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A General Equilibrium Analysis of Alternative Scenarios for Food Subsidy Reform in Egypt

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ABSTRACT

Egypt's food subsidies (in 1996/97 5.5 percent of government expenditures or US$1.1 bn.) cover rationed oil and sugar (23 percent of subsidy cost) and unrationed bread and flour (77 percent). The subsidies enhance food security but are nontargeted and have substantial leakages. This paper uses a Computable General Equilibrium (CGE) model to simulate the short-run effects of alternative food- subsidy scenarios. Savings from reduced subsidy spending are used to reduce direct taxes uniformly for all household types. The model uses a 1996/97 database with detailed household information. The simulated impact of targeting or eliminating oil and sugar subsidies is small: disaggregated real household consumption changes by ±0.3 percent. It is progressive if the subsidy is targeted to "the needy" (the bottom two quintiles in rural and urban areas) and regressive if it is eliminated. The targeting of all food subsidies is pro-needy, in part due to important indirect effects. It raises the consumption of the needy by 0.5 percent with, on average, little change for the nonneedy. The strongest gains are recorded for the rural needy (consumption increase by 1.0 percent). Food subsidy elimination is regressive: the needy suffer a consumption loss of 1.1 percent. If the government savings instead are transferred to the needy, the impact is reversed: consumption increases by 4.2 percent for needy households while the nonneedy register a small loss. The overall policy implication of the paper is that there is scope for reducing food subsidy spending without hurting the low-income groups.

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1. INTRODUCTION

Egypt's food subsidy system currently covers four items: bread, flour, oil and sugar. The system, which accounts for 5.5 percent of government expenditures, significantly enhances household food security by assuring low-cost supplies of calories and protein. However, the system is not specifically targeted to low-income groups and some 15-20 percent of the subsidy benefits leak—the commodities do not reach the intended consumers at subsidized prices.

In this paper, a Computable General Equilibrium (CGE) model is used to explore the short-run equilibrium effects of a set of alternative options for the operation of Egypt’s food subsidy system. The options covered involve targeting, and reducing and/or reorganizing the subsidy system. The economy-wide perspective of the analysis makes it possible to consider the broader economic repercussions of different policy options. The analysis highlights not only the effects of policies on the micro level (for example, changes in household welfare), but also on the macro level (for example, on the government budget) as well as the tradeoffs involved.

Section 2 provides a brief background, focusing on the role of Egypt's food subsidy system in the national economy. In Section 3, the CGE model and its data base are presented. Section 4 is devoted to simulations, while Section 5 summarizes the results and extracts the policy implications. The appendix includes additional data and simulation results as well as a mathematical statement of the CGE model.

2. FOOD SUBSIDIES IN THE EGYPTIAN ECONOMY[1]

Since the 1940s, Egypt's government has operated a system of food subsidies. In the 1970s, the system expanded in terms of commodity coverage and rates of subsidization. At its peak, in 1980–81, it covered more than a dozen items. Food subsidy spending accounted for 14 percent of total government spending and corresponded to 12.8 percent of total private consumption (Ahmed, Bouis, and Ali 1998, p. 71; IMF 1995, p. 349). Since the early 1980s, the government has gradually cut spending in this area, primarily by reducing the number of subsidized commodities. In 1996–97, the system covered four commodities: bread, flour, cooking oil, and sugar and represented 5.5 percent of government spending and 1.9 percent of total private consumption. Given that these commodities are tradable (Egypt is a net importer of wheat products, edible oils, and sugar), the subsidy cost is sensitive to changes in world prices.

Subsidized bread is available from bakeries for virtually every household in Egypt at a fixed price in unlimited quantities. The geographical coverage of warehouses selling fixed-price subsidized flour (all of which has an 82 percent extraction rate) is more limited, with no presence in Egypt four major metropolitan areas. However, for most consumers with access to subsidized flour, the quantities that they can purchase are unrationed. Oil and sugar are made available to consumers in monthly quotas through ration cards, covering, in 1996–97, close to 70 percent of the population. There are two types of ration cards, red and green. Red cards, which cover 7 percent of the ration-card holding population, are aimed at people in higher income professions and offer the commodities at higher fixed prices (i.e., with lower subsidy rates). The remaining 93 percent of the covered population have green cards with lower prices (higher subsidy rates). In practice, there is no strong correlation between household income and access to subsidies through the ration card system (Ahmed, Bouis, and Ali 1998, p. 30). The consumption pattern for oil and sugar is relatively undistorted, given that, for these commodities, most consumers supplement the subsidized quantities with market purchases. From the perspective of the households, the subsidy benefit from consumption of these commodities differs little from a cash transfer. On the contrary, the bread and flour subsidy generates not only an income transfer, but

[1]The description of Egypt’s food subsidy system draws on Ahmed, Bouis, and Ali (1998) and Gutner, Gomaa, and Nasser (1998).

also excessive consumption; i.e., bread is consumed beyond the point where its marginal value to the consumers equals its economic price.

In 1996, the government started a trial program substituting a wheat-maize flour blend (with a 20 percent maize share) for all-wheat flour in the production of subsidized bread (United States Department of Agriculture, 1996, pp. 9, 18-19; Financial Times, December 5, 1996). This policy leads to reduced government spending for two reasons: the flour extraction rate is higher for maize than for wheat flour and, for a typical year, the maize price is lower than the wheat price—in 1996–97, it was 77 percent of the wheat price (Ministry of Agriculture 1998, pp. 142 and 235).

Tables 1 and 2 summarize data on the food subsidy system in 1996–97. Table 1 shows that bread, which is subsidized at the highest rate, accounts for more than 60 percent of the total subsidy cost. Out of the total food subsidy, some 18 percent is leaked (in the sense that the subsidized commodities do not reach the households but are diverted to other uses). The leakage rate is lower for bread than for the other commodities. The information in Table 2 indicates that per capita consumption is lower in rural than in urban areas. In terms of the absolute level of per capita benefits, the rural population gains less from subsidies than does the urban population. If benefits are measured as a share of consumption expenditures, the gains experienced by the rural population are similar to those experienced by the urban population. Within each region, absolute per capita benefits are similar across the different quintiles; however, in urban areas, subsidy benefits are slightly more targeted to low-income groups. At the disaggregated commodity level, the main difference is that flour is relatively more important in rural areas while bread is relatively less important. In sum, the food subsidy system is in practice untargeted and subject to substantial leakage.

This paper uses an economy-wide general-equilibrium model to explore the impact of a set of alternative options for the operation of Egypt's food subsidy system. The options covered involve targeting, and reducing and/or reorganizing the subsidy system. The microeconomic and political-economy aspects of most of these options have been analyzed in Ahmed, Bouis, and Ali (1998) and Gutner, Gomaa, and Nasser (1998). The economy-wide perspective of the analysis in this paper makes it possible to consider the broader economic repercussions of different policy

Table 1 Food subsidies by commodity, 1996-97

	Budgetary cost		Allocation			Subsidy share in production cost
	Value (LE bn.)[a]	Share (percent)	Households (percent)	Leakage (percent)	Total (percent)	(percent)[b]
Baladi bread	2.3	61.7	88.5	11.5	100.0	56.9
Flour	0.6	14.9	70.4	29.6	100.0	43.1
Edible oil	0.4	10.3	72.2	27.8	100.0	54.1
Sugar	0.5	13.1	74.7	25.3	100.0	62.1
Total	3.7	100.0	82.3	17.7	100.0	

Source: Ahmed, Bouis, and Ali (1998), pp. 71 and 87-92.

[a] US$1 = LE 3.39 (1996–97 average).

[b] The oil and sugar subsidy rates are for green ration cards. The red card subsidy rates are 42.7 percent and 43.2 percent, respectively.

Table 2 Food subsidies and the household economy, 1996-97

	Annual subsidy benefit	Annual household consumption	Benefit as share of consumption	Subsidy benefit by commodity			
	(LE/capita)	(LE/capita)	(percent)	Bread (percent)	Flour (percent)	Oil and sugar (percent)	Total (percent)
Rural households (by quintile)							
1	40.3	1272.7	3.2	59.7	18.7	21.6	100.0
2	41.6	1676.6	2.5	51.9	25.2	22.8	100.0
3	47.7	2141.6	2.2	59.1	20.8	20.1	100.0
4	45.6	2687.5	1.7	54.5	23.4	22.1	100.0
5	52.1	4585.1	1.1	56.0	22.7	21.3	100.0
Average	45.5	2472.7	2.1	56.3	22.2	21.6	100.0
Urban households (by quintile)							
1	64.9	1736.3	3.7	77.4	5.0	17.7	100.0
2	69.2	2492	2.8	75.5	4.9	19.5	100.0
3	63.8	3416.1	1.9	79.1	1.9	19.0	100.0
4	63.4	4726.8	1.3	77.6	2.1	20.3	100.0
5	50.3	9628.4	0.5	70.1	3.6	26.3	100.0
Average	62.3	4399.9	2.0	75.9	3.5	20.6	100.0

Source: Ahmed, Bouis, and Ali (1998), pp. 95-96.
Note: In 1996, 57 percent of Egypt's resident population of 59.3 million lived in rural areas.

options, including the consequences of alternative uses of government budgetary savings from reduced subsidy spending and reduced leakage. Before presenting the simulations, we will first turn to a description of the model and its database.

3. THE EGYPT FOOD CGE MODEL: STRUCTURE AND DATA

Background

CGE models may be defined as economy-wide models the solutions to which depict a simultaneous general equilibrium in all markets of the economy. They are widely applied to policy analysis in developing countries and have a comparative advantage in the analysis of tax and subsidy policies, in particular when there is a need to consider links between different producing sectors, links between the macro and micro levels, and the disaggregated impact of changes in policies and exogenous shocks on sectoral structure, household welfare, and income distribution. CGE analyses of the Egyptian economy have a relatively long history, with the first model dating back to 1976.[2]

Our CGE model of Egypt, called the Food CGE model, starts from an earlier model of Egypt (Löfgren and Kherallah 1998). It is in the tradition of trade-focused CGE models of developing countries described in Dervis, de Melo, and Robinson (1982). However, compared to this earlier generation of models, it includes a wider range of features that are tailored to the structure of the economy that is modeled. The distinguishing features of the current model include a detailed treatment of households, agriculture, and food processing, including food subsidies and the benefits they provide to households.

Model Structure[3]

Disaggregation

Table 3 shows the disaggregation of institutions, factors, and activities in the model. Among the factors, labor and capital are used by all sectors, while water, summer land, and winter land are used only by agricultural crop activities. The crop activities are differentiated according to period of land occupation into winter crops, summer crops, and perennial crops. Outside agriculture, there is a one-to-one mapping between activities (the producing sectors) and commodities (the outputs produced). Inside agriculture, the two berseem activities and the two

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[2] See Löfgren (1994b) for a survey of CGE models of Egypt.

[3] Table A6 includes a mathematical model statement.

vegetable activities are both assumed to produce the same commodity (berseem and vegetables, respectively). Given the quality difference between domestic maize (some 95 percent white maize) and imported (yellow) maize, the latter is a separate imported commodity without any domestic production. Moreover, several crop activities produce byproducts that are used as animal feed. This disaggregation of agriculture makes it possible to capture direct links between crop and animal activities: crop outputs (most importantly berseem, maize, and various crop by-products) are used as inputs in the animal activity; animal outputs (manure and animal labor) are used as inputs in crop activities.

Table 3 Disaggregation of factors, institutions, and activities

Set	Elements	
Institutions (12)	Households	(rural and urban, both disaggregated by quintile)
	Government	
	Rest of the world	
Factors of production (5)	Capital	(agricultural and nonagricultural)
	Labor	(agricultural and nonagricultural)
	Water	
	Summer land	
	Winter land	
Activities (28)	Winter crops	(wheat, legumes, long berseem, short berseem, winter vegetables, other winter crops)
	Summer crops	(cotton, rice, maize [including sorghum], summer vegetables, other summer crops)
	Perennial crops	(fruits, sugarcane)
	Other agriculture and food processing	(animal agriculture, subsidized bread, unsubsidized bread, subsidized flour, unsubsidized flour, other food processing)
	Other	(oil, cotton ginning, textiles, other industry, electricity, construction, government services, transportation, other services)

Factors and Production

In crop agriculture, it is assumed that, apart from agronomic and institutional restrictions (described below), the factors land (summer and winter), water, and capital (primarily agricultural machinery) are mobile across crops and allocated so as to equalize the marginal returns to each factor in all relevant crops. In animal agriculture, capital use (primarily animals) is fixed and specific to this sector. For two factor types, land and water, excess supply is possible; if so, the price is zero. The other factors—agricultural labor, crop capital, and animal capital—are fully utilized with flexible market-clearing wages and rents.[4]

Outside of agriculture, capital quantities are fixed by activity; flexible rents assure that these quantities are fully employed. Nonagricultural labor, the market of which is separate from the agricultural labor market, is mobile across nonagricultural sectors. Labor employment is fixed at the level observed in 1996–97 while a flexible wage also clears this part of the labor market.

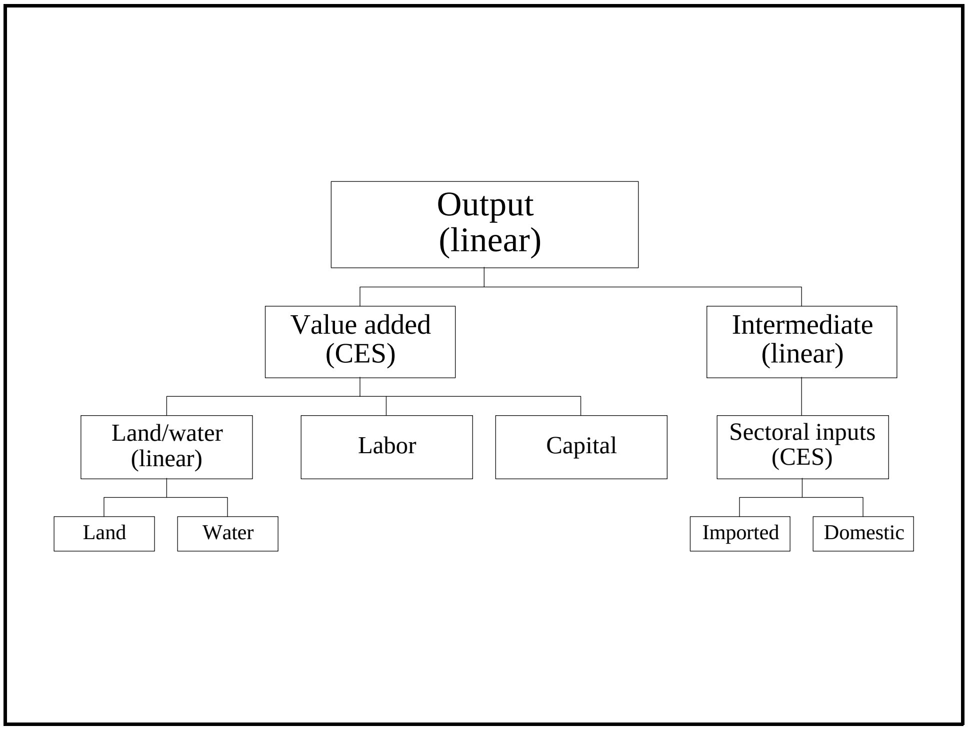
For selected factors (summer and winter land, and nonagricultural labor), the prices (the rents or the wages) are differentiated across the demanding activities on the basis of fixed ratios (calculated from base-year data). This is a reflection of real-world phenomena that are not modeled explicitly.[5] When the (aggregate) factor price changes, this is accompanied by proportional changes in the differentiated activity-specific prices of the factor in question.

The production technologies are summarized in Figure 1. Producers are assumed to maximize profits given their technology (specified by a nested CES value-added function, and Leontief intermediate input coefficients that are flexible inside agriculture but fixed for other sectors), and the prices of inputs and outputs. The arguments of the value-added functions are labor, capital, and (for the crop sectors) a land/water aggregate. The latter is made up of land and water in fixed proportions. Thus, for crops, substitutability is possible between labor, capital, and the land/water aggregate on the level of the value-added functions; there is no substitutability between land and water.

[4]Given that the quantity of water stored in the High Dam at Aswan is high, the water supply is set at a level that is above the quantity demanded for any of the simulations presented in this paper. Hence, land is always in scarce supply. For water, the model records consumption by crop at a scarcity value of zero.

[5] For labor, wage gaps between activities may be linked to differences in job security, educational requirements, status of job, and physical (dis)comfort. In agriculture, recorded monetary returns to land may differ as crops differ in required skills, monitoring, riskiness, and impact on soil fertility.

Figure 1—Production technology



The model accounts for two major agronomic area constraints: the area of short berseem (a crop that precedes cotton) is constrained to equal the cotton area, and the cotton area is limited to a maximum of one third of the land not covered by perennial crops. Given the relatively short-run time frame of the analysis, we fix the areas of perennial crops and, as noted above, the size of animal stock. Agricultural intermediate input coefficients are flexible in the context of producer minimization of intermediate input costs subject to a limited degree of input substitutability (given by a CES function) and a fixed *aggregate* input requirement per unit of the activity. Agriculture deviates from the more standard treatment for other sectors to avoid rigid links between crop and animal activities in Egypt's agriculture, as crop activities supply the animal activity with the bulk of its intermediate feed inputs.[6]

[6] Given that fodder by-products from crop activities are not traded internationally, fixed intermediate input coefficients would, for the animal activity, generate rigid links between, on the one hand, the level of animal production and, on the other hand, the levels for the crop activities producing these by-products. Similar rigidities would appear if intermediate crop demands for manure were a fixed coefficient.

Two nonagricultural sectors are given special treatment. For the oil activity, the quantities of output and factor use are fixed at the 1997 level (treating these decisions as exogenous to the model). For electricity, a flexible capital supply (reflecting surplus capacity) assures that the nontraded electricity commodity is sold at a fixed price.

Domestic Institutions: Households and Government

The model captures the circular flow of incomes in the economy. The income of each factor, generated by the production activities or transferred from the rest of the world (fixed in foreign currency), is split among the domestic institutions in fixed factor-specific shares.[7] In addition to factor incomes, households receive transfers from the government and the rest of the world (fixed in foreign currency). Household income is used to pay direct taxes, save and consume. Direct taxes and savings are fixed and flexible shares of household income, respectively. (The reason for the flexible savings share is discussed below.) Disaggregated consumption is determined by a nested demand system. On the top level, the Almost Ideal Demand System (AIDS) generates demand for disaggregated food items and an aggregated nonfood item. At the lower level, Linear Expenditures System (LES) demand functions splits aggregated nonfood demand into disaggregated items.[8]

Besides factor incomes, government revenue consists of transfers from the rest of the world (fixed in foreign currency) and taxes — direct taxes from households, indirect taxes from domestic activities, sales tax revenues, and import tariffs. All taxes are ad valorem. Transfers from the government to households and aggregate government consumption are fixed shares of nominal GDP. The government buys fixed quantities of commodities in the government consumption basket. In addition, the government subsidizes part of household consumption of foodstuffs, transportation, and electricity. For the two nonfoods, the subsidy is a fixed share of the price paid by the consumer.

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[7]See Table A1 for the structure of household factor incomes according to the SAM for 1996/97. Low-income households rely more heavily on labor income, in rural areas, from work in agriculture; high-income households receive the bulk of their incomes from capital and, in rural areas, land.

[8]For a discussion of these functional forms, see Deaton and Muellbauer (1980).

The treatment of food subsidies is of particular importance. The subsidized food items are disaggregated into subsidized bread, subsidized flour (purchased by consumers and used as an input in the production of subsidized bread), and other processed food (representing oil and sugar). Subsidized bread and flour are available to consumers at fixed prices in nonrationed quantities. Flexible subsidy rates assure that the consumer price remains unchanged also when market conditions change. Given that subsidized oil and sugar are rationed and, for most households, supplemented by market purchases, the subsidy on other processed food has little direct impact on the quantities consumed of these commodities. Hence, it is treated as a cash transfer from the government to the households, with the value received by each household corresponding to the benefit it received from the oil and sugar subsidy in 1996–97. As a result of leakages, part of the subsidy does not reach the households through the intended channels. In the model, the part of the subsidy benefit that is leaked is distributed to households in the same way as nonagricultural capital incomes. This is compatible with the assumption that, at some point in the marketing channel, the subsidized items are sold at full market prices, generating profits for retailers and traders, i.e., owners of capital in the nonagricultural part of the economy (a relatively high-income part of the population).

The Rest of the World, Foreign Trade, and Commodity Markets

In addition to transferring money which adds to or deducts from the incomes of domestic institutions, the rest of the world supplies imports and demands exports. For vegetables and services, exports are demanded according to constant-elasticity demand curves — the lower the export supply price, the larger the quantity exported. For all other commodities, Egypt is able to export or import any quantity it desires at international prices that are fixed in foreign currency.

For imports of wheat and exports of rice and oil, it is assumed that domestic output sold domestically and traded (exported or imported) commodities are perfect substitutes. As a result, if these commodities are traded, the domestic price is determined by the domestic-currency export or import price (transformed from the foreign currency price via the exchange rate and adjusted for any taxes or subsidies).

Apart from the above-mentioned special treatment for wheat, rice and oil, imperfect substitutability or transformability is assumed for foreign trade. The Armington assumption is used to capture the choice between imports and domestic output under imperfect substitutability: if a commodity is imported, all domestic demands—household and government consumption, investment demand, and intermediate demand—are for the same composite commodity, with the mix between imports and domestic output determined by the assumption that domestic demanders minimize cost subject to imperfect substitutability, captured by a CES aggregation function. Similarly, the allocation of domestic output between exports and domestic sales is determined on the assumption that domestic producers maximize profits subject to imperfect transformability between these two alternatives, expressed by a constant-elasticity-of-transformation (CET) function. These assumptions—imperfect substitutability and transformability—grant the domestic price system a certain degree of independence from international prices and dampen export and import responses to changes in the producer environment.

With the above-mentioned exceptions—partially fixing prices of bread, flour, and electricity and linking domestic wheat, rice and oil prices to international levels—domestic prices of domestic outputs and composite commodities are all flexible, performing the task of clearing relevant markets in a competitive setting where both suppliers and demanders are price-takers.

Macro System Constraints

The macro system constraints (or macro closures) determine the manner in which the accounts for the government, the rest of the world, and savings-investment are brought into balance.

Government savings (also called the current government surplus) are invariably fixed.[9] For most simulations, a change in the direct tax rate (an equal change in the rate for every household group) assures that government savings are maintained at the predetermined level.[10] In the balance of the rest of the world, foreign savings (the current account deficit) are similarly fixed;

[9]Government savings are invariably positive given that they refer to the difference between *current* revenues and *current* spending, excluding items on the government *capital* account.

[10]To provide a simple illustration (with fictional numbers), if a cut in direct tax collection is needed to maintain unchanged government savings, the tax rate may, for example, fall by 2 percentage points across all household groups, from 10 percent to 8 percent for an urban high-income group and from 4 percent to 2 percent for a rural low-income group.

the exchange rate (the price of foreign exchange) is the equilibrating variable. Given that all nontrade items (transfers to or from domestic institutions or factors) are fixed, fixing foreign savings is equivalent to fixing the trade deficit. On the spending side of the savings-investment balance, aggregate investment is fixed in quantity terms. On the savings side, uniform changes in the savings rates of each household category are used to generate a level of total savings needed to finance aggregate investment.[11]

The model is homogeneous of degree zero in prices; to assure that only one solution exists, a price normalization equation, in this case fixing the aggregate consumer price index (CPI), has been added. Hence, all endogenous price changes are relative to CPI.

Data Sources

The bulk of the model data is based on a disaggregated SAM (an 85x85 matrix) for 1996–97. This year was selected since it is the year for IFPRI's Egypt Integrated Household Survey (EIHS). It was constructed on the basis of data from various official publications including national accounts, government budget, and trade data as well as Egypt's most recent official Social Accounting Matrix (Central Bank 1995 and 1998; CAPMAS 1996a, 1996b, and 1998; IMF 1998). The EIHS and IFPRI research documents based on the EIHS were the primary source for data on household consumption and benefits from food subsidies. Data in Kherallah *et al*. (1998) were used for flour production. Information from these and other sources were brought together in one matrix, the disaggregation of which parallels the disaggregation of the current model. Underlying the construction of such a SAM is an attempt to make the best possible use of available scattered data. Inevitably imbalances appear when data from different sources and years are integrated in one framework; a SAM-Entropy program, developed at IFPRI, was used to generate a balanced model SAM that retains as much as possible of the information contained in the original data set (Robinson, Cattaneo, and El-Said 1998; Thissen and Löfgren 1998).

For each of the ten households, income and price elasticities for disaggregated foodstuffs and aggregated nonfood consumption are from Yohannes and Bouis (1999). A variety of sources

[11] Savings from nonhousehold sources — the government and the rest of the world — are not free to equilibrate aggregate savings-investment. Given that real investment, (foreign currency) foreign savings, and government savings are all fixed, the changes in household savings rates are very small.

were used for other elasticity estimates needed for the household nonfood LES functions as well as the functions for import aggregation (Armington), domestic output transformation (CET), production (CES), and (constant-elasticity) export-demand.[12]

Mathematical Model Structure, Base Run, Validity, and Time Frame

CGE models are typically formulated and solved as systems of simultaneous equations exclusively made up of strict equalities. However, to permit the inclusion of inequality constraints for resource markets and agronomic constraints, the Food CGE model is formulated and solved as a mixed complementarity problem (MCP), consisting of a set of simultaneous equations that are a mix of strict equalities and inequalities. The latter are linked to bounded (price) variables associated with agricultural resources and labor. The GAMS modeling software is used both to generate the disaggregated SAM and to implement the model. The model may be solved with PATH or MILES, two solvers for mixed complementarity problems.[13]

The base solution of the model is calibrated to exactly replicate the disaggregated 1996-97 SAM. The simulation results indicate the short-run equilibrium responses to changes in policies and exogenous shocks. Each new solution represents a new equilibrium since agents (producers and consumers) have fully adjusted themselves to new prices and incomes. It refers to the short run since capital stocks outside crop agriculture are fixed by sector: the time span is too short for current investment to lead to changes in installed capital or for capital to move between noncrop sectors (cf. Hazell and Norton 1986, p. 300).

[12]Selected values used are given in Table A5 in the appendix. Consumption elasticities are available on request from the authors. See also Löfgren (1994a).

[13] For GAMS, see Brooke, Kendrick, and Meeraus (1998). Rutherford (1995) provides more information on PATH and MILES.

4. SIMULATIONS

The simulations are divided into two sets. The first addresses the consequences of targeting or eliminating food subsidies. The second set investigates two issues: the impact of using 20 percent maize in subsidized flour and of cracking down on leakage without other changes in subsidy policy. Unless otherwise noted, we assume that the government uses the savings that result from the changes in subsidy policy to reduce direct taxes (with an equal percentage cut in the tax rate for every household group).

Targeting or Eliminating Food Subsidies

The simulations are defined in Table 4 and the results are summarized in Table 5. (Appendix Tables A2-A4 present additional simulation data for factor incomes, foreign trade, and production quantities.) In the first two simulations, subsidy benefits are targeted to the needy, defined as the bottom two quintiles (40 percent) of the population in both rural and urban areas. In the last three, parts of or all of the food subsidy program is eliminated.

Table 4 Targeting or eliminating food subsidies: Simulation assumptions

	-1- Targeting oil-sugar subsidy + income tax cut	-2- Targeting total food subsidy + income tax cut	-3- Eliminating oil-sugar subsidy + income tax cut	-4- Eliminating total food subsidy + income tax cut	-5- Eliminating total food subsidy + transfer to needy
	percent change				
Oil and sugar subsidy to nonneedy	-100	-100	-100	-100	-100
Bread and flour subsidy to nonneedy		-100		-100	-100
Oil and sugar subsidy to needy			-100	-100	-100
Bread and flour subsidy to needy				-100	-100
Leakage for oil and sugar subsidy	-62	-62	-100	-100	-100
Leakage for bread and flour subsidy		-60		-100	-100
Government savings to income tax cut	YES	YES	YES	YES	
Government savings to cash transfer to needy					YES

Table 5 Targeting or eliminating food subsidies: Summary of simulation results

	Base	-1- Targeting oil-sugar subsidy + income tax cut	-2- Targeting total food subsidy + income tax cut	-3- Eliminating oil-sugar subsidy + income tax cut	-4- Eliminating total food subsidy + income tax cut	-5- Eliminating total food subsidy + transfer to needy
		percent change from Base				
Real per capita household consumption at 1996–97 price						
Rural households (by quintile)	2459.1	0.0	0.4	0.0	0.6	1.2
1	1269.3	0.2	0.9	-0.3	-0.7	7.4
2	1670.2	0.2	0.8	-0.2	-0.2	5.6
3	2130.9	-0.2	-0.2	-0.1	0.5	-0.8
4	2672.1	-0.1	0.0	0.0	0.7	-0.8
5	4552.9	0.0	0.5	0.1	1.2	-0.1
Urban households (by quintile)	4326.3	0.0	-0.1	0.0	-0.2	-0.7
1	1713.5	0.2	0.1	-0.2	-2.3	2.8
2	2456.5	0.2	0.2	-0.1	-1.4	1.7
3	3361.2	-0.1	-0.8	0.0	-0.6	-2.4
4	4647.0	-0.1	-0.5	0.1	-0.2	-2.0
5	9453.2	0.0	0.3	0.1	0.7	-0.8
Needy households	1734.1	0.2	0.5	-0.2	-1.1	4.2
Nonneedy households	4279.7	0.0	0.0	0.1	0.5	-1.0
Average household	3261.5	0.0	0.1	0.0	0.2	0.1
Government budget items (mn LE at 1996–97 prices)						
Spending on food subsidies	3741.6	-14.4	-64.2	-23.4	-100.0	-100.0
Spending on bread and flour	2867.0	0.0	-64.9	0.0	-100.0	-100.0
Spending on oil and sugar	874.6	-61.6	-61.6	-100.0	-100.0	-100.0
Income tax revenue	14592.0	-3.5	-16.4	-5.7	-25.4	-1.0
Cash transfers to needy[a]						3642.5
Food and agriculture trade (bn $)						
Net imports	1962.8	0.0	-1.8	0.0	-1.2	-0.4
Wheat and flour imports	1100.4	0.0	-6.9	0.0	-7.1	-5.9
Exchange rate	1.0	0.0	-0.6	0.0	-1.4	-1.2
(LE per unit of foreign currency)						

Note: Percent change in all columns except "Base". Values smaller than ±0.1 are shown as 0.0. [a] In mn. LE for all columns.

Targeting Oil and Sugar Subsidies to Needy Households *(Simulation 1)*

In the first simulation, we target oil and sugar subsidies (representing 23 percent of total food subsidy spending) to the needy in rural and urban areas while eliminating these subsidies for the top three quintiles. The latter groups continue to have access to these commodities but at full market prices. Given that these commodities are distributed via red and green ration cards, this may in practice involve eliminating the red cards and limiting the green cards to the targeted population. IFPRI research shows that targeting can be achieved at a minimal cost, in particular since current staff at the Ministry of Trade and Supply could manage the targeting without any need for new hiring.[14] We assume that the oil-sugar subsidy leakage declines in proportion to the reduction in subsidy spending.

In economic terms, given that the ration-card subsidy is treated as inframarginal (i.e., it is nondistorting, having no direct impact on the quantities consumed of oil and sugar), the subsidy cut is equivalent to a withdrawal of cash benefits from nonneedy ration cardholders. In addition, a cash benefit is withdrawn from those who benefitted from the subsidy leakage.

The reductions in total and oil-sugar food subsidy spending are around 14 percent and 62 percent, respectively. This spending cut permits the government to reduce income tax collection by 3.5 percent (via an equal cut in the percentage tax rate for all households) while keeping government savings constant. Given that the subsidy was nondistorting, there is no efficiency gain: aggregate household consumption does not change.[15] In both regions, the two bottom quintiles enjoy small gains (since they receive the tax cut without any subsidy withdrawal). Quintiles three and four lose slightly (the tax cut does not fully compensate for the subsidy loss) whereas the top quintile is unaffected (the tax cut and the subsidy loss were of equivalent cash value).

[14]According to IFPRI estimates, the one-time cost of training and materials needed for targeting is around LE 14 mn, an insignificant amount corresponding to 0.4 percent of the total annual food subsidy budget (or 0.005 percent of GDP).

[15]Real household consumption (at base prices) is used as welfare indicator. Given that the population is fixed, percentage changes in total and per capita consumption are identical.

Targeting All Food Subsidies to Needy Households *(Simulation 2)*

In Simulation 2, targeting is extended to all subsidized items, also including bread and flour (representing the remaining 77 percent of food subsidy spending). Leakage is also reduced for bread and flour. As expected, the effects are stronger. Since bread and flour subsidies are not inframarginal (they influence the quantities consumed of bread and flour), an efficiency gain leads to a slight increase in aggregate consumption.

Food subsidy spending declines by 64 percent. The spending cut permits a significant reduction in income tax collection (by 16 percent). The redistribution of incomes in favor of the needy that follows from subsidy targeting generates increased demand for food and agricultural commodities, increased factor incomes in agriculture, and reduced incomes in nonagricultural sectors.[16] [17] The final impact is a significant gain for the needy, especially in rural areas. However, not only the needy but also the top rural quintile sees its position improve. In every quintile, the rural population does better than its urban counterpart. The major losers are the urban third and fourth quintiles who suffer significantly from the subsidy cut and receive the bulk of their incomes from nonagricultural sources.

Higher prices for bread and flour reduce Egypt's wheat and flour imports (by 7 percent) but, because of substitution toward other products and higher incomes for households with higher food budget shares, other food imports increase while food exports decrease. The ultimate decline in net food imports is less than 2 percent. The exchange rate appreciates slightly to maintain the *total* (food and nonfood) trade deficit fixed in foreign currency at the initial level. (Cf. discussion of macro system constraints in Section 3 of this paper.)

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[16]Most of the simulations of this paper involve changes from price subsidies (a negative indirect tax) to direct taxes (i.e., shifts from a government tool that works through the price system to one that does not). Following Robinson and Thierfelder (1999, p. 2), it is clear that such changes invariably generate declines in real factor returns that confuse the welfare analysis. For this reason, we report computed changes in the distribution of factor incomes rather than absolute levels of factor incomes.

[17]See Table A1 for the structure of household factor incomes according to the SAM for 1996/97 and for the base simulation.

Eliminating Oil and Sugar Subsidies *(Simulation 3)*

In this simulation, we eliminate oil and sugar subsidies (including leakage). After the change, the whole population pays full market prices for these commodities. In practice, this involves eliminating the ration card system (at least for its current purposes). As shown in Table 5, this policy reduces subsidy spending by 23 percent while income tax revenue declines by 6 percent. Aggregate consumption does not change (since the oil-sugar subsidy is nondistorting). In both regions, the distributional shift is small but unambiguously regressive: as opposed to the nonneedy, the needy lose more from the subsidy (including leakage) elimination than they gain from the tax cut.

Eliminating All Food Subsidies *(Simulations 4 and 5)*

According to Simulation 4, the elimination of all food subsidies permits a cut in direct taxes by around 25 percent (reducing direct tax revenue by a value similar to the subsidy savings). The aggregate welfare gain is marginal but positive (similar to the change for Simulation 2). The impact is strongly regressive: in both regions, the higher the household quintile, the more positive the impact. As a result, consumption increases by 0.5 percent for nonneedy households and falls by 1.1 percent for the needy. The pattern of change is, however, strongly pro-rural — rural consumption increases by 0.6 percent while urban consumption declines slightly.

The main reason for the pro-rural pattern is that, due to the subsidy cut for bread and flour, households shift their demand from products based on wheat grain (a commodity without quality differences between imports and domestic production and, therefore, with perfect alignment between domestic and international prices) toward other food products (for which there are quality differences between domestic output sold at home and traded commodities). As a result, the prices of agricultural commodities for which demand increases are boosted without a decline in the prices of agricultural commodities for which demand decreases. Higher agricultural prices and incomes disproportionately benefit rural households who, in turn, have higher budget shares for food. This causes a significant multiplier effect.

The outcome is regressive as a result of the combined impact of changes in subsidies, agricultural prices and factor incomes. Firstly, the needy lose relatively strongly from the subsidy cut since initial subsidy benefits represent a relatively large share of their total consumption. Secondly, higher agricultural prices have a more negative impact on the needy due to their relatively high consumption shares for foodstuffs. Finally, among rural households, the pattern of change in factor incomes (larger gain for agricultural land and capital than for agricultural labor) reinforces this regressive pattern. However, for urban households, that rely almost exclusively on non-agricultural incomes, the impact of the changes in factor incomes is progressive: the non-needy suffer most from the decline in the share of capital in non-agricultural factor incomes.

The shift in demand from wheat-based commodities that, on the margin, are imported toward other commodities necessitates an appreciation of the exchange rate (by 1.4 percent) to maintain the fixed current account and trade deficits. While wheat and flour imports decline significantly (by 7 percent), net food imports decline by much less.

The regressive distributional change for Simulation 4 suggests that full subsidy elimination is not an attractive option unless accompanied by measures that directly benefit the needy. In Simulation 5, the savings from eliminating the subsidies are used to fund a transfer program targeted to the needy. According to the simulation, the transfer program receives more than LE 3.6 bn. (i.e., close to the value of the full subsidy program). The distributional impact inside each region is reversed as a result of the transfer. On the aggregate level, needy households gain 4.2 percent in real consumption while nonneedy incur a loss of 1.0 percent. The pro-rural pattern is reinforced, compared to the above simulation because of the food-intensive demand pattern of the needy households who benefit from the transfer program. In foreign trade, the higher food-import-intensity in demand is reflected in roughly unchanged net food imports.

Wheat-Maize Flour Mix and Leakage Cuts

The second simulation set analyzes the impact of (1) substituting a wheat-maize flour blend for all-wheat flour in the production of subsidized flour, used for producing subsidized bread or sold directly to consumers; and (2) cracking down further on leakages in the food subsidy system.[18] In Tables 6 and 7, we present the simulations and summarize the results.

[18]In the preceding simulations, it was assumed that leakages decline in proportion to the decline in subsidies reaching the consumers.

Wheat-Maize Flour Mix *(Simulations 6-8)*

These simulations explore the impact of a policy shift according to which 100 percent wheat flour is replaced by a wheat-maize mix with a 20 percent maize share. The government uses the resulting savings to cut direct taxes. This policy is relatively broad since it introduces mixed wheat-maize flour not only for the flour used for subsidized bread but also for the subsidized flour that is sold directly to consumers. Technically, the policy shift is represented by changed input coefficients in the production of subsidized flour so that 20 percent of the wheat grain is replaced by maize. It is assumed that household demand behavior is not affected by the introduction of maize, i.e., there is no significant difference in taste. A higher maize flour extraction rate (97 percent compared to 82 percent for this type of wheat flour) and a lower maize grain price (in the base year 23 percent below the wheat price) give rise to government savings (Khalil 1999, p. 123; Ministry of Agriculture 1998, pp. 135, 142).

Table 6 Introducing wheat-maize flour and cutting leakage: Simulation assumptions

	-6- Wheat-maize flour + income tax cut	-7- Wheat-maize flour + income tax cut + leakage cut	-8- Wheat-maize flour + income tax cut + leakage cut + yield increase	-9- Leakage elimination + transfer to needy
	percent change			
Leakage for oil and sugar subsidy				-100
Leakage for bread and flour subsidy		-100	-100	-100
Government savings to income tax cut	YES	YES	YES	
Government savings to cash transfer to needy				YES
20 percent maize in subsidized flour	YES	YES	YES	
Maize yield increase and fixed maize area			YES	

The initial effect of the policy shift is that 20 percent of the wheat demanded for use in production of subsidized flour is shifted to maize at 65 percent of the initial cost, raising the

Table 7 Introducing wheat-maize flour and cutting leakage: Summary of simulation results

	Base	-6- Maize-wheat flour + income tax cut	-7- Maize-wheat flour + income tax cut + leakage cut	-8- Maize-wheat flour + income tax cut + leakage cut + yield increase	-9- Leakage elimination + transfer to needy
Real per capita household consumption at 1996–97 prices		percent change from Base			
Rural households (by quintile)	2459.1	0.1	0.1	0.5	0.1
1	1269.3	0.1	0.2	0.7	1.4
2	1670.2	0.1	0.1	0.7	1.0
3	2130.9	0.1	0.2	0.5	-0.2
4	2672.1	0.1	0.1	0.5	-0.2
5	4552.9	0.1	0.1	0.4	-0.2
Urban households (by quintile)	4326.3	-0.1	-0.1	0.3	-0.1
1	1713.5	-0.2	-0.1	0.5	0.9
2	2456.5	-0.1	-0.1	0.5	0.5
3	3361.2	-0.1	-0.1	0.4	-0.3
4	4647.0	-0.1	-0.1	0.3	-0.3
5	9453.2	0.0	-0.1	0.2	-0.3
Needy households	1734.1	0.0	0.0	0.6	0.9
Nonneedy households	4279.7	0.0	0.0	0.3	-0.3
Average household	3261.5	0.0	0.0	0.4	0.0
Government budget items (mn LE at 1996–97 prices)					
Spending on food subsidies	3741.6	-5.9	-17.4	-19.5	-17.6
Spending on bread and flour subsidies	2867.0	-7.7	-22.7	-25.5	-14.9
Spending on oil and sugar subsidies	874.6	0.0	0.0	0.0	-26.4
Income tax revenue	14591.0	-1.3	-4.0	-3.9	-0.1
Cash transfers to needy[a]					596.8
Food and agriculture trade (bn $)					
Net imports	1962.8	-6.0	-6.0	-10.9	0.1
Wheat and flour imports	1100.4	-12.7	-12.7	-19.8	0.1
Exchange rate (LE per unit of for. curr.)	1.0	-0.3	-0.3	-0.5	0.1
Maize yield (normalized to 1 for Base)	1.0	0.1	0.1	11.4	0.0
Maize area (mn. feddans)	2.0	11.6	11.6	0.0	0.0

Note: Percent change in all columns except "Base". [a] In mn. LE in all columns.

demand for maize with a resulting increase in maize production (by almost 12 percent). This leads to reduced subsidy spending, reflecting a decline in the per-unit subsidy needed to maintain fixed prices for subsidized bread and flour. In Simulation 6, total food subsidy spending declines by 6 percent. The resulting government savings permit a decline in direct tax collection by 1.3 percent. The shift of agricultural demand from a traded commodity (wheat) toward a nontradable leads to a slight increase in agricultural factor incomes which, at the household level, benefits rural households. Net food imports decline substantially (by 6 percent), a reflection of resource savings (the maize flour requires fewer resources than the wheat flour for which it substitutes)

Simulation 7 looks at the impact of combining the introduction of the wheat-maize flour mix with an elimination of leakages for subsidized bread and flour. The rationale for this simulation is the difficulty of diverting mixed flour to unintended uses.

Because of the addition of the leakage cut, the decline in spending on bread and flour subsidies and the direct tax cut are almost tripled, *i.e.*, from the perspective of saving government resources, the main impact of the maize-wheat flour program may come from the fact that it makes leakage more difficult, not from a lower cost of maize flour. Incomes decline for nonagricultural capital, the recipient of leaked subsidy benefits. The net impact is a small but progressive impact on income distribution. Other effects are very minor.

In Egypt, there is considerable potential for raising maize yields (Harrison 1996, p. 241; Khalil 1999, p.121), possibly annulling the need to increase the maize area in the face of increased demand for white maize for use in subsidized bread and flour products. Simulation 8 poses the following questions: What is the increase in maize yields needed to avoid an increase in the maize area in the context of the shift to a wheat-maize flour mix and elimination of subsidized bread and flour leakage? What are the broader economic repercussions of such yield change? Technically, the simulation is implemented by fixing the maize area while endogenizing maize land productivity.

As shown in Table 7, an 11 percent yield increase is required (very close to the relative area increase for Simulation 7). The resulting shift in the supply curve for maize reduces the maize price, further cutting the government subsidy bill. There is an increase in agricultural and rural incomes, bringing about a multiplier process that boosts demand for agricultural products, including crops competing with maize. At the new equilibrium, consumption is higher for every household category, with the largest gains for needy households and a slightly larger aggregate gain in rural areas. However, due to the income redistribution to rural households (who pay smaller income shares in direct taxes), the direct tax cut declines slightly compared to Simulation 7. Increased productivity of land in maize production (and a return of the maize area to the base level) gives rise to changes in agricultural resource allocation, including a shift toward wheat and away from cotton and short berseem. The result is a significant decline in wheat and flour imports and an overall decline in net food and agricultural imports (by 11 percent for the latter).

Leakage Cuts *(Simulation 9)*

The fact that almost 18 percent of Egypt's food subsidies leak to unintended beneficiaries suggests that leakage reductions may permit considerable government savings that can be allocated to other purposes. At the same time, it is possibly costly to intensify efforts to minimize leakage further. It is also important to keep in mind that leaked subsidies also benefit "somebody" although the (little known) beneficiaries differ from those intended. As noted earlier, the model data base assumes that the initial benefits from leakage are distributed in the same way as nonagricultural capital incomes.

To explore the impact of leakage cuts in isolation from the introduction of mixed wheat-maize flour, Simulation 9 considers the extreme case of full elimination of the food subsidy leakage with the savings allocated to direct transfers to the needy (see Tables 4 and 5). The analysis does not consider the (unknown) costs of reducing leakages and transferring benefits to the needy. The subsidy spending cuts (close to 18 percent on the aggregate level) reflect the initial leakage pattern. Close to LE 600 mn are allocated to the needy (as cash or cash-equivalent transfers). The distributional impact is strongly pro-needy and marginally pro-rural. As indicated by the small changes in foreign trade, the broader repercussions are limited, a reflection of the fact that the existing food subsidy program remains in place. In an additional simulation (not reported here), the savings were used to reduce income tax collections. Under this assumption, the distributional change is negligible (for the different households, real consumption changes by 0.1 percent or less). The pattern of change was similar but the impact even smaller when leakage elimination was limited to oil and sugar benefits. In sum, given that the simulation applies to a relatively extreme case, it seems that the broader economic impact of a crackdown is unlikely to be significant unless the savings are carefully targeted. When considering the desirability of intensifying its anti-leakage crackdown, the government also needs to consider the costs involved.

5. SUMMARY AND CONCLUSIONS

In this paper, an economy-wide model of the Egyptian economy has been used to quantitatively explore the short-run equilibrium effects of alternative cost-saving scenarios for the food subsidy system. The simulated impact of targeting or fully eliminating oil and sugar subsidies is relatively small, reflecting the limited size of this program. The savings permit a reduction in income taxes of 4-6 percent. The impact on disaggregated household welfare is also small (changes in real consumption for the different household types are between 0.2 percent and -0.3 percent). It is progressive if the subsidy is targeted to the needy and regressive if it is eliminated.

When similar measures are simulated for the entire food subsidy system, the impact is predictably much stronger, including important indirect effects. Nevertheless, although the current bread and flour subsidy program distorts consumer decisions, only very minor efficiency gains follow from targeting or eliminating these subsidies.

In tandem with a direct tax cut, the targeting of all food subsidies has pro-needy and pro-rural effects. It raises the total consumption of the needy by 0.5 percent with little change for the rest of the population. The strongest gains are recorded for the two lowest quintiles in rural areas, whose consumption goes up by around 1.0 percent. Only the urban households in the third and fourth quintiles lose significantly, by 0.5-0.8 percent. This outcome is influenced by the redistribution of buying power in favor of needy households who allocate larger shares of their consumption to food. Increased demand for food items (other than wheat) raises agricultural prices and the incomes of the rural population in general and the poor in particular.

The distributional consequences of a full elimination of food subsidies in combination with a tax cut (reducing direct tax revenues by 25 percent) remain pro-rural; aggregate rural and urban consumption change by 0.6 percent and -0.2 percent, respectively. However, the pattern of welfare change is regressive. The nonneedy households enjoy a consumption increase by 0.5 percent while the needy suffer a loss of 1.1 percent. On the other hand, if the savings from fully eliminating food subsidies instead are used for transfers to the needy, the household impact is drastically different. In addition to the transfer benefit, the rural needy gain strongly from demand shifts to and within agriculture, raising the consumption of the two lowest rural quintiles by 6-7 percent. On a more aggregate level, consumption increases by 1.2 percent for rural households and by 4.2 percent for needy households. Urban and nonneedy households register small losses.

The targeting or elimination of food subsidies has a significant impact on Egypt's foreign trade if the entire subsidy system is covered by the policy shifts. The declines are by 6-7 percent for wheat and flour imports but, due to substitution effects on the consumption side, much smaller for total net food and agricultural imports.

Subsidy costs are reduced significantly when maize substitutes for 20 percent of the flour used to produce subsidized bread and flour, especially if leakage can be eliminated. Imports of wheat and flour and total net imports of food and agricultural items decline, especially if maize yields increase. If so, the gains in household well-being may also be noteworthy; if not, the impact is pro-rural but negligible.

What are the policy implications of these results? Some of the simulated policy changes seem attractive assuming that the government is looking for ways of reducing food subsidy spending without hurting the needy. A first and relatively easy step is to target ration cards for oil and sugar subsidies to needy households while using the savings to reduce direct taxes. The gains for the needy would obviously be larger if the savings were instead used to fund programs that provide benefits to the needy (for example cash or cash-equivalent transfers). Experience from targeting these subsidies and developing programs for the needy may make it easier to introduce similar changes for the bread and flour subsidy programs. The program of using mixed maize and wheat flour in the production of subsidized bread reduces subsidy spending, permitting the allocation of government resources to other uses, including targeted programs for the needy. Against this background, expanding this program geographically and extending it to subsidized flour sold directly to the consumers are attractive possibilities.

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APPENDIX

Table A1 Structure of household factor incomes in SAM for 1996 97 (percent)

	Rural households					Urban households				
	1	2	3	4	5	1	2	3	4	5
Labor	43.9	39.9	31.9	22.5	17.7	56.6	53.8	47.9	35.0	28.3
Agriculture	19.8	16.7	10.4	6.3	4.2	3.1	2.8	2.3	1.3	0.7
Nonagriculture	24.1	23.2	21.5	16.2	13.5	53.5	50.9	45.6	33.8	27.6
Capital	42.6	45.4	51.0	57.8	61.4	41.8	44.6	50.5	63.4	70.1
Agriculture	7.4	8.0	9.2	10.6	11.2	0.9	0.9	0.9	0.9	0.9
Nonagriculture	35.3	37.5	41.8	47.2	50.1	40.9	43.8	49.6	62.4	69.2
Land	13.5	14.7	17.1	19.7	21.0	1.6	1.6	1.6	1.6	1.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100

Source: Model SAM for 1996/97.

Table A2 Simulation results: distribution of factor incomes

	Base[a]	-1- Targeting oil-sugar subsidy + income tax cut	-2- Targeting total food subsidy + income tax cut	-3- Eliminating oil-sugar subsidy + income tax cut	-4- Eliminating total food subsidy + income tax cut	-5- Eliminating total food subsidy + transfer to needy
		change from Base				
Agriculture	17.3	0.0	0.3	0.0	0.6	0.7
Labor	4.7	0.0	0.1	0.0	0.2	0.3
Land and Capital	12.7	0.0	0.3	0.0	0.4	0.5
Nonagriculture	82.7	0.0	-0.3	0.0	-0.6	-0.7
Labor	27.2	0.0	-0.1	0.0	-0.2	-0.3
Capital	55.5	0.0	-0.2	0.0	-0.4	-0.4
Total	100.0	0.0	0.0	0.0	0.0	0.0

	-6- Wheat-maize flour + transfer to needy	-7- Wheat-maize flour + transfer to needy + leakage cut	-8- Wheat-maize flour + transfer to needy + leakage cut + yield increase	-9- Leakage elimination + transfer to needy
	change from Base			
Agriculture	0.1	0.1	0.1	0.1
Labor	0.1	0.1	0.0	0.0
Land and Capital	0.1	0.1	0.1	0.1
Nonagriculture	-0.1	-0.1	-0.1	-0.1
Labor	0.0	0.0	0.1	0.1
Capital	-0.1	-0.1	-0.2	-0.1
Total	0.0	0.0	0.0	0.0

[a] Base = percent share of total factor income.

Table A3 Simulation results: foreign trade

	Base[a]	-1- Targeting oil-sugar subsidy + income tax cut	-2- Targeting total food subsidy + income tax cut	-3- Cutting oil-sugar subsidy + income tax cut	-4- Cutting total food subsidy + income tax cut	-5- Cutting total food subsidy + transfer to needy
		percent change from Base				
Food and agriculture						
Net imports	1962.8	0.0	-1.8	0.0	-1.2	-0.4
Imports	2333.6	0.0	-2.6	0.0	-2.4	-1.8
Wheat and flour	1100.4	0.0	-6.9	0.0	-7.1	-5.9
Exports	370.8	0.0	-6.9	0.1	-8.8	-8.9
Other goods and services						
Net imports	161.8	-0.2	22.3	0.5	14.6	4.9
Imports	15962.0	0.0	0.0	0.0	0.0	0.0
Exports	15800.1	0.0	-0.3	0.0	-0.3	-0.1

	-6- Wheat-maize flour + transfer to needy	-7- Wheat-maize flour + transfer to needy + leakage cut	-8- Wheat-maize flour + transfer to needy + leakage cut + yield increase	-9- Leakage elimination + transfer to needy
	percent change from Base			
Food and agriculture				
Net imports	-6.0	-6.0	-10.9	0.1
Imports	-5.9	-5.9	-9.3	0.0
Wheat and flour	-12.7	-12.7	-19.8	0.1
Exports	-5.5	-5.5	-0.5	-0.4
Other goods and services				
Net imports	72.5	72.4	132.5	-1.7
Imports	0.1	0.1	0.3	0.0
Exports	-0.7	-0.7	-1.1	0.0

Notes: Changes smaller than 0.05 percent are set at zero. For all simulations total net imports (the trade deficit) are fixed at $2124.6 mn.

[a] Units for Base: million $ at 1996–97 prices.

Table A4 Simulation results: real production

	Base[a]	-1- Targeting oil-sugar subsidy + income tax cut	-2- Targeting total food subsidy + income tax cut	-3- Cutting oil-sugar subsidy + income tax cut	-4- Cutting total food subsidy + income tax cut	-5- Cutting total food subsidy + transfer to needy
		percent change from base				
Agriculture						
Winter crops						
Wheat	5.1	0.0	-4.1	0.0	-9.3	-10.0
Legumes	0.6	0.0	1.5	-0.1	2.7	4.2
Long berseem	1.9	0.0	2.7	0.0	3.7	3.8
Short berseem	0.4	0.0	-7.9	0.0	-7.9	-7.9
Winter vegetables	3.0	-0.1	22.3	0.1	45.9	47.0
Other winter crops	4.8	0.0	0.8	0.0	1.0	1.1
Summer crops						
Cotton	3.2	0.0	-7.9	0.0	-8.0	-8.0
Rice	3.2	0.0	3.4	0.0	6.9	7.0
Maize	4.3	0.0	3.5	0.0	4.9	4.9
Summer vegetables	7.1	0.0	-7.8	-0.1	-17.3	-17.6
Other summer crops	3.4	0.0	0.8	0.0	1.0	1.1
Perennials						
Fruits	6.1	0.0	0.1	0.0	-0.2	-0.3
Sugarcane	1.2	0.0	0.8	0.0	1	1.1
Animal agriculture	17.3	0.0	0.1	0.0	-0.1	0.0
Nonagriculture						
Petroleum	19.1	0.0	0.0	0.0	0.0	0.0
Subsidized bread	3.4	0.0	-19.5	0.0	-29.6	-29.2
Nonsubsidized bread	1.5	0.0	2.2	0.0	2.6	2.8
Subsidized flour	4.1	0.0	-15.5	0.0	-23.3	-22.9
Nonsubsidized flour	2.8	0.0	2.3	0.0	3.3	3.4
Other processed food	39.2	0.0	0.9	0.0	1.2	1.3
Cotton ginning	3.9	0.0	-7.9	0.0	-8.0	-8.0
Textiles	30.3	0.0	0.0	0.0	-0.1	-0.1
Other industry	56.7	0.0	0.1	0.0	0.1	0.2
Electricity	7.0	0.0	-0.3	0.0	-0.7	-0.5
Construction	33.8	0.0	-0.1	0.0	-0.1	0.0
Government services	25.6	0.0	0.0	0.0	0.0	0.0
Transportation	28.4	0.0	0.1	0.0	0.1	0.0
Other services	119.1	0.0	0.0	0.0	0.1	0.0

Table A4 (cont d)

	-6- Wheat-maize flour + transfer to needy	-7- Wheat-maize flour + transfer to needy + leakage cut	-8- Wheat-maize flour + transfer to needy + leakage cut + yield increase	-9- Leakage elimination + transfer to needy
	percent change from base			
Agriculture				
Winter crops				
Wheat	-5.3	-5.3	1.0	0.0
Legumes	-0.4	-0.4	0.5	0.3
Long berseem	1.5	1.5	1.9	0.0
Short berseem	-8.0	-8.0	-7.7	0.1
Winter vegetables	38.5	38.6	-6.9	-0.4
Other winter crops	0.0	0.0	0.0	0.0
Summer crops				
Cotton	-8.0	-8.0	-7.9	0.0
Rice	-2.3	-2.3	0.4	-0.2
Maize	11.6	11.6	11.4	0.0
Summer vegetables	-16.1	-16.1	4.3	0.2
Other summer crops	0.0	0.0	0.0	0.0
Perennials				
Fruits	-0.2	-0.2	-0.3	0.0
Sugarcane	0.0	0.0	0.0	0.0
Animal agriculture	-0.1	-0.1	0.1	0.0
Nonagriculture				
Petroleum	0.0	0.0	0.0	0.0
Subsidized bread	0.7	0.7	-0.3	0.0
Nonsubsidized bread	0.3	0.3	0.3	0.0
Subsidized flour	0.7	0.7	-0.3	0.0
Nonsubsidized flour	0.3	0.3	0.1	0.0
Other processed food	0.0	0.0	0.0	0.0
Cotton ginning	-8.0	-8.0	-7.9	0.0
Textiles	-0.1	-0.1	0.0	0.0
Other industry	0.0	0.0	0.0	0.0
Electricity	0.0	0.0	0.3	0.0
Construction	0.0	0.0	0.0	0.0
Government services	0.0	0.0	0.0	0.0
Transportation	0.0	0.0	0.0	0.0
Other services	0.0	0.0	0.0	0.0

[a] Units for Base: bn LE at 1996–97 prices.

Table A5 Elasticity values used in the model

	CET	CES	Export demand	Armington	Intermediate
Winter crops					
Wheat		0.3			0.3
Legumes	0.5	0.3			0.3
Long berseem		0.3			0.3
Short berseem		0.3			0.3
Winter vegetables	0.8	0.3	3.0	0.3	0.3
Other winter crops		0.3			0.3
Summer crops					
Cotton		0.3			0.3
Rice		0.3			0.3
Maize		0.3		1.6	0.3
Summer vegetables	0.8	0.3	3.0	0.3	0.3
Other summer crops		0.3			0.3
Perennials					
Fruits	0.8	0.3		0.3	0.3
Sugarcane		0.3			0.3
Animal agriculture		0.3		0.3	1.2
Nonagriculture					
Petroleum		0.1		2.0	
Subsidized bread		0.6			
Nonsubsidized bread		0.6			
Subsidized flour		0.6			
Nonsubsidized flour		0.6		3.0	
Other processed food	2.0	0.6		0.3	
Cotton ginning		0.6			
Textiles	2.0	0.6		0.3	
Other industry	2.0	0.6		0.3	
Electricity		0.4			
Construction		0.6			
Government services		0.5			
Transportation	2.0	0.6	1.0	0.3	
Other services	2.0	0.6	1.0	0.3	

Note: For a brief survey of elasticities of CGE models, see Löfgren (1994a). Abbreviations:
CET Elasticity of transformation between exports and domestic sales in CET function;
CES Elasticity of factor substitution in CES value-added functions;
Armington Elasticity of substitution between imports and domestic goods in CES aggregation function;
Intermediate Elasticity of substitution between intermediate inputs in agriculture.

Table A6 Mathematical Statement for the Egypt Food CGE Model[1,2]

SETS

$a \in A$	activities	$z \in Z$	institutions [households, government (= *gov*), rest of the world (= *row*)] and factors
$a \in ACR$ ($\subset A$)	crop activities	$f \in F$ ($\subset Z$)	factors [labor & capital factors, land-water (= *l-w*)]
$c \in C$	disaggregated commodities	$f \in FSUB$	subfactors (summer and winter land, water)
$c \in CF$	disaggregated food and nonfood aggregate	$i \in I$ ($\subset Z$)	domestic institutions (households and government)
$c \in CNF$ ($\subset C$)	disaggregated nonfood	$h \in H$ ($\subset I$)	households

PARAMETERS

cpi	consumer price index	qg_c	government consumption
$cwts_c$	weight of commodity c in consumer price index	$qinv_c$	fixed investment demand for c
$fsav$	foreign savings (foreign currency)	$shrgdp_{h,gov}$	nominal GDP share transferred from government to household h
$gsav$	government savings	$shry_{if}$	share of domestic institution i in income of factor f
ica_{ca}	intermediate input c per unit of activity a	ta_a	indirect tax rates for activity a
ifa_{fa}	quantity of subfactor f per unit of land-water aggregate for activity a	tm_c	import tariff rate (incl. sales tax)
mps_h	share of post-tax income of household h to savings	tq_c	rate of sales tax
pwe_c	world price of exports (foreign currency)	$tr_{zz'}$	transfer to institution/factor z from institution/factor z'
pwm_c	world price of imports (foreign currency)	$trsub_{z,gov}$	subsidy transfer to institution/factor z (for rationed commodity or leakage)
$qdst_c$	stock change for commodity c	ty_h	direct tax rate for household h
qfs_f	supply of factor f	ã$_{ac}$	yield of commodity c per unit of activity a
$qfssub_f$	supply of subfactor f	ó$_{c}$	rate of household consumption subsidy for commodity c

Table A6 **(con't)**

VARIABLES

EG	government expenditures	QF_{fa}	demand for factor f from activity a
EH_h	household consumption expenditures	$QFSUB_{fa}$	demand for subfactor f from activity a
EXR	exchange rate (units of foreign currency per unit of domestic currency)	QH_{ch}	consumption demand for c from household h
GDP	nominal GDP at market prices	$QINT_c$	intermediate input demand for c
PA_a	output revenue per unit of activity a	QM_c	imports of c
PD_c	price of domestic output sold domestically	QQ_c	supply of composite commodity c
PE_c	price of exports	QX_c	total output of commodity c
PM_c	price of imports	W_f	wage of factor f
PQ_c	price of composite good	$WFDIST_{fa}$	wage distortion factor
PVA_a	activity value-added (net) price	$WFSUB_f$	wage of subfactor
PX_c	average producer price for commodity c	YF_f	income of factor f
QA_a	level of activity a	YG	government income
QD_c	domestic sales of domestic output	YIF_{if}	income of domestic institution i from factor f
QE_c	exports	YH_h	income of household h

Functions

CES(•)	constant elasticity of substitution	LES(•)	linear expenditure system
CET(•)	constant elasticity of transformation	AIDS(•)	almost ideal demand system

Table A6 (con't)

#	Equation	Domain	Description
EQUATIONS			
Price Block			
1	$PM_c = pwm_c \cdot (1 + tm_c) \cdot EXR$	$c \in C$	import price in domestic currency
2	$PE_c = pwe_c \cdot EXR$	$c \in C$	export price in domestic currency
3	$PQ_c = \dfrac{(PD_c \cdot QD_c + PM_c \cdot QM_c)}{QQ_c} (1 + tq_c)$	$c \in C$	average demand price of composite commodity
4	$PX_c = \dfrac{(PD_c \cdot QD_c + PE_c \cdot QE_c)}{QX_c}$	$c \in C$	average producer price of commodity c
5	$PA_a = \sum_{c \in C} \tilde{a}_{ac} \cdot PX_c$	$a \in A$	gross activity price (=unit revenue)
6	$PVA_a = PA_a \cdot (1 - ta_a) - \sum_{c \in C} ica_{ca} \cdot PQ_c$	$a \in A$	activity value added (net) price
7	$WF_{l-w} \cdot WFDIST_{l-w,a} = \sum_{f \in FSUB} ifa_{fa} \cdot WFSUB_f$	$a \in ACR$	land-water rent by crop activity
Supply and Trade Block			
8	$QA_a = CES[QF_{fa}]$	$a \in A$	level of production activity
9[3]	$QF_{fa} = CES^*[W_f \cdot WFDIST_{fa}, PVA_a]$	$f \in F$ $a \in A$	demand for factor f from activity a
10	$QINT_c = \sum_{a \in A} ica_{ca} \cdot QA_a$	$c \in C$	intermediate input demand
11	$QFSUB_{fa} = ifa_{fa} \cdot QF_{l-w,a}$	$f \in FSUB$ $a \in ACR$	demand for subfactor f from crop activity a
12	$QX_c = \sum_{a \in A} \tilde{a}_{ac} \cdot QA_a$	$c \in C$	output of commodity c
13	$QX_c = CET[QE_c, QD_c]$	$c \in C$	function transforming output to exports and domestic sales
14	$\dfrac{QE_c}{QD_c} = CET^* \left[\dfrac{PE_c}{PD_c} \right]$	$c \in C$	FOC for output transformation
15	$QQ_c = CES[QM_c, QD_c]$	$c \in C$	function aggregating imports and domestic sales to composite supply
16	$\dfrac{QM_c}{QD_c} = CES^* \left[\dfrac{PD_c}{PM_c} \right]$	$c \in C$	FOC for commodity aggregation

Table A6 (con't)

Institution block

17	$YF_f = \sum_{a \in A} W_f \cdot WFDIST_{fa} \cdot QF_{fa} + trsub_{f,gov}$	$f \in F$	income of factor f
18	$YIF_{if} = shry_{if}\ (YF_f - tr_{row,f} \cdot EXR)$	$i \in I$ $f \in F$	income of domestic institution i from factor f
19	$YH_h = \sum_{f \in F} YIF_{hf} + shrgdp_{h,gov} \cdot GDP + tr_{h,row} \cdot EXR + trsub_{h,gov}$	$h \in H$	household income
20	$EH_h = (1 - mps_h) \cdot (1 - ty_h) \cdot YH_h - tr_{row,h} \cdot EXR$	$h \in H$	household consumption expenditure
21	$QH_{ch} = AIDS^*[(1 - \text{ó}_c) \cdot PQ_c, EH_h]$	$c \in CF$ $h \in H$	household consumption demand for disaggregated food and aggregated non-food
22	$PQ_{n\text{-}f} = LES^*[(1 - \text{ó}_{cnf}) \cdot PQ_{cnf}]$		consumer price index for non-food
23	$QH_{ch} = LES^*[(1 - \text{ó}_c) \cdot PQ_c\ ,\ PQ_{n\text{-}f} \cdot QH_{n\text{-}f,h}]$	$c \in CNF$ $h \in H$	household consumption demand for disaggregated non-food
24	$YG = YIF_{gov,f} + \sum_{h \in H} ty_h \cdot YH_h + \sum_{c \in C} tq_c \cdot (PD_c \cdot QD_c + PM_c \cdot QM_c) + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in C} tm_c \cdot pwm_c \cdot QM_c + tr_{gov,row}$		government income
25	$EG = \sum_{c \in C} PQ_c \cdot qg_c + \sum_{h \in H} shrgdp_{h,gov} \cdot GDP + tr_{row,gov} \cdot EXR + \sum_{c \in C} \sum_{h \in H} \text{ó}_c \cdot PQ_c \cdot QH_{ch} + \sum_{z \in Z} trsub_{z,gov}$		government expenditure
26	$GDP = \sum_{c \in C} \sum_{h \in H} PQ_c \cdot (1 - \text{ó}_c) \cdot QH_{ch} + \sum_{c \in C} PQ_c \cdot qinv_c + \sum_{c \in C} PQ_c \cdot qdst_c + \sum_{c \in C} PQ_c \cdot qg_c + \sum_{c \in C} pwe_c \cdot QE_c \cdot EXR - \sum_{c \in C} pwm_c \cdot QM_c \cdot EXR$		nominal GDP

System Constraint Block

27	$QQ_c = QINT_c + \sum_{h \in H} QH_{ch} + qg_c + qinv_c + qdst_c$	$c \in C$	market equilibrium for composite commodity (S=D)
28	$qfs_f = \sum_{a \in A} QF_{fa}$	$f \in F$ $f \neq l\text{-}w$	market equilibrium for factors (S=D)
29[4]	$qfssub_f \geq \sum_{a \in ACR} QFSUB_{fa} \qquad [WFSUB_f \geq 0]$	$f \in FSUB$	market equilibrium for subfactors (S≥D)

Table A6 (con't)

30	$\sum_{c \in C} pwm_c \cdot QM_c + \sum_{z \in Z} tr_{row,z} = \sum_{c \in C} pwe_c \cdot QE_c + \sum_{z \in Z} tr_{z,row} + fsav$		current account balance (in foreign currency)
31	$gsav = YG - EG$		government savings constraint
32	$\sum_{h \in H} mps_h \cdot (1 - ty_h) \cdot YH_h + gsav + EXR \cdot fsav = \sum_{c \in C} PQ_c \cdot (qinv_c + qdst_c)$		savings-investment balance
33	$cpi = \sum_{c \in C} cwts_c \cdot (1 - ó_c) \cdot PQ_c$		consumer price index (numéraire)

1. The following notational convention is used: Subscripts are set indices. Variables are written with upper-case Latin letters. Parameters appear as Greek letters or as lower-case Latin letters.
2. The mathematical statement is simplified. (See Section 3 for a fuller verbal model description.) The following aspects have been suppressed: (i) perfect substitutability/transformability between exports, imports and domestic output for selected commodities (in place of imperfect substitutability/transformability); (ii) constant-elasticity demand curves for selected export commodities (in place of fixed foreign-currency export price); (iii) domain controls (limiting equations and variables to subsets of the sets indicated); (iv) price-responsiveness of selected intermediate input coefficients; (v) agronomic constraints; (vi) flexing of subsidy rate and fixing of total consumer price, $(1 - ó_c) \cdot PQ_c$, for subsidized commodities with a fixed consumer price.
3. CES*, CET*, AIDS* and LES* indicate relationships derived from the respective functions. In general, WF is flexible and WFDIST is fixed. Exceptions include the aggregate land-water factor (for which WF is fixed while WFDIST is flexible for all land-water crop activity pairs), and factors or activities with special treatment (activity-specific capital for noncrop activities and special assumptions for the oil and electricity activities.
4. Complementary constraints are shown in brackets in the equation column.