A Simulation Impact Evaluation of Rural Income Transfers in Malawi and Ghana*

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A considerable body of experimental economics research examines the impacts of cash transfers (a treatment) on recipient households (the treatment group). In many developing countries, though, cash transfers are insignificant compared to other transfer mechanisms in terms of their claim on public resources. For example, in Malawi, fertilizer subsidies dwarf cash transfers, while next door in Zambia, the government pays farmers prices well above market levels for their maize (Nkonde, Mason, Sitko, & Jayne, 2011). Yet no study to our knowledge has attempted to compare the full impact of cash payments and other kinds of transfers on rural incomes and welfare in low income countries.

Economic theory is unclear on the effectiveness of alternative transfer schemes in a context of imperfect markets; thus, empirical impact analysis is required to analyze, select and design income-transfer mechanisms. It is not clear how to design a feasible randomized experiment or econometric model to compare the efficiency of a variety of alternative transfer schemes with both direct and indirect impacts on a heterogeneous rural population.

This paper employs a simulation model of heterogeneous, interacting agents to compare the impacts of direct payments and alternative transfer mechanisms on production, incomes and welfare in rural Malawi and Ghana. We calibrate our simulations to existing fertilizer subsidy schemes in the two countries: the Malawi Agricultural Inputs Subsidy Program (MAISP) and Ghana's temporary input subsidy program (IS), initiated in 2008 and continued every year since. In each country, we then compare the input subsidy to two other transfer schemes: a market price support for staples, similar to what historically has been implemented in both countries, and cash transfers (the Malawi Social Cash Transfer Scheme, SCTS, and Ghana's Livelihood Empowerment Against Poverty, LEAP).

The widespread view that cash transfers are the most efficient transfer instruments, and that input subsidies are inefficient, has drawn considerable attention to the MAISP in recent years. We begin by focusing on Malawi in an attempt to answer the following questions: Are there conditions under which alternative transfer mechanisms might dominate a simple cash transfer in terms of welfare efficiency or in terms of effectiveness at raising the incomes of particular rural household groups? What would those conditions be in the specific case of the MAISP and SCTS transfers in Malawi?

This is an unusual use of an impact simulation model. Instead of assuming that we have the model right, we ask what kind of model would produce an outcome in which one instrument dominates another. Then we ask whether such a model is likely to reflect the economic reality of rural Malawi. Finally, we turn to Ghana, where the magnitude of agricultural transfers is smaller and the design and implementation of transfer programs is different than in Malawi. A comparison of findings from Malawi and Ghana highlights the importance of both economic structures and program design in shaping the outcomes of alternative transfer schemes. We find that no instrument is unequivocally optimal. Input subsidies easily dominate market price supports as a way of transferring income to all but the largest commercial producing households, under a wide range of model assumptions. Under some arguably plausible conditions, both input subsidies and market price supports may be more efficient than cash transfers. Market price supports, input subsidies, and cash transfers all have the potential to create large welfare multipliers.

I

Impact Evaluation of Alternative Transfer Schemes

The classic approach to evaluate the impacts of income transfers on outcomes of interest involves randomized experiments. An experimental approach requires the creation of treatment and control groups, a well-defined randomized treatment, and a clearly defined outcome of interest. This may be feasible if the goal is to test the impact of a specific transfer mechanism (e.g., a cash transfer) on specific outcomes (e.g., food expenditures by the beneficiary households). However, it is generally not feasible if the objective is to compare the effectiveness of several different transfer instruments, either ex-ante or once the transfer programs already are in place.

An additional complication concerns the transfers' impact on non-beneficiary households. Market linkages transmit the benefits of the transfer from those directly affected (the households receiving the transfer) to others in the rural economy. These linkages almost certainly vary for different types of transfers targeted at different household groups in different market environments. Experiments, in order to be valid, must satisfy the "invariance assumption," which states that the actual program will act like the experimental version of the program. The possibility that treatments affect control groups is one reason why the invariance assumption can break down. Manski and Garfinkel refer to "macro feedback effects," noting that "full-scale programs may change the environment in ways that influence outcomes." (Manski & Garfinkel, 1992, p.15).

A Theoretical Perspective on Transfer Impacts

Our goal is to compare the potential effects of three transfer mechanisms on incomes and welfare in rural areas: An input subsidy (IS) and cash transfer (CT) modeled on actual programs in place in Malawi and Ghana; and a farm gate market price support (MPS). We also want to assess differences in these effects across household groups and market scenarios. We begin by discussing the ways in which each type of transfer might affect income in an agricultural household model.

Cash Transfers

A cash transfer is the most obvious and direct way to increase incomes. The immediate impact of an unconditional cash transfer is to shift a household's budget constraint outward, increasing its demand for normal goods while decreasing its demand for inferior goods. In an agricultural household model with perfect markets, in which the household is a price taker for all goods and services, this is the end of the story. There is a one-to-one correspondence between cash transfers and full income. Cash income actually may increase by less than the amount of the transfer if leisure is a normal good and the household's supply of wage labor diminishes. This distinction between full and cash income is important to bear in mind when measuring the impacts of alternative transfers.

Cash transfers may have other impacts in imperfect-market environments. They may loosen liquidity constraints on purchasing inputs and provide income security that increases the willingness to invest in inputs, new technologies or new income or consumption activities. As a result, they could create an income multiplier within the household.[1] They also could alter expenditure patterns and investments.

Output Market Price Supports

An output price support has the immediate effect of increasing the market value of a crop already planted or on the tree. In this way, it is akin to a cash transfer benefitting surplus producers, while having no direct effect on subsistence producers. Depending on how the support is implemented, it may raise consumption costs, negatively affecting net-buyer farm and nonfarm households.

A market price support also creates incentives for (non-subsistence) producers to increase output, if they are able. In general, short-run supply elasticities are positive: Even growers of perennial crops often can increase supply by intensifying harvest effort. If information about the support is available at planting time, it can influence land use. If it becomes available after planting, it may still affect output by encouraging farmers to use productivity-enhancing inputs more intensively.

As farmers' demand for intermediate and labor inputs increases, income flows to the suppliers of the inputs and labor. Over time, higher profits become capitalized in land rents, benefitting landlords and harming renters. A marked difference between high and low-income countries is that, in the former, a high percentage of agricultural land is rented; thus, rising land

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[1] Sadoulet, de Janvry and Davis found that a cash transfer program in Mexico (PROCAMPO) generated income multipliers in the range of 1.5 to 2.6 in the recipient households (Sadoulet, Janvry, & Davis, 2001)..

rents divert benefits away from agricultural households. In most of the world's small-farm households, rising rents represent an income gain.

These indirect income effects may stimulate additional rounds of demand and income changes. Labor-supplying households that do not benefit directly from the price support, e.g., non-agricultural and farm worker households, may benefit indirectly. However, they also may lose, if the price support induces farmers to shift land from more labor intensive crops to less labor intensive ones.

Input Subsidies

The immediate impact of an input subsidy, like that of an output price support, is akin to a cash transfer—in this case, to farmers already using the input. Input subsidies also create incentives for farmers to intensify their use of the subsidized input while increasing their demand for complementary inputs. For example, labor is required to apply subsidized fertilizer and to bring in the resulting larger harvest; thus, income in agricultural worker households may increase.

People do not eat fertilizer, and this makes for a big difference in welfare effects between output price supports and fertilizer subsidies. Lowering the price of inputs does not raise consumption costs, and given general equilibrium effects, it may do the opposite. Input subsidies also can directly benefit subsistence households, by lowering their input costs. Like output price supports, they may increase wages and land rents and generate complex higher-round impacts on the rural economy: Higher incomes stimulate consumption demands, which in turn may magnify the interventions' effects and create income and employment multipliers.

Given the complexity of the direct and indirect effects of each of these income transfer mechanisms, it is often not possible to theoretically determine the impacts on the income and welfare of a particular household group. Nor is it possible to analytically determine which instrument is most efficient at raising rural incomes in a particular setting, given the manner in which market linkages diffuse both the benefits and the costs of each transfer. An empirical approach is required, one that is capable of capturing both general equilibrium effects and the heterogeneity of economic actors.

II

A Simulation Impact Evaluation Model

General model description

Our simulation models for Malawi and Ghana were designed to evaluate the impacts of alternative income-transfer schemes on the welfare of heterogeneous rural households. The models nest a set of farm household models linked together in a general-equilibrium framework. Each household model is representative of a group of rural households which we select according to the specific eligibility criteria of each transfer program. To add resolution, non-eligible households are disaggregated according to the size of their landholdings.

The basic structure of each household sub-model is that of a Computable General Equilibrium model (CGE), but one representing a very small economy, as in Taylor, Dyer and Yúnez-Naude (2005).[2] A household owns factors of production, which it uses in combination with purchased inputs in various household-specific production activities. For each activity, the household combines factors and inputs in such a way that it maximizes profit given exogenous prices. It consumes the output or trades it on markets, thus generating cash income. It spends this income on purchased inputs for its production activities or consumption goods it buys on markets. Total consumption levels are chosen in such a way that the household maximizes its utility given household full income. As long as the household is connected to markets (i.e., not a pure subsistence household), it takes all prices as exogenous. Under those conditions, production and consumption decisions are independent or "separable." They can be thought of as sequential: the household decides how to maximize its income, and then it decides how to spend this income. As in any economy, the markets for each commodity, input, or factor must clear within a household economy: The sum of quantities produced, purchased or otherwise obtained must balance with the sum of quantities consumed, sold, or otherwise used. Similarly, the "foreign" accounting balance must be satisfied for a household economy, which in this case means that the household is subject to a cash constraint.

Having the household economy as the basic unit of analysis (with household-specific asset endowments, production technologies, and production and consumption decisions) makes it possible to portray the heterogeneity of households in the rural economy. In addition, it allows us to highlight households' dual nature as producers and consumers of food. This duality is important to recognize when evaluating the impacts of alternative transfer mechanisms in an agricultural household-farm economy. Supporting the market price of food benefits farmers as producers (by raising output values) but harms them as consumers (by increasing consumption costs). It is therefore important for the model to portray the net buyer or net seller status for each household type rather than for the rural economy as a whole.

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[2] Detailed descriptions of standard CGE models can be found in Löfgren, Robinson and Harris (2002) as well as Burfisher (2011). The disaggregated modeling approach of Taylor, Dyer and Yúnez-Naude (2005) has been extended to examine the transmission of price shocks to subsistence households (Dyer, Boucher, & Taylor, 2006), the rural welfare effects of trade reforms (J. Edward Taylor, Yunez-Naude, & Jesurun-Clements, 2010), the impacts of migration on migrant-sending economies (J.E. Taylor & Dyer, 2009), and the effects of the corn price surge on landuse in Mexico (Dyer & Taylor, 2011). Recently, Brooks, et al. (2010) used a similar modeling approach to compare the distributional impacts of agricultural policies in six developing countries, including Malawi and Ghana. To our knowledge, the present paper is the first to use disaggregated general-equilibrium modeling as an alternative to randomized experiments for project impact evaluation.

Our full model nests several household models within a model of the rural economy. In modeling terms, this means that in addition to the household-level constraints, we impose rural economy-wide market clearing and trade balance constraints on the aggregate levels of production, consumption, imports into and exports from the rural economy. It also means that households in the model all face the same market prices for all tradable commodities, inputs, and factors. Because we focus on the rural economy, the urban sector is considered exogenous to the model, as are the government and "rest of the world."

The advantage of using a general equilibrium approach (as opposed to a partial equilibrium one) is that it reveals the spillover effects of transfer schemes from beneficiary households to non-beneficiaries and from targeted markets to non-targeted ones. Thus, our model is set up to capture both the direct and indirect impacts we described above for each of the three transfer schemes we are comparing. Models such as this one are traditionally used in policy analysis. The present model includes a typology of rural households based on eligibility for two transfer programs in Malawi and Ghana. Because program eligibility criteria are directly built into the models' household disaggregation, our simulations are uniquely situated at the nexus of policy analysis and program impact evaluation.

III

Malawi: Ignoring the Experts?

The merits of alternative transfer schemes in developing countries have been fiercely debated among economists and, in some cases, between economists and policy makers. A case in point is the controversy surrounding fertilizer subsidies, which have become the principal form of transferring public funds to agricultural households in Malawi. A *New York Times* headline in reference to Malawi entitled, "Ending Famine, Simply by Ignoring the Experts," stated:[3]

> "Successful use of subsidies is contributing to a broader reappraisal of the crucial role of agriculture in alleviating poverty in Africa and the pivotal importance of public investments in the basics of a farm economy: fertilizer, improved seed, farmer education, credit and agricultural research."

Models for OECD countries conclude emphatically that input subsidies are the least efficient way to transfer income to agricultural households. One study concludes:[4]

[3] *NYTimes*, Dec. 2, 2007, http://www.nytimes.com/2007/12/02/world/africa/02malawi.html.

[4] The Incidence and Transfer Effiency of Farm Support Measures. Working Party on Agricultural Policies and Markets, AGR/CA/APM(2001)24/FINAL. Paris: OECD, July 22, 2002.

“Farm households would experience a gain of only seventeen cents for each one-dollar of additional taxpayer costs for a subsidy to inputs they purchase. Put the other way round, taxpayers pay almost six dollars for each one-dollar gain in farm household income due to such a subsidy.”

Poor countries can ill afford such inefficiency.

The case for input subsidies in Sub-Saharan Africa is motivated by pictures like Figures 1(a-b), which show dismally low levels of fertilizer use and yields compared with other world regions. Fertilizer use in sub-Saharan Africa was 8 kg/ha in 2002, compared with 101 kg/ha in South Asia (Morris, Kelly, Kopicki, & Byerlee, 2007). Such massive disparities in fertilizer use between Africa and the rest of the world suggest that there are structural impediments limiting fertilizer availability and demand. It is very unlikely that African farmers are applying fertilizer at a level that equates its marginal value product with the world price. Why the disparity?

Figure 1a. Fertilizer Use Per Hectare

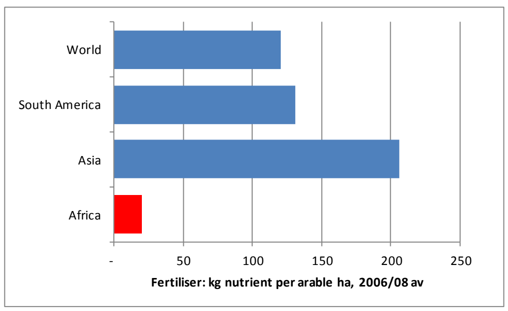
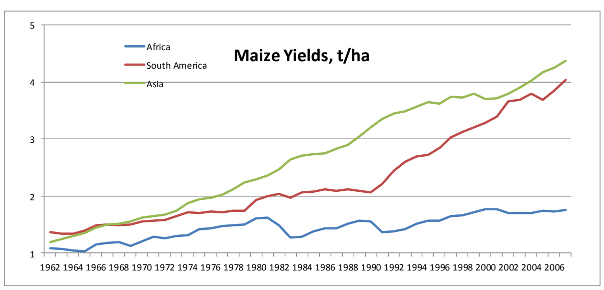


Figure 1b. Maize Yields



Source: FAOSTAT. Graphs courtesy of Steve Wiggins.

One explanation, emphasized in economic research from Malawi and other countries, is the presence of liquidity constraints that prevent poor farmers from applying inputs at their optimal levels. The result is a vicious circle of low productivity and food insecurity: A lack of liquidity limits poor farmers’ ability to purchase fertilizer; food security concerns divert poor people from their farms into low-paying wage work; and as a result, food production decreases (Alwang & Siegel, 1999).

Supply problems further discourage fertilizer use. High transaction costs create a divergence between local and international input prices. For example, in Kenya in 1990, the price of fertilizer in Nakuru was around 3,700 KSH in 1990, well over twice the 1,500 price at the port of Mombasa 400 miles away. The gap closed dramatically as a result of marketing policies, development of marketing networks, and competition in input markets (Minde, Jayne, Crawford, Ariga, & Govereh, 2008). The reliability of input supplies also is critical.[5] A lack of information and income and production risk also may limit fertilizer use. This is clearly not a first-best world to which welfare findings from rich countries necessarily apply.

In an environment of imperfect fertilizer and credit markets, it might make sense to link income transfers to fertilizer use. At very low levels of usage, increases in fertilizer applications can have a high marginal value product, generating a rate of return in excess of one.

Malawi has made the growth of smallholder production a cornerstone of its development and poverty-alleviation strategy, by focusing on improving smallholders' access to agricultural input and output markets. It is one of the poorest and most agricultural countries in the world. Eighty-one percent of its population is rural, and 91% lives on less than US$2/day. Smallholders make up about 90% of the poor. Food production is a major source of livelihood for most rural households. Productivity and, in particular, fertilizer use are low. LSMS data reveal that only 67% of agricultural households (57% in the smallest land-size quintile) used fertilizer in 2004. Raising yields is viewed as a critical element in strategies to reduce poverty and provide food security.

Malawi relied on market price supports to transfer income to farm households prior to 1998. Today, the fertilizer subsidies of the MAISP program are the primary income-transfer method, but the SCTS cash transfer program is scaling up. How do these transfer schemes compare in terms of their effectiveness at turning public transfers into income and welfare gains for rural households?

Data sources and Calibration

Our model for Malawi was designed to depict the agricultural economy of Malawi in the years immediately preceding the first round of the MAISP, which occurred in 2005. Conveniently, an official, nationally representative household survey was collected in 2004, the IHS2 (Second Integrated Household Survey). For our model calibration, we used raw data from this survey, as well as transformed data made available to us by the Rural Income Generating Activities (RIGA) initiative at FAO (which computed poverty lines, income aggregates, etc.). We combined these data with national agricultural production and consumption information

[5] This is an implication of Duflo, et al.'s study (Duflo, Kremer, & Robinson, 2008)

available online from FAOSTAT, using 2003 as our base year (the last completed cropping season before the IHS2 was conducted).

We calibrated the model using a Social Accounting Matrix (SAM), which we built specifically for this purpose. The SAM is in fact a "meta-SAM" nesting a series of household SAMs, each with its own set of household-specific activity and expenditure accounts. Commodity and factor accounts complete the economywide picture. A SAM is an accounting framework, and is balanced by construction. This ensures that our model is in equilibrium at calibration.

The level of household disaggregation is subject to a tradeoff between model richness and data availability. More household types help portray the diversity of the rural economy and the heterogeneity of constraints faced by various actors. On the other hand, we must be able to accurately estimate household consumption and production functions for each crop and each household type. In addition, two out of the three transfer schemes we model in Malawi are targeted (MAISP and SCTS; a market price support is by definition not targeted). The household categorization in our model must reflect eligibility for those programs. Given these constraints, we disaggregated Malawi's rural household population into six categories, five of which include agricultural producers:

- Ineligible non-farm households
- Ineligible small farms
- Ineligible medium and large farms
- Households eligible for SCTS only
- Households eligible for MAISP only
- Households eligible for both SCTS and MAISP

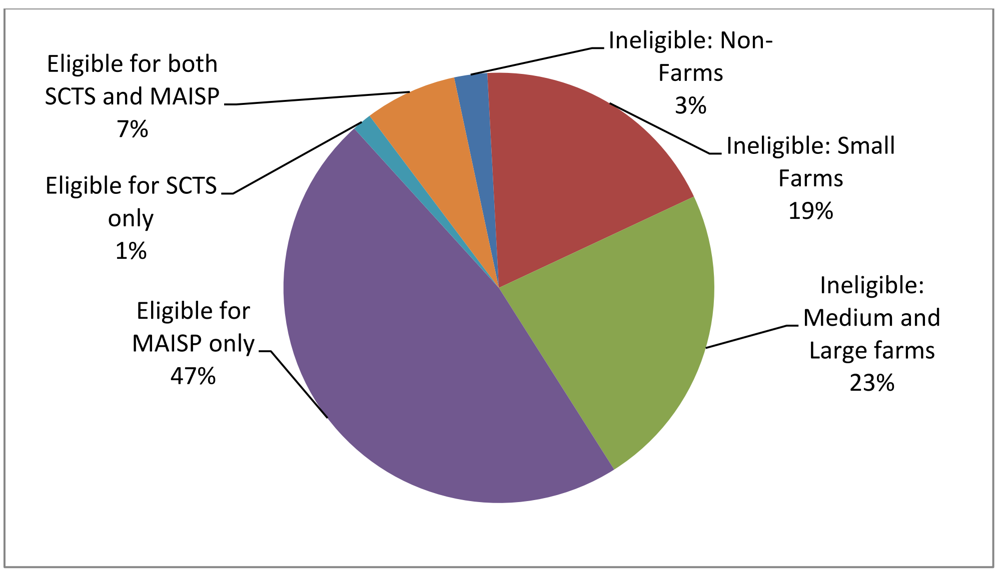
The latest household survey available in Malawi dates from 2004, before the implementation of both the MAISP (2005) and the SCTS (2010). Therefore, we cannot identify with certainty households in the IHS2 who would receive either of those transfers. Nevertheless, we can use eligibility criteria to identify potential recipients.

The eligibility criteria for recipients of the SCTS are described in Miller, Tsoka and Reichert (2011). The SCTS targets households that are "ultra-poor" and "labor constrained." Households below the ultra-poverty line were identified in the IHS2 by the National Statistical Office of Malawi in the primary analysis of the survey data; the ultra-poverty line was set at 10,029 Kwacha yearly per capita expenditures (NSO, 2005). The SCTS considers households to be labor-constrained when their dependency ratio is greater than 3.0, meaning that each able-bodied adult is caring for more than three dependents. Adults are defined as persons aged 19 to 64. Dependents are those who fall out of this age range and those who, regardless of their age, are disabled, chronically ill, or in any way incapacitated. We computed a dependency ratio for each household in the IHS2, using reported ages, disabilities, and chronic illnesses for all members. In addition, we classified as dependents those individuals who reported being unable to sweep the floor, unable to walk 5km, or only able to do those tasks with difficulty.

Eligibility to receive the MAISP subsidy is based on farm size and need but otherwise is somewhat vague: "full time smallholder farmers who cannot afford to purchase one or two bags of fertilizer at prevailing commercial prices as determined by local leaders in their areas" (Dorward, Chirwa, Boughton, et al., 2008). This is by design a progressive transfer, but the criterion covers a large part of the rural population: the overwhelming majority of Malawian rural households are poor smallholders. From the LSMS data, we selected all farm households that were neither in the top landholding quintile nor in the top expenditure quintile as our MAISP-eligible group. As a validation check, this criterion yields an eligible group representing 56% of all farmers, almost exactly the proportion of farm households actually receiving the MAISP vouchers in 2006/07 (54%) (Dorward & Chirwa, 2011).[6] The group is indeed composed of smallholders: the largest landholding in the group is 2.02 hectares, with a mean at 0.86 ha. Over 95% of the households in this group live on less than 3 dollars per person per day (PPP-adjusted).[7]

The MAISP was designed to target over half of the rural households of Malawi, while the SCTS only targets the ultra-poor. The household groups are therefore not equal in size: Figure 2 illustrates the distribution. The largest group by far is that of households eligible for MAISP only: it includes most smallholders in Malawi. The smallest group represents households eligible for SCTS only: those are the ultra-poor and labor-constrained households who are not smallholders (note that they may own land or not). Overall, 55% of rural households would be eligible for at least one of the transfers according to our data.

Figure 2: Household categorisation in the Malawi rural economywide model



[6] The proportion for 2005/06 is not known to us.

[7] This is a yearly per capita expenditure of 20969 Kwacha. The PPP-adjusted conversion rate for 2003 is 19.15 Kwacha per Dollar according to the Penn Tables, version 6.3: http://pwt.econ.upenn.edu/php_site/pwt63/pwt63_form.php.

Table 1. Household Categories in the Malawi model

	Ineligible for transfers			Eligible for transfers		
	(1)	(2)	(3)	(4)	(5)	(6)
	Non-Farms	**Small farms**	**Medium and Large Farms**	**Eligible for SCTS only**	**Eligible for MAISP only**	**Eligible for SCTS and MAISP**
Eligibility criterion	-	-	-	Ultra-poor and Labor-Constrained	Poor Smallholders	Ultra-poor and Labor Constrained Smallholders
Number of households (IHS sample size)	58,000 (237)	440,000 (1,831)	536,000 (2,272)	34,000 (154)	1,102,000 (4,584)	161,000 (660)
Average annual household income (Kwacha)	92,000	112,000	121,000	54,000	63,000	47,000
Average per capita income	40,785	38,324	28,707	7,721	14,023	7,713
Average land holding	0.07 ha	0.6 ha	4.1 ha	2.6 ha	0.9 ha	0.8 ha
Net trading status in:						
Maize	-17,776	126,974	476,077	11,227	-104,375	-65,222
Roots and tubers	-42,818	164,151	1,072,032	25,641	417,004	22,942
Other annual foods	-4,838	365,039	1,191,076	30,945	795,347	65,268
Tobacco	0	12,261	47,156	0	33,009	0
Permanent crops	-4,632	56,554	190,820	4,114	165,065	60,184
Livestock	-2,496	-6,362	13,424	-164	2,089	757

In order to have the most complete picture of agricultural production, it is best to distinguish as many commodities as possible in the model. On the other hand, we are limited by our ability to estimate a production function for each commodity. We therefore disaggregated agricultural production into six commodity categories, using production and consumption data to guide our choice. The six categories are:

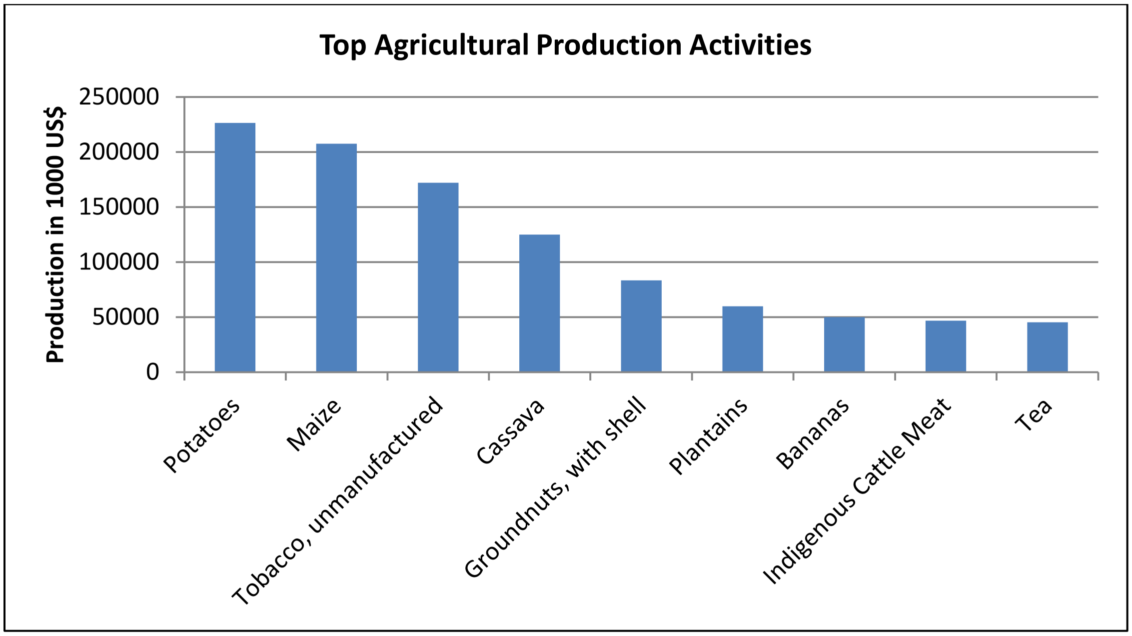
- Maize
- Tubers and starchy roots
- All other annual crops
- Annual cash crops (Tobacco)
- All permanent crops
- Livestock

These six commodity categories depict the most important agricultural activities in Malawi, as shown in Figure 3.[8] The share of total production and consumption of each crop attributable to each of our household groups was determined using the IHS2 data. Those shares

[8] According to the IHS2 household survey, potatoes are only a minor crop in Malawi. However, FAOSTAT data consistently rank potatoes as one of the top three crops, in terms of both value and volume. This suggests that potato growers may have been oversampled in FAOSTAT, undersampled in IHS2, or both. If that is the case, our model may be overrepresenting the place of roots and tubers in the Malawi rural economy. Eliminating the roots and tubers category from our model does not alter our conclusions.

were then applied to total national production and consumption data from FAOSTAT, to determine household production and consumption data needed to fill the SAM matrix.

Figure 3: Top agricultural activities (in value) in Malawi, 2003



Source: FAOSTAT (Values computed using prices on international markets).

Functional forms and market assumptions in the base model

We assumed households display Cobb-Douglas utility functions and used consumption shares from the SAM for calibration. For each household participating in agricultural activities, we also assumed each production process follows a Cobb-Douglas specification with the following inputs: land, capital, labor (family or hired), and purchased inputs. Coefficients for the production functions of all field crops were estimated econometrically from log-log regressions assuming constant returns to scale, using the IHS2 dataset. For tree crops and livestock, the Malawi data did not provide sufficient information to allow regression estimation, so we used factor shares we estimated for Ghana. In the interest of sample size, we estimated the coefficients jointly for all households.[9]

We make a different assumption on the functioning of markets for each input and factor. We assume capital is fixed in each activity, which is a standard short-run assumption. The value

[9] Running the regressions individually for each household group did not show statistical differences between groups, but often returned insignificant coefficients. Our modeling work would benefit from well estimated factor shares. This highlights the need to collect high quality production data as part of impact evaluations.

of capital, or capital rent, is therefore flexible and household- and activity-specific. It reflects the marginal value product of the fixed capital input.

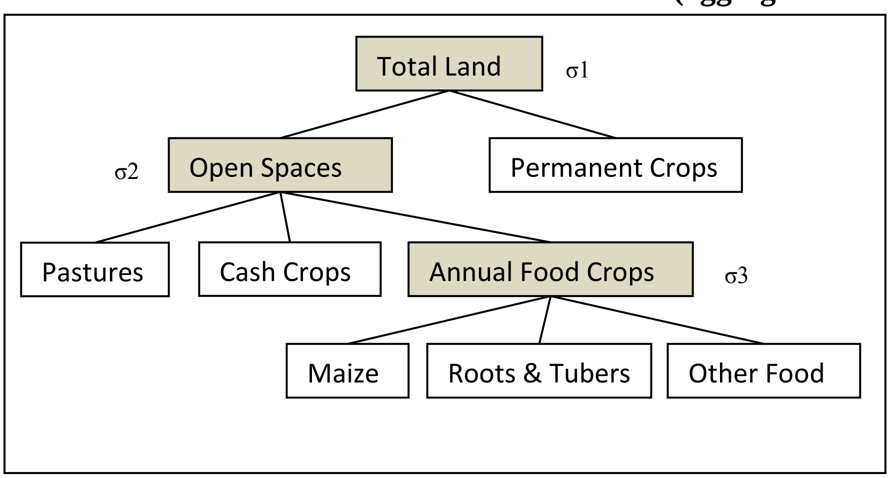
Purchased inputs are assumed to be imported, which is largely the case for fertilizer in Malawi. The price of purchased inputs is therefore exogenously fixed on world markets. Purchased inputs can be used on any crop, but livestock uses specific purchased inputs.

In the base model total labor in the rural economy is fixed at a full-employment level, with a fluctuating rural wage. Rural-urban wage gaps suggest that rural wages may be largely endogenous. We further assume that household and hired labor is interchangeable, such that the value of household labor is also the rural wage.

The indirect impacts of transfer schemes depend critically on households' ability to shift land among income-generating activities. In agriculture in particular, the extent to which a farmer can shift land from one crop to another will shape the ultimate outcome. We model the imperfect transformability of land from one use to another using a constant elasticity of transformation (CET) land supply function. The nested structure is pictured in Figure 4. Reallocation between uses is more difficult at the top of the tree than at the bottom and guided by a constant elasticity function with elasticity σ. In the absence of data to estimate land allocation elasticities, we assume that the elasticities at levels 1, 2 and 3 are respectively equal to -0.1, -0.15 and -0.2.

Finally, we make a "small country assumption" such that market prices are determined exogenously on international markets.

Figure 4: Structure of the nested CET land allocation (aggregates shaded)



IV

The Impacts of Alternative Transfer Mechanisms in Malawi

We used the Malawi model to evaluate the impacts of the following transfer instruments:

- A targeted input subsidy (IS) modeled on the MAISP in the 2005/2006 cropping season. Total government spending (excluding overhead) is equal to US$51.4m, as reported in Dorward and Chirwa (2011).

- The same amount spent on a farm gate market price support for maize (MPS) (which is equivalent to a 22.4% increase in maize prices)

- The same amount in the form of a direct cash transfer (CT) targeted to SCTS eligible households.

We first present a detailed description of our simulations and the results we obtain in terms of incomes and welfare when using the base model. We refer to this version of the model as the "perfect markets benchmark", because it relies on perfect market assumptions (for example, with regard to labor, input, or credit markets). The perfect markets benchmark produces a clear overall ranking of the three transfer mechanisms in terms of their efficiency at converting public expenditures into rural household welfare: cash transfers dominate input subsidies, which in turn dominate output price supports. After reporting these results, we use the simulation model to explore conditions under which this ranking changes. The assumption that markets function perfectly is unlikely to be accurate for a country like Malawi. Under alternative assumptions about the functioning of markets, we find that input subsidies and market price supports may be superior to cash transfers in terms of raising rural welfare.

Transfer targeting and simulations design

Our Input Subsidy (IS) simulation is modeled on the Malawi MAISP program. We chose to model the first round of the program: 2005/2006. The SAM we use to calibrate our model appears adequate, as it was built using household survey data collected in 2004. It hopefully portrays fairly well the economy of rural Malawi shortly before the first round of the MAISP was implemented. The SAM was converted to 2005 dollars (3% inflation rate) to match the survey year.

The MAISP subsidized fertilizer distributed through government channels. [10] Beneficiaries received vouchers, which they could hand over to parastatal retailers to purchase a 50 kg bag of fertilizer in exchange for a fixed fee of MK950 for 23:20 fertilizer, or MK1450 for Urea (Dorward, Chirwa, Kelly, et al., 2008). Those fees represent slightly more than a third of the market price. We simulate the input subsidy to match the total amount spent by the government on fertilizer subsidies in the first round of the MAISP (US$51.4 millions),

[10] The parastatals ADMARC (Agricultural Development Marketing Corporation) and SFFRFM (Smallholder Farmers Fertilizer Revolving Fund, Malawi) distributed the fertilizer in exchange for vouchers in 2005/06. In the 2006/07 and 2007/08 rounds, major private retailers were authorized to distribute the subsidized fertilizer. Private sector was however excluded again in the 2008/09 round (Dorward & Chirwa, 2011).

distributed to eligible households. Given the value share that inputs represent in the production functions of these groups, and given the elasticity of their demand response, this corresponds to a 30% reduction in the price eligible households pay for fertilizer.[11]

By design, the simulated subsidy only goes to eligible household groups: group 5 (poor smallholders) and group 6 (ultra-poor labor-constrained smallholders). This is shown in Table 2, where the first row reported for each simulation is the total amount received in transfers by each household group. Due to its size, group 5 receives the bulk of the vouchers, 93%.

Although recent attention has focused on fertilizer subsidies, Malawi has a history of implementing output price supports, as well. After independence, the country controlled input and output markets through the parastatal agency ADMARC. It offered seed and fertilizer to farmers at below market prices (on a smaller scale than MAISP), while paying farmers guaranteed pan-territorial prices for their maize output. The government agreed to eliminate ADMARC price supports for maize in 1998, shifting to a reserve scheme to stabilize prices.[12]

The market price support (MPS) experiments simulate the rural economy-wide effects of an exogenous increase in the farm gate price of maize. This is essentially what Malawi did by offering farmers a high guarantee price. For better comparability, we calibrate the exact price increase in such a way that the total cost is same as the first round of MAISP: US$51.4 million.[13] In our model, this corresponds to simulating an exogenous 22% increase in the market price for maize. Under such a scheme, the explicit cost of the market price support is borne by taxpayers as well as consumers. Within the rural economy, the guarantee price becomes the opportunity cost of consuming the staple. Thus, the support increases the producer surplus, but it also pushes up the consumption price for rural households, reducing their consumer surplus.

Theory tells us that when an MPS hits, farms that originally were net sellers of the target crop tend to respond by increasing both their output and sales; net buyers on the other hand tend to reduce their purchases and produce for their own consumption. Some households that were previously net buyers can turn into net sellers if the incentive is strong enough (this is the case of group 5). All households selling maize are in effect receiving a transfer, by way of artificially high farmgate prices.

The transfer shares in Table 2 reveal that the distribution of this subsidy across household groups is regressive: 57% of the transfer goes to medium and large households representing only

[11] This is a lower subsidy rate than the 64% reported by Dorward and Chirwa (2011). The discrepancy could mean that the number of recipient households was smaller than is believed, or that we overestimated their use of fertilizer in the baseline. Our estimates are based on official LSMS data. In addition, the 64% figure may be ignoring some of the hidden costs incurred to receive the vouchers ("bribes"), or to redeem them ("tips").

[12] International Monetary Fund, "Malawi—the Food Crises, the Strategic Grain Reserve, and the IMF." July 2002. http://www.imf.org/external/np/exr/facts/Malawi.htm

[13] The total cost of the MAISP has since increased more than three-fold.

a fifth of rural households in the country. Another 22% goes to the ineligible small farms (i.e., non-poor small farms), who also get a disproportionately high share of the transfer. Of the remaining 21%, all but one percent goes to farms eligible for MAISP only, nearly half of rural farms. Households eligible for SCTS receive the last percentage point of the transfer, while those eligible for both programs - the poorest, least-endowed five percent of rural farms - receive a negligible share (<0.05%).

The most recent development in Malawi poverty alleviation efforts has been the SCTS. We simulate this transfer with our model by giving an exogenous payment to eligible households (groups 4 and 6), which relaxes their income and cash constraints. For comparability, we also matched the total amount spent on the intervention to the cost of the 2005/06 MAISP (US$51.4m). The program is not being implemented at full scale yet, but the planned total spending for the 2012 SCTS is US$60 million (Miller, et al., 2011), which is about 52 million in 2005 dollars. We distributed the total between the two groups according to their relative size. This represents a rather large sum distributed to a relatively small share of the rural population (about 7% in our model, the official SCTS target being 10%), an income increase of about 50%. For comparison, the SCTS program distributes an average of MK2,000 per month to eligible households (Miller, et al., 2011), which on a yearly basis is about half of the average household income among the ultra-poor in the IHS2 (MK46,906).

Table 2: Transfer Mechanism Simulation Results for Malawi: Perfect Markets Benchmark

Transfer Mechanism	*Disaggregated effect by rural household group* (1) Ineligible, Non-farm housheolds	(2) Ineligible, Small farms	(3) Ineligible, Large farms	(4) Eligible for SCTS	(5) Eligible for MAISP	(6) Eligible for both SCTS and MAISP	Cost of intervention (millions US$)	Total Transfer Efficiency
a) IS: Crop Inputs subsidies for eligible households							51.4	0.66
Group's share of transfer	-	-	-	-	93%	7%		
Transfer received (mil. US$)	-	-	-	-	47.9	3.55		
Nominal income, % change	0.8%	0%	-0.3%	0.01%	5.47%	4.5%		
Welfare, % change	0.8%	0%	-0.3%	0.01%	5.47%	4.5%		
Household-level efficiency	-	-	-	-	0.69	0.78		
b) MPS: Market Price Support for Maize							51.4	0.57
Group's share of transfer	0%	22%	57%	1%	20%	0%		
Transfer received (mil. US$)	0.0	11.13	29.5	0.49	10.33	0.0		
Nominal income, % change	0.7%	4.1%	4.1%	4.4%	4.1%	3.0%		
Welfare, % change	-1.1%	2.0%	2.7%	1.6%	0.6%	-1.9%		
Household-level efficiency	-	0.64	0.66	0.57	0.37	-		
c) CT: Cash Transfer to eligible households							51.4	1.00
Group's share of transfer	-	-	-	17.5%	-	82.5%		
Transfer received (mil. US$)	-	-	-	9.0	-	42.4		
Nominal income, % change	0.0	0.0	0.0	50.8%	0.0	69.7%		
Welfare, % change	0.0	0.0	0.0	50.8%	0.0	69.7%		
Household-level efficiency	-	-	-	1.00	-	1.00		

Income and welfare effects of transfers

Table 2 reports the changes in nominal incomes as well as welfare for all household groups in the model. We use a variant of the compensating variation (CV) as our welfare measure, as in Taylor, Yúnez-Naude and Jesurun-Clements (2010). It computes the amount of money (positive or negative) a household would have to receive to return to its former level of utility, taking into account all of the household and general equilibrium adjustments taking place in the model. The percent change in welfare is the negative of the ratio of the CV to former income. The income and welfare measures can differ if the transfer scheme triggers changes in consumption prices.

Both groups receiving the IS see increases in nominal income, of 5.5% and 4.5% respectively. Fertilizer is not purchased for consumption, and prices of agricultural goods are fixed on the world market, so the IS does not produce negative consumption effects. Thus, for this transfer mechanism the welfare effects are equal to the income effects.

In addition to helping the recipients of the subsidy, the MAISP affects other households through general equilibrium effects. In the benchmark version of the model with perfect markets, the rural wage is endogenously determined, which leads non-recipient farm groups to be slightly impacted. Large farms suffer from an increase in the rural wage, which creates a slight dip in their income and welfare, as their production costs rise somewhat. This effect is limited, only representing a 0.3% decrease in income. On the other hand, household group 1 (non-farms) benefits from this wage effect, as it provides labor to larger farms. Group 1 experiences a 0.8% increase in income and welfare, even though it is not eligible for the transfer. Identifying such spillover effects is a *raison d'être* of simulation models like this one.

A market price support is not a targeted instrument: it affects all households engaged with the market. There is substantial variation in both the nominal income and welfare effects of the MPS. Nominal income effects are positive for all groups directly affected by this transfer (ranging from 3.0% to 4.4%). This income effect comes mainly from increased farm revenue. Farms sell their maize output at a higher price and increase production. Households providing labor to these farms also benefit from the MPS through wage effects. That is why the two groups that do not receive any direct benefit under the MPS still perceive increases in their nominal income, mild for non-farms (0.7%) but substantial for group 6 (3.0%). Overall, the MPS raises nominal incomes for all groups.

Welfare effects, on the other hand, vary in sign. They reflect the welfare costs of higher consumption prices, which may outweigh the positive effects of higher nominal income. The welfare effect of the maize price increase is invariably smaller than the nominal income effect, and it is negative for both household groups not benefitting directly from the MPS: groups 1 and 6. The welfare of those two groups falls by an amount equivalent to 1.1% and 1.9% of base income, respectively. Although these households benefit as farm laborers, higher consumption costs counteract nominal income gains, yielding this negative overall welfare effect. The largest welfare gains, predictably, accrue to large holders (2.7%). The case of the MAISP-eligible group (5) is noteworthy: its welfare increase is the smallest among the positively impacted groups. This group is a net buyer of maize before the price support is implemented. The MPS increases production sufficiently to generate a surplus and thus produces a positive welfare gain. Since this new marketed surplus is small, so is the welfare effect.

The CT has the most straightforward income and welfare effects. Both targeted household groups perceive a substantial increase in nominal income, of 50.8% and 69.7% respectively, by far the largest nominal income increases in Table 2. The transfer is unconditional, and households can spend their extra income as they wish. However, under the perfect market assumptions in the benchmark model, the production and consumption decisions of the household are separable. Since the intervention does not affect commodity prices (which are set on the world market) households do not alter their production decisions. For both eligible groups, the transfer is used entirely to increase consumption, and the nominal income effect translates fully into a welfare effect. There are no spillover effects from this transfer; all other households are unaffected.

Transfer Efficiencies

We provide two measures of transfer efficiency: the household-level efficiency and the total transfer efficiency. Both are defined as a change in welfare relative to a cost.

The household level efficiency measure divides a group's welfare increase (in dollars) by the transfer the household group received (also in dollars). It reflects the ability of the group to convert its transfer payment into welfare, in other words, to retain the benefits of the transfer. Naturally, the measure can only exist for households actually receiving a transfer payment. A low value of household-level transfer efficiency (closer to zero) indicates that the group retains fewer benefits and most of the transfer's effect leaks away to other actors or is lost in inefficiencies. Conversely, an efficiency value closer to 1 indicates that most of the transfer translates into welfare for the recipient.

The IS produces household level efficiencies that are relatively high for group 6 (0.78) and somewhat lower for group 5 (0.69). The reason for this is that the general equilibrium effects of the transfer favor group 6, which is a net seller of labor and benefits from a higher wage in addition to the transfer itself. In fact, the efficiency measure can be greater than one if general equilibrium effects are large enough.

Household-level efficiencies of the MPS range from 0.37 to 0.66. MAISP-eligible households are at the lower end of the spectrum, because although they now produce a surplus, this surplus is much smaller than the volumes they consume, for which they now pay a higher price. At the other end of the spectrum, the biggest beneficiaries are the households with the largest surpluses.

By construction, efficiencies of the cash transfer are all equal to 1 in the perfect markets benchmark. This is because unlike in the MPS and IS schemes, there are no leakages via general equilibrium effects, and because the cash transfer is direct, there are not diminishing marginal returns via production. Thus, each dollar of transfer creates a dollar of welfare, with no implicit cost to other rural actors.

The total transfer efficiency is a single figure for each simulation. It is the ratio of total welfare change to total transfer received, both summed across all households and expressed in dollars. It tells us how good an instrument is at transforming cash into rural welfare. It captures the welfare impacts not only on households receiving the transfer but also on households that may be impacted indirectly. The total transfer efficiency is low for a mechanism design that lets most benefits leak outside of the rural sector, or one that has large negative impacts on some rural actors. It would be closer to one for a transfer with no leakages or perverse effects, and it could be greater than 1 if there were income multipliers (a case we discuss in the next section).

The last column of Table 2 reveals that the IS has an efficiency of 0.66, meaning that each dollar of input subsidy transfer contributes 66 cents to rural welfare. This is not a very high efficiency level. It is due to the fact that there are diminishing returns to fertilizer use at high subsidy levels.[14] The overall transfer efficiency of the MPS is even lower (0.57), because it creates negative consumption effects for many rural households.

The results presented in Table 2 suggest an efficiency ranking of the three transfer schemes. In our simulations, a market price support is not only the least efficient instrument; it also hurts the poorest of rural households. The IS does a somewhat better job of transferring income to rural households. This can help explain why a market price support was abandoned in favor of input subsidies. Nevertheless, the CT clearly remains the most efficient transfer mechanism, which is partly why cash transfers are growing in popularity.

There are two major caveats to these conclusions. First, transfers may have other goals besides efficiency. Second, this ranking was obtained using a model that assumes perfect markets, an unrealistic assumption for rural areas in Malawi and most other sub-Saharan African countries.

Alternative criteria for instrument choice

The previous findings beg the question of why a poor country like Malawi would choose input subsidies rather than cash transfers as a means of improving rural household welfare (in other words, why the MAISP was implemented years before the SCTS).

One answer is that the intervention has multiple objectives, primary among which is achieving food security through higher agricultural production. Table 3 compares the production effects of the three transfer mechanisms in the base model. Not surprisingly, the CT has no production effect, as it does not alter the decision prices for producers. MPS and IS clearly are superior to a cash transfer if the objective is to raise production.[15] The market price support

[14] Modeling a 10% input subsidy yields an overall efficiency of over 90%.

[15] In fact, it was partly a bad harvest in the 2004/2005 growing season that triggered the MAISP (Dorward, Chirwa, Boughton, et al., 2008)

boosts maize production significantly (50.1%). However, this comes at a cost to most other production activities: overall agricultural production only increases by 1.0%.

Input subsidies are an indirect way to raise agricultural production, by lowering production costs. The hope is that fertilizer use will increase, thus raising production. Total fertilizer sales in Malawi increased from 228 to 292 metric tons between the 2004/05 and the 2005/06 season, a 28% increase (Dorward, Chirwa, Kelly, et al., 2008). Some of the impact of this subsidy represents in fact a pure transfer effect: vouchers could be redeemed for fertilizer that the household would have purchased even without the voucher. If this was predominantly the case, the subsidy would simply be "displacing" commercial fertilizer sales, but not affecting production. However, a recent econometric study found that 0.78 of each additional kilogram of subsidized fertilizer represented fertilizer that would not have been purchased without the subsidy. The share was higher for the poorest farmers (0.82) than for relatively non-poor farmers (0.70), suggesting that targeting the poor increases the production effect of the subsidy (Ricker-Gilbert, Jayne, & Chirwa, 2011). Dorward and Chirwa (2011) report a similar figure for 2005/06 (20% displacement), though their estimates rise for subsequent rounds of the program. Taking this displacement into account, about 50 metric tons of fertilizer would not have purchased in 2005/06 if not for MAISP, a 22% increase over 2004/05. In our IS simulation, the increase in fertilizer use is 24%.

This increase in fertilizer use triggers increases in production. Total maize production increases by 4.7%. Although IS does not match output price supports in terms of stimulating maize production, it benefits some other production sectors besides maize, notably the main cash crop, tobacco. The last column shows that on the whole, IS increases total agricultural output by 4%, which is more than the MPS. The MPS forces an inefficient reallocation of resources to maize, while the IS stimulates the production of all fertilizer-intensive crops.[16] Instrument choice will again depend on specific objectives.

Table 3: Production effects of alternative transfer schemes

	Percent increase in production						
Transfer Scheme	Cereals	Tubers	Other Annual crops	Tobacco	Permanent crops	Livestock	**Total agricultural output (all crops)**
IS	4.7%	-13%	-2.2%	25.1%	-5.8%	-5.2%	**4.0%**
MPS	50.1%	-15.2%	-6.9%	-1.4%	-9.4%	-4.4%	**1.0%**

[16] Our model assumes that all agricultural production uses the same fertilizer. This is not unreasonable, since the subsidized fertilizer types (primarily NPK 23-21-0+4S and Urea) have a wide range of applications. Tuber production uses relatively little fertilizer and gains less from the IS, hence the drop in output in our simulations.

Cash Transfer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**0.0%**

Are IS and MPS ever most efficient? Instrument choice under alternative market conditions

Our perfect markets benchmark model produced a ranking of transfer instruments in terms of efficiency, but this ranking is subject to caveats. Input subsidies or market price supports could be preferable to cash transfers under certain constraints or market conditions not portrayed in the base model. On the other hand, they may also be plagued by other sources of inefficiencies that our model overlooks. An advantage of simulation methods is that they can be used to explore the impacts of a given intervention under different market conditions.

Table 4 explores some of these impacts. We now present four simulations that dramatically alter our efficiency ranking of transfer schemes. We show that IS, MPS, and CT can all be either desirable or undesirable depending on the market environment in which they are implemented.

In the perfect markets benchmark , IS appears rather good at raising output and not too inefficient. But this efficiency of input subsidies relies on the assumption that input prices will remain relatively constant despite the intervention. A 50% discount on fertilizer would not help farmers if the price of fertilizer doubled once the transfer was implemented. Farmers without vouchers would be especially adversely affected. One reason this might happen is if there exist rigidities in the fertilizer supply chain, such that an increase in supply comes at a higher cost. Another is that market power on the supply side could allow retailers to increase prices and extract additional profit from farmers. In the case of MAISP, there were reports of retailers requiring a "tip" for voucher redemption in about 15% of the cases (Dorward & Chirwa, 2011). This is analogous to the government subsidizing retailers rather than farmers; it could seriously undermine the efficiency of an input subsidy if the tips are large. Column (b) of Table 4 presents simulation results for a rather extreme scenario in which the elasticity of input supply is set to 1: each percentage point increase in supply comes at a 1% increase in fertilizer price. Under these conditions, production effects are dramatically reduced. The IS only yields a 1.2% increase in total production. The MPS actually *reduces* total agricultural output, as farmers abandon other crops in favor of maize. Both MPS and IS efficiencies fall, and IS becomes the least efficient transfer. Under such market conditions, the CT emerges as the clear victor in terms of transfer efficiency.

On the other hand, it is possible that our benchmark simulations underestimate both the production effects and the efficiencies of all three transfer schemes, if transfers create income multipliers not reflected in the model. Income multipliers can result from sub-optimal utilization of resources in an economy. For instance, if an income transfer allows farmers to put previously unused land into production, it can create a multiplier. Economic models such as input-output models or SAM multiplier models often produce large income multipliers, because they assume an infinitely elastic supply of factors over the range of the experiment. Conversely, most general equilibrium models assume resources to be in limited supply in the base, with market interactions determining their optimal usage and equilibrium price. In general, the existence of unemployed resources in an economy is consistent with optimality in a CGE model only if the value of the unemployed resource at the margin (i.e., its marginal product) is zero. (Modelers usually assume this is not the case.) We now relax this optimality assumption for the input and labor markets.

Liquidity constraints are often blamed for limited fertilizer use in African agriculture. A market price support may not increase production if farmers cannot purchase the necessary inputs. The timing of an intervention matters: if a market price support provides farmers with extra income at harvest time, it will not solve liquidity constraints prior to the harvest unless borrowing is possible, and poor households may not be able to forgo consumption long enough to save for the next growing season. The same is true for cash transfers. In a cash-constrained rural sector with poor access to credit, the extent to which a cash transfer may have an effect on input purchases or production will depend on various factors such as timing, economic climate, and preferences in the targeted households. For instance, the 2006/07 Dowa Emergency Cash Transfer (DECT) in Malawi was implemented as an emergency drought relief strategy. Evidence from post-program monitoring shows that, not surprisingly, only a small part of the transfer (about 5%) was used for fertilizer purchases, with over 60% going to food purchases (Devereux, Mthinda, Power, Sakala, & Suka, 2007). A targeted input subsidy, on the other hand, directly loosens the liquidity constraint on input use (provided that there is an elastic supply of the input). The SCTC is likely to have an effect in between those two extremes. It is a regular, bi-monthly cash transfer that can be taken into account when households make their production decisions. On the other hand, SCTS targets the poorest segments of the population, for which it is likely that food, education, and health expenditures could take precedence over fertilizer purchases.

Column (c) of Table 4 presents the results of adding a liquidity constraint equivalent to the observed expenditures on purchased inputs in the base model. Despite a perfectly elastic supply of inputs in the economy, this constraint prevents farmers from increasing their input purchases, as does cash availability in Malawi (Dorward, Chirwa, Boughton, et al., 2008; Morris, et al., 2007). The three instruments have different impacts on this constraint. We assume that the MPS has no direct effect: it raises incomes at the wrong time of year, after harvest and long after any fertilizer purchases have been made.[17] The extent to which the CT would relax this constraint is hard to predict. Fertilizer purchases represent on average 31% of cash expenditures in the rural sector in our baseline data (equivalent to 13% of full income), but for SCTS-eligible households this share drops to 15%. To simulate a best-case scenario, we conservatively assume that a third of the cash transfer will be used to relax the fertilizer constraint. The IS scheme directly loosens the liquidity constraint by reducing the fertilizer purchase price. Assuming an elastic fertilizer supply, the entire input subsidy amount received by a household thus goes towards relaxing the liquidity constraint on fertilizer. Interventions that relax this liquidity

[17] A recursive use of our model could show how the MPS may lead to increased fertilizer use in the *following* year… but only if farmers manage to keep their extra income until the next cropping season.

constraint will create multiplier effects, as underutilized inputs in the economy are put to productive use.

The production results from this set of simulations clearly point to the input subsidy as superior. It raises production by the largest amount: 2.3%. Total agricultural output shrinks under the MPS, as farmers intensify maize production but lack the liquidity to fully realize their production potential. Unlike in all previous simulations, the CT now has production effects (0.8%), because it loosens liquidity constraints. This boosts the efficiency of the CT to 1.17. Because the cash transfer relaxes a constraint on production in addition to raising incomes, it has a multiplier effect on the rural economy: a dollar of the transfer raises rural welfare by more than a dollar. In this simulation, the CT comes out even more clearly than before as the most efficient transfer instrument. IS remains only mildly efficient (0.60). The efficiency of the MPS falls dramatically (to 0.04): production expansion is limited by the liquidity constraint, but higher consumption costs still hurt maize purchasers. This simulation represents an optimistic case, in which a third of the cash transfer is dedicated to input purchases, but even if this amount were smaller the CT would still be the most efficient instrument and the only one creating multipliers greater than one. In contrast, column (c) illustrates how liquidity constraints may undermine the effects of a market price support.

The next two simulations depart from the neoclassical labor market assumption of full employment at an equilibrium market wage embodied in the benchmark model. We assume that labor is underutilized and the prevailing wage is a subsistence wage, determined by workers' survival needs rather than by the interplay of supply and demand in a neoclassical labor market.[18] This means that any increase in labor demand will put previously unemployed people to work, potentially generating income multipliers.

Table 4: Production effects and efficiency under alternative market conditions (Malawi)

	(a) Base model: perfect markets benchmark	(b) Base model with inelastic input supply	(c) Base model with constrained input use	(d) Base model with unemployment	(e) Base model with unemployment and constrained input use
Production effects					
Input Subsidy	4.0%	1.2%	2.3%	13.4%	5.0%
MPS	1.0%	-0.2%	-0.3%	8.6%	2.9%

[18] Whether the rural wage in Malawi is a market wage (neoclassical model) or a living wage (classical model) is very difficult to determine. The existence of unemployment in and of itself does not violate the neoclassical assumptions unless this unemployment is "involuntary".

Cash transfer*	0.0%	0.0%	0.8%	0.0%	2.0%
Efficiency					
Input Subsidy	0.66	0.22	0.60	2.59	1.59
MPS	0.57	0.34	0.04	2.29	1.30
Cash transfer*	1.00	1.00	1.17	1.00	1.47

Column (d) reports results from a model without liquidity constraints but with unemployment. As expected, production and welfare effects are larger in column (d) than in column (a). The input subsidy raises total agricultural output by over 13%, because the increased use of fertilizer is accompanied by substantial increases in labor use without any upward pressure on wages. The MPS also increases total agricultural production, by 8.6%, with gains in maize partially counteracted by decreases in other crops. As in the benchmark model, the CT does not increase agricultural output, because liquidity is not modeled as a constraint on production in this scenario. For the same reason, the CT does not produce any multipliers in the economy, and its efficiency is 1.0, as in the benchmark case.

The efficiencies of the MPS and IS instruments, on the other hand, increase dramatically. Each dollar of IS leads to $2.59 of additional welfare. A dollar of MPS leads to $2.29 of extra welfare in the rural sector despite its negative consumption effect. These efficiencies reflect large multiplier effects in the economy, as increased production leads to higher employment and wage income for labor-supplying households.[19] IS and MPS now appear superior to a cash transfer, in terms of both production and efficiency.

These results change somewhat when we model liquidity constraints on input use in addition to unemployment (i.e., the conditions in columns (c) and (d) simultaneously). Column (e) shows reduced production effects for IS and MPS. Though labor is cheap and available, the MPS is plagued by farmers' inability to borrow cash against future production, thus, production rises by only 2.9%. Under this scenario, the CT releases the liquidity constraint on production and boosts agricultural output by 2.0%. This is less than the MPS, but quite substantial given that boosting agricultural production is not an explicit objective of the SCTS. All three transfers create multipliers under these market conditions, ranging from 1.3 (MPS) to 1.59 (IS). Under those conditions, the market price support is again the least efficient instrument. As in

[19] Note that those are not excessively high multiplier values: Sadoulet, De Janvry and Davis report multipliers for the Mexican PROCAMPO program in the range of 1.5-2.6 on beneficiary households alone (not including positive spillover effects on ineligible households) (Sadoulet, et al., 2001).

experiment (d), input subsidies dominate both market price supports and cash payments in terms of welfare and production.

Based on the simulations reported in Table 4, it appears that no single instrument is invariably superior. Rather, the outcome of any given instrument is contingent on specific market conditions. A market price support appears to be a very inefficient instrument because of the consumption costs involved, particularly when liquidity constraints are modeled. However, it also creates substantial multipliers in the presence of unemployment. The input subsidy leads to the largest multipliers in the table, but those effects could be undermined if the input supply is imperfect. When markets function perfectly, cash transfers appear to be the most efficient instrument because they have a one-for-one impact on efficiency, the highest achievable under the assumptions of the benchmark scenario. Cash transfers can create income and welfare multipliers in excess of one when they relieve a cash constraint on input purchases. The size of the multiplier effect hinges on the spending patterns of recipient households. In our simulations, we assumed that 33% of the CT would be spent on agricultural inputs. This does not seem unlikely, but it cannot be verified with the present data. Experiments could be designed to ascertain the impact of a CT on input demand, thereby providing a useful input for simulation impact evaluation.

Which market assumptions are likely to best portray the reality of Malawi is not obvious; however, it is safe to assume that the perfect markets benchmark is overly optimistic. The elasticity of input supply, the responsiveness of wages to shifts in labor demand, and the extent to which there are cash constraints on input demand are all critical in determining the efficiency of alternative transfer mechanisms, and all are likely to vary across project settings.

V

Comparison with Ghana

In order to further illustrate the effects of market structures on transfer outcomes and explore the importance of mechanism design, we now present results of similar experiments using data from Ghana. The government of Ghana, like that of Malawi, is engaged in both an input subsidy and a cash transfer program. However, the two governments made different choices with regard to program design and implementation. As we shall see, these differences lead to different project evaluation simulation results and conclusions.

Background

Like Malawi, Ghana ranks among the poorest nations in terms of human development. The 2010 Human Development Index (HDI) published by the United Nations ranks Ghana 130th out of 169 countries, 23 places in front of Malawi. 29.9% of the population lives on less than \$1.25 per day in PPP terms (UNDP, 2010). In 2008, the government of Ghana implemented a National Social Protection Strategy, the main instrument of which is the Livelihood Empowerment Against Poverty (LEAP) cash transfer scheme. As in Malawi, this program targets the extremely poor, with priority to those with limited productive capacities. The design of the program is slightly more complex than in Malawi, with both unconditional and conditional transfers. Persons with disabilities and elderly people living in extreme poverty receive unconditional social grants. People caring for orphans or "vulnerable children" also receive grants, but under certain conditionalities such as school enrolment, social security membership, or immunization (Government of Ghana, 2008). As the program is still in its pilot phase, the specifics of targeting and implementation are still being honed. According to Devereux (2009), "subsistence farmers and fisher folk" are also a target group. Payments to a household range between 8 and 15 Cedi per month, depending on the number of people in the household considered eligible (Government of Ghana, 2008).[20]

Agriculture in Ghana generated 6.7 billion dollars of value added in 2007, representing a third of Ghana's economy in terms of GDP.[21] Tubers are the main staple, followed by plantains, maize, and rice, while the primary cash crop is cocoa (see Figure 5). The structure of Ghana's agricultural economy is similar to that of Malawi, with a large number of smallholder farms and low levels of capitalization and input use. Partly in order to mitigate the impact of high food prices in early 2008, the government of Ghana implemented a temporary input subsidy program (IS), the operational details of which were described by Banful (2009). This program, which has been continued every year since, consisted of distributing vouchers that could be used towards the purchase of a bag of fertilizer. Four kinds of fertilizer were involved in the program, most importantly NPK 15:15:15, but also NPK 23:10:05, Sulfate of Ammonia, and urea. The government negotiated a public-private partnership with three large fertilizer retailers, by which they would accept the vouchers and sell fertilizer at a pre-determined price. Vouchers and prices were regionally specific, thus ensuring that the subsidy would extend to the whole country. Voucher distribution was carried out by extension agents, but it was not targeted to specific types of farmers. In particular, poverty was not an eligibility criterion like it was in Malawi: any farmer needing fertilizer could in theory receive a voucher. In fact, larger farms could receive several vouchers, since they were likely to use more fertilizer. The total number of vouchers issued was fixed at the regional and district levels, and there is evidence that vouchers were in short supply throughout the nation (A.B. Banful, 2009).[22]

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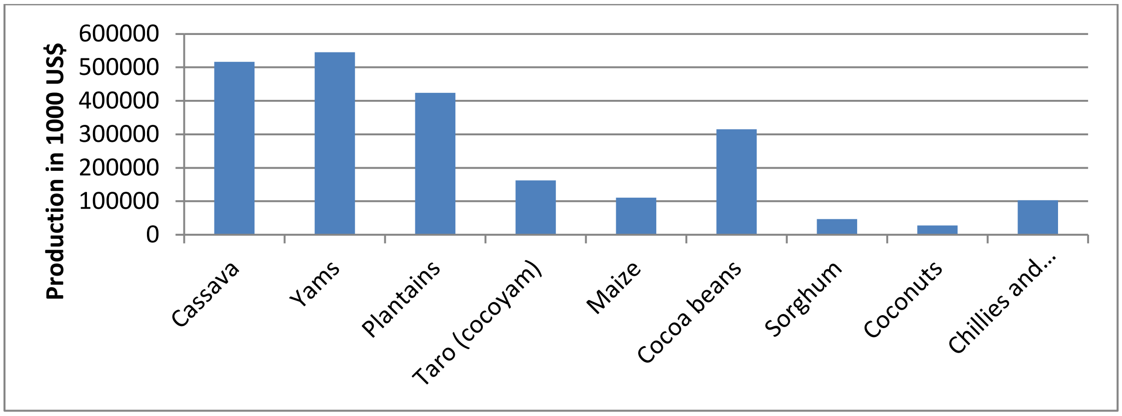
[20] One US dollar equaled 1.21 Cedi in 2008 (0.52 in PPP-adjusted terms) (Heston, Summers, & Aten, 2009)

[21] The World Bank database http://data.worldbank.org/country/ghana. GDP expressed in current dollars.

[22] There is also evidence that a disproportionate amount of vouchers were allocated to districts in which the ruling party had been less popular in the previous election, suggesting that the voucher program was used as a political tool in an attempt to "buy" votes (Afua Branoah Banful, 2010). The ruling party narrowly lost re-election later in 2008.

Figure 5: Top agricultural activities (in value) in Ghana, 1998.[23]



Source: FAOSTAT

Modeling

We model the two transfer schemes using a method similar to the one used for Malawi. We first construct a SAM for rural Ghana using FAOSTAT production and consumption totals combined with household survey data obtained from the RIGA team at FAO. The Ghana Living Standards Survey 4 (GLSS4) was used to identify household groups and their production and consumption patterns. As for the Malawi SAM, we estimated factor shares in the production processes with log-log regressions of output value on land, capital, labor and purchased inputs, jointly for all households. We obtain a consistent SAM for the year 1998, which we rescale assuming 4% annual growth in agricultural GDP (the average annual growth over the 2006-2009 period, according to World Bank country data) and convert to 2007 dollars. The agricultural GDP in the rural SAM that we obtain with this method is $6.0 billion (the World Bank estimate is $6.7 billion).

Households in the Ghana SAM are disaggregated according to the eligibility criteria in effect in Ghana. Because the IS scheme in Ghana is not targeted, this yields only 4 groups of households:

- Ineligible non-farm households
- Small farms (eligible for IS)
- Medium and large farms (eligible for IS)
- Households eligible for LEAP (and for IS if they farm).

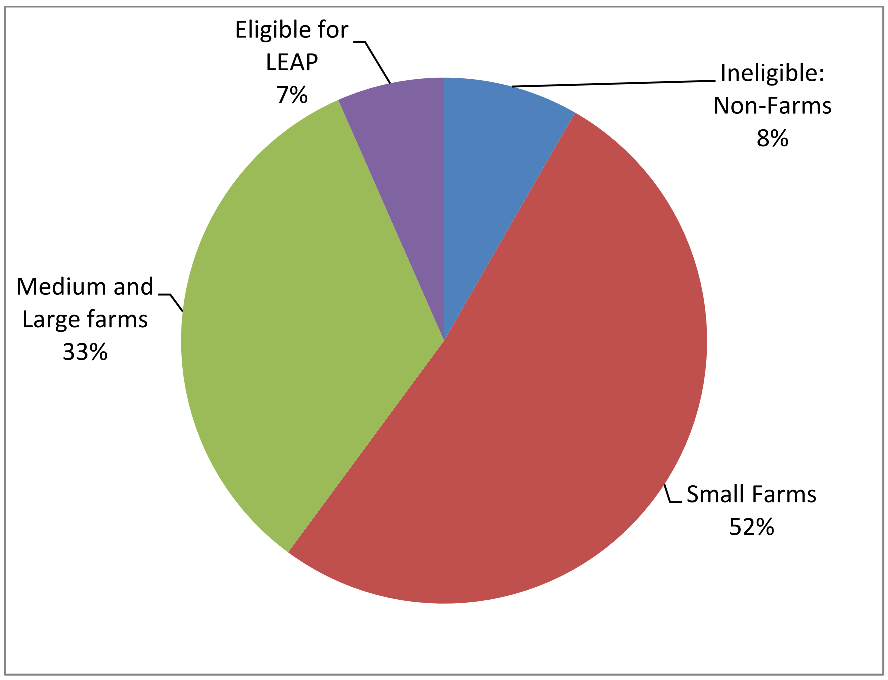
LEAP is generally aimed at the "ultra-poor" households in Ghana, who are the poorest 18.2% nationwide (Government of Ghana, 2008). However, among this group it prioritizes the disabled, the elderly, and "vulnerable" children (orphaned, disabled, affected by AIDS, or those whose caregiver is disabled or chronically sick). In the original formulation of the plan, the

[23] 1998 is the year we have survey data for. However, the order of the top 6 crops is the same for 2008, the latest year in the FAOSTAT production database for Ghana.

target group represented about a fifth of those in extreme poverty (Government of Ghana, 2008), about 3.6% of the total population of Ghana. To reproduce this targeting in our matrix, we identified households in the LSMS dataset who were both among the 18.2% poorest nationwide and counted an elderly member, an incapacitated member, or a sick minor. Elderly members were defined as aged 65 or older, incapacitated members as those who reported being incapable of working because of age, sickness, or disability. Because the GLSS4 survey only asks about health in the two weeks preceding the survey date, we considered as chronically sick only those minors who had been sick for this entire period. The survey gives no information about orphaned or AIDS-affected children. Defined this way, the eligible group represents 4.7% of households in the national survey, which is not far from the prospective 3.6% announced in the original formulation of the scheme. Eligibility rates are higher in the rural sector: 7.2% (see Figure 6).

We use the Ghana rural model simulate the two transfer schemes as they were implemented and to compare results with the Malawi case.

Figure 6: Household Categories in Ghana Model



Simulations of Ghana's IS Scheme

We first present the results of five alternative IS simulations in Ghana, to highlight the issues of program design and program scale. The first year of the program the Government of Ghana announced it would inject 15 million dollars into subsidies for inputs to help farmers. As described above, this entailed negotiating a guaranteed fertilizer price with several large retailer companies; vouchers would give farmers a discount of about 50% on those prices.

Table 5 shows the regional prices that were negotiated by the government and the prevailing prices in the month before the subsidy announcement. Negotiated prices were all higher than prevailing prices before the subsidy except in the Accra capital region where they remained the same. In the extreme case of the Western region, the price more than doubled, meaning that even voucher-holders paid a higher price for their fertilizer than in June 2008. The last column of Table 5 shows that once this price increase is taken into account, the effective subsidy to farmers is on the order of 30% rather than 50%. Of course, nobody can surely know what the prices would have been in the absence of the program: they could have risen to the negotiated price levels or higher. However, Banful (2009) suggests that some farmers actually held off on purchasing fertilizer in expectation of the impending subsidy, even in the peak fertilizer application season. Ironically, farmers who did that in the Western region ended up paying *more* out of pocket for fertilizer, even if they had a voucher.

Table 5: Fertilizer Prices under the IS subsidy

	Fertilizer Sales (%)	NPK price in June 2008	NPK negotiated price in (July-Dec) 2008	Price Increase (%)	Subsidy (% of negotiated price)	Effective subsidy to voucher holders*
Northern	9	33.1	51.2	55%	49.1%	21%
Upper East	6	43.5	52.2	20%	50.1%	40%
Upper West	6	40	51.9	30%	49.9%	35%
Central	9	40	50.88	27%	48.9%	35%
Eastern	9	38	51.2	35%	49.1%	31%
Brong Ahafo	10	37.65	51.7	37%	49.6%	31%
Western	9	25	50.7	103%	48.7%	-4%
Greater Accra	8	50.8	50.8	0%	48.9%	49%
Volta	9	44	51.2	16%	49.2%	41%
Ashanti	25	35	50.5	44%	48.5%	26%
Weighted average		**37.798**	**51.0712**	**39%**	**49.047**	**29%**

Source: (A.B. Banful, 2009) and own calculations. *assuming prices remained the same as in June 2008.

The effect of a transfer design such as this one is akin to what was presented in Table 4, column (b): it creates a leakage of value towards suppliers rather than farmers. In the previous section, we described this as a possible perverse effect resulting from imperfect markets or market structures, by which input prices rise when demand rises. In Ghana, however, this perverse effect was actually built into the transfer design, because negotiated prices were so much higher than prevailing market prices. Simulations (a) and (b) in Table 6 present an illustration of this leakage, using the Ghana model.

Simulation (a) shows the effect of the injection of 15 million dollars towards fertilizer subsidies *without* any shock to prices (market prices remain at their pre-subsidy levels). This corresponds to subsidizing fertilizer prices by 1.1% (or subsidizing by 50% but only for 2.2% of buyers). Because the program is not targeted to any particular type of farmer, large farms get the bulk of the transfer. Effects on farm welfare are mild (0.1%-0.2%), but the transfer is highly efficient: household-level efficiencies are all above 0.95, and overall transfer efficiency is 0.98.

This is not what happened in Ghana. Instead, the Ghanaian government negotiated fertilizer prices which were on average 39% higher than the previously prevailing market price. This is an increase in price as large as three quarters of the subsidy level. When we simulate the injection of 15 million dollars towards such a subsidy scheme, the efficiency drops dramatically, as shown in simulation (b) of Table 6. The cost of the simulation is the same, the transfer is distributed almost identically, and each farm receives the same transfer amount as in simulation (a). However, most of that transfer goes to paying the higher fertilizer price. Impacts on welfare are half of what they were in simulation (a), and overall efficiency drops to 0.22. Such a transfer scheme directs many of the benefits towards input suppliers rather than farmers.

Table 6: Simulation results for IS scheme

	Disaggregated effect by rural household group				Cost of intervention (millions US$)	Total Transfer Efficiency
IS Scheme	(1) Ineligible, Non-farm housheolds	(2) Small farms	(3) Large farms	(4) Eligible for LEAP		
a) IS with no effect on input prices					15.0	0.95
Group's share of transfer		39%	57%	4%		
Transfer received (mil. US$)		5.9	8.5	0.6		
Welfare, % change	0.0	0.1	0.2	0.2		
Household-level efficiency	-	0.99	0.96-	0.98		
b) IS how it was implemented					15.0	0.22
Group's share of transfer		39%	57%	4%		
Transfer received (mil. US$)		5.9	8.5	0.6		
Welfare, % change	0.0	0.0	0.0	0.0		
Household-level efficiency	-	0.23	0.22-	0.22		
c) IS how it was implemented, but at the Malawi Scale					342	0.36
Group's share of transfer		39%	57%	4%		
Transfer received (mil. US$)		134.8	193.2	13.6		
Welfare, % change	0.1	1.13	1.44	1.30		
Household-level efficiency		0.37	0.35	0.36		
d) IS with no effect on input prices, Malawi Scale					342	0.86
Group's share of transfer		39%	57%	4%		
Transfer received (mil. US$)		134	192.9	13.5		
Welfare, % change	0.2	2.7	3.4	3.0		
Household-level efficiency		0.87	0.84	0.86		
e) IS on all input purchases					1164	0.47
Group's share of transfer		39%	57%	4%		
Transfer received (mil. US$)		459.5	659.0	46.1		
Welfare, % change	0.4	5.1	6.4	5.8		
Household-level efficiency		0.48	0.47	0.48		

The Ghana IS scheme did not differ from Malawi's only in terms of design; it also differed in terms of scale. The rural economies of Ghana and Malawi share several striking similarities. The rural populations of the two countries are almost the same size (11.7 million in Ghana, 12.3 in Malawi). In both countries, agricultural value added represents about a third of total GDP (32% in Ghana, 31% in Malawi). However, this represents a much larger total value in Ghana: Ghana's GDP is roughly six times that of Malawi, and the same is true for agricultural value added (6.7 billion current dollars in Ghana in 2007, against 1 billion in Malawi).[24]

Given these numbers, the 51 million dollars Malawi allocated to fertilizer subsidies represented an injection of value into the agricultural economy equal to about 5.1% of agricultural GDP. In comparison, Ghana's subsidy program is modest: the 15 million dollar budget represents only 0.2% of agricultural GDP. This is why, even under the perfect conditions of simulation (a), farm welfare in Ghana rises by only 0.2%. Recent newspaper articles report that the IS budget doubled in subsequent years, which would still represent less than one half of one percent of the agricultural GDP.[25]

Simulation (c) shows what would happen if Ghana were to scale up its intervention to a level similar to that of Malawi. The total program cost would be 341 million dollars. The transfer would still be allocated as in simulations (a) and (b). Assuming prices are negotiated as they were, this injection would only increase farmer welfare by 1.13%-1.44%. The program's efficiency would only be 0.36.

Note that if Ghana spent the same 341 million dollars while negotiating prices at their June 2008 level, farmer welfare would increase by 2.7%-3.4%, and the program would have an efficiency of 0.86 (simulation (d)). This is more efficient than the same intervention simulated in Malawi, which under the fixed-price assumption had an efficiency of 0.69. Such differences are due to the structure of the economy and the specifics of production functions in the two countries. They also stem from the fact that the Ghana IS is not targeted to specific farms, thus spreading the 5.1% of agricultural GDP injection across more farms. Since there are diminishing returns to fertilizer use, it is more efficient to subsidize fertilizer at the margin on all farms than to massively increase fertilizer use on selected farms. On the other hand, an untargeted scheme is less likely to have the desired effect on poverty.

Simulation (e) presents one more scaling-up experiment. It simulates the current IS design applied not just to fertilizer but to all purchased inputs (seeds, chemicals, etc.). All inputs are purchased at a 50% discount, but the price is negotiated at 39% above market value. This would cost Ghana nearly 1.2 billion dollars but only raise farmer welfare by 5.1%-6.4%.

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[24] Population and GDP data from the World Bank data catalog: data.worldbank.org/country

[25] Awuah, E. (2011). 2011 Fertilizer Subsidy Prices Out. In Daily Guide. Accra. http://www.dailyguideghana.com/?p=12186. Last accessed May 30th, 2011.

Simulations of Ghana's LEAP program

Ghana's LEAP program plans to hand out social grants of 8-15 cedi on a monthly basis. The total budget was 8 million dollars in the first year (including overhead) and could reach 26 million when the program reaches full scale in 2012 (IPC, 2008). Overhead represents 82% of the budget in the first year, but by the last year of the scale-up this share should drop to 25% (Government of Ghana, 2008), leaving 19.5 million dollars available for social grants, roughly half of which (9.75 million) should be given to rural households (Devereux, 2009), the rest being given to urban recipients and thus exogenous to the economy we model. Simulation methods are ideal to evaluate program impacts at both the initial and scaled-up phases.

We simulate both of these transfers given to the rural LEAP-eligible households: 0.85 million in the first year, 9.75 million in the last. Table 7 summarizes the results. It only reports values for LEAP-eligible households, since impacts on all other households are negligible. As in Malawi, the cash transfer appears very efficient, with an efficiency of 1.00. It also creates no spillover effects, as we have made no assumptions about market failures such as liquidity constraints or unemployment.

Again, Ghana's intervention seems timid as opposed to Malawi's. In the last year of the scale-up, Ghana only plans to spend 26 million dollars (0.1% of GDP) on the LEAP scheme, while Malawi is planning to spend 60 million dollars (1.2% of GDP) on its SCTS. If Ghana were to scale up its intervention to Malawi levels, this program would cost 312 million dollars nationwide, with roughly 156 million going to rural households (rightmost column). This is more than ten times what Ghana plans to invest in LEAP in 2012 and would represent a 41.3% increase in welfare levels for LEAP-eligible households.

Table 7: Effects of the LEAP transfer scheme on eligible households*

	LEAP scenarios		
ffect on LEAP-eligible households	**CT the first year (2008)**	**CT at full scale (2012)**	**CT at Malawi scale**
Group's share of transfer	100%	100%	100%
Transfer received (mil. US$)	0.85	9.75	156
Welfare, % change	0.22%	2.6%	41.3%
Household-level efficiency	1.00	1.00	1.00-

Source: simulations. *All effects on non-eligible households are negligible and therefore not reported.

There is some suggestion that, beyond the pilot study, all of Ghana's extremely poor may become eligible for LEAP (Government of Ghana, 2008). This would increase the group of beneficiaries five-fold and require a similar increase in budget.

Effects of Ghana's interventions under alternative market assumptions

We now repeat some the IS and LEAP simulations under alternative assumptions about the functioning of markets. For comparability, we model all simulations such that they represent a 15 million dollar transfer cost in the benchmark model. Again, we report input subsidy, market price support, and cash transfer results. For the input subsidy, we also compare the implemented program (with high prices fixed by the government) to a hypothetical program that would have left prices at their pre-transfer levels. We report production and efficiency results under the prefect markets benchmark model, then repeat those simulations with alternative assumptions. Again, we present only overall production effects and overall efficiency, ignoring inter-household variation. The columns in Table 8 are named with primes (') to facilitate correspondence with Table 4.

Table 8: Production effects and efficiency under alternative market conditions (Ghana)

	(a') Base model: perfect markets benchmark	(c') Base model with constrained input use	(d') Base model with unemployment	(e') Base model with unemployment and constrained input use
Production effects				
Input Subsidy with no effect on input prices	0.24%	0.19%	0.45%	0.31%
Input Subsidy as implemented*	0.06%	0.04%	0.10%	0.07%
MPS on tubers	0.12%	-0.05	0.58%	0.24%
Cash transfer**	0.00%	0.06%	0.00%	0.10%
Efficiency				
Input Subsidy with no effect on input prices	0.98	0.78	1.88	1.30
Input Subsidy as implemented*	0.22	0.18	0.43	0.30
MPS on tubers	0.90	0.45	2.86	1.52
Cash transfer**	1.00	1.26	1.00	1.42

Column (a') of Table 8 already tells a slightly different story than column (a) of Table 4 did for the Malawi case. When markets are functioning well, spending 15 million dollars on Ghana's input subsidy stimulates production,by 0.24% or 0.06% depending on implementation.. As we saw earlier, if input prices had remained at their pre-transfer level, the difference in efficiency between IS and a pure cash transfer would have been minor (0.98 versus 1.00). But under a design involving fixed input prices at high levels, the IS is dramatically less efficient then CT (0.22 versus 1.00). The market price support on tubers would increase production by 0.12%, which is less than the input subsidy would have yielded under an ideal design (0.24%), but more than it yields under the implemented design (0.06%). The market price support also appears highly efficient (0.90). This is due to the fact that the rural sector of Ghana produces a large surplus of tubers, thus the negative consumption effect is less of an issue there compared to Malawi.

As in Malawi, MPS and IS both appear worse when we introduce a liquidity constraint on input use. Column (c') shows that the input subsidy has a smaller impact on production when households are constrained by their input budget (0.04%), and is even less efficient than in the base (0.17). The same is true for the MPS, which now even reduces total agricultural output by 0.05%. The CT, on the other hand, looks better than in column (a). It is now not only more efficient than other transfer mechanisms; it also has an effect on production (0.06%) and is the only transfer scheme producing a multiplier (efficiency is 1.26).

In the presence of unemployment (column d'), the input subsidy becomes not only much better at raising production, it also becomes much more efficient. An input subsidy without leakages would have increased production by 0.45%, with an associated 1.88 welfare efficiency, suggesting large multipliers. However, these figures drop to 0.10% and 0.43 for the implemented design, which falls short of creating multipliers. The market price support now yields the largest production effect (0.58%) and creates a large multiplier of 2.86.

The ranking changes again in column (e'), under both constrained input use and unemployment. Both the input subsidy and the market price support appear worse than in column (d'). The "ideal" input subsidy yields the largest production effect (0.31%), but is less efficient than both the MPS and the CT. Here, the cash transfer has a larger impact on production (0.10%) and is only slightly less efficient than the market price support (1.42 vs 1.52). The input subsidy as it was implemented ranks worst on both criteria.

Several of these observations are in stark contrast with the Malawi results in Table 4. Rural Malawi consumed a large part of its maize production before the programs were implemented, which plagued the market price support simulations. The large surplus of tubers in Ghana means greater benefits from an MPS, particularly if unemployment makes cheap labor available. On the other hand, the large leakages resulting from Ghana's input subsidy scheme dramatically reduce its efficiency; the input subsidy is consistently the least efficient transfer mechanism in Table 8. Program design and market conditions will both determine the final outcome of a transfer scheme.

VI

Conclusions

Income transfers affect both beneficiary and non-beneficiary households in complex ways. Untangling the effects of alternative income-transfer mechanisms in economies in which heterogeneous agents interact requires a modeling approach that is micro in focus yet able to capture the linkages that transmit impacts through an economy. The findings presented above highlight some of the advantages of simulation-based impact evaluation, including the ability to:

- Evaluate and compare the impacts of alternative transfer mechanisms when the creation of treatment and control groups is not feasible (e.g., the case for market price supports)

- Estimate rural economy-wide impacts of transfer instruments, instead of being limited to the average impacts on a treatment group of households

- Uncover the pathways by which transfer instruments produce outcomes (i.e., not only whether the transfer has an impact, but why), which is critical in order to improve project impacts

- Evaluate heterogeneous impacts across diverse households, which include both winners and losers

- Assess the efficiency of alternative transfer mechanisms under different market conditions.

Our simulation impact analysis yields insights not usually available from experimental studies. The impacts of income transfer instruments are shaped by the dual nature of agricultural households as producers and consumers. Market linkages transmit the impacts of transfers from the directly-affected households to others in the rural economy. As a result, even non-agricultural rural households are affected by agricultural price supports and subsidies. The importance of general equilibrium effects raises questions about the scalability of experiments involving transfer mechanisms.

Asking under what conditions a given transfer mechanism dominates others is an unusual use of simulation impact models. We use our model to put several widely accepted views to the test: that input subsidies are less efficient than other instruments; that cash transfers are the most efficient transfer mechanism; and that output price supports are preferable to IS but generally rather inefficient. We ask under which market scenarios these views may or may not be correct, and whether there are conditions that might justify the existence of both input subsidies and cash transfers in Malawi. We also compare simulations from Malawi and Ghana to highlight the importance of economic structure and implementation design in determining outcomes of such schemes. An exhaustive review of different schemes under different conditions reveals that no transfer scheme is unequivocally superior to others.

The view that input subsidies are inefficient is not supported by our simulations. In fact, our results show that input subsidies can be more welfare-efficient than both market price supports and cash transfers under certain conditions, for instance, when input and factor supplies are elastic and input demands are constrained by limited liquidity prior to the harvest. Input subsidies can also be more effective at boosting production than either cash transfers or market price supports under these conditions, as is the case in our simulations for Malawi They can reduce costs and stimulate output without increasing consumption costs for agricultural households, which is important in a country where many farmers are net purchasers of staples. In Malawi, the MAISP targeted small farms, which raises transfer efficiency. Targeting also gives IS a considerable distributional advantage over output price supports.

This finding naturally raises the question of which better characterizes input use on Malawi or Ghana farms: an assumption of optimality (in which inputs are applied until their marginal effect on profits vanishes) or of liquidity constraints (input use limited by cash on hand). Observers of sub-Saharan African countries have argued that seasonal cash constraints limit input use prior to harvest while encouraging family members to seek off-farm work. Tradeoffs between satisfying families' food needs in the short run and investing in inputs that raise food production in the longer run contribute to low productivity in African agriculture. With per-hectare fertilizer use not even one fifth of the world average, it is difficult to argue that African farmers exhibit optimality in input use.

The view that cash transfers are the most efficient transfer mechanism is often associated with a perfect markets view of the world; in this case, 1.00 is the highest possible level of efficiency, and only the cash transfer is fully efficient. This view, however, ignores the possible existence of underutilized resources and the resulting potential for multipliers. Our simulations suggest that cash transfers can produce substantial multipliers if they relieve a constraint on input use. However, the extent to which a cash transfer will produce multipliers depends on the spending patterns of the recipient households. Unlike a market price support or an input subsidy, boosting agricultural production may not be part of a CT's objectives, and target recipients may not even be farmers. Our assumption that a third of the transfer is devoted to input purchases is illustrative: better data, ideally from carefully designed experiments, could inform us on the true value of this parameter, which is bound to vary across circumstances. Cash transfers may have an additional advantage that our model is unable to capture: part of the cash may be indirectly productive, if it is spent on hunger-alleviation, healthcare, education, etc. This type of spending may create much larger multipliers in the long run.

All transfer schemes can create multipliers if they alleviate the right constraints or are implemented under the right market conditions. Both in Malawi and Ghana, our simulations suggest that a market price support could create substantial multipliers if unemployment exists in the rural sector, because it allows relatively strong production responses at limited cost. In Ghana, the market price support appears most efficient instrument when labor is cheap and other transfer schemes perform poorly due to liquidity constraints. Our comparison of Ghana and Malawi highlights the effect of context on the outcome of any intervention. Most remarkably, a market price support for the main staple has different effects in the two rural sectors, because of the size of staple surpluses. MPS is never the optimal transfer mechanism in our Malawi simulations because of a large negative impact on consumers. In contrast, the surplus from Ghana's rural sector is large enough that MPS appears rather efficient in the perfect markets benchmark, and produces the largest multipliers when there is unemployment.

The differences between our Malawi and Ghana simulations also underline the importance of transfer design in shaping the impacts of interventions. Ghana was less generous than Malawi in designing transfer schemes. Even at full scale, both of Ghana's transfer schemes represent a much smaller public investment when compared to the size of the country's economy. Ghana's lack of targeting in the IS scheme has two implications. On one hand, it tends to favor larger and richer farms, thus failing to directly address poverty challenges. On the other, it is also less distortive in terms of fertilizer use, which makes it more efficient (all else being equal).

The fixed prices that the government negotiated with fertilizer retailers in Ghana have important ramifications for our simulation results. There is no way to know what prices would have been in the absence of the agreement. However, if expectations deterred farmers from purchasing fertilizer in June 2008 at lower market prices, this mechanism design created an unnecessary transfer of limited government resources to agricultural input suppliers. In addition, shortages were reported both for vouchers and fertilizer. One study reports that 82% of farmers in the central region could not obtain subsidized fertilizer when they needed it, and 92% claimed they were "dissatisfied" or "very dissatisfied" with fertilizer availability (Yawson, Armah, Afrifa, & Dadzie, 2010). Another study interviewed extension agents, who all reported being hassled for vouchers (A.B. Banful, 2009). It found that during the time the scheme was in place there existed the widespread (unfounded) belief that it was *illegal* to buy fertilizer without vouchers. For all these reasons, the subsidy scheme may in fact have prevented some farmers from purchasing fertilizer at a reasonable price.

This brings us to the question of program objectives. If the primary purpose of Ghana's IS had been poverty-alleviation, as in Malawi, then targeting would have been a better choice given limited funding. This is not inconsistent with Banful's theory that the input subsidy program may have been politically motivated (Afua Branoah Banful, 2010). Conversely, if the primary goal of Malawi's SCTS is eradication of ultra-poverty, then the possible production effects and welfare multipliers are side effects (albeit welcome ones).

The flexibility of impact-simulation models offers important advantages in enabling us to explore the conditions under which one transfer mechanism might dominate another in terms of specific desired outcomes. Our findings suggest that there may, indeed, be a compelling economic rationale for transfer mechanisms that might appear inefficient using conventional economic yardsticks. Input subsidies, carefully designed to channel benefits to small farmers, could play a role in the short run in alleviating poverty and increasing welfare in poor agricultural economies, particularly if direct payments are not practicable, e.g., because of administration costs or targeting difficulties.

Despite the impressive performance of input subsidies, market price supports, and cash transfers in some of our simulations, in the long run such schemes are not likely to be viable mechanisms to promote agricultural development. Market price supports distort production incentives and lead to surpluses. Cash transfers may lead to an expensive form of dependency. Input subsidies, in addition to being costly, become less effective at creating benefits for farmers the more they are used, as diminishing marginal returns to the subsidized input set in. This is evident in our findings from Malawi. In the long run, raising the welfare of agricultural households requires a focus on the production function itself, by developing and disseminating technological innovations that raise farm productivity, and on markets, to provide households with reliable and low-cost outlets for production as well as access to inputs and consumption goods. When that happens, the market failures we are concerned about will disappear, and with them the multiplier effects we observe in our simulations. In the meantime, there will be a potential for large benefits from carefully designed transfer schemes.

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