages are fixed, and the employment level adjusts to reach equilibrium in the labor market. Capital is fully employed and sector specific so that capital returns adjust to reach equilibrium in the sector-specific market for capital.

Three macroeconomic closures are specified. First, the saving–investment balance is arrived at by assuming the savings-driven investment closure. In this case, saving rates are fixed and investment adjusts endogenously to the availability of loanable funds. Second, tax rates are fixed and government savings adjust to maintain the government balance. Third, levels of foreign savings are fixed and the exchange rate adjusts to maintain the current account balance, reflecting the managed floating exchange rate system currently prevailing in Ethiopia.

Finally, the domestic producers' price index (DPI) is fixed and considered as a numeraire, while the consumer price index (CPI) is flexible and hence all prices in the model are relative to the weighted unit price of households' initial production bundle.

The model is calibrated on the 2005/06 Ethiopian social accounting matrix (SAM), which has economy-wide data accounts representing the economy of the country (EDRI, 2009). The SAM is disaggregated into 47 activities, 69 commodities, 10 factors, 8 institutions including 6 households, different taxes, saving–investment, inventory, and rest of the world accounts.

Policy Simulations

In the paper we simulate three policies: a fertilizer price subsidy resulting in a 50 percent reduction in fertilizer price, an increase in locally procured food transfers of the same cost as the subsidy and a combination of the two policies.

In the first simulation, fertilizer price subsidy (FERT), we simulate a 50 percent price reduction on domestic price of fertilizer achieved through subsidy. A negative tariff rate is introduced to simulate the subsidy. Two more factors are adjusted. First, we calibrate the demand response to replicate the fertilizer demand elasticities observed at the time of the fertilizer subsidy removal in 1997. This is achieved by modifying the input–output coefficients in the model. Second, we increase total factor productivity (TFP) for agricultural activities using additional fertilizer. We estimate a realistic TFP change through a microsimulation exercise, which is discussed in the subsection below.

In the second simulation (LOCAL), we study the effects of an increase in locally procured food transfers. In this scenario, food aid wheat imports do not change, and food transfers to the rural poor are augmented through locally procured wheat alone. The cost of the intervention is equal to the cost of the fertilizer subsidy in the FERT simulation. An allowance is made for logistic costs involved in food delivery and hence the value of wheat transferred is assumed to be lower than the total cost of the policy. Finally, following the discussion of incomplete additionality above, we ensure household wheat consumption increases by an amount consistent with marginal propensity to consume out of in-kind transfers estimated for developing countries.[11] The latter is achieved through a targeted modification of the subsistence consumption parameter in the household demand equation.

In the third simulation (FERTL), we introduce the same fertilizer subsidy featured in FERT, while replacing some existing food aid wheat imports with locally procured wheat transfers.[12] The amount of locally procured wheat in FERTL is equal to that in LOCAL, but whereas in the LOCAL simulation local procurement is additional to existing food aid, in the FERTL simulation local procurement replaces existing food aid. The cost of the FERTL intervention to the government is hence limited to the subsidy cost alone: local procurement of wheat replaces existing transfers and hence can be implemented with no additional costs to the government.

As explained above, the three simulations are calibrated so that the cost to the government of implementing each of the policies is the same.[13] Such cost amounts to about 1.15 billion Birr. Our simulations assume that the government alone will bear this cost. Given the high government expenditure targets set under the recently launched Growth and Transformation Plan, which projects expenditure to be rapidly scaled up from 71.3 billion Birr in 2009/2010 to 201.2 billion Birr in 2014/1015 (Ministry of Finance and Economic Development, 2010), own-financing is not an unrealistic assumption. In the sensitivity analysis section, though, we also present the results of an alternative sets of simulations where donors sponsor the programmes through a direct transfer to the government.

To carry out the above simulations, we make a small adjustment to the standard model and make the wheat imports exogenous. We need such modification to ensure additional wheat transfers are sourced locally. The assumption finds justification in the low price elasticity of imports of high quality wheat and food aid wheat, which constitute a significant proportion of total wheat imports.

Fixing wheat imports generates implicit rents for the groups to whom imported wheat accrues. This concept is expressed by the idea of an implicit tariff and represented in Figure 4.1 below. IPP corresponds to the import parity price that clears the market before wheat imports are fixed. In this scenario, domestic production is QD and supply QS. The difference between supply and production is imports QM. IPP', then, is the new, higher import parity price that prevails after the fixing of the wheat imports. Domestic production rises to QM' and imports fall to QM'. The net effect on supply—QS'—is negative.

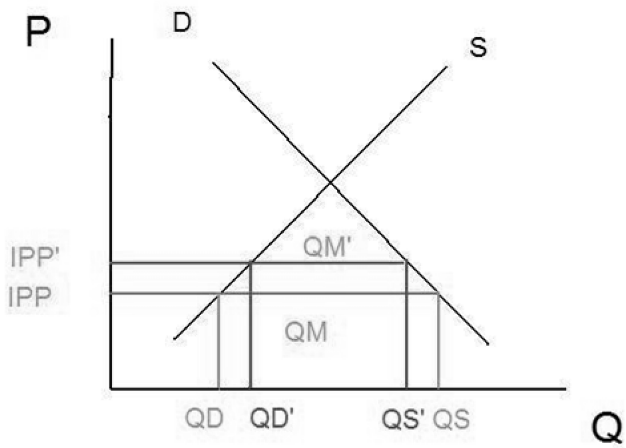
Crucially, the difference between IPP' and IPP represents the implicit rents accruing to the institutions holding wheat, which have now acquired higher value in domestic price terms. The amount of these rents is calculated and distributed to the beneficiaries of the wheat transfer.

[11] Specifically, we use the 0.25 marginal propensity to consume (MPC) reported by (Dorosh & Del Ninno, 2002)Dorosh and Del Ninno (2002).

[12] Rural poor households in both FERT and FERTL receive the same amount of food transfers. The only difference is that in FERTL, some of these transfers are procured locally.

[13] We will see later that this equality of cost applies only in partial equilibrium. In general equilibrium, the different policies will differently affect aggregate economic activity and hence will result in different net effects on government revenue from taxation and government expenditure.

Figure 4.1—An implicit tariff for wheat



Source: Authors.

Table 4.1— below summarizes the three simulations.

Table 4.1—Summary of policy simulations

	Fertilizer Subsidy	TFP productivity shock	Input output coefficients	Total food transfers	Local procurement	Wheat imports fixed in model
FERT	**Yes** approx 50% price reduction	**Yes** informed by micro-simulation	**Yes** reproduce observed elasticities	As in baseline	**No**	**Yes** fixed to baseline level
LOCAL	**No**	**No**	**No**	Baseline + 1.04 billion Birr additional transfers	**Yes** all additional transfers sourced from local markets	**Yes** fixed to baseline level
FERTL	**Yes** approx 50% price reduction	**Yes** informed by micro-simulation	**Yes** reproduce observed elasticities	As in baseline	**Yes** same amount as in LOCAL; substitutes aid wheat imports	**Yes** fixed to baseline – local procurement

Source: Authors.

Microsimulation

Empirical evidence from yield functions tells us that higher fertilizer application increases land productivity (yields). Technology may also affect labor productivity. Hence increased fertilizer application will have an effect on TFP.

The CGE model represents fertilizer as an intermediate input. Total quantity of value added and total quantity of intermediate inputs are mixed by a CGE aggregator. In order to reflect the TFP effect of increased fertilizer use resulting from the fertilizer subsidy we need to shock the TFP parameter of the value added function.

Our problem is to estimate exactly by how much we should increase the productivity parameter. Getting at an exact estimate is crucial for two reasons. First, results are quite sensitive to the assumption we make on productivity growth. Second, recent evidence for Ethiopia summarized above points to relatively low returns and widespread inefficiency in fertilizer use. Agronomic estimates are hence likely to overestimate the impact of increased fertilizer use on farmers' productivity.

We assume that change in the TFP parameter can be approximated by the change in land productivity and devise a microsimulation methodology to estimate the latter, given the increase in fertilizer imports under FERT and FERTL. Our simulation is based on yield response derived from econometric estimation and then applied to real data from the 2005/2006 Agricultural Sample Survey (AGSS) of the Central Statistical Agency (CSA) of Ethiopia.

We devise such simulation in four steps. First, we measure the increase in fertilizer consumption brought about by the subsidy, running the FERT and FERTL simulations omitting any productivity changes but maintaining tariff and fertilizer elasticity shocks only. Second, we allocate the additional fertilizer consumed to enumeration areas (EAs) in the agricultural sample survey following a simple sharing rule. Third, we use the yield function estimated in Asrat, Bizunesh, and Seyoum Taffesse (2010) to predict yields for every EA with the old and new fertilizer quantities.[14] Lastly, we compare average predicted yields across EAs with the old and new fertilizer quantities, calculating the percentage increase in land productivity, our proxy for increasing TFP.

The choice of the appropriate sharing rule is challenging. Farmers' application rates for the same crop vary widely. A significant group of farmers in the AGSS does not use any fertilizer on their field, while other farmers use substantial amounts. Given the non linear shape of the fertilizer return function uncovered by Asrat, Bizunesh, and Seyoum Taffesse (2010), the uneven pattern of adoption will result in different marginal yield responses for different groups of farmers. Such problem is difficult to tackle. First, the AGSS reports only average yields at the EA level, so we can run our microsimulation only using EAs as units of analysis. Second, we need to make an assumption as to the fertilizer demand of different groups of farmers after the subsidy.[15] Luckily, sensitivity analysis reveals that the aggregate effects on land productivity do not change much when the distribution of demand for the newly available fertilizer changes across EAs.

Under the first sharing rule—*All EAs*—each EA is allocated an equal amount of the increased supply of fertilizer. Under the other two rules, the additional supply is divided, in equal parts, only among the bottom 75 and 50 percent of the distribution of EAs according to fertilizer use.[16] Figure 4.2 below shows graphically how application rates of fertilizer on wheat change for wheat growing EAs.[17] In the figure, EAs are ranked according to their application of fertilizer on wheat. It is clear from the baseline graph, which plots real fertilizer application recorded in the AGSS 2005/2006, that almost half of EAs do not use any fertilizer on wheat. All of these are given a fixed share of fertilizer under the three simulations.

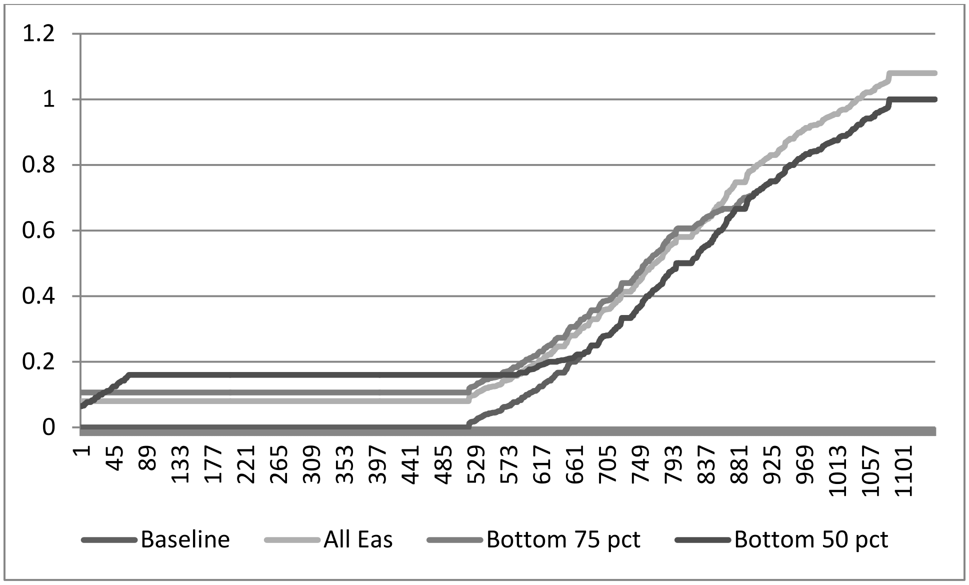
[14]We actually use newly estimated coefficients provided to us by the authors, which differ slightly from the ones published in the paper.

[15] Also notice that we assume throughout that no farmer starts cultivating new crops (or drops the cultivation of currently grown crops) as a result of the subsidy.

[16] Notice that we run the microsimulation for teff, wheat and maize only. Other cereals and cash crops- which are represented in our model in the "non traded agriculture" and "cash crops" categories respectively- use little quantities of fertilizer. For these crops, we impose a small productivity shock corresponding to the lowest shock measured, under a given sharing rule, among the three main cereals.

[17] Figures for teff and maize are given in the appendix.

Figure 4.2—Fertilizer application on wheat among wheat-growing EAs for AGSS 2005/2006 and different sharing rules



Source: Authors' calculations based on data from CSA's Agricultural Sample Survey and simulated increase in fertilizer application

The productivity gains implied by the higher fertilizer application are given in Table 4.2 below. Estimates in Asrat, Bezuneh, and Seyoum Taffesse show decreasing returns to fertilizer use for maize and wheat and increasing returns for teff. So as we move to the right in the table, aggregate productivity effects for maize and wheat increase, while those for teff go down. Importantly, even if results do change depending on the chosen sharing rule, the size of such changes is very small. The biggest percentage point change is for maize under FERTL; it amounts to as little as 0.4 percentage points (from 1.3 to 1.7). Hence, although refining the sharing rule is clearly an important area for future work, more sophisticated rules are not likely to generate productivity estimates that differ substantially from the ones used in the simulations of this paper. More details on the microsimulation methodology are given in the Appendix.

Table 4.2—Estimated productivity increases resulting from higher application under fertilizer subsidy (%)

	All EAs			Bottom 75%			Bottom 50%		
	Teff	**Wheat**	**Maize**	**Teff**	**Wheat**	**Maize**	**Teff**	**Wheat**	**Maize**
FERT	1.1%	1.7%	1.0%	1.0%	1.9%	1.1%	0.8%	1.9%	1.3%
FERTL	1.5%	2.2%	1.3%	1.3%	2.5%	1.4%	1.1%	2.5%	1.7%

Source: Authors' calculations based on data from CSA's Agricultural Sample Survey and yield response functions estimated by Asrat, Bezuneh and Seyoum Taffesse (2010)
Note: EA is enumeration area.

5. RESULTS

In this section we describe the main results for each simulation, compare the policies in a number of dimensions relevant for food security, and analyze the sensitivity of results and policies' ranking to changes in key assumptions.

Main Results

Table 5.1 shows summary variables for the FERT simulation. In FERT, the subsidy brings about a 51 percent reduction in the price of fertilizer. The combination of the price fall and the modified price elasticity results in an increase in fertilizer demand of 23.7 percent. This is not uniformly divided among crops: wheat experiences the largest increase and maize the lowest. The productivity shocks obtained from the microsimulation exercise range from close to 1 percent for maize, nontraded agriculture, and export crops to 1.7 percent for wheat.

As a result of productivity increases and higher use of fertilizer, domestic production rises. This is particularly significant for wheat, with a 9.3 percent increase. Prices of all crops fall, particularly cereals, and the cereal consumption of all households, including the rural poor, consequently rises.

On the macro side, the FERT simulation is characterized by increasing absorption and falling investment. The latter effect is linked to the fall in the government's savings due to the cost of financing the subsidy. Furthermore, additional household income increases the demand for imports: the real exchange rate depreciates, stimulating export growth.

Table 5.1—Fert simulation summary table

% Change from base: Agricultural commodities					
	Teff	Wheat	Maize	Ntraded	Export
Fertilizer application	19.31	28.53	14.69	24.42	22.59
Productivity shock	1.15	1.74	0.98	0.98	0.98
Composite price	-4.17	-4.93	-3.52	-1.13	-1.16
Domestic production	5.70	9.26	4.66	3.08	2.50
Household consumption	6.97	8.22	5.27	3.53	3.56
Rural poor consumption	7.05	8.25	5.25	3.53	3.59
% Change from base: Macro variables					
Absorption	1.5	exports		3.3	
Household consumption, all goods	2.7	imports		1.2	
Investment	-2.4	real exchange rate		0.6	

Source: Authors' simulations.

Summary variables for the FERTL simulation are presented in Table 5.2—. Fertilizer application increases significantly, rising by 29.5 percent on aggregate. The effect is particularly strong for wheat, for which fertilizer application rises by almost 60 percent: high domestic demand resulting from local procurement stimulates production expansion achieved partly through input intensification. Given a higher fertilizer demand response, productivity shocks are higher than in FERT but only modestly so.

Domestic production increases characterize the FERTL simulation too. Wheat is again the most responsive cereal, but local procurement increases the production effect by almost 25 percentage points over the FERT simulation scenario. As wheat imports are fixed in our model, the burden of meeting the increased demand for wheat has to be borne by domestic production alone.[18] High demand generated by local procurement also limits the fall in the price of wheat. The prices of teff, maize, and nontraded agricultural goods fall instead by a magnitude similar to that of FERT. Household consumption of cereals increases following the price falls. Again, poor rural household's consumption responds no differently than aggregate consumption.

Absorption and investment behave similarly to that observed for the FERT simulation, but the real exchange rate, exports, and inputs are basically unchanged from the baseline. Upward pressures on imports and the real exchange rate, coming from increased household incomes, are balanced by the significant reduction in food aid- related wheat imports determined by local procurement.

Table 5.2—FERTL simulation summary table

% Change from base: Agricultural commodities					
	Teff	Wheat	Maize	Ntraded	Export
Fertilizer application	20.33	59.04	15.60	25.54	19.81
Productivity shock	1.5	2.2	1.3	1.3	1.3
Composite price	-4.34	-2.34	-3.60	-1.16	-0.60
Domestic production	6.61	35.19	5.48	3.82	2.32
Household consumption	8.53	6.70	6.66	4.92	4.33
Rural poor consumption	8.86	6.87	6.66	5.05	4.5
% Change from base: Macro variables					
Absorption	2.1	Exports		0.2	
Household consumption, all goods	3.3	Imports		0.1	
Investment	-2	Real exchange rate		-0.2	

Source: Authors' simulations.

Details on the LOCAL simulation are given in Table5.3. Without a subsidy, fertilizer application basically stays put. The only exception is wheat: as local procurement stimulates wheat production, fertilizer application on the crop increases by 6.5 percent. No productivity shocks are introduced in the LOCAL simulation.

Domestic production responses are significant only for wheat, which grows by 6.5 percent,[19] while prices are subject to very modest increases. Household consumption increases for all cereals. Wheat consumption of the rural poor, after the transfer, increases by a significant 20.2 percent. Consumption of other cereals also increases: teff by 4 percent, maize by 3.3 percent, and nontraded agriculture by 3.8 percent.

On the macro side, absorption is almost unaffected and aggregate investment falls. The real exchange rate is basically unchanged, while imports and exports are reduced slightly.

[18] If wheat was fully tradable, the domestic price of wheat would be anchored to import parity. In such a scenario, a local procurement policy exercising upward pressure on domestic wheat prices would result in an increase in both domestic production and imports.

[19] Gelan 2007 simulates a reduction in food aid imports worth 0.94 billion Birr. Such a reduction creates excess local demand in a way not devoid of similarities with our expansion of local procurement, worth 1.04 billion Birr. When the removal of food aid is not accompanied by compensating cash transfers, Gelan's simulation results in a 2.2 percent production increase. When compensating cash transfers are included, in order to preserve households' purchasing power, food production rises by 4.5. For both simulations, prices of food crops increase by about 2.5 percent.

Table5.3—Local simulation summary table

% Change from base: Agricultural commodities					
	Teff	Wheat	Maize	Ntraded	Export
Fertilizer application	0.80	6.54	1.01	0.77	-0.44
Productivity shock	0.0	0.0	0.0	0.0	0.0
Composite price	0.18	0.41	0.18	0.20	0.52
Domestic production	0.80	6.54	1.01	0.69	0.37
Household consumption	2.97	17.96	3.23	3.48	3.04
Rural poor consumption	4.07	20.27	3.38	3.85	3.55

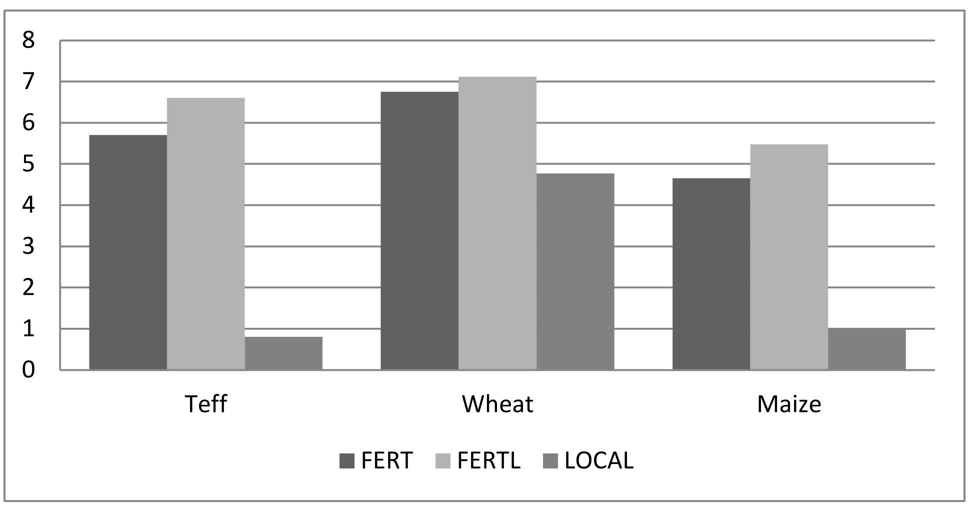
% Change from base: Macro variables			
Absorption	0.2	Exports	-0.7
Household consumption, all goods	1	Imports	-0.3
Investment	-2.7	Real exchange rate	-0.1

Source: Authors' simulations.

Let us now look at how the three policies compare in terms of impacts on food production and supply, poor households' access to food and income, macro effects on GDP, and cost.

Availability of food, in terms of the supply of main staples, is best promoted through a fertilizer subsidy policy. In particular, the combination of subsidies and local procurement of food transfers (FERTL), which stimulates the largest increase in fertilizer application and TFP productivity, produces the highest increase in the supply of each crop. Figure 5.1 below shows this graphically.

Figure 5.1—Percentage change in domestic supply



Source: Authors' simulations.

Domestic production response varies little from that described for domestic supply as trade is not playing an important part in the model: wheat imports are fixed, only little maize is traded and other cereals are not traded. Consequently, subsidy based policies that impact on productivity are also best at stimulating domestic production and, again, FERTL seems the best option. The domestic production response in FERTL is particularly strong for wheat, as it has to cover an imbalance produced by the rise in demand on one hand and decreased imports on the other.

Little supply and domestic reduction response takes place under LOCAL, with the exception of wheat, underlying a fundamental weakness of food transfer policy to sustainably tackle the availability side of food security, even when procurement is carried out in local markets. Table 5.4 below shows the exact figures.

Table 5.4—Percentage increase in domestic production

	Teff	Wheat	Maize
FERT	5.7	9.3	4.7
FERTL	6.6	35.2	5.5
LOCAL	0.8	6.5	1.0

Source: Authors' simulations.

Increases in domestic production for FERT and FERTL are quite high. Nevertheless, they still fall short of the base target of 8.1 percent overall agricultural growth under the Growth and Transformation Plan (GTP). In the FERT simulation this is true for every crop. In the FERTL simulation, on the other hand, only wheat is above the target. The high production response for wheat, though results from the necessity to balance the high increase in demand brought about by local procurement. As the CGE model scarcely incorporates natural constrains and transaction costs, we can think of such a high response as an equilibrium prediction that applies for a time-frame much longer than one year. A realistic yearly growth figure would be lower than what the static CGE model predicts. GTP growth figures for agriculture seem, on the whole, difficult to achieve through fertilizer intensification alone.

Another point worthy of notice is that percentage production gains for FERT and FERTL highlighted in Table 5.4 would most likely be decreasing in the successive years of the policy. A large part of fertilizer application increases is due to the dramatic fertilizer price fall and is already captured in our simulations. Successive years would see further application growth due the pull of rising demand, which, without any price stimulus and given the recent trends in fertilizer application growth, would probably be moderate. Furthermore, decreasing returns to fertilizer application will reduce the yield impact of these moderate fertilizer uptake increases.

The three policies have positive, but different impacts on household income. In the CGE model, household income can be affected through changes in factor incomes or through direct transfers.[20] Figure 5.2 below illustrates.

While raising income from factors by a small measure only, LOCAL significantly increases the incomes of the rural poor through food transfers worth 1.041 billion Birr.[21] Total income of the rural poor grows by 5.3 percent. Incomes of urban poor are on the other hand scarcely affected, as they receive no transfer and supply of labor—the only factor of production they hold in the model—grows only by 0.6 percent.

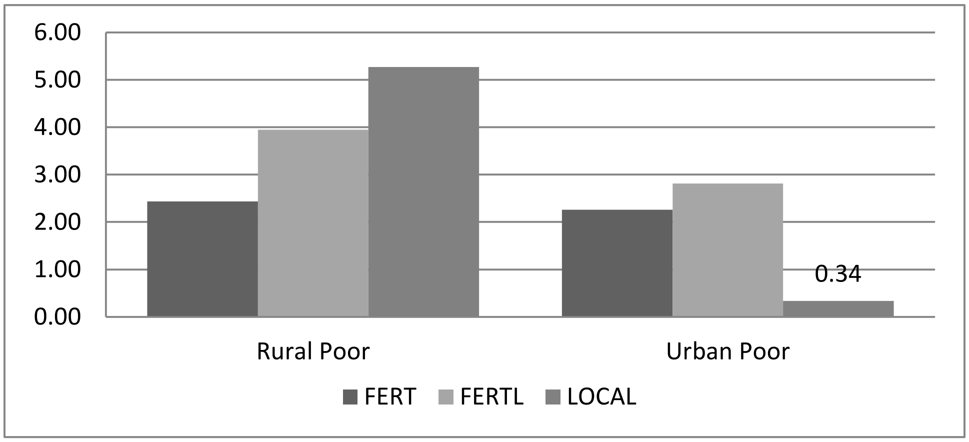
On the other hand, income effects of policies based on fertilizer subsidies are driven by significant positive changes in factor incomes. Labor incomes increase by 3.1 and by 4.4 percent under FERT and FERTL respectively. Land incomes also increase (6.8 and 8.2 percent) and so do livestock incomes (2.6 and 3.1 percent). These positive changes in factor incomes result in relatively similar welfare gains for all household categories. The rural poor, for example, benefit from 2.4 and 3.9 percent income increases under FERT and FERTL respectively. The urban poor experience similar income gains

[20] Under the unemployment closure, income changes are driven by changes in factor quantities. Under the alternative full employment closure, income changes are driven by changes in factor prices. In our model some labor is unemployed, while livestock and land are fully employed. Hence labor income rises through a reduction in the unemployment level, while livestock and land incomes rise through an increase in the price they command.

[21] Notice that, as explained in section 4, the food transfer is modeled as a cash transfer with a higher MPC for wheat.

of 2.3 and 2.8 percent under the two fertilizer subsidy-based simulations. So, while LOCAL offers the highest income impact for the targeted rural poor, FERT and FERTL stimulate factor markets and result in generalized income gains for all household categories.

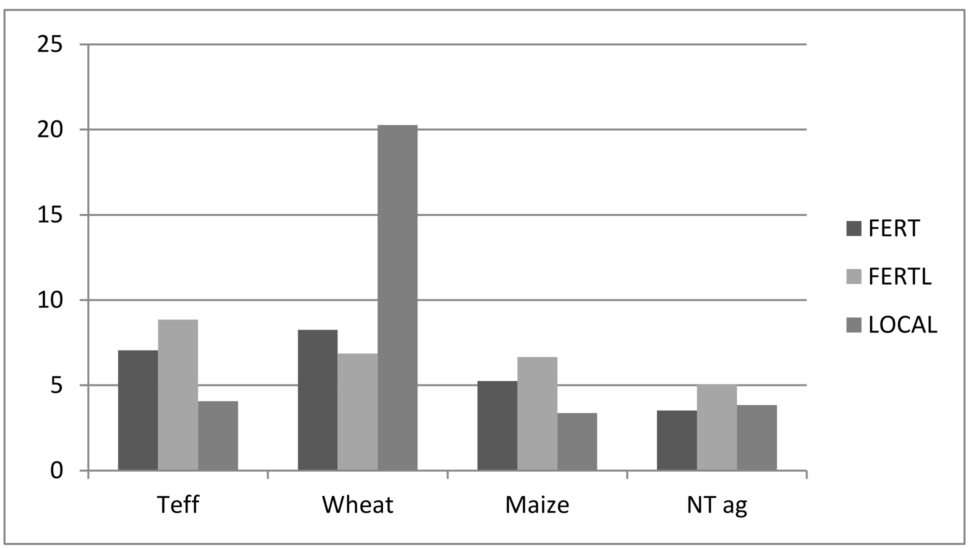
Figure 5.2—Household income percentage change from baseline



Source: Authors' calculations.

Changes in prices and incomes described above jointly affect households' food consumption, as shown in Figure 5.3 below. Consumption is a proxy measure for food access and hence is the most important food security indicator for our paper.

Figure 5.3—Percentage change from baseline of rural poor households' consumption of teff, wheat, maize, and other nontraded crops



Source: Authors' calculations.

LOCAL raises the rural poor's consumption of the transferred cereal by a large amount, 20.2 percent, while impacting consumption of other cereals and crops more modestly. Income effects raising demand for food other than wheat are in fact partially offset by higher cereal and food prices. FERT and FERTL, on the other hand, have a similar impact on consumption of the various food commodities, as income and price effects work in the same direction. Consumption of teff, for example, goes up by 7.0 and 8.9 percent respectively, while consumption of maize increases by 5.3 and 6.7 percent.

Given the different caloric contents of the various cereals and foods and the fact that such content changes with cooking, it is difficult to aggregate figures for different crops into a single index of access to calories.[22] As a rough approximation, in Table 5.5 we present results aggregating consumption of different commodities.[23] In the first column we aggregate teff, wheat, and maize. In the second column nontraded agricultural products (almost all food crops) are also added. As Table 5.5 shows, when aggregating the three staples, the highest consumption improvement is achieved under LOCAL. The consumption effect of LOCAL is coming mainly from wheat, though, so as more crops are considered, its relative advantage on FERT and FERTL diminishes, but it is not fully offset. Even when including the whole range of nontraded agricultural commodities, as in the second column, LOCAL still delivers the highest increase in total consumption.

Table 5.5—Percentage change in rural poor total consumption of teff, maize, wheat, and other food crops

	3 staples	All Food
	Teff, Wheat, Maize	Teff, Wheat, Maize, NT ag
FERT	6.78	5.09
FERTL	7.32	6.13
LOCAL	9.43	6.52

Source: Authors' calculations.

For all other household groups, including the urban poor, consumption changes induced by LOCAL are negligible, while both FERT and FERTL produce increases of a magnitude similar to those of the rural poor. Under FERTL, for example, urban poor's consumption of teff goes up by 7.5 percent, while consumption of wheat goes up by 5.5 percent and maize by 5.6.

As mentioned before, mistargeting is a crucial issue for any food transfer policy. We can think of the impacts on the urban poor in the food transfer simulation as indicative of the impacts on mistargeted rural poor in the same scenario. Under LOCAL, a mistargeted rural dweller receives no transfer, little increase in factor incomes, and faces slightly higher food prices.[24] The effects of the latter two factors seem to offset each other, so that there is almost no effect on food consumption. Fertilizer subsidies, on the other hand, in principle benefit the poor through market channels alone— higher employment of factors and lower prices—and hence, mis-targeting should not take place.[25]

Lastly, we compare the three policies under two more dimensions of impact: GDP and government savings. Table 5.6 presents some summary figures. Fertilizer-subsidy based policies, through the productivity effect, stimulate general economic activity and multipliers in the economy. They raise real GDP at factor costs by 1.9 and 2.9 percent, respectively. LOCAL, on the other hand, has minimal impact on aggregate economic activity, as it represents a transfer from one side of the economy (the government) to another (poor rural households) with small multipliers being activated.

In our simulations the government is paying the cost of the policies. Partial equilibrium costs are designed to be almost identical, as the previous section has discussed. Each policy though has different

[22] The use of appropriate calorie-conversion tables is indeed flagged as an area for future work.

[23] Notice this amounts to assuming that the caloric context of each cereal is the same. Such assumption may be particularly misleading for teff, which is known to have a high caloric content. Hence sensitivity analysis has been performed on the results of aggregated cereal consumption. All results presented still hold qualitatively (the ranking of simulations is unchanged) when assuming teff has a 50 percent higher caloric content than other cereals.

[24] Gelan 2006 also discusses a similar point with respect to nonbeneficiaries.

[25] This is not to say that the distribution of benefits is not skewed—in practice larger or more politically influential farmers often do benefit more. But poor smallholders' households are in principle targeted uniformly.

impacts on the economy and hence affects the government's budget in different ways. Policies that generate more economic activity, for example, will increase tax revenues and hence, in a general equilibrium sense, are less costly to the government. We look at impacts on government savings as these quantify the effect of the policies on the government's budget once revenue and expenditure have adjusted. As it is clear from column 2, policies that raise GDP more reduce government savings by less. So FERT and FERTL have a lower cost to government once general equilibrium effects are fully realized.

The last column in Table 5.6 compares the absolute change in GDP to the absolute change in government savings for each of the policies. In other words, it estimates how many Birr of GDP are generated by a decrease in 1 Birr of government savings. The figure is less than 1 for LOCAL and 2.27 and 3.03 for FERT and FERTL, respectively. When fertilizer subsidies are combined with local procurement of food transfers, each Birr spent by the government in general equilibrium costs generates 3 Birr of GDP growth. Productivity enhancing policies seem thus to be superior from a macro accounting point of view.

Table 5.6—Impacts on GDP and government savings

	% Change in real GDP	% Change in gov savings (GE cost)	DGDP/ GE costs[26]
FERT	1.9	-19.2	2.27
FERTL	2.6	-19.9	3.03
LOCAL	0.3	-22.6	0.30

Source: Authors' simulations.

In summary, our main results point to the superiority of subsidy-based policies for raising food production and supply and in terms of macroeconomic balances. On the other hand, food transfers seem superior in raising household food consumption of targeted rural poor, hence addressing the access part of food security, even at low levels of the marginal propensity to consume (MPC). Nevertheless, welfare gains from food transfers do not flow through market channels and hence do not reach mis- or non-targeted households, whereas gains from subsidy-based policies positively affect the incomes of all household groups.

Sensitivity Analysis

Three main assumptions in our simulations require robustness checks: the imposed productivity shocks, the MPC out of a food transfer, and the financing of the policy. First, given the high economic multipliers associated with agricultural productivity growth and high yield increases observed in recent years (Asrat, Bizuneh and Seyoum Taffesse 2010), the magnitude of the productivity shocks imposed is crucial to determine realistic effects on household consumption. We hence run again the FERTL simulations assuming an increase in productivity double to what our microsimulation model suggests. The new simulation is called FERTL2. Second, to our knowledge there are no econometric estimates of the marginal propensity to consume out of food transfers for Ethiopia. The 0.25 estimate we use comes from Bangladesh and may differ substantially from the real value in Ethiopia. Thus, we also run again the LOCAL simulation, now imposing a 0.5 MPC. The new simulation is called LOCAL2. Third, we also consider a different financing scenario in which donors pay for the implementation cost of each of the policies through a direct transfer to the government. Ethiopia receives substantial amounts of development and humanitarian assistance and it is hence realistic that donors may play an important role in the financing of the simulated policies.

The main results are qualitatively almost unaffected by the introduction of the new assumptions. Subsidy-based policies remain superior at raising domestic cereal production and supply, have more

[26] This is calculated as the ratio of absolute change in GDP over absolute change in government savings.

widespread welfare gains, and larger effects on GDP. Similarly, the transfer-based policy retains some of its appeal in improving access to food. Table 5.7 below shows sensitivity analysis results for rural poor total food consumption, when productivity and MPC assumptions are changed. Even when productivity impacts are doubled and MPC stays at 0.25, fertilizer-based policies are inferior, albeit slightly, to transfer policies in raising consumption of the three staples. Although this statement does not extend to the all food commodities case, comparing simulations doubling both productivity impact and MPC points again to the superiority of transfers in improving access to food.

It is also to be noted that due to a higher upward pressure on prices, the nontargeted urban poor consumption of wheat and teff decreases marginally under LOCAL2, by 0.6 and 0.3 percent respectively, whereas it stayed unchanged under LOCAL.

Table 5.7—Sensitivity analysis on percentage change of rural poor total food consumption

	3 staples	All Food
	Teff, Wheat, Maize	Teff, Wheat, Maize, NT ag
FERTL	7.32	6.13
LOCAL	9.43	6.52
FERTL2	9.2	7.8
LOCAL2	15.6	8.8

Source: Authors' simulations.

We also find different macro dynamics, but little change in our ordinal comparisons of policies when we run the simulations using a different financing assumption. In particular, we now assume that foreign donors bear the full cost of policy implementation. Hence we augment the previous simulations with a transfer from the rest of the world account to the government account equal to the upfront implementation cost of 1.15 billion Birr.

On the macro side, increased capital inflows result in upward pressure on the real exchange rate, depressing exports. On the other hand, the additional resources available to the government allow for more investment spending. The net effect is slightly negative, resulting in lower GDP gains than those achieved under the own-financing option. In general, though, the sensitivity of key macro variables to changes in the source of financing is small.

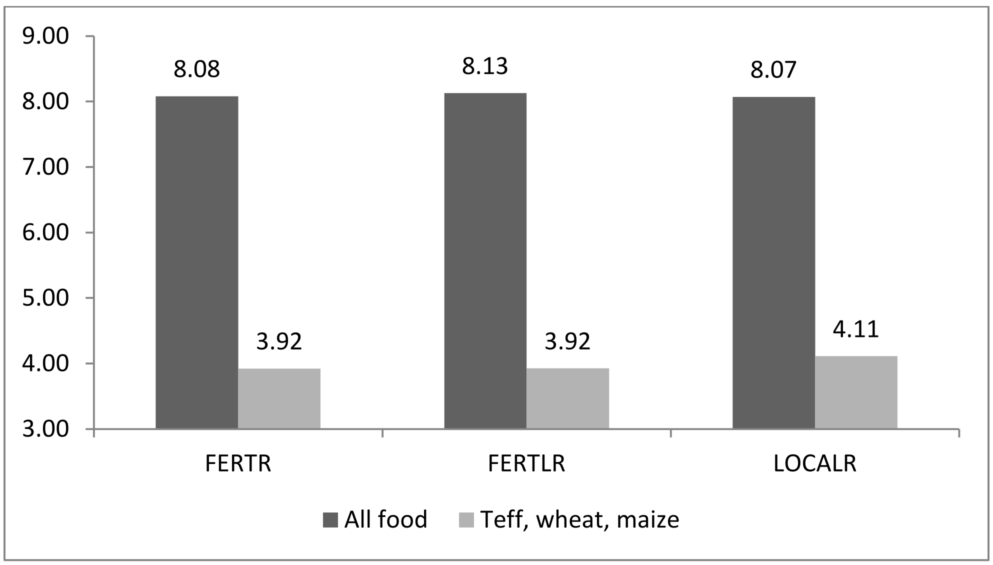
Table 5.8—Percentage change from baseline for selected macro variables under different simulations and financing options

		Own financing	Foreign Financing
Real exchange rate	FERT	0.6	-0.4
	FERTL	-0.2	-1.3
	LOCAL	-0.1	-1.0
Investment	FERT	-2.4	0.9
	FERTL	-2.0	1.2
	LOCAL	-2.7	3.4
Real GDP at factor cost	FERT	1.9	1.4
	FERTL	2.6	2.0
	LOCAL	0.3	0.1

Source: Authors' simulations.

The above macro changes tend to depress the production responses of each of the simulations by small amounts, so that no changes emerge in the ranking. IN FERTL and LOCAL, the appreciation of the exchange rate depresses the production of cash crops and livestock. In FERTL this is more than compensated by the productivity growth resulting from higher fertilizer use, so all factor returns increase. In LOCAL, on the other hand, returns from land and livestock factors fall. Hence in the latter the income gains for poor rural households fall markedly from 5.3 percent under own-financing to 0.3 percent only under foreign financing. The transfer compensates for this in terms of food consumption: LOCAL still dominates the other policies significantly when considering consumption of the three cereals and fares slightly below them for all food consumption. Nevertheless, the fall in factors' income clearly limits the poverty reduction potential of the transfer based policy under foreign financing.

Figure 5.4—Rural poor households' consumption under different simulations and foreign financing



Source: Authors' simulations.

6. CONCLUSIONS

Improved food security is a current policy goal of many developing countries. Yet, debates are still open on the efficacy of a number of food security policies on the table. In-kind transfers are a traditional, but controversial solution because of alleged disincentive effects. Local procurement of transfers offers improvements, especially in terms of effects on food prices and production incentives. Agricultural productivity growth achieved through input subsidies is a second available route, itself subject to much discussion. Such debates are relevant for Ethiopia.

In this paper, we use the standard IFPRI CGE model, adapted to Ethiopia using data from the EDRI SAM, to simulate three food security policies: first, an extension of current food transfers, based on local procurement; second a fertilizer subsidy resulting in a 50 percent reduction in fertilizer price; and third, a policy combining the subsidy with a switch to local procurement of current food transfers. Calibration is performed to equalize the partial equilibrium effect on government expenditure of each policy. Calibration also ensures a degree of realism for fertilizer demand response and associated yield growth and a plausible effect of in-kind transfers on household consumption.

The microsimulation exercise suggests productivity gains produced by substantial increases in fertilizer application are low. General equilibrium results, though, still highlight the superiority of subsidy-based policies in terms of the availability dimension of food security. The small productivity increases brought about by increased uptake generate significant gains in food production and a small fall in price. Income gains, resulting from higher returns to factors, accrue to all households and augment the effect of lower food prices in boosting household food consumption. Fertilizer subsidies perform best when coupled with local procurement of existing food transfers.

On the latter dimension of access, though, expanded food transfers remain superior in virtually all attempted simulations. In-kind transfers represent large income gains for targeted households. Consumption of the transferred good augments significantly and income effects spill over into demand for other food commodities, resulting in the largest increase in food consumption among the simulated policies. Local procurement raises aggregate food demand, resulting in moderate increases in food production and food prices. Factor returns improve slightly. The net effect of higher prices and higher factor incomes on nontargeted poor households is close to zero.

The above results are derived under the assumption that the government pays for the implementation cost of each policy. When it is donors who provide the finance instead, foreign capital inflows appreciate the exchange rate and depress exports. Whereas productivity growth compensates for this effect under the subsidy based policies, no such compensation takes place under the transfer policy. As a result, additional food transfers paid for by donors reduce the returns to some factors and, albeit still effective at raising food consumption, perform poorly in terms of reducing income poverty.

A number of areas for future work have to be flagged. First, nutrient conversion of food consumption has to be performed, especially for calories intake. This will enable the analysis to make more substantive statements about nutrition. Evidence from China, for example, points out that when income elasticities are higher for less nutritious foods, income effects related to transfers may actually worsen calories intake (Jensen and Miller forthcoming). Such a possibility has to be ruled out for Ethiopia in order to be more confident about the effects on food access identified above. Second, a dynamic extension of the analysis is called for. When considering a longer time perspective and to the extent that multipliers from agricultural productivity are reinforcing through time, a different ranking of policies may emerge also on the access dimension. Third, regional disaggregation would add value to the analysis, as the impact of the simulated policies may differ substantially depending on the specific baseline levels of food security and fertilizer yield responses.

Future food security policy in Ethiopia will have to tackle both availability and access issues. This paper shows how input subsidy policies are preferable for the former, while in-kind transfers are superior in terms of the latter. It also points at the high multipliers achieved by the small productivity gains resulting from increased fertilizer use. Low yield responses to fertilizer indeed suggest that if other, superior productivity-enhancing interventions can be devised, investment in agricultural productivity may be preferable to expanded food transfers even in terms of improving access to food. Nevertheless, when such recipes for yield growth are lacking and if internal finance is available to bear the cost of the policy, food transfers may still be the most effective short-to-mid term answer to food access insecurity.

APPENDIX: THE MICROSIMULATION METHOD

The method is based on the following four steps. First, we measure the increase in fertilizer consumption brought about by the subsidy. We use before/after data relative to the subsidy removal in the 1990s to estimate (roughly) an own-price elasticity of fertilizer demand, across crops. Such elasticity is then used to calibrate the input-output coefficient of the model, so that the demand response to the subsidy is realistic. To estimate the increase in fertilizer consumption brought about by the subsidy, we run a simulation where the subsidy is introduced and the input-output coefficient modified, but no productivity shock is included. With this, we calculate the increase in fertilizer consumption *free* as it were from the productivity effect.

Second, we allocate the additional fertilizer to enumeration areas (EAs) in the agricultural sample survey following a sharing rule. We allocate the new fertilizer introduced in the economy among EAs and crops in the agricultural sample surveys using a simple sharing rule: we increase every EA's use of fertilizer by the same amount. Although simplistic, this rule is intuitive. Furthermore, we perform sensitivity analysis showing that results are not affected very much by the use of a different rule with higher effects on yields.

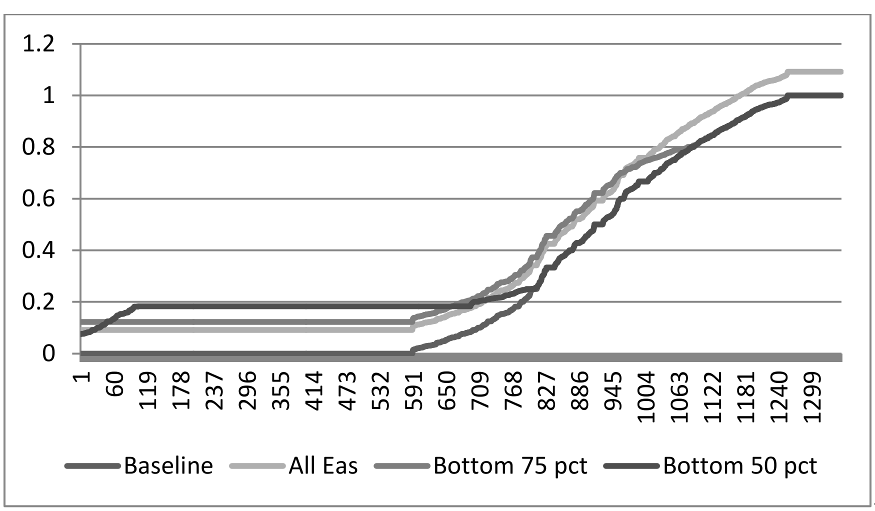
Third, we use the yield function estimated in Asrat, Bizuneh, and Seyoum Taffesse 2010 to predict yields for every EA with the old and new fertilizer quantities. With the coefficient from the estimated yield function, we predict yields for each EA in the survey in two scenarios:

1. The base scenario with actual fertilizer data
2. The simulation scenario with new fertilizer data calculated in step (2)

Fourth, we compare average predicted yields across EAs with the old and new fertilizer quantities to get at the percentage effect on productivity. Once we have predicted yields for every EA, under the two scenarios, we simply calculate the average yield across EAs for each scenario and crop. The percentage difference between average predicted yields in the two scenarios informs us about the effect of the subsidy on land productivity for a specific crop.

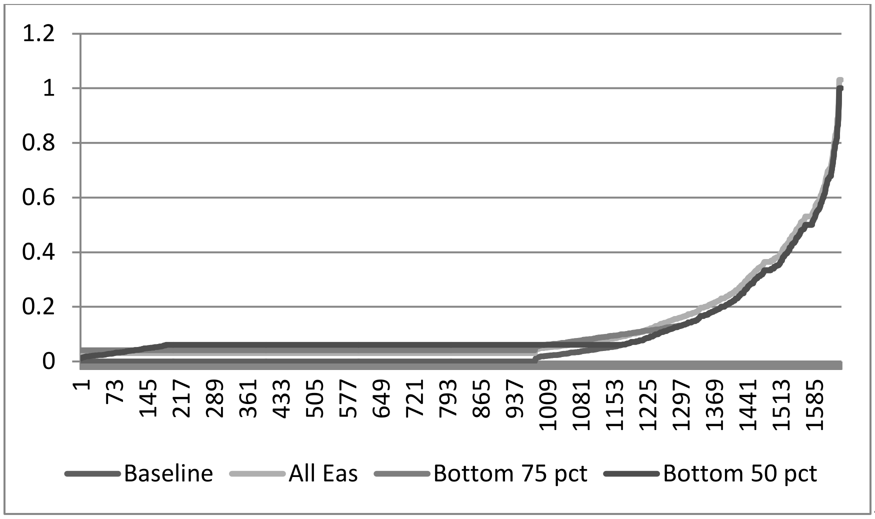
We will assume that this effect on land productivity approximates the effect on total factor productivity (TFP), and hence we will use this figure to augment the crop-specific TFP parameter in the total factor productivity function. Below we also report figures for the change in application of fertilizer for teff and maize growing EAs, which we have omitted from the main text.

Figure A.1—Fertilizer application on teff among teff-growing EAs for AGSS 2005/2006 and different sharing rules



Source: Authors' calculations based on data from CSA's Agricultural Sample Survey and simulated increase in fertilizer application.

Figure A.2—Fertilizer application on maize among maize-growing EAs for AGSS 2005/2006 and different sharing rules



Source: Authors' calculations based on data from CSA's Agricultural Sample Survey and simulated increase in fertilizer application.

REFERENCES

Abdulai, A., C. B. Barrett, and J. Hoddinott. 2005. "Does Food Aid Really Have Disincentive Effects? New Evidence from Sub-Saharan Africa." *World Development* 33 (10): 1689-1704.

Armington, P. 1969. *A Theory of Demand for Products Distinguished by Place of Production*. International Monetary Fund Staff Papers. Washington, DC: International Monetary Fund.

Asrat, S., G. Bizuneh, and A. Seyoum Taffesse. 2010. "Trends and Determinants of Cereal Productivity in Ethiopia." Paper presented at the 8th International Conference of the Ethiopia Economic Association, Addis Ababa, Ethiopia, June 22.

Barrett, C. B. 2006. "Food Aid's Intended and Unintended Consequences." *Background Paper for FAO State of Food and Agriculture*. Rome: Food and Agriculture Organization.

Barrett, C., and E. Lentz. "Food Insecurity." In *International Studies Compendium Project*, edited by R.A. Denemark et al. Oxford: Wiley-Blackwell Publishing, forthcoming.

Barrett, C., and D. Maxwell. 2005. *Food Aid after Fifity Years: Recasting Its Role*. London: Routledge.

Bates, R. H. 1981. *Markets and States in Tropical Africa: The Political Basis of Agricultural Policies*. Berkeley, CA, US: University of California Press.

Clay, E., and C. Benson. 1990. *Aid for Food: Acquisition of Commodities in Developing Countries for Food Aid in the 1980s.* London: Butterworth.

Croppenstedt, A., M.Demeke, and M.M. Meschi. 2003. "Technology Adoption in the Presence of Constraints: The Case of Fertilizer Demand in Ethiopia." *Review of Development Economics 7:* 58-70.

Del Ninno, C. 2000. Improving the Efficiency of Targeted Food Programs in Bangladesh: An Investigation of the VGD and RD Programs. FMRSP Working Paper No. 3. Washington, DC: International Food Policy Research Institute.

Demeke, M., F. Guta, and T. Ferede. 2004. *Agricultural Development in Ethiopia: Are There Alternatives to Food Aid?* Addis Ababa University Working Paper. Addis Ababa Ethiopia: Addis Ababa Univeriesty.

Dercon, S., and L. Christiaensen. 2007. *Consumption Risk, Technological Adoption and Poverty Traps. Evidence from Ethiopia*. World Bank Policy Research Working Paper. Washington, DC: World Bank.

Dercon, S., and R.V. Hill. 2009. "Growth from Agriculture in Ethiopia: Identifying Key Constraints." Study paper prepared for the Agriculture and Growth in Ethiopia Research Project. Addis Ababa, Ethiopia.

Dercon, S., and P. Krishnan. 2000. "In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia." *Journal of Political Economy* 108(4): 688-727.

Disaster Prevention and Preparedness Commission. 2007. *Humanitarian Appeal for Ethiopia*: *A Joint Government and Humanitarian Partners' Appeal.* Addis Ababa, Ethiopia.

_______2008. *Humanitarian Requirements 2008: Government-Partners Joint Document*. Addis Ababa, Ethiopia.

DRMFSS (Disaster Risk Management and Food Security Sector). 2010. *Humanitarian Requirement Document: Joint Government and Partners' Document.* Addis Ababa, Ethiopia.

________2009. *Humanitarian Requirements: Joint Government and Humanitarian Partners' Document*. Addis Ababa, Ethiopia.

Donovan, C., R. Myers, D. Tschirley, and M. Weber. 1999. "The Effects of Food Aid on Maize Prices in Mozambique." In *Food Security, Diversification and Resource Management: Refocusing the Role of Agriculture?* Proceedings of the Twenty-Third International Conference of Agricultural Economists. Brookfield VT, US: Ashgate.

Dorosh, P. A., and C. Del Ninno. 2002. "In Kind Transfers and Household Consumption: Implications for Targeted Food Programs in Bangladesh." FCND Discussion Paper 134. Washington, DC: International Food Policy Research Institute.

Dorosh, P., and E. Schmidt. 2009. *A Regionally Disaggregated Hunger Index for Ethiopia*. IFPRI ESSPII Working Paper 005. Washington, DC: International Food Policy Research Institute.

Duflo, E., M. Kremer, and J. Robinson. 2008. "How High are Rates of Return to Fertilizer? Experimental Evidence from Kenya." *American Economic Review*, 98(2): 482–88.

EDRI (Ethiopian Development Research Institute). 2009. *Ethiopia Input-Output Table and Social Accounting Matrix.* Addis Ababa, Ethiopia.

FAO. 2008. *Current World Fertilizer Trends and Outlook to 2011/12*. Rome.

FAO. 2010. "Guide for Policy and Programmatic Action at Countyr Level to Address High Food Prices." Initiative on High Food Prices Rome: FAO.

Gelan, A. U. 2006. "Cash or Food Aid? A General Equilibrium Analysis for Ethiopia." *Development Policy Review,* 24(5): 601-624.

Gelan, A. U. 2007. "Does Food Aid have Disincentive Effects on Local Production? A General Equilibrium Perspective on Food Aid in Ethiopia." *Food Policy*, 32: 436-458.

Jayne, T., J. Govereh, M. Wanzala, and M. Demeke. 2003. "Fertilizer Market Development: A Comparative Analysis of Ethiopia, Kenya and Zambia." *Food Policy*, 28(4): 293-316.

Jensen, R. T., and N.H. Miller. "Do Consumer Price Subsidies Really Improve Nutrition?" *The Review of Economics and Statistics,* forthcoming.

Lentz, E. 2003. "Annotated Bibliography of Food Aid Disincentive Effects." Mimeo, Cornell University, Ithaca, NY, US.

Lofgren, H., R. Lee Harris, and S. Robinson. 2002. *A Standard Computable General Equilibrium (CGE) Model in GAMS.* TMD Discussion Paper 75. Washington, DC: International Food Policy Research Institute.

Ministry of Finance and Economic Development. 2010. "Growth and Transformation Plan: 2009/2010- 2014/2015." Addis Ababa.

Minot, N. W., and T.D. Benson. 2009. "Fertilizer Subsidies in Africa: Are Vouchers the Answer?" IFPRI Issue Brief No 60. Washington, DC: International Food Policy Research Institute.

Nisrane, F., G.Berhane, S, Asrat, G. Bizuneh, A. Seyoum Taffesse and J. Hoddinott. 2010. "Sources of Inefficency and Growth in Agricultural Output in Subsistence Agriculture: A Stochastic Frontier Analysis." ESSP2 Working Paper 19. Washington, DC: International Food Policy Research Institute.

Ricker-Gilbert, J., T. Jayne, and R. Black. 2009. "Does Subsidizing Fertilizer Increase Yields? Evidence from Malawi." 2009 Annual Meeting, Agricultural and Applied Economics Association, Miluwaukee, WI, US, July 26-29.

Sen, A. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Oxford University Press.

Senaur, B., and N. Young. 1986. " The Impact of Food Stamps on Food Expenditure: Rejection of the Traditional Model." *American Journal of Agricultural Economics*, 68: 37-43.

Southworth, H. M. 1945. "The Economics of Public Measures to Subsidise Food." *Journal of Farm Economics* (68): 37-43.

Spielman, D. J., D. Kelemework, and D. Alemu. 2010. "Policies to Promote Smallholder Intensification in Ethiopia." *Food Policy*, 35(3):185-194.

Tafere, K., and A. Seyoum Taffesse. 2010. "Evolution of Expenditure and Welfare." Paper presented at the 8th International Conference of the Ethiopian Economic Association, Addis Ababa, Ethiopia, June 22.

Tavneet, S. "Selection and Comparative Advantage in Technology Adoption." *Econometrica*. forthcoming.

Walker, D. J., J. Coulter, and R. Hodges. 2005. "Policy Implications Arising from the Development Impact of Local and Regional Procurement of Food Aid." Position Paper, Natural Resource Institute. Greenwich, UK University of Greenwich.

WFP(World Food Programme). 2006. “Food Procurement From Developing Countries, Executive Board Document”. Accessed June 11. www.wfp.org/sites/default/files/Food%20Procurement%20in%20Developing%20Countries%20-%20(2006).pdf.

_______2009. WFP Website. Accessed June 11. www.wfp.org/sites/default/files/WFP%20local%20purchase%20-%20March%2009%20-%20Eng%20-%20lr.pdf.

Woldehanna, T., J. Hoddinott, and S. Dercon, 2008. “Poverty and Inequality in Ethiopia 1995/96- 2004/05.” Paper prepared for the Ministry of Finance and Economic Development (MoFED).

Yu, B., A. Nin-Pratt, J. Funes, and S. Asrat,. 2010. “Cereal Production and Technology Adoption in Ethiopia.” Paper presented at the 8th International Conference of the Ethiopian Economic Association, Addis Ababa, Ethiopia, June 25.

Zeitlin, A., A. S. Caria, R. Dzene, P. Jansky, E. Opoku, and F. Teal. 2010. “Heterogenous Returns and the Persistence of Agricultural Technology Adoption.” Paper presented at the 2010 NEUDC Conference, Cambridge, MA, US, November7.

Zerfu, D., and D. D. Larson. 2010. “Incomplete Markets and Fertilizer Use: Evidence from Ethiopia.” World Bank Policy Research Working Paper 5235. Washington, DC: World Bank.

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