DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

WORKING PAPER NO. 614 Rev.

AGRICULTURAL TRADE LIBERALIZATION FOR THE LOW INCOME COUNTRIES: A GENERAL EQUILIBRIUM-MULTIMARKET APPROACH

by

Elisabeth Sadoulet and Alain de Janvry

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
October 7, 1991

Agricultural Trade Liberalization and the Low Income Countries: A General Equilibrium-Multimarket Approach*

Elisabeth Sadoulet and Alain de Janvry

Agricultural Trade Liberalization and the Low Income Countries: A General Equilibrium-Multimarket Approach

While progress in the Uruguay Round of the general agreement on tariffs and trade (GATT) toward agricultural trade liberalization in the OECD countries is currently marred with difficulties, liberalization remains a goal for the United States and many other GATT members. Recent studies edited by Maunder and Valdés and by Goldin and Knudsen are generally consistent in predicting that liberalization would lead to higher world market prices for cereals and animal products. Concerned with the impact that liberalization may have on the poorer countries, most of which are highly dependent on cereals imports, and on the poor within these countries, who spend a high share of their incomes on foodgrains, we focus on simulating the affects of liberalization on these vulnerable groups. The objective is to assist the more developed countries' negotiators in designing complementary developmental assistance and food aid programs for the less developed countries (LDCs) and for the poor in these countries.

The approach we follow consists in constructing archetype multisector and multiclass computable general equilibrium (CGE) models for groups of countries with similar structural features. In international development, the archetype approach derives from the tradition of Kuznets and Chenery in seeking regularities in the economies of the very large number of LDCs according to their levels of per capita incomes, market sizes, and other structural features. Because it is too costly to construct complete models for every country and to derive from this average policy guidelines by structural group, de Melo and Robinson have pioneered the opposite approach of constructing country averages (archetypes) and deriving policy guidelines for the corresponding country group. Loo and Tower have used an archetype approach to analyze agricultural trade liberalization, but their models include only one agricultural sector and no social disaggregation. In the present paper, we use a multimarket specification of agriculture in

order to capture the richness of substitution effects among products and factors, as well as the role of nonallocatable fixed factors. We also stress the differential roles of public and private investment, how they are affected by changing fiscal revenues from higher food import prices, and the short- and long-run effects these effects have on growth and welfare. Country groups are constructed on the basis of explicit structural criteria. The social accounting matrix for each archetype is rigorously quantified from the national accounts data for the countries in the group and parameters of the models are as much as possible estimated as average values for the countries in the group. From a methodological standpoint, this paper shows how a CGE-multimarket archetype approach, rigorously quantified, provides a very effective tool for the analysis of complex agricultural policy decisions.

We start by grouping the LDCs according to a number of criteria to establish the relevant structural and behavioral characteristics that the archetypes must reflect. In the following sections, we construct social accounting matrices (SAM) for archetype low-income African and Asian countries and explain the features of the CGE models specified. We then use these models to simulate the effects of rising international prices of cereals and livestock products induced by OECD agricultural trade liberalization. Finally, we analyze how complementary measures could be introduced to shelter the poor in both the short and the long run.

Country Classification

We focus on low income countries which, in the World Bank classification, had per capita incomes below $500 in 1985. We exclude from this group the net cereals exporters, who gain from higher cereals prices, and the mineral exporters (with a share of minerals in total exports above 75%), who have no difficulty in importing food, even at a higher price. We also exclude China and India, which are so large as to require country specific modeling. This leaves a set of countries classified by continent (Africa and Asia, since

there are no Latin American countries left in that group) and by degree of substitution in consumption between imported cereals and domestic food crops production.

The degree of substitution in consumption between imported cereals (principally wheat, rice, and corn) and domestic food crops production (which may include wheat, rice, and corn plus other food crops) is a fundamental determinant of the impact of an increase in imported cereals prices on domestic producer and consumer food crops prices.[1] Producer prices of wheat, rice, and corn follow the price of imports. What happens to the prices of other food crops and of the food crop aggregate, however, depends on the elasticity of substitution in consumption between domestically produced food crops and cereal imports, as well as on supply and demand elasticities and the import dependency ratio of food crops. This can be seen in a simplified one-sector model as follows.

Let D be the domestic production of food crops and M the cereals imports, and p_d and p_m their respective prices. If they are imperfect substitutes and aggregate in a CES utility function with elasticity σ, a cost-minimizing consumer will purchase the two products in a share that depends on their relative prices:

$$\frac{D}{M} = \frac{1 - s_m}{s_m} \left(\frac{p_d}{p_m} \right)^{-\sigma},$$

where $s_m = M/C$ is the initial share of imports in consumption and $C = D + M$ is total consumption.

If ε is the price elasticity of demand for C and μ is the price elasticity of supply for D, the market for food crops is written as:

$C = p^{-\varepsilon}$, where $p = \frac{p_m M + p_d D}{M + D}$ is the consumer price and

$D = p_d^{\mu}$.

These equations can be solved for quantities C, D, and M, producer price p_d, and consumer price p as a function of import price p_m. Differentiating the system around the

initial point where, by proper normalization, all prices are equal to 1 gives the following relations for rates of change in equilibrium prices:

$$(1) \qquad \dot{p}_d = \frac{s_m(\sigma-\varepsilon)}{s_m(\sigma-\varepsilon)+\mu+\varepsilon}\,\dot{p}_m \quad \text{and} \quad \dot{p} = \frac{s_m(\sigma+\mu)}{\sigma+\mu+(1-s_m)(\varepsilon-\sigma)}\,\dot{p}_m .$$

This shows that the elasticities of transmission of the import price of cereals on domestic producer and consumer prices of food crops are less than one for all finite values of the elasticity of substitution σ. The change in producer price is negative if σ is lower than the elasticity of demand ε. This comes from the fact that aggregate consumption decreases in response to the aggregate consumer price increase and, with the low substitutability between imported and domestic commodities, consumption of both components decreases. For σ greater than ε, the elasticity of transmission to the producer price increases with the initial share of imports s_m and decreases with the supply elasticity μ. Thus, an increase in international cereal price will have a relatively small effect on the producer price of food crops if domestic production is a poor substitute for imports, if the share of imports is small, or if the supply elasticity is large. Consumer price, by contrast, always increases. The rise in consumer price is greater with higher substitutability σ, with lower demand elasticity ε, and with a greater share s_m of imports in total supply. If there is sufficient substitutability (σ greater than ε), then a higher supply elasticity μ reduces the magnitude of price transmission.

Starting from an exhaustive list of 73 countries, for which World Bank and FAO data are available for 1985, the selection criteria mentioned above give us 26 low income countries which are neither cereal nor major mineral exporters. To separate those in which domestic food crop production is competitive with imported cereals from those in which it is not competitive, we use an index of competitiveness defined as the share of wheat, rice, and corn (the three cereals whose prices are most affected by OECD trade liberalization) in total domestic food crop production. The index threshold is 25%. The resulting three groups of low income countries that we model as archetypes are:

1. African countries with noncompetitive cereal imports (Africa I): Burkina Faso, Mozambique, Togo, Burundi, Central Africa Republic, Rwanda, Sudan, Senegal, Ghana, Mauritania, and Lesotho.

2. African countries with competitive cereal imports (Africa II): Ethiopia, Mali, Madagascar, Benin, Somalia, Kenya, Tanzania, Guinea, Sierra Leone, and Liberia.

3. Asian low-income countries: Bangladesh, Sri Lanka, Pakistan, Philippines, and Papua New Guinea.

These three country groups together account for only 14.3% of LDC population, 7.7% of LDC gross domestic product (GDP), and 14% of LDC cereal imports (table 1). While marginal in terms of grain trade, they are, together with India and China, the countries where the bulk of world absolute poverty is located and, as such, deserve special attention.

Data in table 1 show that the two groups of African low income economies have very similar structural and behavioral characteristics. For this reason, we model these two archetypes with the same social accounting matrix and the same elasticities of supply response and factor demand in agriculture. We, however, impose different elasticities of substitution between imported cereals and domestic food crops in order to reflect the fact that the index of competitiveness is low in the Africa I group (10%) and high in the Africa II group (45%).

The low-income Asian countries import mainly wheat, and some countries import rice as well. Most of these countries are themselves important producers of wheat (Pakistan) or rice (Bangladesh, Philippines, and Sri Lanka), while coarse grains are secondary. Cereal imports are for this reason highly competitive with domestic food crops, resulting in an index of competitiveness of 94%. Even though cereal import dependency is not high (8%), domestic prices are very much influenced by international prices. The population's diet is based largely on cereals (70% of dietary energy), with the

result that a rise in the consumer cereal price has a strong incidence on the consumer price index (CPI) and on the welfare of net buyers.

In the low-income African countries, cereals are less important in the diet: 47% of dietary energy in Africa I and 48% in Africa II. Consumers are consequently more sheltered than in Asia from a rise in cereal prices, particularly in countries with noncompeting imports. Countries in Africa I produce mostly coarse grains, root crops, and plantains and import wheat and rice. Domestic food production is thus quite isolated from international cereal prices. Countries in Africa II produce coarse grains and rice and import rice, coarse grains, and wheat in approximately equal shares. International cereal prices consequently strongly affect the domestic food price.

The African and Asian SAMs (tables 2 and 3, respectively) replicate as closely as possible the aggregate values reported in table 1 for the structures of production, demand, international trade, and government revenues. Other values (input-output coefficients, distribution of value added to factor incomes, transfers, and consumption shares) are drawn from different sources, mostly from a Kenya SAM (Republic of Kenya) for Africa and from a Sri Lanka SAM (Pyatt and Roe) for Asia. The size of the country has no influence, and the data are reported in 1985 U. S. dollars per capita to allow comparison between the two SAMs.

An Integrated CGE-Multimarket Approach[2]

The model used here integrates the standard specification of the neoclassical CGE with multimarket models (Quizon and Binswanger). We use a Generalized Leontief profit function from which are derived output supplies for the three agricultural products and factor demands for the two labor categories. For nonagricultural sectors, we use the traditional multi-level CES production function for primary factors and fixed coefficients for intermediate inputs.

For labor markets, we assume urban labor in Asia and unskilled labor in Africa are in surplus and hired at an exogenous real wage. For rural labor in Asia and skilled labor in Africa, wages are, by contrast, flexible and clear a competitive market. Public service employees receive an exogenous real wage. On the foreign exchange market, country indebtedness currently is limited by the global context of the debt crisis. The foreign exchange constraint forces a flexible real exchange rate, endogenously determined, to equilibrate in the foreign exchange market at a given level of capital inflow.

The numéraire used in the model is the average producer price index. The transmission mechanism between international cereal prices and domestic food crop prices is a key feature of the analysis. It is specified through CES aggregation in which imported cereals and domestic food production are substitutes with an elasticity σ. The resulting shares determine the consumer food price.

As with any other CGE model, calibration is based on exact replication of base year data compiled in the SAM. All share parameters in the different aggregation functions are derived from the SAM. Complementary information is necessary only for elasticities, as follows:

i) The demand system is an LES, with parameters derived from observed average consumption shares (in the SAM), estimated income elasticities by income class (from econometric estimates available in the literature, calibrated to satisfy the additivity constraint), and income-class-specific values for the flexibility of money. The latter are well established from international comparisons and range from -4 for the poorer to -2 for the richer groups of these low income countries.

ii) On the supply side, all nonagricultural production functions are CES in capital and labor, with a standard medium value of substitutability between factors equal to 0.8. With respect to agricultural sectors, base values for supply and demand elasticities were taken from Sullivan, Wainio, and Roningen. These elasticities were forced to satisfy additivity and symmetry constraints by minimizing the sum of the squares of the distances to the

base values while maintaining the base values of the direct price elasticities. The base values and the initial structure of shares, which places constraints on the elasticities, differ between African and Asian archetypes. Resulting elasticities are given in table 4.

iii) For aggregation elasticities between imports and domestic consumption, a relatively low substitution elasticity (0.5) has been assumed for the nonagricultural products. This assumes differentiation between domestically produced commodities and imports within these large aggregates.[3] For the other agricultural sector (predominantly animal products), high substitution elasticity (3.0) is assumed. However, with the observed low share of imports in domestic Asian consumption, the transmission of an external price increase to domestic price is still low. For the African archetype, foreign price changes are irrelevant since there are no imports. Substitution elasticity between imported cereals and domestic food crops, a key to our analysis, has been calibrated as follows. In the Asian archetype, a very high substitutability (30) is chosen to characterize the observed high degree of competitiveness. In the Africa I archetype, where domestically produced food crops are different from imported cereals, choice of σ is based on the relation between the elasticities for these crops and their cross price elasticities of demand with respect to the price of the imported cereals. Based on Sullivan and others, cross-price consumption elasticities are approximately equal to zero for Sub-Saharan African countries, indicating, in equation (1), that substitution elasticity σ equals the direct price elasticity of consumption ε for the aggregate food crop. Although these direct price elasticities vary across households, they are all close to 0.6 for the majority of consumers, and σ was thus set to 0.6 for this archetype. In the Africa II archetype, where the degree of competitiveness is similar between domestic production and imports, an intermediate value of 3 was chosen for σ.[4]

iv) On the export side, transformation elasticities are evidently dependent on the homogeneity of the sectors and, on the consumption side, these elasticities must be of medium values at the high level of aggregation considered here. Thus, a medium-high

elasticity of transformation (1.2) is used for the agricultural export sector, a medium-low value (0.8) for the industrial sector, and a lower value (0.5) for the food processing sector, which is dominated by mills producing for the domestic market.

The model is used to solve for both short-run and long-run solutions. The long run is captured through the productivity effects of public and private investment. In the short run, investment has no output effect other than through the composition of demand for investment goods. In the long run, investment leads to both capital accumulation and productivity gains. The public goods nature of public investment is captured by a higher total productivity effect (with an elasticity of total factor productivity with respect to public investment equal to 0.1) than that induced by private investment (an elasticity of 0.07). Productivity effects of public investment affect all sectors equally; those of private investment, which is sector-specific, are assumed for lack of better information to be equal in all sectors. Despite general recognition that growth in total factor productivity is the major source of economic growth and that investment in new capital vintages, human capital, and research helps determine this productivity growth, empirical studies are dramatically missing on the subject. Not much confidence can therefore be placed in the values chosen for these elasticities, and long-term effects presented here should be seen only as qualitative results.

We use the archetype CGEs to conduct two series of experiments. The first looks at the growth and welfare effects of a 20% increase in world prices of cereals and other agricultural (mainly animal) products. Fiscal policies are assumed to maintain a constant government deficit in both the short and the long run. The second series of experiments explores the use of compensatory measures such as food subsidies, targeted income transfers, and international food aid to shelter the poor from the negative effects of rising food prices.

Impact of Rising World Prices of Cereals and Animal Products

The first experiment we report in table 5 gives the short-term effects of rising world prices of cereals and animal products. Results differ sharply between African countries in which cereal imports are not competitive with domestic production (Africa I) and African (Africa II) and Asian countries in which they are competitive. In the end, GDP falls and all countries lose, but for very different reasons, eventually calling on differential policy measures to restore growth and protect the welfare of the poor.

Short-Run Effects

In Africa I, domestic food crops prices are sheltered from rising international cereal prices. As a result, domestic food prices increase only by 3% and consumption of both imported cereals and domestically produced food falls 2.3%. Cereal imports fall 10.7%. However, this is less than the 20% rise in cereal import price with the result that the cereal import bill increases, forcing a currency depreciation of 0.7%. Real exchange rate devaluation raises the domestic price of agroexports (0.7%), depresses the relative price of other agricultural goods (-1.6%), and reallocates resources from other agricultural goods (output falls by 0.4%) to agroexports (output rises by 0.6%). Balance-of-payments equilibrium is restored by rising agroexports and falling imports of cereals and industrial goods. Rising agroexports (0.6%) increase export tax revenues (1.4%), balancing losses in other tax revenue associated with a fall in GDP. Combined with a reduction in nonagricultural prices, this allows a slight increase in government current expenditures and maintains public investment. The short-run effect on GDP is small (-0.3%) because of the expenditure switching induced by exchange rate devaluation. However, the impact on domestic absorption is larger (-0.8%), suggesting a global cost. In agriculture, absence of a labor market and predominance of fixed factors eliminate any short-run aggregate output response.

The social cost, measured by changes in real income, is spread over all social classes. Losses are, however, regressive in agriculture because small farmers produce animal products whose prices fall, while larger farmers are more engaged in agroexports whose prices rise (see SAM in table 2). In the urban sector, the poor lose little because the rise in food prices is small. The rich lose from the slowdown in economic growth.

The impacts of rising world prices of cereals and animal products on Africa II and Asia contrast sharply with those described above. While the response in Africa I was to increase agricultural trade through a higher cereals import bill and more agroexports, the response in Africa II and Asia is to reduce trade through cereal import substitution and declining agroexports.

In these two archetypes, the rising world cereal price is transmitted to the whole food crop sector, where producer prices increase by 5.9% (Africa II) and 8.8% (Asia). Terms of trade thus turn in favor of agriculture (2.0% in Africa II and 5.3% in Asia) whereas they had turned against agriculture in Africa I. This leads to both a sharp fall in cereal consumption (-3.2 and -3.7% in Africa II and Asia, respectively) and an increase in domestic food crop production (1.6% and 2.9%). The result is that cereal imports fall by much more (-25% and -77%) than the 20% increase in world cereal price, bringing a foreign exchange saving and appreciation of the real exchange rate (2.4% and 4.8%). Domestic price of agroexports thus falls (-2.4% and -3.5%) and production declines (-2% and -2.3%), as resources are reallocated to food crops for import substitution. International trade shrinks, whereas it had expanded in Africa I. The government budget is negatively affected as export tax and import tariff revenues fall. (In Asia, the cost of food subsidies also rise with higher food prices.) Government therefore needs to sharply reduce expenditures, leading to a cut in public investment (-2.5% and -5.5%) that compromises long-term growth.

The higher elasticity of food crop supply response in Asia (0.35, see table 4) than in Africa (0.2) allows Asia to increase food production (2.9% as opposed to 1.6% in

Africa II) and hence incur a lesser fall in GDP (-0.8% versus -1.0%) and in absorption (-1.0% versus -1.4%). Of all three countries, it is thus the Africa II countries that bear the highest macroeconomic effect. This is because price transmission in cereals carries through to the domestic food sector, but with little positive effect on production due to low supply response, while exchange rate revaluation hurts the production of agroexports.

The social effects of rising world prices are also quite different in the Asian and the Africa II contexts. As food crop prices rise much more than the price of agroexports falls, large farmers' real incomes increase sharply in Asia because they have a large marketed food surplus. Small farmers and landless lose since they are net buyers of food at the higher price. In Africa II, by contrast, the large share of agroexport crops in total agricultural production, for which prices fall, and the relatively low increase in food prices induce a fall in the real incomes of all farmers. Medium farmers are the worst hit as they are both net food buyers and significant producers of agroexports. Rising food prices have a heavy negative real income effect on the rural and urban poor in both Asia and Africa II. The urban rich are largely sheltered from rising food prices because their food budget share is low, but they are negatively affected by the reduction in direct and indirect employment linked to falling government expenditures. In Asia the social impact is thus highly regressive, with the poorest rural and urban dwellers losing most while the large and medium farmers gain. In Africa, all classes lose, but the impact is more equally distributed due to smaller differences in income structure.

Long-Run Effects

We saw the sharp contrast across regions in the impact of rising world prices on government budgets: In Africa I, increased tax revenues allow the government to raise current expenditures and maintain public investment, while in Africa II and Asia, the government has to sharply reduce both current expenditures and public investment. With losses in capital accumulation and the associated productivity gains, the implication is

that Africa II and Asia will experience further long-run negative consequences through budget adjustment. We analyze, in table 5, the case of Asia where this is most pronounced.

The sharp cut in public expenditures permits private investment to rise both because of lower government competition for private savings and because the price of industrial goods falls (-2.2%) due to exchange rate revaluation. The long-run effect is, however, disastrous on growth: In spite of the modest protection of private investment achieved in the short run, the fall in public and private investment leads to a long-run fall in GDP (-1.5%). Absorption falls correspondingly and real incomes of every social class worsen over time. Similar effects would result for Africa II. For these countries, the long-run problem created by OECD trade liberalization is thus one of falling economic growth associated with falling government revenues and rising prices of investment goods. This shows that, unless loans are made available to allow governments to protect public investment programs, there will be serious growth problems in regions with competitive cereals imports.

Compensatory Policies for the Poor

We have seen that rising world prices of cereals and animal products have a high welfare cost on the rural and urban poor. LDCs have, for this reason, exercised pressure in GATT negotiations to obtain compensations for their poor through income transfers or food aid. We explore, in table 6, three approaches to compensation—domestic food subsidies, domestic income transfers to the poor, and targeted international food aid—paying particular attention to the general equilibrium effects of each approach and to the distribution of benefits and costs which it implies.

When food subsidies are introduced to maintain the consumer price of food constant at the preliberalization level, we see that macroeconomic effects are enormously costly and the strategy fails to shelter the urban poor due to the loss in growth which it

implies. Africa II countries fare the worst. Introducing a price wedge implies an increase in cereal imports, a sharp decrease in other government expenditures, and a fall in GDP. Macroeconomic effects are strongly negative and urban populations consequently lose, including the poor. The worst effect is in Africa II since this is where subsidies are most costly; food prices had risen sharply due to a combination of strong price transmission and low elasticity of supply response. The producer price of food rises as the demand for food increases, particularly in Africa where supply response is more inelastic. As a result, all social groups in the rural sector gain, particularly small farmers in Africa and large farmers in Asia because they are, respectively, the main food producers. Food subsidies are progressive on the distribution of rural income in Africa and regressive in Asia, where landlessness is pervasive. Food subsidies are, however, an inadequate response to the hardships of rising world prices because of their costs on growth and urban welfare. Targeted compensatory schemes would be a less costly alternative.

Two targeted schemes can be considered. In both cases, the objective is to maintain the real income of the rural and urban poor relative to the overall CPI (which explains why there are small changes in their real incomes relative to class-specific CPIs in table 6). In the first case, income transfers are financed by reallocating government expenditures. In the second, transfers occur under the form of international food aid.

Compared to global food subsidies, targeted income transfers sharply reduce macroeconomic and public expenditure costs of sheltering the poor. However, the scheme has two major inconveniences. One is that, while the short-run GDP cost is modest, sharply reduced public investment has a high cost on long-run growth. The scheme adds to that already implied by rising world prices a decline in GDP of 2.9% in Africa I and 5.3% and 6.9% in Africa II and Asia, respectively (data in parentheses in table 6). This implies that the cost will be very high and will rise for all nonsubsidized classes. The other inconvenience is precisely that this high cost on the nonpoor makes the political feasibility of such income transfers highly unlikely, requiring us to look for food aid as an alternative.

If targeted international food aid is used, the negative macroeconomic consequences are largely removed and the welfare of the poor is effectively protected. Compared to the situation without food aid, lower commercial cereal imports allow reduction in the government deficit, increases in public investment, and GDP growth in all regions. As with all food aid programs, producer food crop prices fall and large farmers are hurt, particularly in Asia where producer prices fall the most and where large farmers have a high marketed food crop surplus. While targeted food aid is important as a short-run instrument to palliate negative welfare effects of rising food prices, it is not a substitute for a long-run strategy of agricultural development.

The magnitude of the food aid program required to achieve protection for the poor is important in terms of the share of these countries' commercial imports but is modest in volume. It is equal to 8.3% of the preliberalization level of cereal imports in Africa I, 16.3% in Africa II, and 54.6% in Asia. For the three groups of countries together, the total food aid package required is 35.2% of their preliberalization imports or 3,770 thousand metric tons. The decline in commercial cereal imports is 59.5% of their preliberalization imports (tables 5 and 6) or 6,361 thousand tons, and the net decline after aid is 24.2% of their preliberalization imports or 2,592 thousand tons. Clearly, the more rapidly domestic agroexport (Africa I) and food crop (Africa II and Asia) supply can be made to respond, the shorter is the time that food aid will be necessary and therefore the program for international donors will be cheaper.

Policy Implications

If OECD trade liberalization leads, as expected, to an increase in world prices of cereal and animal products, the effects on low income countries will sharply differ between those where cereal imports are noncompetitive with domestic food crop production (Africa I) and those where imports are competitive (Africa II and Asia). We have seen that, in Africa I, rising world prices have little impact on domestic food crops prices but result in a sharp

increase in the cereal import bill, in exchange rate depreciation, and in rising cash crop prices. In Africa II and Asia, rising world prices transmit directly into higher domestic food crop prices, while a falling cereal import bill brings exchange rate appreciation and a consequent fall in agroexports price. Implications for resource reallocation follow directly from these opposite price movements, with resources flowing toward cash crops in Africa I and toward food crops in Africa II and Asia.

The policy implications are, for the Africa II and Asian countries, to enhance the response to rising cereal prices by improving the elasticity of supply response and seeking productivity gains in food production. This calls upon greater investment in food production and promotion of new technological packages, particularly in Africa II where the Green Revolution has not yet made significant headway. These countries will reduce their exposure to trade and attempt to become as efficient as possible in import substitution. Welfare effects of this strategy on the poor will result from reducing the prices of foods they consume.

In Africa I countries, by contrast, policy implications are the reverse. To capitalize on exchange rate devaluation induced by a rising cereal import bill, Africa I should specialize further in the production of what they do best and trade for the rest. Provided that tropical goods markets do not deteriorate as more countries follow this strategy, and within the limits of food security objectives, these poor African countries should concentrate on producing agroexports and importing cereal consumption needs to complement their own food crops sectors. For equity purposes, rural development projects need to be organized to assist small farmers participating in agroexport crop production, an orientation different from traditional rural development efforts that tend to focus on the production of staple foods.

In the long run, falling government revenues in Africa II and Asian countries, where agricultural trade shrinks, implies an inability to maintain the level of public investment in the absence of fiscal reforms, thus compromising long-run growth. This

calls upon the availability of international loans for investment in food production or in other nonagricultural sources of growth. In the current context of tight international financial markets, OECD countries will need to organize a special program of structural adjustment loans for investment in food crops in the countries where trade revenues are being lost.

Short-run compensatory food aid should also complement OECD trade liberalization. With proper targeting, food aid would shelter the poor from the effects of rising world cereal prices until production strategies in agroexports in Africa I and food crops in Africa II and Asia have been put into effect. For OECD countries, the compensation scheme would be far cheaper than the current strategy of subsidizing all importers through lower world prices caused by agricultural protectionism. Further, for OECD countries the scheme would absorb only a small fraction of net social gains from trade liberalization. Anderson and Tyers, for instance, estimate such gains to be of the order of 50 billion U. S. dollars. At a world cereal price of $200 per metric ton, food aid cost to compensate the poor in the three country groups we have studied would represent only one and a half percent of this gain, a clearly affordable cost to shelter the poor from the negative effects of OECD liberalization.

Footnotes

*Elisabeth Sadoulet is lecturer and assistant research economist and Alain de Janvry is professor of agricultural and resource economics both at the University of California, Berkeley. Research funded by the Economic Research Service, USDA, in support of the GATT trade negotiations. We are indebted to Kelley White, Matthew Shane, Lon Cesal, Barry Krissoff, Alex McCalla, and John Mellor for helpful suggestions.

[1]For animal products, as we shall see below, transmission is not important because there are no imports in Africa and a very low share of imports in total consumption in Asia.

[2]A complete description of the model and of the calibration procedures can be found in Sadoulet and de Janvry (1991), which is available from the authors upon request.

[3]Sensitivity analysis on this elasticity (from 0.5 to 1.2) show that, despite the very large share of industrial imports in total imports, the results obtained are not sensitive to the elasticity (Sadoulet and de Janvry, 1991). This is mainly because we do not consider direct changes in prices of the commodities, and the only change in the relative price of imported and domestic industrial goods comes from the exchange rate.

[4]Sensitivity analysis confirmed that the results are not qualitatively affected by specific choices of these values within an acceptable range, that is, for an elasticity in the range of 0.4-0.8 for Africa I, 2-5 for Africa II, and above 5 for Asia (see Sadoulet and de Janvry, 1991).

References

Anderson, K., and R. Tyers. "How Developing Countries Could Gain from Agricultural Trade Liberalization in the Uruguay Round," in *Agricultural Trade Liberalization: Implications for Developing Countries*, I. Goldin and O. Knudsen, eds. Paris: Organisation for Economic Co-operation and Development and The World Bank, 1990.

de Melo, Jaime, and S. Robinson, "Trade Adjustment Policies and Income Distribution in Three Archetype Developing Countries," *Journal of Development Economics*, Vol. 10, No. 1, 1982, pp. 67-92.

Goldin, I., and O. Knudsen, eds. *Agricultural Trade Liberalization: Implications for Developing Countries*, Paris: Organisation for Economic Co-operation and Development and The World Bank, 1990.

Loo, T., and E. Tower. "Agricultural Liberalization, Welfare, Revenue and Nutrition in the Developing Countries," in *Agricultural Trade Liberalization: Implications for Developing Countries*, I. Goldin and O. Knudsen, eds. Paris: Organisation for Economic Co-operation and Development and The World Bank, 1990.

Maunder, A. and A. Valdés, eds., *Agriculture and Governments in an Interdependent World*, Dartmouth: Gower House for the International Association of Agricultural Economists, 1989.

Pyatt, G., and A. Roe. *Social Accounting for Development Planning with Special Reference to Sri Lanka*, Cambridge: Cambridge University Press, 1977.

Quizon, J., and H. Binswanger. "Modeling the Impact of Agricultural Growth and Government Policy on Income Distribution in India." *The World Bank Economic Review*, 1(1986):103-48.

Republic of Kenya, *Social Accounting Matrix 1976 (Revised)*, Central Bureau of Statistics, Ministry of Economic Planning and Development, 1983.

Sadoulet, E., and A. de Janvry, Appendix to "Implications of OECD Agricultural Trade Liberalization for the Low Income Countries: A General Equilibrium-Multimarket Approach," Working Paper No. 614, Department of Agricultural and Resource Economics, University of California, Berkeley, 1991.

Sullivan, J., J. Wainio, and V. Roningen, *A Data Base for Trade Liberalization Studies*, Economic Research Service, USDA, Washington D.C., March 1989.

U. S. Department of Agriculture. "World Indices of Agricultural and Food Production, 1977-86." Statistical Bulletin Number 759, USDA, ERS, 1988.

Table 1. Characteristics of Country Groups

(data in % unless otherwise indicated)

Indicators	Africa I*	Africa II*	Asia*
General indicators			
Population (million, mid-1985)	82	124	271
GNP/capita (dollars, 1985)	276	221	339
Share in developing countries cereal imports (1985-86)	3	3	8
Structure of production (% of 1985 GDP)			
Agriculture	34	45	31
Industry	18	15	27
Services	48	39	42
Structure of demand (% of 1985 GDP)			
Private consumption	86	80	82
Gross domestic investment	11	14	17
Government consumption	13	15	9
Exports	15	16	16
Resource balance	-11	-9	-6
Structure of trade (% of 1985 merchandise exports)			
Agricultural commodities	66	65	40
Fuels, minerals, and metals	25	26	12
Manufacture	9	10	48
Trade taxes (in % of 1985 government revenues)	39	24	26
Characteristics of cereals supply			
Food in total imports (1985)	18	15	14
Index of competitiveness**	10	45	94
Net cereal imports/domestic supply (1985-86)	21	10	8
Net cereal imports/domestic food production	13	8	8
Cereals in dietary energy supply (1979-81)	47	48	70

* Africa I: non-competitive cereals imports.
Africa II: competitive cereals imports.
Asia: excluding India and China.

** Share of wheat, rice, and corn in food crops production.

Sources: World Bank, World Development Report, 1987; FAO, Trade Yearbook, 1986; FAO, Production Yearbook, 1986; FAO, Food Balance Sheets, 1979-81; USDA-ERS, World Indices of Agricultural and Food Production, 1977-86.

Table 2. Social Accounting Matrix for an Archetype Poor African Economy

	Activities							Labor		Households											Rest	
	Agric. exports	Food crops	Other agric.	Agric. proc.	Industry	Constr. services	Admnstr.	unskilled	skilled	Urban poor	Urban rich	Small farmers	Medium farmers	Large farmers	Firms	Govt.	Trade margins	Private invt.	Public invt.	Export taxes	of world	TOTAL
Agric. exports	1.7			.7	1.1															2.8	26.6	32.9
Food crops		2.3	3.0	14.4						1.9	.7	8.4	17.2	5.5								53.3
Other agric.										4.4	.9	5.0	11.4	5.2				4.6				31.5
Agric. process			1.2	3.0	2.9	5.4	2.1			14.0	4.1	4.5	10.7	6.9							3.9	58.9
Industry	2.6	3.4		7.0	14.9	20.7	1.4			9.7	8.9	3.5	12.1	11.2				12.3	3.0		9.3	120.2
Constr. services				5.1	8.6	13.6	4.1			16.6	10.3	1.9	5.0	7.6			30.9	7.3	6.5			117.6
Administration																37.0						37.0
Labor-unskilled	4.2	3.7		3.2	3.8	10.5																25.4
Labor-skilled	1.1			5.3	7.0	35.8																49.2
Hh-urban poor							15.4	9.2	22.1						9.3	1.0					.3	57.4
Hh-urban rich							13.9		7.4						15.4						.4	37.1
Hh-small farmers		8.1	8.0					4.0	1.7	2.7												24.5
Hh-med. farmers	8.4	15.6	17.4					6.4	4.7	5.1	2.2											59.8
Hh-large farmers	9.9	9.7						5.8	13.3	1.8	1.6					.5					.6	43.3
Firms				5.5	9.4	17.3										2.1						34.3
Govt. subsidies																						
Indirect taxes				6.4	8.0	2.7					2.1			1.7	2.8						4.4	40.7
Import tariffs				.7	9.2																	9.9
Export taxes	2.8																					2.8
Trade margins	2.3	3.0	1.9	5.5	16.8	1.4																30.9
Private savings										1.0	1.8	1.0	3.5	5.1	5.6				-.1		6.2	24.2
Public savings																-.5					9.9	9.4
Rest of world		7.4		2.0	38.5	10.1					4.6				1.2	.6						64.4
TOTAL	32.9	53.3	31.5	58.9	120.2	117.6	37.0	25.4	49.2	57.4	37.1	24.5	59.8	43.3	34.3	40.7	30.9	24.2	9.4	2.8	61.6	

Table 3. Social Accounting Matrix for an Archetype Poor Asian Economy

	Activities							Labor		Households												
	Agric. exports	Food crops	Other agric.	Agric. proc.	Industry	Constr. services	Admnstr.	Urban	Rural	Urban poor	Urban rich	Rural landless	Medium farmers	Large farmers	Firms	Govt.	Trade margins	Private invt.	Public invt.	Export taxes	Rest of world	TOTAL
Agric. exports				.6						1.7	.5	4.0	4.3	1.0						4.1	18.2	34.5
Food crops		2.7		4.5						4.3	1.3	10.3	13.1	2.0								38.2
Other agric.			3.3	2.4	5.6	1.2	.6			9.3	4.7	14.2	19.1	4.9								65.3
Agric. process			3.1	1.1	5.9	1.0	.8			8.2	3.5	12.5	17.9	4.1							7.0	65.1
Industry	4.1	4.4	2.7	3.1	22.8	16.5	2.0			12.9	13.9	12.7	25.7	11.3				22.3	3.3		25.4	182.9
Constr. services	1.5			2.1	3.7	3.2	3.3			9.7	8.2	8.7	19.4	6.6			49.9	19.9	12.5			148.7
Administration																31.2						31.2
Labor-urban			2.6	7.6	11.6	14.2																35.9
Labor-rural	11.9	22.2	11.3	8.6	15.0	17.3																86.3
Hh-urban poor							3.6	35.9							8.7	1.7						49.9
Hh-urban rich							6.9								32.7	.9						40.4
Hh-rural landless			3.5				1.4		37.7						19.1	2.0						63.7
Hh-med. farmers		3.7	21.0				3.8		45.4						34.4	1.9						110.2
Hh-large farmers	8.7	6.9	7.9				8.7		3.2							.4						35.8
Firms				15.7	30.3	66.9										5.4						118.3
Govt. subsidies		-8.5														8.5						
Indirect taxes				7.6	9.5	4.8				2.0	3.3		2.8	2.2	6.1							52.6
Import tariffs				.8	9.2																	10.1
Export taxes	4.1																					4.1
Trade margins	4.1	3.7	6.6	6.1	21.1	8.3																49.9
Private savings										1.8	5.0	1.2	7.9	3.6	14.7				7.9			42.2
Public savings																-1.4					25.2	23.8
Rest of world		3.1	3.4	5.1	48.1	15.3									2.6	2.3						79.9
TOTAL	34.5	38.2	65.3	65.1	182.9	148.7	31.2	35.9	86.3	49.9	40.4	63.7	110.2	35.8	118.3	52.6	49.9	42.2	23.8	4.1	75.8	

Table 4. Multimarket Elasticities of Output Supply and Factor Demand for Agriculture

	Agroexports	Food crops	Other agriculture	Unskilled rural labor	Skilled urban labor
Poor African archetype					
Agroexports	0.45	-0.23	-0.17	-0.04	0.00
Food crops	-0.15	0.20	-0.03	-0.02	0.00
Other agriculture	-0.16	-0.04	0.20	0.00	0.00
Unskilled labor	0.16	0.12	0.00	-0.30	0.02
Skilled labor	0.01	0.04	0.00	0.15	-0.20
Poor Asian archetype					
Agroexports	0.45	-0.11	-0.07	-0.27	0.00
Food crops	-0.08	0.35	-0.19	-0.08	0.00
Other agriculture	-0.04	-0.14	0.40	-0.22	-0.01
Rural labor	0.17	0.07	0.26	-0.50	0.01
Urban labor	0.02	0.02	0.18	0.17	-0.40

Table 5. Impact of a 20% Increase in the Prices of Cereals and Animal Products on the Poor African and Asian Countries
(Percent changes over base values)

	Short-run effects			Long-run effects
	Africa I	Africa II	Asia	Asia
Macroeconomy				
GDP at market prices	-0.3	-1.0	-0.8	-1.5
Absorption	-0.8	-1.4	-1.0	-1.6
International trade				
Nominal exchange rate	0.7	-2.4	-4.8	-4.9
Agricultural exports	0.6	-2.1	-3.9	-4.5
Cereal imports	-10.7	-24.9	-76.7	-76.9
Producer prices				
Agricultural terms of trade	-0.4	2.0	5.3	5.0
Price of agricultural exports	0.7	-2.4	-3.5	-3.4
Price of food crops	0.1	5.9	8.8	8.6
Price of other agriculture	-1.6	-1.9	2.1	1.9
Agricultural production				
Total agriculture	0.0	0.0	0.2	-0.3
Agricultural exports	0.6	-2.0	-2.3	-2.7
Food crops	0.0	1.6	2.9	2.3
Other agriculture	-0.4	-0.2	0.1	-0.5
Government budget				
Export taxes	1.4	-4.5	-8.4	-9.2
Food subsidies			5.7	4.9
Tariff revenues	0.0	-2.8	-3.6	-4.3
Current expenditures	0.2	-2.4	-5.2	-6.2
Investment				
Public investment	0.0	-2.7	-5.5	-6.6
Private investment	-0.2	0.8	1.6	1.0
Real incomes				
Landless and small farmers	-2.0	-0.9	-2.5	-3.0
Medium farmers	-1.5	-1.6	0.1	-0.5
Large farmers	-0.4	-0.5	5.2	4.3
Urban poor	-0.7	-2.0	-2.6	-3.1
Urban rich	-0.7	-1.7	-2.0	-2.6
Consumption				
Food consumption	-2.3	-3.2	-3.7	-4.3
Consumer price of food	3.0	7.3	9.0	8.8

Table 6. Compensatory Policies: Food Subsidies, Income Transfers, and International Food Aid
(in deviation from the effects in Table 5)

	Food subsidies			Targeted income transfers			Targeted food aid		
	Africa I	Africa II	Asia	Africa I	Africa II	Asia	Africa I	Africa II	Asia
Macroeconomy									
GDP at market prices	-2.4	-3.7	-1.2	-0.7	-0.3	-0.7	0.5	0.7	0.8
(Long run GDP)				(-2.9)	(-5.3)	(-6.9)	(+0.2)	(-1.1)	(-.3)
Absorption	-2.3	-3.5	-1.2	-0.7	-0.3	-0.7	0.4	0.7	0.8
International trade									
Nominal exchange rate	-0.5	0.8	0.6	-0.3	1.5	0.1	0.1	1.4	-0.2
Agricultural exports	-1.8	-1.6	-0.1	-0.4	1.2	-0.1	0.1	1.2	0.1
Cereal imports	4.7	16.0	24.0	0.7	8.5	5.4	-1.0	-9.1	-13.9
Producer prices									
Agricultural terms of trade	4.8	7.2	2.6	0.8	-0.7	1.1	-0.4	-0.8	-1.5
Price of agricultural exports	-0.4	0.9	0.6	-0.2	1.5	0.1	0.1	1.4	-0.2
Price of food crops	6.2	7.6	3.3	0.7	-2.8	0.8	-1.3	-2.8	-3.4
Price of other agriculture	1.6	2.9	0.5	0.8	1.0	0.8	0.9	1.1	0.7
Agricultural production									
Total agriculture	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Agricultural exports	-1.8	-1.7	0.0	-0.4	1.1	-0.1	0.1	1.0	0.1
Food crops	1.3	1.2	0.9	0.2	-0.8	0.1	-0.3	-0.8	-1.2
Other agriculture	0.2	0.2	-0.2	0.2	0.0	0.2	0.2	0.1	0.6
Government budget									
Export taxes	-2.3	-0.8	0.5	-0.6	2.7	0.0	0.2	2.6	-0.1
Food subsidies	0.0	0.0	6.0	0.0	0.0	1.4	0.0	0.0	-5.6
Tariff revenues	-2.2	-2.3	-0.2	-0.6	1.1	-0.2	0.4	1.4	0.3
Current expenditures	-11.6	-18.4	-11.2	-4.4	-3.2	-7.4	0.3	1.3	1.4
Investment									
Public investment	-11.1	-17.8	-11.3	-4.2	-3.0	-7.5	0.4	1.5	1.3
Private investment	-0.6	-1.6	-0.3	-0.1	-0.7	-0.1	0.0	-0.6	0.1
Real incomes									
Landless and small farmers	4.2	6.6	0.9	1.4	-0.1	1.5	1.8	-0.1	1.8
Medium farmers	3.0	5.3	1.2	0.1	0.3	-0.3	0.3	0.4	0.4
Large farmers	1.1	1.9	1.9	-0.3	-0.2	-0.9	-0.1	-0.2	-2.7
Urban poor	-4.1	-6.4	-0.5	1.1	2.7	2.8	0.9	2.6	2.7
Urban rich	-5.2	-8.5	-2.4	-1.9	-1.3	-1.9	0.4	0.2	0.8
Consumption									
Food consumption	3.2	6.0	3.1	0.4	0.9	0.6	1.0	1.0	2.2
Consumer price of food crops	-3.0	-7.3	-9.0	0.6	-2.1	0.8	-1.1	-2.2	-3.4
Cost of subsidies	25.6	43.6	167.7	10.4	11.4	120.3	3.8	7.7	57.4

Food subsidies are designed to hold constant the consumer price of food crops at the pre-liberalization level.
Income transfers and food aid are targeted to the rural landless and small farmers and to the urban poor in order to maintain their real incomes constant relative to the overall CPI.