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INTERNATIONAL INTERACTIONS IN FOOD AND AGRICULTURAL POLICIES: THE EFFECT OF ALTERNATIVE POLICIES

by

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Changing Comparative Advantage in Food and Agriculture

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SUMMARY

This paper presents a model of longer term interactions in the international markets for cereals, soybeans and meat, and draws policy conclusions for developing countries. The model is comparative static in nature and, largely, partial equilibrium, incorporating constant elasticity demand and supply functions. It is an extension of earlier similar models: commodity interdependence is modelled explicitly and long-run effects, of productivity growth on domestic production and of income growth on demand, are incorporated. Moreover, demand for feed, as derived from livestock production, is separated from food demand.

The focus is on policy analysis and on developing countries. The results are somewhat surprising. First, real prices of wheat and coarse grains would continue to fall under liberalisation assumptions. Second, developing countries' agricultural policies emerge as more important (in relation to OECD countries' policies) than expected, and as relatively uncertain.

RESUME

Ce document présente un modèle d'interactions à moyen terme des marchés internationaux des céréales, du soja et de la viande et établit des conclusions sur le plan de l'action à suivre pour les pays en développement. C'est un modèle de statique comparative et, pour l'essentiel, d'équilibre partiel comprenant des fonctions de demande et d'offre à élasticités constantes. C'est un développement de modèles similaires antérieurs : l'interdépendance des produits de base est modélisée explicitement et les effets à long terme de la croissance de la productivité sur la production intérieure ainsi que ceux de la croissance du revenu sur la demande sont pris en compte. De plus, la demande pour l'alimentation destinée au bétail telle qu'elle est dérivée de la production du bétail, est séparée de la demande pour l'alimentation humaine.

L'accent est mis sur l'analyse des grandes orientations et sur les pays en développement. Les résultats sont plutôt surprenants. Tout d'abord, les prix réels du blé et des céréales secondaires continueraient à chuter dans le cadre d'hypothèses de libéralisation. Deuxièmement, les politiques agricoles des pays en développement apparaissent comme encore plus importantes que prévues (par rapport aux politiques suivies dans ce domaine par les pays membres de l'OCDE) et comme relativement incertaines.

PREFACE

The Development Centre initiated research in 1987 on "Changing Comparative Advantage in Food and Agriculture" under the responsibility of Martin Brown. The programme has brought together shorter term issues about global markets, including surpluses and policy-distorted prices, with longer term issues, including trends in new technologies and the food system, and the prevalence of hunger in low income countries.

One of the sets of issues on everyone's agenda concerns the effects on global markets of food and agricultural policies in both OECD and developing countries, and of likely policy changes. Agricultural policy reform is perhaps the most difficult issue in the current Uruguay Round of trade negotiations in the GATT. Several attempts have been made to model the economic consequences of agricultural reform -- not least by OECD's own Secretariat in its MTM model.

However, most of the research so far has focussed primarily on OECD countries' policies, since OECD trade has been dominant in most global food markets. Moreover, most analysis so far has been relatively "static" and "partial", in that it examines what would be the effects of policy changes in relation to a base year situation but ignoring some of the economy-wide effects and the effects of underlying changes during the adjustment period.

The analysis below moves the discussion forward. Developing countries' policies receive considerable attention and, indeed, their policy changes are found -- surprisingly -- to be more important in some respects than OECD policy changes. Moreover, while the model presented is still one of partial equilibrium, it is important that income effects are endogenously represented for most developing countries. And, very importantly, the analysis incorporates assumptions about underlying growth in incomes and productivity so that the results are presented in terms of the effects of policy changes in the Year 2000. Consequently, some of the results are surprising and counter-intuitive. While the actual numbers generated by the model are only illustrative, their relative magnitudes and the direction of changes implied should be of considerable relevance to current policy discussions.

Louis Emmerij

President of the OECD Development Centre

April 1989

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PURPOSE AND SCOPE OF STUDY

The purpose of this study is to identify how long-run changes in agricultural productivity and overall income growth as well as alternative economic policies by developing countries (LDCs) and industrialized countries (ICs) will impact on agricultural production, consumption, and trade flows of both groups of countries.

Compared with the OECD-MTM modeling effort, the focus of this study is not restricted primarily to the effects of OECD agricultural policies on other OECD-countries. The emphasis is rather on the ramifications that changes in OECD agricultural policy may have on LDCs. Equally important for this study is the question of how changes in economic policy and, in particular, in agricultural policy, in LDCs would affect, through their impact on world prices, both developing countries themselves and industrialized countries.

Similar to the OECD-MTM modeling effort, the current study employs a multi-country multi-commodity model, where commodity interdependencies enter via cross price elasticities. In contrast to the OECD-MTM model, however, the present study is long-run in focus in the sense that productivity and per capita income growth are modeled explicitly. Furthermore, the study provides considerably more detail for developing countries.

The study is organized as follows. The next chapter provides a descriptive overview of the formal world trade model that is used to investigate the following three questions: (a) how can the world market for key food products be expected to evolve in the long run if current economic policies continue in industrialized and developing countries? (b) how will trade liberalization and hence lower output levels for agricultural products in OECD countries affect world markets and hence LDCs? (c) what is the likely effect on world markets, OECD-countries, and LDCs of alternative development strategies in developing countries, in particular a move toward a more export-oriented policy in agriculture? The presentation of the formal model is followed by a detailed description of the data, their sources and transformations. The model simulation results are presented in the following chapter along with an interpretation in terms

DESCRIPTION OF THE MODEL

The analysis is based on a nonspatial price equilibrium model of the world grain, soybean, and meat markets. The model is comparative static in nature and, largely, partial equilibrium. The model is built around constant elasticity demand and supply functions rather than explicit utility and production frontiers. All demand and supply relationships are modeled in terms of percentage changes from a base period. In that sense, the model is in the Johansen (1960) tradition of model building.

The model can handle n commodities and m countries simultaneously. Commodity interdependence is introduced through the use of cross-price elasticities of demand and supply. Long-run trend factors enter the model via income and population effects on the demand side and productivity growth on the supply side. Some rudimentary general equilibrium effects are incorporated for LDCs. In particular, to take into account the importance of the agricultural sector for many LDCs, the overall growth rate of income as measured by gross domestic product (GDP) is modeled as a function of model endogenous changes in agricultural growth in most agriculture-based developing countries.

The model is an extension of Valdes and Zietz (1980) and Zietz and Valdes (1986) in that commodity interdependence is modeled explicitly and long-run effects of productivity growth on domestic production and of income growth on demand are incorporated. The model is close in spirit to Tyers and Anderson (forthcoming) and also of Roningen et al. (1988). It goes beyond these models in that the demand for feed as derived from livestock production is separated from food demand. In the latter sense the model resembles the OECD's (1987) MTM model. The current study goes beyond the above studies as well as the modeling effort by IIASA (Parikh et al. 1988) in that the latest available information on the price incentives facing farmers in developing countries is incorporated in a PSE-like measure.

1. Some Preliminaries

All absolute or percentage changes are defined over the model's time horizon (T). As the percentage changes to be handled by the model are potentially large, model equations based on logarithmic differentiation are inappropriate because of the inherent approximation errors. Rather than using a stepwise solution procedure, where the data are updated between each pair of steps as suggested in Dixon (1982),[1] the percentage changes are simply calculated

[1]Valdes and Zietz (1980), for example, used a two-step procedure for their calculations. It is not clear to what extent the approximation problem is taken into account in the work of Tyers and Anderson (forthcoming) or Roningen et al. (1988).

using the discrete changes formula which generates exact results for arbitrarily large changes.[2] Hence, for a Cobb-Douglas function such as

$$c = A\, p^n\, q^x,$$

the percentage change in c (dc/c) is calculated as

$$dc/c = (1 + dp/p)^n\, (1 + dq/q)^x - 1.$$

rather than by the common approximation formula

$$dc/c = n\, dp/p + x\, dq/q.$$

All model equations depend, either directly or indirectly, on the percentage world price changes of the n commodities that are considered. Hence, there are only n independent equations. As the model is highly nonlinear due to the use of the exact changes formula, it cannot solved by simple matrix routines. Hence, the choice of solution algorithms reduces to one of following three types: fixed-point methods, techniques that make use of the derivatives of the excess demand function, and simple tatonnement processes, where the prices are adjusted in response to excess demand. The latter method is implemented in this paper: the model is solved by Gauss-Seidel for a vector of n world price changes.

The model is comparative static in nature, yet it is used for a forecast exercise. As the model ignores the complexities of the adjustment path to the new equilibrium, it assumes that all long-run changes occur simultaneously at the base period. All exogenous changes are translated into excess demands at the base period and the model is projecting the price adjustment needed to eliminate these excess demands. In reality obviously, growth cannot be regarded as imposed in a single year. It is a complex evolutionary process. However, it can be shown that a comparative static model very closely approximates the results to be obtained from a sequence model with explicit time and permanent market clearing, as long as one assumes that all growth rates are constant over the model's time horizon and not excessively large.[3]

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[2]This method is also used in Zietz and Valdes (1986). For large changes, use of the discrete changes formula clearly makes a difference for the results. Ignoring the problem of large changes can easily lead to odd results. Although changing model parameters can eliminate these results in most cases, it is unlikely to be a satisfactory approach.

[3]As an empirical matter, the size of the growth rates and the time horizon used in this model provide for very good approximations to what one can expect from an explicit sequence model.

2. Production

The absolute change in domestic production of crop i in country k (dq_{ik}) is derived as

$$dq_{ik} = q0_{ik} \left[\Pi_j \; (1+php_{jk})^{sijk} \; (1+qh_{ik}) \; - 1 \right] \qquad i=1,...,n, \; k=1,...,m \; \text{(except beef)}$$

where

dq_{ik} = absolute change of production of commodity i in country k
$q0_{ik}$ = base period production of commodity i
php_{jk} = percentage change in producer price of commodity j
sijk = cross-price elasticity of production between commodities i and j
qh_{ik} = "price-constant" percentage change of production of commodity i.

The value for the price-constant percentage change of production of commodity i is derived from the average annual exogenous growth rate of production yields (rq_{ik}) as

$$qh_{ik} = \exp(rq_{ik} \; T) - 1 \qquad i=1,...,n, \; k=1,...,m.$$

Price changes for commodities that are used as feed clearly affect the profitability of beef production. Hence, beef production is made a function of the percentage change in feed cost. As the relative price of alternative feeds changes, profit maximizing beef producers will shift their feed consumption, as far as substitution possibilities exist, toward the relatively inexpensive feed products. For all countries, the feedback from feed prices to beef production is incorporated through a feed-cost term that is added to the above determining equation for production for i=beef. As a result, the absolute change in beef production is given as

$$dq_{ik} = q0_{ik} \left[\Pi_j \; (1+php_{jk})^{sijk} \; (1+qh_{ik}) \; (1+phfc_k)^{efck} \; - 1 \right] \qquad i=\text{beef}, \; k=i,...,m$$

where phfc represents the percentage change in feed cost given cost minimization behavior of beef producers and where efc is the elasticity of beef production with respect to feed cost. The value of qh_{ik} for beef is derived from the predicted change in livestock production for each country k. Details of the derivation are given in the data section.

The percentage change in feed cost (phfc) is calculated as

$$phfc_k = \left[\Sigma_i \; p0c_{ik} \; (1+phc_{ik}) \; f0_{ik} \; \Pi_j \; (1+phc_{jk})^{efbijk} \; / \; \Sigma_i \; p0c_{ik} \; f0_{ik} \right] - 1, \qquad k=1,...,m$$

where

$p0c_{ik}$ = price of feed i to beef producers of country k in base period
phc_{ik} = percentage change in consumer price of feed commodity i
efbijk = cross price elasticity of demand, in beef production, between feed i and j, country k.

The base year price of feed i to beef producers in country k ($p0c_{ik}$) is derived as

$$p0c_{ik} = pw0_i \; (1 + cse0_{ik}), \qquad i=1,...,n; \; k=1,...,m$$

where $pw0_i$ is the base year world price of commodity i and $cse0_{ik}$ stands for the base year consumer subsidy equivalent for commodity i in country k.

3. Domestic Utilization

Domestic utilization of commodity i,j (i,j=1,...,n) in country k (k=1,...,m) consists of food consumption, feed consumption, and other uses, such as seed and waste.

Food Consumption

The absolute change in food consumption over the model's time horizon is determined by

$$dc_{ik} = c0_{ik} \left[\prod_j (1+phc_{jk})^{eijk} (1+nh_k) (1+ynh_k)^{eiyk} - 1 \right], \qquad i=1,...,n,\ k=1,...,m$$

where

dc_{ik} = absolute change of food consumption of commodity i in country k
$c0_{ik}$ = base period food consumption of commodity i in country k
phc_{ik} = percentage change in consumer food price of commodity i in country k
eijk = cross price elasticity of demand between product i and j, country k
nh_k = expected percentage change in population of country k
ynh_k = expected percentage change in real per capita income of country k, calculated as $(1+yh_k)/(1+nh_k) - 1$
eiyk = income elasticity of food demand for commodity i in country k.

The percentage changes identified by nh_k and yh_k are derived from the corresponding average annual percentage growth rates (rn_k and ry_k) and the models time horizon (T) as

$$nh_k = \exp(rn_k\ T) - 1 \quad \text{and} \quad yh_k = \exp(ry_k\ T) - 1 \qquad k=1,...,m,$$

where exp denotes exponents.

Feed Consumption

Feed demand is derived demand. As such it depends on the level of livestock production, the production technology utilized, and relative feed prices. Livestock production technology as well as production levels are subject to change, especially so for LDCs experiencing significant growth in per capita income such as, for example, the Republic of Korea and China (Taipeh) (Sarma 1986). Production also reacts to changing trends in consumption. Important in this respect has been the shift away from ruminant meats toward non-ruminant meats, i.e. pig and poultry. As non-ruminants are dependent on significantly larger rations of feed grain than ruminants such as cattle and mutton and lamb, a shift toward ruminants implies, ceteris paribus, an increase in feed demand.

Feed consumption, as defined in this model, consists of feed for all types of meats, i.e. for beef, which is one of the commodities explicitly incorporated in the model, and of feed for other meats that are not treated explicitly in this model (i.e. pork, poultry, mutton and lamb).[4]

The fact that none of the meats apart from beef is modeled explicitly in this study causes a potential problem because the level of meat production is decisive for feed demand. In order to avoid a serious underestimate of feed demand and hence of changes in the markets for feed grains, it appears mandatory to include meat production at least in a rudimentary form in the model. A simple yet fairly realistic way to do this is to make the percentage change in total meat production a function of the forces that determine meat demand in the long run, i.e. per capita income and population growth. Historical data, as assembled for example in Sarma and Yeung (1985), appear to support this simple approach. They show not only that meat production is highly correlated with meat consumption across countries but also that the growth rates of production and consumption are almost identical. In other words, trade plays a negligible role as a way to balance meat consumption and production for the vast majority of countries. This stylized fact is incorporated in the model in that trend meat production is made, in a direct way, a function of demand parameters. In particular, for meat importing countries, the predicted percentage change in meat production in country k over the model's time horizon ($louh_k$) is derived as

$$louh_k = [(1 + ynh_k)^{elyk} - 1] + nh_k \qquad k=1,...,m$$

where elyk is the elasticity of per capita meat production with respect to per capita income that is calculated for this purpose.[5] For the meat exporting countries or regions, i.e. Australia, New Zealand, Argentina, and the remainder of Latin America, world averages are used for ynh, ely, and nh rather than country-specific values indexed by k.

The long-run shift in consumption from ruminant meats to non-ruminant meats, mentioned above, is captured in the present model by a feeding ratio that is assumed to grow over time as the production share of non-ruminants to ruminants increases. The expected feeding ratio (frat) T years from the base period is approximated by attaching a constant growth factor to the base period ratio between total feed use of cereals (and soybeans) and the level of total meat production,

$$frat_k = (tf0_k/lou0_k) \exp(gfr_k\, T) \qquad k=1,...,m$$

where

$tf0_k$ = base period feed consumption of cereals and soybeans in country k, all livestock
$lou0_k$ = base period meat production in country k

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[4]A more complete model would also include other livestock products to determine feed demand, in particular milk and eggs. Restricting the coverage of livestock products to meats will not introduce a significant error in the present model as long as one can assume that production of meats, milk, and eggs are following a rather similar growth path.

[5]Details of the elasticity derivations are given in the data section.

gfr_k = predicted average annual percentage change of the feeding ratio in county k
T = time horizon of the model.

Given the predicted percentage change in meat production and in the feeding ratio, the change in feed consumption of commodity i in country k is given as

$$df_{ik} = [\, f0_{ik} \prod_j (1+phc_{jk})^{efijk} / tf1_k \,]\; frat_k\; lou0_k\; (1+louh_k) - f0_{ik} \qquad i=1,\dots,n,\; k=1,\dots,m$$

where

df_{ik} = absolute change in feed consumption of commodity i for all livestock
$f0_{ik}$ = base period feed consumption of commodity i, all livestock
$tf1_k$ = total feed consumption (all i) in year t+T, based on relative price changes alone, i.e.

$$tf1_k = \sum_i f0_{ik} \prod_j (1+phc_{jk})^{efijk}$$

phc_{jk} = percentage change in price of commodity j to livestock producers
efijk = cross-price elasticity of feed demand between commodities i and j,

and where all variables and parameters are indexed by country (k).

The above equation determining the change in feed demand for commodity i in country k represents a compromise solution for several reasons. First, as mentioned above, the percentage change in meat production is used as a proxy for the percentage change in livestock production. Second, feed demand is based on total meat production rather than being decomposed by individual meat product. As feed demand for cereals, soybeans, and other feeds varies considerably by meat product, a decomposition of feed by meat product would clearly be preferable. However, there are no data on feed use by meat or livestock product (Sarma 1986) for most LDCs. Third, by defining lou in terms of total meat, there is no direct link between the model's predictions of beef production and the above equation determining feed demand. Given the unavailability of feed data by meat product, however, adding this feed back from beef production to feed demand is not considered worth the added complication that it would introduce. Fourth, it has to be realized that meat production or its predicted change over time is dependent solely on the income elasticity of meat demand and population growth. The relative price of meats is assumed to remain unchanged over the model's time horizon and hence to have no effect on meat production. Finally, total meat production does not depend in any way on changes in input costs. Changes in the relative prices of feeds affect meat production only insofar as they alter the share of alternative feeds in total feed consumption. But a rise in feed costs will not lower meat production as it will beef production in the model.[6]

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[6]Clearly, most though not all of the above simplifying assumptions regarding meat production can be avoided if one extends the model to cover ruminants, non-ruminants, and dairy production, rather than restricting the commodity coverage to beef.

Other Domestic Demand Components

Other domestic uses are comprised of seed and waste. Since seed and waste are lumped together in the data that are being used, this number can be large for some commodities even if production is minimal but consumption is large. Hence, assuming a constant ratio of this composite of other uses to production does not make sense for each country and commodity. After studying the available data, the following assumptions are made.

For ICs, seed and waste are assumed to be a constant proportion of production for wheat and coarse grains and a constant proportion of food and feed consumption for rice and soybeans. Other uses of wheat and coarse grains in LDCs are defined as those for rice and soybeans for industrialized countries.[7]

More formally

$do_{ik} = dq_{ik}\ rat_{ik}$ i=wheat and coarse grains, k=ICs

$do_{ik} = (dc_{ik} + df_{ik})\ rat_{ik}$ i=rice and soy, k=1,...,m

$do_{ik} = 0$ i=beef and sugar, k=1,...,m,

where

rat_{ik} = constant ratio of seed and waste to production or food and feed consumption.

It may be added that assuming constant ratios between other uses and production or food and feed consumption poses a potential problem: price changes as well as advances in technology could very likely change these ratios, especially in the long run. In many countries, better reporting could also significantly affect these numbers.

4. Price transmission

The production decisions of farmers in country k depend on the real net price received relative to their costs of production. The real net output price received by farmers depends on the world market price, tariff and non-tariff barriers to trade, the real exchange rate, product and trade taxes, marketing costs and the rate of inflation as measured by the consumer price index. The costs of production depend, among other factors, on the prices of input factors and government subsidies.

For OECD-countries, all government interventions on the price or cost side are captured by the concept of producer subsidy equivalents (PSE) (OECD 1987). For most countries, government interventions tend to give farmers a positive subsidy equivalent. For most LDCs, PSEs and

[7]Other uses of soybeans for Argentina and Brazil are defined as other uses of wheat for developing countries.

CSEs are measuring only nominal protection rates.[8] However, in contrast to the methodology of previous studies, the PSE measure includes not only the effect on incentives of direct government interventions in agriculture but also the indirect effects resulting from import protection outside of agriculture. As reported in Krueger, Schiff, and Valdes (1988), these indirect effects that can be traced to protection of domestic industry and exchange rate overvaluation make up a very considerable part of the incentive effect of economic policy to farmers. They tend to provide farmers in many LDCs not only with a negative level of protection for exportables but also for importables.

In calculating the percentage change of prices received by producers for commodity i in country k, it is assumed that all factors other than those captured by PSE or the equivalent concept used for LDCs remain constant.[9] This applies in particular to quality factors, transportation costs, and changes in a country's underlying inflation rate. Under those assumptions, the percentage change in producer prices can be written as a function of the percentage change in world price and PSE as

$$php_{ik} = (1+pwh_i)\ (1+pse1_k)/(1+pse0_k)\ - 1 \qquad i=1,...,n,\ k=1,...,m$$

where

php_{ik} = percentage change in producer price of commodity i, country k
pwh_i = percentage change in world price of commodity i
$pse0_{ik}$ = PSE for commodity i in country k before policy change
$pse1_{ik}$ = PSE for commodity i in country k after policy change.

The percentage change in consumer prices is calculated in a way equivalent to that of producer prices. Consumer subsidy equivalents (CSEs) are used instead of PSEs.

$$phc_k = (1+pwh_i)\ (1+cse0_k)/(1+cse1_k)\ - 1 \qquad i=1,...,n,\ k=1,...,m$$

where

phc_k = percentage change in consumer price of commodity i
$cse0_k$ = CSE for commodity i before policy change
$cse1_k$ = CSE for commodity i after policy change.

Both equations above assume that domestic producer or consumer prices change in tandem with the world price for constant levels of PSE and CSE. This assumption implies full transmission of world price changes. This clearly makes little sense in a short run analysis for countries such as the EC that largely insulate the domestic market from world price changes through the use of variable import levies or similar devices. It is also questionable for many

[8]More detail on the construction of the protection measures for LDCs is provided in the data section.

[9]For simplicity of exposition, PSE is used to identify both measures in what follows.

developing countries. For instance, Krueger, Schiff, and Valdes (1988) report that, for a sample of 18 developing countries and the period 1960 to 1984, direct price policies by governments managed to reduce producer price variability by 27 percent for export goods and by 31 percent for import goods relative to the variability of world market prices.

For a long-run analysis such as this, however, the assumption of full price transmission appears more acceptable. After all, what counts for a long-run analysis is not whether a country manages to insulate domestic prices from the fluctuations of world market prices around their trend, but whether the trend of domestic prices deviates from the trend of world market prices. Full insulation of the domestic market in the long run would imply that the two trends diverge systematically. However, this appears to be quite unrealistic an assumption for most countries because it would be very costly, even for a relatively rich country group such as the EC. Hence, for a long-run analysis it seems more realistic to assume that domestic output levels and hence trade is adjusting to trend changes in world market prices and quantities traded. This has been the case in recent years for the EC's common agricultural policy, as it has been modified through a variety of restrictions on price guarantees to cope with the pressures of inflating agricultural budgets.[10] Complete transmission of world price changes can therefore be interpreted as assuming that what remains constant is not the EC's Common Agricultural Policy (CAP) or U.S.'s farm policy of 1985 but rather the process of adapting the CAP and U.S. farm policy to cope with the pressures of inflating agricultural budgets. Full price transmission, in other words, implies that the CAP and U.S. farm policy are presumed to continue to evolve in the sense that the methods of containing production growth will develop over time. The same applies to agricultural policies in developing countries.[11]

5. The Dependence of GDP Growth on Growth in Agriculture

Changes in development strategy in LDCs are likely to have a strong influence not only on the agricultural sector or, even more limited, on the specific commodity groups that are explicitly considered in this study. They are likely to have significant effects also on industrial development. Although modeling the influence of development strategy on overall growth in some detail is far beyond the scope of this study, ignoring it altogether is certain to underestimate the impact of a change in economic policy. As a compromise solution, this study makes two simplifying assumptions. First, agricultural growth is equal to the average endogenous (simulated) growth rate of this study's commodities, following economic liberalization. Second, the growth rate of income (GDP) as predicted from historical trends ($r0_y$) is modified by a fraction of the difference between the model endogenous growth rate of agriculture (r_a) and its historical growth rate ($r0_a$). As far as economic liberalization in LDCs leads to an increase in the growth rate for agriculture compared to its historical mean, it is assumed to increase the growth rate of GDP. The higher growth rate of income, in turn,

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[10]Compare, for example, the discussions in Commission of the European Communities (1988).

[11]In some countries, part of the pressure for adjustment may originate from outside the country, for example from the intervention of international lending organizations such as the World Bank or the International Monetary Fund.

stimulates human consumption of cereals and meats, including beef. As meat consumption is directly linked to meat production, a rise in income translates into larger meat prodution and hence increased consumption of grains and soybeans for feed. In equation form, the average annual growth rate of income (r_y), which enters food and feed demand, is assumed to be given as

$$r_y = r0_y + \lambda\,(r_a - r0_a),$$

where λ is a parameter relating agricultural growth to GDP growth and where r_a is calculated as

$$r_a = [\ 1 + (1/n)\ \Sigma_i\ dq_i/q0_i\ ]^{1/T} - 1,$$

where country subscript k has been left out for clarity.

The above modification of the exogenously predicted growth rate of income applies to all developing countries and country groups for which the share of agricultural GDP to total GDP exceeds one third or for which more than a third of all export earnings derive from the agricultural sector. In practice, this means that only three developing countries or country groups are excluded from this modification of the overall growth rate of income. They are Egypt, the Republic of Korea, and the country group identified as North Africa/Middle East.

6. <u>Market Clearing</u>

Simultaneous equilibrium in all n markets requires that the model's n excess demand functions equal zero. Excess demands are expressed in terms of net exports as

$$dx_{ik} = dq_{ik} - dc_{ik} - df_{ik} - do_k \qquad i=1,...,n \text{ and } k=1,...,m$$

where do_k identifies changes in waste and seed, as explained above. As stock changes are not entering the excess demand function, they are implicitly assumed to be constant.

Given world market equilibrium in the base period, equilibrium in period T requires that the sum of the absolute changes in net exports for all m countries equals zero for each of the n commodities, i.e.

$$\Sigma_k\ dx_{ik} = 0 \qquad i=1,...,n$$

If world stock changes are different from zero in the base period, setting stock changes constant means either constant stock accumulation or decumulation. Although stock accumulations are sensible as production grows, the stock changes in the base period are not necessarily optimal. The problem of stock changes in the base period is handled in this comparative static model in the same way as any other exogenous change, for example those deriving from income or productivity growth. Stock accumulations in the base period are interpreted as excess supply that is eliminated through appropriate changes in the world price.

This modifies the above world market equilibrium condition to

$$\Sigma_k \; dx_{ik} + d(stocks)_i = 0 \qquad i=1,\ldots,n$$

where d(stocks) identifies the sum of base period stock changes for all countries except China and the CPEs of Eastern Europe. The existence of stock changes in the base period in combination with the above modification of the model's equilibrium condition also requires a reinterpretation of exports at the individual country level. In particular, if actual net exports in the base period (xact0) are given by

$$xact0_{ik} = q0_{ik} - c0_{ik} - f0_{ik} - o0_{ik} - d(stocks)_{ik} \qquad i=1,\ldots,n \text{ and } k=1,\ldots,m$$

then the actual net export level at the end of the model's time horizon is

$$xact1_{ik} = xact0_{ik} + dx_{ik} + d(stocks)_{ik} \qquad i=1,\ldots,n \text{ and } k=1,\ldots,m.$$

Hence, the change in net exports in the case of stock changes in the base period and the modified world equilibrium condition will be

$$dxact_{ik} = dx_{ik} + d(stocks)_{ik} \qquad i=1,\ldots,n \text{ and } k=1,\ldots,m$$

in this model. Clearly, the world equilibrium condition remains defined in terms of dx_{ik}.

DATA NOTES

Commodities, Countries, Base Period

As requested in the terms of reference, the study covers 6 commodities: wheat, coarse grains, rice, beef, sugar, and soybeans. A category called "all meats" is also included in the model, although it is not treated symmetrically to the other commodities.

The world is divided into 22 countries and country groups, of which 10 are ICs or country groups according to the FAO classification and 12 are developing.

The definition of the groups of ICs follows largely the OECD classification, i.e. the European Community combines in its EC-10 definition Belgium/Luxembourg, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, and the United Kingdom; the "Mediterranean Countries" include Malta, Portugal, Spain, and Yugoslavia; the "Nordic Countries" consist of Finland, Iceland, Norway, Sweden, and Switzerland. The group "Other developed countries" includes Israel and South Africa. Australia, Austria, Canada, Japan, New Zealand, and the United States enter the model as individual countries.

The following LDCs are modeled separately: Argentina, Brazil, Egypt, India, the Republic of Korea, Nigeria, Pakistan, and Turkey. All remaining LDCs are grouped together into the regions Asia, North Africa/Middle East, Sub-Saharan Africa, and Latin America. The regional classification follows that of IFPRI (Paulino 1986).

China and the centrally planned economies of Eastern Europe (Albania, Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland, Romania, and the USSR) are not incorporated in the model.[12] This implies that their exports and imports are assumed to remain at base year levels for each year of the model's time horizon. The main reason for treating China and the CPEs as exogenous relative to the world market is the very unpredictable nature of their future development and, hence, export and import behavior. For example, China is in the middle of significant changes regarding economic policy. After a strong movement toward freer markets, this process seems to be under review currently. At the same time, the Soviet Union appears to be ready to divert resources from government consumption toward private consumption. To what extent these trends will continue and/or pick up momentum is highly uncertain. But as both economic entities are large relative to the world market, internal structural changes can have significant effects for the world market. To model their behavior by rely on continuing trends for domestic consumption and production or for exports and imports could lead to predictions that are far off the mark.

The specified time horizon of the model is 20 years, the base period is 1981-83. The latter is chosen because the comparable data set on production and supply utilization for wheat, rice, and coarse grains for later years has not been completed or released yet by IFPRI.

Definition and Sources of Model Variables and Parameters

The base year data on production and consumption for all commodities are simple averages of the years 1981-83. The basic input data on food and feed consumption, production, waste and seed for wheat, rice, and the coarse grains are derived from the Agricultural Supply/Utilization Accounts Tape of the Food and Agriculture Organization of the United Nations. All data are in raw equivalents. The consumption of processed products, such as bread, is converted back into the consumption of its basic ingredients, as, for example, wheat. Food consumption data on beef and sugar are derived from FAO production and trade yearbooks as production plus imports minus exports. Total domestic utilization of soybeans is calculated as domestic production plus imports minus exports of soybeans plus imports minus exports of soymeals and -cakes, with the latter two converted back to soybean equivalents. Approximate values of the conversion factors and the shares of food, feed, seed and waste use in total domestic utilization are obtained from various issues of the FAO Food Balance Sheets.

The values for total meat production in the base period (lou0) are taken from a printout provided by FAO (June 26, 1988). The product (meats) is identified as commodity 2944 of the FAO Agricultural Statistics.

Most of the elasticities are drawn from estimates by other researchers. In particular, all price elasticities of demand and supply for ICs match those used in the OECD-MTM model (OECD 1988a). This applies to price elasticities of food demand and supply as well as to feed demand.

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[12]For the purpose of comparison, the basic input data for both China and the CPEs are included in the data appendix.

Price elasticities of demand and supply for LDCs are taken from a variety of sources, including Parikh et al. (1988) and its various prior IIASA documents, Scandizzo and Bruce (1980), Tyers and Anderson (1986), USDA (1986), Valdes and Zietz (1980), and Zietz and Valdes (1986). Feed demand elasticities for all livestock (efij) are constructed for each industrialized country or country group as simple averages of the feed demand elasticities for individual livestock categories for that country.[13] Feed demand elasticities for beef (efbij) as well as the feed cost elasticity of beef production are taken from the MTM-model without any modification. For countries and country groups that are not treated separately in the MTM-model, feed demand elasticities for all livestock (efij) are equated to those of the EC or Australia, depending on which country provides a better match with respect to the production structure. The New Zealand feed demand elasticities for beef as well as the corresponding feed cost elasticity are used for all developing countries. This choice reflects the fact that, similar to New Zealand, most cattle in developing countries is grass-fed rather than raised on grains.

Estimates of average annual changes in feeding ratios are calculated from data provided by Sarma (1986, Table 26). In particular, gfr is found as the difference between the average annual growth rate of cereal feed use between 1966-70 and 1976-80 and the corresponding growth rate of livestock output. For ICs the value of gfr is set uniformly at 0.5 percent per annum.

Per capita income elasticities of demand are predominantly from Parikh et al. (1988) and its various prior IIASA documents, Sarma (1986), Sarma and Yeung (1985), and USDA (1986). An upper limit of unity is imposed on all income elasticities for cereals. Income elasticity estimates of livestock production with respect to per capita income (ely) are derived from a regression on a cross-section of 52 LDCs for the year 1985. The estimated regression equation is given by

$$\underset{}{lou/n} = \underset{(5.3)}{66.2} + \underset{(3.4)}{.019\,Y} - \underset{(-2.9)}{.000003\,Y^2} + \underset{(1.5)}{.0017\,area} + \text{regional dummies}$$

$$R^2 = .71 \qquad F(12, 39) = 7.8$$

where lou represents 1985 livestock production in 1000 mt, defined as the sum of all meat production, fresh milk production divided by 10, and hen egg production.[14] Variable n represents population in millions. Y and Y^2 are per capita income and its square, respectively, and area the land area of each country included in the sample.[15] The intercept term holds for the countries in the southern part of Latin America. The dummy variables for all other regions are negative and lower the intercept term by a value between 45 and 66. For ICs, the

[13]Feed demand elasticities for rice are set to unity for lack of better information, cross price elasticities with respect to other feeds to zero.

[14]Compare Sarma (1986) for the rationale of dividing fresh milk production by a factor of 10.

[15]Data on meat production are from the FAO printout mentioned earlier, data on milk and hen egg production from the 1986 FAO Production Yearbook. Per capita income levels for 1985 and land area are taken form the World Development Report 1987.

parameter ely is set equal the maximum of two times the value of the income elasticity of beef demand and 0.5, which closely approximates the average value of ely for developing countries.

Data on PSEs for OECD-countries come from OECD (1988b). CSE values are derived from OECD (1987) values by assuming the ratio between PSEs and CSEs remained approximately the same between 1979-81 and 1981-83. PSE and CSE measures for the group "Others" are derived from the data for South Africa given in USDA (1988). For the Republic of Korea, India, and Nigeria, the values substituting for PSEs and CSEs are also taken from USDA (1988).[16] All other values are derived from the nominal protection rates reported in Krueger, Schiff, and Valdes (1988). Although these rates are nominal as opposed to real rates of protection, they include both direct and indirect effects of protection on agriculture. The direct effects derive from tariffs, quotas and other intervention measures directly aimed at agriculture. The indirect effects result from currency overvaluation and protection of non-agriculture. As figures are available for only 18 countries and 2 commodities at this time (information on more commodities will be released in Krueger, Schiff, and Valdes, forthcoming), the information on the direct and indirect incentive effects of prices for all other countries, country groups, and commodities are best-guess averages of the data available so far. The values substituting for the PSE and CSE values for LDCs are derived from the given data in Krueger, Schiff, and Valdes (1988) as follows. First, the six commodities analyzed in this study are grouped into importables and exportables for each of the LDC countries or country groups defined in this study. Second, for exportables and importables separately, PSEs are derived as the sum of the direct effect and one half the indirect effect.[17] For the four LDC country groups included in the study, PSEs are calculated as simple averages of PSEs for those countries in the country group that are covered in Krueger, Schiff, and Valdes (1988). CSEs are approximated by setting them equal to the direct effect given in Krueger, Schiff, and Valdes (1988).

Information on expected average annual growth rates of population is taken from World Bank (1987, Table 27). The growth rates refer to the time period 1985 to 2000. The expected average annual growth rate of income is set at 2.5 percent for most ICs. Slightly different rates are used for Austria, Japan, and New Zealand to take into account differences in expected growth potential compared to this average. Income growth rates for LDCs ($r0_y$) are generally derived as a simple average of the average annual growth rates of GDP for the time periods 1965-80 and 1980-85, as reported in World Bank (1987, Table 2). Expected growth rates of agriculture are determined in a analogous way.

Average annual growth rates of productivity (rq_k) are based on simple log-linear time trend regressions of yields for wheat, coarse grains, and rice. The regressions cover the years 1961-83. Due to the difficulty of obtaining consistent time series of real producer prices for most

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[16]To allow model calculations to proceed, it was decided to convert the PSE figure of -1.5 quoted for Nigeria in USDA (1988) to -0.9.

[17]Although it is unclear to what extent the indirect effect translates into output changes, simply restricted the PSE measure and hence the output effect to the direct effect appears too conservative. Setting the PSE measure equal to the simple sum of direct and indirect effect, however, is likely to lead to an overestimate of the output effect.

LDCs, the regressions do not control for changes in producer prices. Hence, rq_k and therefore qh_k may contain the effect of changes in producer prices. But as few LDCs have followed a constant price policy for food products over the complete sample, the calculated growth rate may not be overly biased. The situation is somewhat different for OECD-countries. The price-constant growth rate of yields and production may be less likely to be captured by a simple log-linear time trend. Hence, the estimated exogenous rates of growth of production may be more biased than the one for LDCs.

The estimates of the above growth rates are adjusted as follows: (a) insignificant or negative trend coefficients are converted to zero; (b) trend growth rates for production are substituted for trend growth rates in yields for countries and crops for which the growth in yields exceeds that in production. The latter is the case, for example, in coarse grains for the country group identified as Asia. Hence, the rate of growth of production (3.7) is substituted for the rate of growth of yields (8.8). There are a number of reasons for this somewhat more cautious approach.[18]

Exogenous production growth is dependent on both the ability to increase arable land and the introduction of new technologies to raise the productivity of existing land. Both are difficult to handle for forecasting purposes. Simply extrapolating past trends may lead to large forecast errors, especially over a long time horizon. Forecast problems exist for developed as well as for LDCs.

One important question in this context is to what extent productivity increases are independent of price changes. This age-old question is far from resolved. Genetic improvements, the rate of yield change due to more intensive use of fertilizer, and the yield change induced through other types of chemicals, machines, improved irrigation etc can all be assumed to depend on price incentives, although, of course, to a varying extent and over different time horizons. Fertilizer use is considered to be quickly price responsive, genetic improvements respond rather slowly by comparison. If one assumes, as done in this paper, that there will be more emphasis on the containment of production growth in ICs, in particular the EC, one can doubt whether the rate of growth in productivity experienced over the past 30 years will be maintained also in the future. In addition, there is growing concern about the effect of the so-called "greenhouse" effect, in particular as it could affect the North American plains.

Extrapolating past yield growth seems particularly treacherous for LDCs. The "Green Revolution" led to significant production growth in the sixties and early seventies. At the moment, however,

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[18]The more cautious approach advocated here contrasts with the rather more optimistic predictions for output growth by Anderson and Herdt (1988). As part of a simple model for cereal output growth, they assume that yields of cereals will grow at an average annual rate of 2.65 on non-irrigated land and of 3.57 on irrigated land. Area is predicted to grow between 0.5 and 1 percent per annum, respectively. Overall then, output growth amounts to 3.16 percent per annum on non-irrigated land and 4.54 percent on irrigated land. These predictions assume constant relative prices.

the momentum seems to have been lost[19]. Also, there is no similar technological breakthrough in sight. Although biotechnology promises to be able to revive the momentum, there appears to be little it will contribute to production in the developing world in this century.[20] Significant resources are required for biotechnology applications. Even if one assumes that these resources could be provided in ICs, the technology does not transfer readily to LDCs. This is because biotechnology applications must be specifically designed for the target environment.

LDCs face another problem in their effort to increase food production. In recent years, environmental stress has become apparent in Sub-Saharan Africa as well as countries as diverse as India, Indonesia, Mexico, and a number of other countries. Soil erosion, receding water tables and increasing competition of agriculture with industry for water resources are alarming signs.[21]

The average annual price-constant growth rates for sugar and soybean production are derived from yield averages as given in the FAO production yearbook for 1961-65 and 1984-86. Beginning and end years are modified in a number of cases to take into account the decrease in growth rates in more recent years.[22] For beef, the average annual growth rate of production is derived as a function of the predicted percentage change in total meat production, which is identified as louh in the model. The relationship between rq_{ik} and louh is given by

$$rq_{ik} = \iota_k \, (1 + louh_k)^{1/T} \qquad \text{for } i=\text{beef} \quad k=1,\ldots,m$$

where parameter ι is set to unity for all industrialized countries and where ι varies between 0.71 for Latin America and 0.84 for North Africa/Middle East. The values of ι are calculated based on data on average annual growth rates of beef and total meats as reported in Sarma and Yeung (1985, p. 26).

The parametric link between GDP growth and agricultural growth is based on a regression on a cross-section of LDCs similar to that employed for the estimation of the parameter ely described above. The basic idea behind the regression is described in some detail in Hwa (1986). The estimated equation is given by

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[19]Compare on this World Watch Institute (1988).

[20]For more detail, see the discussion in Anderson and Herdt (1988).

[21]Compare World Watch Institute (1988).

[22]In the case of soybeans, for example, the growth rate in yields for Australia and the country category identified as "others" is calculated on the period between 1974-76 and 1984-85. Average annual growth rates of sugar yields are generally calculated for the period covering the years 1961-65 to 1979-81.

$$\dot{Y} = \underset{(1.1)}{1.3} - \underset{(-.6)}{.03}\,\dot{K} + \underset{(1.8)}{.59}\,\dot{L} + \underset{(3.7)}{.20}\,\dot{X} - \underset{(-2.0)}{.02}\,\dot{P} + \underset{(6.7)}{.81}\,\dot{A} + \underset{(4.5)}{7.0}\,OILD$$

$$R^2 = .86 \qquad F(6, 21) = 21.9$$

where $\dot{Y}$, $\dot{K}$, $\dot{L}$, $\dot{X}$, $\dot{P}$ and $\dot{A}$ represent, respectively, average annual growth rates, between 1970 and 1979, of gross domestic product, the country's capital stock, its labor force, exports, its GNP deflator, and of its agricultural sector. All data are from Hwa (1986, Annex Table 2). OILD is a dummy variable that equals unity for oil exporting countries. The equation is estimated on a sample of 28 countries for which either one of two conditions holds: (a) the share of agricultural exports in total exports exceeds 30 percent; (b) the share of the agricultural sector in GDP surpasses 30 percent.

RESULTS OF MODEL SIMULATIONS

The model described above is used to identify the impact of changes in the agricultural policies of both OECD-countries and LDCs. To be able to clearly distinguish these policy-induced changes from those that can be attributed to the growth of productivity, population, and other trend factors, the model is simulated first without any policy changes. This simulation serves as the base-line run.

1. Base-Line Model Projections

The base-line run of the model with base year 1981-83 projects prices and quantities for all six commodities 20 years into the future. The results of the base-line run can be summarized in a number of ways. They are presented in aggregate form in Tables 1 through 7.

Table 1 reports the predicted changes in real world prices over the model's time horizon. For the purpose of comparison, the predictions of some other studies are also presented. From a methodological viewpoint, the study by Roningen et al. (1988) is the closest to the current. Similar to the present study, it is a nonspatial world trade equilibrium model that is essentially partial equilibrium in nature.[23] Both studies assume for the reference run that world price changes will feed back one for one into the markets of all ICs. Unlike Roningen et al., this study also assumes that world prices will be fully transmitted to producers and consumers in all LDCs. The econometric studies cited in Table 1 by Mitchell (1988) and Lord (1988) are also partial equilibrium in nature. In contrast to this study and the one by Roningen et al. price transmission in the econometric studies is governed by constant parameters that are based on estimates of historical performance. For the purpose of predicting future developments, the historical trend is assumed to continue. This means, inter alia, that the Common Agricultural

[23]We ignore, for the moment, the endogenous feedback of agricultural growth on the growth rate of GNP in this study.

Policy of the EC and the U.S. farm policy as contained in the 1985 Farm Bill are presumed to remain unchanged.[24] The IIASA study (Parikh et al. 1988) consists of linked country-specific general equilibrium models. Of all the models cited, it is the most general in its approach. All studies except the present try to model explicitly the likely behavior of China and the centrally planned economies of Eastern Europe.

All cited studies have two things in common with the current one. They predict lower real grain and higher beef prices for the year 2000. The disagreement among studies on real price changes is the lowest for the heavily traded commodities wheat and coarse grains. It is substantial for most other commodities, even to the extent that there is no agreement as to the direction of change of real prices for three out of the six commodities.[25]

As Table 2 provides some clues as to the underlying reasons for some of the differences in predicted world price changes. For example, it shows that there are only small differences between the present study and that by Mitchell (1988) in the predicted rates of growth of both rice consumption and production in LDCs, by far the main market for this commodity. The studies differ, however, in the predicted production and consumption changes in ICs, with Mitchell projecting a decline in both and the present study positive growth. Although rice production and consumption in ICs is minimal compared to that in LDCs, they appear to cause a large difference in the predicted price change for rice. A partial explanation is provided by the thinness of the rice market (Siamwalla and Haykin, 1983): even small differences in predicted quantities traded can lead to large differences in predicted world price changes.

Table 1. Predicted Long-Run Changes in World Prices (Base Year to approximately 2000)

Studies	Base	Wheat	CGs	Rice	Beef	Sugar	Soya
<u>Present Study</u>	1982	-16.5	-13.7	20.5	1.4	62.9	-2.3
<u>Other Studies</u>[a]							
Roningen et al.[b]	1986	-8.8	-9.6	-7.0	10.2	-5.3	-9.8
IIASA (Parikh et al.)	1980	-8.0	-10.0	1.0	53.0	..	..
Lord	1984	..	-22.5	..	63.4	50.1	65.9
Mitchell	1987	-23.0	-16.4	-13.4	..	..	-31.6

Notes: [a] China and the CPEs are treated on par with other countries rather than assuming that their net imports and stock changes remain constant at base period levels. [b] Roningen et al. use oilseeds and products instead of soybeans.

[24]See, in particular, the study by Mitchell based on the World Bank model.

[25]It is not clear, however, whether Lord uses real prices in the case of soybeans. If he is not, there is a good chance that all studies predict real soybean prices to decline toward the year 2000.

Table 2 provides some insight also into the underlying causes of the predicted world price changes in beef and sugar. Lagging production growth in ICs appear to be the main reason behind the very strong rise in world beef prices predicted by IIASA compared to the present study. The possibly surprising rise in sugar prices projected in this study results mainly from very strong demand growth in LDCs. One can be certain in this connection that substituting larger supply elasticities into the model, especially for developing countries, could reduce the resulting price increase substantially.

Table 2. Predicted Average Annual Growth Rates of Quantities (circa 1980-2000)

	Production		Domestic Utilization		Net Export	
	ICs	LDCs	ICs	LDCs	ICs	LDCs
<u>Present Study</u>						
Wheat	1.7	2.7	1.1	3.2	2.6	4.5[a]
Coarse Grains	2.7	2.0	2.2	3.1	5.7	10.8[a]
Rice	1.1	2.4	0.6	2.4	3.5	5.7[a]
Beef	1.6	2.1	1.2	2.8	30.8	..
Sugar	2.4	1.6	-0.1	2.9	20.1	..
Soybeans	1.6	1.4	1.3	3.3	14.4	-2.1
<u>Mitchell[b]</u>						
Wheat	2.4	3.0	1.4	3.5	5.0	5.0[a]
Coarse Grains	1.7	1.8	1.8	2.4	12.2	8.5[a]
Rice	-.3	2.3	-1.3	2.4	15.2	24.3[a]
Soybeans	3.4	4.3	3.3	4.2	-13.1	4.5
<u>IIASA[c]</u>						
Wheat	2.8/1.1	3.3	1.9		3.0	
Coarse Grains	2.4/1.4	2.1	1.7		3.7	
Rice	3.4/0.7	2.9	2.1		3.4	
Beef	0.9/1.0	2.8	1.5		2.8	

Notes: [a] Imports increase in this case; [b] figures for LDCs include China; [c] first column gives growth rates for North America and Oceania and growth rates for all remaining ICs; consumption and export columns give global growth rates, for all countries combined.

Table 3. Cereal Production, Domestic Utilization, and Net Imports in the Year 2000

	Present Study		Mitchell (1988)		IIASA (1988)		Paulino (1986)	FAO AT2000	Sarma (1986)
	ICs	LDCs	ICs	LDCs	ICs	LDCs	LDCs	LDCs	LDCs
					mill. tons				
Production	886	763	832	1270[a]	829	656	787	679	..
Domestic Utilization	648	935	593	1246[a]	640	788	867	851	..
food	94	565					488	575	..
feed	471	233					379[b]	276[b]	245
Net Imports	-238	173	-229	177[a]	-189	132	80	136	..

Note: The centrally planned economies are excluded from the figures. [a] China is included in the figures. [b] includes feed and other uses, such as seed and waste.

Table 4. Cereal Self-Sufficiency of LDCs in 1981-83 and the Year 2000

		2000		
	1981-83	This Study	Mitchell[a]	IIASA
			percent	
Wheat	76	68	73	73
Coarse Grains	95	76	85	79
Rice	100	99	99	98
All Cereals	92	82	86	83

Note: [a] The figures include China.

Tables 3 and 4 illustrate how the differences among studies in predicted world price changes and growth rates of quantities affect the estimated levels of production, domestic utilization and net exports for the year 2000. It is apparent from Table 3 that the predictions for cereal production and domestic utilization in LDCs vary considerably among models when compared to those for industrialized countries. The predictions of the present study for both LDC conumption and production of cereals are somewhat above the average for the studies referenced in Table 3. This is especially true for domestic utilization, although it does not apply its sub-components food and feed consumption. Notice, for example, that this model's predicted feed demand of LDCs matches almost exactly that by Sarma (1986), a study that concentrates on this component of domestic consumption. Similarly, there is a very close match between the results of the present study and those of FAO for both LDC food and feed consumption. Yet this still leaves a substantial difference in total domestic utilization. This can be traced to a substantially larger seed and waste component in domestic utilization in the present study compared to FAO's.[26] Corresponding to the larger figures for domestic utilization the present model also projects a larger cereal gap than the other studies. For example, the cereal gap without China is almost equal to the one projected by Mitchell for all LDCs including China. Similarly, it is twice the size of the low estimate by Paulino (1986). However, the cereal gap is only about 30 percent higher than the one projected by the IIASA project.

Table 4 translates the cereal gap in LDCs evident from Table 3 into levels of self-sufficiency for each type of cereal and for cereals as a whole. Again some comparisons to other studies are provided. Except for rice, the model predicts a marked drop in self-sufficiency ratios for cereals. The reduction is particularly pronounced for coarse grains. Self-sufficency ratios are predicted to fall somewhat more in this study than in the other cited studies. The one exception is rice. The overall levels of cereal self-sufficiency, however, do not differ significantly among studies. The consensus appears to be that self-sufficiency levels in cereals will drop by about 10 percentage points between the early 1980s and the year 2000.

Table 5. Cereal Import Needs by Developing Country Region, 1981-83 to 2000

	Import Level 1981-83	Import Level 2000	Percentage Change in Import Bill	Self-sufficiency 1981-83	Self-sufficiency 2000
	mill. mt.			percent	
All LDCs	48	173	174	92	82
Asia	10	30	29	97	94
North Africa/Middle East	28	86	143	70	51
Sub-Saharan Africa	8	44	350	84	55
Latin America	2	12	293	99	92

Note: The figures exclude China.

[26]As mentioned earlier, it may be unrealistic to assume that seed and in particular waste will grow in fixed proportion with production or consumption. Changes in technology or relative price changes may very well reduce the waste component of domestic utilization. If that is true, the present study would overestimate total domestic utilization for the year 2000.

Table 5 provides a breakdown of the cereal gap and self-sufficiency levels by region. It also identifies what the cereal gap implies for the cereal import bill of LDCs. The absolute level of cereal imports are predicted to triple for Asia and North Africa/Middle East by the year 2000 compared to the early 1980s. For Sub-Saharan Africa and Latin America, cereal imports are projected to increase five-fold. The large percentage increase in cereal imports, however, does not necessarily imply a large drop in self-sufficency levels. The latter drop only slightly for Asia and Latin America. But for North Africa/Middle East and Sub-Saharan Africa the model projects a rather dramatic drop in self-sufficiency levels. Sub-Saharan Africa is also the region that is likely to experience by far the largest increase in its cereal import bill, whereas the cereal import bill is predicted to rise only marginally for Asia.

Tables 6 and 7 provide the base-line results for beef, sugar, and soybeans. Quantities of production, consumption, and trade as well as corresponding self-sufficiency ratios are provided for both ICs and LDCs. The main directions of change are the same for all three commodities: self-sufficiency levels grow for ICs and they fall for LDCs. The only exception to this is soybeans in Sub-Saharan Africa: self-sufficiency levels are predicted to grow rather than fall.

Table 6. Production, Domestic Utilization, Net Imports of Beef, Sugar, and Soybeans in 2000

	Beef	Sugar	Soybeans
		mill. tons	
<u>ICs</u>			
Production	31	46	74
Domestic Utilization	29	28	70
Net Imports	-3	-18	-4
<u>LDCs</u>			
Production	19	88	28
Domestic Utilization	21	98	21
Net Imports	3	10	-7

Note: The balance of net imports is absorbed by the centrally planned economies and China.

Table 7. Self-Sufficiency of ICs and LDCs in Beef, Sugar, and Soybeans, 1981-83 and 2000

	Beef		Sugar		Soya	
	1981-83	2000	1981-83	2000	1981-83	2000
			percent			
All ICs	100	109	102	167	100	106
All LDCs	100	88	115	90	194	132
Asia	97	77	105	80	49	38
North Africa/Middle East	78	65	46	30	24	16
Sub-Saharan Africa	97	86	109	62	83	131
Latin America	106	99	162	157	353	270

Note: The figures exclude China.

2. The Impact of Policy Changes in ICs and LDCs

Central to the model simulations that are supposed to capture the effect of a change in OECD policies toward lower output levels are the assumptions that are made with respect to how the reduction in output comes about. Is the output reduction associated with a decrease in PSEs or is a policy of acreage reduction pursued without a change in border protection? For the purpose of the model simulations it is assumed that all changes come about as changes in PSEs and CSEs. Furthermore it is accepted that a change in PSEs and CSEs translates one for one into changes in trade volumes. As explained in some detail in Zietz and Valdes (1988), this may be quite unrealistic because there is no unique correspondence between changes in PSEs and in trade. Even if one ignores this potential problem, there still remains the question how PSEs will be reduced. Will PSEs be decreased by an equal percentage amount across-the-board for all OECD members and commodities or will the highest PSEs be reduced the most? To make the simulations as comparable as possible to those of other studies, PSEs and CSEs are varied in a variety of ways for industrialized countries. The model is used to simulate percentage reductions in PSEs and CSEs of 10, 50, and 100 percent.

The resulting world price changes corresponding to these alternative percentage reductions are given in Table 8. Also given in this table are the results of a number of other studies. A ten percent reduction in PSEs and CSEs in industrialized countries causes a rather significant increase in the world price of sugar and beef. The orders of magnitude of these predicted price changes relative to those of the other commodities are similar to those of the OECD (1987) study. This also applies to the price changes for rice whereas the predicted change in the world price of wheat is significantly different from that of the OECD study. Coarse grain and soybean prices are projected to decline more in the OECD study. The price changes in wheat, rice, beef, and sugar predicted for the 50 percent scenario correspond rather closely to those of Valdes and Zietz (1980). Real prices of coarse grains and soybeans, however, are predicted to decline rather than rise in the present study. For both commodities, interdependencies in feed demand play a fairly large role. These were not modeled explicitly in Valdes and Zietz (1980).

Eliminating support levels as measured by PSEs and CSEs altogether leads to changes in world prices that are fairly modest compared to the predictions of the other studies quoted in Table 8. An exception is sugar. The price increases for wheat and coarse grains for one of the simulations of Tyers and Anderson (1987) are also fairly close to those of the present study. Overall, the results of complete liberalization appear to be close in spirit to what one would expect from the OECD model. This is not very surprising since many of the price elasticities are taken from that model. To explain the fairly large differences in predicted world price changes among models, one has to address the issue of base or reference periods. Model predictions are quite sensitive to the values of PSEs and CSEs. These values, however, can vary considerably over time. Hence, the choice of the base period is fairly crucial for the model's predictions of world price changes. This has been demonstrated in some detail by Zietz and Valdes (1986) for sugar. It is also apparent in Table 8. The differences in the two model simulations reported by Tyers and Anderson (1987) are largely the result of different protection levels.

Table 8. Changes in World Price Relative to Base-Line Run Resulting from Trade Liberalization in Industrialized Countries

Percentage Reduction in PSEs and CSEs	Wheat	CGs	Rice	Beef	Sugar	Soya
<u>Present Study</u>						
10 percent	.4	-.1	.2	.9	1.5	-.3
50 percent	2.0	-.7	.9	4.9	7.6	-1.5
100 percent	3.5	-2.8	1.7	10.5	15.0	-4.0
<u>Other Studies</u>						
OECD-1987 (10%)	-.1	-.3	.1	1.5	1.0	-1.0
Valdes/Zietz-80 (50%)	4.9	2.1[a]	.4	6.8	7.7[b]	1.0
IIASA (100%)	18.0	11.0	21.0	17.0	..	..
Tyers/Anderson-87[c] (100%)	9.0	3.0	10.0	21.0	10.0	..
Tyers/Anderson-87[d] (100%)	25.0	3.0	18.0	43.0	22.0	..
Roningen et al. (100%)	25.9	18.8	18.1	17.3	31.0	6.8
Zietz/Valdes-86[e] (100%)	12.1	11.0	..	17.4	18.2	..

Notes: [a]maize; [b] raw sugar; [c]based on protection levels of 1980-82; [d]based on projected protection levels for 1988; [e]the reported price increases are simple averages of the various alternative model simulations reported in Table 1 of Zietz and Valdes (1986); the estimates are based on 1979-81 protection levels.

The model simulations that capture the effects of alternative development strategies of LDCs on home and world agricultural markets assume a policy change toward export promotion. In the context of the present model this is interpreted to mean changing the modified PSE values (as developed from the information in Krueger, Schiff, and Valdes 1988) to zero.[27] At the same time, all CSE values are also set at zero.

Table 9. Changes in World Price Resulting from Trade Liberalization in LDCs and All countries

100 Percent Reduction in PSEs and CSEs in	Wheat	CGs	Rice	Beef	Sugar	Soya
Present Study						
Developing Countries	-13.6	-20.9	-21.8	2.9	-12.1	-11.5
All Countries	-11.7	-24.4	-21.1	13.3	0.8	-15.9
IIASA						
Developing Countries	5.0	4.0	1.0	-3.0	..	..
All Countries	23.0	13.0	16.0	11.0	..	..
Tyers/Anderson-87						
All Countries	10.0	2.0	-8.0	13.0	-1.0	..

Two policy simulations are conducted for the LDC liberalization scenario. The first one assumes that only developing countries liberalize. The second simulation combines liberalization in LDCs with complete trade liberalization in all industrialized countries. The effect of these two alternative liberalization scenarios on world prices is given in Table 9. Liberalization in developing countries alone is predicted to drive world prices down considerably. With the exception of beef, world prices drop by more than 10 percent. These results are totally different from those of the IIASA model. The main reason for this discrepancy is that the latter study considers only border distortions, that is tariffs and quotas. All other distortions, consumer subsidy equivalents and the indirect effect of protection in non-agriculture on agriculture, are kept constant. Indirect effects are also left out in the study by Tyers and Anderson (1987).

The large negative protection rates accorded to agriculture in LDCs are predicted to have a more significant effect on world prices than protection in ICs. The two exceptions are beef and

[27]Ideally, one would want to run another simulation that sets the value to .10, that is a value identical to that proposed for developed countries. However, to do this, detailed information would be required from Krueger, Schiff, and Valdes (forthcoming). Yet, it is unlikely that this will be available before the Spring or Summer of 1989.

sugar, the two commodities for which protection rates are significant in ICs. It is not surprising to find that, for these two commodities, the world price effects of global liberalization are the closest for all three studies quoted in Table 9. Overall, the strong world market effects of LDC incentive structures that are unfavorable to agricultural production in LDCs may well be the biggest surprise of this study.

Tables 10 through 14 provide information on how the predicted price changes associated with the various liberalization scenarios translate into changes in trade quantities, self-sufficiency levels and cereal import needs.

Table 10 shows the predicted change in net exports by developing countries as they result from setting producer and consumer support levels to zero in industrialized countries. Liberalization by ICs causes an increase in net exports of LDCs in all commodities except for coarse grains and soybeans. Similar findings are reported by Tyers and Anderson (1987). The results by IIASA show significantly larger export changes in wheat and rice than either this study or the one by Tyers and Anderson (1987). Furthermore, LDCs are predicted to increase rather than reduce coarse grain exports in the IIASA study.

LDC liberalization is predicted to increase net exports of coarse grains, rice, and sugar. Net exports of wheat are unaffected in the aggregate and beef and soybeans exports decline. Again it is not surprising that the IIASA model predicts effects that are opposite in sign given IIASA's definition of liberalization by LDCs.

Table 11 demonstrates that liberalization in either ICs or LDCs does not dramatially change the import needs of developing countries for wheat and coarse grains. They remain large under any scenario. Trade flows of the other commodities are affected more significantly. But then again, trade flows in these other commodities are small when compared to those of wheat and coarse grains.

Table 12 reports self-sufficiency levels of ICs and LDCs for all commodities and trade liberalization scenarios. Compared to the base-line simulations, trade liberalization tends to improve self-sufficiency levels of LDCs in all commodities except soybeans. However, the improvement generated by trade liberalization is not enough to compensate for the decrease in self-sufficiency ratios predicted to materialize up to the year 2000. The long-run forces of growth in productivity, population, and per-capita income appear to dominate the effect of trade liberalization for all commodities with regard to self-sufficiency levels. The fact that trade liberalization can reverse only part of the downward trend in LDC self-sufficiency levels, however, may underestimate the overall benefit of liberalization to LDCs. As detailed later in this report, the full effects of trade liberalization on LDCs are unlikely to be captured by a model that covers only six commodities but leaves out most of the agricultural products that generate the bulk of LDCs' foreign exchange earnings.

Table 13 is a supplement to Table 12 in the sense that it provides a breakdown of self-sufficiency levels of LDCs by region. All commodities and liberalization scenarios are covered. Table 14, in contrast, concentrates on the cereal import needs of LDCs. It demonstrates that cereal imports and the cereal import bill of LDCs as a group are predicted to drop under all liberalization scenarios. The reduction is most dramatic for the scenarios that include LDC liberalization. For the latter two cases Asia as a group is even projected to generate export earnings from cereal exports that exceed in magnitude the cereal import bill under the base-line simulation run. Cereal import needs are predicted to increase slightly for Sub-Saharan Africa and Latin America under liberalization. The cereal import bill of Sub-Saharan Africa, however, decreases under the two liberalization runs that include LDC liberalization. The opposite is true for the cereal import bill of Latin America. It decreases only for the case of IC liberalization.

Table 10. Absolute Change from Base Line Run in LDC Net Exports under Various Liberalization Scenarios

	Wheat	CG	Rice	Beef	Sugar	Soy
			mill. tons			
<u>Present Study</u>						
ICs-liberalize	8.8	-11.6	4.0	0.8	5.1	-0.9
LDCs-liberalize	0	16.1	2.5	-1.8	2.5	-4.0
All-liberalize	8.9	1.7	6.4	-0.7	7.8	-5.3
<u>IIASA</u>						
ICs-liberalize	11.1	1.3	9.1	1.8	..	..
LDCs-liberalize	-11.0	-10.0	-0	0.3	..	..
<u>Tyers/Anderson</u>						
ICs-liberalize	4.9	-2.3	4.0	2.9	2.9	..

Note: Liberalization means complete removal of all PSEs and CSEs as given in the Appendix. Liberalization is superimposed on the base line results.

Table 11. Imports of LDCs in the Year 2000 Under Various Liberalization Scenarios

	Base Line Run	Liberalization By		
		ICs	LDCs	All
		mill. tons		
Wheat	86.8	78.1	86.8	77.9
Coarse Grains	82.4	93.7	66.3	80.7
Rice	3.5	-0.5	1.0	-2.9
Beef	2.5	1.7	4.3	3.2
Sugar	9.7	4.6	7.2	1.9
Soybeans	-6.8	-5.9	-2.8	-1.5

Note: The figures exclude China. Liberalization means complete removal of all PSEs and CSEs as given in the Appendix. Liberalization is superimposed on the base line results.

Table 12. Self-Sufficiency of ICs and LDCs, 1981-83, Base-Line and Liberalization Runs

	Cereals	Wheat	CG	Rice	Beef	Sugar	Soya
				percent			
<u>1981-83</u>							
ICs	124	178	107	108	100	102	100
LDCs	92	76	95	100	100	115	194
<u>Base-Line Results</u>							
ICs	137	189	122	128	167	100	106
LDCs	82	68	76	99	88	90	132
<u>ICs liberalize</u>							
ICs	136	185	124	104	106	143	107
LDCs	82	71	73	100	92	95	127
<u>LDCs liberalize</u>							
ICs	134	195	118	113	115	155	112
LDCs	84	69	81	100	82	93	111
<u>All liberalize</u>							
ICs	134	190	121	91	112	133	113
LDCs	84	72	77	101	86	98	106

Note: The figures exclude China. Liberalization means complete removal of all PSEs and CSEs as given in the Appendix. Liberalization is superimposed on the base line results.

Table 13. Self-Sufficiency of LDCs by Region, 1981-83, Base-Line and Liberalization Runs, 2002

	Cereals	Wheat	CG	Rice	Beef	Sugar	Soya
				percent			
<u>1981-83 Averages</u>							
Asia	97	86	94	102	97	105	49
North Africa/ME	70	67	75	69	78	46	24
Sub-Sah. Africa	84	29	95	66	97	109	83
Latin America	99	83	106	97	106	162	353
<u>Base-Line Run</u>							
Asia	94	87	77	104	77	80	38
North Africa/ME	51	52	46	77	65	30	16
Sub-Sah. Africa	55	18	64	40	86	62	131
Latin America	92	63	102	95	99	157	270
<u>ICs liberalize</u>							
Asia	94	89	72	105	85	86	37
North Africa/ME	52	55	43	79	67	32	15
Sub-Sah. Africa	54	19	63	41	89	65	128
Latin America	92	66	100	96	102	164	261
<u>LDCs liberalize</u>							
Asia	98	87	87	107	44	83	25
North Africa/ME	54	58	46	75	72	32	17
Sub-Sah. Africa	53	14	66	33	83	64	130
Latin America	92	58	107	82	104	160	299
<u>All liberalize</u>							
Asia	98	89	81	108	49	89	24
North Africa/ME	54	61	42	76	75	34	16
Sub-Sah. Africa	52	15	64	34	86	66	126
Latin America	91	60	105	83	107	167	287

Note: The figures exclude China. Liberalization means complete removal of all PSEs and CSEs as given in the Appendix. The figures for the base line results and the various liberalization scenarios are predictions for the year 2002, i.e. 20 years from the base year.

Table 14. Cereal Import Needs by Developing Country Region Under Various Liberalization Scenarios, Year 2000

	All LDCs	Asia	NA/ME	Sub-S. Africa	Latin America
Base Line Run					
Import Level (mill mt)	173	30	86	44	12
Cereal Import Bill (% change)	174	29	143	350	293
ICs liberalize					
Import Level (mill mt)	171	29	85	45	13
Cereal Import Bill (% change)	157	-56	137	352	287
LDCs liberalize					
Import Level (mill mt)	154	11	81	48	14
Cereal Import Bill (% change)	106	-204[a]	88	322	384
All liberalize					
Import Level (mill mt)	156	10	81	49	14
Cereal Import Bill (% change)	93	-267[a]	81	323	383

Note: The figures exclude China. The percentage change in the cereal import bill is calculated with reference to the cereal import bill of 1981-83. [a] Export earnings exceed the import bill in the reference period.

Some Qualifying Interpretations of the Simulation Results

There are a number of caveats to keep in mind regarding the assumed policy changes and their predicted results. First, domestic policy reforms for a particular country are difficult to model in a global trade model such as this. The success of liberalization depends on a number of favorable conditions. As the experience with the Southern Cone countries has demonstrated, the liberalization steps have to be taken in the proper sequence and be timed right to be successful.[28] In addition, there is ample evidence from African countries that price policy reform alone is not sufficient to spur economic activity. On the contrary, higher prices could lead to little change in economic activity of farmers if the expected increase in cash income cannot be transformed into the desired consumer goods. The income effect of higher prices may, in other words, just compensate for or even outweigh their substitution effect.[29]

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[28]See, for example, the discussion in Congdon (1985).

[29]Compare Bevan et al. (1987) on the importance of this point for two East African countries.

A global trade model such as this that is limited to six agricultural products is unlikely to be the proper instrument to identify complex domestic policy changes. This applies, for example, for purely domestic policies aimed at raising self-sufficiency levels for basic food crops. To capture such policies adequately in a model, one would have to take into account not only the relationship between food crops and competing cash crops but also the impact of possibly reduced foreign exchange earnings on the entire economy. This would require incorporating a sufficient number of cash crops in the model as well as some representation of the non-agricultural sector. How this can be done for countries that are grouped together in such aggregates as Asia or Latin America is an open question. It therefore appears that intricate domestic policy reforms are better modeled within the context of general equilibrium country models rather than in global trade models.

A large number of commodities of potential economic interest to LDCs have not been subject to any discussion in this study. These include primary tropical products, such as beverages, oilseeds other than soybeans, and groundnuts, as well as temperate-zone commodities such as horticultural products. LDCs have considerable potential for growth in many of these.[30] In particular, horticultural products offer both excellent possibilities in terms of employment generation as well as in terms of foreign exchange earnings (Islam 1988).

Another group of commodities completely left out of the discussion are processed agricultural products. Similar to horticultural products, they may contribute significantly to growth in employment and foreign exchange earnings. Structural adjustment policies in LDCs along the lines assumed in the model simulations are likely to provide a strong incentive to develop the production and marketing of processed products if, at the same time, OECD-countries manage to lower their import barriers on these goods. The study of the trade of processed agricultural goods and its potential effect on economic growth in LDCs as well as OECD-countries is clearly in its infancy. Yet, it is here, where a large part of the potential benefits of structural adjustment in LDCs toward a more export-oriented economic policy and trade concession by OECD-countries could be most important for long-run economic growth.

In short, the focus on traditional temperate-zone agricultural products may severely underestimate the long-run gains to LDCs of both following a policy of export-orientation and lower protection in agricultural products in OECD-countries.

Another qualification relates to potential data problems, in particular the data on feed grain substitutes. Although soybean consumption for feed has been included in this study, all other feed grain substitutes have not. Yet they are of considerable importance in the case of the EC and also for certain LDCs that supply them (e.g. cassava from Thailand). Hence, actual tariff harmonization between feed grains and feed grain substitute may lead to results that are somewhat different from those generated by the model. A more elaborate feed grain subsector would have to be incorporated into the model to capture the potential changes more adequately (see OECD 1988a). Yet this is clearly beyond the scope of the present modeling exercise.

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[30] Compare, for example, the trade liberalization study by Valdes and Zietz (1980) on the quantitative importance for LDCs of tropical products vis-a-vis temperate zone products.

CONCLUSIONS AND OUTLOOK

The simulations and a comparison of their results with other studies have shown that there is a fairly large degree of uncertainty regarding the development of world prices of food commodities over the next 20 years or so. There appears to be a consensus, however, that real prices of wheat and coarse grains are likely to continue to fall, whereas the real prices of beef are going to rise.

The base line simulations have shown that despite large differences in predicted prices among various studies, there appears to be less controversy about the level of production, consumption, and net trade, in particular in cereals. This conclusion is essentially independent of the type of modeling effort, be it a simple trend forecast, an econometric model, a partial equilibrium world trade model or a linked applied general equilibrium model. The convergence of predicted quantities of production, consumption, and trade seems to be particularly high with regard to industrialized countries. Much less certainty appears to surround the forecasts for developing countries. It seems that the modeling of developing countries' reactions would require considerably more work.

This conclusion is even more warranted in the light of the considerable impact LDC economic policies seem to have on world trade and prices of agricultural products. In fact, the major surprise of this study may well be the predicted dominance on world prices of the large negative protection rates by LDCs compared to positive protection in industrialized countries. As demonstrated in this study, a removal of the disincentive effects of negative protection is likely to lead to an increase in both LDC self-sufficiency levels of cereals and other products. In addition, there appears to be no evidence that trade liberalization will increase the cereal import bill of LDCs. On the contrary, for LDCs as a group and all regions except Latin America the cereal import bill will either remain constant under trade liberalization or decrease. This also applies for Sub-Saharan Africa.

Further investigation of the role of trade liberalization appears to be highly desirable. For that purpose, the current modeling effort would have to be extended in a number of ways. Apart from including more commodities in the study and updating the data, it seems that a thorough comparison with other similar modeling efforts is highly desirable. Such an exercise should, however, go beyond a comparison of simulation results, as done in this paper. One would like to make some comparisons of the underlying assumptions regarding crucial elasticity values. A first step in this direction may be possible within a few months when the input data for the USDA model (Roningen et al.) will be published. Running a model with alternative input data and comparing the results could help clarify the differences among models. It would also put any discussions on modeling strategies on a more solid basis.

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APPENDIX A: INPUT DATA

This data appendix gives the values of all variables and model parameters that are employed in this modeling exercise. The appendix is organized into two sections, the one for industrialized countries and one for developing countries. In each of these sections, the data are defined by the same symbols used for the description of the theoretical model described above.

Table A1. Basic Input Data for Industrialized Countries

	U.S.	AUSTRALIA	AUSTRIA	JAPAN	NEW ZEALD	NORDIC
c0-wheat	12337	1100	366	3789	221	1296
c0-cg	4949	272	279	2480	62	591
c0-rice	1154	66	25	9790	8	74
c0-beef	11004	976	186	610	280	498
c0-sugar	8164	801	389	2709	138	1058
c0-soy	0	0	0	4607	0	0
eww	-0.06	-0.1	-0.09	-0.1	-0.1	-0.1
ewc	0.12	0	0	0	0	0
ewr	0	0	0	0	0	0
ewb	0	0	0	0	0	0
ews	0	0	0	0	0	0
ewy	0	0	0	0	0	0
ecw	0.08	0	0	0	0	0
ecc	-0.21	-1	-0.2	-0.1	-0.5	-0.5
ecr	0	0	0	0	0	0
ecb	0	0	0	0	0	0
ecs	0.14	0	0	0	0	0
ecy	0	0	0	0	0	0
erw	0	0	0	0	0	0
erc	0	0	0	0	0	0
err	-0.1	-0.5	-0.97	-0.1	-0.3	-0.2
erb	0	0	0	0	0	0
ers	0	0	0	0	0	0
ery	0	0	0	0	0	0
ebw	0	0	0	0	0	0
ebc	0	0	0	0	0	0
ebr	0	0	0	0	0	0
ebb	-0.96	-0.92	-0.67	-1	-0.56	-0.82
ebs	0	0	0	0	0	0
eby	0	0	0	0	0	0
esw	0	0	0	0	0	0

esc	0.13	0	0	0	0	0
esr	0	0	0	0	0	0
esb	0	0	0	0	0	0
ess	-0.23	-0.18	-0.12	-0.6	-0.2	-0.5
esy	0	0	0	0	0	0
eyw	0	0	0	0	0	0
eyc	0	0	0	0	0	0
eyr	0	0	0	0	0	0
eyb	0	0	0	0	0	0
eys	0	0	0	0	0	0
eyy	0	0	0	-0.6	0	0
rn	0.006	0.009	0.001	0.004	0.006	0.002
ry	0.025	0.025	0.02	0.03	0.03	0.025
ewy	0.07	-0.05	-0.12	0.07	-0.05	-0.1
ecy	0.11	0.08	-0.3	0.31	0.08	0.4
ery	0.59	0.65	0.3	-0.26	0.65	0.11
eby	0.34	0.09	0.43	0.28	0.09	0.4
esy	0.06	0.06	0.2	0.24	0.06	0.23
eyy	0	0	0	0.2	0	0
q0-wheat	72305	15666	1226	675	306	2336
q0-cg	211492	6396	3476	395	542	8393
q0-rice	5275	568	0	10299	0	0
q0-beef	10507	1528	200	482	523	516
q0-sugar	5321	3337	494	877	0	609
q0-soy	52845	63	0	218	0	0
sww	0.5	0.92	1.53	0.44	0.83	0.7
swc	-0.09	-0.1	-0.89	-0.1	-0.11	-0.34
swr	0	0	0	0	0	0
swb	0	-0.14	0	0	0	0
sws	0	0	0	0	0	0
swy	-0.09	-0.02	0	0	0	0
scw	-0.8	-0.09	-0.48	-0.1	0	-0.1
scc	0.43	1.08	1.45	0.38	0.83	0.3
scr	0	0	0	0	0	0
scb	0	-0.14	0	0	0	0
scs	0	0	0	0	0	0
scy	-0.18	-0.36	0	0	0	0
srw	0	0	0	0	0	0
src	0	0	0	0	0	0
srr	0.37	0.5	0	0.3	0	0
srb	0	0	0	0	0	0
srs	0	0	0	0	0	0
sry	0	0	0	0	0	0

sbw	0	0	0	0	0	0
sbc	0	0	0	0	0	0
sbr	0	0	0	0	0	0
sbb	0.69	0.34	0.49	0.23	1.05	0.63
sbs	0	0	0	0	0	0
sby	0	0	0	0	0	0
ssw	0	0	0	0	0	0
ssc	0	0	0	0	0	0
ssr	0	0	0	0	0	0
ssb	0	0	0	0	0	0
sss	0.3	0.5	0.55	1	0	0.34
ssy	0	0	0	0	0	0
syw	-0.06	-4.5	0	0	0	0
syc	-0.3	3.01	0	0	0	0
syr	0	0	0	0	0	0
syb	0	-0.14	0	0	0	0
sys	0	0	0	0	0	0
syy	0.41	1.89	0	1	0	0
rqw	0.017	0.000	0.025	0.016	0.011	0.026
rqc	0.026	0.015	0.033	0.013	0.023	0.019
rqr	0.009	0.000	0.000	0.007	0.000	0.000
rqb	0.000	0.000	0.000	0.000	0.000	0.000
rqs	0.018	0.006	0.016	0.043	0.000	0.013
rqy	0.013	0.007	0.000	0.016	0.000	0.000
lou0	24746	2764	757.3333	3102.333	1233	1558
ely	0.5	0.2	0.5	0.5	0.2	0.5
f0w	10795	1434	372	2068	117	1015
f0c	131934	2515	2898	16820	374	8260
f0r	276	49	2	1285	0	0
f0y	16379	110	515	468	5	605
gfr	0.005	0.005	0.005	0.005	0.005	0.005
efww	-2.21	-1.48	-1.48	-0.004	-0.91	-1.48
efwc	1.6	0.88	0.97	-0.076	0.64	0.97
efwr	0	0	0	0.092	0	0
efwy	0.22	0.026	0.08	-0.012	0	0.08
efcw	0.04	0.62	0.25	-0.001	0.15	0.25
efcc	-0.66	-1.34	-0.78	-0.14	-0.86	-0.78
efcr	0	0	0	0.139	0	0
efcy	0.22	0.026	0.1	0.002	0	0.1
efrw	0	0	0	0.007	0	0
efrc	0	0	0	0.192	0	0
efrr	-1	-1	-1	-0.579	0	0

efry	0	0	0	0.38	0	0
efyw	0.02	0.17	0.04	-0.002	0	0.04
efyc	0.73	0.14	0.23	0.024	0	0.23
efyr	0	0	0	0.35	0	0
efyy	-1.78	-1.96	-1.12	-0.37	0	-1.12
efc	-0.239	-0.039	-0.242	-0.106	-0.208	-0.349
efbww	-3.006	-2.3	-1.4	-0.011	0	-1.4
efbwc	2.148	1.4	0.74	-0.068	0	0.74
efbwy	0.022	-0.03	-0.02	-0.045	0	-0.02
efbcw	0.044	0.16	0.22	-0.001	0	0.22
efbcc	-0.902	-1.7	-0.85	-0.22	-1.07	-0.85
efbcy	0.022	0.001	0.02	0.004	0	0.02
efbyw	0.005	-0.03	-0.03	-0.008	0	-0.03
efbyc	0.255	0.013	0.08	0.044	0	0.08
efbyy	-1.138	-1.75	-1.4	-0.516	0	-1.4
pse0w	0.24	0.12	0.16	0.96	0.10	0.57
pse0c	0.19	0.06	0.12	0.98	0.10	0.55
pse0r	0.26	0.26	0.00	0.73	0.00	0.00
pse0b	0.09	0.12	0.46	0.48	0.17	0.62
pse0s	0.40	0.10	0.50	0.64	0.00	0.33
pse0y	0.08	0.00	0.00	0.80	0.00	0.00
cse0w	0.00	0.03	-0.16	-0.25	0.00	-0.30
cse0c	0.00	0.00	-0.10	-0.05	0.00	-0.30
cse0r	0.00	-0.41	0.00	-0.45	0.00	0.00
cse0b	-0.01	0.00	-0.20	-0.30	-0.02	-0.40
cse0s	-0.20	0.21	-0.40	-0.20	0.00	-0.20
cse0y	0.00	0.00	0.00	0.00	0.00	0.00
ratw	0.04	0.08	0.08	0.77	0.10	0.14
ratc	0.09	0.09	0.09	1.95	0.10	0.12
ratr	0.41	0.59	0.04	0.03	0.00	0.00
raty	0.31	0.05	0.00	0.01	0.00	0.00

	MEDITER	EC-10	OTHER	CANADA	CPE
c0-wheat	6867	20136	1947	1365	38467
c0-cg	1553	6117	3309	586	11641
c0-rice	429	905	192	101	2609
c0-beef	890	6906	607	1023	8865
c0-sugar	2439	10289	1555	932	18829
c0-soy	0	0	48	0	122
eww	-0.34	-0.09	-0.34	-0.2	0

ewc	0	0	0	0	0
ewr	0	0	0	0	0
ewb	0	0	0	0	0
ews	0	0	0	0	0
ewy	0	0	0	0	0
ecw	0	0	0	0	0
ecc	-0.3	-0.2	-0.3	-0.2	0
ecr	0	0	0	0	0
ecb	0	0	0	0	0
ecs	0	0	0	0	0
ecy	0	0	0	0	0
erw	0	0	0	0	0
erc	0	0	0	0	0
err	-0.2	-0.68	-0.2	-0.2	0
erb	0	0	0	0	0
ers	0	0	0	0	0
ery	0	0	0	0	0
ebw	0	0	0	0	0
ebc	0	0	0	0	0
ebr	0	0	0	0	0
ebb	-0.61	-0.76	-0.61	-0.85	0
ebs	0	0	0	0	0
eby	0	0	0	0	0
esw	0	0	0	0	0
esc	0	0	0	0	0
esr	0	0	0	0	0
esb	0	0	0	0	0
ess	-0.3	-0.59	-0.3	-0.24	0
esy	0	0	0	0	0
eyw	0	0	0	0	0
eyc	0	0	0	0	0
eyr	0	0	0	0	0
eyb	0	0	0	0	0
eys	0	0	0	0	0
eyy	-0.3	0	-0.3	0	0
rn	0.005	0.002	0.02	0.007	0.005
ry	0.025	0.025	0.025	0.025	0.025
ewy	-0.1	-0.1	0.2	0.07	0.2
ecy	0.11	0.4	0.1	0.11	0.35
ery	0.53	0.11	0.11	0.59	0.2
eby	0.22	0.4	0.4	0.34	0.4
esy	0.23	0.23	0.2	0.06	0.2
eyy	0	0	0.2	0	0.3

q0-wheat	9404	57925	2409	26015	110907
q0-cg	20751	67025	9663	23101	138574
q0-rice	413	864	2	0	2126
q0-beef	867	6784	558	1027	8590
q0-sugar	2014	14165	2002	132	12353
q0-soy	175	53	23	728	1034
sww	0.82	0.46	0.82	0.72	0
swc	-0.58	-0.25	-0.58	-0.13	0
swr	0	0	0	0	0
swb	0	0	0	0	0
sws	0	0	0	0	0
swy	0	0	0	-0.05	0
scw	-0.31	-0.24	-0.31	-0.2	0
scc	0.82	0.41	0.82	0.65	0
scr	0	0	0	0	0
scb	0	0	0	0	0
scs	0	0	0	0	0
scy	0	0	0	-0.05	0
srw	0	0	0	0	0
src	0	0	0	0	0
srr	0.57	0.36	0.57	0	0
srb	0	0	0	0	0
srs	0	0	0	0	0
sry	0	0	0	0	0
sbw	0	0	0	0	0
sbc	0	0	0	0	0
sbr	0	0	0	0	0
sbb	1.6	0.62	1.6	0.24	0
sbs	0	0	0	0	0
sby	0	0	0	0	0
ssw	-0.15	-0.02	-0.15	0	0
ssc	-0.12	0	-0.12	0	0
ssr	0	0	0	0	0
ssb	0	0	0	0	0
sss	0.29	0.1	0.29	0.5	0
ssy	0	0	0	0	0
syw	0	0	0	-0.06	0
syc	0	0	0	-0.18	0
syr	0	0	0	0	0
syb	0	0	0	0	0
sys	0	0	0	0	0
syy	0.8	0.4	0.8	0.34	0
rqw	0.032	0.028	0.025	0.021	0.027
rqc	0.030	0.023	0.018	0.027	0.018

rqr	0.010	0.010	0.028	0.000	0.024
rqb	0.000	0.000	0.000	0.000	0.000
rqs	0.023	0.017	0.000	0.013	0.011
rqy	0.029	0.034	0.000	0.010	0.026
lou0	4648	22603	1292	2463	25420
ely	0.4	0.5	0.5	0.5	0.5
f0w	3402	22570	527	2474	67853
f0c	26907	58744	5088	16032	120142
f0r	42	446	1	0	205
f0y	4100	19941	469	1376	8618
gfr	0.005	0.005	0.005	0.005	0.005
efww	-1.48	-1.48	-1.48	-0.73	0
efwc	0.97	0.97	0.97	0.56	0
efwr	0	0	0	0	0
efwy	0.08	0.08	0.08	0.08	0
efcw	0.25	0.25	0.25	0.31	0
efcc	-0.78	-0.78	-0.78	-0.91	0
efcr	0	0	0	0	0
efcy	0.1	0.1	0.1	0.09	0
efrw	0	0	0	0	0
efrc	0	0	0	0	0
efrr	-1	-1	-1	0	0
efry	0	0	0	0	0
efyw	0.04	0.04	0.04	0.11	0
efyc	0.23	0.23	0.23	0.38	0
efyr	0	0	0	0	0
efyy	-1.12	-1.12	-1.12	-1.3	0
efc	-0.563	-0.291	-0.291	-0.079	0
efbww	-1.4	-1.4	-1.4	0	0
efbwc	0.74	0.74	0.74	0	0
efbwy	-0.02	-0.02	-0.02	0	0
efbcw	0.22	0.22	0.22	0	0
efbcc	-0.85	-0.85	-0.85	-0.8	0
efbcy	0.02	0.02	0.02	0.02	0
efbyw	-0.03	-0.03	-0.03	0	0
efbyc	0.08	0.08	0.08	0.35	0
efbyy	-1.4	-1.4	-1.4	-1.2	0
pse0w	0.11	0.27	0.12	0.19	0.00
pse0c	0.15	0.17	0.47	0.19	0.00

pse0r	0.42	0.36	0.00	0.00	0.00
pse0b	0.18	0.50	0.17	0.14	0.00
pse0s	0.40	0.53	-0.30	0.24	0.00
pse0y	0.22	0.48	0.00	0.00	0.00
cse0w	-0.05	-0.16	0.32	0.03	0.00
cse0c	-0.07	-0.10	0.32	-0.02	0.00
cse0r	-0.20	-0.04	0.00	0.00	0.00
cse0b	-0.10	-0.12	0.32	-0.01	0.00
cse0s	-0.20	-0.50	0.30	-0.03	0.00
cse0y	-0.10	0.00	0.00	0.00	0.00
ratw	0.13	0.06	0.15	0.05	0.21
ratc	0.15	0.14	0.12	0.09	0.25
ratr	0.09	0.14	0.07	0.03	0.13
raty	0.00	0.00	0.06	0.04	0.02

Table A2. Basic Input Data for Developing Countries

	EGYPT	KOREA	NA/ME (remainder)	ARGENTINA	BRAZIL	INDIA
c0-wheat	5120	1127	19644	2566	4529	29721
c0-cg	2394	571	5945	327	3374	24458
c0-rice	1385	5778	3037	110	5279	46834
c0-beef	236	150	1117	2374	2284	31
c0-sugar	1469	397	5148	1049	6593	15639
c0-soy	25	387	17	23	0	169
eww	-0.05	-0.36	-0.05	-0.04	-0.12	-0.15
ewc	0	0.08	0	0	0	0
ewr	0	0.2	0	0	0	0
ewb	0	0	0	0	0	0
ews	0	0	0	0	0	0
ewy	0	0	0	0	0	0
ecw	0	0.1	0	0	0	0
ecc	-0.15	-0.22	-0.15	-0.19	-0.05	-0.2
ecr	0	0.19	0	0	0	0
ecb	0	0	0	0	0	0
ecs	0	0	0	0	0	0
ecy	0	0	0	0	0	0
erw	0	0.03	0	0	0	0
erc	0	0.03	0	0	0	0
err	-0.04	-0.18	-0.04	-0.19	-0.03	-0.24
erb	0	0.04	0	0	0	0
ers	0	0	0	0	0	0
ery	0	0	0	0	0	0
ebw	0	0	0	0	0	0
ebc	0	0	0	0	0	0
ebr	0	0	0	0	0	0
ebb	-0.1	-1	-0.1	-0.19	-0.06	-0.21
ebs	0	0	0	0	0	0
eby	0	0	0	0	0	0
esw	0	0	0	0	0	0
esc	0	0	0	0	0	0
esr	0	0	0	0	0	0
esb	0	0	0	0	0	0
ess	-0.16	-0.23	-0.16	-0.2	-0.06	-0.11
esy	0	0	0	0	0	0
eyw	0	0	0	0	0	0
eyc	0	0	0	0	0	0
eyr	0	0	0	0	0	0

eyb	0	0	0	0	0	0
eys	0	0	0	0	0	0
eyy	-0.41	-0.4	-0.41	-0.2	0	-0.02
rn	0.022	0.012	0.0276	0.012	0.018	0.018
r0y	0.06	0.07	0.0539	0.014	0.052	0.045
r0a				0.02	0.039	0.028
ewy	0.18	0.14	0.18	-0.11	0.4	0.3
ecy	-0.17	0.30	-0.17	0.30	0.18	0.3
ery	0.17	-0.22	0.17	0.30	0.1	0.1
eby	0.5	1.1	0.5	0.03	0.5	1.2
esy	0.68	0.78	0.68	0.21	0.2	0.46
eyy	0.48	0.1	0.48	0.14	0	0.1
q0-wheat	1984	78	16423	11867	2091	38853
q0-cg	4131	953	11880	19511	21036	31106
q0-rice	1898	5884	1693	267	6854	64062
q0-beef	127	93	875	2609	2333	79
q0-sugar	748	0	1296	1627	9256	16022
q0-soy	153	235	144	3890	14141	563
sww	1.355	0.45	1.355	0.24	0.362	0.263
swc	0	0	0	-0.0143	-0.14	-0.193
swr	0	-0.37	0	0	0	0
swb	0	0	0	0	0	0
sws	0	0	0	0	0	0
swy	0	0	0	0	0	0
scw	0	-0.28	0	-0.011	0	-0.588
scc	0.666	0.5	0.666	0.236	0.17	0.824
scr	0	-0.2	0	0	-0.1	0
scb	0	0	0	0	0	0
scs	0	0	0	0	0	0
scy	0	0	0	0	0	0
srw	0	0	0	0	0	0
src	0	0	0	0	0	0
srr	1.806	0.14	1.806	0.258	0.27	0.62
srb	-0.12	-0.12	-0.12	0	0	0
srs	0	0	0	0	0	0
sry	0	0	0	0	0	0
sbw	0	0	0	0	0	0
sbc	0	0	0	0	0	0
sbr	0	0	0	0	0	0
sbb	0.321	0.321	0.321	0.12	0.25	0.143
sbs	0	0	0	0	0	0
sby	0	0	0	0	0	0
ssw	0	0	0	0	0	0

ssc	0	0	0	0	0	0
ssr	0	0	0	0	0	0
ssb	0	0	0	0	0	0
sss	0.3	0	0.3	0.3	0.23	0.366
ssy	0	0	0	0	0	0
syw	0	0	0	0	0	0
syc	0	0	0	0	0	0
syr	0	0	0	0	0	0
syb	0	0	0	0	0	0
sys	0	0	0	0	0	0.27
syy	0.1094	0.1094	0.1094	0.1094	0.04	0.2234
rqw	0.011	0.022	0.021	0.011	0.012	0.037
rqc	0.015	0.032	0.014	0.034	0.014	0.017
rqr	0.004	0.023	0.033	0.000	0.000	0.016
rqb	0.000	0.000	0.000	0.000	0.000	0.000
rqs	0.000	0.000	0.011	0.000	0.015	0.009
rqy	0.000	0.025	0.029	0.039	0.000	0.013
lou0	457	536	2798	3400	4851	1049
ely	0.61	0.5	0.58	0.1	0.32	0.93
f0w	1606	433	4753	348	1602	3530
f0c	2392	3348	10258	5957	15244	2439
f0r	148	610	180	21	577	5327
f0y	292	590	972	239	1003	118
gfr	0.01	0.00635	0.0067	0	0.0055	0
efww	-1.48	-1.48	-1.48	-1.48	-1.48	-1.48
efwc	0.97	0.97	0.97	0.88	0.88	0.88
efwr	0	0	0	0	0	0
efwy	0.08	0.08	0.08	0.026	0.026	0.026
efcw	0.25	0.25	0.25	0.62	0.62	0.62
efcc	-0.78	-0.78	-0.78	-1.34	-1.34	-1.34
efcr	0	0	0	0	0	0
efcy	0.1	0.1	0.1	0.026	0.026	0.026
efrw	0	0	0	0	0	0
efrc	0	0	0	0	0	0
efrr	-1	-1	-1	-1	-1	-1
efry	0	0	0	0	0	0
efyw	0.04	0.04	0.04	0.17	0.17	0.17
efyc	0.23	0.23	0.23	0.14	0.14	0.14
efyr	0	0	0	0	0	0
efyy	-1.12	-1.12	-1.12	-1.96	-1.96	-1.96
efc	-0.208	-0.208	-0.208	-0.208	-0.208	-0.208

efbww	0	0	0	0	0	0
efbwc	0	0	0	0	0	0
efbwy	0	0	0	0	0	0
efbcw	0	0	0	0	0	0
efbcc	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07
efbcy	0	0	0	0	0	0
efbyw	0	0	0	0	0	0
efbyc	0	0	0	0	0	0
efbyy	0	0	0	0	0	0
pse0w	-0.28	0.62	-0.18	-0.32	-0.14	-0.27
pse0c	-0.28	0.54	-0.18	-0.32	-0.26	-0.27
pse0r	-0.28	0.68	-0.18	-0.32	-0.14	-0.30
pse0b	-0.28	0.77	-0.18	-0.32	-0.26	-0.21
pse0s	-0.28	0.00	-0.18	-0.32	-0.14	-0.21
pse0y	-0.28	0.76	-0.18	-0.32	-0.26	-0.12
cse0w	0.21	0.20	0.08	0.13	0.07	0.16
cse0c	0.21	-0.65	0.08	0.13	0.19	0.16
cse0r	0.21	-0.66	0.08	0.13	0.07	0.12
cse0b	0.21	-0.76	0.08	0.13	0.19	0.11
cse0s	0.21	-0.68	0.08	0.13	0.07	0.11
cse0y	0.21	-0.74	0.08	0.13	0.19	0.45
ratw	0.11	0.09	0.17	0.09	0.32	0.19
ratc	0.13	0.16	0.19	0.05	0.12	0.15
ratr	0.20	0.04	0.07	0.33	0.24	0.21
raty	0.04	0.03	0.02	0.11	0.03	0.20

	NIGERIA	PAKIST	TURKEY	ASIA ------	SSAFRICA (remainder)	LAT.AM. ------	CHINA
c0-wheat	937	10231	7110	6729	2935	7879	51840
c0-cg	5771	1086	679	7417	20878	13669	39095
c0-rice	1311	2157	199	72130	4788	4164	92674
c0-beef	274	206	201	883	1542	2857	205
c0-sugar	1024	2878	1588	7473	2180	10195	6428
c0-soy	53	2	0	701	91	0	4535
eww	-0.35	-0.15	-0.2	-0.36	-0.35	-0.25	0
ewc	0	0	0	0	0	0	0
ewr	0	0	0	0.2	0	0	0
ewb	0	0	0	0	0	0	0
ews	0	0	0	0	0	0	0
ewy	0	0	0	0	0	0	0
ecw	0	0	0	0.1	0	0	0

ecc	-0.08	-0.2	-0.2	-0.22	-0.08	-0.2	0
ecr	0	0	0	0.19	0	0	0
ecb	0	0	0	0	0	0	0
ecs	0	0	0	0	0	0	0
ecy	0	0	0	0	0	0	0
erw	0	0	0	0	0	0	0
erc	0	0	0	0	0	0	0
err	-0.23	-0.24	-0.2	-0.18	-0.23	-0.3	0
erb	0	0	0	0	0	0	0
ers	0	0	0	0	0	0	0
ery	0	0	0	0	0	0	0
ebw	0	0	0	0	0	0	0
ebc	0	0	0	0	0	0	0
ebr	0	0	0	0	0	0	0
ebb	-0.06	-0.21	-0.2	-1	-0.06	-0.1	0
ebs	0	0	0	0	0	0	0
eby	0	0	0	0	0	0	0
esw	0	0	0	0	0	0	0
esc	0	0	0	0	0	0	0
esr	0	0	0	0	0	0	0
esb	0	0	0	0	0	0	0
ess	-0.14	-0.11	-0.2	-0.23	-0.14	-0.1	0
esy	0	0	0	0	0	0	0
eyw	0	0	0	0	0	0	0
eyc	0	0	0	0	0	0	0
eyr	0	0	0	0	0	0	0
eyb	0	0	0	0	0	0	0
eys	0	0	0	0	0	0	0
eyy	-0.2	-0.02	-0.2	-0.4	-0.2	0	0
rn	0.034	0.027	0.019	0.0194	0.0317	0.021	0.013
r0y	0.034	0.056	0.054	0.0549	0.0262	0.0301	0.081
r0a	0.014	0.027	0.029	0.0348	0.014	0.0239	0.062
ewy	0.5	0.65	0	0.5	0.5	0.3	0.5
ecy	-0.18	-0.24	-0.07	0.17	-0.18	0.25	0.17
ery	0.5	0.3	0.1	0.3	1	0.5	0.82
eby	1.2	0.87	0.8	0.42	0.25	0.1	0.42
esy	0.71	0.46	0.24	0.63	0.71	0.25	0.63
eyy	0.43	0.1	0	0.66	0.43	0	0.66
q0-wheat	30	11731	16994	2649	1422	5132	69836
q0-cg	8022	1620	8181	16892	26821	27130	84907
q0-rice	998	4139	265	98481	4137	5594	129087
q0-beef	248	206	211	851	1517	3041	195
q0-sugar	93	2852	1707	8926	3410	17971	4981
q0-soy	73	2	37	1208	127	981	9384

sww	0.328	0.263	0.468	0.263	0.328	0.362	0
swc	0	-0.193	-0.385	-0.193	0	-0.14	0
swr	0	0	0	0	0	0	0
swb	0	0	0	0	0	0	0
sws	0	0	0	0	0	0	0
swy	0	0	0	0	0	0	0
scw	0	-0.588	-0.521	-0.588	0	0	0
scc	0.335	0.824	1.04	0.824	0.335	0.17	0
scr	0	0	0	0	0	-0.1	0
scb	0	0	0	0	0	0	0
scs	0	0	0	0	0	0	0
scy	0	0	0	0	0	0	0
srw	0	0	0	0	0	0	0
src	0	0	0	0	0	0	0
srr	0.336	0.62	0.623	0.62	0.336	0.27	0
srb	0	0	0	0	0	0	0
srs	0	0	0	0	0	0	0
sry	0	0	0	0	0	0	0
sbw	0	0	0	0	0	0	0
sbc	0	0	0	0	0	0	0
sbr	0	0	0	0	0	0	0
sbb	0.298	0.143	0.347	0.143	0.298	0.25	0
sbs	0	0	0	0	0	0	0
sby	0	0	0	0	0	0	0
ssw	0	0	0	0	0	0	0
ssc	0	0	0	0	0	0	0
ssr	0	0	0	0	0	0	0
ssb	0	0	0	0	0	0	0
sss	0.162	0.366	0.228	0.366	0.162	0.23	0
ssy	0	0	0	0	0	0	0
syw	0	0	0	0	0	0	0
syc	0	0	0	0	0	0	0
syr	0	0	0	0	0	0	0
syb	0	0	0	0	0	0	0
sys	0	0	0	0.27	0	0	0
syy	0.1	0.2234	0.2	0.2234	0.1	0.04	0
rqw	0.016	0.037	0.031	0.012	0.019	0.014	0.009
rqc	0.000	0.016	0.015	0.035	0.019	0.028	0.008
rqr	0.033	0.032	0.008	0.019	0.002	0.030	0.035
rqb	0.000	0.000	0.000	0.000	0.000	0.000	0.000
rqs	0.004	0.006	0.014	0.003	0.002	0.011	0.010
rqy	0.000	0.000	0.029	0.026	0.076	0.000	0.025
lou0	762	786	884	4611	2587	7560	15759

ely	1.07	0.45	0.45	0.86	0.35	0.34	0.23
f0w	218	878	2984	1267	451	3134	15792
f0c	547	241	5605	7178	3358	18419	37499
f0r	21	339	25	9735	251	823	12957
f0y	40	0	34	1922	5	3144	4554
gfr	0.00415	0	0.00255	0.00635	0.00465	0.0076	0.00635
efww	-1.48	-1.48	-1.48	-1.48	-1.48	-1.48	0
efwc	0.88	0.88	0.88	0.88	0.88	0.88	0
efwr	0	0	0	0	0	0	0
efwy	0.026	0.026	0.026	0.026	0.026	0.026	0
efcw	0.62	0.62	0.62	0.62	0.62	0.62	0
efcc	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34	0
efcr	0	0	0	0	0	0	0
efcy	0.026	0.026	0.026	0.026	0.026	0.026	0
efrw	0	0	0	0	0	0	0
efrc	0	0	0	0	0	0	0
efrr	-1	-1	-1	-1	-1	-1	0
efry	0	0	0	0	0	0	0
efyw	0.17	0.17	0.17	0.17	0.17	0.17	0
efyc	0.14	0.14	0.14	0.14	0.14	0.14	0
efyr	0	0	0	0	0	0	0
efyy	-1.96	-1.96	-1.96	-1.96	-1.96	-1.96	0
efc	-0.208	-0.208	-0.208	-0.208	-0.208	-0.208	
efbww	0	0	0	0	0	0	
efbwc	0	0	0	0	0	0	
efbwy	0	0	0	0	0	0	
efbcw	0	0	0	0	0	0	
efbcc	-1.07	-1.07	-1.07	-1.07	-1.07	-1.07	
efbcy	0	0	0	0	0	0	
efbyw	0	0	0	0	0	0	
efbyc	0	0	0	0	0	0	
efbyy	0	0	0	0	0	0	
pse0w	-0.24	-0.24	-0.45	0.08	0.13	0.05	0.00
pse0c	-0.35	-0.24	-0.45	-0.31	-0.22	-0.22	0.00
pse0r	-0.51	-0.24	-0.45	-0.31	0.13	0.05	0.00
pse0b	-0.35	-0.38	-0.45	0.08	0.13	0.05	0.00
pse0s	-0.90	-0.38	-0.45	-0.31	-0.22	-0.22	0.00
pse0y	-0.35	-0.38	-0.20	0.08	-0.22	-0.22	0.00
cse0w	1.60	0.07	0.28	-0.21	-0.41	-0.18	0.00

cse0c	1.60	0.07	0.28	0.19	-0.07	0.12	0.00
cse0r	0.35	0.07	0.28	0.19	-0.41	-0.18	0.00
cse0b	0.63	0.21	0.28	-0.21	-0.41	-0.18	0.00
cse0s	1.60	0.21	0.28	0.19	-0.07	0.12	0.00
cse0y	0.63	0.21	0.03	-0.21	-0.07	0.12	0.00
ratw	0.07	0.10	0.69	0.09	0.09	0.10	0.16
ratc	0.28	0.19	0.24	0.15	0.18	0.11	0.13
ratr	0.17	0.21	0.27	0.17	0.24	0.14	0.17
raty	0.21	0.00	0.00	0.06	0.35	0.04	0.15