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The effect of trade liberalization in agriculture on the US economy: projections to 1991

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Summary

By 1986, domestic policies to support farm income and trends in international markets conspired to reduce prices for agricultural goods to two-thirds of what they were, on average, in 1982. In running our model from 1982 to create a 1986 benchmark, we were able to account for this deterioration endogenously by setting farm policy instruments at their 1986 levels, increasing the US government budget deficit (which put upward pressure on the exchange rate), and setting world market prices at their observed levels. In this paper we explore whether or not that process can be turned around, at least for the United States, by dismantling all distorting farm policies under the assumption that by 1991, both the US trade and government budget deficits are significantly reduced.

One of the fundamental macro assumptions underlying our base projection to 1991 is that the US greatly expands exports. The US agricultural sector is competitive in world markets and, given the real devaluation that must accompany macro adjustment, will account for a significant portion of these increased exports. The removal of producer subsidies in US agriculture, if the rest of the world also liberalizes, does not compromise this important role.

If a failure to achieve agricultural trade liberalization should lead to a round of protectionist policies worldwide, the resulting shrinkage of world trade could endanger the ability of the US to achieve macro balance, with potential negative feedbacks to other economies. Thus, as a policy stance, the US should seek liberalization. The question is whether the US is willing to accept the structural adjustments that will necessarily accompany the changes in domestic agricultural policies underpinning liberalization.

Our results suggest that the US faces a classic trade liberalization dilemma. Policy reform leads to an improvement in GNP and a reduction in the trade and government budget deficits. But it also leads to changes in the functional distribution of income and migration of labour out of the agricultural sectors. These are two of the problems that the agricultural subsidy programs were originally intended to redress. On the other hand, our experimental results do show gains outweighing losses from liberalization. Finally, the concomitant structural adjustment, at both the sectoral and macro levels, provides a firmer basis for future growth in an environment of freer trade.

I Introduction *

In recent years, two trends have dominated world agricultural markets. First, there has been a steady increase in the rates of protection of the agricultural sector in developed countries. Second, there has been a dramatic drop in world prices of primary commodities. The decline in world prices, which was not met by an increase in demand, has led to spiralling costs of domestic support programs as governments sought to maintain farm incomes in the face of declining revenue from the world markets.

Governments have come to realize that they operate in an increasingly interdependent world. Their domestic support policies have served to exacerbate the excess supply on both world and domestic markets since, in many countries, support has not been accompanied by programs to reduce output. The lesson is that policies with a primarily domestic focus can nonetheless have a significant impact on trade.

It is particularly difficult to measure the welfare effects of policy-induced distortions that have both domestic and international allocative impacts. The theoretical literature, which is largely concerned with the benefits of free trade in undistorted economies, provides little guidance on how to determine whether or not the removal of one of many distortions will improve welfare in a particular country. We might then turn to the second-best literature on gains from trade. This literature yields some counter-examples to the 'universal gains from trade' proposition, but does not provide specific guidelines for assessing the impact on domestic welfare of the removal of a particular distortion.

The welfare gains (or losses) from reducing distortions in a tradeable sector will depend on a number of factors. These include the size of the original distortion, the magnitude of the distortion relative to the difference between the undistorted domestic price and the world price, and the difference between the free trade domestic outputs and prices in the distorted and undistorted equilibria. In turn, the magnitudes of these differences will depend on elasticities of transformation between tradeables and non tradeables, sectoral trade substitution elasticities and trade shares, the price elasticity of demand for exports, and price and income effects on the domestic demand side. These are likely to be commodity, distortion, and economy specific.

To analyze this complex problem, we use an empirical approach by constructing a computable general equilibrium (CGE) model of the US. The CGE model consists of a set of parameterized simultaneous equations that simulate a market economy and which are solved

to yield equilibrium prices and levels of market activity. The parameters of the model include those required to determine the magnitudes of welfare changes arising from changes in policy instruments: measures of distortion, elasticities, shares, and the initial conditions reflected by sectoral structure of input use, output, and relative prices.

The present paper analyzes the prospective impact of removing a particular set of distortions – producer subsidies in US agriculture – on the structure of the economy in 1991. Agriculture is a major trading sector and has significant linkages with the rest of the economy, both forward and backward. Agricultural exports contribute significantly to the US balance of trade. The major forward linkage is with the food and fibre processing sectors, the products of which comprise a large share of consumer expenditure.[1] Finally, agriculture is capital-intensive and competes with other sectors for the employment of capital as well as of labour.

In this paper, we first outline the subsidy programs in US agriculture in place through 1990-1991 under the 1985 Farm Bill. We then describe the CGE model which is used to provide a base-run projection from 1986 to 1991, assuming the policies established by the 1985 Farm Bill remain intact. Next, a series of experiments is conducted to analyze the impact of removing the producer subsidies. Finally, we discuss implications for policy.

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1 For an analysis of these linkages, see Henry and Schluter (1985).

II Producer subsidies in US agriculture

In the United States, federal and state programs targeting agriculture include some which distort production incentives, some which are intended to be pure income transfers, and others that seek essentially to internalize externalities. Here we are primarily concerned with the programs which influence production and marketing decisions. The criterion used to determine which programs directly influence supply and demand behaviour is whether or not the policy instrument is an argument in the agent's behavioural equation. Accordingly, we draw on the voluminous theoretical and applied literature analyzing the effect of US farm programs on agricultural employment and output. We focus on the programs which distort production incentives and the domestic/imported commodity mix in the short run, and which affect the use of land in the medium-to-long run.

The other program expenditures are intended to be, and are treated as, either lump-sum income transfers or expenditures on public goods. Agricultural research and extension can be seen as public goods by virtue of the lack of proprietary control over agricultural production technology. Soil conservation also represents a public-good issue. These programs deal with externalities and are not considered to affect producer behaviour at the margin.

In our model there are three agricultural sectors. The 'dairy and meat' sector includes milk, eggs, poultry, and meat. The 'grains' sector includes food and feed grains, as well as soybeans and cotton. The 'other agriculture' sector includes sugar, tobacco, vegetables, and all other agricultural output. Agricultural programs differ between these sectors but are relatively homogeneous within each sector.

Programs which distort production incentives in the short run are measured ex post by a summary 'producer incentive equivalent' (PIE) rate, calculated as the value of the subsidies paid to each sector divided by the value of sectoral output. In the US in 1986, 25.9 billion dollars was spent to support the agricultural sector in ways that distort producer incentives. For the three agricultural sectors in the model, these translate into the following PIE rates: 6.24 per cent in dairy, 28.39 per cent in grains, and 1.26 per cent in other agriculture. The dollar values of the sum of price-increasing and cost-reducing transfers per sector are calculated from the data reported in the Mid-Session Review of the Commodity Credit Corporation (July, 1987). The denominators for these rates are calculated using the input-output data that are the basis for the value of output in our model.

The dairy and meat sector subsidies arise from programs that support prices, restrict

imports (both directly and through the use of quality controls), and subsidize exports. In particular, the price of milk is supported through a mandatory marketing order program that establishes the minimum price, handlers must pay to milk producers. Milk production amounts to 17 per cent of the value of output of the dairy and meat sector. The support price for milk is maintained by the existence of import quotas on processed milk products and government purchases of butter, cheese, and non-fat dry milk. As long as the quotas are binding, the domestic price of processed dairy products will be higher than the world prices. Then, if necessary, the government accumulates stocks to support the price processors pay to milk suppliers.

The export program operates by awarding a payment-in-kind to exporters of US products to specified foreign markets that compensates exporters for the low competitive price paid by the importer. This selective export enhancement program (EEP) is available for dairy cattle, poultry, and eggs, in the dairy and meat sector. An export enhancement program that operates in the same way as the export program in the dairy and meat sector is also in effect for wheat and some minor grains. This program reduces the downward pressure on market prices and loan rates exerted by excess domestic grain stocks.

The EEP is modelled as an ad valorem subsidy on exports of farm products. The ad valorem rate is the ratio of the EEP bonuses to the value of exports, by sector. In 1986, the export subsidies under the EEP amounted to 20.9 in 'dairy and meat', 3.6 in 'grains', and 1.0 in 'other agriculture'.[2]

Direct subsidies in other agriculture are available for only a few crops in that sector, including sugar, tobacco, and peanuts. The price paid by processors to producers of sugar (about 5 per cent of the value of the 'other agriculture' sector) is supported by quotas on sugar imports and by a non-recourse loan program. Government stocking and production quotas help maintain producer prices in the tobacco and peanut industries. Phytosanitary regulations and seasonal restrictions on fruit and vegetable imports also help to raise the market price of domestic production in the other agriculture sector.

In the grains sector, market prices are supported by government accumulation of stocks under the non-recourse loan programs, which apply to nearly 80 per cent of the sector's output in value terms. Income support is provided to farmers who participate in acreage reduction programs through government transfers called deficiency payments. In 1986, participation in government programs rose to a record high, with (for example) over 85, 90, and 97 per cent of farmland in wheat and corn, cotton, and rice, respectively enrolled in the

2 The value of EEP bonuses for 'dairy and meat' and 'other agriculture' was calculated from FAS REPORT press releases for calendar year 1986. The EEP for 'grains' was provided by Mark Smith at ERS/USDA.

Acreage Reduction Programs; to be eligible for deficiency payments.[3]

The deficiency payment rate is equal to the difference between the target price and the higher of the market price or the loan rate price, and is applied per unit of predetermined output. The levels of the target and loan rate prices and the amounts of acreage to be withdrawn from production are determined in accordance with the provisions of the 1985 Farm Bill and announced before planting. The loan rate is set at 75-85 per cent of past average market prices for the grains sector. The government's accumulation of commodity stocks in lieu of loan repayment supports the market price to some extent. Nevertheless, in 1986, the average loan rate was over 150 per cent of the average market price.[4]

Which (or what combination) of the target, loan rate, or market prices represents the incentive to produce? Clearly, given all the subsidy programs, the market price is not the determinant of the returns to labour, land, and capital in agriculture. For participants, the loan rate price is the value of the production forfeited under the loan program, but it is not a measure of total net returns to producers who participate in farm support programs since deficiency payments would also be included in total returns. Deficiency payments in 1986 almost doubled net farm income on grain farms. Farmers assume tha eligibility for future payments depends on the current allocation of resources to program crops, so the target price provides an incentive for current resource allocation and the supply of grains. This conclusion is particularly true when participation in the programs is high, as is currently the case. While the loan rate and the market prices also have some effects on expectations and incentives, the target price appears to be the most important signal.

At issue is how to model supply behavior in the agricultural sectors. Econometric models include the target price relative to the market clearing price as a major determinant of land use under farm programs in agriculture.[5] Similarly, in our model, the incentive signal for farmers is assumed to be the target price for 1985 through 1991, which has already been set according to the provisions of the 1985 Food Security Act.

In the dairy and meat and the other agriculture sectors, where the target prices are supported largely by the existence of import controls, and secondarily by government stock

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3 For participation rates for the years 1983 through 1987, see table 22, page 48, in *Agricultural Outlook*, ERS/USDA AO 139, (March, 1988).

4 The predetermined output is calculated as the five-year moving average yield per acre times the 'program' acreage. The 'program' acreage is the amount of land that the farmer has previously planted to program crops which he has certified to be part of the base acreage. The 'program' acreage includes the land set aside (not currently in production of program crops) as well as planted acreage. See Glaser, (1986).

5 For an exemplary analysis, see Houck et al, 'Analyzing the Impact of Government Programs on Crop Acreage', 1976.

accumulation, we assume that the quotas reduce actual imports to half of their desired value, of given observed prices. Also, since the processed dairy products, against which the import quotas are applied, comprise a very small portion of the value in the light consumer sector, we assume that the quotas are levied against the raw products.

To model these agricultural programs, we calibrated the model for 1982, with target prices, loan rates, import quotas, export subsidies, land set-asides, and government stocking behaviour in place. The model was then benchmarked for 1986 by setting those policy instruments at the 1986 levels relative to 1982, adding the Export Enhancement program export subsidies, which were not present in 1982. Given the target prices, resources are employed in the agricultural sector according to profit maximization behavioural rules. Market clearing prices are determined endogenously and simultaneously with production, the levels of government commodity accumulation, export supply, and domestic demand.

Two measures of sectoral subsidization are then calculated ex post, the PIE ad valorem rate and the Producer Subsidy Equivalent (PSE). The PIE rate is calculated as the percentage difference between the exogenous target or support price and the endogenous market clearing price. This wedge represents the part of the output subsidy due to the existence of support prices, that has been paid by the government to producers. Since border measures and government stocking raise the market clearing price closer to the support price, the wedge between the market and the target price does not measure all of the incentive distortion arising from the programs.

The producer subsidy equivalent (PSE) is loosely defined as the amount of direct income transfer necessary to compensate the producer for the loss of the subsidy programs, at the observed level of supply. It is estimated as the amount of income due to the programs, in each sector. The PSE can be defined in relation to several bases: with respect to total income, the quantity produced, or the value of production (in terms of domestic or world prices). Following the OECD and Ballenger et al (1987), we use total sector income as the denominator. The PSE rate is then calculated as the ratio of income generated by the support programs to total income.[6] The PSE rates are not calculated using the exact same data as used some in other studies, and will, of course, differ from calculations which use another base as denominator.[7]

The income due to programs includes deficiency payments, the value of excess stocking

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6 For further discussion of PIE and PSE rates, see Rausser and Wright (1987); Josling and Tangermann (1987); and Tangermann et al (1987).

7 The rates of PSE subsidies are calculated by a USDA-ERS team using similar data from different sources. See also Ballenger et al (1987).

to support the market price, and part of the premium rent arrising from quantitative restrictions. Since the import controls are on processed farm products, in this model the rents generated by the existence of quotas are first accumulated by the importing sector. The producing sector's share of the quota rents is assumed to be equal to the producer share of the retail value of the item. The value of the market price support provided by government stocking behaviour is the value of government stock demand for program commodities in excess of normal carryover demand. Government stock demand is modelled as a function of the ratio of the market price to the loan rate, with a demand elasticity of 5.0. The sum of program-related sectoral income elements comprises the numerator of the PSE ratio. The denominator is the sum of the sectoral program income, market income, and any other direct transfer payments to the sector.

III A CGE model of the US economy

Our US CGE model is in the tradition of models developed for the analysis of trade policy.[8] The model equations describe the behaviour of the various economic agents in markets for factors and commodities. It is neoclassical and Walrasian in spirit, solving for a set of relative prices, including the real exchange rate, that achieve full employment, and flow equilibria in all markets.

There are ten sectors producing commodities for domestic use and for export: three agricultural sectors, five industrial sectors, and two service sectors.[9] The agricultural sectors are roughly categorized by trade shares. In the dairy and meat sector, both exports and imports are very low. In the grains sector, exports are very significant. Finally, other agriculture produces a heterogeneous mix of agricultural products for which there are smaller, but still significant, levels of exports and imports.

There are three primary factors of production: labour, capital, and agricultural land. The aggregate supplies of labour and capital are assumed fixed, but both factors are assumed to be freely mobile among sectors. Land is specific to two of the agricultural sectors (grains and other agriculture) and can be freely shifted between them. In this model, based in 1986, when program participation rates were high, the aggregate supply of crop land is bound from above under the set-aside constraints of the farm programs. For the 'no program' experiments, land supply for crops is modelled as a fairly inelastic function of the ratio of the solution productive rate of return relative to the 1986 rate of return.[10]

The model is designed to perform experiments in a comparative static framework spanning a period long enough so that it is reasonable to assume that sectoral investment is affected by changes in relative prices and policies. In equilibrium, the model will determine average rentals for land and capital, and an average wage rate that clears the markets for land, capital, and labour. Different returns to land, labour, and capital among sectors are taken into

8 Our particular model is an extension of the model by Adelman and Robinson (1987). It is close in spirit to the model described in Condon et al (1985). Related models are discussed in Dervis et al(1982) and Robinson (1987).

9 See Appendix I for the industry composition of sectors in the model.

10 The land supply equation is similar in content to the land supply equations in the model AGSIM at the University of Illinois (C.R. Taylor, 1988). Estimated elasticities of regional land supply with respect to expected productive returns to land range from 0.06 to 8.89. We assume a 0.5 elasticity of land supply with respect to the relative productive return to land. With this elasticity, the acreage restrictions (on land in crops while subsidy programs are operative) reduce land in crops by about 16 per cent which is close to the required cropland set-aside rate under the 1985 Farm Bill.

account in the model by imposing fixed ratios of the factor return in each sector relative to the economy-wide average rate of return. These ratios are computed from the 1982 base-year data.

Equilibrium solutions under existing policies represent allocations of labour and capital (implicitly, investment) among sectors that maintain the relative profit and wage distortions observed in the economy in the base year. The results of induced changes in sectoral investment (and disinvestment) are modelled by assuming intersectoral capital mobility. When agricultural subsidy policies are dismantled, these fixed ratios of rates of return to capital in agriculture are exogenously specified to fall to the economy-wide average, and capital investment is reallocated accordingly.

Production technology in all sectors is specified by Cobb-Douglas functions in labour and capital, (and also in land in the two land-using agricultural sectors). Intermediate inputs are assumed to be required according to fixed input-output coefficients. This simple formulation is adequate for our present purposes, but is clearly worth extending.[11] Technological change, which is specified exogenously over time, is assumed to be Hicks (and Harrod) neutral, output-augmenting, productivity growth.

On the demand side, the model includes the following actors who receive income and demand goods: households, government, capital account, and the rest of the world. There are three types of households in the model, categorized by income class, who own capital and land, and receive income from wages, profits, rents, and government transfers. Households pay taxes and save according to fixed average saving rates and then allocate their consumption expenditure according to a simple linear expenditure system.

The treatment of foreign trade

The behaviour of the 'rest of the world' in the model is characterized very simply. On the import side, the US is assumed to be a 'small country' and hence can purchase as much imports as it wishes with no impact on world prices. For non-agricultural exports, the US is also assumed to follow the 'small country' assumption, with world prices fixed exogenously. For two of the three agricultural sectors, however, there are equations describing world export demand behaviour as a function of US export prices. World prices of exports are assumed to be inversely related to US agricultural export volumes, with fixed price elasticities.[12] The

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11 For a discussion of the implications of the Cobb-Douglas model, see Hertel (1988).

12 Estimates of the price elasticities of world demand for US agricultural exports are based on an examination of a number of econometric studies. Given the medium-to-long run focus of our analysis, we have sought estimates of long-run demand elasticities. The export demand elasticities for both grains and other

constants in these world demand functions are shifted up exogenously in the base-run projection to 1991, reflecting an assumed increase in world income in the 1986-91 period. The functions are of the form:

$$E = E0 * (PWE/PWSE)^{-ETA}$$

where E0 is a constant, PWE is the world price of US exports, PWSE is the exogenous world price of competing exports from other countries, and ETA is the elasticity of export demand.

The US share of total world exports has fallen in recent years and is currently below 12 per cent. For imports, the share is around 15 per cent.[13] In world agricultural trade, however, the US is much more important. For example, the US accounts for over half of the world grain trade.[14] These stylized facts imply that agriculture should be treated differently from non-agricultural trade, as we have done in the model.

Products in the model are distinguished by place of origin, domestic or foreign. The sector aggregation of the model was chosen to highlight the differences between sectors with respect to shares of domestic and foreign goods in production and consumption. Imports are assumed to be imperfect substitutes in consumption for domestically produced goods of the same sector classification.[15] Consumers purchase composite commodities which are constant elasticity of substitution (CES) aggregates of the imported and domestically produced good. The share of imports in sectoral demand is inversely related to the relative price of imports (PM in domestic currency) to domestically produced goods of the same sector classification (PD).

Producers in each sector supply a composite commodity which has to be transformed in order to be shifted between the domestic and export market. The sectoral composite is defined as a constant elasticity of transformation (CET) aggregate of exports and domestic-market goods.[16] Sectoral supply behaviour thus depends on the target price (TP) in the agricultural sectors; and on the composite good price (PX) in sectors without explicit distortions. PX is a weighted average of the domestic and export prices (PD and PE), net of indirect taxes. The proportion of output destined for the export market is positively related to the price of the good in world markets (PE in domestic currency) relative to the price in the domestic market (PD).

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agriculture are assumed to equal 3.0.

13 US Department of Commerce (1986).

14 Houck (1986).

15 This treatment follows Armington (1969).

16 For a description of this treatment in a CGE model, see Condon et al (1985).

Given the distinctions in the model between imports and import substitutes, exports and goods destined for domestic demand, and composite commodities, the model specifies a number of different prices associated with each sector. The composite domestic-demand price (P) corresponds to a retail sales price and is a weighted average of the domestic price of imports (PM) and the price of goods sold on the domestic market (PD), with the weights being the quantities of imports (M) and domestic goods sold on the domestic market (XXD) as ratios to composite good supply (X):

$$P = PM * (M/X) + PD * (XXD/X)$$

The domestic price of an import depends on the world price (PWM in foreign currency), the currency exchange rate (EXR), and any tariff (TM):

$$PM = PWM * EXR * (1 + TM)$$

The domestic price of an export (PE) is defined symmetrically, where any subsidy or tax on exports are given by TE:

$$PE = PWE * EXR * (1 + TE)$$

The composite producer price (PX) is a weighted average of the domestic price of exports (PE) and the price of goods destined for the domestic market (PD), with the weights coming from the CET export aggregation function. Producers make supply decisions based on the value-added price (or net price), which is defined as:

$$PVA(i) = PX(i) * (1 - ITAX(i) + PIE(i)) - SUM(j, P(j)*A(j,i))$$

where ITAX is the indirect tax rate, PIE is the producer incentive equivalent, P is the composite good price (defined earlier), and the A's are the input-output coefficients. The subscripts i and j refer to sectors, and SUM is the summation operator. Given that input-output coefficients are fixed, changes in PVA measure changes in 'resource pull' effects. A sector whose relative value-added price rises, whether due to increases in PX or changes in taxes and subsidies, will tend to pull resources away from other sectors.

For the non-agricultural sectors, PIEs equal zero. For the agricultural sectors, as discussed above, it is assumed that producers respond to an exogenous target price, and hence to a value-added price where the target price replaces PX. In these sectors, the PIE is determined endogenously to reflect the difference between the target price and the solution market price.

The model is Walrasian in that only relative prices matter. Thus, in addition to these

sectoral prices, one must specify a numeraire good whose price is set to one, thereby defining the base for all relative price computations. In this model, the GNP deflator is chosen as numeraire and is set to one in the base year (1982). For the 1986 base, the value of the GNP deflator is set to its actual value, which is then kept fixed in the forward projections to 1991. Thus, all 1991 nominal magnitudes solved in the model can be interpreted as being roughly in 1986 prices, since the model solution is 'normalized' on the 1986 GNP deflator. One must also interpret the solution prices as being relative prices, relative to the fixed GNP deflator.[17]

The balance of trade constraint can be written (summing over sectoral imports and exports) as:

$$SUM((i, PWM(i)*M(i)) = SUM(i, PW(i)*E(i)) + FSAV + FBOR + REMIT$$

where FSAV represents foreign capital inflows, FBOR is net foreign borrowing by the government, and REMIT is remittance income from abroad. In the base run, each of these items (FSAV, FBOR, and REMIT) is specified exogenously, so the model must adjust to a fixed balance of trade. The equilibrating variable is the exchange rate (EXR). Changes in the equilibrium exchange rate, however, must be seen as changes in a relative price, given the choice of numeraire (the GNP deflator). The equilibrating mechanism is through changes in the real exchange rate, which is the relative price of tradeables to domestic goods sold on the domestic market. Thus, the real exchange rate must increase (devalue) if the exogenous balance of trade is required to improve, or decrease (revalue) if the balance of trade is assumed to worsen. Given the choice of numeraire, there will be a monotonic relationship between changes in the 'nominal' exchange rate in the model and changes in the real exchange rate, but the two will not be equivalent.[18]

In the various experiments, an alternative foreign closure is used. The exchange rate is fixed at the 1991 solution level, while foreign savings are allowed to adjust to any change in the endogenous balance of trade. Thus, FSAV indicates the status of the current account.

Macro-economic closure

The model determines only flow equilibria and does not include any assets or asset markets. It does, however, incorporate the major macro-economic aggregate nominal balances:

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17 This choice of numeraire differs from Adelman and Robinson (1987), who chose as numeraire an index of the price of domestically produced goods sold on the domestic market. They fixed this index at one for all their experiments.

18 See Dervis et al (1982), Chapter 7, for a discussion of this issue. See also de Melo and Robinson (1987).

$$Z = SH + SG + F$$

$$SG = T - G$$

$$F = M - E$$

where Z is aggregate investment, SH is total private savings, SG is government savings, F is foreign savings (the balance on current account), T is total government revenue, G is government expenditure, M is aggregate imports, and E is aggregate exports. Much effort and controversy have revolved around describing how an economy achieves balance among these macro aggregates. For our analysis, in which we assume full employment and exogenous inflation, the issue is relatively straightforward. Our focus is on the impacts of exogenous changes in macro-economic aggregates on sectoral structure, not on interactions among macro-economic aggregates.

The government receives revenue from taxes; and spends it on goods, transfers to households, program commodity stock accumulation, and subsidies to producers. Government expenditure on commodities is allocated among sectors according to observed shares. The government also borrows from (or lends to) the rest of the world, with the amount fixed exogenously. Aggregate government expenditures on goods and transfers are fixed exogenously, and the government is assumed not to be subject to a revenue constraint.[19] Any deficit or surplus in the government budget is determined residually and is assumed to be balanced by a withdrawal from, or injection into, the loanable funds market. The model thus embodies the macro assumption of perfect crowding out or in of government deficits or surpluses.

In the model, investment is 'savings driven.' In effect, there is a loanable funds market which gathers savings from all sources (private, government, and foreign) and allocates them to the purchase of investment goods.[20] Private savings are determined by fixed savings rates out of disposable income. Foreign savings are given exogenously for the base run and projection, but are endogenous in the experiments. Government savings (or deficits) are determined endogenously, given government expenditure and endogenously determined revenue.

In the experiments reported below, major changes in the balance of trade and government spending are assumed to occur between 1986 and 1991. Given the assumption of full

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19 Aggregate expenditure on goods is fixed in real terms, with sectorally fixed shares. Aggregate transfers are also fixed in real terms, using the GNP deflator to deflate nominal transfers.

20 Note that the model is static in the sense that this investment is not installed and has no effect on the aggregate capital stock within the period.

employment, these changes can have little or no effect on aggregate GNP. One focus of the analysis of the forward projection, however, is on the impact of shifts in macro aggregates on the sectoral structure of demand, supply, value added, and prices. For this analysis, we consider only one macro scenario, which is discussed in the next section. The ultimate focus is on the impact of changes in sectoral incentive policies and in world market conditions – trade liberalization – on the economy. In these experiments, the macro scenario is held constant, although the government budget deficit is still determined residually.

The sectoral composition of value added, the shares of exportable good production by sector, the ratio of imported goods to domestic production, and the main parameters of the model for 1986 are presented in Table 1.[21] These data provide a picture of the economy in the base year and are useful for understanding the experiment results reported below.

Table 1 **Sectoral composition of national income, trade shares, and elasticities**

Sector	Sectoral composition: Value added	Gross output	Exports	Imports	Trade shares: Exports/ output	Imports/ output	Elasticities: Import subs	Export trans
	per cent				per cent			
Dairy and meat	.30	1.20	.06	.14	0.25	0.86	2.00	0.50
Grains	.95	1.18	5.90	.02	26.50	0.11	4.00	4.00
Other agriculture	.77	0.78	.51	1.08	3.36	10.38	4.00	2.00
Sum/average	2.02	3.16	6.47	1.24	--	--	--	--
Light consumer	6.94	10.90	7.18	10.39	3.48	7.18	2.00	2.00
Basic intermediate	9.94	13.84	11.37	34.46	4.34	18.76	0.75	2.00
Capital goods	5.07	8.37	20.58	20.54	12.99	18.50	0.75	2.00
Construction	4.94	7.31	.02	--	.01	--	0.90	1.50
Electronics	1.94	2.26	4.76	9.63	11.13	32.08	1.10	2.00
Sum/average	28.83	42.68	43.91	75.02	--	--	--	--
Trade and finance	16.85	14.47	6.58	--	2.40	--	0.20	0.00
Other services	52.30	39.69	43.04	23.74	5.73	4.51	0.20	0.60
Sum/average	69.15	54.16	49.62	23.74	--	--	--	--
Total/average	100.00	100.00	100.00	100.00	--	--	--	--

Note (--) indicates not applicable

21 The data are from a model solution for 1986. The model starts from a 1982 benchmark equilibrium and the 1986 solution was calibrated to match the national accounts for 1986 as closely as possible. The fit, however, is not exact; the model was not 'recalibrated' on 1986.

IV The 1986-91 base run

All of our liberalization scenarios start from a baseline, five-year projection from 1986 to 1991. This base run of the model consists of a comparative static experiment which starts from a solution for 1986 and is solved assuming annual rates of growth in exogenous variables over the five years to 1991. These assumptions are compared to recent historical rates of growth in Table 2. The modelled growth in GNP is driven by assumptions about exogenous growth rates of total factor productivity (1.7 per cent per year), the capital stock, and the labour force.

We have chosen to model a single macro-economic scenario for the projection to 1991 as the base solution. Counterfactual experiments consisting of different agricultural policy mixes are conducted with respect to this base; that is, assuming no change in this basic macro-economic projection. Comparisons of liberalization scenarios against the base are relatively insensitive to variations in the macro assumptions. The projected macro-economic structure is compared to the current situation in Table 3. The most important assumptions are that as shares of GNP, the government deficit shrinks and net exports increase.

The macro scenario for the 1986-91 period is mildly optimistic. The government deficit is assumed to fall by $113 billion, to $34.5 billion, largely by not permitting significant growth in real government expenditure rather than by tax increases.[22] As the government deficit shrinks, so does the trade deficit, by assumption.

The improvement in the foreign trade balance accompanies the projected devaluation of the real exchange rate. Earlier analysis of the 1982-86 period with a related model indicated that macro policy choices leading to a large government deficit and trade deficit were responsible for the major real revaluation observed in the period.[23] With the assumed reversal of these swings in macro aggregates in the 1986-91 period, the real exchange rate is projected to move slightly above its 1982 value. In both periods, an implication of the analysis is that the movements in real exchange rates are largely the result of US policy choices, rather than any policy choices by other countries.

As shown in Table 4, the real exchange rate (the price of non-tradeables relative to the

22 Note that as far as the model results are concerned, it does not matter much whether the government deficit is removed by decreased expenditure or increased taxes.

23 See Adelman and Robinson (1987).

Table 2 **Annual growth rates of selected variables**

Variable	Annual Growth Rates (per cent) Actual 1982-1986	Base run 1986-1991
Consumption	4.6	2.1
Investment	10.0	1.1
Government	4.1	0.7
Exports	1.1	6.6
Imports	11.7	2.2
GNP	4.1	2.1
Agricultural value added	2.8	-2.7
Factor Inputs		
Capital	2.6	2.4
Labour	2.4	1.2

Notes 'Actual' rates of growth calculated from *Survey of Current Business* data. 'Base Run' rates calculated with respect to model solution. 'Rate' is the per cent annual compound rate of growth.

Table 3 **Composition of GNP (current prices)**

Share of GNP	Actual 1982	Actual 1986	Base run 1991
Consumption	64.8	66.1	65.9
Investment	14.1	15.9	16.7
Government	20.3	20.5	18.9
Exports	11.4	8.9	12.6
Imports	10.6	11.4	14.1
Agricultural value added	2.8	2.2	1.8
Government deficit	3.5	3.5	.73
Exports - imports	0.6	-2.5	.29

Notes: 'Actual' data are from the *Survey of Current Business*, July 1987. 'Base Run' data are the results of the base forward projection to 1991. 'Agricultural value added' in the National Income and Product Accounts (NIPA) include, by definition, imputed rent from owner-occupied dwellings; which are included instead in the service sector in the input-output accounts. The model results are adjusted to be consistent with the NIPA definition. The trade deficit, (exports - imports) also follows the NIPA convention and equals the current account balance.

Table 4 **Various price indices (1982 = 100)**

Variable	Actual 1986	Base Run 1991
GNP deflator	114.1	114.1
World price of exports	97.8	94.8
World price of imports	88.8	88.8
Nominal exchange rate	100.0	120.1
Real exchange rate	118.8	100.6
Domestic price of exports	103.6	114.4
Domestic price of imports	92.6	109.8
Domestic sales price	116.6	112.4
Cost of living	113.2	113.1
Real wage	105.1	110.7
Agricultural terms of trade		
Output prices	83.5	82.8
Value added	76.6	80.8
World prices, imports	108.5	109.3

price of tradeables) revalues in the 1982-86 period by 18.8 per cent and then devalues in the 1986-91 period, with the index falling to 0.6 per cent above the 1982 base value. The devaluation is necessary to boost exports and reduce import demand, according to the projected improvement in the trade balance. The nominal exchange rate also devalues by about 20 per cent.

The agricultural sectors benefit from the devaluation and the small improvement in the international terms of trade relative to 1986, with exports increasing 20 per cent over the projection period. Otherwise, agriculture's contribution to the overall economy shrinks during the projection period because of the falling value of agricultural output under the assumed conditions of continuing excessive supply at market prices. Although target prices increase to 1991 according to the provisions of the 1985 Farm Bill, loan rates fall closer and closer to the market clearing prices and land set-aside constraints continue to bind. Excess supplies accumulate and government stocking tops out, with the result being relatively low market returns in agriculture. The PSE rates are much higher in 1991 than 1986, with 75 per cent of the net income for grains coming from government programs.

V Trade liberalization experiments

All trade liberalization experiments have been conducted with respect to the base solution for 1991. The projected rates of growth of productivity, aggregate supplies of primary factors of production, and the levels of non-agricultural program federal spending for 1991, remain the same throughout the experiments. In order to focus on the effects of agricultural policy changes, we also assume that the exchange rate remains at the projected 1991 solution level, with foreign savings adjusting to maintain balance between the current and the capital accounts at that exchange rate. The experiments consist of varying the agricultural subsidy program instruments, first one by one, and then in various combinations.

The first set of experiments demonstrates the impact of the separate components of the US farm programs: resource-use constraints, border measures, and domestic price and income supports. We model the economy with one set of distortions removed, while the other distortions are left intact. These experiments thus measure the direct general equilibrium impact of each distortion on output, trade, and prices. The experiment 'Land' relaxes the constraints on land use imposed on the farm sector under the subsidy programs. The experiment 'Border' removes the protection offered by the border measures. The quotas on imports of dairy and other agricultural goods are removed, and the export subsidies are repealed, while the target price and loan rate programs remain operative, and the resource constraints are still binding. The third experiment, 'Domestic,' maintains the border measures, but repeals the domestic income protection provided by the target price and loan programs. The fourth experiment, 'All subsidies', removes both border and domestic subsidies, while leaving the land use constraints intact.

The removal of distortions alone results in increases in economy-wide output, while the relaxation of resource constraints in addition leads to further improvements in GNP. In the second set of experiments, both the subsidy programs and the resource constraints are relaxed. The first of this set, 'Unilateral,' consists of relaxing land constraints and removing all subsidies, without assuming any cooperation from the rest of the world on agricultural trade liberalization. Finally, we calculate the qualitative results of multilateral liberalization in experiment 'Multilateral', in which all features of US farm programs are removed, and world agricultural prices are assumed to increase.

Summaries of the experiment results are presented in Tables 5 to 9. Table 5 presents the consumption, investment, trade, net absorption, and the government budget deficit results of the various experiments relative to the base run for 1991. Table 6 displays some of the

more important agricultural sector variable results expressed as ratios to the base run results, and Table 7 displays the same variables for the non-agricultural sectors. Table 8 compares the income and value-added by sector under the experiments to the base run. The results in Tables 5 and 8 are further disaggregated into agricultural and non-agricultural subsets. Table 9 presents the elasticities of response of these variables with respect to increases in the prices of competing agricultural products on world markets.

Experiment 1: Land constraints relaxed

Not all aspects of US agricultural subsidy programs directly promote excess supplies from the US and exacerbate falling world market prices. One of the most important features of the US program is the constraint on resource use required of the major beneficiaries of support. In order to be eligible for deficiency payments and non-recourse loans, the farmer must take land out of production. The set-aside constraint is intended to offset the production-inducing signal provided by the target price, control total output, and thus limit the budgetary exposure. In principle, the existing program is designed to protect farm income without generating surpluses at the prevailing domestic market prices.

The US has also supported world market prices through the stock accumulation activities under the non-recourse loan program. In effect, until the 1985 Farm Bill, the loan rates announced in advance of the marketing period represented the US price floor, and since the US share of world agricultural trade is large, also signalled a world price floor. Under the 1985 Farm Bill, loan rates are set in reference to average market prices, and are negatively related to the level of stocks. Therefore, market prices indicate the loan rate rather than vice versa. Nevertheless, even under the current program, farmers repay the loans by forfeiting crops and thus diverting supplies off the market, if the market price is not high enough relative to the loan rate to be profitable. Thus, the loan rate continues to serve as an indicator of US prices to the rest of the world.

In the first experiment, 'Land', we consider what might happen if US farmers were not subject to resource use constraints while the subsidy programs remain in effect. The experiment consists of projecting to 1991 with subsidies, while land supply is determined endogenously rather than constrained to the set-aside level under the 1985 Farm Bill. The amount of land in production increases 15.6 per cent over the base 1991 projection, which, interestingly, nearly equals the minimum set-aside rate in 1986 for program crops under the 1985 Farm Bill (Table 6).

The deficiency payment responsibility that arises due to the relaxation of acreage controls is costly to the government. The government budget deficit almost doubles, govern-

ment stock accumulation increases by almost $10 billion, and foreign capital inflows increase by 60 per cent. Real GNP increases by about $3 billion dollars due to the increase in resources used in production (Table 5). Farm income, of course, improves under these assumptions. Subsidy-ridden net returns to land, labour and capital in the grains sector increase by 40 per cent. In the other sectors of the economy, value added falls (Table 8). Savings and investment also fall to only 95 per cent of the base projection levels. But what havoc is wreaked on international markets for grain!

US exports of grains almost double, while imports of grains (small to begin with) fall by two thirds (Table 6). The world price of 'grains' falls almost 40 per cent from the 1986 level, an additional 20 per cent lower than the world price relative to the base 1991 projection. This occurs because we have modelled the loan rate following the falling US market prices to a certain extent, according to the provisions of the 1985 Farm Bill. The balance of trade deficit improves by $14 billion. This includes a $17 billion dollar improvement in net agricultural exports, and a $3 billion deterioration in net non-agricultural trade (Table 5).

Experiment 2: Border policies removed

Traditionally, the GATT has been concerned with border measures; especially quotas on imports and subsidies on exports. The progenitors of the proposals to the Uruguay Round of the GATT negotiations have correctly identified that the most trade distorting farm support policies are not the border measures but the 'domestic' programs. Breaking with the GATT tradition, they have agreed that all agricultural subsidy programs are subject to consideration in this round of the GATT.

The 'Border' experiment in which only border distortions are dismantled, is designed to highlight the relative importance of border and domestic measures. In the US, border measures supporting exports are relatively minor, while protection against certain imports are very important (cf quotas against imported cheese and sugar).[24] The results of this exercise should then be compared with the results of the 'domestic' experiment (next), to highlight the importance of bringing domestic measures under the GATT. Including domestic support programs under the GATT is shown to be important, particularly if the objective is to reduce potential budget exposure and to strengthen world agricultural prices.

In the 'Border' experiment, the quotas against imports of dairy and meat and other

24 In 1986, the Secretary of Agriculture announced that over $47 million dollars worth of export enhancement program bonuses were awarded. This amounts to only .18 per cent of the value of 1986 agricultural exports. On the other hand, US sugar programs supported domestic prices at 3.4 times the 1986 world market price for sugar; Barry and Angelo (1988).

agriculture products are removed, and the ad valorem export subsidies for all agricultural exports are dropped to zero. Meanwhile, the constraints on land in production and the domestic price and income support programs remain intact.

The removal of the border measures results in a tiny increase in real GNP, a $3.4 billion dollar deterioration in the net balance of trade (due entirely to lower net exports from agriculture), a corresponding increase in foreign savings in the US, and an increase in the government budget deficit of about $3 billion, while expenditures to support the farm sector increase by $3.8 billion, or 10 per cent. The effect on non-agricultural sector employment, output and prices is likewise negligible. Only the light consumer goods sector is affected. Lower domestic costs of raw agricultural product inputs to the light consumer goods industries reduce intermediate input costs, increasing value added and income in that sector by about one billion dollars (Table 8).

Imports of dairy and meat and other agriculture products increase by $0.8 and $3.5 billion dollars, respectively, when the import quotas are removed. Exports fall insignificantly. Land is released from the other agriculture sector into the grains sector, and production of grains increases accordingly by about 2 per cent. Exports of grains increase by 4.8 per cent, and imports fall by 20 per cent, affecting a decline in world prices of 1.5 per cent (Table 6).

The 'Border' experiment illustrates how little would be achieved if only US border measures were to be dismantled. The effect on world markets appears quite small. Meanwhile, costs of domestic programs and the government budget exposure increases, although not prohibitively. These results underscore the importance of including both border measure liberalization and domestic programs under the purview of the GATT.

Experiment 3: Domestic subsidies terminated

The third experiment, 'Domestic', focuses on the impact of US domestic policies on domestic resource allocation, the government budget deficit, and net agricultural trade. We remove the income support provided by the target price programs and the part of domestic price support provided by government stock accumulation activities. The constraints on resource use and the border measures remain in effect.

The main impact of the removal of domestic support programs is a movement of labour and capital out of agriculture. Capital and labour both decline to 96, 82, and 92 per cent of the subsidy-ridden 1991 levels in the dairy and meat, grains and other agriculture sectors. Production likewise falls, although less so in other agriculture into which land moves from the

grains sector. US grains exports fall dramatically, imports increase, and domestic 'grains' prices increase by 60 per cent (Table 6). The cost of living increases by 0.2 per cent, as these cost increases at the unprocessed level are passed through to the rest of the economy as farm products are processed.

The light consumer goods sector suffers along with the agricultural sectors. Employment, output, and exports decline by a few percentage points, and light consumer goods imports increase. The $2.0 billion dollar deterioration in net trade in light consumer goods accounts for most of the non-agricultural net trade deterioration. Overall, the net trade balance worsens by $12 billion. The loss of $10 billion worth of grains net exports accounts for most of this deterioration in the trade deficit ('Domestic' results not shown in Table 5).

The savings to the government due to termination of the domestic programs results in a $24.2 billion dollar reduction in the deficit, and hence less of a drain on the loanable funds market. Savings and investment increase by $30.0 billion, and the current account deteriorates by $5.7 billion.

The reduction in US 'grain' exports precipitates a 30 per cent increase in the world price of grains. Taken together, the implications of this experiment are that terminating domestic programs may have the largest desired effects of strengthening world agricultural markets and reducing government budget exposure.

Experiment 4: All subsidy programs terminated

In the 'All subsidies' experiment, all direct price support activities and border measures in agriculture are removed, without relaxing the acreage constraints that accompany the subsidy programs. This experiment is essentially the sum of experiments 2 and 3. The experiment isolates the impact of the incentive-distorting effects from the resource-constraining effects of the existing farm programs. The direct effect of removing the programs is to reallocate factors out of agriculture into sectors where they are more productive. Overall, real GNP increases by $5.8 billion dollars, and nominal by $6.7 billion, (0.14 per cent) when the agricultural subsidy programs are terminated (Table 5).

In particular, in this exercise there are no target prices or loan rates. Government stocking of program commodities to maintain market prices through the non-recourse loan program is discontinued. The import quotas are repealed. The export enhancement program subsidies drop to zero. Having removed the wedges between TP and PX, and the tariff equivalent distortions between the domestic and world prices for traded agricultural goods; the market clearing price (PX) signals resource allocation economy-wide.

Economy-wide, more is produced, consumed, saved, and invested when all distortions subsidizing the agricultural sectors are removed. Real GNP increases by $5.8 billion dollars compared to the subsidy-ridden 1991 projected level of GNP. The federal deficit is reduced from $34.5 billion to only $9.7 billion (Table 5). The reduction in the deficit is due to a $34.7 billion savings from agricultural subsidies no longer paid, net of expenditure on 1991 stock holding.[25] In the 1991 base solution, the government was releasing stocks from previous excessive accumulations, since solution market prices still exceeded the loan rate. Under liberalization, net government demand for agricultural products is set at the level observed in 1982 when carryover stocking was relatively low.

The net improvement in the government budget deficit results in 5.2 per cent more savings and investment. Investment demand consists largely of residential construction and demand for capital goods (machinery etc.). The increased demand for construction and capital goods is met by increased employment of capital and labour in both sectors, increased output, and almost no change in domestic prices. Output in the construction and capital goods sectors increase by 3.0 and 2.5 per cent, respectively (Table 7).

Labour and capital move into the construction and capital goods sectors from the agricultural sectors. With the release of factors of production from agriculture, economy-wide wages and average returns to capital both fall by about half of a per cent. Since agriculture is a very small employer of resources, even major changes in the marginal value product in agriculture on the economy-wide wage:rental ratio is likely to be small. On the other hand, the returns to land (used only in agriculture) fall almost 22 per cent with the removal of agricultural subsidies.[26]

In this experiment we assume no world agricultural price response or reaction by the rest of the world to liberalization in US agriculture, so world prices remain artificially low. Hence, the US appears to be less competitive in world agricultural markets, agricultural exports fall and imports increase.[27] Thus, the balance of trade deteriorates by $16.7 billion dollars, largely because the contribution of the agricultural sectors to net exports falls by $15.4 billion dollars. Increased net imports of light consumer goods (processed dairy products, animal feeds, textiles) account for the rest of the deterioration in the trade balance (Table 5). With the increase in domestic agricultural prices, domestic output for this sector is priced higher than the substitutable import.

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25 There are also minor revenue changes as the structure of the economy changes.

26 This result is sensitive to our specification of production technology in the three sectors. If capital and labour were assumed to be less substitutable with land, the output adjustment would be lower and the price increase would be smaller.

27 Also, although the nominal exchange rate is held constant in the experiment at the 1991 solution level, there is a very slight increase in the real exchange rate. It increases by .18 per cent.

Removing the subsidies without relaxing the acreage constraints reduces income in the agricultural sectors, particularly the export-dependent grains sector. Without the export subsidies and high level of domestic supply, grains export volume falls to 52 per cent of the level in 1986 and is 58 per cent lower than the base projection to 1991 with programs intact. Imports of grains increase because of the 60 per cent increase in the relative price of domestic to imported grain. Imports of dairy and meat products triple with the relaxation of the quota constraints, and dairy and meat exports fall 27 relative to the 1991 level (Table 6).

The light consumer goods sector, in which the processing of agricultural products takes place, again suffers along with the agricultural sectors, with output falling by 2.25 per cent against the 1991 base run. Given the size of the sector, this decline is significant. Exports also fall by 6.7 per cent and imports also increase as import quotas are relaxed and the domestic price increases 2.5 per cent against the world price (Table 7).

The net impact of this experiment is a deterioration in the trade balance to accommodate a $22.5 billion increase in total absorption. This lost export income results in $16.4 billion lower farm income (the sum of income in the dairy and meat, grains, and other agriculture sectors). This result suggests that unilateral liberalization would jeopardize the US trade balance, with negative economy-wide as well as sectoral consequences. Unfortunately, as the results of the next experiment show, these undesirable results obtain even if the constraints on land in agriculture are relaxed.

Experiment 5: Unilateral liberalization

The experiments above analyzed the impact of removing parts of the US farm programs. This experiment represents complete unilateral liberalization. All programs that distort returns to production and/or constrain input use are removed. Constraints on land use are relaxed, as in the 'Land' experiment; border measures are removed, as in 'Border;' and domestic programs are dismantled, as in 'Domestic.' Thus, this experiment is the sum of all previous experiments, but the general equilibrium results are not simply the sum of the component experiment results.

With neither the constraints nor the subsidies, land use in agriculture increases by 4.7 per cent (compared to the result of 'Land' where land use increased nearly 16.0 per cent). Even more capital and labour leaves the farm sector as land is substituted for the other factors. The use value of land also falls 34 per cent against the 1991 base rate of return.[28] Output and exports of grains nevertheless increase marginally. Complete unilateral dismantling of US

28 Again, these results are sensitive to the specification of agricultural production technology.

farm programs, even without assuming an impact on world import prices, results in a $9.6 billion dollar increase in GNP.

The effects on factor employment, output, trade, and income in the non-agricultural sectors of this experiment are parallel to the results reported for experiment 4. There is a $15.6 billion dollar deterioration in the balance of trade, a $26.1 billion reduction in the government budget deficit, and a $35.7 billion increase in investment. The construction and capital good sectors also expand. Absorption is $24.4 billion higher than the subsidy-ridden 1991 level. Again, these increases contrast with agriculture's losses. Net agricultural exports fall almost to zero, and farm income falls by $20.6 billion (Tables 5 and 8).

Experiment 6: Multilateral liberalization

While this is not a multi-country model, it is perfectly suitable for analyzing the domestic impact of changes in conditions on world markets. This is done by resolving the model with respect to the new world market prices of importables and substitutes for US exports. In the sixth experiment, 'multilateral,' we assume increases in the world prices of competing agricultural goods in addition to the program removal elements of the previous 'unilateral' experiment. It is designed to represent multilateral agricultural liberalization. The increase in world prices of competing agricultural goods is assumed to result from a decline in exportable supplies worldwide and an increase in world demand arising from a relaxation of import quotas.

We assume an 11.1 per cent increase in the world price of dairy and meat, and increases of 42.9 and 3.1 per cent for grains and other agriculture goods, respectively. These rates of increase relative to 1986 represent zero increases relative to 1982 prices in each sector. Roningen, et al (1987) estimate increases of about 21, 8, and 3 per cent, respectively, relative to 1984 prices (which translate into much higher increases relative to the actual, and lower, 1986 prices); while Tyers and Andersons' dynamic, partial equilibrium, multi-country model estimates initial increases in international food prices of about 20 per cent owing to liberalization in all markets other than the US, and ultimate increases of another third by 1995.[29]

Demand for US agricultural exports depends on the difference between the US agricultural export price and the price of substitutes in world markets. In the analysis of multilateral agricultural trade liberalization, it is assumed that the world prices of imports and substitute export agricultural goods equalize. The price of US exports is then determined endogenously and simultaneously with the volume of US agricultural exports.

29 Tyers and Anderson (1987), page 23.

An overall average price of tradeable agricultural goods in world markets is calculated as the weighted average of the US export price and the world price of substitutes, the weights being the shares of US exports in world markets.[30] Thus, the changes in international prices resulting from our 'multilateral' experiment are found to be increases of 11 per cent in dairy and meat, 23 per cent in grains, and 3 per cent in other agriculture.

The near $26 billion in government budget deficit reduction allows savings and investment increases of 1.4 per cent. The trade deficit also reduces by $4.8 billion, and foreign saving in the US goes down by $10.6 billion. Real GNP increases by $9 billion. Otherwise, multilateral liberalization, if it does indeed result in world agricultural prices regaining their 1982 levels in real terms, results in a picture of non-agricultural output, income, and employment that is very similar to the baseline projection. Overall, the economy-wide average wage lowers by .4 per cent.

On the other hand, there are substantial differences in the structure of agriculture. The increase in world prices stimulates production for export, especially in the grains sector. Land in agriculture increases 15 per cent over the base projection under the programs. Most of this land is in grains. Labour and capital also move into the grains sector, so that grains output increases by almost 12 per cent. Of this additional output, 65 per cent is exported. Agriculture's contribution to the balance of trade increases by $5 billion (Tables 5 and 6).

This type of expansion is not observed in the dairy and meat or other agriculture sectors, because those sectors were not competitive export sectors in the first place. Labour moves out of those sectors and output is down accordingly, relative to the protected 1991 result. Sector income is down the most in dairy and meat, somewhat in other agriculture, while it is slightly higher in the grains sector.

The fate of the light consumer goods sector, as in the other exercises, is shown to be linked to agriculture. Production and exports are lower, and imports are higher, than in the protected 1991 base run. The higher domestic prices of the raw agricultural products and the relaxation of import quotas squeeze net returns to the light consumer good processing sector.

Experiment 7: Elasticities of response to world prices

While we cannot be sure about the exact change in prices due to multilateral liberalization in world markets for agricultural goods, we can determine if the qualitative results are robust with respect to general change in world agricultural prices. The following experiments

30 US weights are calculated from market share data in Table 2.1 of Tyers and Anderson (August, 1987).

provide qualitative information about the response of domestic market prices, output, employment, and trade, to changes in the world prices of agricultural goods. In particular, we numerically compute the elasticities of these economic variables with respect to world agricultural prices. First, one-by-one elasticities are computed. Then, we find the per cent change in the variables due to simultaneous 1 per cent changes in all three world agricultural prices. The results are presented in Table 9.

The results should be considered in light of the results of unilateral liberalization as well as with respect to the base scenario. As discussed earlier, domestic market-clearing prices in the three agricultural sectors increase following liberalization. The increase in prices occur because fewer resources are devoted to agriculture when subsidies are discontinued, so that output falls while consumption stays relatively constant. Thus, the market-clearing prices rise when subsidies are removed. Where domestic prices are supported by the existence of quotas against imports, since the share of these imports in consumption are small, the price depressing effects of lower-priced substitutes are outweighed by the price increasing affects of reduced domestic supplies, and these domestic prices rise also. If world market prices rise in addition, domestic prices rise even further.

The observed effect on domestic prices of increases in world prices is thus to raise them, but not by 100 per cent, since the importable, the exportable, and the good for domestic consumption are imperfect substitutes. Since foreign and domestic versions of dairy and meat are fairly substitutable, the US export price of dairy and meat increases 0.83 per cent for every 1 per cent increase in the price of dairy and meat from the rest of the world. The US export price of grains increases 0.41 per cent for every 1 per cent increase in the world price of grain. This reflects the lower substitutability between domestic and foreign grain, which is more likely due to the political distinctions between sources of grain which lead to stabilized market shares than to physical differences among the actual products. The US export price of other agricultural goods increase by 0.5 per cent for each 1 per cent increase in world prices. Again, the other agricultural goods exported by the US (temperate fruits, nuts, and seeds) are not easily substituted for the imports (tropical fruits, coffee, vegetables in season).

The prices faced by US consumers are also positively related to world market prices, but since imported goods comprise such a small portion of the consumption basket, these increases are negligible in the first two agricultural sectors and marginal in the other agricultural good sector. The price consumers pay for the composite other agricultural good increases .13 per cent for every 1 per cent increase in the world price.

The elasticities of US export supply with respect to world market price increases are between .48 for dairy and meat, and 1.78 for grains. The elasticity for dairy and meat is

lowest because production in this sector is largely for domestic consumption. For each 1 per cent increase in the world price of grain, the US increases grain exports by 1.78 per cent. Likewise, for each 1 per cent increase in the world price of other agricultural goods, US other exports increase by 1.48 per cent.

With producer prices rising, and export volumes increasing, resources are drawn back into the agricultural sectors relative to unilateral liberalization. The elasticity of the 'resource pull' effects of world price increases under multilateral liberalization are indicated by the elasticities of the value-added price (PVA). In each of the elasticity experiments, the agricultural sectors show an increased resource pull at the expense of the non-agricultural sectors. Thus, the qualitative impact of multilateral agricultural liberalization on resource allocation in the US is to offset the tendency for resources to move out of agriculture.

Winners and losers

Table 8 shows the changes in sectoral income and aggregate value added (GNP at factor cost) arising from the experiments. In general, the removal of agricultural subsidies hurts agricultural income: it falls as much as 19 per cent under the subsidy removal experiments ('Border', 'All subsidies', 'Unilateral' and 'Multilateral'). Aggregate farm income will be lower without the current farm programs; under the 'Multilateral' liberalization experiment, it is 4.4 per cent lower than the 1991 base run. But labour and capital also move out of agriculture, so that farm income per unit of farm labour actually increases, albeit imperceptibly, by .76 per cent. Aggregate income in the non-farm economy also falls, but even less perceptibly: non-agricultural income by either measure falls only .44 per cent under the 'Multilateral' scenario.

The total value of the subsidies is $34.7 billion (in the 1991 base run), but their removal only leads to declines in agricultural incomes of $5-21 billion between the 'Multilateral' and the 'Unilateral' experiments. Thus, when market distortions are removed multilaterally, it would cost the government only $4.8 billion dollars of pure transfers to guarantee the farm sector an income comparable to the 1991 base run level.

A large portion of the lost subsidy is also shared with the non-agricultural sectors. The sectors directly linked to agriculture (light consumer, trade and finance, and other services) are most affected. The construction and capital goods industries are also affected indirectly, owing to the increase in savings following the reduction in the federal deficit. Thus, the loss of $34.7 billion dollars of agricultural subsidies, with at least $10 billion dollars of additional income arising from the more efficient allocation of resources, ultimately amounts to only a $24.7 billion dollar decrease in overall sectoral income.

Although aggregate sectoral income falls in all subsidy removal experiments, it is important to note the distinction between net sectoral income (which includes subsidies) and sectoral value added (or GNP at factor cost, which does not include subsidies). In the experiments, sectoral incomes fall because the policy reform diverts income away from the accounts of producers and gives it back to the government. In terms of the GNP accounts, however, these subsidies are treated as non-productive transfers. Total value added, or GNP, rises significantly in all experiments (except the 'Border' experiment where the increase is tiny). The removal of a distortion should lead to an increase in efficiency and, hence, in GNP. Our experimental results indicate that this is indeed the case.

Table 5 **Real absorption in 1986, 1991, and differences from 1991 by experiment**

		Billions of 1982 dollars						
		Level		Difference from 1991				
		1986	1991	Land	Border	All	Uni	Multi
Consumption	total	2482.9	2720.3	15.3	2.6	-18.6	-16.4	-13.8
	ag	27.9	29.9	1.0	0.6	-1.1	-0.8	-1.9
	non-ag	2455.0	2690.4	14.2	2.1	-17.5	-15.6	-11.9
Investment		629.0	690.9	-35.3	0.3	36.0	35.7	12.8
Government	total	755.3	781.2	9.6	0.9	5.2	5.2	5.2
	ag	15.0	4.6	9.6	0.9	5.2	5.2	5.2
	non-ag	740.3	776.6	0.0	0.0	0.0	0.0	0.0
Exports	total	378.8	519.7	12.1	0.9	-7.3	-6.5	8.2
	ag	17.5	21.5	17.2	0.8	-10.8	-10.3	6.4
	non-ag	361.3	498.2	-5.2	0.2	3.5	3.8	1.8
Imports	total	534.5	582.6	-2.6	4.3	9.3	9.1	3.4
	ag	6.8	6.7	-0.0	4.3	4.6	4.4	1.2
	non-ag	527.7	575.9	-2.5	0.1	4.8	4.8	2.2
GNP	total	3711.7	4130.0	3.0	0.5	6.7	9.6	9.1
	ag	65.0	38.1	26.9	-1.9	-10.7	-9.7	8.4
	non-ag	3646.7	4091.9	-23.9	2.5	17.3	19.3	0.7
Absorption	total	3867.2	4192.4	-10.5	3.8	22.5	24.4	4.2
	ag	42.9	34.5	10.6	1.4	4.0	4.3	3.3
	non-ag	3824.4	4157.9	-21.1	2.4	18.4	20.1	0.9
Net exports	total	-155.7	-62.9	14.6	-3.4	-16.7	-15.6	4.8
	ag	10.8	14.8	17.3	-3.5	-15.4	-14.6	5.1
	non-ag	-166.5	-77.8	-2.6	0.1	-1.3	-1.0	-0.4
Govt deficit		147.9	34.5	31.7	3.0	-25.1	-26.1	-25.7

Table 6 Agricultural sector results (1991 = 100)

Sector	World Price	Signal Price	Capital Rental	Land Rent	Land	Labour	Capital	Output	Export	Imports
					Land					
Dairy and meat	97.7	90.8	83.5			90.1	108.5	103.2	107.1	100.0
Grains	80.4	100.0	96.4	102.6	132.2	139.9	145.9	136.7	192.2	31.4
Other agriculture	101.7	104.7	129.8	102.6	102.0	107.9	83.6	100.7	95.0	100.0
					Border					
Dairy and meat	102.7	98.7	100.1			99.4	99.4	99.4	92.2	200.2
Grains	98.5	100.0	100.1	100.0	101.9	103.0	102.9	102.3	104.8	80.3
Other agriculture	101.7	100.2	100.1	100.0	93.6	94.6	94.6	94.2	95.1	159.3
					Domestic					
Dairy and meat	102.7	112.6	99.2			96.4	96.7	96.6	92.3	100.0
Grains	130.7	98.1	99.2	85.6	97.4	82.2	82.4	91.4	44.8	696.6
Other agriculture	99.8	95.9	99.2	85.6	108.9	91.9	92.1	98.8	100.7	100.0
					All subsidies					
Dairy and meat	106.0	111.9	99.2			94.6	94.9	94.8	83.9	315.9
Grains	132.5	96.7	99.2	81.4	98.0	79.3	79.5	90.6	43.0	656.2
Other agriculture	100.6	94.9	99.2	81.4	106.9	86.5	86.8	94.7	98.3	144.3
					Unilateral					
Dairy and meat	104.9	107.1	82.1			83.5	101.3	96.1	86.5	268.4
Grains	129.8	93.6	94.8	74.4	101.1	75.4	79.2	91.8	45.8	578.0
Other agriculture	100.8	95.4	127.6	74.4	117.0	87.2	68.1	94.6	97.6	147.4
					Multilateral					
Dairy and meat	111.4	107.6	82.2			84.6	102.3	97.2	89.9	181.5
Grains	148.3	98.6	94.9	87.3	115.5	102.5	107.4	111.9	134.3	145.1
Other agriculture	103.9	99.7	127.7	87.3	109.3	96.9	75.4	97.6	97.8	109.3

Notes:
'World price' is the price foreigners pay for US agricultural products.
'Signal Price' equals the target price or support price when domestic programs are operative; equals market price without programs.
'Capital rental' and 'Land rent' are the marginal revenue products of capital and agricultural land.

Table 7 **Non-agricultural sector experiment results (1991 = 100)**

Sector	PVA	PX	Labour	Capital	Output	Export	Import
				Land			
Light consumer	100.7	98.9	101.4	100.9	101.2	103.5	98.8
Basic intermed	100.7	100.6	99.9	99.4	99.7	98.5	100.2
Capital goods	100.5	100.5	97.5	97.0	97.5	96.5	98.1
Construction	100.6	100.5	96.9	96.5	96.9	96.2	---
Electronics	100.6	100.5	98.7	98.2	98.6	97.7	99.4
Trade	100.6	100.6	100.0	99.5	99.9	99.6	---
Services	100.7	100.6	100.2	99.7	100.0	99.6	100.1
				Border			
Light consumer	100.1	99.7	100.3	100.3	100.3	100.9	99.6
Basic intermed	100.1	100.0	100.0	100.0	100.0	99.9	100.1
Capital goods	100.1	100.1	100.0	100.0	100.0	99.9	100.1
Construction	100.1	100.0	100.0	100.0	100.0	100.0	--
Electronics	100.1	100.0	100.0	100.0	100.0	99.9	100.1
Trade	100.1	100.1	100.0	100.0	100.0	100.0	--
Services	100.1	100.1	100.0	100.0	100.0	100.0	100.0
				Domestic			
Light consumer	99.4	102.5	97.6	97.8	97.7	93.0	103.2
Basic intermed	99.3	99.6	100.5	100.7	100.6	101.5	100.2
Capital goods	99.4	99.6	102.3	102.5	102.3	103.1	101.8
Construction	99.4	99.7	102.8	103.0	102.8	103.3	--
Electronics	99.4	99.7	101.2	101.4	101.2	101.8	100.6
Trade	99.4	99.6	100.1	100.3	100.2	100.4	--
Services	99.4	99.6	99.9	100.2	100.0	100.3	99.9
				All subsidies			
Light consumer	99.4	102.2	97.8	98.1	97.9	93.6	102.8
Basic intermed	99.4	99.6	100.6	100.9	100.7	101.5	100.3
Capital goods	99.5	99.6	102.6	102.9	102.6	103.4	102.1
Construction	99.5	99.7	103.2	103.5	103.2	103.7	--
Electronics	99.5	99.7	101.3	101.6	101.3	102.0	100.8
Trade	99.4	99.6	100.1	100.4	100.2	100.5	--
Services	99.4	99.6	99.9	100.2	100.0	100.3	99.9
				Unilateral			
Light consumer	99.5	101.7	98.3	98.6	98.4	95.2	102.1
Basic intermed	99.5	99.7	100.6	100.9	100.7	101.4	100.4
Capital goods	99.6	99.7	102.5	102.8	102.5	103.1	102.1
Construction	99.6	99.7	103.2	103.5	103.2	103.6	--
Electronics	99.6	99.8	101.3	101.6	101.3	101.8	100.9
Trade	99.6	99.7	100.2	100.5	100.2	100.4	--
Services	99.5	99.6	99.9	100.2	100.1	100.3	100.0
				Multilateral			
Light consumer	99.4	101.9	98.1	98.1	98.1	94.4	102.3
Basic intermed	99.4	99.6	100.6	100.5	100.6	101.3	100.2
Capital goods	99.4	99.6	101.2	101.2	101.2	102.0	100.6
Construction	99.4	99.7	101.2	101.2	101.2	101.6	---
Electronics	99.4	99.7	100.7	100.7	100.7	101.4	100.1
Trade	99.4	99.6	100.1	100.1	100.1	100.4	---
Services	99.4	99.6	100.0	100.0	100.0	100.3	99.9

Table 8 **Sector income: Differences between 1991 and experiments**

Sector	Level 1991	Land	Border	All	Uni	Multi
	Sector Income					
		Difference				
Dairy and meat	5.867	-2.5	-0.2	-1.6	-4.4	-4.2
Grains	44.718	18.2	1.4	-9.4	-11.1	0.8
Other agriculture	38.145	3.3	-2.1	-5.4	-5.0	-1.4
Light consumer	315.185	6.0	1.2	-8.5	-6.4	-7.8
Basic intermed	426.345	1.7	0.4	0.3	1.0	-0.1
Capital goods	261.334	-5.3	0.2	5.4	5.5	1.6
Construction	237.532	-6.1	0.2	6.3	6.6	1.4
Electronics	93.742	-0.8	0.1	0.8	0.8	0.1
Trade	687.059	3.7	0.7	-2.5	-1.5	-3.1
Services	2232.512	15.8	2.2	-12.9	-9.9	-12.0
Agriculture	108.73	19.0	-0.9	-16.4	-20.6	-4.8
Non-agriculture	4253.709	15.1	4.9	-11.1	-3.9	-20.0
Total	4362.439	34.1	4.0	-27.5	-24.5	-24.7
.+ indirect taxes	367.951					
+ tariffs	16.723					
- subsidies	34.708					
- ag premium rents	.129					
= Value added	4712.276					

Sector	Level 1991	Land	Border	All	Uni	Multi
	Value Added					
		Difference				
Dairy and meat	27.730	-2.5	-0.2	-1.4	-4.3	-4.0
Grains	12.956	-13.6	-2.5	23.7	22.0	34.3
Other agriculture	37.529	3.2	-2.0	-3.4	-3.1	0.6
Light consumer	336.935	6.1	1.2	-8.5	-6.4	-7.8
Basic intermed	474.449	1.8	0.4	0.4	1.2	-0.0
Capital goods	270.099	-5.4	0.2	5.6	5.7	1.6
Construction	244.196	-6.2	0.2	6.5	6.8	1.5
Electronics	95.901	-0.8	0.1	0.8	0.9	0.1
Trade	794.563	4.2	0.8	-2.7	-1.6	-3.4
Services	2417.918	16.7	2.4	-13.3	-10.2	-12.5
Agriculture	78.215	-12.9	-4.7	18.9	14.5	30.9
Non-agriculture	4634.061	16.3	5.2	-11.3	-3.7	-20.5
Total	4712.276	3.4	0.5	7.6	10.9	10.4

Table 9 **Elasticities of sector responses to world agricultural prices**

Sector	PVA	Consumer Price	World Price(US)	Sector Income	Output	Exports	Imports
			Increase world 'dairy' price				
Dairy	0.0	2.2	82.9	7.5	7.5	48.1	-310.7
Grains	1.3	0.8	0.1	4.0	2.7	-0.2	6.3
Other	0.9	0.5	0.3	0.7	-0.2	-0.8	2.2
Ltcons	-0.0	0.3	0.0	-0.2	-0.1	-0.7	0.6
Basint	-0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1
Kgood	-0.1	0.0	0.0	-0.4	-0.3	-0.3	-0.3
Constr	-0.0	0.0	0.0	-0.5	-0.4	-0.4	0.0
Elec	-0.1	-0.0	0.0	-0.2	-0.2	-0.2	-0.2
Trade	-0.0	-0.0	0.0	-0.1	-0.0	-0.0	0.0
Serv	-0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
			Increase world grain price				
Dairy	0.1	0.3	-0.0	0.3	0.3	0.1	1.4
Grains	9.0	0.4	41.4	27.8	18.7	178.3	-315.3
Other	6.1	3.2	2.0	3.5	-2.6	-5.8	12.2
Ltcons	-0.0	0.2	0.0	-0.2	-0.2	-0.5	0.1
Basint	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1
Kgood	-0.1	-0.0	0.0	-0.9	-0.9	-0.8	-0.9
Constr	-0.1	-0.0	0.0	-1.3	-1.3	-1.3	0.0
Elec	-0.1	-0.0	0.0	-0.5	-0.4	-0.4	-0.4
Trade	-0.0	-0.0	0.0	-0.1	-0.1	-0.0	0.0
Serv	0.0	0.0	0.0	-0.0	-0.0	-0.0	-0.0
			Increase world 'other ag' price				
Dairy	-0.1	1.8	0.5	-0.8	-0.7	-1.4	6.6
Grains	7.4	4.3	2.6	6.1	-1.3	-7.6	16.7
Other	5.0	13.2	50.5	53.4	48.1	148.1	-282.6
Ltcons	-0.1	0.8	0.0	-1.0	-0.9	-2.5	0.9
Basint	-0.1	-0.0	0.0	-0.5	-0.4	-0.4	-0.4
Kgood	-0.1	-0.0	0.0	-1.7	-1.6	-1.5	-1.6
Constr	-0.1	0.0	0.0	-2.3	-2.2	-2.2	0.0
Elec	-0.1	-0.0	0.0	-1.0	-0.9	-0.9	-0.9
Trade	-0.1	-0.0	0.0	-0.4	-0.3	-0.2	0.0
Serv	-0.1	-0.0	0.0	-0.2	-0.1	-0.1	-0.1
			Increase all world agricultural prices				
Dairy	0.0	4.3	83.4	7.0	7.0	46.7	-305.1
Grains	17.7	5.5	44.2	38.0	19.9	169.2	-299.4
Other	11.9	17.0	52.7	58.2	45.8	140.9	-271.9
Ltcons	-0.2	1.3	-1.4	-1.3	-3.8	1.6	0.0
Basint	-0.1	0.0	-0.7	-0.6	-0.6	-0.6	0.0
Kgood	-0.2	-0.1	-3.0	-2.7	-2.6	-2.8	0.0
Constr	-0.2	0.1	-4.1	-3.9	-4.0	0.0	0.0
Elec	-0.2	-0.0	-1.7	-1.5	-1.4	-1.5	0.0
Trade	-0.2	-0.1	-0.5	-0.3	-0.3	0.0	0.0
Serv	-0.1	0.0	-0.3	-0.2	-0.2	-0.2	0.0

Note: The 'elasticity' is the per cent change in the column variable due to a one per cent change in the price (or prices) in the rest of the world, as indicated; multiplied by 100.

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Appendix I Sector aggregation

Sector	Industries (major)	BEA Industry Classification
Dairy and meat	milk, eggs, meat animals, poultry	1.02-1.02, 1.03
Grains	wheat, corn, rice, soy, cotton, peanuts, flax	2.01, 2.0201-2.0203 2.06
Other agriculture	sugar, tobacco, fruits, vegetables, nuts, other	2.03, 2.04-2.0503, 2.07, 3.0, 4.0
Light consumer	food and kindred products, leather, footwear, textiles, apparel, furniture containers, printing	14-25, 32-33
Basic intermediates	mining, petroleum, chemicals, plastic, rubber, glass and stone, iron and steel, fabricated metals	5-10, 27-32, 35-42
Capital goods	munitions, engines, machinery, communications, trucks, motor vehicles	13, 43-50, 56.03, 56.04, 57.03, 59-61
Construction	private and government construction	11-12
Electronics	office equipment, household appliances, semi-conductors, equipment, misc. electronics, TV, radio and other industry	51, 57-57.02, 58, 62-64, 81, 84-85
Trade	wholesale and retail trade, banking and insurance	69-70
Services	real estate, services, government, non-comparable imports	65-68, 71-79, 80

Note BEA industry classification from Appendix B: 'Industry Classification of the 1977 Input-Output Tables', page 80 *Survey of Current Business* (May, 1984).

Economy-wide effects of unilateral trade and policy liberalization in US agriculture

by

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Summary

During the 1980s US farm program expenditures have grown very rapidly. In recent years the cost of price and income supports has come close to $30 billion per year. This growth has occurred at a time of increasing budget austerity and has prompted debate about the economy-wide effects of these farm programs. There is little doubt that they significantly alter the allocation of resources, both within the farm economy and between the farm and non-farm sectors. This study measures the magnitude of these economy-wide effects.

The vehicle for this analysis is a general equilibrium model of the US economy. It places primary emphasis on the farm and food system which is modelled in considerable detail. Recent econometric evidence is combined with information from the input-output tables, the national income and product accounts and a variety of recent studies of taxation and agricultural policy. Standard assumptions about economic behaviour and market clearing are made, and the model is used to simulate the effects of removing those agricultural policies in place in 1984. However, in keeping with important changes implemented in the 1985 Farm Bill, the US is no longer assumed to support world grain prices at the loan rate.

The results indicate that there are substantial non-farm costs to supporting US agriculture with the current configuration of policies. These costs include the following (measured in 1987 dollars and expressed in terms of farm jobs saved by current policies): (i) reduced non-food output (-$107,000/year per farm job saved), (ii) increased treasury outlays ($80,500/year per farm job saved), (iii) lower real domestic income (-$28,700/year per farm job saved), and (iv) higher food costs ($14,000/year per farm job saved).

Unilateral liberalization of US agriculture results in short-run losses to the landowners, labour, and capital employed in agriculture. (These would be considerably dampened if other countries were to join suit and reduce agricultural support levels.) In the long run, capital and labour leave agriculture to higher productivity employment in non-farm activities. As a result, farmland rents drop even further and food prices rise considerably. The capitalized value of landowners losses (at a 5 per cent real interest rate) equals $113.8 billion. Compensation for these losses, as well as adjustment assistance for farm labour and capital owners, can be more than covered out of the increased treasury revenues generated by the policy changes. In fact, in the long run a domestic surplus of $5 billion per year is generated because of a more efficient allocation of resources in the US economy.

I Introduction

There is a long history of federal government involvement in US agriculture. Current farm programs date back to 1933 when the Commodity Credit Corporation (CCC) was set up to implement a set of price and income support measures designed to save farmers from bankruptcy. Since that time the nature of American farming has changed dramatically. So, too, have conditions in the world marketplace. While net farm income and government program costs vary widely from year to year, there has been an upward trend in the 1980s which appears unsustainable. Expenditures on farm programs have grown three times as fast as defence expenditures. Annual CCC outlays in recent years have reached nearly $30 billion. This budget growth has occurred at a time of increasing fiscal austerity. It has motivated many policy makers to ask whether these costs can be reduced, and what the implications of such cuts might be.

The current mix of farm programs is quite complex (Council of Economic Advisers, 1984 and 1986). By and large they are directed at reducing production costs and enhancing producer commodity prices in order to bolster farm incomes. When domestic consumer prices are also maintained at levels above world prices, border measures such as tariffs, quotas, or other non-tariff barriers are required in order to validate the domestic policy. The most striking example of this in recent years has been that of the sugar program. The import quota on sugar has been continually tightened in order to maintain legislated support prices at levels occasionally exceeding the world market price by 700 per cent! Because of these interactions, domestic and trade policies affecting US agriculture must be examined in combination with one another.

The presence of extensive government intervention in agriculture brings with it real costs. Recent estimates of the resulting net economic cost to society (ie consumer and taxpayer costs, less producer gains) totalled between six and seven billion dollars (Council of Economic Advisers, 1986). More specifically, price supports and input subsidies have tended to encourage excessive use of scarce resources in agriculture. As a result, many nonagricultural sectors have been implicitly penalized by these farm programs. The objective of this paper is to measure these economy-wide effects associated with US agricultural policies.

II Background

In order to put the current situation in proper perspective, it is useful to reconstruct some of the recent events leading up to the current farm budget crisis. During the decade of the 1970s, grain production in the rest of the world grew at about 24 million tons/year. This was outstripped by global consumption which was growing at the annual rate of 34 million tons. US farmers stepped in to fill this production deficit and the value of US farm exports increased more than five-fold over this decade. The percentage of farm receipts coming from exports increased from less than 15 per cent to more than 30 per cent. US producers met this increased demand by expanding planted acreage, investing in additional equipment, and intensifying the use of purchased inputs.

In the 1980s this situation changed dramatically. A global recession slowed the growth in grain consumption to 19 million tons per year. Meanwhile the rate of increase in global grain production had risen to 29 million tons/ year. Rather than a 10 million ton deficit, a 10 million ton surplus was accumulating annually. Rather than responding to this global glut in the grain market by reducing prices, the US chose to maintain the high support prices legislated in the 1981 Farm Bill. As the dollar appreciated in value, these support prices became more and more out of line with world market conditions. By 1983, grain stocks had built up to the point where further production restraints were necessary. In that year, almost 80 million acres of farmland were taken out of production, much of this in exchange for payment-in-kind (PIK) commodities designed to reduce government-held stocks. Total payments to farmers amounted to $28 billion, which actually exceeded net farm income earned in that year.

While farmers were compensated for their reduced production levels, the 1983 PIK program had a devastating impact on the farm-related economy. This served to highlight how interdependent the US farm and non-farm economies have become. Farmers spend almost half their gross income on purchased inputs. Fifty-eight per cent of these are produced in the non-farm sector. In addition, after the food products leave the farm, food processing, transportation, and marketing activities generate almost five times as many jobs as does production agriculture. Thus, when farm production levels were curtailed in 1983, these input supply and marketing sectors experienced sharp reductions in output and employment.

As the decade progressed, farm exports continued to fall, largely as a result of the high US support price and the appreciating dollar. By 1985-86 they had dropped, from a high of $44 billion in 1981, down to $26 billion. It was in this environment that the 1985 Farm Bill

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was written. In an effort to rectify past mistakes, loan rates were cut dramatically. It was hoped that this would stimulate exports and reduce the build-up of stocks. However, with target prices unchanged, this has resulted in very high budget costs (eg $26 billion in fiscal year 1986). In an effort to contain these government expenditures, set-aside requirements have been increased. Also, there has been considerable interest in extending the Conservation Reserve Program which is already intended to take 40 million acres of erosive land out of production by 1990.

With these massive government interventions in US agriculture it is no longer possible to assess their combined impact by looking at the sum of the individual commodity market effects. Nor is it even adequate to analyze the farm sector as a whole. The budgetary, trade, consumption, and factor market effects of current farm programs are potentially large enough to have an impact on the entire economy. In order to assess these effects a general equilibrium model of the US economy is discussed. It is specifically designed to assess the economy-wide effects of liberalizing agricultural policies.

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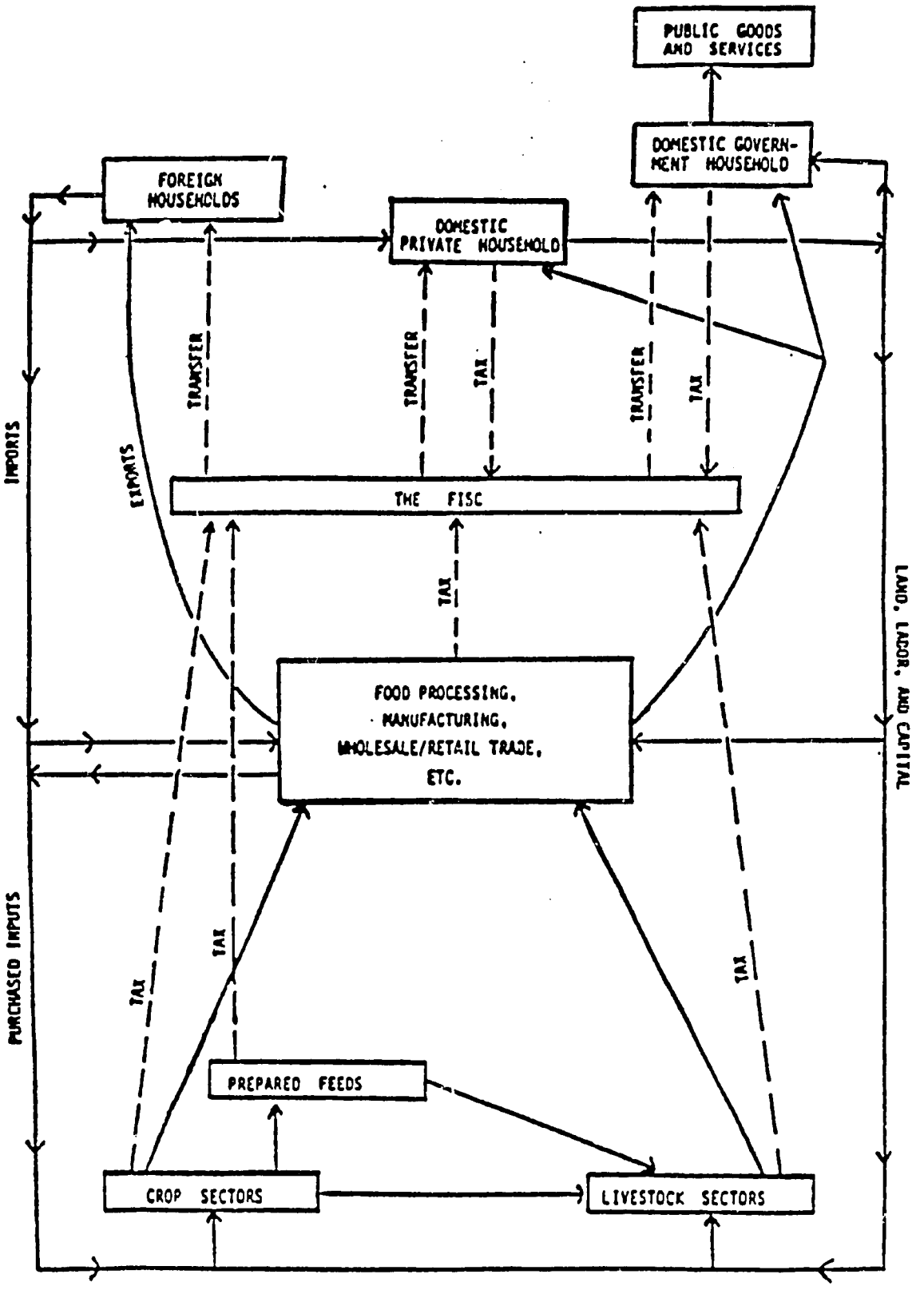
III Overview of a US CGE model with an agricultural emphasis

Figure 1 portrays the circular commodity flows in the computable general equilibrium (CGE) model used in this study. Crop and livestock farms (see bottom of figure) are highlighted. They rent primary input services (land, labour, and capital) from the private domestic household. These are combined with intermediate inputs (both domestic and imported) to produce farm products. Commodities also flow from the six crop sectors to the three livestock sectors, in part via the prepared-feeds industry.

Raw farm products pass through the rest of the economy, generally receiving some additional value added, before being sold to domestic households or exported. These food products compete with non-food commodities and imports in the product markets. (See Appendix A for a complete listing of the 42 sectors included in this model.) The agricultural sectors also compete with non-farm firms in the factor markets.

Government functions are divided into two components (Keller, 1980). The first involves the provision of public goods and services by the government 'household'. Since these products are assumed non-rival in consumption, their demands are not explicitly modelled. (However, their supply can be measured by real government outlays on private goods and services which are endogenously determined.) Treasury activities are handled by the 'fisc', which collects all tax revenues from product and factor market transactions. (Subsidies are simply negative taxes.) These revenues are then distributed to the government, private, and foreign households. Any deficit financing is handled by a lump sum tax on, negative transfer to, the relevant households.

Figure 1 Real flows in the economy



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IV Model specification

Expenditures in initial equilibrium

A detailed discussion of the model's specification is provided in Appendix B. Two types of information are required. The first relates to expenditures by all firms and households, corresponding to the arrows in Figure 1 (for some benchmark period). These are based on the US input-output table and the national income and product accounts. The initial policy environment, as summarized by the taxes, subsidies, and transfers shown in Figure 1, must also be specified. Policy distortions are modelled as ad valorem price wedges. These are obtained from a variety of studies (see Appendix B). Since the most recent set of model-consistent tax rates on capital, labour, output, and consumption applies to the year 1984, this was selected as the base year for the liberalization experiments. Thus, agricultural policy and trade distortions in the model are also based on 1984 subsidy levels. While support levels have risen in recent years, they are now falling with recent increases in US farm exports. Thus 1984 subsidy levels may be more indicative of those observed in the next couple of years. However, in order to be applicable in the post-1985 Farm Bill environment, we assume (unlike 1984) that the US loan rate does not support the world price for program crops.

A detailed discussion of the treatment of agricultural programs is provided in Appendix B. This treatment is quite extensive. Dairy and sugar programs are introduced as a domestic/world price differential. Set-aside requirements for grains and cotton serve to shift these supply curves backwards, while output subsidies encourage producers to move further up their program supply curves. These output subsidies include deficiency and disaster payments, crop insurance subsidies, as well as other subsidies explicitly tied to the amount of program crop output produced. The provision of low-cost capital to agriculture via the Farmer's Home Administration and the Farm Credit System is captured in the form of capital subsidies. Similarly, subsidies on land improvements as well as grazing are treated as input subsidies to the relevant farm sectors.

Marginal behaviour in the model

The second type of information required to specify the CGE model used in this study is that which describes the behaviour of firms and households in the economy. All firms are assumed to maximize profits subject to a production function. (In competitive equilibrium, this means that they will be operating in an area of locally constant returns to scale.) Households are assumed to maximize utility subject to a budget constraint. However, the observed

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potential for substitution among inputs and among consumption goods differs considerably across firms and among households. In an effort to capture these differences, different marginal behaviour, ie different price and income elasticities, are specified. This is an important point and deserves further elaboration.

Input substitution possibilities in the nine farm sectors are based on econometric evidence for aggregate US agriculture (see Appendix B). Seven distinct input groups are identified, including: land, labour, two different types of capital, feed, chemicals, and other inputs. In addition, further substitution within the feed aggregate is permitted. Prepared feeds substitute for the on-farm feed mix, where the latter consists of a (price-sensitive) combination of feed grains and soy meal.

The distinguishing feature between prepared feeds and the on-farm feed mix lies in the prepared feeds sector's greater access to feed ingredients. As the price of soy meal increases, it may be desirable to bring in small amounts of fishmeal, for example. Incorporating alternative ingredients may only be feasible if a very large amount of feed is being prepared. There are three prepared feeds sectors, one for each type of livestock in the model (dairy, poultry, and red meats). These sectors each exhibit differing elasticities of substitution between food and feed grains, between soy meal and other sources of protein, and between the grain and protein aggregates. These are implicitly determined by the nutrient requirements of these three livestock groups.

Given the nature of the liberalization experiments conducted below, less detail is required in the non-farm production functions. Capital-labour substitution is dictated by a constant elasticity which varies across sectors. Intermediate inputs are assumed to be employed in fixed proportion to the output level in each non-farm sector.

The total availability of capital and labour is held fixed in order to highlight the competition between farm and non-farm sectors for scarce domestic resources. The total supply of agricultural land is also constant. However, acreage supplied to individual crop and grazing uses is responsive to changes in relative rental rates.[1] For example, holding all other prices constant (and abstracting from acreage controls), a 10 per cent increase in the price of feed grains induces an increase in the return on land used in feed grain production and hence a 4.5 per cent increase in feed grain acreage.

Income and price elasticities of demand for the private domestic household were obtained by estimating a complete demand system for eight food groups and one non-food aggregate (Appendix B). Government demands are assumed to be determined legislatively,

1 The one exception is land employed in sugar crop production. This is fixed, reflecting the relatively limited alternative uses for sugarcane land. (See Appendix B for more details.)

and are thus not price responsive in the model. Moreover, any change in the government expenditures is assumed to be allocated proportionately across all demands.

The final group of parameters required by the model are those which determine the responses of imports and exports to relative price changes. On the import side, this is tantamount to specifying an Armington elasticity of substitution between domestic and imported goods. When a product is relatively difficult to trade, as is the case with raw livestock products, this parameter is small (0.5 in the model). By contrast, a product such as prepared feeds is quite homogeneous and is given a large Armington elasticity (4.0). The Armington parameters for dairy and sugar products are specified in such a way that, in the long run, the model generates a plausible influx of imports when trade barriers are removed. Specifically, the model reproduces the same increase in imports (relative to domestic production) as is predicted by USDA's multicommodity trade model (SWOPSIM) under unilateral trade liberalization (Roningen, et al).[2]

Export price elasticities of demand for the major export crops are taken from a USDA study (Seeley, Tables 5, 9, and 13). They represent two-year responses, although the implications of increasing these to their longer run (4-year) levels are also explored. The own-price elasticities follow (4-year responses are given in parentheses): wheat -1.49 (-2.15), feed grains -1.70 (-2.65), and protein feed (used in the model for soy meal, soybeans and other prepared feeds) -1.52 (-1.78). Seeley's cross-price elasticities are also included in the model. Due to their smaller market share, other agricultural products are assigned a larger elasticity of -2.0 (-3.0). Non-agricultural products are assumed to face an export demand elasticity of -2.0 (-3.0).

2 Unilateral trade liberalization experiments with USDA's SWOPSIM model (1984 base) predicted the following changes in imports - expressed as a percentage of domestic production - sugar, +88 per cent and dairy products, +25 per cent.

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V Policy liberalization experiments

In this section, results from the policy liberalization experiments are reported. Emphasis is placed on the impact of removing those distortions specific to agricultural markets. While these agricultural trade and policy wedges are completely eliminated, other distortions, including the general system of taxes, non-agricultural tariffs, and transportation subsidies, are not altered. Thus domestic 'liberalization' is only partial. Furthermore, the demand for, and supply of, products by the rest of the world is not altered. Thus the simulated liberalization is a unilateral one.

Treatment of set-aside acreage

Complete elimination of all agricultural subsidies removes the incentive for holding farmland out of production. Thus, in our experiments all set-aside acreage moves back into production. Of course, land which was lured into, for example, wheat production because of generous farm programs may return to grazing or other crop production when these program incentives are eliminated. The extent to which this acreage shifting occurs will be a function of relative returns per acre in competing uses, as well as the elasticity of transformation among land types (Appendix B, Figure B.2).

Factor mobility assumptions

In the tables below, two alternative sets of liberalization results are presented. The first set is called the 'short run' scenario. It has been constructed with a two-year time horizon in mind. The following factor mobility assumptions are made.

(SRL) Farm labour (primarily proprietor and family labour) is mobile within agriculture, but immobile out of the farm sectors. Non-farm labour is mobile among non-farm sectors.

(SRK) Capital is immobile out of agriculture; however, crop capital is free to move among crops sectors. Livestock capital is sector specific and non-farm capital is mobile among non-farm sectors.

Thus, in the short run there is little potential for moving resources out of agriculture, but there is considerable leeway for shifting labour and capital among alternative farm activities.

In the longer run (four years or more), perfect factor mobility is introduced so that (LR) is now the operable assumption.

(LR) The market prices of labour and capital in the farm and non-farm sectors are equal.

Associated with these two domestic factor mobility scenarios are two alternative sets of export demand elasticities (detailed above). They are taken from Seeley who simulated the rest of the world's response to a US price shock, using the IIASA model. These export demand elasticities reflect increasing price responsiveness over time, as factors are reallocated within the foreign economies. To be compatible with the domestic scenarios, Seeley's two-year and four-year export demand elasticities are used here.

Price effects

The commodity and factor price effects of complete liberalization in agriculture are presented in Table 1. Owing to the presence of price wedges in initial equilibrium, the percentage change in one firm's price may not equal the price change faced by other firms or by the households. In this table percentage changes in the producing firm's price and in the private household's price are reported. Consider first the short run results. Higher market prices for program crops indicate that the release of set aside acreage, and subsequent outward shift in supply, is insufficient to offset the effects of lower input and output subsidies. Raw dairy and sugar prices drop, as the influx of processed imports augments domestic availability of these commodities. The price of other crops also falls. This is due to the availability of excess labour and crop capital released from the program crops sectors.

The decline in demand for farm labour and capital is reflected in lower short-run factor returns. The largest percentage declines are in the rents paid to owners of crop, dairy, and poultry capital. In the short run, payments to owners of existing dairy capital are completely eliminated. Land rents drop by less than labour and capital returns in the short run.

In the long run, labour and capital leave agriculture in favour of the higher returns offered by non-farm employment. Thus, most of the costs of reduced farm subsidies are passed forward to consumers in the form of higher food prices while land rents drop by an additional 3.22 per cent. The only agricultural prices which drop are the prices of sugar and other crops. It is striking that the price paid by domestic consumers for processed dairy products increases under the 'long run' scenario. This arises because the absolute increase in dairy imports is not large enough to outweigh the effects of: (a) higher feed prices, (b) a higher cost of capital, and (c) demand stimulating cross-price effects in consumption.

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Table 1 **Change in selected prices (per cent)**

	Short run		Long run	
	Firm price[1]	Private household price	Firm price[1]	Private household price
Commodity markets				
Raw commodities				
Dairy	-5.79	-5.79	4.23	4.23
Poultry	-0.84	-0.84	3.66	3.66
Red meats	-0.87	-0.87	3.70	3.70
Cotton	-11.60	5.60	-5.13	12.07
Food grains	-11.15	17.35	-9.31	19.20
Feed grains	-5.44	7.54	-3.56	9.42
Sugar crops	-24.31	-24.31	-19.71	-19.71
Oilseeds	-1.55	1.24	0.37	3.16
Other crops	-6.39	-6.39	-0.33	-0.33
Processed Commodities				
Red meats	-1.23	-1.23	1.83	1.83
Poultry	-0.62	-0.62	2.36	2.36
Dairy	-3.13	-3.13	0.59	0.59
Sugar	-14.01	-14.01	-13.50	-13.50
Factor markets				
Labour				
Farm	-16.61	-16.61	0	0
Non-farm (numeraire)	0	0	0	0
Capital services				
Crops	(see Appendix C)	-28.89	(see Appendix C)	-2.10
Dairy	-83.80	-100.00	21.40	-2.10
Poultry	-0.64	-30.26	27.52	-2.10
Red meats	0.07	-17.61	15.58	-2.10
Non-farm	-1.64	-1.64	-2.10	-2.10
Land	(see Appendix C)	-14.98	(see Appendix C)	-18.20
Fertilizer	-0.06	-0.06	-0.25	-0.25
Prepared feeds	1.42	1.42	2.15	2.15
Imported commodities	1.86[2]	1.86	1.48[3]	1.48

1 For raw and processed commodities this is the price received by the firm producing this commodity. For factors of production this is the price paid by the firm employing this factor.

2 The firm prices of imported red meats, dairy, and sugar drop by 10.35, 19.35, and 26.65 per cent, respectively.

3 The firm prices of imported red meats, dairy and sugar drop by 10.73, 19.72 and 27.03 per cent, respectively.

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The price of imports, relative to the numeraire (non-farm labour), rises under both the short- and long-run scenarios. This is necessary in order to achieve balance of payments equilibrium in the face of an exogenous capital account. As farm export prices rise, elastic foreign demand reduces expenditures on US exports. Thus, *ceteris paribus*, import expenditures must also shrink. However, the demand for imports is stimulated by lower domestic prices for foreign sugar, dairy, and red meat products. Import prices must rise in order to equilibrate these forces.

The quantity changes engendered by this unilateral liberalization in US agriculture are presented in Table 2. These refer to the long-run outcome when labour and capital are mobile out of agriculture. All entries are in billions of 1987 dollars. It should be emphasized that these are not changes in receipts, since they do not include the effect of price changes. They are pure quantity effects, where one unit is defined as the amount of a commodity which can be purchased for one dollar, at market prices in initial equilibrium.

The largest long-run percentage adjustments in domestic production occur in the raw and processed sugar sectors (-70.63 per cent and -79.45 per cent). The largest absolute long-run drops in output are in the raw and processed dairy sectors ($4.6 and $8.6 billion, respectively). The feed grains sector also experiences a large drop in long-run output ($4.5 billion). The majority of this drop is caused by declining feed demand in the domestic economy. (Intermediate uses of feed grains drop by $4.1 billion). The only farm sector to increase output in the long run is oilseeds. This is due to the cross-price effect between feed grains and soy meal in the domestic and foreign feed mixes.

This contraction of agriculture translates into an exodus of labour and capital from the farm sectors. We estimate that, in the long run, an additional 5.5 per cent reduction in the US agricultural labour force would occur as a result of unilateral agricultural policy liberalization. (This is over and above the ongoing exodus of labour from agriculture due to technical and structural change.) The long-run stock of non-land farm capital is projected to fall by 13.9 per cent.

The final group of results in Table 2 refers to the impact of agricultural trade and policy liberalization on the non-food sectors. Farm input suppliers are hurt, but the other services and manufacturing sectors experience a combined $19.6 billion increase in output. This is driven by three general equilibrium forces. The first of these stems from the factor market linkages identified in Figure 1. As labor and capital leave agriculture, they may now be employed by other industries. This lowers non-food production costs, hence increasing non-farm output and exports in the new equilibrium.

Table 2 **Changes in long-run commodity supply and demand[a] (billions of 1987 dollars[b])**

Commodity	% Change dom prod	Dom prod	Interm use	Dom hhlds	Export	Imports
Raw food commodities						
Dairy	(-21.38)	-4.6	-4.6	*	*	*
Poultry	(-0.84)	-0.1	-0.1	*	*	*
Red meats	(-2.34)	-1.1	-1.1	*	*	*
Cotton	(-10.39)	-0.7	*	*	-0.7	*
Food grains	(-12.17)	-1.1	-0.1	*	-1.0	*
Feed grains	(-10.57)	-4.5	-4.1	*	-0.4	*
Sugar crops	(-70.63)	-1.3	-1.3	*	*	*
Oilseeds	(1.04)	0.2	*	*	0.2	*
Other crops	(-0.02)	*	-0.2	0.1	0.1	*
Processed agr, and food commodities						
Red meats	(-1.71)	-0.9	*	-0.2	*	0.7
Poultry	(**)	*	*	*	*	*
Dairy	(-24.98)	-8.6	*	*	*	8.7
Other food	(0.69)	0.3	*	0.1	0.1	-0.1
Wet corn mill	(-1.23)	*	*	*	*	*
Feed and flour mill	(0.11)	0.1	*	*	*	*
Prepared feeds						
Dairy	(-13.82)	-0.6	-0.6	*	*	*
Poultry	(2.11)	0.1	0.1	*	*	*
Red meats	(3.76)	0.3	0.3	*	*	*
Sugar	(-79.45)	-3.8	0.1	0.1	*	3.9
Fats and oils	(0.77)	0.1	*	*	0.2	*
Other agr commod	(1.06)	0.5	*	0.1	0.1	-0.4
Other commodities[c]						
Agr inputs	(-0.69)	-1.2	-1.7	0.1	0.1	-0.3
Other services	(0.24)	6.5	0.4	2.7	3.4	*
Other manufacture	(0.87)	13.1	-1.8	0.8	7.5	-6.6

a Equilibrium requires that the sum of changes in intermediate use, domestic households' demand, and exports must be equal to the sum of changes in domestic production and imports. However, column sums in this table are not equal because figures have been rounded.

b The model is actually solved for percentage changes in quantities measured in 1977 dollars (see Appendix B). For ease of comparison, these have been converted to 1987 dollars by applying the common conversion factor: $1 in 1977 = $1.75037 in 1987.

c These rows represent the aggregation of results for 18 non-food sectors into three broad groups for reporting purposes.

* This entry is less than 0.05 $billion in absolute value.

** This entry is less than 0.005% in absolute value.

The second phenomenon stimulating the non-food sectors is that they become more competitive, relative to foreign producers. This is because, as noted above, the relative price

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of imports must rise in order to maintain balance of payments equilibrium in the face of an exogenous capital account. As a result manufactured imports fall, and these are replaced by domestic production.

Finally, as will be shown below, eliminating a large group of distortions reduces excess burden in the economy and real domestic income goes up by almost $5 billion. This increased income is allocated among consumption items according to the income elasticities of demand given in Table B.4 of Appendix B. As a result, the household demand for services increases by $2.7 billion.

Table 3 presents the short- and long-run welfare effects of agricultural policy liberalization in the US Equivalent variations for the domestic and foreign households are decomposed into their component parts. For example, domestic households could pay $3105 million in exchange for lower short-run food prices, and still be just as well off as before liberalization. However, they would require $2402 million to compensate them for the higher food prices they would face in the long run. Foreign households, in their role as consumers of US food exports, suffer under both scenarios. They also lose $1115 million in reduced dairy and sugar quota rents. However, they sell a lot more of these products to US consumers. This induces a terms of trade effect which benefits the rest of the world, at the expense of US consumers who must now pay more for all imports.

In the short run, most of the domestic burden falls on the relatively immobile farm factors of production. From the point of view of the aggregate domestic household, this is offset by the increased treasury revenues which are transferred back in a lump sum equal to $12,884 million. In the long run, as labour and capital move into higher tax, higher productivity, non-farm uses, this change in net revenue increases slightly to $13,838 million. Thus, the United States as a whole is unambiguously better off as a result of liberalization. This means that farmers could be fully compensated for their losses and some money would still be left over.

The issue of compensation is important and deserves further discussion. In the long run, the main losers in the farm sector are the landowners. At a real interest rate of 5 per cent, the capitalized value of their losses equals $113.8 billion. This would be devastating for a sector which is already experiencing severe financial problems due to high debt/asset ratios. Some form of severance payments to these landowners will be required in order to make such a policy palatable. However, the funds will be available, since the capitalized value of treasury savings (at a 5 per cent real discount rate) is $276.8 billion.

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Table 3 **Distribution of gains and losses from unilateral liberalization of US agricultural and food policies: equivalent variations (millions of 1987 dollars)[1]**

	Short run		Long run	
	Households		Households	
	Domestic	Foreign	Domestic	Foreign
Food	3,105	-1,280	-2,402	-2,051
Non-food	6,634	117	9,347	418
Imports	-186	5,447	-149	4,351
Non-farm labour (numeraire)	0	0	0	0
Non-farm capital services	-7,595	674	-9,821	861
Sub-total	1,958	5,018	-3,025	3,579
Farm labour	-4,776	0	0	0
Crop capital services	-1,019	0	-74	0
Livestock capital services	-2,347	0	-121	0
Land services	-4,682	0	-5,690	0
Sub-total	-12,824	0	-5,885	0
Transfer	12,884	-1,155[2]	13,838	-1,155[2]
Total	2,018	3,863	4,928	2,424

1 The model is actually solved for percentage changes in quantities measured in 1977 dollars (see Appendix B). For ease of comparison, these have been converted to 1987 dollars by applying the common conversion factor: $1 in 1977 = $1.75037 in 1987.

2 This represents the loss in rents associated with elimination of the sugar and dairy quota (based on 1977 import levels, but the 1984 domestic/world price differential).

In the shorter run, adjustment assistance for labour and some compensation to owners of non-land capital will be required. Table 3 estimates that the proper amount for such annual payments will be about $4.8 billion for farm labour and $3.4 billion for owners of capital. These payments should be transitory, only covering the period required to redeploy these resources in the non-farm economy.

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VI Conclusions

One rather concise way of summarizing the economy-wide effects of liberalizing US agricultural policies is to compare them to the number of farm jobs which would be lost. Such ratios may also be interpreted as the average annual cost of protecting one farm job with the current configuration of policies. This study has found these costs to include: (i) reduced non-food output (-$107,000 per farm job saved), (ii) increased treasury outlays ($80,500 per farm job saved), (iii) lower real domestic income (-$28,700 per farm job saved), and (iv) higher food costs ($14,000 per farm job saved).

In addition to lowering agricultural employment, unilateral policy liberalization induces capital to leave agriculture and lowers land values. However, our results indicate that the owners of these farm assets can be more than compensated for their losses by using a portion of the budget savings generated by this experiment. Furthermore, it should be pointed out that the losses to agriculture as a whole would be much less if other countries were simultaneously to liberalize their farm policies. Roningen, et al estimate that farm sector losses from unilateral policy liberalization are cut in half when liberalization is global. This is because export prices facing US producers increase significantly as excess resources are withdrawn from agricultural production worldwide.

In sum, there are substantial economy-wide benefits to be realized through removal of current domestic and trade policy interventions in US agriculture. Non-food producers, taxpayers, and consumers all stand to gain from such measures. Furthermore, these gains are sufficient to compensate farmers for their losses, even if other nations do not simultaneously liberalize their agricultural policies.

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Appendix A Detailed listing of sectors in the model

CGE model sectors and associated input-output identifiers

Sector name	*1977 I/O Sector Numbers*
Dairy farm products	1.01
Poultry and eggs	1.02
Meat animals	1.0301
Cotton	2.01
Food grains	2.0201
Feed grains	2.0202
Sugar crops	2.0502
Oil-bearing crops	2.06
Other farm products	1.0302, 2.0203, 2.03, 2.04, 2.0501, 2.0503
Meat products	14.0101, 14.0102
Poultry products	14,0103, 14.0104
Dairy products	14.02 - 14.06
Canning, freezing and dehydrating	14.07 - 14.13, 14.30, 14.32
Wet corn milling	14.17
Feed and flour milling, confectioner, bakery and macaroni	14.31
Prepared feed nec	14.1502
Sugar	14.19
Non-alcoholic beverages and flavourings	14.22 - 14.23, 14.2002, 14.2003, 14.28
Alcoholic beverages	14.21
Fats and oils	14.24 - 14.27, 14.29
Forestry, fishery and horticultural products	2.07, 3.0, 4.0002
Agricultural services	4.0001
Other mining	6.0 - 7.0, 9.0
Crude petroleum and natural gas	8.0
Chemical and fertilizer mining	10.0
Tobacco and fibre manufactures	15.0 - 19.0
Fertilizer	27.02
Chemicals (no fertilizer)	27.01, 27.03 - 27.04
Petroleum ref. and related products	31.01
Rubber and miscellaneous plastics	32.0
Leather and leather products	33 - 34
Other manufacturing	13, 20 - 26, 28 - 30, 31.02, 31.03, 35 - 64
Transp., wareh., wholesale/retail	65.0, 69.0
Electricity services	68.01
Gas production and distribution	68.02
Steam, sanitation and irrigation	68.0302
Finance, insurance and business services	70.0, 73.0
Real estate	71.0
Eating and drinking places	74.0
Other non-commodities	11 - 12, 66, 67, 68.0301, 72, 75 - 79
Special industries	82 - 85

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Appendix B Supplementary discussion of the model

General structure

The general structure of this CGE model follows Keller, 1980. His model is in the Johansen (1974) tradition, whereby the structure of the economy is approximated in the neighbourhood of a particular point of interest, with a set of log-linear equations. This concept of a local approximation is compatible with recent work on consumer and producer behaviour (eg Fuss and McFadden, 1978). Most of this research is conducted with flexible functional forms designed to provide a local, second-order approximation to the true, but unknown production/ utility structure (Diewert, 1973). Since these unrestricted elasticities are only valid in the neighbourhood of the point of approximation, the results from this CGE model, which employs estimates from several flexible demand systems, will be only locally valid as well.

Two types of information are required by the Keller model. Information concerning net expenditures by all agents in the initial equilibrium situation generates the (locally constant) expenditure shares in the behavioural equations for firms and households. The second type of information describes marginal responses to changes in prices, output, and income. Based on initial prices (which will differ among firms and households in the presence of taxes), equilibrium quantities may be extracted from the equilibrium expenditures. These quantities generate the share-weights which are used to aggregate the behavioural responses (elasticities) of firms and households to the market level where the general equilibrium solution is obtained.

Expenditures in initial equilibrium

The economy-wide set of accounts developed for this study is constructed in two parts. First, a consistent set of dollar flows is established for the entire US economy. This is based on the most recent published input-output table available (1977). Additional discussion of the data base modifications and manipulations is available in Hertel and Tsigas (1988). The next step involves inserting a set of 1984 policy wedges into these accounts. (See Hertel, Chattin, and Tsigas, 1987, for a more detailed treatment of this topic.) These wedges are crucial in determining the excess burden as well as the fiscal implications of any new policy intervention

Table B1 identifies the types of distortions incorporated into the initial equilibrium. They reflect 1984 policies and are modelled as ad valorem price wedges. These interventions are grouped into two categories, those applying to outputs and intermediate inputs and those

Table B1 **1984 Price wedges employed in equilibrium data set**

(Positive sign indicates presence of wedge raises firm receipts (payments) or household payments (receipts). Negative sign implies the opposite. Unaltered wedges are placed in parentheses.)

	Productive sectors															Households		
	Dairy	Poultry	Red meats	Cotton	Food grains	Feed grains	Sugar	Oil seeds	Other crops	Proc dairy	Proc sugar	Proc red meats	Trans wath w/r	Other firms	Land distr	Private	Government	Foreign
Commodity wedges																		
Output wedges																		
Def.payments[a]				+	+	+												
Disaster payments[a]																		
Crop insurance[a]				+	+	+	+	+										
Govt storage and invent[a]				+	+	+		+										
Interest rate[a]				+	+	+		+										
Output tax[f]	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)		(-)	(-)				
Net output wedge	(-)	(-)	(-)	+	+	+	-	+	-	(-)	(-)		(-)	(-)				
Proc dairy program[a]	+	+	+	+	+	+	+	+	+	+	+		+	+		+	+	-
Proc.sugar program[a]	+	+	+	+	+	+	+	+	+	+	+		+	+		+	+	-
Import Tariff[a]												+		(+)				
Transport subsidy	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)		(-)	(-)				
Sales tax																(+)		
Primary factor wedges																		
Capital services																		
FmHA/FCS[b]	-	-	-	-	-	-	-	-	-									
Factor tax[f]	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)		(+)	(-)			
Net capital services wedge	+	-	+	+	+	-	-	-	-	-	(+)		(+)	(+)				
Land services																		
FmHA/FCS[b]	-	-	-	-	-	-	-	-	-									
Land and structural improvement[a]	-	-	-	-	-	-	-	-	-									
Grazing[a]			-															
Acreage reduction[c]															(-)		-	
Factor tax	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)									
Net land wedge	+	+	+	+	+	+	+	+	+									
Labour services																		
Factor tax[f]	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)		(+)	(+)				
Income tax[e]																(-)		

Sources:

a Chattin, 1987 (and unpublished worksheets). See also USDA/ERS (1987).
b Hughes, et al.
c Hertel, Chattin and Tsigas (1988).
d Corps of Engineers (1984) (Table 5).
e Cline et al, 1978, (Table 2-1), and UNCTAD (1982), paragraph 32.
f Boyd.

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applying to primary factors of production. A positive sign indicates that the effect of the wedge is to raise the firm (or household) price above the equilibrium market price. In the case of outputs this is a subsidy, while it would represent a tax for an intermediate input, a primary input, or a commodity purchased by one of the households. A negative sign indicates that the wedge has the opposite effect.

There are two distinct types of interventions in this table, namely those that are altered in the liberalization experiment and those that are left unchanged. (The unaltered wedges are placed in parentheses.) Some discussion of the treatment of these wedges is in order. Those government payments tied explicitly to output are treated as output subsidies. A variety of farm programs serve to lower the per unit cost to farmers of using capital and land. Dairy and sugar programs raise the prices received by domestic producers and those paid by US consumers, relative to world price levels. The final farm program effect treated here is that of acreage reduction. In contrast to all of the previous wedges, this limitation in land used for program commodities tends to reduce output.

There are three important characteristics of the acreage set-aside programs in US agriculture: (1) the land is left idle (or occasionally permitted to move into very low value crops such as hay); (2) the shadow price of land in the production of program crops is higher than would otherwise be the case; and (3) most of the incentive for setting aside acreage comes in the form of an output subsidy 'bribes' – namely deficiency payments on program crop production. In order to capture these three factors in the benchmark equilibrium, we proceed as follows. The government rents the idled acreage and the cost of this rental activity is fully subsidized by the treasury. Thus its social marginal value product is zero in initial equilibrium. This captures point (1). At the same time there is a tax on the use of program crop land in production. This accomplishes (2), and (3) as well, since the tax is computed to exactly offset the subsidy on the government's land rental. Thus the set aside program is fiscally neutral. This circumvents double counting farm program expenditures, since the deficiency payment 'bribes' are already incorporated as output subsidies in the initial equilibrium accounts.

Economy-wide price wedges are unaltered in the subsequent analysis. However they are still important, particularly to the extent that they affect agriculture differentially. Transport subsidies capture the annual cost of inland waterways not covered by users. These subsidies tend to lower the cost of mining and agricultural outputs, relative to other products. Differential treatment of farm and food sectors in the basic tax structure has also been shown to have an important impact on the size and mix of US agriculture (Hertel and Tsigas, 1988). Average tax rates for 1984 are based on the work of Boyd (1987). Taxes are levied on the use of labour and capital, as well as output, retail sales and income. These rates are approximated

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with ad valorem price wedges.

A condensed version of this benchmark data set is reported in Table B2, which provides net expenditures by industries and households on goods and services. The first row of Table B2 describes the sale and purchase of the aggregated, net output of the 41 producing sectors in 1977 dollars. This totals $1.88 trillion. Final demands for these products are as follows: investment = $373 billion, private consumption = $1.28 trillion, government purchases = $187 billion and exports = $140 billion. The presence of output and consumption taxes means that consumers of a given product pay more than producers receive. This gives rise to a positive row total equal to the resulting tax revenue. (This total would be larger in the absence of agricultural output subsidies.)

In order to handle savings and investment in a static model, we follow Johansen and Keller by introducing a 'dummy' capital goods sector which collects and distributes investment goods. Replacement investment is assumed to equal purchases of scrap and depreciation, and is entered in the capital goods row for the 38 non-livestock sectors. (Livestock sectors are assumed to generate their replacement investment internally.) The remaining portion of capital goods output (net investment) is allocated to the domestic household as savings.

Table B2 **Net expenditures at net prices (millions of 1977 dollars - receipts are indicated by negative expenditures)**

	41 Industries	Capital goods	Private domestic household	Government domestic household	Foreign household	Row total (taxes)
41 industries	-1,886,013	373,573	1,281,990	187,675	140,446	97,671
Capital goods	218,101	-349,275	205,990	846	1,560	77,222
Imports	170,970	53	1,551	4,135	-167,235	9,474
Labour services						
Farm	20,957	0	-16,426	0	0	4,531
Non-farm	1,015,690	0	-953,287	203,675	-29	266,049
Capital services						
Crops	1,977	0	-2,014	0	0	-37
Dairy	812	0	-774	0	0	38
Poultry	552	0	-559	0	0	-7
Red meats	2,170	0	-1,940	0	0	230
Non-farm	432,538	-24,351	-266,450	-765	23,411	164,383
Land services	22,246	0	-17,852	1	0	4,395
Column total						
(Transfers)	0	0	230,229	395,567	-1,847	623,949

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Imports of foreign goods are treated as augmenting the domestic availability of output from the 41 producing sectors. When combined with direct sales to final demand, total imports ($167 billion) are obtained. These are supplied by the foreign household.

The remaining rows of Table B2 document the flows of primary factor service payments to the private domestic household. Note that labour is disaggregated into farm and non-farm components. Similarly capital stocks generating capital service flows to the private households are disaggregated into crop capital (eg tractors and combines), three types of livestock capital, and all other (non-farm) capital. Finally, the payments to land are accounted for. Each of these factor service flows generates net tax revenue. In the case of crop and poultry capital, the estimated value of credit subsidies exceeds estimated tax revenue and the row totals are negative. A total of $624 billion in taxes (net of subsidies) is collected by the treasury (sum of row totals) which must equal the sum of transfers to households.

Marginal behaviour of firms and households

Keller and most other CGE modelers (eg, Ballard, et al and Dervis, et al (1982) - Jorgenson is an exception) employ nested CES relationships to describe production and utility structures in their CGE models. This study departs from a strict adherence to convenient functional forms to incorporate more flexible demand systems in the model. Thus specification of the domestic household's demand for food builds on the recent work of Huang and Haidacher (1983). The derived demand for inputs by crop and livestock farms is based on an aggregate translog cost function for US agriculture.

In the absence of commodity-specific time series data on input use, an aggregate multi-product cost function was estimated based on the data of Ball (1985) (Hertel, Ball, Huang and Tsigas, 1987). Inputs and outputs were defined to match sectoral disaggregation and factor concepts in the CGE model. Assuming a translog cost function, a system of cost and revenue share equations was derived for seven inputs [crop capital (durable equipment), land, livestock capital (herd and structures), labour, feed, fertilizer, and other inputs] and nine outputs (dairy, red meats, poultry, feed grains, food grains, oilseed crops, sugar, cotton, and other crops). Constant returns to scale were imposed and a time trend was included in each share equation to represent technical change over the sample period (1948-79). The estimated partial elasticities of substitution, evaluated at the fitted 1977 shares are reported in Table B3.

Since factor tax (and subsidy) rates differ across agricultural commodities, the production of each commodity must be treated as an independent activity facing a distinct vector of factor prices. In order to utilize the estimated matrix of substitution effects, while permitting

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Table B3 **Estimated Allen partial elasticities of substitution for US agriculture.[a,b] (Evaluated at fitted 1977 shares - approximate t-values in parentheses).**

	Land	Crop capital	Livestock capital	Labour	Feed	Fertilizer	Other[c] inputs
Land	-3.31	0.01	-0.12	-0.33	0.52	0.68	0.79
	(-1.8)	(0.2)	(-0.4)	(-1.0)	(3.2)	(2.8)	
Crop capital		-2.77	0.48	-1.20	0.92	0.67	1.49
		(-5.2)	(2.0)	(-3.7)	(4.3)	(1.9)	
Livestock capital			-3.11	0.27	0.58	0.28	1.04
			(-13.9)	(1.3)	(4.2)	(1.2)	
Labour				-0.84	0.07	-0.83	1.99
				(-2.1)	(0.3)	(-2.1)	
Feed	(Symmetric)			-0.91	0.50	-0.37	
					(-4.5)	(1.4)	
Fertilizer						-6.91	2.07
						(-6.2)	
Other Inputs							-4.88
Fitted cost shares	0.07	0.12	0.14	0.20	0.23	0.07	0.17
	(7.8)	(35.4)	(37.8)	(34.1)	(65.8)	(46.0)	
Time trend in share equation	-0.0002	0.0018	0.0024	-0.0077	0.0003	0.0020	-0.0014
	(-0.4)	(4.5)	(7.1)	(-11.2)	(1.2)	(8.3)	

a For details on variable definition, aggregation, and specific treatment in the model, see Hertel, Ball, Huang, and Tsigas (1987).

b The eigenvalues of the hessian of the cost function with respect to these 7 input prices follow: [0.99, -22.67, -8.40, -6.83, -0.00, -3.87, -1.84].

c Coefficients associated with other inputs are derived via homogeneity. Approximate standard errors are not computed for these elasticities.

each sector to face different factor prices, the same (7x7) matrix of Allen partials was assigned to each individual farm sector. The sectoral demand elasticities will differ across commodities since they are equal to the Allen partials weighted by the cost share which corresponds to the relevant input price. For example, the demand elasticity for feed in the crops sectors will be zero owing to a zero cost share for feed in those activities. However, the shape of the aggregate farm sector isoquants will reflect the substitutability implied by the multi-product cost function.

Figure B1 provides the overall structure of domestic production in the agricultural sectors. Total supply is modelled as a CES aggregation of foreign and domestic production which, following Armington, are treated as imperfect substitutes. The ease with which this

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substitution occurs, as measured by σ^m, varies by commodity and is a function of product homogeneity. Figure B1 also shows the feed input as a nested CES aggregate of the on-farm feed mix and purchases from the prepared feeds sectors. The on-farm mix is a combination of feed grains and soy meal. Substitution between these inputs varies across livestock types and is identical to the grain-protein substitution parameter used for prepared feeds.

Figure B2 shows how a nested CET function 'transforms' one type of land into another. The land groups include: sugar, cotton, food grain, feed grain, oilseeds, and other agricultural land. Other agricultural land is employed in the production of both other crops and livestock. A 0.2 constant elasticity of transformation among different types of non-sugar land gives the model generally plausible partial equilibrium (commodity price) acreage response elasticities.

Production technology in the prepared feeds sectors is summarized in Figure B3. Domestic output consists of a nested CES technology with separability between protein sources and grains. (This follows closely the work of John Zeitsch for the OECD.) The protein aggregate combines soy meal with other protein sources, while food grains may substitute for feed grains in the grain aggregate. These two elasticities of substitution, as well as the substitutability of grains for proteins, depend on the type of feed being produced. For example, the dairy and beef industries are assumed to substitute more easily between grains than can poultry producers.

Figure B4 describes the production structure in the non-farm sectors. Capital and labour are combined with a constant elasticity of substitution to produce a value-added aggregate. These substitution parameters are taken from Ballard, Fullerton, Shoven, and Whalley (1987), pp132-34. Value added is then combined with intermediate inputs using the assumption of fixed coefficients.

Substitution in private household consumption is characterized by a 9x9 matrix of unrestricted demand elasticities which disaggregates food into eight groups and treats all non-food consumption as a single aggregate. These elasticities (provided in Table B4) were obtained by re-estimating the model reported in Huang and Haidacher (1983) using a slightly more aggregate data set and imposing symmetry, homogeneity, and Engel aggregation at the budget shares used in the CGE model. (See Hertel, Ball, Huang, and Tsigas (1987) for more details.) These commodity demands are the only source of price responsiveness for the domestic household since the demands for leisure and savings are fixed in this model.

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Figure B1 Production structure in the farm sectors

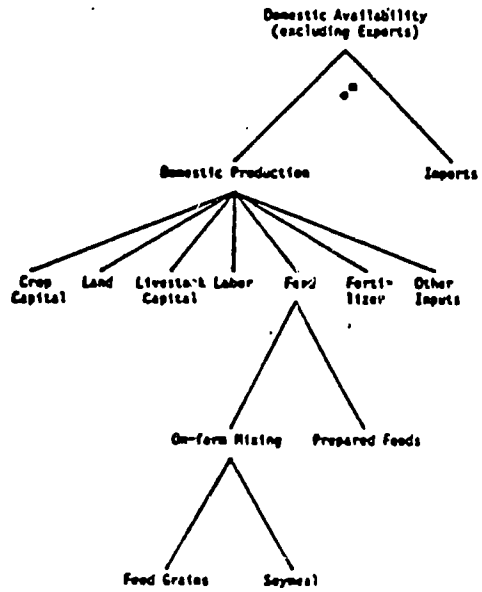


Figure B2 The land distributing sector

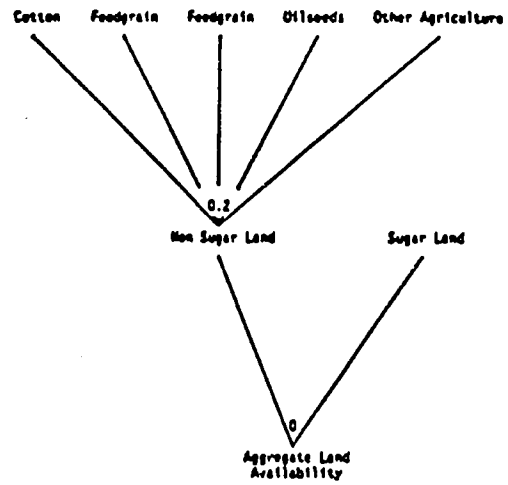
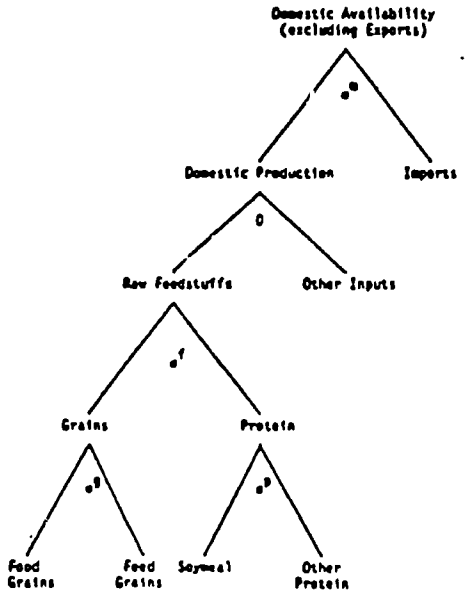
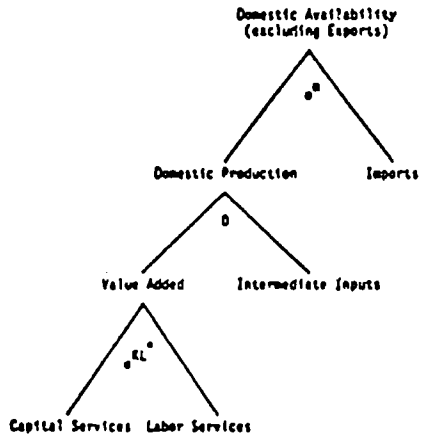


Figure B3 Production structure in the prepared foods sectors



Sector	Base Parameter Values σ^g	σ^p	σ^f
Dairy P.F	3.06	4.29	1.25
Poultry P.F.	1.60	4.29	1.09
(Beef)	(3.06)	(4.29)	(1.14)
(Hogs)	(1.32)	(2.38)	(1.70)
Red Meat P.F.	2.32	3.72	1.41

Figure B4 Production structure in the non-farm sectors



* σ^{KL} taken from BFSW, pp. 132-34.

Table B4 **Estimated demand elasticities for the private domestic household (Second row provides the associated standard errors.)**

Quantity	Prices*									
	Red meat	Cereal	Poultry	Dairy	Fats	Sugar	Beverages	O. food	N. food	Expend**
Red meat	-0.4587	0.0107	0.0328	-0.0338	0.0006	-0.0550	-0.0152	-0.0014	-0.0255	0.5455
	0.0271	0.0110	0.0107	0.0128	0.0083	0.0120	0.0093	0.0031	0.0693	0.0673
Cereal	0.0735	-0.0414	-0.0014	0.0621	0.0158	0.0005	-0.0145	-0.0307	0.0664	-0.1204
	0.0451	0.0570	0.0296	0.0553	0.0279	0.0285	0.0151	0.0140	0.1034	0.0948
Poultry	0.1149	-0.0034	-0.1965	0.1273	0.0470	-0.0601	0.0030	0.0220	-0.1471	0.0930
	0.0313	0.0212	0.0234	0.0264	0.0140	0.0159	0.0112	0.0066	0.0782	0.0752
Dairy	-0.0252	0.0220	0.0683	-0.1501	-0.0743	0.0446	0.0033	0.0069	0.1438	-0.0392
	0.0191	0.0205	0.0137	0.0484	0.0185	0.0113	0.0071	0.0114	0.0533	0.0431
Fats	0.0227	0.0171	0.0820	-0.2535	-0.1519	0.1135	0.0032	-0.0016	0.0661	0.1024
	0.0423	0.0347	0.0254	0.0622	0.0434	0.0239	0.0147	0.0189	0.1062	0.0966
Sugar	-0.0374	-0.0034	-0.0215	0.0213	0.0206	-0.2014	-0.0247	0.0076	0.0400	0.1988
	0.0126	0.0070	0.0056	0.0079	0.0048	0.0146	0.0071	0.0018	0.0056	0.0815
Beverages	-0.0458	-0.0179	-0.0011	-0.0051	-0.0004	-0.0977	-0.1863	-0.0015	-0.0404	0.3963
	0.0325	0.0127	0.0133	0.0171	0.0101	0.0239	0.0251	0.0032	0.1452	0.1545
O. food	0.0035	-0.0695	0.0657	0.0340	-0.0035	0.0706	-0.0011	-0.1894	-0.0871	0.1769
	0.0273	0.0303	0.0199	0.0667	0.0328	0.0158	0.0081	0.0435	0.0688	0.0480
N. food	-0.0284	-0.0131	-0.0189	-0.0300	-0.0085	-0.0420	-0.0104	-0.0054	-1.0037	1.1607
	0.0022	0.0009	0.0009	0.0014	0.0008	0.0014	0.0011	0.0003	0.0082	0.0079
Weight***	0.0440	0.0108	0.0152	0.0292	0.0067	0.0460	0.0128	0.0050	0.8281	

* This is the 9 x 9 matrix of uncompensated price elasticities employed in the model, courtesy of Kuo Huang. For details on variable definition and treatment in the model see Hertel, Ball, Huang and Tsigas (1987).

** These are the income elasticities of demand.

*** These are the expenditure shares at which the neoclassical restrictions are imposed, for estimation purposes. They are also the actual expenditure shares used in the CGE model.

Detailed specification of the experiment

As noted above, all price wedges are introduced in an *ad valorem* fashion. For firms in the model, $p^F = t * p^M$, where p^F is the price received by the firm, p^M is the market price, and t is the *ad valorem* tax (subsidy) rate. When output supply is undistorted, t = 1. In the case of program crops (in 1984), t > 1 indicating that farmers receive a price in excess of the market price. Total differentiation yields: $\hat{p}^F = \hat{p}^M + \hat{t}$, where the hat (^) denotes a percentage change from initial equilibrium. In the policy liberalization experiment, t is reduced so that $\hat{t} < 0$ and the 'wedge' between firm and market prices is reduced.

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Note that the value of t in initial equilibrium is determined by the full set of 'wedges' described in Table 1. Thus t is not equal to one plus the per unit output subsidy. It also includes a (small) output tax. Similarly, in the case of capital services employed in agriculture, the estimated FmHA/FCS subsidy serves to offset the capital income tax rate, resulting in a value of t which is closer to one. This does not, however, alleviate the factor market distortion. Since non-farm sectors face higher capital tax rates and do not receive the benefit of low cost FmHA/FCS loans, the subsidy serves to exacerbate further an existing distortion. That is, the marginal value product of capital in agriculture (in initial equilibrium) is far below the average for non-farm sectors.

In the case of processed sugar and dairy products, both domestic producers and consumers face an artificially enhanced price, ie, p^F, p^H exceed the world price. However, $p^F \neq p^H$ owing to the presence of output and sales taxes. Policy/trade liberalization in these markets involves reducing the 'wedge' between domestic and world prices. (The costs of dairy and sugar imports are simultaneously reduced.)

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Appendix C Changes in sectoral costs of capital and land services

	Short run	Long run
	Firm price	Firm price
Crop capital services		
Cotton	-21.63%	5.15%
Food grains	-9.93	16.85
Feed grains	0.82	27.61
Sugar crops	22.47	49.26
Oilseeds	22.97	49.76
Other crops	23.50	50.29
Land		
Dairy	-5.14	-14.18
Poultry	-5.40	-14.44
Red meats	-0.09	-9.13
Cotton	-45.19	-63.93
Food grains	-21.42	-24.18
Feed grains	-13.42	-15.03
Sugar crops	-92.45	-96.72
Oilseeds	0	-0.60
Other crops	-4.79	-13.83

Agricultural policies and the US Federal budget and the trade deficit

by

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Summary

The aim in this paper is to analyze the effects of agricultural policies, in particular spending on subsidies, on the macroeconomy in the United States. Subsidies have not only direct budgetary implications, in that they represent expenditures of the government, but they also distort the relative price structure and thereby the allocation of scarce factors. In addition, a reduction in subsidies will, via its impact on domestic interest and inflation rates, have implications for private savings and investment that can cause major changes in both real income and the trade balance.

Four types of agricultural subsidies are examined. The first is a subsidy on the inputs of value added to production. The second is a trigger price mechanism in which the government guarantees a fixed price for agricultural output. The third is a consumption support to consumers, while the fourth is a payment for land set-asides, ie a payment to farmers in return for withdrawing land from production. All these subsidies have both direct and indirect implications. Import subsidies and guaranteed minimum prices will tend to expand US output, all other things being equal. Consumption supports, on the other hand, will tend to increase domestic output and consumption but decrease exports. Finally, set-asides result in not only an increase in government spending, but also in a reduction in acreage. The relative rental price of land increases, as does the price of agricultural output, thereby having a negative effect on US farm exports.

The analysis uses the framework of a general equilibrium model with forward looking agents.[1] It is essential to use a general equilibrium framework, since a partial equilibrium approach ignores most of the macro-economic interactions that are important. The simple macro-economics of a reduction in subsidies may be thought of as follows. The initial impact of the reduction is to reduce the government's budget deficit, decreasing the rate of growth of monetary expansion and raising the real interest rate. This outcome depends on the formulation of gevernment financing assumed in the model in which the sale of bonds is fixed and monetization is derived as a residual. In response to the higher real rate, consumers increase their savings, while the rate of private investment declines. Accordingly, overall domestic savings increases, leading to an initial improvement in the trade balance. At the same time, the reduction in subsidies, in particular of set-asides, have caused the export price index, in which agriculture is an important component, to decline. Thus foreign export demand increases. These conclusions are subject to a number of conditions, in particular that export

1 The simulation model that underlies this study is available upon request from the author. It is designed to run on a personal computer, and model changes may be easily incorporated in the program.

supply is elastic, which seem justified by empirical studies. At the same time, however, the improved trade balance brings about a strengthening of the US dollar, causing imports to increase and the final improvement in the trade balance to be less than the initial impact.

After having given the model parameters to replicate reasonably the macro-economic outcomes of 1985-86, an experiment is conducted which asks what the results would have been if all agricultural subsidies had been removed in those years. It is determined that the removal of subsidies, which would have resulted in a direct budgetary savings of $58 billion over the two years, would have actually saved a total of $74 billion through its impact on interest rates and the tax base. Thus the currently sought-after $30 billion could be more than achieved by reducing or eliminating agricultural subsidies.

The trade balance also improves by more than the reduction in subsidies. In 1986 the elimination of the $31 billion in subsidies would bring about an estimated improvement of approximately $42 billion in the trade balance. This improvement stems from the impact of an increase in the real interest rate on domestic savings and investment, as well as a relative decline in the export price index. Key nominal variables also improve sharply under the counterfactual simulation. Both the nominal interest rate and the inflation rate decline significantly, although the real interest rate increases. The rate of decline in the US dollar exchange rate slows, so that in 1986 the nominal value of the dollar would be about 18 per cent higher than with the original level of subsidies. In addition, the real value of the dollar would be about 5.5 per cent higher than before.

A qualified conclusion may thus be drawn that a reduction, or perhaps elimination, of agricultural subsidies would have a major impact in reducing the current budgetary and trade imbalances. In particular, an elimination of subsidies would bring about an almost 30 per cent improvement in the trade balance, and would go far towards lessening pressure on the dollar. These results may, indeed, be overly conservative, since any efficiency gain in agriculture, or elsewhere, due to reductions in subsidies has not been incorporated. Many other studies have indicated that there would be substantial efficiency gains, and if they were to be incorporated into the study, the predicted results of subsidy elimination would be yet greater improvements in trade, budget, and price variables.

I Introduction*

The aim of this paper is to analyze the effects of agricultural policies on the macroeconomy in the United States. Limited resources prevent all aspects of agricultural policy being encompassed, so the paper concentrates on the role played by subsidies, since these are major items of government expenditure and are often highly controversial. Subsidies are examined in the context of an intertemporal general equilibrium model, since major errors are made in using partial equilibrium analysis. Subsidies have not only direct budgetary implications, in that they represent expenditures of the government, but they also distort the relative price structure and, thereby, the allocation of scarce factors, in particular, of land. In addition, a reduction in subsidies will, via its impact on domestic interest rates, have implications for private savings and investment that can, as will be seen, cause significant changes in both real income and the trade balance.

Four types of subsidies present at least to some extent in the USA will be examined. The first of these is a simple percentage subsidy on the inputs of value added, in this case land, to agricultural output. The second type of subsidy is based on a trigger price. If the price of a particular agricultural item falls below some predetermined fixed price, then the difference between the fixed price and the market price is paid as a direct subsidy to the producers of the product. The third type of subsidy is not realized as a direct payment, but rather is a support that permits the price paid by consumers not to rise above some specified fixed price. Thus if the market price of an agricultural product rises above some fixed price, then consumers pay only that price and the government subsidizes the difference as a payment to producers, who receive the market price. The final subsidy is a payment to farmers *not* to produce. This is represented by payments made for farmland that is set aside from production. Thus, the government contracts with farmers to take a certain amount of land out of production, and to then pay the farmers the market price for the land. Thus, the supply of land falls, tending to drive up the market price of the land while at the same time reducing the tax base.

There have been many studies that attempt to analyze the interaction between general fiscal policies and macro-economic outcomes in the USA. Possibly the most relevant, from the point of view of this study, is the recent book, *Deficits and the World Economy at Risk*, by Stephen Marris. Here a strong connection is made between the rising structural budget deficit in the US and the increase in investment demand, leading to capital inflows and the rise of the dollar that occurred from 1980 to 1985. The book then, quite remarkably in view of the fact that it was written in 1985, fairly accurately predicts the current collapse of the dollar and the

massive US trade deficit. These predictions are based on an underlying model which asserts that the trade deficits, brought about by US budget imbalances, will cause a massive devaluation of the dollar as US foreign debt comes intolerably large.

The model underlying the Marris book has certain characteristics typical of macroeconomic studies that make its usefulness doubtful for our concerns.[2] Production is fully aggregated, so it is not possible to consider sector specific policies such as agricultural subsidies. The domestic interest rate, one of our primary concerns, is not determined within the model, but is set externally, as are GNP growth rates and exchange rates changes in the US. There is also no direct way to incorporate disaggregated fiscal policies, since only the structural budget deficit enters into the calculations. Possibly most important, because the model is essentially static, there is no endogenous determination of domestic savings based on current interest rates and the price and income expectations of forward-looking consumers. As will be seen, the lack of endogenous savings determination can cause the impact of public spending cuts on the trade balance to be seriously underestimated. In particular, it would not be possible to arrive at the eventual conclusion that an elimination of the $31 billion currently spent on agricultural supports could lead to a reduction of about $42 billion in the overall US trade deficit.

* I would like to thank participants in the San Diego Conference of the Global Agricultural Trade Study for helpful comments on this paper. The views expressed here do not necessarily reflect the opinions of the World Bank.

2 For a full description of this model, see Marris (1985), Technical Notes 1-2, p. 269-287.

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II Policy issues

The key policy question that this paper wishes to consider is straightforward. What would be the macro-economic implications of a reduction in agricultural subsidies? More particularly, how would a cut in subsidies affect, first, the overall budget deficit, and, second, the trade balance? Clearly these two issues are connected since a large budget deficit that leads to an excess of demand for domestic investment over domestic savings will cause a trade imbalance. What is not clear is the magnitude of the numbers involved. Suppose, as an extreme example, that agricultural subsidies were completely eliminated. Would there be a net reduction of $31 billion in the budget deficit, or is it possible that there would be significant efficiency gains for agriculture, and possibly for the rest of the economy, so that the tax base would increase and the net reduction in the deficit would be greater than $31 billion? Is it also possible that the reductions might lead to a decrease in the excess demand for domestic investment, causing the trade balance to improve by more than the subsidy cuts? In short, can the country expect to get more bang for its buck?

To have a more concrete understanding of how these issues are answered here, it may be useful to outline briefly the macro-economic workings of the model. Section IV will discuss how the use of general equilibrium modelling techniques enters the analysis. A start might be made with a simple macro-economic accounting identity:

$$(S - I) + (T - G) = X - M \tag{2.1}$$

where S represents domestic private savings, I domestic private investment, T federal tax revenues, G federal spending, X exports, and M imports. Assume that the government reduces agricultural subsidies. The initial impact is that G declines. Thus the federal deficit, D = G - T also declines.[3] If, for simplicity, foreign financing and domestic bond sales are taken as fixed, then this means that the rate of growth in the money supply will also decline. Hence the real interest rate will tend to rise and the rate of inflation will decline. In the face of a rising real interest rate, the forward-looking consumer, seeing that he is getting a relatively better deal on future consumption, will increase his savings. At the same time, investors, who equate the current cost of borrowing to the anticipated future return on capital, will tend to reduce their investment, since financing has become more expensive. Although the initial impact of the subsidy cuts may also be to reduce savings, perhaps by as much as the total

3 It is also possible that tax revenues may change as a result of these cuts. If they decline, it is highly unlikely that they would fall by as much as the cuts in subsidies, so that there would still be a net decline in the deficit.

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reduction, since part of the subsidies are paid as income supports to farmers, this decrease in income affects relatively few consumers. Increased real interest rates affect all consumers, however, and at least given the parameters of our study, the overall effect is to raise private savings. Thus S - I rises so that the current H account, X - M, rises more than the simple change in G - T. Thus the improvement in the trade balance may be considerably greater than the improvement in the budget deficit. Also, since inflation declines, there may be a positive terms-of-trade effect, causing X and S simultaneously to increase further.[4]

A general equilibrium approach must be used to determine simultaneously the interaction of the consumer, determining S, the investor, determining I, and the subsidy cuts, determining G and T. Since the US is a large country, these are equated, via price and exchange rate adjustments, with the outcomes of export and import equations. It is precisely this type of simultaneous solution that is missing from the type of work represented by the Marris (1985) book.

4 There will be a second round of effects in which the exchange rate appreciates, owing to the improved trade balance, and imports increase, so that the full initial improvement in the trade balance is not realized.

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III Agricultural support policies and the US macro-economy

Some background information

Just how significant are agricultural spending policies, in particular on price supports, in the overall US budgetary picture? Some recent statements by Prime Minister Margaret Thatcher of Great Britain might be cited in which she is reported to have said that in Iowa, farmers this year will receive more loans and other aid from Washington than all the nations of Africa get from the World Bank.[5] As a matter of fact, the amount of money spent on agricultural support programs in America represent a major portion of the Federal budget deficit.

Table 1 gives total revenues and expenditures of the Federal government over the period 1979-86. The well-known increase in the deficit of the Federal government, which grew from $40 billion in 1979 to $220 billion in 1986, should be noted. If the partial breakdown of expenditures is examined it can be seen that agriculture represents the largest single item in current expenditures after defence, health, social security, and interest payments on outstanding debt. Of these four larger types of outlays, social security and interest payments represent essentially prior commitments and are thus less susceptible to immediate budgetary action than are other expenditure items. It is interesting to note that of the remaining items, health expenditures grew by 80 per cent between 1979-86, while expenditures on agriculture grew by 182 per cent, even more than the 135 per cent increase in defence spending.

The amount spent on agricultural support programs thus represents a major portion of the overall budget deficits.

> Between 1981 and 1985, the Federal Government spent about $60 billion on farm price and income-support programs. The original estimate for farm program outlays for 1986 was significantly below the actual cost of $25.9 billion associated with Commodity Credit Corporation (CCC) activities to support the agricultural sector. Other related programs also support agricultural production and rural America; in 1986 the outlays for these programs amounted to approximately $4

5 This statement was reported in the Washington Post of 15 November, 1987. A direct quotation is not available. In the same article Prime Minister Thatcher is also reported to have said that farmers in Japan were being paid eight times the world price to grow rice. In addition, she is quoted as saying, 'and in Europe, believe it or not, the subsidy for every cow is greater than the personal income of half of the people in the world.'

billion. The largest single item was Farm Home Administration outlays at $8 billion.[6]

Thus, merely the costs associated with support of the CCC represent almost 12 per cent of the budget deficit of $220 billion in 1986. Just how was this money spent? Corresponding to the first type of subsidy, in which ad valorem payments are made to agricultural producers, an export enhancement scheme helps to finance US agricultural sales abroad both by providing export guarantees as well as direct price subsidies. A deficiency payment system, in which producers receive payments for the difference between the market price and a target price, corresponds to the second type of subsidy. In 1986 more than $20 billion was spent on food assistance programs, in which an implicit lump sum payment is made to certain consumers to finance their consumption of agricultural prices at below market prices. Thus this corresponds to the third type of subsidy in which the price paid by consumers is subsidized if the market price rises above some predetermined target price. Finally, the 1985 Food Security Act aims to manage agricultural output by inducing farmers to accept reductions in the total acreage that they plant, thus raising prices and reducing the need for deficiency payments. These set-asides thus correspond to the fourth kind of subsidy.

Table 1 **USA: Macro-economic indicators and agricultural supports (in billions of dollars)**

	1979	1980	1981	1982	1983	1984	1985	1986
Federal revenues	463	517	599	618	601	666	734	769
Federal expenditures	503	591	678	746	808	852	946	990
of which								
Agriculture	11	9	11	16	23	14	26	31
Defence	116	134	158	185	210	227	253	273
Transportation	18	21	23	21	21	24	26	28
Education and social services	30	32	34	27	27	28	29	30
Health	20	23	27	27	29	30	34	36
Social security	104	119	140	156	171	178	189	199
Veteran administration	20	21	23	24	25	26	26	26
Interest payments	43	53	69	85	90	111	129	136
Other	141	179	193	205	212	214	234	231
Federal deficit	-40	-74	-79	-128	-207	-186	-212	-221
Exports	184	224	237	211	201	219	214	219
Imports	212	250	265	248	269	332	339	370
Merchandise trade deficit	-28	-26	-28	-37	-68	-113	-125	-151
Personal savings	118	137	159	154	131	169	143	116
Gross private domestic investment	455	437	516	447	502	662	661	686

Source: *Economic Report of the President* (1987), and *International Financial Statistics* (August 1987).

6 *Economic Report of the President* (1987), p. 155.

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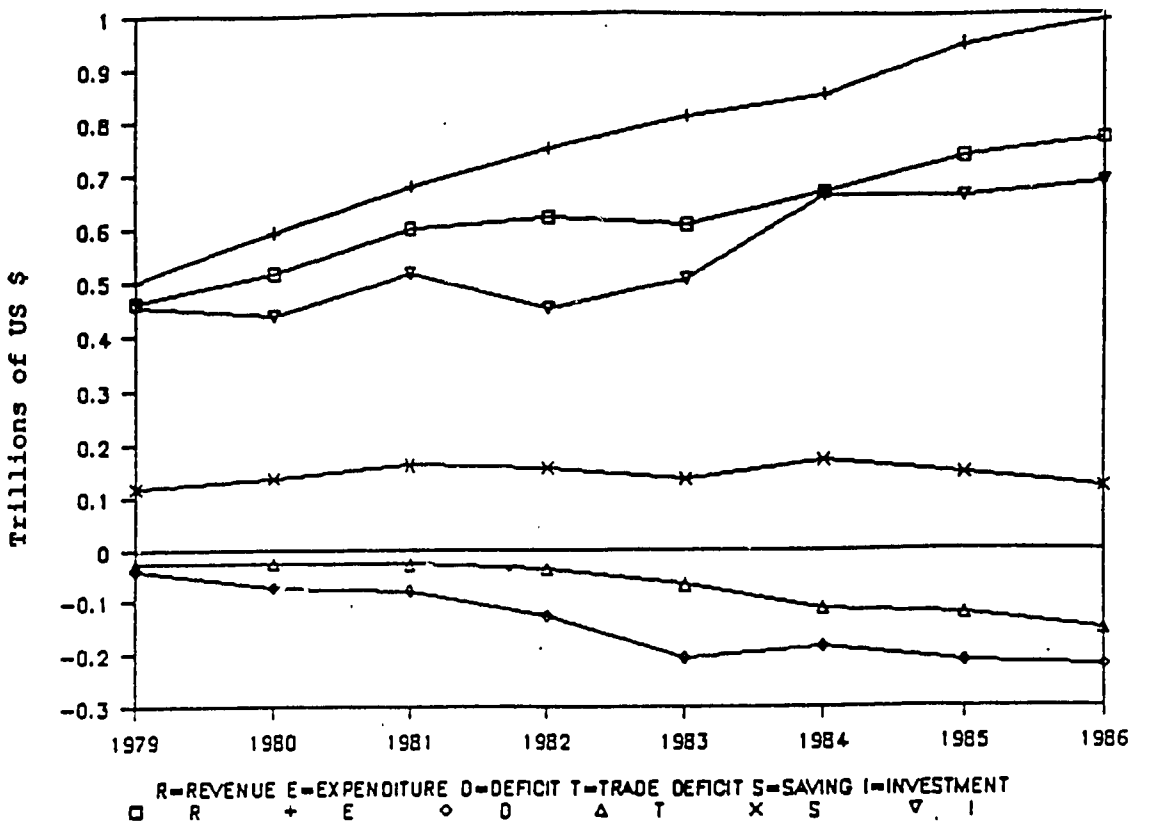
Figure 1 **US macro-economic indicators**



An examination of Table 1 enables some non-rigorous connections to be made between the growth in the budget deficit and the increase in the trade deficit, which grew from $28 billion in 1979 to $152 billion in 1986. Figure 1 gives an illustration of these variables, as well as indicating the stagnant behaviour of personal savings over the period and the rapid increase in gross private investment. It is thus possible to see the general historical support for the story underlying the model. The rapid increase in government spending, combined with reduced growth in revenues, caused the budget deficit to soar. At the same time, the stagnant behaviour of personal savings combined with rapid increases in investment demand to bring about rising trade deficits. In the next section it will be indicated how a general equilibrium framework is to be used to link all these elements analytically.

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IV An overview of the model

In this section the general equilibrium structure of the study will be outlined, and some of the underlying empirical parameters indicated. The functional forms of the structural equations are given in the Appendix.[7]

Production

An input-output matrix is used to determine intermediate and final production. Because the model incorporates perfect foresight in both production and consumption, this matrix may be thought of as being replicated in each of two years. Corresponding to each sector in the input-output matrix, value added is produced using capital, land, and labour. The technology that produces this value added is sector-specific so that, for example, agriculture would have a higher relative share of land in valueadded than would chemicals.

We suppose, for simplicity, that there is a single type of capital, which is produced via an investment technology that uses inputs of capital and labour to produce new capital. The investment is carried out by the private sector, and since the capital that is produced in one period becomes available only in the next period, the investment firm must pay for the input costs of its production in the current period, but will receive the revenue from that capital in the next period. Suppose, then, that the rental price of capital in period i + 1 is P_{Ki+1}. If C_{Hi} is the cost-minimizing cost of producing the quantity of capital, H_i, then future debt obligations must be equal to the return on new capital. Hence

$$C_{Hi} = \frac{P_{K(i+1)} H_i}{1 + r_i} \tag{4.1}$$

where $r_i = P_{Mi}/P_{Bi}$ is the interest rate in period i. Hence the level of private investment depends on both the current interest rate and the perfectly anticipated future return on capital. Thus government policies that affect interest rates, such as cutting spending, will have an immediate impact on private investment.

All sectors in the economy pay both income and profit taxes, while agriculture may receive a subsidy on its use of land. Along with its spending on agricultural subsidies, transfer payments, and interest obligations, to be discussed shortly, the government produces

7 The theoretical structure of the analysis is based on Feltenstein (1986), Feltenstein, Lebow and Sibert (1987), and Feltenstein and Morris (1987).

public goods using capital and labour as inputs to production. The government's target for output of public goods is determined exogenously in terms of constant dollars. An attempt to model an optimizing government is thus not made.

Consumption

There is a single generation of consumers who live for the entire period of the model. The consumers have perfect foresight, and hence perfectly anticipate all prices of period 2 while in period 1. The individual consumer maximizes a utility function, U, which has as arguments the levels of consumption and leisure in each of the two periods.[8]

The consumer maximizes his utility function, subject to a set of intertemporal budget constraints. He has an initial allocation of money and bonds, M_0 and B_0, at the beginning of period 1, and, if he is a shareholder in the capital goods-producing firm, he will also hold capital K_0, while he may also hold land, A_0. Let P_{Ki}, P_{Ai}, P_{Li}, P_{Mi}, P_{Bi}, e_i represent the price of capital, land, labour, money, domestic bonds and the exchange rate, respectively, in period i, and let TR_i represent whatever transfer payments the government pays to this consumer during period i.[9]

Bonds are considered to be long term, so that a consumer owning a bond receives its par value, assumed to be $1, as an interest payment in each period. Since this payment is made in units of money, his income from the bond in period 1 is 1, while in period 2 it is P_{M2}. He also has the possibility of selling the bond at market prices P_{Bi}. The consumer's income, or, to be more precise, his purchasing power, in period 1, is then given by

$$I_1(P_1) = P_{K1}K_0 + P_{A1}A_0 + P_{L1}L_0 + M_0 + B_0 + P_{B1}B_0 + TR_1. \tag{4.2}$$

The consumer's income in period 2, $I_2(P_2)$, becomes

$$I_2(P_2) = P_{K2}(1-\delta)K_0 + P_{A2}A_0 + P_{L2}L_0 + P_{M2}X_{M1} + P_{M2}X_{B1} + P_{B2}X_{B1} + e_2(1+r_{F2})X_{BF1} + TR_2 \tag{4.3}$$

where X_{M1} is the nominal quantity of money that the consumer holds in period 1, X_{B1} is the quantity of domestic bonds he purchases and X_{BF1} is the quantity of foreign bonds he buys. Thus if $P_{B2} > P_{B1}$ the consumer realizes a capital gain on his purchase of domestic bonds in

8 There are several consumers in the model, each of whom has different preferences. Hence the utility functions differ across consumers.

9 The price of money in period 1 is the numeraire; hence P_{M2} represents the purchasing power of money in period 2, relative to period 1. Thus if there has been an inflation P_{M2} would be less than 1.

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period 1, while if $e_2 > e_i$, ie the exchange rate depreciates, raising the domestic currency value of foreign bonds, then he realizes a capital gain on foreign bonds. Thus government policies that affect either the domestic interest rate or the exchange rate will have an immediate impact on the consumer.

The consumer pays market prices for all goods except agriculture – which, for some consumers, is subsidized.[10] Personal income taxes are not paid directly by the consumer, but are withheld at the enterprise level, where profit taxes are also collected. The consumer has a demand for money represented by a functional form, uniform across all consumers, in which demand for nominal cash balances depends on the value of current consumption and the nominal interest rate. This demand may thus be interpreted as a cash-in-advance constraint in which the velocity of money is interest-sensitive. An increase in the nominal interest rate then lowers the demand for money, tending to raise the rate of inflation.

The total value of the consumer's consumption each period must be equal to or less then the corresponding income, hence

$$P_i x_i + P_{Li} x_{Li} + P_{Bi} x_{Bi} + e_i x_{BFi} + x_{Mi} \leq I(P_i) \tag{4.4}$$

P_i represents the set of sectoral prices in period i. In order to close the model, some assumption must be made about consumers' holding of debt in period 2.[11] Accordingly, it will be supposed that demand for bonds in period 2 is determined by the long-run savings rate of the economy, assumed to be constant. Finally, it is assumed that the consumer allocates savings between domestic and foreign bonds according to relative rates of return, evaluated in terms of domestic currency. Thus savings rates are endogenously determined by intertemporal maximization in period 1, but are fixed in period 2.

Financing the central government

The government collects income and profit taxes, as well as import duties, and pays the subsidies described in Section 1. In addition the government must cover both domestic and foreign interest obligations on public debt. The deficit of the central government in period 1, D_1, is then given by

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10 See the Appendix for the formulation of the subsidy.

11 In a dynamic model consumers save in order to finance future consumption. Hence in the final period we need to impose a savings constraint if all debt is not to be liquidated. Thus, consumers save in period 2 according to an exogenously given rate, equal to the long-run savings rate of the economy. The government is therefore not required to liquidate outstanding debt at the end of period 2 and may run a deficit in that period. Thus the private savings rate is variable in period 1 and depends on future prices, while it is fixed in period 2.

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$$D_1 = G_1 + S_1 + B_0 + e_1 r_{F1} B_{F0} - T_1 \tag{4.5}$$

where S_1 represents subsidies given to agriculture in period 1, G_1 is spending on goods and services, while the other two terms reflect domestic and foreign interest obligations of the government. Thus, for example, policies that cause the exchange rate to depreciate will increase foreign interest payments. T_1 represents total revenues of the government.

The resulting deficit is financed by a combination of monetization and domestic and foreign borrowing. Then if y_{BG1} represents the face value of domestic bonds sold by the government in period 1, and C_{F1} represents its foreign borrowing, then its budget deficit[12] in period 2 is given by:

$$D_2 = G_2 + S_2 + p_{M2}(y_{BG1} + B_0) + e_2 r_{F2}(C_{F1} + B_{F0}) - T_1 \tag{4.6}$$

where S_2 represents agricultural subsidies in period 2, P_{M2} $(y_{BG1} + B_0)$ the interest obligations on outstanding debt plus domestic borrowing from period 1, and $e_2 r_{F2}(C_{F1} + B_0)$ is the interest payment on foreign debt plus period 1 foreign borrowing.

The foreign sector

The foreign sector is represented by a simple export equation in which aggregate demand for exports is determined by relative domestic and foreign price indices as well as world income. Hence exports are sensitive to changes in the exchange rate as well as to domestic price changes. The combination of the export equation and domestic supply responses then determines aggregate exports. Capital flows are derived from the domestic consumers' portfolio balance equation, in which relative shares of domestic and foreign bonds are determined by relative current interest rates, deflated by anticipated changes in the exchange rate. Foreign lending has not been modelled, but has been taken to be exogenous. Thus gross capital inflows are exogenous, but net capital flows are determined endogenously by the savings behaviour of domestic consumers.

12 It should be noted that the analysis does not require that the government run budget deficits. Indeed, it could run surpluses and use the surpluses to finance open market operations.

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V An application to the US

In this section some of the basic empirical methodology used is described. The extent to which actual US outcomes for 1985-86 have been replicated will be indicated. This replication is important if there is to be any confidence in the predictions of the counterfactual simulations.

Intermediate and final production is taken from an 80 x 80 input-output matrix representing 1983, which is condensed to being 10 x 10, corresponding to the aggregate production sectors of the US national accounts.[13] These sectors are:

1 Agriculture	6 Domestic trade
2 Mining	7 Finance
3 Construction	8 Services
4 Manufactures	9 Government
5 Transportation and utilities	10 Imports

The Armington (1969) assumption is made that goods are distinguished by type as well as by place of origin. Hence imports are a separate row in the input-output matrix.

The derivation of sectoral production functions is given in the Appendix. Profit and labour tax rates have been taken to be the average effective rates across the economy for 1985-86, so that at this stage no attempt has been made to derive rates on a sector-by-sector basis. Spending by the government is taken to have its actual values also for 1985-86, while the shares of capital and labour in government production were derived from the wage bill of the public sector. Factor shares in the construction industry were used to represent the corresponding shares in private investment. All initial allocations of factors and financial assets were given their end-of-1984 values. Thus, for example, a unit of land is that amount of land which earned $1.00 in 1984, while the money supply is given by the end of 1984 value of M1.

There are essentially two sets of behaviour parameters to be estimated. The first of these relate aggregate money real demand to interest rates and real income. Here the estimates of Wenninger and Sivesind (1979) are used. The long-run form of this equation is:

$$\text{Log } M/P = -0.426 \text{ Log } r + 0.99 \text{ Log } y$$

13 See *Survey of Current Business* (January 1983).

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In order to generate aggregate demand for US exports, export elasticities reported in Stern et al (1976) are used. The annual relative price elasticity of exports is -1.24, while the elasticity of world income is 0.77.[14] The value shares of each of the nine domestic sectors is fixed and is given by their relative shares in 1984. Finally, the model has been taken to have three consumers. The first two of these are domestic and consumer represents the non-landowning consumer who owns capital, while consumer owns the stock of land but does not own capital. The third consumer is the rest of the world, and is thus represented by the export demand equation.

As an initial experiment intended to test the accuracy of the model in replicating true US outcomes in 1985-86, a simulation was carried out in which agricultural price supports and set-asides are given their true values. The equilibrium outcomes for the two periods are given in Table 2. The actual figures for the US are in parenthesis. Thus it can be seen that the model generates outcomes which are reasonably close to the actual results for the US, with the only significant inaccuracies coming in the inflation rate and the 1985 interest rate. It thus seems plausible to use these parameters as the basis of counterfactual simulations.

14 These figures are derived from Houthakker and Magee (1969).

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VI The macro-economic effects of elimination of agricultural supports

Now follows a simple, if extreme, exercise. It is supposed that the government totally eliminates all agricultural price subsidies and, in addition, no longer pays for land set-asides. Columns 2 and 4 are the same as Columns 1 and 3 of Table 1, that is, they are the results of the simulation using historical parameters. Table 2 reports the outcomes of the simulation with the elimination of price subsidies, with results being given in columns 1 and 3.

The budget deficit declines by 1.0 per cent of GDP in 1985 and 0.8 per cent in 1986, even though the direct reduction in spending on agricultural subsidies was only 0.6 per cent of GDP in both years. The general reason for this difference comes from several sources. First, the nominal interest rate drops significantly when subsidies are eliminated, thereby reducing the value of domestic debt servicing. At the same time, although not reported in Table 3 the nominal wage rate declines by less in both periods than does the overall price level, thus causing the supply of labour to increase and thereby leading to an increase in income tax revenues.

It will also be noticed that the real interest rate in 1986, which was negative in the base simulation, has now become positive as the reduction in the budget deficit has cut the rate of monetary expansion. Accordingly, private investment has declined, as in the model description in Section II. Private savings also increases, although not shown here, as consumers have a Fisherian response to the higher real rate. As a result there is an overall improvement in the trade balance of 0.8 per cent of GDP in 1986, as compared with the base case. This improvement is generated by an increase in exports, which is itself a product of a decline in the foreign currency value of the export price index. It is partly negated, however, by an increase in the volume of imports caused by the strengthened dollar.

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Table 2 **Base simulation for 1985-86: historical agricultural subsidies**

	1985		1986	
	(1)	(2)	(3)	(4)
Real GNP: [a]	3585	(3585)	3625	(3677)
Change in real GNP: [b]	-	(2.8)	1.1	(2.6)
Government spending: G [c]	22.5	(23.7)	23.0	(23.5)
Tax revenues: T [c]	18.4	(18.4)	18.2	(18.3)
Government budget deficit: D [c]	4.1	(5.3)	4.8	(5.2)
Agricultural subsidies: S [c d]	0.6	(0.6)	0.6	(0.7)
Private investment: I [c e]	8.7	(8.6)	8.7	(8.7)
Exports: X [c]	9.4	(9.1)	10.1	(8.8)
Imports: M [c]	9.5	(11.8)	10.3	(12.4)
Trade balance: TB [c]	-0.1	(-2.7)	-0.2	(-3.6)
Inflation rate: Π [b f]	-	(3.3)	10.5	(2.6)
Price level: [i]	100.0	(100.0)	110.5	(102.6)
Interest rate: [i f g]	15.5	(7.5)	8.4	(6.0)
Change in exchange rate: [b f h]	-	(3.5)	-20.6	(-21.8)
Exchange rate: [e h i]	100.0	(100.0)	79.4	(78.2)

(Columns 2 and 4 report actual outcomes for 1985 and 1986, while Columns 1 and 3 report simulation results.)

a In billions of 1982 dollars.
b The percentage changes in the first year cannot be calculated.
c As per cent of GNP.
d The simulated figures (Columns 1 and 3) incorporate payments made for price subsidies and for land set-asides.
e The model treats investment as being expenditure on producers' durable equipment and treats expenditure on structures as being current expenditure. Hence the figures in Columns 2 and 4 reflects actual investment spending on producers' durable equipment rather than total fixed investment.
f In per cent.
g The 3-year US Treasury bill rate is used for the actual figure.
h The multilateral trade-weighted value of the US dollar is used to calculate the actual US exchange rate. The exchange rate is in terms of units of foreign currency per US$.
i An index number based on 1985.

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Table 3 **Counterfactual simulation for 1985-86: agricultural subsidies eliminated ***

	1985		1986	
	(1)	(2)	(3)	(4)
Real GNP: [a]	3596	(3585)	3653	(3625)
Change in real GNP: [b]	-	-	1.6	(1.1)
Government spending: G [c]	21.7	(22.5)	22.3	(23.0)
Tax revenues: T [c]	18.6	(18.4)	18.3	(18.2)
Government budget deficit: D [c]	3.1	(4.1)	4.0	(4.8)
Agricultural subsidies: S [c d]	0.0	(0.6)	0.0	(0.6)
Private investment: I [c e]	8.5	(8.7)	8.4	(8.7)
Exports: X [c]	9.4	(9.4)	10.5	(10.1)
Imports: M [c]	9.5	(9.5)	9.9	(10.3)
Trade balance: TB [c]	-0.1	(-0.1)	0.6	(-0.2)
Inflation rate: Π [b f]	-	-	4.6	(10.5)
Price level: P [i]	93.7	(100.0)	98.8	(110.5)
Interest rate: i [f g]	11.8	(15.5)	5.5	(8.4)
Change in exchange rate [b f h]	-	-	14.0	(-20.6)
Exchange rate: e [h i]	106.5	(100.0)	93.8	(79.4)

* All footnote letters of Table 2 apply here also. The figures in parenthesis are the outcomes of the base case.

VII Conclusion

The results of the simulated elimination of agricultural subsidies tends to support the intuitive macro outcomes described in Section II. An elimination of the supports and set-aside payments, equal to about 0.6 per cent of GNP in replication of 1985 and 1986, leads to improvements of 1.0 per cent of GNP in the budget deficit in 1985 and 0.8 per cent in 1986. In 1985 this would have been equivalent to approximately $40 billion while in 1986 it would have been $34 billion. Accordingly, a total reduction of $58 billion over the two years in agricultural subsidies would have saved $74 billion in accumulated budget deficits. Thus the currently sought-after $30 billion in deficit reductions could be more than achieved by eliminating agricultural supports.

The trade balance also improves by more than the reduction in agricultural subsidies. It is estimated that the elimination of the $31 billion in subsidies in 1986 would bring about an improvement of approximately $42 billion (ie 0.2 per cent of GNP more than the subsidy reduction) in the trade balance. This improvement stems from the impact of an increase in the real interest rate on domestic savings and investment, as well as a relative decline in the export price index, due to the overall lower rate of inflation and, in particular, to the sharp decline in the price of agricultural exports. Eliminating land set-aside payments has lowered the price of agriculture by approximately 27 per cent in 1985, with respect to the base case, and by almost 28 per cent in 1986. Thus, overall, domestic savings increases and investment declines, while public savings also increases, leading to an increase in the trade balance, which, in turn, corresponds to the increase in the aggregate foreign demand for exports.

Key nominal variables also improve sharply under the counterfactual simulation. Both the nominal interest rate and the inflation rate decline significantly, although the real interest rate increases. The rate of decline in the US dollar exchange rate slows, and the real exchange rate index improves by about 5.5 per cent.[15] Accordingly, it seems that an elimination, or perhaps more realistically, a reduction of agricultural support spending would achieve 'more bang for the buck.'

15 Looking at the price level and exchange rate rows of Table 3, the real exchange rate in, for example, the base case simulation reported in Column 4 is given by 110.5 x 0.794 = 87.7. Recall that the nominal exchange rate is denominated in terms of units of foreign currency per U.S. dollar. This is not, however, equivalent to the real export price index, for which a different price level index is derived. Here agricultural exports have a much higher weight than they do in their domestic price index. (Approximately 13.8 per cent in 1985 for their export price weight versus 2.3 per cent for the corresponding GNP weight).

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There are several caveats to be made. Relatively little direct estimation has been done, but most of the parameters have been taken from literature surveys. Accordingly, an argument could be made that these parameters do not accurately reflect present day reality. Forward-looking domestic consumers have been modelled; they derive their consumption and savings on the basis of current and future prices and interest rates, which in turn determine anticipated capital gains, cost of consumption, and so forth. A similar foreign consumer has not been modelled so that, in particular, gross capital inflows are exogenous, although the net capital flows are endogenous, determined by the behaviour of domestic consumers and the financing policies of the government. Clearly a more elaborate model would have endogenous foreign financial behaviour, given the role of the US in world financial markets.

Despite these and other qualifications, the results are probably quite conservative and the actual trade and budgetary improvements would be greater than reported here. No efficiency gain in agricultural production as a result of the subsidy removals has been assumed. Many other studies have indicated that there would be substantial efficiency gains both in agriculture and in other parts of the economy as an outcome of subsidy reductions. If these gains were to be incorporated endogenously into the model, the results of the counterfactual simulation would be to predict yet larger improvements in the endogenous trade, budget, and price variables.

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Appendix

Model formulation

a. The consumers maximization problem is given by:

$$\max_{x_1\, x_2 \ldots x_{2N}\, x_{L1}\, x_{L2}} d_1\, d_2 \quad d_{2N}\, d_{L1}\, d_{L2}$$

such that

$$P_1x_1 + P_{B1}x_{B1} + e_1x_{BF1} + x_{M1} \tag{1}$$

$$\leq + P_{K1}K_0 + P_{A1}A_0 + P_{L1}L_0 + M_0 + B_0 + P_{B1}B_0 + e_1(1 + r_{F1})B_F + TR_1$$

$$P_2x_2 + P_{L2}x_{L2} + P_{A2}\,A_0 + P_{B2}x_{B2} + P_{M2}x_{M2} \tag{2}$$

$$\leq P_{K2}(1-\delta)K_0 + P_{A2}A_0 + P_{L2}L_0 + P_{M2}x_{M1} + P_{M2}x_{B1} + P_{B2}x_{B1} +$$

$$e_2(1 + r_{F2})x_{BF1} + TR_2$$

$$P_{B2}x_{B2} = (1 + t_2)P_2x_2/z \tag{3}$$

$$\frac{P_{Bi}x_{Bi}}{P_{Fi}xB_{Fi}} = c\left(\frac{1 + r_i}{\frac{e_i+1}{e_i}(1+r_{Fi})}\right)^d \qquad c, d \geq 0 \tag{4}$$

$$P_{mi}x_{Mi} = ar_i^{-b}\, P_{xi}x_i \qquad a, b \geq 0 \tag{5}$$

Here equations (1) and (2) are the budget constraints in each of the two time periods, incorporating the cash-in-advance constraint, while equation (3) is the final period closure rule, imposing a constant savings rate in period 2. Equation (4) is a portfolio balance equation determining the relative shares of domestic and foreign assets in the consumer's savings on the basis of relative rates of return, deflated by the anticipated change in the exchange rate. Equation (5) determines the nominal demand for money as a function of the interest rate and current consumption.

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b. The subsidies paid by the government to agriculture in period i, S_i are given by:

$$S_i = -t_i^a P_{ai} y_{ai} + \sum_{j=1}^{I} t_i^s \delta(P_{si} - P_{ai}) x_{ai}^j$$

$$+ \sum_{j+i}^{I} t_i^c \delta(P_{ai} - P_{ci}) x_{ai}^j + P_{ai} w A_0$$

Here t_i^a is the subsidy rate given to value added, y_{ai}, in agriculture in period i, P_{si} and P_{ci} are the support prices for agricultural output and consumption in period i. Hence, for example, $P_{si} - P_{ai}$ represents the per unit subsidy paid to agricultural production if $P_{ai} < P_{si}$, where P_{ai} is the market price of agriculture in period i [$\delta(y = y;\ y \geq 0$ and $\delta(y) = 0;\ y \leq 0$]. Finally $P_{ai} w A_0$ represents the payments for set-asides.

Parameter estimates :

a. The money demand equation used the form:

$$\log M/p = \underset{(2.0)}{-0.030} \log TD - \underset{(3.8)}{0.013} \log TB + \underset{(4.4)}{0.100} \log GP + \underset{(18.5)}{0.899} \log (M/p) -1$$

M = M1 + other checkable deposits less foreign deposits held

P = wholesale price index

TD = interest rate on time deposits

TB = interest rate on Treasury bills

GP = Real GDP.

The numbers in parenthesis are t-statistics. The coefficients for TD and TB in the simulations have been combined. This equation, taken from Wenninger and Sivesind(1979) was estimated using quarterly data over 1960-1979.

b. Exports were determined in a two stage manner. Aggregate foreign demand for US non-agricultural exports was first determined from an export elasticity with respect to relative prices of -0.98. The export elasticity with respect to world income is 0.90.[16] Demand for agricultural exports was then determined by a relative price elasticity of -0.82 and a world income elasticity of 0.51.

16 These figures are taken from Houthakker and Magee (1969).

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c. Production functions for value added in current production, as well as the investment function, were estimated using the *Economic Report of the President*, Tables B-10, B-24. Effective tax rates for domestic industry are derived from Tables B-23, 77, and import duty rates are taken from Tables B-74, 99. Gross capital flows, which are exogenous, are taken to have their actual 1985-86 values, given in Table B-103. Finally, all initial allocations are given the value of the corresponding stocks at the end of 1984. Capital and labour come from Table B-103, land from B-93, money from B-64, and domestic and foreign bonds from B-81.

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Effects of agricultural trade liberalization on West Germany's economy

by

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Summary

The Common Agricultural Policy (CAP) of the European Community (EC) has come to a deadlock. It is financially unsustainable; the farmers are deeply dissatisfied with their income levels; concern of the general public about the chronic domestic production surpluses is growing; trade disputes with non-member temperate countries over import barriers and dumping are more serious than ever; signs of political antagonism between member state governments are mounting. A fundamental reform of the CAP and associated national policies, based on market principles, is overdue. Such a reform still meets with stiff opposition in politically influential circles in Germany, in particular from the Farmers Federation.

Agriculture in Germany accounts for less than 2 per cent of the gross domestic product and employs roughly 5 per cent of the total labour force (3 per cent in full-time equivalents). It is one of the sectors which have received most government assistance for decades (other highly protected activities include coalmining, iron and steel, textiles and clothing, aircraft and aerospace, railways.) Currently, total public subsidies to agriculture amount to well over DM20 billion, equivalent to about 70 per cent of this sector's gross value added at domestic prices. More than half of these subsidies stem from German sources (though officially considerably less is defined as subsidy.) The impact of these German subsidies is largely to increase, or at least maintain, production. Thus the role of national policies within the framework of the CAP is quite significant indeed.

The counterpart of farm subsidies is the financial burden placed on German taxpayers other than farmers, who pay only around DM1.5 billion a year. Another direct cost which Germany's non-farm community has to bear results from the effect of the protective devices on domestic prices of agricultural products: these prices are raised well above world market levels, for instance, by about 50 per cent on average during 1978-81. It is by no means certain that the gains to farmers exceed the losses to taxpayers and consumers; the opposite is much more likely.

According to government reports, the farmers' gains through price support and subsidies have not satisfied the income objectives. However, the economic situation of German farmers is much better than asserted for two reasons: first, farm households earn as much income from non-farm activities as from agricultural production; 40 per cent of the farms are operated on a part-time basis and those farmers with permanent jobs in other sectors seem to be, on average, better off than full-time farmers. Second, since most German farmers are also

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landowners they additionally benefit from the increase in land prices induced by the agricultural policies; this, however, has widened the wealth gap between rich and poor farmers.

The distorting effects of high agricultural prices artificially induced by policy are not confined to the producers and do not only cause real income losses to taxpayers and food consumers. The whole German economy is affected. The policy removes the links between relative internal prices of productive factors as well as of tradeable and non-tradeable goods from their relative scarcities and demand structures. Therefore, too much land, labour, capital and entrepreneurship is kept in agriculture, although these resources could achieve a higher productivity elsewhere; the income and price effects lead to substitution in production and demand away from less protected non-agriculture sectors; these sectors are also harmed by the protection-induced appreciation of the exchange rate for the D-mark. To put it another way: the policy intended to help farmers in fact constitutes a taxation of Germany's growth and export industries.

Given the economy-wide costs associated with present agriculture policies the question which suggests itself is this: what would happen to the German economy as a whole if agricultural production were removed? We estimated the effects of agricultural liberalization using an applied general equilibrium model of the German economy. The model comprises 13 sectors reflecting the variety of public assistance in Germany. The base data are for 1980. The numerical results refer to the medium run.

Estimates in this paper show that agricultural liberalization would have increased both skilled and unskilled employment by around 4 per cent (850,000 workers in 1987 terms) and the real gross domestic product by more than 3 per cent, relative to the status quo. The employment effect would have reduced the rate of unemployment from its 1987 level of about 9 per cent to 5 per cent. Output would have been higher in all sectors but agriculture and food processing. This higher output would have been accompanied by an even greater increase in foreign trade (around 5 per cent in real terms). That the expansionary effect would have fallen notably more on trade than on output is an indication of the significant welfare gains arising from liberalization that the German society could have enjoyed.

Important changes in the commodity composition of trade would have occurred, moving away from agriculture products towards the investment goods industry, in which Germany has a distinctive comparative advantage. Agriculture and food processing would have experienced a rise in real net imports (by 65 and 70 per cent, respectively), whereas mechanical and electrical engineering would have improved their net export positions (by 12 and 16 per cent, respectively).

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Simulation results also show that the economy-wide benefits of a policy reform in agriculture could be increased if liberalization is extended to other sectors with high protection in Germany. Then, the positive employment effect would amount to 11 per cent, or the elimination of current unemployment levels, the positive overall output effect to 9 per cent, and the positive foreign trade effect to 26 per cent. This said, the increased demand for skilled labour may well run up against supply bottlenecks. The ability to alleviate such shortages will influence the extent to which the potential employment gains of both agricultural and full liberalization can be realized.

As expected, the loser from agriculture liberalization would be the agricultural sector itself. Employment and reductions in agriculture output would be in the order of 24 per cent; land rentals would suffer a decline of 17 per cent, to which must be added a drop in the value of other sector-specific assets such as buildings and livestock. A hypothetical full liberalization would result in even more adverse consequences for agriculture. This may be the root cause of the fierce resistance within Germany's farming community against the badly needed policy reform. In order to overcome this resistance it may be necessary to compensate farmers financially for these one-off wealth losses. After all, not only would the German economy as a whole - let alone other agriculture-oriented countries - be better off, but also the German farmers themselves who would have the choice to do something else, be it in forestry, industry or services, be it in rural or non-rural areas.

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I Introduction

West German agriculture is a highly protected economic activity. The array of policy measures shielding the sector from competitive pressure on markets for goods, capital and labour is wider and the burden taxpayers and consumers have to suffer is heavier than in most other protected industries. To be sure, farmers have a political influence disproportionate to their number; the proportion of agricultural employees (full-time equivalent) in the total labour force amounted to roughly 3 per cent in 1986 (compared to 8 per cent in 1960). Abroad, Germany is regarded as one of the strong remaining oppponents to a market-oriented reform of the Common Agricultural Policy (CAP) of the European Community (EC), even though this contradicts its liberal-minded trade policy stance in other areas and its professed awareness of the virtues of a functioning price mechanism.

The support to West German agriculture, as with agriculture in the other EC countries, is provided under the auspices of the CAP. However, the CAP is not established by an independent supranational agency but by a cooperative process in which the national governments of member states are important players. In this process, national governments pursue selfish agricultural policies, notwithstanding that the Treaty of Rome (1957) commits member states not to disturb the functioning of a common market. In Germany, the historical roots of these agricultural policies have to be seen in the creation of a cartel of interest groups in the pre-CAP era when the Farm Law ('Landwirtschaftsgesetz') of 1955 was enacted. The law has triggered off programs which benefit German farmers at the expense of both foreign farmers and domestic non-farmers. In the early 1960s the German agricultural policy-making bodies strongly influenced the negotiations on how the common market for agricultural products should be organized. Indeed, the main features of the European common agricultural market - from the organizational framework to the level and structure of protection to a large extent rather resembles the pre-CAP protection of German agriculture. Moreover, the German Federal Government persisted in raising protection on the national and the EC level even after it had become evident that this policy was not meeting the declared objectives of agricultural policy but rather creating notable budgetary and economic costs.

The protectionist policies have been facilitated by the fact that these costs are hardly transparent. However, this is changing because other sectors and, in particular, industrial exporters, are realizing that agricultural protection is associated with economy-wide costs: higher taxes, a higher valuation of the D-mark and the risk of retaliation by countries which are net exporters of agricultural products. The chance is therefore growing that the cartel of interest groups set up in the early 1950s could dissolve in the not-too-distant future. Thus, for

example, the Federation of German Industry has, only recently, cautiously supported a reform of the agricultural policies (Bundesverband der Deutschen Industrie, 1987) and the Farmers Federation itself is showing substantial internal division. Transparency of the income and employment losses caused by these national and EC policies may help to speed up the institutional change and to pave the way for the overdue radical reform of both the CAP and Germany's domestic agricultural policy.

The purpose of this paper is to contribute to this process by analyzing the economy-wide costs associated with the present agricultural policies and thereby examine the prospective benefits associated with agricultural liberalization. In Section II, we first investigate the direct costs of agricultural support: the budgetary costs and the increased prices paid by consumers. The former in particular is rather opaque. We then analyze the 'benefits' claimed for agricultural protection before briefly describing the interest group structure which has led to the present position. In Section III we analyze, by means of an applied general equilibrium model, the prospective benefits and costs from agricultural trade liberalization. Section IV presents our conclusions together with observations on the political economy of reform.

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The direct costs

The price which taxpayers and consumers would voluntarily pay for the support of the German farm sector if they had the option is unknown. Even the price which taxpayers and consumers are forced to pay is difficult to establish given the lack of transparency of the measures adopted and uncertainty about the financial cost of tax relief. The number of budget programs directed to the agricultural sector exceeds 400, of which approximately 100 are run by the EC.[1] Based on these programs, the Kiel Institute estimates the subsidies to agriculture to be some DM20 billion in 1984. Table 1 clearly shows that, in contrast to the focus of public attention, only half of the total subsidies directly arise from the operation of the CAP. Moreover, the subsidy report of the Federal Government refers to national subsidies of 'only' DM3.7 billion in 1984 in contrast to the Kiel Institute's estimate of DM10.9 billion. Apart from the wider coverage of the latter, a major difference is the treatment of tax relief. As a reaction to the reduction of agricultural support prices which was decided by the Council of Agricultural Ministers, the German Government compensated farmers by cutting value-added taxes.[2] Between 1981 and 1985 the total recorded tax relief doubled from DM2 billion to about DM4.1 billion; these figures (among others) are not included in the official subsidy report but they are counted as subsidies by the Kiel Institute.

Preliminary estimates for 1985 place the subsidies to the agricultural sector in the order of DM21 billion, of which DM8.7 billion was provided by the EC[3]. Even if the taxes paid by farmers are deducted (around DM1.5 billion a year) the net outlay is still remarkable. In spite of the government's commitment to slowing public spending and to reducing subsidies, real agricultural outlays have in fact further increased. The financial cost per employee amounted to DM14,500 in 1985[4]; the equivalent sum for the non-farm sector was DM4000. Ranking subsidies per employed person over 45 industries, agriculture ranks as the fifth highest, exceeded only by sectors such as railways, coalmining and aerospace (Jüttemeier, 1987).

1 See Gerken, Jüttemeier, Schatz, Schmidt (1985) and Jüttemeier (1987).

2 Since 1984 the value-added tax is actually negative.

3 Germany's contribution to the EC agricultural budget amounted to about 28 per cent or DM13.2 billion in 1985.

4 Related to the number of farm owners, the financial cost in 1985 was DM26,460.

Table 1 **Subsidy disbursements to the German agricultural sector by source and reporting (DMbillion)**

Source / Year	1973	1974	1980	1981	1984	1985	1986
General CAP	3.0	3.6	6.0	5.1	7.3	6.8	na
CAP export subsidy	0.4	0.1	2.0	1.8	2.0	1.9	2.6
EC total	3.4	3.7	8.0	6.9	9.3	8.7	na
National subsidies	7.0	7.1	9.1	8.4	10.9	12.0	na
Total subsidies	10.4	10.8	17.1	15.3	20.2	20.7	na
Reporting agency							
Federal Government	5.7	4.4	4.7	3.5	3.7	4.7	4.9
Kiel Institute [a]	7.0	7.1	9.1	8.4	10.9	na	na

[a] Preliminary.

Source: Derived from Jüttemeier, 1987 and Federal Government Subsidy Reports ('Subventionsbericht'), various issues.

Subsidies to farmers represent only one form of direct cost. The agricultural policy regime also prevents German (and other EC) consumers buying from the cheapest source in the world; they have to pay, for the benefit of domestic farmers, prices which are notably above those abroad (Table 2).

Furthermore, owing to many quantitative restrictions on imports, consumers are not allowed to buy the best quality. Apart from quality aspects, the relative agricultural support prices have a strong impact on the consumption structure. For instance, per capita consumption of fresh beef and veal, held to be rather income-elastic products, is three times higher in Brazil than in West Germany where the price is double the world level (Kravis, Heston, Summers, 1982). Were there not such an interference through agricultural protection, German consumers would presumably buy high-quality beef from Brazil or elsewhere. Beef prices in countries rich in natural resources, like Brazil, would increase so that consumers in those countries would reduce their consumption; but the country would still benefit from the positive terms of trade effect on income.

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Table 2 **Prices of selected agricultural products in the EC and world market (ECU/100 kg)**

Product	Year[a]	EEC Entry price	Third country offer price[b]	Excess (%) of EC price over world price
Common wheat	1978-79	20.23	10.50	93
	1979-80	20.72	12.69	63
	1980-81	21.93	15.07	46
Durum wheat	1978-79	27.78	12.89	116
	1979-80	28.38	17.80	59
	1980-81	30.07	21.83	38
Husked rice	1978-79	37.35	23.75	57
	1979-80	39.15	29.88	31
	1980-81	41.67	41.51	00
Barley	1978-79	18.40	8.19	125
	1979-80	18.86	11.71	61
	1980-81	19.96	14.91	34
Maize	1978-79	18.40	9.14	101
	1979-80	18.86	9.92	90
	1980-81	19.96	13.55	47
White sugar	1978-79	42.62	15.46	176
	1979-80	43.26	32.32	34
	1980-81	45.55	53.58	-15
Beef, veal (live weight)	1978-79	152.29	76.47	99
	1979-80	154.58	75.63	104
	1980-81	160.76	84.75	90
Pigmeat (carcase weight)	1978	129.56	83.47	55
	1979	139.07	91.36	52
	1980	150.58	111.21	35
Butter	1978-79	309.17	76.71	303
	1979-80	309.90	75.39	311
	1980-81	319.59	111.73	186
Skimmed milk powder (spray)	1978-79	135.23	29.52	358
	1979-80	135.54	35.77	279
	1980-81	139.00	68.14	104
Olive oil	1978-79	231.56	115.72	100
	1979-80	235.04	125.78[c]	87
	1980-81	247.97	115.64[c]	114
Oilseeds	1978-79	38.96	24.18	61
	1979-80	39.55	21.39	85
	1980-81	42.28	25.20	68

a Marketing year varies according to product.
b Annual average third country offer price, usually lowest used for administration of agricultural markets.
c Ten-month average.

Source: derived from OECD (1987), Table 13, p165.

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Estimates of price gaps and therefore of the nominal rate of protection diverge[5]. However, in most studies, estimated price gaps between the EC as a whole and world markets are in the range of 50 per cent (see Table 2). For this study we will use Anderson's and Tyers' (1987) estimate for 1980-82 of 54 per cent. In fact the price difference in Germany appears to be higher than for other EC partners[6].

Ambiguous income achievements

The goals laid down in Article 39 of the Treaty of Rome for the CAP are to (a) raise agricultural productivity, (b) ensure thereby a fair standard of living for the agricultural population, (c) stabilize markets, (d) guarantee regular food supplies to consumers, and (e) maintain reasonable consumer prices. The German 1955 Farm Law also aims at an increase of incomes by raising productivity. The ultimate objective is to secure and strengthen family farms.

Whether or not the income objective has been achieved depends on how income is defined. If one looks at the disposable income of farm households, regardless of the source, the policy results seem reasonable. As Table 3 shows, the household income of farmers exceeds those of total private households and workers' households in 1974 and 1984. This gap has, however, narrowed because the income of non-farmers has grown relatively faster between 1974 and 1984. However, this picture changes when one considers the source of income. In particular, 40 per cent of the farms are operated on only a part-time basis and 52 per cent of the farmers' gross income arises from non-farming activities. When this factor is taken into account, farm households receive incomes out of agricultural activities about 20 per cent less than workers' households. Moreover, an important component of agricultural income is subsidies. In this respect, agricultural protection has not been particularly successful in achieving its income objective.

The concept of disposable income used does not take changes of wealth into account. The value of wealth, particularly the value of land, rises when nominal income increases in the economy. Land as a non-reproducible resource has seen higher than average price increases for more than a century. The market price of agricultural land depends, inter alia, on agricultural commodity prices and on the price of land for non-agricultural uses. The price for agricultural land regardless of its size increased from DM1.72 per square metre in 1975 to

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5 For a discussion of the measurement problems see for example OECD (1987) and US Department of Agriculture (1987).

6 See World Bank, World Development Report 1986, p123. In a world comparison, countries with higher nominal protection rates include Sweden, Italy and Japan. EC partners UK and France have lower rates.

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Table 3 **Disposable income (after taxes) of West German households, 1974-1984 (D-mark)**

Year	Households of					
	Farmers	Civilian employees	Clerks	Workers	Unemployed	Total private households
	DM / household / year					
1974	30,431	32,891	29,913	23,046	16,544	25,557
1984	44,318	51,473	48,113	37,988	19,916	41,983
	DM / Member of household / year					
1974	6,655	10,500	10,678	7,264	5,768	9,773
1984	10,264	17,142	18,179	12,472	8,028	17,361
	Annual average increase (pc) of income of household member					
1974-1984	5.4	6.3	7.0	7.1	3.9	7.7

Source: Own calculations derived from Federal Government statistics.

DM3.92 in 1981 and thereafter declined to DM3.68 (Table 4). The purchase price for larger tracts of land was lower and increased more slowly. The latter price is used in order to calculate the value of farmland per average holding. Adding to this sum the market value of non-land assets and subtracting net debts, one obtains the wealth per farm household. Table 4 clearly shows that farm owners made reasonable profits in the past ten years. On average, their wealth increased by DM36,300 a year, equivalent to DM8,403 per member of a farm household. In 1985, the mean value of wealth of the average farm household totalled DM667,000, that is DM154,398 per family member. However, herein lies a major distribution problem, for farm households cannot be equated with farm owners. There is a presumption that income disparities between rich and poor farmers in West Germany have increased over time.

Interest groups

The major features of a protective system are usually deeply rooted in a society and change little in structure over time. In the late 1940s, a new tariff schedule was established by a commission comprising thirteen members, five of whom could be viewed as directly pro-agriculture. Agriculture succeeded in getting high tariffs and, more importantly, in

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Table 4 **Land prices, market values of farmland and of average farm (selected years)**

	1975	1981	1985	Difference between 1985 and 1975	Difference between 1985 and 1981
Land prices of properties (DM per m2)[a]	35.09	72.66	78.69	43.60	6.03
Prices of farmland					
average purchase price	1.72	3.92	3.68	+1.96	-0.24
purchase price of land larger than 5 ha	1.41	3.66	3.11	+1.70	-0.55
Farm rent (DM per 10,000 m2)	237.00	331.00	395.00	+158.00	+64.00
Farmland per farm in 10,000 m2	13.98	15.52	16.83	+2.85	1.31
Value of farmland[b] per farm owner in DM1000	194	568	523	+326	-45
Total wealth minus net debts per farm in DM1000	304	702	667	+363	-35

[a] m2 = square metre
[b] Farmland was valued with the lower purchase price.
[c] ha = hectare, equivalent to 2.76 acres or 10,000 m2

Source: own calculations derived from Federal Government statistics.

preserving a support system based on import controls and government marketing intervention. After Germany became a member of GATT in 1951 trade was substantially and progressively liberalized; however, agriculture was exempted.

During this period interest groups became more and more reorganized, Germany taking on an increasingly corporative structure under the mantle of the social market economy. But this was only a return to normality, the continuation with the past being quite strong. One of these traditions was a 'live and let live' strategy between interest groups: one does not attack

the other unless the benefits from so doing are high and the repeated game is not endangered. In this vein, the key institutional change initiated by the Farmers Federation was the Farm Law of 1955. This committed the government to using trade, tax, credit, and price policy in order both to counter the 'natural and economic disadvantages' which agriculture supposedly suffered relative to other sectors, and to increase productivity. Moreover, young farmers were to be assisted by a lump sum when they start working (currently DM10,000). Interestingly enough, the Farmers Federation cleared the legislation in good time with both the German Federation of Industry and the German Federation of Trade Unions. Since then, the German farming lobbyists have maintained their position fundamentally unaltered - in spite of the slow rise of food consumption, the buoyant production surpluses, the grave budgetary burden, and the increasing dissatisfaction of farmers with their income levels. In order to secure public support, the Farmers Federation continue to insist on the intrinsic value which agriculture has for the society, now as a protector of the environment and as a source for providing food aid to developing countries.

The CAP is said to be the concession which West Germany had to make for reaching an agreement on a common market for manufactured goods. Indeed, during the founding negotiations, France insisted on agriculture being included in a customs union. The institutional framework of a common agricultural market had not then been decided. The EC treaty offered three options: (a) common competition rules, (b) binding coordination of the different national market organizations, and (c) a single European market organization. From an economic point of view a single European market organization is inferior to option a) because it must set prices. The French and German farmers' associations and the parliaments had been in favour of guaranteeing stable prices within the common market organization. It was therefore decided at the meeting of agricultural ministers in Stresa (in 1958) that a single European market organization for the main temperate zone commodities should be created. In 1962, German and French delegates in the Council of Ministers were at odds about the level at which the common prices should be set. France, having an advantage in agriculture compared to Germany, argued for low support prices, especially for grain where France was a net exporter. As can be seen from Table 5, French prices were below German prices before the unified market organizations were decided in 1962. The common prices of 1968 were then set at a level near or above German prices.

Since then, the EC Commission has from time to time made attempts to reduce agricultural support prices but these have mostly been overruled by the Council of Agricultural Ministers. In most farm price negotiations, the German minister, in accordance with the Farmers Federation, has argued for prices higher than the Commission wished (Dicke et al, 1987). In the 1985 round, the German Minister of Agriculture even vetoed the EC Council's decision for a small reduction in grain prices.

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Table 5 **CAP prices and producer prices in Germany and France DM/100 kg, 1960-61, 1983, 1984**

Commodity	German producer price		French producer price		CAP price	
	1960-61	1983	1960-61	1983	1968-69	1984
Wheat	40.8	49.59	32.34	38.90	43.7[b]	57.99[b]
Sugar beets	7.11	12.80	5.60	5.43	7.00[c]	9.15[c]
Cattle, beef	214.20	329.00	191.50	312.37	279.86[d]	458.86[d]
Pigs, slaughtered	257.40[a]	353.00	221.30[a]	358.75	308.67[d]	455.07[d]
Cow milk	36.80[e]	62.71	31.00	51.00	42.39	61.39

a 1960-61 prices for living pigs.
b Target price.
c Minimum purchase price of the factory.
d Guide price.
e Including production subsidies

Source: own calculations derived from Krohn, Schmitt (1962) and data from the Statistical Office of the EC and Federal Ministry of Agriculture.

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III Medium-run effects of agricultural trade liberalization

In order to assess the economy-wide effects of current agricultural policy we examine the obverse: a liberalization of the policy. As with most policy changes, the response depends on the time perspective. In this section we will focus on the medium run, which is defined as the period required for mobility of labour and capital between sectors. For the investigation, we use the Kiel Institute's general equilibrium model of Germany[7].

The general equilibrium approach

In modelling the effects of agricultural liberalization it is important to place the sector correctly within the context not of a free trade system but of a trade regime with protection and distortions. In West Germany, as in other industrial countries, non-tariff barriers (NTB) (ranging from 'voluntary' export-restraint arrangements through import quotas to subsidies) have become a major tool of the government for intervening in product markets in order to attain specific growth, income and employment goals (Donges and Schatz, 1985). Nowadays, NTBs on selected manufactures are as widespread as in agricultural products. Within the manufacturing industry, the nature and extent of incidence varies widely with a clear trend towards selectivity (Klepper et al. 1987).

We have accordingly specified a model with 13 sectors, their salient features with regard to the government support they enjoy are documented in Table 6. Apart from agricultural and food-processing sectors, we incorporate seven manufacturing and three service sectors. In terms of total protection, the 'gang of four' are thus explicitly represented: agriculture, coalmining, iron and steel, and clothing and textiles. We have therefore included not only high and low protected sectors but also a variation in the nature of protection; for example, agriculture relies to a great extent on subsidies whereas clothing and textiles are protected in ways which do not directly involve budget transfers (through the Multi-Fibre Arrangement).

7 The model is derived from the Orani work of Dixon et al (1982) and an earlier version is documented in Gerken Gross (1985). Previous applications include studies on steel subsidies (Gerken et al, 1986), subsidy reductions (Gerken et al, 1985) and trade liberalization (Kirkpatrick, 1987a) as well as on the impact of alternative subsidies-cum-import protection packages (Donges and Glissmann, 1987; Donges et al, 1988). It is currently being once more refined and extended (Kirkpatrick, 1987b).

Table 6 **General features of the protection system (1980) (per cent)**

	Production sector	Nominal tariff	Effective protection		
			Implicit	Rate of subsidy	Total protection
1	Agriculture, forestry and fishing	11.5(a)	na	na	na
2	Food processing and beverages	11.8(a)	na	na	na
3	Coalmining	0.0	189.2	147.6	336.8
4	Iron and steel	7.0	20.0	7.0	22.0
5	Basic commodities	5.0	14.0	2.0	15.0
6	Aerospace	7.0	15.8	29.6	45.4
7	Electrical engineering, data processing	6.0	8.0	4.0	10.0
8	Mechanical engineering	7.0	2.0	2.0	4.0
9	Clothing and textiles	13.0	95.0	2.5	97.0
10	Other consumer goods	8.0	13.0	2.0	14.0
11	Construction and housing	0.0	na	11.1	na
12	Market services	0.0	na	8.1	na
13	Non-market services	0.0	na	na	na

(a) The nominal tariffs have been derived from the national accounts data on customs income and are therefore biased in the well-known manner. They should not be confused with the true nominal protection derived directly from price comparisons.

Source: with the exception of sectors 1, 2, 11, 12 derived from Witteler, 1986.

The model is calibrated for 1980. The allocation of subsidies by sector and use, including also CAP production and export subsidies, is shown in Table 7. It is clear that not only is the allocation of subsidies across sectors uneven, but that the use of the subsidy also differs. Whereas in agriculture the bulk of the subsidy is production oriented, in other sectors it relates primarily to investment. The intra-industry allocation of subsidies is thus explicitly taken into account by our model.

We do not disaggregate the agricultural sector further, at least not at this stage. This nas a drawback in that competing and non-competing agricultural imports are not explicitly

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Table 7 Allocation of subsidies by sector and use, 1980

	Producer sector	German IO categories	Allocation of subsidy (per cent) by +				
			Sector	Use (a)			
1	Agriculture, forestry and fishery	1, 2	16.66	1	48.7	4	34.6
				2	7.7	5	6.0
				3	3.0		
2	Food processing and beverages	38-40	0.87	1	50.3	4	0.4
				2	1.6	5	40.5
				3	7.2		
3	Coalmining	6	5.86	1	38.0	4	4.7
				2	18.7	5	16.7
				3	21.9		
4	Iron and steel	16, 18, 19	0.44	1	7.4	4	0.0
				2	18.4	5	61.5
				3	12.7		
5	Basic commodities	4, 5, 7-10, 12, 13, 17, 30, 32	1.66	1	7.4	4	0.0
				2	15.7	5	62.5
				3	9.8		
6	Aerospace	25	0.76	1	6.0	4	0.0
				2	42.5	5	21.1
				3	30.3		
7	Electrical engineering, data processing	22, 26	1.65	1	27.7	4	0.1
				2	20.3	5	22.4
				3	29.5		
8	Metal working and mechanical engineering		2.54	1	22.6	4	1.8
				2	13.3	5	44.7
				3	17.6		
9	Textiles and clothing	36, 37	0.22	1	34.8	4	0.0
				2	3.9	5	46.0
				3	13.7		
10	Other consumer goods	11, 14, 15, 27 29, 31, 33-35	1.13	1	34.8	4	0.0
				2	3.8	5	49.3
				3	12.0		
11	Housing and construction	41, 42, 51	17.13	1	12.2	4	20.3
				2	1.2	5	65.1
				3	1.2		
12	Market services	43-50 52-55, 3	32.76	1	23.6	4	20.7
				2	15.4	5	19.7
				3	20.6		
13	Non-market services	56-58	18.32	1	3.4	4	34.8
				2	14.0	5	14.6
				3	33.2		

(a) 1 = production, 2 = intermediate inputs, 3 = wages, 4 = property income, 5 = capital formation.

Source: derived from Jüttemeier (1987).

recognized. The fact that a great deal of agricultural imports are of the non-competing variety (ie tropical products) is, however, implicitly represented by a low elasticity of substitution between home and foreign goods.

In its present form the model considers only Germany, no EC linkages being explicitly recognized. This is an important omission since the customs union provides important protection for German industry which is not thereby represented. We do assume, however, that Germany is not a small country, the export demand for all trading sectors being governed by finite export demand elasticities. Import demands, by contrast, do not affect world prices.

Domestic commodities are produced by four types of primary factors (unskilled labour, skilled labour, reproducible capital, and a sector-specific factor called land) and by domestic and foreign intermediates. A differentiation of labour by skills is important given comparative advantage considerations and the observation that unemployment in Germany (as in other West European countries) is primarily concentrated in unskilled (or wrongly skilled) groups (Donges et al, 1988). All primary factors except 'land' are considered mobile among sectors in the medium run. Labour, however, is not mobile among skill groups. The capital market is believed to be fully integrated both domestically and internationally: any differences in the long run after tax rates of return to capital are assumed to reflect considerations which are not affected by agricultural protection. Note that capital costs to producers can differ widely because of taxes and subsidies which are incorporated in the model.

The government budget equation recognizes direct and indirect taxes and subsidies which, as noted above, include all CAP payments. In this model the government budget is balanced, the endogenous policy instrument in all reported simulations being the direct tax rate. Direct taxes will therefore decline as an immediate consequence of budget savings. It should be noted that we have in effect aggregated the Commission's budget restriction with the domestic budget.

Given the endogeneity of the direct tax rate it is important to specify its impact in a little more detail. Investment is assumed to be influenced by after-tax rates of return, but more significant is our assumption about wages and the labour market. For all simulations, we assume that real consumer wages after tax remain constant so that a decline in the direct tax rate would lower nominal wages. At this real wage, employment is determined by the demand for labour, there being either an unspecified pool of unemployed or an infinitely elastic labour supply function. This wage assumption rests on the idea that trade unions may not be prepared to accept cuts in real net wages, but they may permit the efficiency gains arising from liberalization to accrue to the business sector, also by way of tax reductions, in order to improve employment opportunities.

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In our representation of agricultural trade liberalization, the mechanism of CAP protection - variable levies, monetary compensatory amounts, stockpiling and so forth - is not explicitly represented; instead, we are concerned with the removal of equivalents. A change in the intervention price is therefore simulated by reducing the implicit protection rate in agriculture from 54 per cent to zero. With respect to subsidies one must be careful to avoid double counting and to consider only 'coupled' programs. Consequently, the export subsidies (see Table 1) are treated explicitly and are not viewed as a production subsidy (Table 7). Similarly, the income subsidy defined as category 4, Table 7, mainly refers to social security provisions and is therefore treated as 'uncoupled'. It will, of course, be a retarding factor in the migration of labour out of agriculture and in the determination of land prices. The liberalization experiment therefore involves the removal of all production, input and investment subsidies which, together with the change in the implicit tariff, corresponds to the concept of producer subsidy equivalent and consumer subsidy equivalent (see OECD, 1987).[8] For the food-processing sector the subsidy programs are quite specific (eg Berlin promotion) and are not taken into account. Liberalization in this case involves removal of an implicit protection rate of 11.8 per cent (Table 6).

An agricultural trade liberalization will, of course, also have general equilibrium effects on the world prices of agricultural commodities, industrial goods and traded services. These changes will depend on whether one is considering a world liberalization or only liberalization on the part of the EC. Given this uncertainty we have arbitrarily incorporated an increase in the world price of agricultural goods of 10 per cent.

One of the most controversial aspects of applied general equilibrium modelling is the macro-economic content. Results will depend on the closure chosen. In our case there are two aspects. First, we have assumed a constant after-tax consumer real wage, thereby implying that change in the level of employment is determined by labour demand. A Walrasian closure along the lines of trade theoretic models would hold the level of employment constant and allow wages to change. We have chosen our closure since there is a lot of evidence to suggest wage rigidity (both level and structure) and because current policy concerns are strongly oriented toward employment. Second, one must specify the operation of the savings/investment identity. We assume a pre-specified balance on current account together with a balanced government budget. With respect to the latter, government expenditure is assumed to be targeted on the nominal level which is held constant. The ratio between aggregate real investment and aggregate real consumption is held constant.

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8 These are concepts to measure the subsidy needed to compensate producers (consumers) for the income loss (price increase) likely to occur if all farm support programs were eliminated.

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Macroeconomic consequences

The results are presented in Table 8, where the nominal exchange rate is taken to be the numeraire. The most striking finding is the significant increase in the volume of employment if protective measures were removed: the level of unskilled employment increases by 3.8 per cent, skilled employment by 4 per cent.[9] Put another way, under agricultural protection, and within a distorted system, unskilled employment is the relatively protected factor but at the price of an overall lower level of employment. Similarly, agricultural protection (liberalization) decreases (increases) GNP by 3.3 per cent and real income by 2.5 per cent. The difference is due to induced terms of trade effects (see Table 10).

With respect to foreign trade, agricultural protection is clearly trade contractionary. Under liberalization, the trade volume increases by 5.1 per cent and the real exchange rate (defined in terms of the consumer price index) consequently depreciates by 1.8 per cent. As is clear from Table 9, the relatively small change in the consumer price index is due to conflicting influences. On the one hand, reduction of the target price reduces agricultural import prices by 44 per cent but the simultaneous removal of the production subsidies increases the prices of domestically produced goods.

Examining the public finance aspects of Table 8, it is apparent that partial analysis overstates the budget savings arising from liberalization. Thus Table 7 implies a change in subsidies of around 11 per cent (in 1980 prices this amounts to DM12.1 billion) yet Table 8 indicates a saving of 9.5 per cent. The explanation is that other subsidized sectors expand following liberalization (see following section). The restricted budgetary savings also imply that the direct tax rate does not decrease to the extent that partial analysis would suggest. In the present simulation real government expenditures increase by 1.7 per cent. In simulations not reported here we held the real expenditure level constant. Employment increases by around 1.8 per cent, establishing a lower limit for our estimates.

As stressed above, agriculture is highly protected but so are several other sectors. In Table 8, we therefore also report the effects of a full liberalization: the elimination of all implicit tariffs and subsidies (see Kirkpatrick, 1987a, for a full description). Taking this as a reference case, agricultural protection accounts for about a third of the substantial costs associated with the present trade regime. It will be noted that both simulations imply substantial increases in the level of skilled employment (in a Walrasian closure this would be reflected in a substantial increase in the relative wage of skilled labour). The certainty that

9 The results generally support the findings by Stoeckel (1985) for the EC as a whole that the CAP has caused a substantial loss of jobs.

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Table 8 **Summary of macroeconomic simulation results - agricultural liberalization and full trade liberalization (percentage change in variable)**

Variable	Agricultural liberalization	Full liberalization
Macroeconomic		
GNP	3.3	9.1
Real income	2.5	6.9
Real consumption	2.7	7.8
Aggregate imports and exports	5.1	25.9
Real exchange rate[a]	-1.8	-4.2
Unskilled employment	3.8	11.2
Skilled employment	4.0	12.1
Real wages after tax	0.0	0.0
Real wages before tax[a]	-0.1	-8.8
Consumer price index	-1.8	-4.2
Government finance		
Average direct tax rate	-0.2	-20.2
Direct tax revenue	1.4	-23.6
Revenue from direct and indirect taxes	-2.4	-25.9
Subsidies excluding exports	-9.5	-102.0
Government expenditure	0.0	0.0
Real government expenditure	1.7	4.1

[a] Defined with respect to the consumer price index.

this supply would in fact be forthcoming or that relative wage changes would reduce the demand for skilled labour raises the question of appropriate internal liberalization measures to accompany external liberalization. We will return to this point below.

Structural and trade effects

The sectoral effects of agricultural liberalization are documented in Table 9. As to be expected, output in agriculture and food processing decreases by 24.7 and 10.3 per cent, respectively. This is mirrored by a similar fall in sectoral employment and a decrease in land rentals (the factor specific to the agriculture sector) of 17.2 per cent. Both these factors are crucial in describing the political economy of protection. This is particularly so if labour and capital in agriculture are viewed as also being sector specific: the removal of agricultural

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Table 9 **Sector and commodity simulation results of agricultural trade liberalization (percentage change in variable)**

	Production sector	Output - Agricultural liberalization	Output - Full liberalization	Labour demand[a]	Producer price	Consumer demand	Price of land
1	Agriculture	-24.7	-26.5	-23.8	15.5	3.8	-17.2
2	Food processing	-10.3	-8.5	-10.3	-1.1	2.0	-
3	Coalmining	5.4	-63.7	5.5	-1.5	1.5	3.6
4	Iron and steel	7.8	7.6	7.9	-1.4	2.1	-
5	Basic commodities	5.7	16.2	5.9	-1.1	2.1	-
6	Aerospace	7.5	-23.1	7.6	-1.3	0.0	-
7	Electrical engineering	9.0	33.1	9.2	-1.4	1.2	-
8	Mechanical engineering	5.3	19.0	5.4	-1.5	1.3	-
9	Clothing and textiles	15.1	-23.4	15.3	-3.3	2.2	-
10	Other consumer goods	4.2	9.5	4.4	-1.4	1.3	-
11	Construction and housing	2.8	11.6	3.2	-1.3	2.6	-
12	Market services	3.4	8.8	3.7	-1.6	3.8	-
13	Non-market services	1.8	4.4	1.8	-1.8	1.7	-

a As relative wages are held constant, skilled and unskilled sectoral employment alter in the same proportion to overall sectoral employment.

protection would substantially reduce returns to these factors - hence their opposition to a radical reform of existing price and market policies.

Output and employment in all other sectors would increase, particularly so in the two important engineering sectors. In other words, agricultural protection taxes these industries through general equilibrium processes such as wage, tax, and exchange rate behaviour. Rather surprisingly, output in three problem sectors (coalmining, iron and steel, clothing and textiles) grows following partial liberalization. As partial liberalization within a distorted system can lead to unpleasant surprises (theory of second best), we also present in Table 9 the changes in sectoral output arising from a full liberalization (see Kirkpatrick, 1987a). Particularly noticeable are the coalmining and clothing and textiles sectors where partial liberalization results in output increases, yet full liberalization leads exactly to the reverse. With the minor exception of aerospace, all other sectors move in the correct general direction. This suggests that the best package of liberalization is one which does not focus attention solely

on agriculture but on the sectors with the highest protection. In terms of international trade negotiations and the current 'Uruguay Round', our analysis sugests a 'Tokyo Round' approach, ie across-the-board cuts of protective measures with greater reductions in the more highly protected sectors, agriculture and clothing and textiles.

Also of interest from Table 9 is the implication that iron and steel, one of the problem sectors, is in fact taxed by agricultural protection. It therefore implies that the supporting measures for this industry are primarily offsets for distortions elsewhere in the economy. Whether the nature of the game is such that these production increases would be accepted by other countries is a question not dealt with by our present model.

Reflecting the structural shift in production are important changes in the commodity composition of trade, presented in Table 10. As expected, agricultural exports decline and imports substantially increase. Food processing imports increase by around 72 per cent. Matching the increase in agricultural and food-processing imports is a decline in the imports of all other commodities, in particular clothing and textiles (-15.3 per cent). With full liberalization this result is, of course, reversed; clothing and textiles and coal imports substantially increase. On the other hand, basic commodities (this includes chemicals) and electrical and mechanical engineering all increase their net export positions. This reflects the industries in which Germany has a comparative advantage (Donges et al, 1988). The simulation results therefore generally support the claim that agricultural protection taxes the classic export industries reducing their net exports, production and employment.[10] Not only are relativities affected but also the overall levels.

10 See Clements and Sjaastad (1984) for a discussion of the mechanism by which the costs of sectoral protection is passed on to other (the less protected) activities.

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Table 10 **Sectoral development of foreign trade following an agricultural trade liberalization (percentage change in variable)**

	Production sector	1980 Share of		Volume of		Price of	
		Imports	Exports	Imports	Exports	Imports[a]	Exports[b]
1	Agriculture	7.7	0.7	33.9	-31.0	-44.0	15.5
2	Food processing	5.8	4.0	71.9	2.3	-11.8	-1.1
3	Coalmining	0.4	1.0	-9.6	2.9	0.0	-1.5
4	Iron and steel	3.9	6.1	-3.5	9.2	0.0	-1.5
5	Basic commodities	39.7	18.9	-0.4	5.4	0.0	-1.1
6	Aerospace	1.0	0.5	0.7	6.6	0.0	-1.3
7	Electrical engineering	6.9	9.5	-1.8	14.4	0.0	-1.4
8	Mechanical engineering	10.6	32.0	-4.7	7.3	0.0	-1.5
9	Clothing and textiles	6.9	3.4	-15.3	6.6	0.0	-3.3
10	Other consumer goods	7.5	7.0	-6.4	2.8	0.0	-1.4
11	Construction and housing	1.6	2.3	0.4	1.3	0.0	-1.3
12	Market services	8.0	14.3	0.5	3.2	0.0	-1.6
13	Non-market services	-	-	-	-	-	-

a Import price in domestic currency including tariffs. Foreign prices are fixed.
b Foreign currency export price including the effect of any export subsidies.

IV Conclusions

The objective of the present study has been to enhance agricultural policy reform by improving transparency of the real economy-wide costs of current agricultural policies and the gains from liberalization. We have therefore focused on broad aggregates, neglecting the detailed commodity composition of agriculture which is normally of central interest in public debate.

The approach which we have followed shows that quantifying the budgetary costs, or undertaking a consumer-surplus analysis does not capture fully the economy-wide costs of the German Government support programs for the agricultural sector. Our use of the term 'cost' is more differentiated. With this in mind, the primary cost associated with agricultural protection (under conditions of real wage rigidity) is a decrease in the level of overall employment in the order of 200,000 - 400,000 workers and a loss in income of about 3 per cent: expansion of employment in the two agricultural sectors has been bought at the cost of lower overall employment. Seen on a sectoral level, agricultural protection lowers employment and output in practically all other sectors, particularly those such as electrical and mechanical engineering in which West Germany is viewed as having a comparative advantage. Classic export industries are therefore taxed by agricultural protection. Under the contrary policy - agricultural trade liberalization - there is the prospect for the society to achieve higher employment and income levels. This general benefit is the obverse of the reported economy-wide costs. Our analysis has also shown that to take a liberalization strategy beyond agriculture to encompass the whole economy, the net output and employment effects would be even more significant.

It was therefore a timely decision to put agricultural trade liberalization on the agenda for the Uruguay Round, which started early in 1987 under the auspices of GATT. However, there is no need for the German Federal Government and the other member governments of the EC to wait for the completion of the Uruguay Round before they embark on a market oriented reform of the CAP, given the fact, as demonstrated here, that such a reform would be in their own best interest.

So far, policy decisions have gone in the wrong direction: they are treating the symptoms rather than the disease[11] and, in addition, do not satisfy the farmers (they consider that they are harmed by these policies). In a liberalization strategy, the farmers would also

11 This assessment need not be modified in the light of the agreements reached at the special summit in February 1988, which took place after this paper had been written. On the contrary, the idea has been reinforced that budgetary outlays are the only costs and that the German 'national' interest is served by agricultural protection.

lose, mainly because the reduction of agricultural prices would depress land rentals and the value of other sector-specific assets such as buildings and livestock. This may be the root cause of the resistance within the farming community against the overdue reform. It may therefore be necessary to consider whether this resistance could be overcome by a scheme which compensates farmers for these wealth losses. As first suggested by Professor Giersch, this could be undertaken by an issue of government bonds to be allocated among farmers who could then use the interest income or proceeds from the sale of their bonds for whatever purpose they considered profitable: in agriculture (but then at world market prices) in forestry, in industry or in services in either rural or non-rural areas. The details of such a scheme are currently under investigation.

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Domestic effects of agricultural protection in Asian countries with special reference to Korea

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Summary

Government protection of domestic agriculture is widespread in the Asian region. Rates of protection, as measured by conventional domestic-to-border price ratios for agricultural products, have grown at a rapid rate for the East Asian economies of Japan, Korea and Taiwan to reach levels which are now commensurate with, or exceed, those of the European Community.

This rapid growth of agricultural protection reflects the attempts by respective governments to cushion (and in the case of Korea, eliminate) the adverse adjustment pressures imposed on domestic agriculture by the spectacular rates of export-led manufacturing growth achieved by these countries. The policy response of increased agricultural protection has had inevitable consequences in turn for the growth prospects of both agricultural and non-agricultural activities and for overall economic performance in these countries.

Results from a computable general equilibrium model analysis of the effects of agricultural protection in one such country, Korea, suggest the following:

- Agricultural protection in Korea has substantially reduced the volume of competing agricultural imports into that country. In the absence of such protection agricultural import volumes would more than double.

- This in turn has allowed domestic agricultural producers to raise selling prices and greatly expand their output (by up to 20 per cent) and employment (by up to 60 per cent) measured against the situation which would have existed in the absence of agricultural protection.

- As a result, farm incomes in Korea have been raised significantly, more than 40 per cent in real terms for cereals, about 20 per cent for producers of other crops and about 12 per cent for producers of livestock, principally through an escalation in the returns earned by agricultural land. The price of agricultural cropping land has been inflated by about 44 per cent in the case of cereals and 28 per cent in the case of other crops.

- Thus, ignoring its wider effects, the policy of agricultural protection in Korea has gone a long way towards meeting its narrowly specified objectives.

- However, these gains to agriculture have been achieved at considerable cost to other sectors of Korean economic activity.

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- Measured against an economy characterized by an inflexible labour market with respect to nominal wages these costs are in the form of a substantial reduction in real wages and in the international competitiveness of Korean export activities and, to a lesser extent, sectors outside agriculture competing for domestic market share against imports. As a result exports, output, employment and incomes in these sectors have been heavily curtailed relative to the situation in which there was no agricultural protection. As an example, the model projects that if agricultural protection were removed, then as a result of the deflationary effect on domestic prices, particularly food prices, real wages CPI deflated would increase by about 6 per cent (around 277,000 won) in 1987. Aggregate export earnings would increase by nearly 9 per cent, equivalent to about 3329 billion won in 1987. Assuming that the labour market gains were taken in the form of increased aggregate employment at a constant real wage, then the results indicate that the removal of agricultural protection would provide a boost of more than 8 per cent to total employment.

- Measured against an economy characterized by flexible adjustment of the labour market, these costs are in the form of reduced exports, output and employment in Korean manufacturing and a sizable reduction in the economy-wide wage level, total labour income and the share of the national income going to labour. For example, the results suggest that the removal of agricultural protection would lead to a boost to aggregate exports of about 4484 billion won, increased employment in various processing and manufacturing activities of about 580,000 jobs and an increase in the average wage level of about 250,000 won per worker in 1987. Clear winners from agricultural protection in Korea are the owners of agricultural land.

Increasing numbers of Asian economies are moving along the path of economic development experienced initially by Japan and subsequently by Korea and Taiwan. This path is characterized by rapidly rising national incomes generated by export-led manufacturing growth with the resultant adjustment pressures on agriculture being offset by escalating domestic agricultural protection.

This suggests that the conclusions drawn from the Korean case study are likely to be more widely applicable throughout Asia in the near future.

I Introduction

This chapter addresses the issue of agricultural protection in the Asian region, its evolution, present level and effects. Countries within the Asian region exhibit considerable differences in government policies towards agriculture. In part this reflects the diversity of such countries in agricultural land endowment, stage of economic development, growth strategy being pursued and sectoral composition of economic activity and employment. In considering the effects of agricultural protection in Asian countries it is difficult therefore to make broad generalizations. Rather, a case study approach is needed which takes into account the salient features of individual countries or country categories that comprise the Asian region.

The chapter is structured as follows: Section II compares the recent economic performance of selected Asian economies and the present structure and relative importance of the agricultural sector in each country. An understanding of the development process in each country and the implications for the agricultural sector is a necessary precursor to interpreting current patterns of agricultural protection in Asia. This forms the subject of Section III. This analysis clearly identifies the East Asian countries of Japan, the Republic of Korea (hereafter Korea) and Taiwan as being those in which agricultural protection is currently highest and likely to be imposing significant costs on the performance of other sectors and on the economy as a whole. In Section IV, a computable general equilibrium model of the Korean economy is used to study in some detail the effects of Korean agricultural protection on domestic economic performance.

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II Agriculture in Asian economies

Table 1 provides some summary information on economic performance, the commodity composition of agricultural production and the importance of agriculture in the economy for a selection of Asian countries. These statistics are a useful aid to interpreting the different intensities of domestic agricultural protection which have emerged throughout the Asian region.

The table considers countries from North Asia (China), East Asia (Japan, Korea, Taiwan), three members of the ASEAN group (Indonesia, Philippines, Thailand) and countries of the Indian subcontinent (India, Pakistan, Bangladesh). While this coverage is not exhaustive it is sufficiently comprehensive to encompass most of the economic activity of the Asian region and sufficiently diverse to represent each of the archetypical Asian economies with respect to agricultural resource base, stage of agricultural development and stance towards agricultural assistance.

Agricultural production in each country is dominated by food production. In the table this is divided into seven categories of commodities – rice, wheat, coarse grains, sugar, dairy, ruminant meat, non-ruminant meat.[1]

China has experienced rapid economic growth in recent years. As a result of wide-scale liberalization of domestic agricultural pricing policies, growth of the Chinese agricultural sector has matched that of the economy as a whole. Agriculture, which is dominated by rice and wheat, represents about one-third of Chinese GDP and employs three-quarters of the work force.

The three East Asian countries of Japan, Korea and Taiwan have all experienced high rates of economic growth over the past two decades, although Japan's growth rate has fallen considerably in recent years. Agriculture's share in GDP and employment has declined rapidly in these countries to levels which are very low compared with Asia as a whole. Within the group Korea has the highest share of agriculture in GDP and employment. The rate of growth of agriculture in Korea has increased markedly in the 1980s in response to rapidly escalating protection to that sector (see Section III) although agriculture's share of GDP has continued to decline. The sectoral composition of food production in each country is dominated by rice and non-ruminant meat.

1 Most categories are self-explanatory. Coarse grain includes barley, oats and sorghum. Ruminant meat includes beef and sheep meats. Non-ruminant meat includes pig meat and poultry.

Table 1 Importance of agriculture in selected Asian economies

	North Asia	East Asia			ASEAN			West Asia		
	China	Japan	Korea	Taiwan	Indonesia	Philippines	Thailand	India	Pakistan	Bangladesh
Commodity composition of food production[a]										
Rice	0.27	0.22	0.57	0.32	0.66	0.31	0.51	0.35	0.09	0.76
Wheat	0.29	0.02	0.00	0.00	0.00	0.00	0.00	0.17	0.32	0.05
Coarse grain	0.14	0.01	0.02	0.01	0.08	0.11	0.10	0.09	0.02	0.00
Sugar	0.01	0.01	0.00	0.03	0.08	0.10	0.09	0.03	0.02	0.00
Dairy	0.03	0.26	0.10	0.00	0.01	0.01	0.00	0.31	0.23	0.08
Ruminant meat	0.03	0.21	0.12	0.01	0.09	0.14	0.11	0.04	0.30	0.08
Non-ruminant meat	0.23	0.29	0.19	0.63	0.08	0.39	0.19	0.01	0.02	0.03
Share of agriculture in GDP[b]	0.33	0.03	0.14	0.06	0.24	0.27	0.17	0.31	0.25	0.50
Share of agricultural employment in total employment[b]	0.74	0.11	0.36	0.27	0.57	0.52	0.71	0.70	0.55	0.75
Recent economic performance[c]										
Annual growth rate of economy (per cent)										
1960 - 1980	6.4	6.3	9.5		7.9	5.9	7.4	3.8	5.2	2.4
1980 - 1985	9.8	3.8	7.9		3.5	-0.5	5.1	5.2	6.0	3.6
Annual growth rate of agriculture (per cent)										
1960 - 1980	3.0	0.8	3.0		4.3	4.6	4.9	2.8	3.3	1.5
1980 - 1985	9.4	1.6	6.3		3.1	1.7	3.4	2.7	2.1	2.8

a Figures represent shares computed from producer value of production and refer to 1985-86.
Source: Food and Agriculture Organisation, *Production Yearbook* and Taiwan Department of Agriculture and Forestry, *Taiwan Agricultural Yearbook*.

b Figures for countries except Taiwan refer to 1985 and were obtained from World Bank (1987). Figures for Taiwan refer to 1980 and were obtained from Anderson and Hayami (1986).

c Obtained from World Bank (1987).

The ASEAN countries included in table 1 have a considerably greater agricultural land base per capita than the three East Asian countries. Although the agricultural sectors of these countries grew substantially over the past two decades, agriculture's growth rate was less than that for the economy as a whole in each country. While agriculture's share of total output and employment in each country has steadily declined, agriculture represents a significantly higher proportion of GDP and total employment in these countries than is the case for East Asia. Rice and sugar are the predominant agricultural activities, with non-ruminant meat

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being particularly important in Thailand and the Philippines.

The West Asian countries in the table have exhibited somewhat lower rates of economic growth than that experienced for Asia as a whole. Although agriculture's share of GDP and employment has declined in each country, agriculture accounts for half of total economic activity in Bangladesh and one-quarter to one-third in Pakistan and India. Agricultural employment represents 55 to 75 per cent of the labour force in these countries. In India food production is dominated by rice, wheat and dairy. In Pakistan, wheat and ruminant meat are important, while for Bangladesh rice accounts for over three-quarters of total food production.

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III Agricultural protection in Asian countries

The previous section has highlighted the generally rapid economic expansion achieved by most Asian countries over the past two decades. Average rates of growth throughout much of the region have been more than double those for the world as a whole. This growth performance has been most spectacular for the East Asian countries who have vigorously pursued an outward-looking strategy centred on exports of manufactures. While the rapid industrialization of this part of Asia has resulted in rising national incomes and living standards, it has also imposed severe adjustment pressures on the domestic agricultural sectors of industrializing countries.[2]

These pressures have encouraged increased import penetration of agricultural products and resulted in a decline in agriculture's share of GDP and employment. The policy response of governments to this reduction in agriculture's comparative advantage induced by growth of manufacturing has been to attempt to slow the rate of adjustment out of agriculture by progressively altering the structure of domestic industry incentives in agriculture's favour. In part, this policy response has also been motivated in some countries by a desire to achieve a measure of food self-sufficiency irrespective of the domestic resource costs.

Why do governments intervene in agriculture?

Government intervention in agriculture is a worldwide rather than just an Asian phenomenon. Many studies have examined the reasons why it is so widespread and so vigorously pursued. One proposition with considerable factual support is that, by and large, governments in poor countries tend to tax agriculture relative to other tradeable sectors. They do this directly via domestic pricing policies and indirectly by maintaining overvalued exchange rates. This is despite the overwhelming evidence that taxing agriculture to free resources to manufacturing distorts comparative advantage in low-income countries and retards economic growth. However, as the process of economic development leads to national income growth, the bias in sectoral policies against agriculture changes to a bias towards agriculture. This change occurs at an earlier stage of economic growth for countries whose agricultural resource base, especially land, and hence comparative advantage in agriculture, is lowest.

2 The development process experienced by these countries is analogous to what has become known as the economics of booming sectors. According to this theory, the rapid emergence of say manufacturing exports, will, via an appreciation of the real exchange rate, act in much the same way as a reduction in protection to import competing activities. See Gregory (1976) and Corden (1981) for examples of this theory in the context of Australian mineral export growth and the exploitation of North Sea energy.

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Anderson and Hayami (1986) provide an explanation of why countries change from taxing to subsidizing agriculture as their economies grow. Their explanation is centred on the economic theory of politics, the basic axiom of which is that political leaders devise policies to maximize their chances of holding power. The more an interest group expects to gain from a particular policy the greater its demands on government to provide it. Conversely, the more effective the opposition from groups who would lose by that policy, the higher the political cost of supplying it. As per capita incomes grow the decreasing importance of food prices in household expenditure ensures that political pressure for lower food prices diminishes. Manufacturing-led economic growth increases adjustment pressures on agriculture and hence demands by farmers for compensating assistance to reduce these pressures. At the same time the declining relative importance of agriculture in total output and employment makes it less costly politically for governments to accede to farmer pressures.

The proposition that in the course of economic growth governments switch from taxing to subsidizing agriculture is strongly supported by the East Asian experience. There are also signs that it is being followed in ASEAN. Table 2 indicates how nominal rates of agricultural protection (measured in terms of the percentage by which domestic producer prices exceed border prices) have escalated in Japan, Korea and Taiwan since 1955 while over the same period the share of agriculture in GDP in each country has steadily diminished. This coincides with the period of rapid industrialization undergone by these countries and hence increased adjustment pressures on domestic agriculture.

In the case of Korea and Taiwan, where the process of industrialization lagged behind Japan, the effects of government sectoral policies were to hold producer prices for agriculture below world prices as late as until the mid 1960s. Since then discrimination in favour of agriculture has grown rapidly to reach extremely high levels, particularly in case of Korea.

Current rates of agricultural assistance in Asian countries

Table 3 provides estimates of rates of assistance afforded each of seven food commodity categories in the ten Asian countries. The estimates refer to the 1980-1986 period. They are expressed as ratios of the domestic producer price inclusive of subsidies to the border price. The domestic producer price has been calculated as the world reference price plus the producer subsidy equivalent of assistance per unit of production. The measure of assistance calculated in this way is similar to that provided by the producer subsidy equivalent concept

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Table 2 **Nominal rates of agricultural protection in East Asia: 1955 - 1984**

	1955	1960	1965	1970	1975	1980	1984
Nominal rate of agricultural protection[a] (percent)							
Japan	18	41	69	74	76	85	102
Korea	-45	-15	-4	29	30	117	137
Taiwan	-17	-3	-1	2	20	52	43
Share of agriculture in GDP							
Japan	13	10	7	5	4	3	3
Korea	45	40	39	27	22	14	14
Taiwan	28	27	23	15	12	7	6

a Defined as the percentage by which the producer price exceeds the border price. The estimates shown are the weighted averages for 12 commodities using production valued at border prices as weights. The 12 commodities are rice, wheat, barley, corn, oats, rye, beef, pork, chicken, eggs, milk and sugar.

Source: Hayami (1987) and Honma and Hayami (1986).

(PSE) used by the OECD and US Department of Agriculture[3]. A ratio of less than one indicates that government policies act to lower the producer price of a particular product relative to the border price[4]. For example, domestic pricing policies for rice in Thailand over the 1980-82 period resulted in the domestic producer price of rice being only 75 per cent of the border price. By contrast the producer price of rice to Japanese farmers was estimated at more than five times the border price.

Before interpreting the estimates in Table 3 it should be emphasized that summary measures of assistance calculated in this way have a limited economic interpretation. This is especially so when such measures are considered for a particular sector independently of the degree of assistance received by other sectors. This measure of assistance does not set out the tax effect on an industry of subsidies provided elsewhere in the economy, the products of which may be purchased as inputs by the industry in question at inflated (subsidy inclusive) prices. In addition, such measures do not take into account the supply and demand responses

3 In percentage form PSEs are generally expressed as the ratio of the per unit PSE to the relevant domestic market price.

4 The border price is defined as the fob export price or the cif import price depending on whether the country is judged to be a net exporter or importer of the product in the absence of its distortionary food policies.

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as a result of the subsidy in the sector being subsidized and the flow-on effects to closely related industries and the economy as a whole. They therefore have nothing at all to say about the economic cost of agricultural protection in a particular country in terms of its effect on the level and sectoral composition of economic activity and employment. Nor do they capture what would happen to world commodity prices if protection were removed on either a unilateral or a multilateral basis. To do this requires a framework of analysis which traces the effects of removing such assistance on the behaviour of producers and consumers of agricultural products and, through direct and indirect linkages with other sectors, on the economy as a whole.

Despite these caveats, the following points can be drawn from Table 3:

- With few exceptions (rice in China, Indonesia, Thailand and West Asia; sugar in Thailand and West Asia; and ruminant meat in China, Thailand and Bangladesh) producer prices exceed border prices for food commodities in Asian countries, often by very large amounts.

- Rates of assistance are highest in Japan, Korea and Taiwan across most product groups relative to those in other Asian countries. Assistance is a good deal less in ASEAN countries. With the exception of the dairy group, rates of assistance are negative, zero or modest in China and the West Asian countries.

- All countries in the region provide high rates of assistance to their domestic dairying sectors.

- Within a particular country the dispersion of assistance rates between agricultural commodities which compete for a common land base is often very large. Hence it is likely that agricultural assistance in these countries, as well as distorting the allocation of resources between agricultural and other activities, is also distorting the input structure and product mix of the agricultural sector. Both the within sector and between sector efficiency losses from this protection may well be large.

Table 3 **Estimates of rates of agricultural assistance[a] in selected Asian countries: 1980 - 1986**

	North Asia	East Asia			ASEAN			West Asia		
	China (b)	Japan (c)	Korea (b)	Taiwan (b)	Indonesia	Philippines	Thailand	India	Pakistan (d)	Bangladesh (d)
Commodity										
Rice	0.90	6.60	3.05	1.70	0.85[b]	1.00[b]	0.75[b]	0.85[e]	0.75	0.95
Wheat	1.50	10.00	1.10	3.00	1.00[b]	1.00[b]	1.00[b]	0.70[e]	0.90	1.00
Coarse grain	1.30	10.70	2.35	1.60	0.95[b]	1.00[b]	0.95[b]	1.00[d]	0.90	1.00
Sugar	1.15	3.05	4.20	3.45	1.40[b]	1.00[b]	0.90[b]	0.80[d]	0.70	0.60
Dairy	2.90	5.20	2.00	1.50	1.60[d]	1.70[d]	1.60[d]	1.50[d]	1.65	1.30
Ruminant meat	0.75	2.55	3.25	1.55	1.80[d]	1.00[b]	0.95[d]	1.00[d]	1.00	0.90
Non-ruminant meat	0.70	1.10	1.30	1.10	2.00[d]	1.25[b]	1.00[b]	1.00[d]	1.00	0.90

a The rate of assistance is calculated as the ratio of the domestic producer price inclusive of subsidies to the border price expressed in domestic currency units.

b Based on USDA estimates of PSEs for 1984.

c Estimates refer to 1986.

d Estimates refer to 1980-82.

e Based on USDA estimates of PSEs for 1982-1984.

Source: The estimates are taken from Walker (1988). These have been derived by building on the work of Tyers and Phillips (1986) and USDA (1987).

The clear message from the table is that, in terms of the effects of agricultural protection on domestic economic performance in each country, the most interesting Asian countries for detailed study are Japan, Korea and Taiwan. The Japanese situation is covered in some detail in a separate chapter. In the remainder of this chapter the case of Korea is considered in some detail.

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IV Measuring the effects of agricultural protection in Korea

In the 1950s industry policy in Korea was characterized by import-substituting industrialization. This low-growth strategy was supported by manufacturing tariffs and the direct taxation of domestic agricultural production. This in turn had the effect of holding down domestic food prices and hence the wage demands of industrial workers. Export-oriented industrialization began in the 1960s encouraged by a reduction in manufacturing tariffs and the removal of taxes on agricultural production. Manufacturing was largely based on the transformation of imported raw materials and components into finished or semi-finished products for export. This international trade orientation has allowed Korea's manufacturing sector to expand far beyond the limits imposed by reliance on the domestic market. Exports now represent about 38 per cent of Korean GDP.

From the mid 1960s to the mid 1970s exports were mainly light manufactured goods, especially textiles, footwear, plywood and unsophisticated electronic products. Korea has become less competitive in these products as economic development has proceeded. Increasingly, exports have shifted towards heavy industrial goods and more sophisticated electronic equipment.

This manufacturing export growth strategy has been spectacularly successful. At the end of the Korean War in 1953 the Korean economy was dominated by peasant agriculture, which represented about 80 per cent of GDP. Average income per head of population was $450 per year (1987 $US). Throughout the 1950s Korea was one of the world's poorest countries, heavily dependent on US economic aid. In 1987 income per head of population had reached $2900 and agriculture's share of GDP had fallen to about 14 per cent. The rate of economic growth has averaged more than 8 per cent annually since the mid 1960s.

For much of the phase of export-led industrialization Korea has maintained significant restrictions against imported manufactured goods in addition to its protection of domestic agriculture. Since 1980 there has been a progressive relaxation of restrictions against manufactured imports so that now there are few substantive import restrictions outside primary products and processed foods.

Since the 1970s and in line with the rapid shift in comparative advantage from agriculture to manufacturing the domestic policy stance towards agriculture has been one of steadily increased protection. The stated government objectives of this policy have been to ensure that (a) the growth in farm incomes keeps pace with the growth in non-farm incomes, and (b) a

high degree of food security is achieved. Ignoring for the present its economic costs, the policy appears to have been moderately successful in achieving its aims (Anderson 1987). The incomes of farm households have maintained parity with the incomes of non-farm households and a high degree of self-sufficiency in grain production, especially rice, has been achieved, though self-sufficiency in ruminant meat production has fallen. However, the degree of self-sufficiency achieved in agricultural products has necessitated an increasing reliance on imported agricultural inputs, especially fertilizers and animal feedstuffs.

As noted in Table 3, to achieve the government policy objectives towards farm incomes and food self-sufficiency has involved a steady increase in the wedge between domestic producer (and consumer) prices for food relative to border prices sustained mainly by tariffs and quantitative restrictions against food imports[5]. The result is that the rate of protection to Korean agriculture as measured by domestic-border price differentials now rivals that of Japan.

Anderson (1987) provides a quantitative assessment of the effects of Korean agricultural protection on food production, consumption and imports in that country. His analysis is based on a partial equilibrium model of agricultural food markets in Korea. While this model captures the transfers from consumers to producers caused by agricultural protection it is unable to address the economy-wide effects of this protection. It is to these effects that we now turn.

An economy-wide model for Korea

To deal with the effects of domestic agricultural protection in Korea in a comprehensive manner requires an economy-wide framework. This framework must distinguish the direct linkages, both forward and backward, between agricultural activities, other domestic sectors and world trade. These so-called input-output linkages specify the inputs of other domestic sectors and overseas suppliers to agriculture and the sales of sector products to the various categories of domestic users and exports. In addition, and perhaps more importantly, the framework must capture the indirect linkages between agriculture and other sectors by recognizing that agriculture competes with other sectors in an economy which is itself subject to overall constraints. Examples are the foreign exchange constraint which requires consistency between the current account outcome and the willingness of the rest of the world to lend to or accept capital from that country and the constraint on total labour supply. The operation of these and other constraints ensures that the performance of industries is linked irrespective

5 Government subsidies on farm inputs, in particular agricultural credit concessions and government-financed infrastructure developments, have also encouraged resources to remain in agriculture as agriculture's comparative advantage has declined.

of whatever input-output connections might exist between them. For example, to the extent that increased protection to one sector bids up the price of labour employed by that sector will ensure that other sectors must also pay a higher price to attract labour.

To capture the direct and indirect linkages between agriculture, other sectors of the domestic economy and world trade, the Centre for International Economics has developed an economy-wide general equilibrium model of the Korean economy[6]. This model is of the comparative-static neoclassical type. Its theoretical structure is based on that of the ORANI general equilibrium framework of Dixon et al, (1982). The model is centred on a 1980 system of input-output accounts published by the Bank of Korea. It distinguishes thirteen production sectors, three for agriculture, two other resource-based sectors, five manufacturing sectors, one of which is concerned with food processing and three service sectors. The choice of sectors reflects the basic orientation of the study (the effects of agricultural protection) and the need to distinguish export from import-competing activities.

Industry production technology in each sector is depicted by two level nested functions. At the first level different categories of purchased inputs and an aggregate of primary factors are assumed to be used in fixed proportions. At the second level CES substitution is allowed between domestic and imported sources of a particular input category and between the primary factors land, capital and labour[7]. Each of the agricultural sectors (cereals, other crops, livestock) is modelled as using its own commodity-specific land base, with the model solving for different rental prices on each type of land[8].

The labour market is characterized by only one type of labour assumed to be mobile across all sectors. In each of the agricultural sectors the labour force is divided between hired workers and family (including owner-operator) labour. This distinction is particularly important. On a persons basis, only 9 per cent of the farm labour force is rewarded out of wages paid, with the remainder being rewarded from the gross operating surplus of the farm sector. In the very short term, family labour can be regarded as being immobile in much the same way as is farm capital[9]. In the medium term, however, the situation is different, as

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6 A technical appendix describing this model is available from the Centre for International Economics.

7 The resultant intermediate input and primary factor input demand relationships require estimates of the elasticity of substitution between factors of production in each industry and between domestic and imported sources of each commodity category. The former are based on the Korean industry production function studies of Nam (1975) and Kim (1977) and range from 0.8 (manufacturing and services) to 1.4 (agriculture). The latter are judgmental, 2.0 (manufacturing), 5.0 (agricultural products) being within the range indicated by the few available published studies for other countries.

8 While there is some multi-product land use in Korean agriculture, a reasonably clear distinction exists between paddy land, other more undulating cropping land, and hill grazing land. Livestock production is becoming increasingly specialized on grazing land.

9 This can be modelled by treating family labour as a fixed factor of production.

witnessed by the decline in the farm labour force from about two-thirds of the total labour force in the 1950s to about one-third in the 1980s.

Capital is modelled as being sector specific in the short term. Relative rates of return on that capital deviate between sectors in response to economic changes. Over the longer term, capital mobility between sectors is assumed to take place to eliminate these deviations. The model contains a simple theory for allocating aggregate investment between sectors[10]. New investment does not augment the capital stock in the short term.

On the demand side, the 13 categories of domestic and imported products are absorbed by industries as inputs into current production and capital formation, by households and by government. Private consumption behaviour is depicted by the conventional utility maximization framework. One representative household is assumed to substitute between different categories of consumer goods and between domestic and imported sources of those goods[11]. Government demands are simply indexed to total private consumption demands. Their composition is set exogenously.

Exports are determined according to the differential between domestic costs of exporting industries and world export prices in local currency. Foreign demand curves facing all Korean exports are assumed to be highly elastic[12]. World import prices are assumed independent of Korean import demands.

Macro-economic behaviour is largely exogenous or determined by the way in which the model is closed. Total real domestic absorption (aggregate expenditure by households, government and private investment) is either set exogenously or determined by the difference between the outcome for real gross domestic product and the balance of trade. The shares of this absorption between component parts are set exogenously. The government's public sector borrowing requirement (PSBR) is always endogenous.

The model incorporates a number of different prices for each activity, producer prices, export prices and import prices. Margins and taxes levied on commodity flows within the domestic economy are not explicitly modelled.

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10 This theory ensures that industries which experience the most pronounced increases in their rates of return to capital obtain increased shares of aggregate investment. See Dixon et al (1982).

11 The utility function is assumed to be of the Klein-Rubin form. Own, cross price and expenditure elasticities of demand are derived from Lluch, Powell and Williams (1977), who applied Lluch's extended linear expenditure system to Korean National Accounts data for the period 1963-1972.

12 This is captured by setting all export demand elasticities to -20.0.

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The nominal exchange rate is the numeraire. While the model is able to explain movements in the real exchange rate, it is unable to explain how much of a given change in the real exchange rate is due to a change in the nominal exchange rate between Korea and the rest of the world on the one hand, or differences in the rate of inflation between Korea and the rest of the world on the other.

The effects of removing agricultural protection

Agricultural protection in Korea is dominated by the use of quantitative restrictions against imports and to a lesser extent import tariffs. These border protection measures raise producer prices (and hence encourage self-sufficiency and raise farm incomes) well above world prices. Behind this protection, large-scale domestic procurement and price setting programs are operated by the government, particularly in the case of grains.

The domestic implications of agricultural protection in Korea are assessed by using the model to determine the effects of its removal. These effects will depend critically on the nature of the adjustment environment envisaged, in particular domestic spending and an improvement in the trade balance and the degree to which labour market gains are shared between increased real wages and increased employment; the extent to which real income gains are shared between increased domestic spending and an improvement in the trade balance; and the degree to which capital is mobile between domestic sectors and between Korea and the rest of the world.

Table 4 contains model projections for a range of variables of interest of the effects of removing protection to each of the agricultural sectors distinguished – cereals (mainly rice), other crops, and livestock. In the case of the farm-based livestock sector, assistance is provided via protection against imports of livestock products. Based on the rates of assistance estimated for these product categories for the mid 1980s as shown in Table 3, the removal of protection would result in the following reduction in the power of the tariff[13] and hence local price of competing imports – cereals (61 per cent), other crops (67 per cent), livestock (69 per cent) and food products which includes livestock products (28 per cent).

13 The power of the tariff is defined here as one plus the ad valorem equivalent of tariffs and other quantitative restrictions against imports. This model variable can be used to capture the domestic-world price distortion imposed by agricultural protection. The size of the shift in the power of the tariff needed to reflect the shift in domestic producer prices relative to the world price was calculated using the information on domestic-world price distortions in Table 3. For each of the model industries, cereals, other crops, livestock and food products, the appropriate change in the power of the tariff was arrived at by weighting, using output weights, the size of the domestic-world price distortion for products classified to these sectors.

The table contains two columns of results. They refer to different assumptions about the extent of macro-economic and labour market adjustment assumed to take place in response to the removal of protection. Both refer to an adjustment horizon in which capital in use in each industry is assumed fixed. Industry investment takes place but is not allowed to augment industry capital stocks. Hence the adjustment horizon refers to a calendar time period long enough for industries to alter their investment plans (and hence the demands faced by industries producing capital goods) in response to changes in their growth prospects following the removal of agricultural protection, but short enough for the effects of new investment on capital stocks to be ignored.

In column 1 the labour market is assumed to be demand-determined with firms able to employ as much labour as they require at a constant nominal wage. The economy's nominal wage is regarded as being set independently of the level of agricultural protection. To the extent that the removal of such protection causes consumer prices to fall then the purchasing power of the constant nominal wage (ie the economy-wide real wage) will increase.

An alternative assumption would be that workers seek to maintain their real wage. Hence to the extent that removal of agricultural protection lowers the rate of growth of domestic prices then the rate of growth of nominal wages would be reduced by the same amount.

Labour (both hired and the farm proprietor and family component) is assumed mobile between sectors. At the macro-economic level real absorption (consisting of aggregate real private consumption, investment and government expenditure) is also assumed constant. This can be thought of as being achieved by changes in fiscal and/or monetary policies which are not modelled in this framework. Hence, under this scenario changes in international competitiveness arising from changes in protection affect national income solely through changes in the trade balance.

In contrast the results in column 2 assume that real wages will adjust to maintain the aggregate employment of labour at the level existing before the removal of border protection to agriculture. Real absorption is assumed to adjust (by way of equi-proportional changes in real household consumption, investment and government expenditure) to ensure that the balance of trade outcome remains unchanged.

World import prices are assumed fixed, that is, independent of changes in protection to Korean agriculture. While this assumption is reasonable in the context of agricultural trade liberalization by Korea, which is a very small player in world agricultural markets, it would not be appropriate in a study of the effects of global liberalization of agricultural protection.

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It is further assumed that to the extent that the removal of agricultural protection improves the economic incentives facing domestic export-oriented activities, export expansion is allowed to take place. That is, additional exports are not suppressed by either existing or new barriers levied against Korea. This assumption is an important one in the context of the present international trading environment. Protectionist policies ranging from import quotas, variable export restraints, countervailing and anti-dumping duties and administrative and procedural measures have increasingly been levied against Korean exports in recent years. Korean exports are poorly diversified in terms of product and producer. This makes them especially visible on overseas markets[14] and vulnerable to retaliatory action.

Finally, the nominal exchange rate is the numeraire. The model is unable to partition the change in the real exchange rate (which is endogenous) into a change in the domestic inflation rate on the one hand and a change in the nominal exchange rate on the other. With the nominal exchange rate as the numeraire changes in the model's domestic price indexes, for example the consumer price index, can be interpreted as changes in domestic relative to world prices.

Column 1 – Constant nominal wages and real domestic expenditure

The direct or first round effect of the removal of border protection to agriculture is a large reduction in import prices and hence to a lesser extent domestic producer and consumer prices for agricultural products. Price reductions to these products are passed on through the economy via input-output linkages. As a result the overall level of domestic costs is reduced. This is shown by the 4.5 per cent reduction in the GDP deflator. The reduction in the consumer price index is even more marked (fall of 6.2 per cent) reflecting the larger weighting given to food products in this index. The reduction in Korea's domestic cost structure relative to world prices implies a sharp improvement in the international competitiveness of Korea's traditional export activities and non-agricultural import competing sectors.

As a result, aggregate exports are projected to expand by 8.8 per cent. However, agricultural imports are projected to more than double resulting in a growth in aggregate imports of 9 per cent and hence a small deterioration in the trade balance. With aggregate real domestic expenditure assumed constant this in turn implies a small decline in real GDP (0.7 per cent) and aggregate employment demand. The major reason for the slight decline in overall economic activity and employment is the very large increase in the economy-wide real wage level (6.2 per cent).

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14 About 40 per cent of Korea's exports are sold on the US market.

Table 4 **Effects of removing agricultural protection per cent[a]**

	Column 1 Constant minimal wages and aggregate real domestic expenditure	Column 2 Constant aggregate labour demand and balance of trade
Macro-economic		
Real GDP[b]	-0.7	0.2
Real domestic expenditure	0.0	-0.0
Aggregate exports	8.8	12.0
Aggregate imports	9.2	9.5
Balance of trade[c]	-0.9	0.0 (Ex)
Consumer price index	-6.2	-7.7
GDP deflator	-4.5	-5.9
Labour market		
Aggregate labour demand	-1.5	0.0 (Ex)
Nominal wage	0.0 (Ex)	-2.5
Real wage (CPI deflated)	6.2	5.4
Labour's share of national income	5.5	5.2
Industry outputs		
1 Cereals	-22.3	21.2
2 Other crops	-12.4	12.0
3 Livestock	-8.7	-8.0
4 Forestry, fishing	-0.7	5.4
5 Mining	1.0	3.4
6 Food, beverages	2.1	2.7
7 Textiles, leather	19.1	21.8
8 Timber and wood products	2.3	4.7
9 Paper, chemicals etc	1.6	2.5
10 Manufactures	1.4	3.3
11 Construction	0.1	0.1
12 Margins services	0.3	0.7
13 Other services	1.0	1.5
Major exports		
4 Forestry, fishing	6.2	29.2
7 Textiles, leather	33.5	38.1
8 Timber and wood products	7.5	15.2
10 Manufactures	2.7	6.8
Major imports		
1 Cereals	148.8	145.7
2 Other crops	70.4	71.0
5 Mining	1.5	2.2
6 Food, beverages	-4.6	-7.3
9 Paper, chemicals etc	2.0	3.0

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Table 4 (continued)

	Column 1 Constant minimal wages and aggregate real domestic expenditure	Column 2 Constant aggregate labour demand and balance of trade
Industry employment		
1 Cereals	-61.1	-58.0
2 Other crops	-33.6	-32.4
3 Livestock	-22.7	-20.7
4 Forestry, fishing	-0.8	6.4
5 Mining	1.2	4.2
6 Food, beverages	4.0	5.0
7 Textiles, leather	31.2	35.6
8 Timber and wood products	2.3	4.7
9 Paper, chemicals etc	3.5	5.3
10 Manufactures	2.5	6.0
11 Construction	0.2	0.2
12 Margins services	0.3	0.9
13 Other services	1.3	2.0
Price of land		
1 Cereals	-43.6	-43.7
2 Other crops	-24.0	-25.4
3 Livestock	-16.2	-17.0
Real net farm income[d]		
1 Cereals	-43.8	-42.3
2 Other crops	-21.4	-21.2
3 Livestock	-12.5	-11.7

a All results are expressed as percentage changes from the levels that would have been reached assuming no change in agricultural protection.

b Calculated from expenditure side.

c Expressed as a percentage of base period GDP.

d Calculated as a share-weighted average of the nominal returns to land capital and labour employed in each agricultural activity deflated by the model's consumer price index.

(Ex) Denotes variable set exogenously.

At the sector level the very strong boost to imports of agricultural products results in substantial reductions in the output of agriculture (22 per cent for cereals, 12 per cent for other crops and 9 per cent for livestock)[15]. Employment in each of these sectors is projected

15 A key factor determining the output responses of industries concerns their output supply elasticities. With capital and land in each sector assumed fixed the output supply elasticity for sector j (Zj) is given by

$$Zj = Bj\ Svj / (1-Svj)\ [1/Spj]$$

to fall sharply. Real farm incomes (nominal returns to capital land and labour employed in farming deflated by the model's index of consumer prices) are projected to fall by 44 per cent (cereals), 21 per cent (other crops) and 13 per cent (livestock). A major component of this reduction in farm income is a sharply reduced return to rural land. Agricultural land rental prices are projected to fall by from 16 to 44 per cent.

The output, employment and income losses in agriculture are offset by gains in output, employment and income elsewhere in the economy. These gains are concentrated particularly in manufacturing export activities. The largest percentage increase in exports occurs in the textiles and leather sector. This sector is particularly dependent on imports from the upstream other crops and livestock sectors; hence it benefits directly from the lower domestic prices of both domestic and imported sources of these products following the removal of border protection on competing imports.

A key assumption shaping the above story, particularly the macro-economic results, is that of constant nominal wages. Under this assumption all of the labour market gains from the removal of agricultural protection are captured by those in work in the form of a 6 per cent increase in the economy-wide real wage. Suppose, for example, that real, rather than nominal, wages were assumed constant. Then our results show that, following the removal of agricultural protection, the improvement in international competitiveness as reflected in the reduction in the GDP deflator is considerably more marked, the first round effects of lower agricultural prices being reinforced by lower nominal wage growth. As a result, the boost to aggregate exports exceeds the increase in imports leading to an improvement in real GDP of about 5 per cent and an increase in aggregate labour demand of over 8 per cent. With real domestic spending assumed constant, all of the gains in national income register as an improvement in the trade balance. This in turn could be used to reduce Korea's foreign debt which, although falling, is still about $US35 billion, equivalent to 30 per cent of GNP.

At the sector level the greatly enhanced international competitiveness of exports ensures that the losses to output, employment and income in agriculture are greatly outweighed by the

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where Bj is the CES substitution elasticity between primary factors in industry j, Svj is the share of variable factor costs (ie labour) in j's primary factor costs and Spj is the share of primary factor costs in total costs. Values for Zj in agriculture are 0.10 (cereals), 0.19 (other crops) and 0.90 (livestock). The main reason for the much higher short-run supply elasticity for livestock is its considerably greater share of material inputs (principally livestock feed) in its total costs.

Despite its much higher supply elasticity the livestock sector shows a smaller output response than the cropping sectors because of a much smaller reduction in its output price. By comparison with cereals and other crops the livestock sector does not face as much direct competition from imports (base period import share of domestic usage of only 4 per cent compared with 15 to 20 per cent for other agriculture). The livestock sector faces indirect competition from imports through its sales to the food and beverages sector for processing. The output of the food and beverages sector is projected to rise by about 2 per cent, thereby increasing this sector's demand for livestock inputs, most of which are supplied domestically.

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expansion experienced by export-oriented activities such as textiles and leather, timber and wood products and manufactures.

Column 2 – Constant aggregate employment demand and balance of trade

The results in column 2 (generated under the assumptions of a flexible labour market in which wages adjust to hold employment demand constant and the adjustment of real domestic spending to match changes in the economy's real income) tell a broadly similar story at the sector level. Under these assumptions the removal of agricultural protection is projected to lead, through heavily increased import penetration of agricultural products, to output contractions in agriculture of 21 per cent (cereals), 21 per cent (other crops) and 8 per cent (livestock). Employment in agriculture is projected to fall by 58 per cent (cereals), 32 per cent (other crops) and 21 per cent (livestock). Real net farm incomes are projected to fall by 42 per cent (cereals), 12 per cent (other crops) and 12 per cent (livestock). Labour released from agriculture is re-employed in the traditional export-oriented sectors which experience export-led output and employment growth.

With capital fixed in aggregate and by sector and labour fixed in aggregate, real GDP increases only slightly. However, there are significant changes in the composition of this GDP between returns to labour and returns to capital and land. The removal of agricultural protection results in sharp reductions in the returns to capital and land[16] employed in agriculture.

Wage earners appropriate these agricultural income losses in the form of a 5 per cent increase in the economy-wide real wage and hence a similar increase in the share of the national income going to labour. This gain in the average wage level in the economy results as labour is released from agriculture, where its average wage is low, to sectors in which its average wage is high.[17]

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16 According to estimates from the Bank of Korea about 60 per cent of value added in Korean agriculture in the early 1980's was in the form of a return to agricultural land.

17 Much of the rewards to those engaged in agriculture are in the form of returns to agricultural land. The average wage payment per person employed in agriculture in the base economy is only about one quarter of that in other sectors.

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The taxation of Australian agriculture through assistance to Australian manufacturing

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Summary

According to a recent report published by the United States Department of Agriculture (Ballenger et al, 1987), of the 12 major agricultural producing countries Australia provides the least assistance to its agricultural sector. What these statistics do not reveal, however, is that Australian agriculture must compete for domestic resources against Australian manufacturing industries, many of which receive considerable protection from imports.

In this paper estimates are first presented of the effects of unilaterally removing assistance to Australian agriculture. These estimates are based on simulations made with the ORANI multi-sectoral model of the Australian economy. It is found that removing assistance to agriculture would cause agricultural output to decline on average by 2.5 per cent after about two years relative to what it would have been with the assistance in place. The contraction in agriculture leads to a small decline in the size of the economy. On the other hand, the revenue saved by the government through removing its assistance to agriculture results in an improvement in the public sector borrowing requirement. The international competitiveness of traded sectors is boosted from the fall in domestic prices and costs. The resultant stimulus to non-agricultural exports partially offsets the decline in agricultural exports. Aggregate imports are projected to decline owing to both the small contraction in the size of the economy and the improvement in competitiveness of the domestic import-competing sectors.

Estimates are also presented of the effects of the removal of protection from imports for Australia's manufacturing sector. The removal of this protection lowers the price to domestic purchasers, including agriculture, of imported goods. This causes switching towards imports which results in a decline in output in some of the heavily protected sectors. However, the removal of protection also lowers the consumer price index. As wages are assumed to be indexed to the consumer price index, the first round reduction in consumer prices flows into wages and hence back into further price reductions. The end result is an improvement in the competitiveness of traded activities, which includes agriculture. Agricultural output is projected to increase on average by 3.4 per cent after about two years relative to what it would have been with manufacturing protection in place. There is a small increase in aggregate employment and real GDP and, mainly as a result of the government's loss of tariff revenue, an increase in the public sector borrowing requirement. These results are of particular interest given that the Australian Prime Minister, Mr Hawke, in his address to the contracting parties of the GATT in Geneva on 22 October 1987 talked of phasing out 'all our quantitative restrictions, including tariff quotas, licensing and embargoes'.

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Finally, estimates are presented of unilaterally removing assistance to both agricultural and manufacturing industries. The key findings of this study are that this package would result in an increase in aggregate employment, an increase in real GDP, and allow the government to reduce the public sector borrowing requirement. Furthermore, the net effect is for an increase of about 1 per cent in agricultural output after about two years. Thus if assistance to manufacturing industries is taken into consideration, then Australia is actually taxing its agricultural sector.

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I Introduction

Agriculture has been for the most part exempt from the conditions contained in the General Agreement on Tariffs and Trade (GATT).[1] As a result, world agricultural trade has for decades been subject to a myriad of distortions initiated by numerous agricultural producer organizations and governments.[2] Currently, protection afforded to agricultural industries is a growing topic of interest worldwide. This mood of re-evaluation is evident in the initiative of the Cairns group, in the Davos proposal, and in the US mid 1987 proposals.[3] Partially as a result of these initiatives, agricultural trade distortions are currently being given some attention at the Uruguay Round of multilateral trade negotiations. However, some commentators (eg Carmichael, (1986) believe that reform of the international agricultural trading system is most likely to be achieved by a better understanding in each of the major agricultural producing countries of the deleterious effects at home of their own domestic trade distortions. In this paper estimates are presented of the effects of unilaterally removing assistance to Australia's agricultural and manufacturing industries.

In the case of Australia, the effects of subsidies and protection given to her agricultural and manufacturing industries is a long-standing issue which goes back at least as far as the Brigden Committee Report (1929). Rather than review the debate on protection here, the reader is referred to Edwards and Watson (1978), Lloyd (1978), and Cobb (1983). Recently this issue received much public attention in Australia when the National Farmers' Federation (1985) made a submission to the Prime Minister on farm costs. The submission stated that, from the viewpoint of farmers, protection given to Australia's manufacturing industries is easily the costliest of government interventions. Furthermore, the deleterious effects of such protection were claimed to outweigh any government benefits received in the form of fertilizer subsidies etc, by a considerable margin.[4]

To analyze the impact on Australian agriculture of removing assistance requires an economic model that captures: the larger domestic economic environment within which the Australian agricultural sector operates; the vulnerability of the agricultural sector to competi-

1 This was initially due to efforts by the United States, and then due to representations made by the Europeans at the Kennedy Round; see Dam (1970) and Rausser and Wright (1987).

2 See, for example, Ballenger, Dunmore, and Lederer (1987).

3 See Stoeckel and Cuthbertson (1987).

4 Note that Parmenter (1986) found that the National Farmers' Federation (who based part of their submission on work by Clements and Sjaastad (1985)) had actually overestimated the cost penalty of manufacturing protection. However, the revised estimate is still easily the largest item among the cost penalties suffered by farmers owing to government intervention in the economy.

tion on world markets; and the ability of agriculture to adapt its product-mix to changing circumstances. The ORANI model of the Australian economy (developed by Dixon et al,1982) is ideally suited for such an analysis.[5] ORANI characterizes the operation of the economy in a series of equations describing:

1. the demand for commodities and primary factors (labour, capital and agricultural land) by intermediate and final users;

2. the supply of commodities by domestic producers;

3. the relationship between commodity prices and the costs of production;

4. balances between commodity and factor supplies and their demands; and

5. various descriptors of the macro-economy (eg gross domestic product, the balance of trade, aggregate price indexes) built up explicitly from their micro-economic components.

The equations are derived from micro-economic assumptions about the behaviour of producers and final consumers, about technology and household preferences, and about market structures.

ORANI is a computable general equilibrium (CGE) model which represents the latest generation of structurally detailed economy-wide models. ORANI has a special multi-product treatment of industries in the agricultural sector which is probably unique among such models.[6] Another novel characteristic of agricultural sector modelling in ORANI is the treatment of the agricultural database supporting the model. The 1977-1978 database has been augmented using a time-series of data from 1967-68 to 1982-83 to reflect typical conditions in the agricultural sector. The notional typical year is interpreted for the most part as an average over a particular period; for example, the average values of shares of returns to land in gross operating surplus are imposed. However, if a significant trend was evident in a share, then the most recent in-sample trend value was imposed; this procedure was followed for example, in the case of the share of exports in total sales of live sheep.[7]

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5 Other studies which have used the ORANI model to look at the implications of protection and which report results for the agricultural sector include Dixon, Powell, and Parmenter (1979), Crowley and Martin (1982), Dixon, Parmenter, and Powell (1982), Quiggin and Stoeckel (1982), Dixon, Parmenter, Powell, and Vincent (1983), Dixon (1985), and Industries Assistance Commission (1985).

6 See Vincent, Dixon, and Powell (1980).

7 Australian agricultural production and profitability exhibits marked year-to-year variability, largely as a result of fluctuations in both climatic conditions and world prices. It is important therefore that the database of a model designed to yield policy insights, as opposed to forecasts, captures typical-year

An additional noteworthy feature of the version of ORANI used here is its inclusion of equations which describe the distribution of revenue between the public and private sectors. These additional equations comprise the ORANI National and Government Accounts module (NAGA) developed by Meagher (1983, 1984) and by Meagher and Parmenter (1985). Finally, the ORANI model is solved in a linearized form (following Johansen, 1960) using GEMPACK, a general purpose software system for CGE models developed at Impact by Pearson and Codsi (1988).[8]

The rest of the paper is organized as follows. In Section 2 a brief description is given of the various forms of assistance given to Australian agriculture and some subsidy equivalent measures of this assistance are presented. In section 3 the economic environments assumed for the ORANI simulations are defined. The results are presented in Section 4. First discussed are the short-run (two-year) effects on key macro-economic variables. Then the effects on sectoral outputs and farm incomes are studies in detail. Some concluding remarks are offered in section 5. Finally, an appendix documents some of the technical details involved with the ORANI simulations.

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features and not transient influences. For more details see Adams (1984), Higgs (1985), and Adams and Higgs (1986). Note that the non-agricultural part of the model is calibrated from the 1977-78 input-output table; see Australian Bureau of Statistics (1983) and Bruce (1985).

8 See also Pearson (forthcoming) and Agrawal and Meagher (1987). Note that the process of solving the linear equations uses the Harwell sparse matrix code; see Duff (1977).

II Assistance to Australian agriculture

The Industries Assistance Commission (IAC) has conducted two major studies of the assistance given to Australian agriculture; see IAC (1983 and 1987). These studies found that agricultural assistance is provided through a wide range of measures which increase producers' gross returns either directly by assisting output (eg domestic pricing arrangements) or indirectly by assisting the value-adding factors used in the activity (eg income tax concessions and drought relief). Assistance is also provided through schemes which reduce input costs (eg fertilizer subsidies). In this section a brief discussion is presented of the various types of assistance along with the estimates made by IAC (1987) of the assistance levels for 1984-85, the latest year for which detailed estimates are available. A description of how these different types of assistance are converted into producer subsidy equivalents is given in the Appendix.

Assistance to output

Many Australian agricultural products are assisted by one or more of the following: home consumption pricing schemes; export diversification schemes; export incentive schemes; export inspection services; government purchasing policies; import restrictions (including tariffs, quantitative trade restrictions, and quarantine restrictions); local content schemes; marketing support; price stabilization funds and underwriting arrangements; production bounties; restrictions on substitute products; and sales tax concessions on output. Estimates of the levels of output assistance given to Australian agricultural commodities are given in Table 1. Rather than discuss these in detail the reader is referred to IAC (1983 and 1987). Here we briefly expand on some of the more significant measures of output assistance.

Domestic pricing arrangements for major export commodities have been the principal form of output assistance to agricultural industries in recent years (see Table 1, column [I]). These arrangements can provide assistance to producers by maintaining domestic prices above world prices. Home consumption pricing schemes are usually administered through statutory marketing authorities, supported by restrictions placed on imports of the commodity, and are exempt from the Trade Practices Act which would otherwise declare such schemes illegal.[9]

9 See Parmenter, Sams, and Vincent (1981) for a study of the allocative effects of home-price schemes using the ORANI model.

Table 1 **Estimates of assistance given to Australian agricultural commodities***

	Commodity[a]	Assistance to output: Domestic price arrangements [I]	Assistance to output: Other assistance [II]	Assistance to value-adding factors [III]	Assistance to inputs[b] [IV]	Total assistance [I] + [II] + [III] + [IV] [V]	Value of output [VI]
A1.	Wool	0.0	27.2	57.1	8.2	92.5	2,288.5
A2.	Sheep	0.0	5.1	10.9	1.8	17.8	509.5
A3.	Wheat	43.1	4.0	46.5	14.8	108.4	2,836.9
A4.	Barley	0.0	0.4	9.2	4.6	14.2	574.5
A5.	Other cereal grains						
	Maize	0.0	0.0	0.3	0.0	0.3	38.2
	Oats	0.0	0.1	2.3	2.3	4.7	161.4
	Oilseeds	0.0	0.0	2.5	0.4	2.9	134.5
	Rice	8.4	0.0	1.6	0.1	10.1	117.9
	Sorghum	0.0	0.1	2.4	0.4	2.9	168.5
		8.4	0.2	9.1	3.2	20.9	620.5
A6.	Meat cattle	0.0	19.9	78.9	29.6	128.4	2,075.0
A7.	Milk cattle and pigs						
	Manufacture	122.5	6.5	13.2	1.2	143.4	509.6
	Market	220.0	6.6	13.6	1.2	241.4	528.8
	Pigs	0.0	0.2	5.2	-23.1	-17.7	406.1
		342.5	13.3	32.0	-20.7	367.1	1,444.5
A8.	Other farming (sugarcane, fruit and nuts)						
	Apples and pears	4.4	1.2	2.9	0.1	8.6	177.0
	Bananas	0.5	0.0	1.2	0.0	1.7	73.5
	Citrus	0.0	24.1	2.0	0.1	26.2	123.4
	Deciduous canned fruits	2.5	0.1	0.9	0.1	3.6	18.9
	Dried vine fruits	13.0	0.2	1.4	0.1	14.7	76.4
	Sugarcane	68.2	0.3	8.7	2.3	79.5	515.3
		88.6	25.9	17.1	2.7	134.3	984.5
A9.	Other farming (vegetables, cotton, oilseeds and tobacco)						
	Cotton	7.0	0.0	5.8	0.2	13.0	326.4
	Honey	0.2	0.1	0.3	0.0	0.6	21.0
	Onions	0.0	0.5	0.3	0.0	0.8	38.8
	Potatoes	0.0	10.1	1.1	0.2	11.4	136.1
	Tobacco	0.0	17.1	1.1	0.0	18.2	63.4
	Tomatoes	0.0	1.1	0.7	0.1	1.9	80.2
	Other vegetables	0.0	1.6	1.0	0.2	2.8	119.2
		7.2	30.5	10.3	0.7	48.7	785.1
A10.	Poultry						
	Eggs	24.8	0.1	2.7	-8.2	19.4	233.6
	Poultry	0.0	0.0	8.9	-25.0	-16.1	510.3
		24.8	0.1	11.6	-33.2	3.3	743.9
Total		514.6	126.6	282.7	11.7	935.6	12,862.9

Source: Industries Assistance Commission (1987).

a For a detailed description of the subcategories of the ORANI agricultural commodity classifications see Higgs (1986, Table 1.2).

b Note that this excludes tariffs on materials and capital, which act as a negative form of assistance.

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The other major form of output assistance is marketing support. The Australian government assists in the promotion of agricultural products. The largest grants in this category have been to wool.

Assistance to value-adding factors

Australian agricultural producers may be assisted by one or more of the following: adjustment assistance; agricultural extension services; agricultural research; concessional credit; income taxation concessions; income equalization deposits; and natural disaster relief. Again these are only briefly discussed here. Adjustment assistance and concessional credit both refer to schemes whereby finance is made available to farmers at subsidized interest rates. Extension services are agricultural advisory services which, along with agricultural research, are supported by government funds. Significant income tax concessions are available to primary producers which are not available to other taxpayers. The three main tax concessions are: (1) the ability to depreciate certain capital items not depreciable for most commercial taxpayers, or to depreciate certain capital items at higher than scheduled rates; (2) the ability to defer certain income to subsequent financial years; and (3) tax averaging. Finally, direct assistance in the form of grants or concessional loans may be made available in the event of natural disasters such as cyclones, floods, bushfires, and droughts.

Assistance to inputs

Assistance is given to inputs to the agricultural industries in the form of: disease control; fertilizer subsidies; and sales tax concessions. The value of such assistance is relatively small, the most significant items being subsidies for the input of phosphatic and nitrogenous fertilizers.

III Assumed economic environment

Certain features of the economy are not projected endogenously by ORANI. For these, the user of the model must specify an environment before computing a solution. In other words, there are more variables than equations in the model; therefore, the user must set values for some of the variables exogenously so that the number of unknown variables equals the number of equations.

The key features of the economic environment are as follows.[10] It is assumed that there are no shortages of labour at the going real wage rates.[11] Thus employment levels are demand determined. It is assumed that plant and equipment in use in every industry do not change (from the levels they otherwise would have reached) because of the shock under analysis (ie industry capital stocks in use are exogenous). Note that the short-run time period simulated allows for revisions in all industries' investment plans, for orders for capital goods to be placed and met, and for the new plant and equipment to be installed (but not yet switched on). The length of the short run in ORANI has been estimated by Cooper (1983) as 7.9 quarters. In policy work 'about two years' is the appropriate level of precision for describing the ORANI 'short run'. Next, the ORANI model does not distinguish between changes in the relative prices of traded and non-traded goods brought about on the one hand by a change in the nominal exchange rate, or on the other hand by a change in the domestic price level. Here it is assumed that induced changes in the real exchange rate appear as changes in the domestic price level. In other words, the nominal exchange rate is the numeraire. Finally, it is assumed that both tax rates and real government expenditure are exogenous and, with the exception of tariffs, set to zero change. Thus if a shock leads to an increase in real government income, then, under these assumptions, there will be a fall in the real public sector borrowing requirement.

10 A complete list of the variables selected as exogenous is given in Table A1.

11 That is the percentage change in the pre-tax wage rate is exogenous and set equal to the percentage change in the CPI.

IV Effects of the removal of assistance to Australian agricultural and manufacturing industries

In this section we discuss the results of ORANI simulations of the effects of the removal of assistance to Australian agricultural and manufacturing industries. To simulate the effects of the removal of assistance to agriculture, the input costs of the agricultural industries were increased to the extent of estimated producer subsidy equivalents.[12] Where the subsidy is in the form of home consumption pricing schemes, the prices of some key downstream sales were adjusted to capture the appropriate fall in agricultural prices that would occur if these schemes were disbanded. To simulate the effects of the removal of assistance to manufacturing industries, the nominal rates of protection for Australian manufacturing industries for 1986-87 were removed.[13] These are estimates of the extent to which tariff and quota protection raised the domestic prices of imported goods.

Macro-economic projections

The short-run effects of the removal of assistance to agricultural and manufacturing industries on some nominal aggregates are given in Table 2. The table also gives the reader a feel for the size of the Australian economy. The estimated impacts on the macro-economic aggregates reported in Table 2 can be used to study the effects of removing trade distortions in terms of the sectoral balances identity. The latter may be written:

$$(E - M) \quad (S - I) + (T - G) \; ; \qquad (1)$$

where E and M respectively are exports and imports; S and I respectively are private savings and private investment; and T and G respectively are government income and government expenditure. Equation (1) says that if Australia absorbs more resources than it produces (ie if I exceeds S, and/or if G exceeds T) then the balance of trade must move towards deficit. The first thing to note is that in the base period the data satisfies the sectoral balances identity. This can be checked by substituting the appropriate values from the first column of Table 2 into equation (1).

12 For the technical details see Appendix.

13 The nominal rates are listed in Table A2. See also Parmenter (1977) and Lawson (1984) for a description of how the tariff rates are calculated in ORANI, and Chai and Dixon (1985) for the estimation of the average rates of protection.

Table 2 **Projections for some nominal aggregates***

Variable		Base period $m 1984-85 prices	Projected change in $m: Removal of subsidy equivalents to the agricultural sector [I]	Removal of protection from imports for the manufacturing sector [II]	[I] + [II] [III]
(E)	Exports	34,148	-626	1,839	1,213
(M)	Imports	39,005	-326	2,440	2,114
(C)	Private consumption	125,967	-1,551	-4,615	-6,166
(I)	Private investment	36,499	-390	1,707	-2,097
(G)	Government expenditure[a]	52,136	-524	-2,463	-2,987
(G*)	Government outlays[b]	86,535	-1,163	-4,198	-5,361
(T)	Government income	71,417	-919	-4,400	-5,319
(PSBR)	Public sector borrowing requirement[c]	15,118	-244	202	-42
(S)	Private savings	12,361	-295	-371	-665
(Y)	Gross Domestic Product	209,745	-2,765[d]	-9,386[d]	-12,150[d]

* Note that columns I, II and III contain the dollar values of deviations from control expected to occur about 2 year after the imposition of the shocks. These deviations reflect both price and quantity effects. Hence the dollar amounts in these columns correspond to the thought experiment in which, in the absence of the shock(s), the aggregate values of the variables are arbitrarily scaled to their 1984-85 values; the deviations from these values depend partly on the fact that the shock(s) are expected to be deflationary (ie to make prices lower than they would otherwise have been), and partly on quantity effects. The key price and quantity effects are shown in Table 3.

a This refers to government consumption plus government investment.

b This refers to all government outlays including government expenditures and transfer payments.

c Note that PSBR = G*-T, which in turn equals the negative of government savings.

d Note that these negative entries do not necessarily indicate falls in real magnitudes; see Table 3.

Removal of agricultural assistance

The projected changes in terms of millions of Australian dollars at 1984-85 prices due to the removal of subsidy equivalents to the agricultural sector are given in column [I] of Table 2. These results can be explained as follows. The removal of the subsidy equivalents has an impact effect of causing a contraction in the agricultural sector. As agriculture is a significant export sector, the contraction in agriculture results in a decline in exports. In terms of equation (1), this corresponds to a fall in E. The revenue saved by the government through removing its assistance to agriculture is assumed not to be redistributed, rather it shows up here as an improvement in the public sector borrowing requirement (PSBR). As a result, the contraction in the agricultural sector leads to a decline in the nominal (and, as we shall see, also the real) size of the economy. This tends to cause a reduction in imports, M. However,

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before any conclusions can be reached about the final impact on the balance of trade we must study the effect on relative prices.

Table 3 contains projections for some key price indices and real macro-economic variables. As simulated here, the removal of assistance to agriculture is deflationary owing to both the removal of the home consumption pricing schemes and the contraction in the size of the economy. All of the price indices in column [I] of Table 3 are projected to fall. The consumer price index (CPI) is projected to fall the most; this is due to the removal of the home consumption pricing schemes for agricultural products which have larger weights in the CPI relative to the other price indices. As wages are assumed to be fully indexed to the CPI, the fall in the CPI causes a fall in nominal wages. This in turn improves the competitiveness of the internationally traded sectors. This improvement in competitiveness partially offsets the decline in aggregate exports brought about by the contraction in agriculture. Aggregate imports are projected to decline owing to both the contraction in the size of the economy and the improvement in competitiveness of the domestic import-competing sectors. However, the decline in exports dominates and the balance of trade (ie E-M) moves $300m (1984-85 prices) towards deficit. As the economy is absorbing more resources than it produces we would expect either I to exceed S, and/or G to exceed T.

Next we look at the effects on government income and expenditure. As government expenditure is assumed to remain constant in real terms, nominal government expenditure falls by $524m (1984-85 prices). However the income collected by the government also falls, in this case by $919m. On balance (T-G) is projected to decline by $395m. This exceeds the above fall in the balance of trade by $95m. Thus we would expect (S-I) to increase by $95m.

It is assumed that the percentage change in real private investment is equal to the percentage change in real disposable income. As the size of the economy declines this tends to cause a fall in real disposable income and hence in real private investment; see Table 3, column [I]. It can be seen from column [I] of Table 2 that nominal private investment falls by $390m (1984-85 prices), which is $95m more than the projected fall in private savings.

Finally, real GDP and aggregate employment are both projected to decline slightly if assistance to agriculture is removed; see Table 3, column [I]. These results largely follow from our assumption that the revenue saved by the government is used to reduce the PSBR rather than being redistributed via, say, tax cuts. The PSBR is projected to decline by $244m (1984-85 prices). The real wage rate as a cost to employers of labour (ie the pre-tax wage

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Table 3 Macro-economic Projections*

Variable	Removal of subsidy equivalents to the agricultural sector [I]	Removal of protection from imports for the manufacturing sector [II]	[I] + [II] [III]
Consumer Price Index (CPI)	-1.0	-4.8	-5.8
Investment Price Index (IPI)	-0.9	-5.8	-6.7
Government Price Index (GPI)	-1.0	-4.8	-5.7
Factor-cost GDP deflator (FCGDP)	-0.9	-4.6	-5.5
Aggregate exports (foreign currency value)	-1.8	5.4	3.6
Aggregate imports (foreign currency value)	-0.8	6.3	5.4
Balance of trade	-0.1	-0.3	-0.4
Real private consumption	-0.2	1.1	0.9
Real private investment	-0.2	1.1	0.9
Real GDP[a]	-0.4	0.7	0.3
Aggregate employment[b]	-0.5	0.9	0.4
Real pre-tax wage rate (FCGDP deflated)	-0.1	-0.2	-0.3
Government expenditure[c]	-1.0	-4.7	-5.7
Government outlays[d]	-1.3	-4.9	-6.2
Government income	-1.3	-6.2	-7.5
Public sector borrowing requirement[e]	-1.6	1.3	-0.3

* All projections, with the exception of the balance of trade, are percentage deviations from the value the variable in question would have taken in the absence of the shock at the head of the column. The balance of trade, while also a deviation from control, is expressed as the change in the balace of trade divided by the base-period GDP.

a Real GDP is calculated here as a weighted sum of industry output responses using value-added weights.

b This is calculated by weighting the employment by occupation projections by persons weights.

c This refers to government consumption plus government investment.

d This refers to all government outlays including government expenditures and transfer payments.

e This is equal to government outlays less government income.

rate factor-cost GDP deflated) is projected to fall slightly. This stimulates employment and so partially offsets the decline in aggregate employment brought about by the contraction in the real size of the economy.

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Removal of manufacturing protection

We now examine the projected changes due to the removal of protection from imports for the manufacturing sector. The removal of tariffs has an impact effect of lowering the price to domestic purchasers of imported goods. Thus imports will increase as domestic purchasers switch towards the now cheaper imported goods. Furthermore, the fall in import prices causes a decline in the CPI. As wages are assumed to be fully indexed to the CPI, the decrease in the CPI flows on into wages and then back into further price reductions etc. The end result is a 4.8 per cent decrease in the CPI. The other price indices in column [II] of Table 3 are also projected to decrease, with the largest decline occurring in the investment price index (IPI). The IPI is projected to decline slightly more because of its relatively heavier weights for imported investment goods whose prices are projected to fall significantly if nominal rates of protection are removed. The falls in these price indices improve the competitiveness of the traded sectors. This tends partially to offset the above increase in imports. However the removal of protection for manufacturing also causes an expansion in the size of the economy which causes an increase in imports. On balance, aggregate imports are projected to increase by $2440m (1984-85 prices). Aggregate exports are projected to increase by $1839m owing to the improvement in competitiveness. The increase in imports exceeds the increase in exports and the balance of trade is projected to move $601m towards deficit.[14]

The deflationary effect of the tariff cut means that nominal government expenditure (which is assumed to remain constant in real terms) falls by $2463m (1984-85 prices). Government income is also projected to fall, in part due to the loss of tariff revenue, by $4400m.[15] On balance (T-G) is projected to decline by $1937m. This exceeds the above fall in the balance of trade by $1336m. Thus we expect (S-I) to increase by $1336m.

The removal of manufacturing protection causes a small increase in real consumption and investment; see Table 3, column [II]. Under our closure of the model, this would tend to increase nominal investment. However, the fall in the IPI (see Table 3, column [II]) dominates and nominal investment is projected to decline by $1707m (1984-85 prices). Finally, private savings is projected to fall by $371m. Thus (S-I) increases by the expected $1336m.

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14 This result is at variance with ORANI results in which the closure holds real absorption constant (eg Dixon, Parmenter, Sutton, and Vincent (1982, chapter 7)). In the simulations reported here, the expansions in consumption and investment lead to the increase in imports outstripping the increase in exports.

15 Note that this is only a rough estimate of the effect of the tariff cut on government income. This is due to the tension between the 1986-87 tariff rates which are used to shock relative prices and the implicit tariff rates in the NAGA module. However, as the tariff equivalents of quotas are relatively insignificant in 1986-87 due to the depreciation of the Australian dollar, the tension is less than it would otherwise have been.

The removal of protection from imports for the manufacturing sector causes a small increase in aggregate employment and real GDP; see Table 3, column [II]. On the other hand, as simulated here, it also causes an increase in the PSBR.

The combined effect

Column [III] of Tables 2 and 3 shows the total effect of the removal of assistance to agricultural and manufacturing industries. Note that as the model is solved as a linear system, the total effect is simply given by the addition of columns [I] and [II]. It can be seen from Table 3 that the total package is projected to cause a fall in domestic price indices. Both aggregate exports and aggregate imports are projected to increase, with a small decline in the balance of trade. However, real aggregate consumption and investment are projected to increase slightly, as are real GDP and aggregate employment. Furthermore, a small decrease in the PSBR is projected if assistance to both agricultural and manufacturing industries is removed.

Sectoral output projections

The short-run effects of the removal of assistance on industry outputs are given in Table 4. The industries have been divided into four broadly defined groups: export, export-related, import-competing, and non-traded.

Removal of agricultural assistance

It can be seen from Table 4, column [I] that, not surprisingly, the agricultural sector is projected to decline if its levels of assistance are removed. (The results for each of the individual agricultural industries are discussed in detail in the next section.) The resulting increase in agricultural prices causes a decline in the outputs of the agricultural processing industries, meat products, other food products and cotton ginning, wool scouring and top making. As the removal of the subsidies is deflationary the international competitiveness of the industries in the mining sector improves. Thus we observe projected increases in the outputs of the mineral export industries. With the exceptions of services to mining and water transport, all of the export-related industries are projected to decline in output. This is largely caused by reduced demand from agriculture for their products or services. The next group of industries compete (to varying extents) with imports. Even though these industries are now slightly more competitive, given the projected fall in domestic costs, they are projected on average to experience a small decline in output. This is due to the contraction in the size of the economy. Note that the Milk Products industry experiences an increase in output. This is

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Table 4 **Sectoral output projections***

Industry		Removal of subsidy equivalents to the agricultural sector [I]	Removal of protection from imports for the manufacturing sector [II]	[I] + [II] [III]
Export				
1-8	Agriculture[a]	-2.5	3.4	0.9
12	Ferrous metal ores	-0.7	3.8	4.5
13	Non-ferrous metal ores	1.0	4.9	5.9
14	Black coal	1.2	6.0	7.3
18	Meat products	-3.4	6.0	2.6
25	Other food products	-10.6	11.0	0.5
30	Cotton ginning, wool scouring and top making	-1.7	2.3	0.6
64	Non-ferrous metals	1.2	5.9	7.1
Export related				
9	Services to agriculture	-2.4	2.8	0.4
11	Fishing and hunting	-1.0	1.5	0.5
16	Other minerals	-0.0	1.1	1.1
17	Services to mining nec	3.2	1.9	5.1
49	Chemical fertilizers	-2.2	3.3	1.1
70	Railway rollingstock	-0.1	1.3	1.2
76	Agricultural machinery	-17.5	20.7	3.1
93	Road transport	-0.7	1.3	0.6
94	Rail and other transport	-0.4	1.8	1.5
95	Water transport	0.0	1.4	1.4
Import-competing				
19	Milk products	0.8	-0.5	0.4
20	Fruit and vegetable products	-0.4	0.1	-0.3
21	Margarine, oils and fats nec	-0.5	0.2	-0.3
22	Flour and cereal products	-0.5	0.7	0.2
23	Bread, cakes, biscuits	-0.1	0.2	0.2
24	Confectionery and coca	0.1	-0.8	-0.7
28	Other alcholic beverages	-0.7	-2.8	-3.4
29	Tobacco products	-0.1	0.6	0.5
31	Man-made fibres yarns	1.4	-29.2	-27.8
32	Cotton yarns, fabrics	1.1	-22.3	-21.3
33	Wool, worsted fabrics	0.0	-5.5	-5.5
34	Textile finishing	0.1	-4.7	-4.6
35	Textile floor coverings	0.0	-5.0	-5.0
36	Other textile products	-0.2	-1.3	-1.5
37	Knitting mills	0.2	-10.1	-9.9
38	Clothing	0.2	-8.4	-8.2
39	Footwear	0.8	-40.1	-39.3
40	Sawmill products	0.2	0.5	0.7
41	Veneers and wood boards	0.1	-1.4	-1.3
42	Joinery and wood products nec	0.1	-0.0	0.0
43	Furniture and mattresses	0.2	-0.9	-0.8

continued

Table 4 (continued)

Industry		Removal of subsidy equivalents to the agricultural sector [I]	Removal of protection from imports for the manufacturing sector [II]	[I] + [II] [III]
44	Pulp, paper, paperboard	-0.1	-0.7	-0.8
45	Bags and containers	-0.9	0.9	0.0
46	Paper products nec	-0.3	-0.9	-1.2
47	Newspapers and books	-0.0	1.2	1.2
48	Commercial printing	-0.3	0.4	0.1
50	Other basic chemicals	0.4	-4.3	-3.9
51	Paints, varnishes	0.1	-2.3	-2.2
52	Pharmaceutical goods	-0.5	1.2	0.7
53	Soap and detergents	-0.3	0.4	0.1
54	Cosmetics and toiletries	-0.0	0.7	0.7
55	Other chemical goods	0.1	-0.9	-0.9
56	Petrol and coal products	-0.3	1.0	0.6
57	Glass and glass produts	-0.0	-0.6	-0.6
58	Clay products, refactories	-0.0	1.3	1.3
62	Non-metallic mineral products	-0.1	0.7	0.6
63	Basic iron and steel	0.0	-1.1	-1.1
65	Structural metal products	-0.0	0.5	0.5
66	Sheet metal products	-0.4	0.2	-0.2
67	Other metal products	0.4	-3.5	-3.1
68	Motor vehicles and parts	0.7	-13.2	-12.5
69	Ships and boats	1.3	-1.1	0.2
71	Aircraft	1.0	0.7	1.7
72	Scientific equipment	0.0	0.8	0.8
73	Electronic equipment	0.6	-4.1	-3.6
74	Household appliances	-0.2	-1.2	-1.4
75	Other electrical goods	0.8	-2.0	-1.2
77	Construction machinery	2.3	-1.2	1.2
78	Other machinery	0.8	-1.1	-0.3
79	Leather products	0.3	-15.7	-15.4
80	Rubber products	0.1	-4.0	-3.9
81	Plastic products	-0.3	-3.1	-3.4
82	Signs, writing equipment	0.1	-1.2	-1.2
83	Other manufacturing	0.2	-2.2	-2.0
Non-traded				
10	Forestry and logging	2.6	-2.1	0.5
15	Oil, gas and brown coal	0.1	0.4	0.5
26	Soft drinks, cordials	-0.2	0.3	0.1
27	Beer and malt	-0.1	0.9	0.7
59	Cement	-0.2	1.1	0.9
60	Ready mixed concrete	-0.3	1.0	0.8
61	Concrete products	-0.2	1.0	0.8
84	Electricity	-0.2	0.8	0.6
85	Gas	-0.2	0.2	0.1
86	Water, sewerage, drainage	-0.3	0.6	0.3

continued

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Table 4 (continued)

Industry		Removal of subsidy equivalents to the agricultural sector [I]	Removal of protection from imports for the manufacturing sector [II]	[I] + [II] [III]
87	Residential building	-0.2	1.0	0.8
88	Other construction	-0.3	1.1	0.8
89	Wholesale trade	-0.8	1.2	0.4
90	Retail trade	-0.2	1.3	1.1
91	Mechanical repairs	-0.3	1.6	1.3
92	Other repairs	-0.3	1.7	1.4
96	Air transport	-0.1	2.0	1.9
97	Communication	-0.3	0.9	0.6
98	Banking	-0.2	0.6	0.4
99	Non-bank finance	-0.2	0.6	0.4
100	Investment and services	-0.2	0.5	0.3
101	Insurance	-0.2	1.2	1.0
102	Other business services	-0.3	0.8	0.4
103	Ownership of dwellings	0.0	0.0	0.0
104	Public administration	-0.1	0.1	0.1
105	Defence	0.0	0.0	0.0
106	Health	-0.1	0.9	0.8
107	Education, libraries	-0.0	0.1	0.1
108	Welfare services	-0.1	0.6	0.5
109	Entertainment, leisure	-0.3	1.1	0.8
110	Restaurants, hotels	-0.2	1.3	1.0
111	Personal dervices	-0.2	1.3	1.1
112	Non-competing imports	-0.0	-0.0	-0.0

* All projections are percentage deviations from what the output of the sector would have been in the absence of the shock at the head of the column.

a The agricultural sector's results are disaggregated in Table 5.

due to the dismantling of the home consumption pricing scheme for milk. The final group of industries are classified as non-traded. These industries do not have any real scope for replacing imports and therefore, with a few exceptions, they experience declines in output. Note that industries which sell mainly to the government sector (104-108) do worse than average because of the fall in real government spending (Table 3).

Removal of manufacturing protection

Column [II] of Table 4 shows the sectoral effects of the removal of protection for manufacturing industries. Recall from Table 2 that the removal of protection is deflationary, and so improves the competitiveness of the traded sectors. As a result, all of the export and export-

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related industries are projected to experience an increase in output. Overall the import-competing industries decline owing to the removal of their protection from imports. This is particularly true for industries 31-39 (which constitute the textiles, clothing, and footwear sector) and industry 68, the motor vehicles and parts industry. Note that some of the import-competing industries actually benefit from the across-the-board removal of protection. This is due first of all to their improved competitiveness via the lowering of domestic costs; second, to the increase in real absorption; and third, to their links (where applicable) to the export sector. The non-traded industries in general experience a small increase in output due to the removal of protection. These industries largely benefit from the increase in real consumption and investment that occurs.

The combined effect

Column [III] of the table shows the total effect of the removal of assistance to agricultural and manufacturing industries. All of the export (including agricultural) and export-related industries benefit from the total package. The big losers are the textiles, clothing, and footwear sector and the motor vehicles and parts industry. On average, relatively small increases are projected for the non-traded industries.

Agricultural output projections

The short-run effects of the removal of assistance on agricultural industry outputs are given in Table 5. It can be seen from column [I] of the table that all the agricultural industries are projected to experience declines in output if the subsidies to agriculture are removed. The differential responses between the industries can be explained using the ORANI short-run supply function, which for industry j can be written:[16]

$$z_j = \lambda_j(p_j - \psi_j) \quad ; \tag{2}$$

where

$$\lambda_j = \sigma(1 - S_{Fj})/(S_{Fj}H_{Xj}) \quad . \tag{3}$$

In these equations the percentage change in industry j's output is represented by z_j; p_j is the percentage change in the farm-gate price of industry j's output (this is an appropriately weighted index for the multi-product industries); ψ_j is the percentage change in an index of

16 See Higgs (1986, Appendix A.2) for the derivations of equations (2) and (3).

Table 5 **Agricultural output projections***

	Industry	Removal of subsidy equivalents to the agricultural sector [I]	Removal of protection from imports for the manufacturing sector [II]	[I] + [II] [III]
1	Pastoral zone	-1.6	3.1	1.5
2	Wheat-sheep zone	-1.3	2.7	2.8
3	High rainfall zone	-2.1	3.9	1.7
4	Northern beef	-4.0	6.3	2.4
5	Milk cattle and pigs	-1.2	1.8	0.6
6	Other farming (sugarcane, fruit and nuts)	-6.8	6.4	-0.3
7	Other farming (vegetables, cotton, oilseeds and tobacco)	-2.5	1.8	-0.7
8	Poultry	-1.8	3.2	1.4
	Agriculture	-2.5	3.4	0.9

* All projections are percentage deviations from what the industry outputs would have been in the absence of the shock at the head of the column.

costs to industry j; σ is the elasticity of substitution between primary factors (assumed to be 0.5 for all industries in the short run); S_{Fj} is the share of the fixed factors in industry j's primary-factor inputs; and H_{Xj} is the share of primary-factor inputs in industry j's total costs.

Equation (2) suggests that we need look only at three influences to determine an industry's output response. The first is λ_j which, according to equation (3), is determined by base-period shares and an elasticity. The second is the change in the industry output price, and the third is an index of costs. The greater the fixed-factor share, S_{Fj}, and the primary-factor share, H_{Xj}, the less responsive is the industry (ie the smaller is λ_j). For the three zonal industries the λ_j's are as follows: $\lambda_1 = 0.75$, $\lambda_2 = 0.57$, and $\lambda_3 = 0.92$. Thus, given equal changes in output prices over costs, of the zonal industries we would expect the high rainfall zone (j = 3) to be the most responsive, followed by the pastoral zone (j = 1), and finally by the wheat-sheep zone (j = 2).

Removal of agricultural assistance

The subsidies to the pastoral, wheat-sheep, and high rainfall zones, as a percentage of total costs are, respectively, 4.32 per cent, 4.55 per cent, and 4.90 per cent. Thus the changes in costs to the zonal industries (ψ_j) due to the removal of these subsidies are fairly similar.

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Furthermore, as the zonal industries' output is largely sold as exports, and as the export demand schedules faced are fairly flat, these industries will be unable to pass on the cost increases induced by the removal of the subsidies to any significant extent. As a result the changes in output prices (p_j) will be small and roughly equal for each of the zones. Consequently, the changes in the price-cost ratios (p_j - ψ_j) will not differ greatly between zones. Hence the relative responses suggested by the λ_j's are indeed evident in the projections listed in column [I] of Table 5. Finally, if we make the crude approximations (for the purpose of this back-of-the-envelope calculation) that the output price of, say, the pastoral zone did not change (ie $p_1 = 0$) and that this industry's costs increased by just the direct effect of its *own* subsidy removal (ie $\psi_1 = 4.32$), then according to equation (2) the output of the pastoral zone would decline by roughly 3 per cent (ie $0.75 \times (0 - 4.32)$), whereas the projected decline is 1.6 per cent. The main reason for the back-of-the-envelope approach overestimating the decline is its failure to account for the second-round effects on costs due to the fall in the CPI and hence in nominal wages.

The Northern beef industry produces only meat cattle which is largely exported after being processed by the meat products industry. As a result, it is not generally true that the price of unprocessed meat is determined solely on world markets. However as processing costs are not projected to change significantly here, it turns out that the price of meat cattle only changes by -0.9 per cent. The subsidy to the Northern beef industry as a percentage of total costs is equal to 6.19 per cent. The λ_j for the Northern beef industry is equal to 0.67. If we again make the assumption that this industry's costs increased by just its *own* subsidy removal, then according to equation (2) the output of the Northern beef industry would decrease by roughly 4.75 per cent (ie $0.67 \times (-0.9 - 6.19)$), whereas the projected decline is 4.0 per cent. The back-of-the-envelope approach again slightly over-estimates the decline due to its failure to account for second-round effects on costs.

The subsidy to the milk cattle and pigs industry is equal to 24.25 per cent of the total costs of the industry. As a percentage of total costs this is by far the largest subsidy to the agricultural industries. However, the output of the milk Cattle and pigs industry is projected to decline by only 1.2 per cent when the subsidies are removed. This is because milk cattle and pigs sells primarily to the domestic market and can pass on nearly all of the cost increase. In fact the price of the commodity milk cattle and pigs is projected to increase by 24.2 per cent. The λ_j for the milk cattle and pigs industry is equal to 1.11. As 93 per cent of the output of the milk cattle and pigs industry consists of the commodity 'milk cattle and pigs', we could reckon that this industry's output price increased by about 22.5 per cent (ie 0.93×24.2). Furthermore, if we assumed that its costs increased by 24.3 per cent, then according to equation (2), the output of the milk cattle and pigs industry would decline by roughly 2 per cent (ie $1.11 \times (22.5 - 24.25)$). This is about double the actual projection – the difference

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once again is due to second-round effects under which nominal wages are reduced because of the fall in the CPI.

The largest percentage decline in output occurs in the other farming (sugarcane, fruit and nuts) industry. The subsidy to this industry is equal to 13.64 per cent of its total costs. This represents the second largest subsidy as a percentage of total costs to an agricultural industry. However, unlike the milk cattle and pigs industry, which receives the largest subsidy, roughly half of the output of the other farming industry is exported after being sent to a food processing sector. Thus the other farming industry is unable to pass on all the cost increases it would incur if the subsidies given to it were removed. As a result it is projected to experience a 6.8 per cent decline in output if the agricultural subsidies are removed.[17]

The other farming (vegetables, cotton, oilseeds, and tobacco) industry sells to a number of sectors of the economy. If the subsidies are removed, then this industry is projected to decline by 2.5 per cent. This is partially due to the decline in real consumption; see Table 2, column [I].[18]

The last agricultural industry to be discussed is poultry. Although the subsidy to the poultry industry is only equal to 0.44 per cent of total costs to the industry, the removal of agricultural subsidies is projected to cause a decline of 1.8 per cent in the poultry industry. This can be explained as follows. The poultry industry sells about half of its output to the export-oriented meat products sector. The decline in the output of the poultry industry is largely due to the contraction in the meat products sector.[19]

Removal of manufacturing protection

Column [II] of Table 5 shows the effects on agricultural outputs of removing protection from the manufacturing sector. All of the agricultural industries are projected to experience an increase in output. However, the benefits to the agricultural sector are not uniform across the agricultural industries. The differential responses between the industries can again be explained by making reference to equation (2). First we make the approximation that the change in costs to the agricultural industries is equal to the change in the factor-cost GDP deflator of -4.6 per cent; see Table 2, column [II]. (In other words, we assume that λ_j is equal to -4.6 for j = 1,..., 8.) Next we assume (for the purpose of this back-of-the-envelope calcu-

17 Note that $\lambda_6 = 1.65$.

18 Note that $\lambda_7 = 3.09$ and the subsidy to the other farming (vegetables, cotton, oilseeds, and tobacco) industry is equal to 6.20 per cent of its total costs.

19 The meat products industry is modelled as using unprocessed meat inputs in fixed proportions. Note that $\lambda_8 = 2.97$.

lation) that the output prices of the zonal industries do not change (eg for the pastoral zone, $p_1 = 0$). Thus according to equation (2), the output of the Pastoral Zone will increase by about 3 per cent (ie $0.75 \times (0 - -4.6)$) which is in agreement with the projected increase of 3.1 per cent. The projections for the wheat-sheep and high rainfall zones can be explained in a similar fashion.

The Northern beef and other farming sugarcane, fruit, and nuts) industries benefit the most from the removal of protection to the manufacturing industries. As mentioned above, both of these industries sell a significant amount of their output to food processing sectors which then export their produce. The reduction in domestic costs, especially wages, improves the competitiveness of the food processing sectors, which in turn results in significant gains to the agricultural producers.

The milk cattle and pigs industry and the other farming, vegetables, cotton, oilseeds, and tobacco) industry both sell largely to the domestic market. These industries benefit from the projected increase in real consumption. They also sell a small percentage of their output to the processing industries which are stimulated by the reduction in domestic costs. As a result these industries are only projected to experience relatively small increases in output. Finally, the poultry industry is projected to experience a 4.4 per cent increase in output. This is largely due to increased demand from the meat products sector.

The combined effect

It can be seen from column [III] of Table 5 that, with the exceptions of small declines in the two Other Farming industries, the agricultural industries are projected to experience a net increase in output if assistance to both agricultural and manufacturing industries is removed.

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V Conclusion

It was shown in this paper that the net effect of removing assistance to both agricultural and manufacturing industries on the agricultural sector would be for an increase in farm output. Thus on balance, Australia is actually taxing its agricultural sector with its current set of trade distortions. On the other hand, the net effect is for a decline in output in some of the import-competing sectors. Of note are the declines projected for the textiles, clothing and footwear sector and the motor vehicle and parts industry.

In future research this study could be extended in a number of areas. Not all distortions that affect trade have been removed here. For example, distortions in the area of transport can have a significant effect on agricultural exports, however, we have not studied these. Furthermore, the net benefits from reducing agricultural assistance are underestimated, to the extent that the reduction would be associated with the rationalization of some agricultural industries via the removal of cumbersome government regulations.

Finally, the results presented in this paper may be of particular interest given the following statement made by Australia's Prime Minister, Mr Hawke, in an address to the contracting parties of the GATT in Geneva on 22 October 1987:

> We are prepared to negotiate a broad package of measures to reduce overall levels of effective assistance to Australian industry – including tariffs – as part of a broad-based multilateral approach. In this context, we are prepared to eliminate, over an appropriate implementation phase, all quantitative import measures designed to protect domestic industry. This means we would phase-out all our quantitative restrictions, including tariff quotas, licensing and embargoes. This is a radical approach – but it is the kind of radical approach necessary to provide the world with its best chance to capture fully the potential gains from trade.

Appendix

This appendix contains three sections. The first documents the closure and the nominal rates of protection used for the ORANI simulations. The second describes the method used to calculate the size of the exogenous shocks when simulating the removal of assistance to agriculture. The third section describes how the public sector borrowing requirement projections were corrected for flows not captured by the NAGA model. All of these sections are essential for the reproducibility of the results presented in this paper.

Closure and nominal rates of protection

The set of exogenous variables chosen for the ORANI simulations is defined in Table A1 in terms of the notation used by Dixon, Parmenter, Sutton, and Vincent (1982) and Meagher and Parmenter (1985). The input-output and elasticities files as documented in Bruce (1985) were used for this study. The values for the user-specified indexation parameters that were assumed are as in Higgs (1986, Table A1.2).

Table A2 shows the nominal rates of protection for Australian manufacturing industries for 1986-87. These are estimates of the extent to which tariff and quota protection raised the domestic prices of imported products. For example, the nominal rate of protection for motor vehicles is 27.10 per cent. Thus in 1986-87 an imported car costing $10,000 at the port of Melbourne would cost $12,710 by the time it cleared customs.

Calculation of the exogenous shocks when simulating the removal of assistance to agriculture

In this section we first estimate the producer subsidy equivalents of the assistance given to Australian agriculture. The magnitudes of some 'correction' shocks are then calculated to appropriately capture the price effects when the home consumption pricing schemes are removed.

Subsidy equivalent measures

Recall from Table 1, column [IV] that the IAC has made estimates of the total level of assistance given to agricultural commodities in 1984-85. To simulate the effects of the removal of

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Table A1 **The set of exogenous variables for the ORANI simulations**

Exogenous variable	Subscript range	Number	Description
ORANI variables[a]			
pm_{i2}	$i = 1, \ldots, g.$	g	Cif foreign currency import prices
t(i2,0), v(i2,0)	$i = 1, \ldots, g.$	2g	Tariff terms
t(is,jk), v(is,jk)	$i = 1, \ldots, g,$ $s, k = 1, 2,$ $j = 1, \ldots, h$	8g	Ad valorem and specific sales-tax terms
t(is,3), v(is,3)	$i = 1, \ldots, g.$ $s = 1, 2.$	4g	
v(i1,4)	$i \in G.$[b]	g	Selection of specific export-tax terms and complementary selection of export volumes
$x^{(4)}_{(i1)}$	$i \in G.$		
t(i1,4)	$i = 1, \ldots, g.$	g	Ad valorem export tax terms
a's (excluding a(j))	subscript ranges can be read from Table 23.2 in DPSV	$4g^2h + 5g^2 + 7gh + Mh + 8h + 3g + \sum_{j=1}^{h} N(j)$	Technological changes and changes in household preferences
$k_j(0)$	$j = 1, \ldots, h.$	h	Current capital stocks
n_j	$j = 1, \ldots, h.$	h	Use of agricultural land in each industry
$f^{(1)}_{(g+1,1)}$		1	Wage shift variables
$f^{(1)}_{(g+1,1,m)}$	$m = 1, \ldots, m.$	M	
$f^{(1)}_{(g+1,1)j}$	$j = 1, \ldots, h.$	h	
$f^{(1)}_{(g+1,1,m)j}$	$m = 1, \ldots, M.$ $j = 1, \ldots, h.$	Mh	
$f^{(5)}_{(is)}$	$i = 1, \ldots, g.$ $s = 1,2.$	2g	'Other' demand shift terms
$f^{(2)}_{j}$	$j \notin J.$[c]	h - J*	Exogenous investment
$f^{e}_{(i1)}$	$i = 1, \ldots, g.$	g	Shifts in foreign export demands

continued

Table A1 continued

Exogenous variable	Subscript range	Number	Description
$f^{(1)}_{g+2j}$	$j = 1, \ldots, h$	h	Shifts in the price of 'other cost' tickets
q		1	Number of households
φ		1	The exchange rate $A per $US, say
NAGA variables[d]			
f_R		1	The ratio of real private investment expenditure to real household consumption expenditure
g_R		1	Real government consumption expenditure
θ		1	Shock control variable
α_P		1	Payroll tax rate
α_V		1	VAT tax rate
α_L		1	Labour income tax rate
α_K		1	Capital income tax rate
f_W		1	Shift variable wage indexation

$$\text{Total} = 4g^2h + 5g^2 + 2Mh + 13h + 15g + M + \sum_{j=1}^{h} N(j) + 11 - J^* = 6{,}084{,}052^{c}$$

a Notation and further details are explained in Dixon, Parmenter, Sutton and Vincent (1982), hereafter DPSV.

b G is the set of commodities for which export demands are determined endogenously. The set G, together with the export demand elasticities, is listed in Higgs (1986, Table 2.2).

c J is the set of industries for which investment is endogenous. The set $\{j \in J\}$ for which the rate-of-return theory is considered inappropriate, consists of industries 17, 84, 85, 86, 94, 103-108, 111 and 112. For a key to the industry numbers see Higgs (1986, Table 5.2).

d Notation and further details are explained in Meagher and Parmenter (1985).

e For the version of ORANI used here:

g (the number of commodities)	=	114
h (the number of industries)	=	112
M (the number of occupations)	=	10
J* (the number of industries for which investment is endogenous)	=	99

Table A2 **Nominal rates of protection for 1986-87***

	Commodity	Nominal rate of protection (per cent)
18	Meat products	0.00
19	Milk products	25.26
20	Fruit and vegetable products	11.20
21	Margarine, oils and fats nec	6.75
22	Flour mill cereal products	8.39
23	Bread, cakes, biscuits	0.46
24	Confectionery and cocoa	15.75
25	Other food products	10.10
26	Soft drinks, cordials	10.68
27	Beer and malt	30.67
28	Other alcoholic beverages	20.56
29	Tobacco products	7.25
30	Cotton ginning, wool scouring and top making	2.13
31	Man-made fibres, yarns	30.63
32	Cotton yarns, fabrics	28.57
33	Wool, worsted fabrics	12.19
34	Textile finishing	36.20
35	Textile floor coverings	33.67
36	Other textile products	18.94
37	Knitting mills	63.04
38	Clothing	64.03
39	Footwear	63.53
40	Sawmill products	5.09
41	Veneers and wood boards	18.88
42	Joinery and wood products nec	12.46
43	Furniture and mattresses	22.27
44	Pulp, paper, paperboard	9.27
45	Bags and containers	20.60
46	Paper products nec	20.94
47	Newspapers and books	0.48
48	Commercial printing	18.99
49	Chemical fertilizers	0.97
50	Other basic chemicals	11.76
51	Paints, varnishes	13.43
52	Pharmaceutical goods	6.21
53	Soap and detergents	17.56
54	Cosmetics and toiletries	6.07
55	Other chemical goods	11.19
56	Petrol and coal products	0.12
57	Glass and glass products	6.09
58	Clay products, refractories	3.65
59	Cement	3.26
60	Ready mixed concrete	0.00
61	Concrete products	0.61

continued

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Table A2 continued

	Commodity	Nominal rate of protection (per cent)
62	Non-metallic mineral products	8.90
63	Basic iron and steel	8.58
64	Non-ferrous metals	2.68
65	Structural metal products	12.51
66	Sheet metal products	15.14
67	Other metal products	17.35
68	Motor vehicles and parts	27.10
69	Ships and boats	14.80
70	Railway rolling stock	17.44
71	Aircraft	1.64
72	Scientific equipment	4.68
73	Electronic equipment	19.03
74	Household appliances	22.59
75	Other electrical goods	18.24
76	Agricultural machinery	7.09
77	Construction machinery	17.45
78	Other machinery	12.96
79	Leather products	8.53
80	Rubber products	21.98
81	Plastic products	19.82
82	Signs, writing equipment	12.69
83	Other manufacturing	15.59

* Source: Unpublished Industries Assistance Commission estimates.

assistance these estimates must first be converted to the appropriate units given the ORANI model's base-period prices and production levels.

The IAC (1987) estimates of the 1984-85 levels of assistance and value of output by commodity are given in columns [I] and [II] of Table A3. Next, in column [III] of the table, the ratio of the level of assistance, or commodity subsidy equivalent, to the value of output is calculated. This ratio is then multiplied by the value of output in the base period (see column [IV]) to produce estimates of the subsidy equivalents in terms of the base-period prices and with respect to the base-period production levels, see column [V].

The next step is to convert the commodity subsidy equivalents listed in column [V] of Table A3 to industry subsidy equivalents. This was done according to the base-period mix of commodities produced by each of the industries; see Higgs (1986, Table 3.1). The resulting matrix of subsidy equivalents by commodity and industry is given in Table A4. The industry subsidy equivalents are listed in the final column of the table.

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Table A3 **Calculation of the base-period agricultural commodity subsidy equivalents**

Commodity		1984-85 subsidy equivalent[a] ($m 1984-85 prices) [I]	1984-85 value of output[b] ($m 1984-85 prices) [II]	Ratio of subsidy equivalent to value of output {ie [I]/[II]} [III]	Typical-year value of output[c] ($m 1977-78 prices) [IV]	Typical-year subsidy equivalent ($m 1977-78 prices) {ie [III] x [IV]} [V]
A1.	Wool	92.5	2,288.5	0.0404	1,508.74	60.95
A2.	Sheep	17.8	509.5	0.0349	578.67	20.20
A3.	Wheat	108.4	2,863.9	0.0382	921.07	35.18
A4.	Barley	14.2	574.5	0.0247	176.51	4.36
A5.	Other cereal grains	20.9	620.5	0.0337	161.64	5.45
A6.	Meat cattle	128.4	2,075.0	0.0619	803.59	49.74
A7.	Milk cattle	367.1	1,444.5	0.2541	985.00	250.29
A8.	Other farming (sugarcane, fruit and nuts)	134.3	984.5	0.1364	1,257.67	171.55
A9.	Other farming (vegetables, cotton, oilseeds and tobacco)	48.7	785.1	0.0620	956.61	59.31
A10.	Poultry	3.3	743.9	0.0044	400.42	1.76
	Total	935.6	12,862.9		7,749.93	658.79

a See Table 1, column [V].
b See Table 1, column [VI].
c Source: Higgs (1986).

All that remains now is to explain how the effects of the removal of the industry subsidy equivalents listed in Table A4 were simulated. This was done by making use of the 'other costs' input category for each of the agricultural industries. Note that an exogenous increase in other costs is equivalent to the imposition of a production tax. Column [II] of Table A5 contains the inputs of other costs in the base period. It is possible to simulate the effects of the removal of the industry subsidy equivalents by exogenous setting the appropriate percentage change in other costs; see column [III] of Table A5.

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Table A4 Subsidy equivalents to the agricultural sector*

Industry	Commodity										
	A1 Wool	A2 Sheep	A3 Wheat	A4 Barley	A5 Other cereal grains	A6 Meat cattle	A7 Milk cattle and pigs	A8 Other farming (sugar-cane, fruit and nuts)	A9 Other farming (vegetables, cotton, oilseeds and tobacco)	A10 Poultry	Total subsidy by industry
1 Pastoral zone	12.69	2.00	1.64	0.21	0.14	4.55	0.13	0.06	0.80		22.21
2 Wheat-sheep zone	26.17	10.32	32.73	3.67	3.84	13.51	15.37	0.41	2.26		108.27
3 High rainfall zone	22.10	7.88	0.82	0.48	1.48	15.21	5.97	0.90	3.35		58.19
4 Northern beef						12.88					12.88
5 Milk cattle and pigs						3.59	228.81				232.40
6 Other farming (sugarcane, fruit and nuts)								170.19			170.19
7 Other farming (vegetables, cotton, oilseeds and tobacco)									52.89		52.89
8 Poultry										1.76	1.76
Total subsidy by commodity[a]	60.95	20.20	35.18	4.36	5.45	49.74	250.29	171.55	59.31	1.76	658.79

* These figures are estimates of the subsidy equivalents of the various forms of government assistance given to agriculture in terms of millions of 1977-78 Australian dollars.

a Source: derived from IAC (1987); see Table A3, column [V].

Correction for home consumption pricing schemes

The above producer subsidy equivalent shocks will result in increased costs to the agricultural producers which is appropriate if we are simulating the removal of a subsidy. However the above shocks also tend to result in increased domestic agricultural prices which is not appropriate if we were attempting to capture the effects of the removal of a home consump-

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Table A5 **The exogenous shocks to 'other costs' required to simulate the effects of the removal of the agricultural industry subsidy equivalents**

	Industry	Industry subsidy equivalent[a] ($m 1977-78 prices)	'Other costs'[b] ($m 1977-78 prices)	Exogenous shock to 'other costs' (percentage change) {ie 100 x [I]/[II]}
		[I]	[II]	[III]
1	Pastoral zone	22.21	21.62	102.74
2	Wheat-sheep zone	108.27	88.04	122.98
3	High rainfall zone	58.19	33.91	171.60
4	Nothern beef	12.88	4.47	288.13
5	Milk cattle and pigs	232.40	29.04	800.34
6	Other farming (sugarcane, fruit and nuts)	170.19	60.42	281.68
7	Other farming (vegetables, cotton, oilseeds and tobacco)	52.89	38.79	136.36
8	Poultry	1.76	44.02	4.00

a See Table A4.
b Source: Bruce (1985).

tion pricing scheme. Recall from Table 1, column [I], that part of the subsidy to agriculture consists of home consumption pricing schemes. These act to raise the price to domestic consumers of products within such arrangements. Therefore we must correct, where possible, for the effects of the above shocks on prices when the subsidy is in the form of a home consumption pricing scheme.

Approximately two-thirds of total assistance to agriculture due to home consumption pricing schemes is for milk (both manufacture and market); see Table 1, column [I]. Below we explain how to correct for the effects of the above shocks on the price of the commodity milk cattle and pigs. The first step is to estimate the value of the home consumption pricing scheme in terms of base-period prices and with respect to base-period production levels. This is done by taking the ratio of the estimated values in Table 1 of the home consumption pricing scheme ($342.5m 1984-85 prices) to the value of total assistance ($367.1m 1984-85 prices) and multiplying it by the subsidy equivalent for the commodity milk cattle and pigs as reported in Table A4 ($250.29m 1977-78 prices). This results in an estimated value of $233.52m 1977-78 prices (ie (342.5/367.1) × 250.29).

The second step is to note that in the base period nearly all the sales of the milk component of the commodity milk cattle and pigs were to the milk products industry. This repre-

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sented a sale of $609.94m 1977-78 prices. Thus we would expect a reduction in the costs of milk purchased by the milk products industry of 38.29 per cent (ie 100 × 233.52/609.94) if the home consumption pricing scheme were disbanded. However, because of the component of the shock to other costs that accounts for the home consumption pricing scheme, the price of milk is projected to increase by approximately 23.71 per cent (ie 100 × 233.52/985.00, where the base-period total sales of milk cattle and pigs is $985.00m 1977-78 prices).

The third and final step is to compute the size of the shock to other costs in the milk products industry that will both cancel out the effect on this industry's costs of the above 23.71 per cent increase in the price of milk, plus capture the desired effect of a 38.29 per cent fall in the price of milk to this industry. In other words, what percentage change in other costs is equivalent to a 62 per cent (ie 23.71 + 38.29) fall in the price of milk sold to the milk products industry? The input of other costs in the base period to the milk products industry is $36.07m 1977-78 prices. Thus a 62 per cent fall in the cost of milk to this industry, which equals $378.16m (ie 0.62 × 609.94m), is equivalent to a 1048.41 per cent (ie 100 × 378.16/36.07) decrease in the input of other costs.

The next home consumption pricing scheme we correct for is for wheat. As above, the first step is to estimate the value of the home consumption pricing scheme in terms of base-period prices and with respect to base-period production levels. This is done by taking the ratio of the estimated value in Table 1 of the home consumption pricing scheme ($43.1m 1984-85 prices) to the value of total assistance ($108.4m 1984-85 prices) and multiplying it by the subsidy equivalent for wheat reported in Table A4 ($35.18m 1977-78 prices). This results in an estimated value of $13.99m 1977-78 prices (ie (43.1/108.4) × 35.18).

The second step is to note that, because of the component of the shocks to other costs that accounts for the domestic pricing scheme for the producers of wheat, the price of wheat is projected to increase by 0.41 per cent. This is calculated as follows. The elasticity of the farm-gate price of wheat with respect to other costs in the wheat-sheep zone (which produces 93 per cent of the total output of wheat in the base period) is 0.0259. Next we note that $13.99m (1977-78 prices) represents a 15.89 per cent increase in other costs in the wheat-sheep zone. Thus a 15.89 per cent increase in 'other costs' would generate a 0.41 per cent (ie 15.89 × 0.0259) increase in the price of wheat.

The third step is to note that in the base period domestic sales of wheat to non-wheat producing industries was $127.43m 1977-78 prices. Thus we would expect a fall in the price of wheat to domestic purchasers of approximately 10.98 per cent (ie 100 × 13.99/127.43) if the home consumption pricing scheme were disbanded. Furthermore, of the $127.43m (1977-78 prices) domestic sales of wheat, $63.44m is sold to the flour and cereal products industry.

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This sale represents approximately 12 per cent of total costs to the flour and cereal products industry. The remaining $63.99m of wheat is largely sold to non-wheat producing agricultural industries. However these sales represent a relatively small percentage of total costs in these industries.

The final step is to compute the size of the shock to other costs in the flour and cereal products industry (which accounts for approximately 90 per cent of domestic non-agricultural sales of wheat in the base period) that will both cancel out the effect on this industry's costs of the above 0.41 per cent increase in the price of wheat, plus capture the desired effect of a 10.98 per cent fall in the price of wheat if the domestic price arrangements were disbanded. In other words, what percentage change in other costs is equivalent to an 11.39 per cent (ie 0.41 + 10.98) fall in the price of wheat sold to the flour and cereal products industry? The input of other costs in the base period to the flour and cereal products industry is $18.42m, 1977-78 prices. Thus an 11.39 per cent fall in the price of wheat to this industry, which equals $7.23m (ie 0.1139 × $63.44m), is equivalent to a 39.25 per cent (ie 100 × 7.23/18.42) decrease in the input of other costs.

The public sector borrowing requirement projections

In this note we explain how the PSBR projections reported in Tables 2 and 3 were corrected for flows not captured in the NAGA model. Recall that the PSBR is equal to government outlays less government income. It is assumed that the flows not captured by NAGA only affect government outlays. Before any corrections were made, the NAGA model projected a $742m (1984-85 prices) decline in government outlays if assistance to agriculture were removed. This projection failed to account for the direct savings to the government from the subsidies being removed. These direct savings can be estimated from Table 1. Total assistance to agriculture is equal to $935.6m (1984-85 prices), however $514.6m is in the form of domestic price arrangements. Thus roughly $421.0m (ie 935.6 - 514.6) of assistance is direct government outlays. This amount needs to be subtracted from the projected decrease in government outlays of $742m to give a corrected projection of a decline of $1163m. In other words, a reduction of 1.34 per cent (ie 100 × 1163/86,535) is the corrected projection for government outlays.

To calculate the corrected PSBR projection we subtract the projected decline of $919m (1984-85 prices) in government income from the above reduction of $1163m in government outlays. This produces a corrected PSBR projection of a fall of $244m. In other words, a fall of 1.61 per cent (ie 100 × 244/15,118) is the corrected projection for the PSBR.

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Some economy-wide effects of agricultural policies in the European Community:

a general equilibrium study

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I Introduction

Reform of agricultural policies is now one of the most pressing problems in the European Community. The European Budget is essentially broke and spending must be curtailed further or additional revenue raised. By ingenious financial innovations, and some changes to agricultural programs, the EC has in recent years managed to avoid substantial reforms of its agricultural policies and has gone from one financial crisis to the next.

This financial problem, and how it should be tackled, consumes most of the time of EC officials and much public debate. However, what is less visible and receives less debate, despite its greater significance, is the non-budgetary costs and the economy-wide effects of the support given to agriculture. And it is this lack of debate which lies behind the main political economy problem limiting the prospects for reform of agricultural policies in the EC. The recent OECD survey by Winters (1987) of economy-wide effects of agricultural policies in OECD countries underscores this dearth of knowledge.

The purpose of this chapter is to highlight the inter-sectoral or economy-wide effects of the agricultural policies of the European Community. The approach taken is to use the multi-country general equilibrium model of the EC, developed by Breckling, Thorpe and Stoeckel (1988). The findings of this study confirmed the results reported by Stoeckel (1985) and Breckling, Stoeckel and Thorpe (1987). All these studies identified large economy-wide effects of the agricultural support policies – so large that agricultural protectionism is a significant factor in the EC's relative economic malaise. The multi-country version of the general equilibrium sector analysis (Breckling et al, 1987) further revealed large differences between countries as to who benefits and who loses from the Common Agricultural Policy (CAP).

In this study the results from this earlier work are updated to incorporate the greater knowledge about the size of the transfers to EC agriculture from the work undertaken by OECD (1987). The main non-agricultural effects examined in this chapter are the effects on the other export and import-competing sectors of the European Community and unemployment.

Why reform of the CAP is so slow

The need for reform of the CAP has been recognized for many years. Consider the following comment, written by the European Commission at a time when the Mansholt plan was drawn

up more than a decade and a half ago.

> The Community is now saddled, for many commodities, with surpluses some of which have no prospect of outlets on saturated world markets. Where outlets do exist, surpluses depress prices so that they can only be sold at high cost to the Community's budget . . . It is therefore vital, in future, to adopt another policy for farm prices. (From Duchene, Szczepanik and Legg, 1985, p192)

As Duchene et al conclude:

> That an early text from the heart of the Community should still be apposite today, and that during the intervening period so little attention has been paid, in itself conveys a message. Ideas in this field have no weight unless they commit the political forces in play. Social pressures of immense power have determined the progress of the CAP, as they have the national policies before and since its inception. Only political counter-forces of similar power are likely to divert them (p192).

In essence, it is argued, that reform of the agricultural policies will come only about when sufficient countervailing political forces exist to offset the vested interests in the agricultural sector. These offsetting forces must come from those groups bearing the burden of the CAP: and those groups principally lie outside the agricultural sector. For reform to be slow, either the costs to the groups bearing the burden must be too small to worry about or they must be unaware of the real costs of the CAP.

The third case – that those groups bearing the burden actually want to support agriculture in the present form – cannot logically hold. The reason is that objectives stated for the CAP can be achieved by more efficient, less costly means (BAE, 1985; Stoeckel, 1985). Only if a stated objective of the CAP was to become more than self-sufficient, over-produce embarrassing surpluses which have to be disposed of on world markets at a substantial loss, and if the intention is to give three-quarters of the support to the top one-quarter of farmers – only then would the present reliance on price support instruments for agricultural protection be consistent with some revealed European preference for support of their agricultural sector. In short, the agricultural supports for EC farming do not achieve all of their stated objectives and to the extent they do, more direct and efficient policy instruments – such as direct income supports – are available.

The slow reform of the CAP must then lie in the first two explanations: either the costs are not that great or those groups bearing the burden are largely unaware of the real costs of the CAP – that is, the full economic costs and not just the visible and relatively smaller (but

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absolutely large) budgetary costs. What then are the real economic costs of the CAP and what is already known about these costs? (For a brief summary of the objectives and instruments of the CAP see Appendix A.)

The economic costs of EC agricultural policies

A basic fact of economics is that support of one sector in an economy has large costs elsewhere. Someone has to pay and in the case of support for a tradeables sector, like agriculture, the theory is reasonably clear: it is the other tradeables sectors that largely bear the burden. This *burden* is in terms of lower output, lower factor returns and lower incomes than otherwise.

In the case of the European economy, it is the manufacturing exporting and import-competing sectors that largely bear the burden of agricultural protectionism. And the economic effects are not just confined to the static effects of lower output or incomes: dynamic effects such as lower investment and even the failure of new industries to emerge is apparent. As Clements and Sjaastad (1984) note:

> The protection of import-competing industries . . . has been at the expense of the export industries, particularly non-traditional exports like manufactures in developing countries. Non-traditional exports have grown slowly (or even failed to emerge) because the required resources (including entrepreneurial skills) are locked by protection into import-competing activities. The protection of jobs in import-competing industries is clearly at the expense of jobs elsewhere. If existing jobs are protected, one should not be surprised to see few new jobs being created in export-oriented industries. Although by its very nature protection is designed to help domestic industry and employment, the economy-wide implications of protection mean that such policies have perverse effects and, on balance, can hurt the domestic economy. That is to say, the implicit tax on exporters does so much damage to the economy in terms of economic inefficiency and unemployment that it may entirely destroy the beneficial effects enjoyed by the import-competing firms (pp.3-4).

Other costs can also be apparent depending on the make-up of domestic regulations in each economy. For example, if factors of production cannot move to more profitable uses, the costs of distortions will be greater. In the EC, institutionalized rigid real wages impede the movement of resources in response to protection for a given sector and increase the economic costs of the support. The evidence for this real wage rigidity is given below but the effects on unemployment and industry output depend on domestic policy settings.

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The total transfers to agriculture in the EC from all sources have been estimated at between 57 and 73 billion ECU a year (in 1984 values) between 1976 and 1985 (BAE 1985). That is, approximately 60 per cent of the value added by the sector has been derived from transfers from elsewhere in the economy. These direct and indirect transfers, after allowing for the effect of the Community's policies on world prices, have been responsible for a large transformation of EC agriculture. Under these agricultural policies, the Community has gone from the world's largest importer of temperate zone agricultural products to become the world's second largest exporter (BAE, 1985).

With transfers of this size, it is understandable that there could be large effects on other sectors of the economy. The earlier study by Stoeckel (1985) estimated that manufacturing output in the EC could be 1.5 per cent lower and exports 4 per cent lower as a consequence of the agricultural supports. Also, with real wage rigidity, around one million jobs could have been lost. The subsequent updated and disaggregated study by Breckling et al (1987) estimated that the manufacturing and services sectors contract by roughly 1 per cent in each of the four main countries except the UK where the contraction is much sharper at 2.5 per cent for manufacturing and 3.1 per cent for services. For the four countries, around 860,000 fewer persons could be employed as a consequence of the agricultural policies of the Community – a total loss (on a pro rata basis) for the EC-10 of around 1 million jobs. However, in the study by Breckling, Stoeckel and Thorpe (1987), national government supports were not considered and elasticities of export demand which could be considered as a lower limit was used. Since the release of this study considerable work has been published on the size of agricultural support in OECD countries and the impact on world prices and quantities traded (OECD, 1987; USDA, 1987, Tyers and Anderson, 1987). These estimates rely on partial calculations, but nevertheless model complex agricultural systems with feed grain/livestock trade-offs. This detailed knowledge concerning estimates of support and the elasticities is used here together with the general equilibrium model reported in Breckling, Thorpe and Stoeckel (1988) to test for their economy-wide impacts. For a summary of other studies, for example Gerken (1986), Spencer (1986) and several partial equilibrium analyses, see Winters (1987).

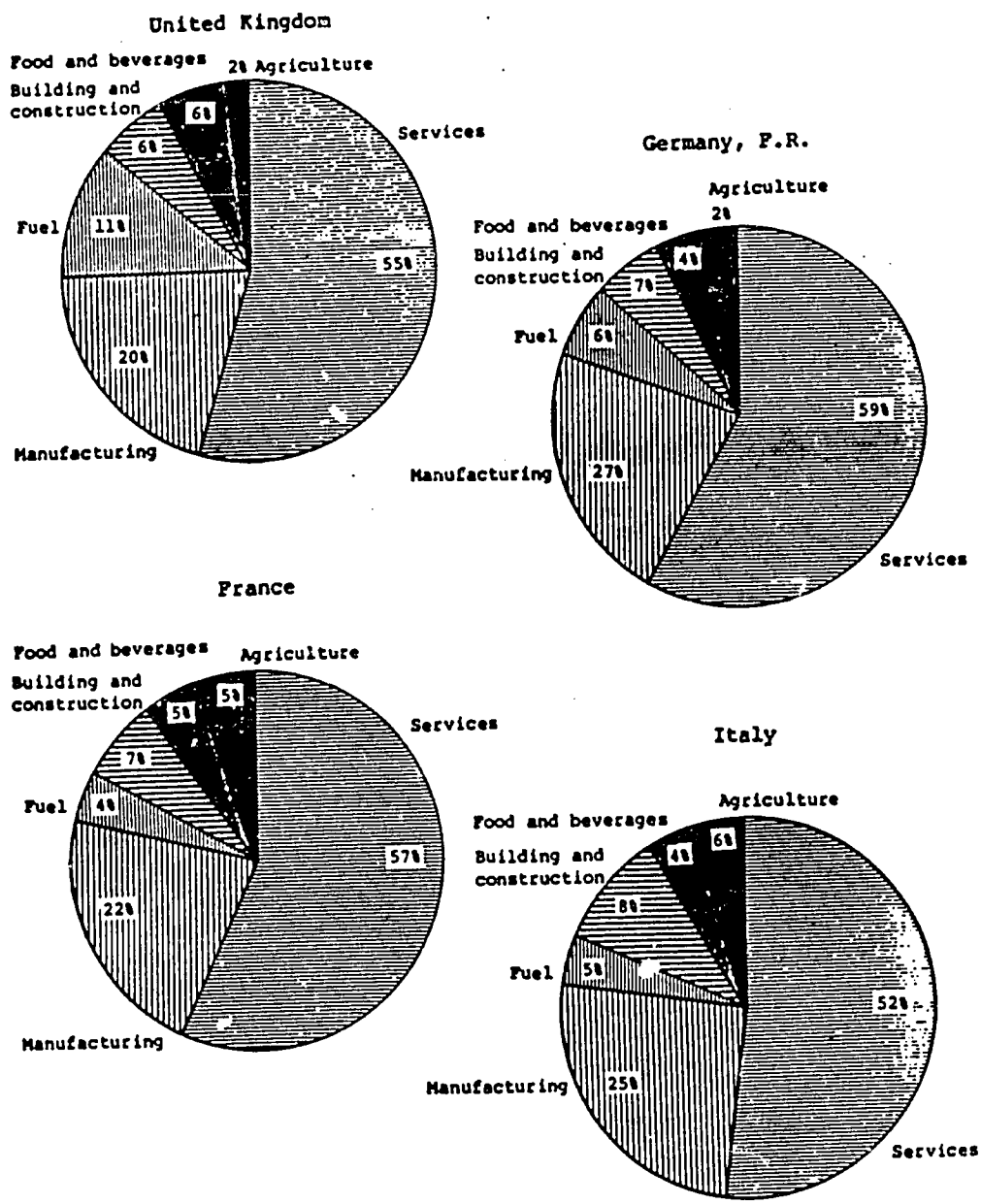
Economic features of the EC

There are three features of the European Community which need to be incorporated in the model and are reviewed here to interpret the results. First, the broad structure of the Community – the sectoral composition and given relationships between the different sectors of the Community; second, the existence of a large number of small farms and a quite rapid structural adjustment in the agricultural sector; and third, the presence of unemployment and real wage rigidities.

Broad sectoral composition of the EC

The broad sectoral composition of each of the four largest economies is shown in Figure 1. These four economies account for 86 per cent of the gross domestic product in the EC-10. Of the four countries, the Federal Republic of Germany is the largest, accounting for 28 per cent of the gross domestic product of the EC-10. Germany is the largest manufacturing economy, is the only country, which is a net importer of EC agricultural product and is the largest net contributor to the EC Budget.

Figure 1 **Sectoral gross value added at market prices for selected EC countries in 1982**



Source: Eurostat (1984)

France is the second largest economy, accounting for some 23 per cent of gross domestic product in the Community. Of the four main economies of the Community, France has the largest agricultural sector, and as such has been a large net recipient of support provided under the CAP. More lately, however, with the inclusion of Spain and Portugal it has moved closer towards balance between contributions and receipts. France also has a large manufacturing sector and is comparatively export oriented.

Like France, Italy has a large agricultural sector and thus has tended to be a net recipient. Unlike France, however, its economy is more domestically oriented. The United Kingdom is a more recent member of the European Community. It has a relatively small agricultural sector, and, like Germany, is a net contributor.

Accounting for more than 50 per cent of each economy's gross domestic product services are the largest sector in all four countries, followed by manufacturing which varies between 20 to 27 per cent. Agriculture is typically small, but when considered along with the closely allied food-processing sector, they account for 6 to 10 per cent in each economy. Note that most of the agricultural trade protection in the Community is on processed products such as cheese, wine and sugar which are classified as food and beverages by the national accounts.

Large and small scale farming

There are a few large farms which produce the bulk of the output. Farms over 50 hectares account for no more than 6 per cent of all farms (Commission of the European Communities 1985, p83). Ranking farms in terms of their economic size, approximately half of the output is produced by the 10.5 per cent largest farms. In the EC-10 the agricultural labour force declined by 2.5 million between 1973 and 1983 – a 24 per cent fall (Stoeckel, 1985). By comparison, in Australia – where assistance to the rural sector is negligible – farm employment has decreased by only 6 per cent. In this study it is argued that the large reduction in the rural labour force in the Community happened as a result of the structural adjustments induced by its agricultural policies. The reduction reflects a significant amalgamation of a large number of small sub-optimal farms, and at least until 1973, the relative attractiveness of employment opportunities outside agriculture. The pattern of agricultural investment subsidies, in particular a large level of displacing investment influenced by the subsidies of agricultural production (Stoeckel, 1985). From 1973 to 1983 there was a 24 per cent reduction in agricultural employment (EC-10) as shown in Table 1.

Table 1 **Reductions in agricultural employment in selected EC countries between 1973 and 1983**

	Germany FR	France	Italy	UK	EC-10
Decrease in '000	553	609	946	100	2490
Decrease in %	29	26	27	14	24

Accounting for this very large drop in agricultural employment and the large increase in average farm size is an important factor to be considered when simulating the effects of agricultural policies on the agricultural sector.

If a homogeneous agricultural sector is specified producing a homogeneous product under constant returns to scale, then simulating protection for such a sector would result in an increase in the use of all primary and intermediate factors of production and thus farm employment. However, the opposite has happened, the reason lying in the technology change and diverse structure of the rural economy. Detailed specification of this dual agricultural sector is described in Breckling, Thorpe and Stoeckel (1988). From the results of this study, it can be deduced that the specification of the agricultural sector is important for simulating the effects on large and small scale farms. But, more importantly for this study, it does not have a material bearing on the aggregate agricultural sector nor on the non-agricultural sectors. Also, even though there has been a large exodus of employment from agriculture, principally from the much more numerous small farms, the results suggest that this does not have a large effect on the aggregate employment results. In essence, it is important to consider the differences between large and small scale farming. This is particularly important for policy purposes, since a large number of small holdings consists of part-time farmers, that is farmers who have other sources of income. However, aggregate non-agricultural effects are not sensitive to this heterogeneous structure of European farming.

Labour market rigidities

One of the most significant distortions and intractable problems in the EC is the real wage rigidity that exists and the high unemployment in the economy. The evidence for this real wage rigidity was described as follows:

> Unemployment remains one of the major economic problems of the Community. The unemployment rate has averaged around 11 per cent over the past three years in the EC-10 and is expected to remain around that level in 1987. The increase in

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unemployment between 1975 and 1982 was most severe in the United Kingdom. While many possible explanations have been advanced for this unemployment, the most widely accepted explanation appears to be rigidity of real wages (Commission of the European Communities 1985b, 1986). See Figure 2 for the relationship between short run real wage rigidity and unemployment.

This labour market inflexibility, both at the aggregate and microeconomic level, has been analyzed by Klau and Mittelstädt (1986). The United Kingdom, France and Italy are estimated to have the highest real wage rigidities of all OECD economies, as shown in Figure 2. In Germany, however, real wage rigidity is low despite narrow wage differentials reflecting minimum wage legislation and cost-of-living adjustments. Figure 3 shows the relationship between aggregate short run wage rigidity (on the vertical axis) and microeconomic wage rigidity, which is inversely related to average inter-industry wage differentials (on the horizontal axis). (Breckling, Stoeckel & Thorpe 1987)

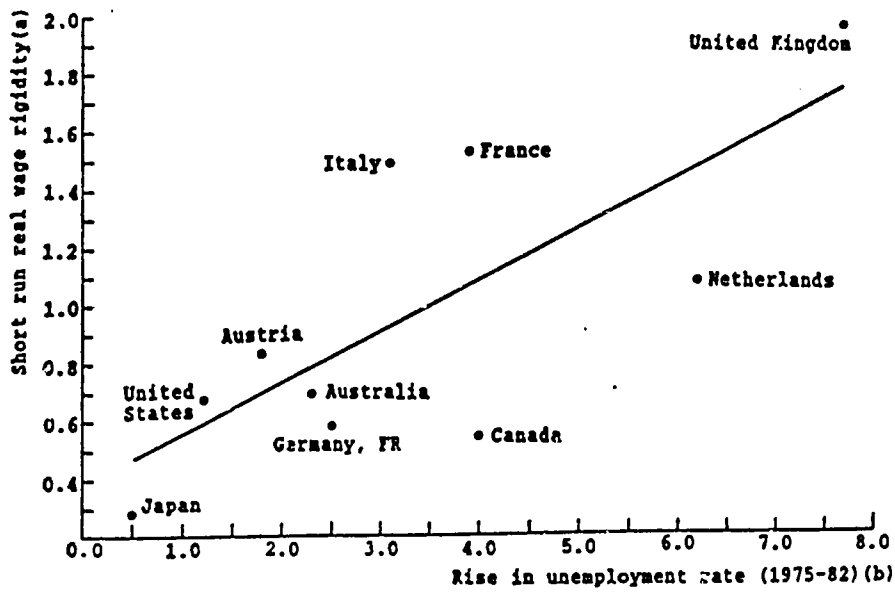
The labour market rigidities are not confined to the easily observed direct labour costs. In describing the lower efficiency of investment in the Community compared to the US and the fact that the real product wage exceeded the increase in total fact of productivity, the Commission of European Communities (1984a, p90) stated that:

> It is therefore difficult to avoid the conclusion that the capital-deepening in the EC and the loss of investment efficiency since 1973 by and large represent the response of the enterprises to the rapid rise in direct and indirect labour costs (including social security contributions) and to emerging labour market rigidities which have entailed an increase in the (invisible) costs of labour related to hiring, firing, training, etc . . . the data . . . suggest that the real product wage in the EC over the whole period 1960-81 rose, annually, by about 1 percentage point more than the rate of growth of total factor productivity.

These indirect labour costs at the inter-firm level are most apparent in Germany. Employment has improved in recent years in the Federal Republic of Germany. However, this is more recent and is related to the relative increase in economic activity in that country.

So great has this unemployment problem in Europe been that it is given as the main impediment for reform of agricultural policies. For example, Mr Frans Andriessen, the Commissioner for Agriculture in the European Commission is reported as saying:

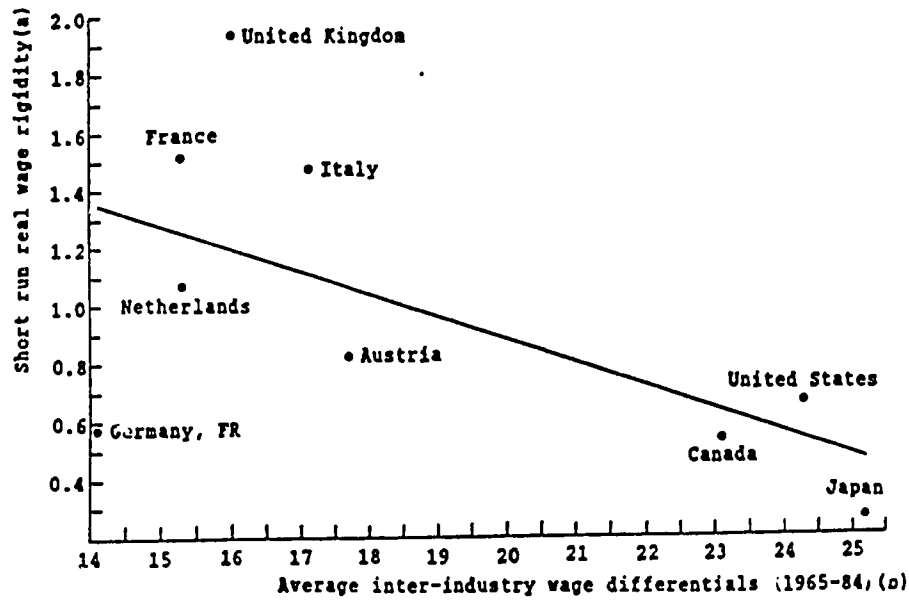
Figure 2 **Short run real wage rigidity and unemployment**



(a) Short run price coefficient divided by unemployment rate coefficient.
(b) Percentage points. Source: Klau and Mittelstädt (1986).

(a) Short run price coefficient divided by unemployment rate coefficient.
(b) Percentage points. Source: Klau and Mittelstädt (1986).

Figure 3 **Real wage rigidity and wage differentials**



(a) Short run price coefficient divided by unemployment rate coefficient.
(b) Based on hourly wage earnings for time worked for manufacturing industries, except for Japan where only total labour costs were available.
Source: Klau and Mittelstädt (1986).

(a) Short run price coefficient divided by unemployment rate coefficient.
(b) Based on hourly wage earnings for time worked for manufacturing industries, except for Japan where only total labour costs were available. Source Klau and Mittelstädt (1986).

> It is my conviction that if we allowed the market to operate, we would lose millions of farmers and the economy would be charged with the burden of supporting them. (*Australian Financial Review*, 12 March 1987)

And, the Commission of the European Communities (1987, paragraph 121) wrote:

> Today the economic scene has changed considerably. Given a total unemployment level of some 17 million persons in EUR-12, . . . the redundant farm worker is now more likely to be found among the ranks of the unemployed.

But the earlier work by Stoeckel (1985) and Breckling, Stoeckel and Thorpe (1987) suggests the opposite is more likely to be true: that jobs are being lost as a consequence of agricultural policies. Despite the importance of this issue, there has been little attention given to this aspect. The unemployment problem and real wage rigidity is therefore an important part of this study.

Model features

The model used in this study is that developed by Breckling, Thorpe and Stoeckel (1988). It is best described as a linearized Heckscher-Ohlin general equilibrium model comprising four countries and four sectors of production. The four countries considered are the Federal Republic of Germany, France, the United Kingdom and Italy, which account for about 86 per cent of the Community's total gross domestic product. For each of these economies four sectors of production are distinguished: agriculture, food processing, other manufacturing and services. The agricultural sector has been further disaggregated into small and large scale subsectors in accordance with the heterogeneous structure of European farming.

Given the coordination and central administration under the Common Agricultural Policy, in this study agriculture is treated as a homogeneous Community enterprise. The market for agricultural product clears at the EC level, and prices are linked in EC currency after allowing for a price differential to represent monetary compensatory amounts (MCAs). With this exception all commodities are distinguished by country of origin as well as country of destination. In addition, it is assumed that all countries are large enough to influence the world price of its traded goods.

The primary factors available in the production processes are general labour, family farm labour, land and capital. Family labour, land and capital are used on both small and large farms. General labour, however, while accessible to large farms, cannot be employed on small farms. The two subsectors therefore compete for all factors of production except

general labour. Family labour and land are also specific to the agricultural sector. Given these constraints, factors are assumed mobile within each economy but not between countries. While both types of labour can be unemployed, all other factors are fully employed. Furthermore, savings and new investments are not included in the model.

The main behavioural postulates are those standard to general equilibrium models. Producers minimize costs subject to technological constraints. Each sector uses primary and intermediate factors and produces a single commodity. Competitive conditions ensure that all factors except labour receive their marginal products, while returns to general labour are fixed to reflect the presence of real wage rigidities. To represent household behaviour, it is assumed that there is a single consumer in each country who minimizes expenditure given the level of utility. A highly simplified version of the model, which provides a detailed discussion of the main driving forces and underlying principles, is contained in Breckling, Thorpe and Stoeckel (1986).

The price support measures listed in Appendix A are captured in this model by combinations of import tariffs, export subsidies, production subsidies and a uniform consumption tax to fund EC expenditures. Since this study focuses on the removal of CAP price support, all exogenous shocks are directed at the agricultural and closely related food-processing sectors, with all other exogenous variables, including factor resource endowments, held unchanged. For the effects of a full, sector-wide liberalization in Germany the reader is referred to Dicke, Donges, Gerken and Kirkpatrick (1988).

Liberalizing agricultural protection

One of the difficult tasks in any simulation design is to represent the myriad of interventions into supply and demand shocks such that their effects can be traced. One approach is to use measures such as the producer subsidy equivalents (PSEs) which capture a range of interventions into a single number. Although PSEs are derived from a partial concept, they do have the advantage that OECD member countries have generally accepted them (OECD, 1987).

The PSEs combine the transfer payments by both taxpayers and consumers to the combined agricultural and food processing sector. Estimates of these transfer payments derived by OECD (1987) and BAE (1985) are presented in Table 2. It can be seen that in 1980 the cost to consumers was much greater than the cost to taxpayers. However, over the last decade, the cost to taxpayers has risen at a faster rate than the cost to consumers, though both have steadily increased.

Table 2 **Taxpayer and consumer transfer payments to agriculture in the EC (average 1979 - 1980 - 1981)**

	Taxpayer billion ECU	Consumer billion ECU	Total billion ECU
OECD 1987	21.1	35.8	56.9
BAE 1985(a)	18.7	29.5	48.2

(a) Excluding social security payments.
Sources: OECD (1987, p132), BAE (1985, pp102-100)

For the purpose of this study, it is assumed that consumer transfers derive from border measures such as tariffs and non-tariff barriers (NTBs). Taxpayer transfers, on the other hand, represent VAT contributions, import levies, direct input subsidies and deficiency payments, and are used to fund export and production subsidies. When estimating the transfers presented in Table 2, both OECD (1987) and BAE (1985) assumed that imported and domestically produced goods are completely homogeneous. To the extent that they are not, the transfers of CAP intervention have been overstated. It was therefore decided to use the slightly more conservative BAE estimates when determining the size of the exogenous shocks. The result is given in Table 3. For a derivation the reader is referred to Appendix B.

Finally, still concerning the model closure, a comment on the balance of payments is required. The assumption of a current account equilibrium adopted in Stoeckel (1985) and Breckling et al (1987) has been criticized by the European Parliament Secretariat (1987). Over time exports and imports in the Community have broadly tracked each other, and it is only in recent times that the Community has moved into surplus. This is principally a result of Germany moving into surplus with the rest of the world (like Japan) while America has accumulated large deficits on its current account. Although from one year to the next large swings can occur, over time the current account will tend to balance and this is what has been assumed in this study. In 1973 exports exceeded imports by only US$10 billion. By 1983 exports had increased by 181 per cent while imports had risen by 183 per cent. A different closure of the model – for example, a reduction in the agricultural balance together with a deficit on the current account, as suggested by the European Parliament Secretariat (1987) – could easily be implemented. However, since savings and net new investment are held constant in this study, this would imply a domestic deficit and this would in turn imply domestic effects as well, depending on where the extra money was spent.

Table 3 **Exogenous shocks used in simulation study**

	Agriculture %	Food processing %	Whole economy %
Consumption tax			-2.0
Import tariff(a)	-0	-9	
NTB	-2	-29	
Export subsidy	-25	-22	
Production subsidy	-18.6	-4.7	

(a) Including NTB equivalents.

Table 4 **EC-aggregate simulation results** (a)

	Gross output %	Exports to the ROW %	World price %
EC Agriculture	-18.7	-65.6	7.8

(a) All results are given in percentage change form.

Simulation results

To study the effects of liberalizing agricultural protection, the policy scenario described in Table 3 is imposed on the model. Generally speaking, the consumption tax and production subsidies are domestically oriented, while the other instruments are trade oriented. Hence, given the relative size of the exogenous shocks and the largely domestic orientation of European agriculture and food processing, the simulation results are obviously dominated by the consumption tax and production subsidy effects. For each country the consumer price index was chosen as numeraire so that all price changes can be interpreted *as real*. The results are presented in Tables 4 to 6. The database used in this simulation is described in Appendix C.

Table 5 **Country-specific simulation results** [(a)(b)]

	Germany, FR %	France %	United Kingdom %	Italy %
Gross Output				
Small farms	-0.3	16.4	9.8	4.9
Large farms	-62.5	-58.5	-52.4	-41.3
Total agriculture	-25.6	-15.6	-31.6	-7.3
Food processing	-12.2	-12.8	-18.7	-9.6
Manufacturing	1.1	2.1	1.1	0.5
Services	0.5	0.5	1.2	-0.2
Labour Movement				
General labour	3.8	4.3	5.5	3.5
Family labour	2.8	2.4	6.2	6.6
Income				
Maximum	-0.9	-1.2	-0.9	-1.6
Actual	1.5	1.1	3.1	0.7
Primary Factor Returns				
General labour	0.0	0.0	0.0	0.0
Family labour	-18.9	-11.1	-33.4	-13.5
Land	-50.1	-32.3	-56.0	-30.8
Capital	-0.7	-0.9	-2.0	-1.5
Domestic Consumer Prices				
Agriculture	7.4	8.1	6.9	7.2
Food processing	5.7	6.9	3.4	6.1
Manufacturing	-1.8	-1.8	-2.2	-2.1
Services	-1.9	-2.1	-2.4	-2.3
Domestic Consumer Demand				
Agriculture	-9.0	-3.1	-5.4	-2.1
Food processing	-6.5	-6.3	-11.3	-5.7
Manufacturing	0.8	0.7	1.4	-0.1
Services	0.5	0.2	-1.3	-0.3
Exports to the ROW				
Agriculture (to the EC)[(c)]	-162.6	-15.2	-174.1	68.2
Food processing	-56.0	-57.1	-52.5	-57.4
Manufacturing	4.5	6.3	3.9	4.3
Services	6.2	9.6	6.3	6.6
Imports from the ROW				
Agriculture	8.8	13.2	4.5	10.2
Food processing	60.4	62.2	53.2	61.3
Manufacturing	-2.6	-3.4	-2.0	-2.7
Services	-2.2	-3.0	0.0	-2.1
Exchange Rate	-1.6	-2.3	-1.2	-1.4
Terms of Trade	0.3	0.7	1.6	0.5

(a) All price changes are relative to the country-specific consumer price index.

(b) Labour movements are relative to the employed and not the total work force.

(c) These numbers are relative to each country's exports to the EC, with corresponding imports of EC agricultural product held constant. Changes of <-100% thus can arise, for example, if a country switches from a net exporter of EC agricultural product to a net importer. In the case of Germany, net imports increase by 885 million ECUs, while in the United Kingdom net imports rise by 1020 million ECUs.

Table 6 **Inter-EC transfers[a]**

	Germany, FR %	France %	United Kingdom %	Italy %
Transfers				
Value of exports	2.9	2.5	0.5	5.2
Value of imports	3.8	1.4	3.3	2.2
Consumption tax	-8.8	-10.8	-8.7	-10.2
Production subsidy on agriculture	-5.4	-9.0	-3.6	-10.0
Production subsidy on food processing	-2.5	-2.9	-2.3	-3.2
Import tariff on agriculture	-0.1	-0.0	-0.1	-0.0
Import tariff on food processing	-1.9	-1.6	-3.6	-2.1
Export subsidy on agriculture	0.3	-1.3	-0.0	-0.1
Export subsidy on food processing	-0.4	-0.9	-0.7	-0.2
Net Transfers	2.8	-1.7	5.8	-1.2

(a) For all intra-EC transfers the value of total export receipts in the base period has been chosen as a reference point, against which all entries are expressed in percentage terms.

Production and trade

The main results can be summarized as follows. Mainly because of the removal of the production subsidies, EC agricultural output decreases by 19 per cent, while food processing output falls by an average of more than 13 per cent. Agricultural and food processing exports to the ROW fall by 66 per cent and 56 per cent respectively, while corresponding imports from the ROW rise by 9 per cent and 59 per cent. These results largely reflect the effects of trade liberalization and the size of the relevant export demand and import supply elasticities.

The removal of the agricultural production subsidy is associated with a 6.3 per cent drop in the price received by producers. Hence, in order to decrease the cost of production, producers must force down the price of those inputs which are used most intensively. Indeed, returns to land and family labour fall by an average of 42 per cent and 19 per cent respectively. It follows that those agricultural sectors, which are the least intensive users of land and family labour, and thus have the least control over the cost of their production, experience the greatest output contractions. This is in the United Kingdom and Germany, where production decreases by 32 per cent and 26 per cent respectively, while in Italy output declines by only 7 per cent.

While large farms experience massive contractions in all member countries, small farms are actually able to expand, the main reason being that the latter are more intensive users of

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inputs which are specific to agriculture and, as explained above, are therefore cheaper. This subsectoral growth differential, which is most pronounced in France, clearly indicates that the production subsidy has had an adverse effect on small farms. Furthermore, since small-scale agriculture is an intensive user of family farm labour, its employment prospects are substantially improved. Though at lower wages, employment of family labour increases by 6.6 per cent in Italy, 6.2 per cent in the United Kingdom, 2.8 per cent in Germany and 2.4 per cent in France. This suggests that the CAP has not necessarily secured farm employment, even though agriculture has been its main focus of support. In fact, the opposite appears to be true. As far as small farms are concerned, that is, the advantage of receiving explicit support has been more than outweighed by increased competition from large farms.

Food-processing production decreases for the following four reasons. First, the removal of the agricultural production subsidy makes this good more expensive. However, since food processing is an intensive user of agricultural inputs, its cost of production increases. Second, the removal of the food-processing production subsidy means that producers receive a lower price than they would otherwise. Third, the removal of the import tariff makes food processing goods from the ROW much cheaper so that both consumers and producers are encouraged to switch demand in favour of ROW product. Finally, removal of the export subsidy makes domestic product much more expensive on the world market. Production growth differentials between countries therefore largely reflect agricultural input intensities and differences in export shares. As for agriculture, the contraction is greatest in the United Kingdom with 19 per cent.

Whereas food-processing exports from the four countries to the ROW change by roughly the same amount, agricultural export growth figures vary widely. On the one hand, there are virtually no more German and British agricultural exports. On the other hand, exports from Italy actually expand. This reflects the competitive nature of European farming under the CAP, which has been captured in the model by the specification of a common agricultural sector. Concerning agricultural and food processing imports from the ROW, the figures for the four countries are again fairly similar. Intra-EC trade in food-processing product generally declines.

The rise in agricultural and food processing imports from the ROW and the drop in corresponding exports cause a devaluation of all member countries' currencies, which amounts to 1.6 per cent on average, though it is slightly higher in France at 2.3 per cent and slightly lower in Italy at 1.4 per cent. Note that only in France and Italy agricultural export earnings form a significant component of their trade accounts. Hence, despite the massive drop of agricultural exports from the United Kingdom and Germany, exchange rates in these two countries overall are no more affected than in France or Italy.

As a result of the devaluations manufacturing and services exports to the ROW rise by about 5 per cent and 7 per cent respectively. Given the export orientation of the manufacturing industry, this sector expands by 1.2 per cent Community-wide, while the domestically oriented services sector is less favourably affected. At the same time manufacturing and services imports from the ROW decline by an average of 3 per cent and 2 per cent respectively, while intra-EC trade in these commodities reflect relative exchange rate movements.

Employment of general labour

Given real wage rigidities and the fact that the expanding manufacturing sector is relatively labour intensive, employment of general labour improves by more than 3.5 per cent throughout the Community. It is estimated that 1.4 million persons less would be unemployed in the United Kingdom alone, if agricultural and food processing protection was removed. The corresponding numbers for Germany, France, and Italy are 1.0 million, 0.9 million and 0.7 million. Extrapolating these results to the EC-10 on the same pro-rata average basis suggests that over 4.6 million persons more could be employed as a result of removing agricultural and food-processing protection.

Had real wages been completely flexible, returns to general labour would have risen by more than 2 per cent Community-wide and employment of both labour categories would have remained virtually unchanged, though still showing a significant drop in the price of family labour. However, all other results would have been only marginally affected, since supply response and funding of unemployment benefit have an only small effect on the aggregate economies. The unemployment outcome obtained in this simulation can therefore be largely attributed to real wage rigidities.

Even if in the real world real wages were only somewhat sticky, translated into jobs it can be said that the unemployment consequences of the CAP are highly significant. Given that even in the long term real wages tend to be more rigid than flexible (Klau and Mittelstädt, 1986), unemployment is likely to be in the order of two to four million people. Compared with the results reported in Stoeckel (1985) and Breckling et al (1987), this is a much higher level of unemployment, the main reason being that in the current study national government support has been included along with EC budgetary assistance. The fact remains that there is mounting evidence that diverting resources into agriculture does not save jobs but exacerbates the unemployment problem throughout the Community and across all sectors including agriculture.

Income and consumption

Largely as a result of increased employment (or increased returns to general labour in case of flexible wages) aggregate income rises by 1.6 per cent on average. Since the agricultural and food-processing sectors form a larger part of the French and Italian economies, it is not surprising that these two countries as a whole emerge as the main beneficiaries of CAP price support. Whereas in the United Kingdom liberalization causes real income to rise by 3.1 per cent, in Italy it increases by only 0.7 per cent. Nevertheless, all four economies could be better off, though to different degrees, if agricultural and food-processing protection was removed.

Reflecting relative price movements, consumers of agricultural and food-processing goods switch demand in favour of ROW product, while consumers of manufacturing and services goods switch demand in favour of domestic product. Whereas consumer demands for domestic agricultural and food-processing goods decline by an average of 5 per cent and 7 per cent respectively, demands for ROW product increase by 18 per cent and a massive 65 per cent, largely because of trade liberalization. Further, reflecting the rise in real income, consumer demands for domestic manufacturing and service goods tends to increase. Demands for ROW product, on the other hand, fall by 3 per cent and 2 per cent respectively, mainly because of the devaluations. That is, demands for domestic goods are largely determined by the consumption tax and production subsidies, while demands for ROW product mirror the effect of trade protection measures.

Money transfers

In this section, the net money transfers between EC member countries are analyzed. The effects of the seven policy instruments used in the simulation are summarized in Table 6. For each country the value of total export receipts in the base period, which is assumed to be the same as the value of total import expenditure, has been chosen as a reference point against which all changes are expressed in percentage terms. That is, transfers are measured relative to the value total exports would have taken in the absence of any change to the CAP.

The first five rows in Table 8 represent the four major components in each country's trade balance – that is, value of exports, value of imports, the consumption tax and the two production subsidies. These rows therefore add up to zero, provided the signs are set appropriately. Consequently, standard trade accounts excluding the consumption tax and production subsidy components can be in deficit or surplus. Export subsidy receipts and import tariff revenue, on the other hand, do not explicitly appear in the individual trade accounts. Combining the effect of the seven instruments, the net transfers give an indication of the

extent to which each economy is affected by the CAP.

France and, more particularly, Italy are the main beneficiaries of the agricultural production subsidy, since their agricultural sectors form a much larger part of their economies. The agricultural production subsidy, funded by a consumption tax of appropriate size, amount to a net money transfer from the United Kingdom and Germany to Italy and France. The food-processing production subsidy causes a transfer in the same direction, though of smaller magnitude, as food processing is about equally important in the four economies.

Agricultural trade support also involves a net transfer from Germany and the United Kingdom to France and Italy. However, here it is France rather than Italy which is the main beneficiary, and Germany rather than the United Kingdom which carries the major burden. Because of the importance of the French agricultural export sector, France is the main recipient of export subsidy assistance. Germany and the United Kingdom, on the other hand, both being significant importers of agricultural product, miss out on the import tariff receipts, which are levied by the EC and not passed on to them.

Food-processing trade support, however, causes a net money transfer from Italy and the United Kingdom to France, leaving Germany largely unaffected. The United Kingdom and Italy are the main contributors to the EC budget while France and to a lesser extent the United Kingdom are the main recipients. Thus France is the main beneficiary and Italy is the main loser of the food processing export subsidy combined with a corresponding tariff. As evident from Table 6, these net transfers can be equivalent to more than 4 per cent of a country's total gross export earnings.

In summary, France, gaining under each scenario, clearly benefits from the CAP, while the United Kingdom, losing under each, carries the major burden as indicated in Table 6. Although Italy is slightly disadvantaged by the trade protection measures, it is the main recipient of the production subsidies. Given that these are more important than trade support, Italy too emerges as a beneficiary of CAP price support. Germany, like the United Kingdom, is a net contributor, mainly because of agricultural protection. Trade in general is adversely affected by the CAP, with the value of both total exports and total imports being reduced in each country. If protection was removed, the terms of trade would improve throughout the Community, though most significantly in the United Kingdom with 1.6 per cent.

It is acknowledged that an adjustment for the linearization approximation would have changed some of the results, in this section, particularly on the trade side. It can be shown, however, that the main results, including the level of unemployment, income loss and net money transfers, would have been affected only marginally.

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Conclusions

The findings of this study show that the agricultural policies of the European Community impose costs which are much greater than the direct and visible budgetary costs. Although the combined agricultural and food-processing sector does not account for more than 10 per cent in any of the four major economies, there are significant costs to the other sectors in the EC. The reason is that the rate of agricultural protection in the EC is among the highest observed for any sector anywhere in the world. As this study indicates, the adverse effects associated with the CAP may be summarized as follows:

- the support afforded the agricultural and food processing sectors does not save jobs. Rather, it exacerbates the unemployment problem in other sectors and in the Community as a whole;

- it is estimated that employment in the EC-10 is reduced by 2 to 4 million people. The employment consequences are most severe for the United Kingdom where up to 1.4 million people more could be employed if agricultural protection were removed. The corresponding numbers for Germany, France and Italy are 1.0 million, 0.9 million and 0.7 million respectively;

- the support provided under the CAP may have led to a contraction of particular agricultural subsectors. In fact, most of the assistance goes to large farms, causing small farms to decrease production. It thus appears that the CAP worsens unemployment also within the agricultural sector;

- the manufacturing industries (apart from food processing) suffer significant contraction throughout the Community and hence, are the main losers of the CAP;

- there are significant transfers between member countries, with the United Kingdom and Germany carrying the burden, and France and Italy being the beneficiaries.

Compared with the studies by Breckling et al (1987) and Stoeckel (1985), these results show that national government support has an equally adverse effect on the other sectors of the Community as EC budgetary assistance.

The Community has made a conscious decision to increase agricultural output. It has done this by diverting resources from other areas, thus reducing growth in these areas below their potential, and by encouraging significant growth in agricultural exports, mostly at a loss. Had the Community chosen not to direct research and other resources into agriculture, these resources could have been used in areas where world demand has grown strongly. Had they

done so, the economic growth rates in the United Kingdom and Germany, the level of manufacturing and services exports, and the EC share of those exports in world trade would be greater today. By concentrating resources in agriculture, an area where the Community has not traditionally had a comparative advantage and where it is unlikely to gain a comparative advantage in the future, the Community has had to pay a high price.

These results show that agricultural protection has cost jobs, rather than saved them as has been asserted by the Commission. Contrary to the main reason given for the lack of reform, namely that jobs would be lost, the opposite in fact is true. Reform of agricultural policies in the EC would enhance job prospects, and would increase manufacturing output and manufacturing exports.

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Appendix A Objectives and instruments of the CAP

The objectives of the Common Agricultural Policy were set down at the formation of the Community in Article 39 of the Treaty of Rome, 1957 (see BAE, 1985). As summarized in Breckling et al (1987) the objectives of the CAP are to promote technological and productive efficiency, support farm incomes, provide stable prices, and assure food supply.

To achieve these objectives a vast array of instruments has been used. The basic principle is a unified agricultural market. This has primarily been achieved through CAP price support and by permitting free trade within the Community's agricultural sector, with members sharing joint budgetary responsibility (BAE, 1985).

CAP price support is based on three price differentials for agricultural products – between EC countries and the rest of world, between EC countries themselves, and between EC producers and consumers. More specifically, the price support measures can be summarized as follows:

- **Intervention purchasing arrangements.** Government or semi-government agencies purchase commodities to prevent their market prices from falling below specified intervention prices.

- **Variable export subsidies.** They bridge the gap between internal market prices and prices that can be obtained for exports to the rest of the world. Within the Community these subsidies are also known as export refunds or restitutions.

- **Budgetary assistance.** Paid for either by the Community or national governments, this assistance is for farm restructuring, research and technological development, and input subsidies. In addition, some national governments provide subsidies on output. All of these assistance measures have the effect of increasing the supply of agricultural products.

- **Variable levies.** Imports of both agricultural and food processing products are subject to levies to ensure that they do not enter the Community at prices that may circumvent the effects of domestic support policies.

- **Monetary compensatory amounts (MCAs).** These exist to ensure that some products do not flow across national boundaries at prices that might 'disrupt' production in EC members as a result of varying exchange rates. The MCAs can be either positive or

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negative and therefore act as either export taxes or import subsidies.

- **The consumption or value added tax (VAT).** Currently, the fixed statutory maximum of the tax is 1.4 per cent of the base on which the VAT is levied. The tax provides the main revenue source to fund EC expenditure on agriculture.

In addition to these price support measures, the Community has adopted production quotas and quantitative import restrictions as instruments of agricultural support.

In most years, assistance provided to the agricultural sector by the variable import levies has exceeded that provided directly by the Community or national governments. Because the impact of the variable import levies depends on the disparity between the domestic and international prices of agricultural products, the levy component of the assistance package has tended to fluctuate considerably over time. Nevertheless, the trend has been upward since 1971-72.

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Appendix B Derivation of the exogenous shocks

As shown in Table 2, the cost to taxpayers in 1980 was estimated at 18.7 billion ECU (bECU). This amount consists of 9.2 bECU raised by the centralized budgetary authority of the Community and 9.5 bECU from national governments (BAE, 1985, p102). Hence, national government support, excluding social security benefits, was of the same order of magnitude as that financed by the EC budget. EC revenue is raised mainly from VAT contributions, agricultural and food processing import levies, and other customs duties. Since the latter were held constant in the model, the other revenue figures had to be adjusted such that EC expenditures could be financed. This procedure led to 7.2 bECU raised from the VAT and 2.0 bECU from import tariffs.

While EC revenue is spent about evenly on export restitutions and other intervention measures – mainly storage, and aids to producers, processors and marketers (BAE,1985, p103) – domestic support falls almost entirely into the second category. Table 7 gives a breakdown of EC expenditure in 1980, as derived from the financial report on the European Agricultural Guidance and Guarantee Fund (BAE, 1985, p64).

For the purpose of this paper it is assumed that storage aids are implicit export subsidies and that other intervention expenditure – basically price compensatory measures – is captured by a production subsidy. This implies that taxpayer transfers can be allocated as in the last row of Table 8. Furthermore, it is assumed that national government expenditure on agriculture and food processing is funded from general taxes which are collected in the same way as the VAT. While the VAT ceiling for the EC Budget was 1.0 per cent in 1980, to fund both national government and EC expenditures, consumers in the Community were effectively confronted with a uniform consumption tax of 2.1 per cent. This raises an amount of 16.7 bECU, with the remaining 2.0 bECU coming from import levies.

Taking the values of agricultural and food-processing production, exports and imports (Commission of the European Communities 1984b, pp 188-195 and 253), support provided under the CAP can be quantified as in the last two columns of Table 9.

So far, agriculture and food processing have been treated as a combined sector, although CAP support of the two industries differs widely. As evident from Table 8 non-tariff protection is much greater for food processing than for agricultural products, while production aids are generally greater for the latter. It is therefore necessary to disaggregate

Table 7 **EC expenditure by sector and economic category in 1980**

	Export Refunds bECU	Intervention measures			Total expenditure bECU
		Storage bECU	Other aids bECU	Total bECU	
Agriculture	1.8	0.2	1.3	1.5	3.3
Food processing	2.8	1.1	2.0	3.1	5.9
Combined	4.6	1.3	3.3	4.6	9.2

Table 8 **PSEs for agriculture and food processing**

	Taxpayer			Consumer	Total
	Export subsidies bECU	Production subsidies bECU	Total bECU	bECU	bECU
Agriculture	2.0	8.9	10.9	1.0	11.9
Food processing	3.9	3.9	7.8	28.5	36.3
Combined	5.9	12.8	18.7	29.5	48.2

Table 9 **Estimated relative size of agricultural and food-processing protection measures**

	Agriculture %	Food processing %	Combined %	Whole economy %
Consumption tax				2.1
Import tariff	0.3	9.6	4.9	
NTB	1.7	41.1	22.8	
Export subsidy	33.9	28.8	30.4	
Production subsidy	22.8	4.9	10.9	

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the assistance measures into agricultural and food-processing components. Estimates of relative PSEs for all major agricultural and food-processing commodities are obtained from OECD (1987, p117). Given the share of these commodities in total production (Commission of the EC, 1984b, p190), the total PSE of 48.2 bECU can then be divided between agriculture and food processing as indicated in the last column of Table 8.

Total EC expenditure under the Guarantee Section on agriculture and food processing has been disaggregated by product in BAE (1985, p64). Further, referring to Commission of the European Communities (1984c, p30), 80 per cent of domestic support are directed towards agriculture and only 20 per cent towards food processing. This implies that 10.9 bECU of the taxpayer's contribution of 18.7 bECU are spent on agriculture and 7.8 bECU on food processing. Disaggregated consumer transfers are then obtained residually, yielding the figures presented in Table 8. It follows that consumer transfers are much greater for food processing than for agriculture, reflecting the greater non-tariff protection of the former sector as mentioned above.

Referring to BAE (1985, p64), expenditure on storage and export restitutions can be disaggregated in exactly the same way as total taxpayer transfers. By residually determining the amount spent on other production enhancing measures, Tables 7 and 8 are completed. Finally, assuming that the tariff revenue from agricultural and food-processing products is raised in exact proportion to the corresponding NTBs, it is possible to derive the size of the CAP induced distortions as listed in the first two columns of Table 9. Finally, in order to simulate the effect of trade liberalization, these protection measures need to be removed, yielding the simulation package presented in Table 3 above.

When estimating the figures presented in Table 9, it was assumed that the entire amount raised domestically goes into agricultural and food-processing production. However, to the extent that these funds are not used efficiently, the production subsidy figures have been revised downwards by 16 per cent, which at the same time ensures a balanced EC budget. As in Breckling et al (1987), monetary compensatory amounts are held constant. It is also assumed that the EC expenditure constraint and all individual trade accounts remain unchanged, in accordance with the long-run framework adopted in this study and also consistent with the historical evidence of an unchanged net trade position for the Community in aggregate (Commission of the EC 1986, p22).

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The major source for the share parameters associated with the equilibrium position was the Standardised Input Output Tables of EEC Countries for Years around 1975 (United Nations, 1982). These data were augmented by 1980 trade shares obtained from OECD trade tapes used in the INTERLINK Model (OECD, 1983). Country-specific unemployment figures were obtained from OECD statistics for 1979 (OECD, 1985). The ratio of unemployment benefit to employment wage was set to 0.5 for all countries. The input-output shares of the agricultural subsectors were derived from the Farm Accountancy Data Network (Eurostat, 1982). Small farms were defined as those producing less than 16000 ECU and large farms as those producing this amount or more. Further details on the database are provided in Breckling, Thorpe and Stoeckel (1988).

Behavioural elasticities were taken from studies by Whalley (1985), Stern, Francis, and Schumacher (1976) and Deaton and Muellbauer (1980). Table 10 provides a list of the elasticities used in this study. Even though the estimates may vary considerably, the sensitivity analysis reported in Breckling et al (1988) shows that, except on the trade side, most results are fairly robust and that the effects on the domestic economies are negligible.

In the simulation study described in Breckling et al (1988) an elasticity of substitution between domestic and imported agricultural and food processing product of e = 1.0 was chosen. Even though this caused the world price of ROW product to rise and the domestic price of the same good to drop sharply, the price of EC product was hardly affected despite the size of the substitution elasticity. The reason was that the share *a* of ROW product in the corresponding effective commodities is so small, that agricultural and food-processing product could almost be regarded as non-traded items. It is argued, however, that these shares are so small just because of the protection and that they would be much greater in the absence of the CAP. The substitution elasticities were therefore set to 3.0 so that the implicit import demand elasticity ae takes a more realistic value. By the same token, the import supply elasticities were also slightly revised.

Table 10 **Key behavioural elasticities**

Description	Best Guess
Production substitution elasticities (CES)	
Between commodities and primary factors for all countries	0.8
Production and consumption elasticities	
Between domestic and imported goods for all countries	
Agricultural products	3.0
Food-processing products	3.0
Manufacturing products	4.0
Services goods	2.0
Consumer income elasticities	
Agricultural products for all countries	0.2
Food-processing products for all countries	0.4
Manufacturing products for all countries	0.8
Services goods[a]	
Germany, FR	1.16
France	1.15
United Kingdom	1.15
Italy	1.21
General labour leisure demand	2.0
Family-farm labour leisure demand	2.0
Export price elasticities of ROW demand	
Agricultural and food-processing products for all countries	2.0
Manufacturing products for all countries	3.0
Services goods for all countries	4.0
Import price elasticities of ROW supply	
Agricultural and food-processing products for all countries.	4.0
Manufacturing products for all countries.	4.0
Services goods for all countries.	5.0

(a) These settings ensure that the weighted sum of expenditure elasticities is unity in each country.

Effects of agricultural protection in Japan: an economy-wide analysis

by

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Summary

Japan is now the world's largest importer of agricultural products. Yet agricultural imports into Japan are more restricted than for any other OECD country. The main instruments of protection for the Japanese agricultural sector are quantitative restrictions against imports and, to a lesser extent, import tariffs and domestic subsidies to farm inputs.

As a result of border protection measures, domestic producer prices for Japanese grains in 1986 were on average 420 per cent above world prices. The corresponding margin for livestock products averaged 116 per cent.

While government protection of Japanese agriculture has a long history, the major expansion in protection has occurred since the mid 1950s – which marked the start of the rapid export-led growth of Japanese manufacturing and hence steady decline in agricultural comparative advantage. Underlying the government's policy response of increasing agricultural protection have been the notions of food security and parity between farm and non-farm incomes.

Foreign critics of Japan's trade policies give particular emphasis to a lowering of import barriers to agricultural products. While concessions in this area by Japan would provide an important signal to the rest of the world of Japan's preparedness to liberalize its trading regime, domestic forces opposing the reform of agricultural protection remain strong. Around 20 per cent of Japanese households are farm-based with farmers (many of which are part-time) a potent political force.

Nevertheless, there are powerful domestic interest groups outside agriculture with an interest in the reform of agricultural protection. What is needed is support for such groups in the form of a better understanding of the domestic effects of Japanese agricultural protection, in particular the extent to which such protection operates as a tax on the economic performance of other sectors of the Japanese economy. To date no such analysis along these lines has been published.

The domestic costs of agricultural protection, in particular its effects on other domestic sectors, are assessed here. The analytical framework used is a multi-sectoral economy-wide model which incorporates the direct and indirect linkages within and between agriculture, other domestic sectors and Japanese international trading performance.

The results emphasize the way in which agricultural protection, by raising domestic

costs and hence decreasing the purchasing power of a given nominal wage, acts to reduce significantly the living standards of wage earners.

Increased domestic costs relative to world prices imply reduced international competitiveness of non-agricultural traded activities, especially Japanese manufacturing. Our projections show that a major part of the bad news is in the form of an implicit tax on Japanese manufacturing, particularly the sectors producing and exporting transport equipment, other machinery, mineral and metal products, and chemical products. This tax is sufficient to curtail manufacturing export earnings by about 3 per cent on average, equivalent to about 1.2 trillion yen (in 1985 prices). This leads to reductions in output in these sectors over the short to medium term of between 0.3 and 2 per cent and reductions in manufacturing employment demand of from 0.4 to 4 per cent.

An alternative way of viewing agricultural protection is in terms of its effects in a macro-economic environment in which the economy's average real wage level is assumed to adjust to ensure constant aggregate employment, and in which induced changes in aggregate spending are equivalent to induced changes in aggregate income, such that the outcome for the balance of trade does not change. In this environment the effects of agricultural protection at the sector level are much the same as those described above. The boost to output, employment and income in agriculture through heavily reduced agricultural imports is offset by greatly diminished manufacturing export performance and hence a reduction in output, employment and income in export-oriented manufacturing activities.

Overall, macro-economic performance is also diminished. There is a small reduction in the economy's real income, and hence the level of real spending that it can sustain, and a reduction in the average real wage level of 2.5 per cent – equivalent to about 101,000 yen per worker in 1984. That is, a particularly important consequence of Japanese agricultural protection is to reallocate significantly a diminished aggregate income away from Japanese wage earners and towards the owners of rural land. The rental price of rural land is raised by about 68 per cent.

In recent years Japan has accumulated a massive surplus of exports over imports. Pressures from the USA in particular for Japanese agricultural trade liberalization have intensified as Japan's current account surplus has continued to grow contemporaneously with the continuing large trade deficits of the USA. It is tempting, though incorrect, to regard Japanese agricultural protection as a contributing factor in this surplus.

While our analysis shows that imports of Japanese agriculture would increase by over 90 per cent if domestic protection were removed, Japanese manufacturing export earnings would also increase significantly. In fact, if the labour market gains were appropriated not by

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higher real wages but by increased employment, then Japan's trade surplus would increase. That is, the tax effect on aggregate export earnings from agricultural protection exceeds the savings in aggregate import expenditures from such protection.

The fundamental cause of Japan's current account surplus is too little spending relative to income, implying a surplus of domestic savings over that needed by domestic investment at home. Our analysis shows that the removal of this surplus through a balanced increase in domestic spending would have adverse effects on Japanese agriculture. Put another way, the continuation by Japan of a trade surplus is favourable to Japanese agriculture in the sense that, if this surplus were eliminated, either Japanese agriculture would contract, or to prevent this contraction taking place, the rate of protection required by Japanese agriculture would need to be increased.

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I Introduction

Japan is now the world's second largest economy. It is also the world's largest importer of agricultural products. Despite this, Japan has a domestic agricultural sector which is highly protected from import competition. The level of protection has escalated in recent years to the point where Japanese agriculture is now considerably more highly protected than the agricultural sectors of any of the other major industrial countries (OECD, 1987).

The heavy protection given to Japanese agriculture has important implications for both the domestic economy and the international trading system. It is trite, though nevertheless important, to emphasize that every part of domestic economic activity is linked to every other part. These linkages occur through product market purchases and sales, through factor markets, through the relationship between aggregate income and expenditure, and hence the balance of trade, and through institutional arrangements such as labour market settings.

Because of such linkages, assistance to Japanese agriculture must inexorably involve a tax on other more lightly protected sectors of domestic economic activity – in the Japanese case this is manufacturing. This protection for agriculture in turn will alter both the level and sectoral distribution of economic activity and employment in Japan, and, through different factor intensities across sectors, the distribution of national income between labour, the owners of manufacturing capital and the owners of rural land.

At the international level Japanese agricultural protection has several important consequences. First, it is a major source of friction between Japan and her trading partners, particularly agricultural exporters such as the USA and Australia. Pressures from the USA, in particular for Japanese agricultural trade liberalization, have intensified as Japan's current account surplus has continued to grow hand in hand with the continuing large trade deficits of the USA. Given the substantial share of world economic activity encompassed by Japan and the USA, the threat of retaliatory action, if carried out, has the potential to damage the world trading system well beyond agriculture.

Second, because Japanese agriculture is heavily protected relative to Japanese manufacturing, such protection, as well as operating to tax the exports to Japan of agricultural products, in effect acts as a subsidy to foreign suppliers of manufactured goods on the world market.

This chapter discusses two main issues concerning Japanese agricultural protection.

The first, which is taken up in Section II, is concerned with how Japanese agricultural protection has developed in the postwar period, the reasons for its development and the level it has now reached. The second, which forms the subject of Section III, is concerned with the costs to the Japanese economy of this protection in terms of diminished macro-economic performance and living standards and the extent to which it has restricted the economic performance of more efficient domestic activities such as manufacturing and reduced the earning of factors of production employed outside agriculture.

The analysis of the effects of Japanese agricultural protection is performed at a time of large and persistent trade imbalances in the world economy. Japan, with export earnings twice the size of expenditure on imports in fiscal year 1986 yielding a trade surplus of $US100 billion or around 4.3 per cent of GNP, is at the centre of this international economic disequilibrium. Until this disequilibrium is resolved, it will continue to cast a long shadow over prospects for the world economy. It is timely therefore to consider the issue of what role, if any, Japanese agricultural protection has played in Japan's current account surplus and the contribution the dismantling of such protection might make towards arresting the Japanese current account imbalance. This is done in Section IV.

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II Agricultural protection in Japan

History

Government intervention in Japanese agriculture to protect it from import competition has a long history. In reviewing this history Hayami (1987) draws attention to the 15 per cent tariff imposed on imported rice in 1905, initially as a revenue measure to help finance the 1904-1905 war with Russia, but retained as a longer term protective device after lobbying from land interests. Following the rice riots of 1918, an imperial food self-sufficiency policy was implemented. A key feature of this policy involved the development of rice growing in the then Japanese colonies of Korea and Taiwan. This provided a means of meeting the growing demand for food over and above that which could be provided by the adoption of land-saving agricultural technology on the Japanese mainland. Rice imported from these territories entered free of duty.

The major expansion in Japanese agricultural protection has occurred since the mid 1950s. This marked the start of the rapid export-led industrialization of Japanese manufacturing and hence steady decline in the comparative advantage of agriculture. The government's response was to provide offsetting assistance to agriculture in steadily increasing amounts, thereby ensuring that part of the adjustment, which would otherwise have been borne by the farm sector, was passed back on to other sectors of the economy.

Underlying the government's policy response were the notions of (a) food security, if not food self-sufficiency, and (b) equity expressed in terms of parity between farm and non-farm incomes. In 1961 the Agricultural Basic Law was passed in which the government accepted responsibility to raise agricultural productivity and thereby close the income gap between farm and non-farm. Despite positive efforts at structural adjustment, the rate of agricultural productivity growth was not in itself sufficient to close this gap. Farmers sought, and were granted, additional protection to achieve this – initially through high domestic prices for rice. In recent years, farm and non-farm income parity has been achieved through:

(i) steadily escalating protection; and

(ii) a significant shift to part-time farming made possible by the growth in off-farm employment opportunities.[1]

1 According to figures reported by Winters (1986) in 1984 only 13 per cent of Japanese farms were operated by full-time labour while 71 per cent of farm households received more than half their income from non-farm sources. Average income per household member in these latter households was about 25 per cent higher than in full-time farming households.

Despite this increased protection, agricultural production has not kept pace with the growth in domestic demand for agricultural products so that the level of agricultural self-sufficiency is steadily declining.[2]

Level of protection to Japanese agriculture

An indication of the level of protection received by a particular sector can be obtained by reference to a number of summary measures. One such measure frequently used to this end is the nominal rate of protection. This measure reflects the extent to which assistance raises the producer price of the product above the world price at the border. While this measure incorporates assistance arrangements which impact on the output price it does not take account of assistance provided by subsidies to inputs. Nor does it incorporate penalties (negative subsidies) on inputs which may arise through protection to other products in the economy used as inputs by agriculture.

Table 1 shows how agricultural protection, as measured by the percentage by which the producer price exceeds the border price, has increased in Japan since 1955. For example, in 1955 the producer price of rice was 24 per cent above the border price. By 1980 this price differential had risen to 192 per cent and by 1986 to 414 per cent. Protection is large, and has grown most quickly, for the more land-intensive commodities. This reflects Japan's scarce endowment of land relative to capital and, hence, lower comparative advantage in this part of agriculture.

An alternative measure of the degree of protection which has been strongly promoted in the context of agriculture by the OECD and the US Department of Agriculture is the producer subsidy equivalent (PSE).[3] Because it incorporates assistance provided to agricultural inputs this measure is somewhat broader than the nominal rate of protection measure.

Input subsidies, particularly those concerning infrastructure development, are a significant form of assistance to Japanese agriculture. According to estimates compiled by the EC Commission in the early 1980s the ratio of agricultural subsidies (current plus capital) to agricultural GDP in Japan was about 33 per cent. Measures of Japanese agricultural protection based on the PSE concept, which include input subsidies, are generally higher than

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2 According to figures from the Japanese Ministry of Agriculture, Forestry and Fisheries, Japan's food self-sufficiency has declined from 91 per cent in 1960 to 76 per cent in 1975 and 73 per cent in 1985.

3 See in particular OECD (1987). The PSE is defined as the payment that would be required to compensate farmers for the loss of income resulting from the removal of assistance. It can be expressed either as a monetary amount or as an amount per unit of commodity produced or as the ratio of total assistance to the total value of receipts.

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Table 1 **Nominal Rates of Protection in Japan for Selected Agricultural Commodities: 1955-1986**

Commodity (per cent)	1955	1960	1970	1980	1984	1986
Grains						
Rice	24	47	135	192	235	414
Wheat	31	51	134	261	318	541
Barley	24	52	158	307	363	611
Average (all grains)	24	48	135	196	239	420
Livestock products						
Beef	39	84	108	100	103	211
Pork	2	97	-9	17	21	86
Chicken	-52	19	18	23	9	67
Eggs	-19	-7	-9	-1	-7	42
Milk	4	5	212	186	185	338
Average (all livestock products)	-8	22	24	40	41	116

Source: Hayami (1987).

the nominal rate of protection estimates of Table 1. For example, estimates by Walker (1988) on a PSE basis (value of assistance as a percentage of the unassisted producer value of production) are as follows: rice (565); wheat (285); dairy products (235); ruminant meats (mainly beef) (240) and non-ruminant meats (mainly pork, chicken) (110).

Form of agricultural protection

Agricultural protection in Japan is provided by two types of instruments – border protection measures and domestic subsidies. Protection from imports in turn allows a complex system of internal price supports to be maintained . The system for rice, for example, involves, in addition to price support, area restrictions and marketing regulations.

Border protection

Border protection measures are mainly in the form of quantitative restrictions against imports. In addition there is a regime of import tariffs, though tariff rates are low in ad valorem terms. Dairy products, beef and processed meat products, flour and cereal products, fresh and

processed fruit and vegetable products, and sugars are all subject to import quotas administered by the Ministry of Agriculture, Forestry and Fisheries. For some products, imports are controlled by government or semi-government trading agencies – eg rice, wheat and barley by the Food Agency and beef, butter and powdered milk by the Livestock Industry Promotion Corporation.

Tariffs are a good deal less important than quantitative restrictions. According to the Japanese Ministry of Agriculture, Forestry and Fisheries, the average tariff rate on imported agricultural commodities was 8.6 per cent in 1984 (Hayami, 1987).

The tariff equivalent of the amount of protection provided by quantitative restrictions set at a particular level, as measured by the extent to which domestic prices are raised above world prices, will fluctuate over time in response to movements in the world price in foreign currency and the exchange rate. To the extent that the yen appreciates against the currency in which world agricultural commodity prices are denominated then the amount of protection delivered by the quota increases. Given the 28 per cent appreciation of the yen against the US dollar over calendar year 1987 this suggests that the nominal rates of protection, as measured for 1986 in Table 1, will now be distinctly higher. As such, the effects reported in this study of agricultural protection on the Japanese economy could be considered as conservative.

Input subsidies

Input subsidies are used extensively in Japanese agriculture. They are particularly important in financing agricultural investment, especially in infrastructure. In the early 1980s the ratio of current subsidies to agricultural GDP was about 9 per cent and the ratio of total subsidies (current plus capital) to agricultural GDP about 33 per cent (Hayami,1987).

It is difficult to ascertain how effective these subsidies are in reducing agricultural production costs, and hence improving farm output and incomes. Some component of them would be non-productive in this sense. In recent years there has been a reduction in agricultural subsidies as a result of tighter government fiscal policy to reduce the budget deficit. According to recent OECD estimates (OECD, 1987) expenditure on agriculture as a percentage of total government outlays is about 3 per cent in Japan. This compares with a figure of about 4 per cent for the USA.

III Measuring the effects of Japanese agricultural protection

The summary measures of protection referred to earlier are useful indicators of the size of the wedge between the domestic producer price and the border price caused by agricultural protection. However, they do not incorporate the supply and demand responses to this price wedge by the sector concerned and the flow-on effects in the economy. They therefore have nothing to say about the effects of such protection on commonly used indicators of economic performance such as output, employment and income in the sector being protected, in other domestic sectors and for the economy as a whole. To do this requires interfacing the protection measures with a framework which allows for economic responses. The simplest of these is the partial equilibrium framework.

Several studies have used a partial equilibrium framework to estimate the welfare costs of Japanese agricultural protection at the much lower levels which existed in the 1970s and early 1980s. Examples are O'Mara et al (1981) for 1978 levels of protection, Bale and Lutz (1981) for 1976 levels of protection and Tyers and Anderson (1986) for 1979-80 levels of protection. Although the partial equilibrium framework provides a useful approach, it cannot answer the central question posed in this study – what are the economy-wide consequences of high agricultural protection in Japan? The reason is that the partial analysis does not incorporate linkages, both direct and indirect, between agriculture, other domestic sectors and world trade. Without these linkages such an approach is unable to capture the spill-over effects of agricultural protection on other domestic sectors and the economy as a whole and the way in which these feed back to modify agricultural outcomes. In short, the partial equilibrium framework is unable to deal in any comprehensive way with the real opportunity costs of agricultural protection and hence the incentives for Japan to reverse unilaterally such policies. To do this, an economy-wide framework with sectoral detail is required.

An economy-wide model for Japan

The domestic costs of Japanese agricultural protection are assessed in this chapter using an economy-wide model. This model incorporates the direct and indirect linkages between agriculture, other domestic sectors and Japanese international trading performance.

The model developed here is of the comparative-static neoclassical type. It is derived from the ORANI general equilibrium framework of Dixon et al (1982). This basic framework also lies behind the Korean model (Vincent, 1988) and the West German model (Dicke et al, 1988), companion papers of the overall global agricultural trade liberalization study. The

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model's inter-industry, factor market and trade linkages are derived from a 1980 system of input-output accounts for Japan. These are interfaced with agricultural protection estimates for 1986.

The model distinguishes 19 production sectors. There are two types of agriculture (crops; livestock), three additional primary sectors (forestry and fishing; crude oil; other mining) and two downstream food-processing activities (livestock products which includes beef, pork and poultry; other food products, which is a major purchaser of agricultural crops). These allow for the modelling of various instruments of agricultural protection which are applied at the farm level or downstream. For example, production subsidies are applied at the farm level but some import quotas such as those for beef are applied at the livestock product level.

Eight additional manufacturing sectors are distinguished (textiles; pulp, paper, printing; chemical products; petroleum products; mineral and metal products; machinery; transport equipment; other industrial). In addition to its primary role of analyzing the effects of Japan's domestic protection policies the model is therefore well suited to handling the effects on Japan of changes in the world economy such as, for example, changes in world oil prices or changes in the world demand for motor vehicles.

Service activities are divided into four sectors (construction; transport and communication; government services; other private services). Expansion in some or all of these essentially non-traded activities provides one way in which Japan might seek to correct its present balance of trade surplus.

The theoretical structure of the Japanese model is simple and orthodox.[4] Producers in each sector are assumed to minimize their costs subject to neoclassical production functions of a two-level nested form. At the first level different categories of purchased inputs and an aggregate of primary factors are assumed to be used in fixed proportions. At the second level substitution is allowed, according to CES functions, between domestic and imported sources of each intermediate input and between the three types of primary factors distinguished – capital, labour and rural land. Two types of land are distinguished – cropping land and grazing land. These are industry-specific. The model provides projections of the effects on the rental price of each type of land due to changes in agricultural protection.

The inclusion of a treatment of rural land is particularly important. One of the important consequences of Japanese agricultural protection is its effects on land prices and hence

4 An algebraic specification of the Japan model is available on request from the Centre for International Economics.

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the costs of private dwellings and land-based recreation facilities. High land prices in turn restrain aggregate private expenditure on these items, making it more difficult for Japan to correct its aggregate income-expenditure imbalance.

The labour market is characterised by only one type of labour assumed mobile between sectors. In agriculture the distinction is made between hired workers, self-employed and unpaid family workers. Only about 3 per cent of the work force engaged in agriculture is hired labour. The remaining 97 per cent, consisting of self-employed and unpaid family workers, are rewarded from the gross operating surplus of farm activities. In the very short term, self-employed labour can be regarded as being immobile and are modelled as such by treating them as part of the farm capital stock. This is not the case over the medium term as witnessed by the considerable changes which have occurred in the farm labour force. For example, between 1960 and 1985 the number of full-time farmers fell by about 60 per cent. However, the number of part-time farmers increased by about 70 per cent, reflecting increased off-farm employment opportunities within commuting distance. Overall the number of persons engaged in agriculture fell by about 44 per cent.[5]

Model closure options allow for several treatments of the other primary factor, capital. One option, more relevant for the short-to-medium term, is to consider the quantity of capital in each sector as fixed. Under this option industry specific rates of return to this capital respond differently to the change under study. A second option, more applicable to the longer term, is to allow capital mobility between sectors to eliminate these changes in industry-specific relative rates of return on capital.

Aggregate investment is either set exogenously or determined as a fixed share of total real domestic absorption (aggregate expenditure by households, government and private investment). Aggregate investment determined in this way is allocated among sectors according to changes in industry rates of return.[6]

The model contains a full treatment of demands for each of the 19 domestic and imported products. These are used as inputs into the production of current and capital goods, produced and consumed by households and by government, and exported. Prospects for relative price induced substitution between domestic and imported sources of each product in each of the uses, the production of current goods, the production of investment goods and household consumption are described by Armington elasticities of substitution.[7]

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5 Estimates from the Japan Ministry of Agriculture, Forestry and Fisheries.

6 See Dixon et al (1982).

7 Values assigned to the import substitution elasticities range from 1.0 for mining, 1.2 for manufacturing activities, 3.0 for agriculture to 4.0 for processed foods. The estimates for manufacturing are drawn from

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Household consumption behaviour is depicted by the conventional utility maximization framework. A representative household is assumed to substitute between the different categories of consumer goods and between domestic and imported sources of each category.[8] There is no behavioural theory of government demands. These are simply indexed to aggregate private consumption.

Exports are determined according to the differential between domestic costs of exporting industries and world prices in local currency. Export demands are assumed to be fixed in the case of textiles, highly elastic in the case of those products for which Japan's exports represent an insignificant part of world trade and moderately elastic in the case of the major Japanese export items. World import prices are assumed independent of Japanese import demands.[9]

Market-clearing relationships equate demands with supplies for domestic commodities. They also require that factor demands be satisfied though not necessarily at full employment levels.

The model distinguishes a number of different prices for each activity – producer prices, export prices and import prices. Margins and taxes levied on commodity flows within the domestic economy are not explicitly modelled. Since constant returns to scale and competitive behaviour are assumed, profits accrue only to factors of production. Zero pure-profits conditions equate prices with costs for each of the activities current production, capital creation, exporting and importing.

In the experiments reported later the nominal exchange rate performs the role of numeraire. That is, while the model determines the implications for the real exchange rate of a specified policy shock it is unable to explain how much of this change is due to a change in

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the work of Shinkai (1972). Those for agriculture and processed foods are judgmental. They are higher than for manufacturing to reflect the more basic nature of the product and hence reduced scope for product differentiation between domestic and imported sources of supply.

8 The utility function is of the Klein-Rubin form. To complete the system of household demand equations requires estimates of expenditure elasticities and household budget shares for each consumption good and the Frisch parameter. Expenditure elasticities range from 0.37 (agriculture and processed foods), 1.12 (manufactured goods) to 1.39 (transport and communication). The Frisch parameter estimate for Japan is -0.64. These estimates are based on the work of Theil and Clements (1987).

9 In the case of textiles, export earnings of which represent about 14 per cent of total Japanese export earnings, export volumes were assumed unable to respond to the removal of agricultural protection. This assumption is designed to reflect the regulation of world textile trade through the international multi-fibre arrangement and other means. For those exports where Japan's share of the world market is small, export demand elasticities were assumed to be highly elastic (export demand elasticity of -20.0). For the major Japanese exports of machinery, metal products, transport equipment and other industrial, export demand elasticities were set to -5.0. This figure is judgmental. It is designed to reflect moderate terms of trade power by Japan in these products.

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the value of the yen against foreign currencies or a change in the rate of inflation between Japan and her trading partners.

There is no inbuilt macro-economic closure. Total real domestic absorption can be set exogenously or determined by the difference between the outcomes for real gross domestic product and the balance of trade. The shares of this absorption between private consumption, government expenditure and private investment are set exogenously. There is no explicit accounting of the net revenue position of the government sector. Hence the government's public sector borrowing requirement can be regarded as being always endogenous. This is of little consequence to the overall results as government outlays on agricultural protection, although prominent when compared with agricultural value added, represent less than 3 per cent of total government outlays.

Effects of removing agricultural protection

We concentrate on the implications of removing Japanese agricultural protection for the economic performance of agriculture, other domestic sectors and the Japanese economy as a whole in the context of a short-to-medium term adjustment horizon. This is defined by the assumption that capital in use in each industry remains fixed. Labour, both owner-operator and hired is, however, free to move between sectors. While industries respond differently in terms of investment, any new investment or disinvestment is assumed not to augment the capital stock. In this environment one effect of the removal of agricultural protection is to change existing differentials between industry rates of return to capital. In an environment of longer term adjustment these induced differences could be expected to be diffused by capital flows between sectors.

Within this short-to-medium term adjustment environment we consider two alternative scenarios. They differ according to the treatment of the labour market and the determination of the split between national income and expenditure.

In scenario A we consider the labour market to be characterized by constant nominal wages.[10] Hence, to the extent that the removal of agricultural protection lowers domestic food prices, workers will appropriate some of the gains in the form of higher real wages. The assumption of constant nominal wages is critical to the results in scenario A. We illustrate this by contrasting these results with those under the polar assumption of constant real wages.

We also consider the level of real aggregate domestic expenditure in the economy

10 This is the view of the labour market adopted by Ezaki (1986) in his computable general equilibrium modelling study of oil prices, and fiscal and monetary policy changes in Japan.

(aggregate private consumption, investment and government spending) to remain constant. Hence, any changes in national income following the elimination of agricultural protection show up as a change in the balance of trade. This closure therefore captures the extent to which agricultural protection operates to reduce the international competitiveness of Japanese manufacturing.

In scenario B the labour market and aggregate expenditure assumptions are reversed. In the case of the labour market, wages are assumed to adjust to ensure that the economy's total demand for labour remains constant. Similarly the level of real expenditure is assumed to adjust[11] to ensure that the outcome for the balance of trade is unchanged. That is, the change in aggregate expenditure is equivalent to the change in aggregate income caused by the removal of agricultural protection.

The extent of assistance to be removed

For scenarios A and B we analyze the effects of:

a) removing domestic subsidies to the two land-based agricultural industries: 1 (agricultural crops) and 2 (livestock); and

b) removing border protection (tariffs and the tariff equivalent of import restrictions) to the products which compete with imports in the industries 1 (agricultural crops), 6 (livestock products), in which beef and other meat imports are classified as competing products and 7 (other food products) which includes milled grains and refined sugar.

We take Hayami's estimate for the early 1980s that subsidies on current inputs to agriculture represented on average about 9 per cent of agricultural GDP. The removal of subsidies is simulated by increasing the unit costs of production of agricultural crops and livestock by this equivalent. In the case of border protection measures we take the estimates in Table 1 for 1986 of nominal rates of protection of 420 per cent for agricultural crops and 116 per cent for livestock products as our starting point. We then calculate the percentage reduction in the power of the tariff and hence local price of competing imports that would occur for these sectors and for sector 7 (other food products) if such protection were removed.[12] These

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11 The change in real aggregate expenditure is assumed to be balanced, ie involving equi-proportional changes in its components (aggregate household consumption expenditure, private investment expenditure, aggregate government expenditure). The composition of household consumption expenditure and private investment changes according to the theory outlined above.

12 The shocks to the power of the tariff variable (expressed in percentage changes) which correspond to the complete removal of agricultural protection are 1 (-76.19), 6 (-13.79) and 7 (-9.09). The model's zero pure-profits condition in importing is of the form $P_{2i} = eP^m_i (1 + t_i)$ where P_{2i}, P^m_i and t_i are respectively the local price of imported good i, the cif foreign currency import price of good i and the tariff equivalent of all border protection on good i. The power of the tariff on i is given by $1 + t_i$. e represents the nominal exchange rate (yen/unit of foreign currency).

represent the exogenous shocks driving the results.

The results

Table 2 contains projections of the separate and combined effects on the performance of the macroeconomy, agriculture and other sectors of removing subsidies to agriculture and border protection to agricultural products. It is important to emphasize the comparative-static interpretation of these projections. They represent the percentage changes in the levels of the variables due solely to the removal of assistance. Thus the figure in line 3, column 3 shows that, after a short-to-medium term adjustment period, Japan's aggregate foreign currency export earnings would be 3.2 per cent higher following the complete removal of agricultural protection than they would have been assuming no change in agricultural protection.

Scenario A – constant nominal wages and real domestic expenditure

Removing farm subsidies causes unit farm production costs and domestic agricultural prices to increase. This results in a slight deterioration in international competitiveness and hence diminished international trading performance. The effects, however, are small. The results in total are dominated by the effects of removing border protection.

The immediate impact of the elimination of border protection to agriculture is a large fall in the domestic prices of competing imports of agricultural products. This encourages substitution towards the now cheaper imported product. As a result, aggregate imports are projected to increase by about 5 per cent, largely as a result of a doubling in imports of agricultural crops. Imports of products classified to agricultural crops, livestock and downstream livestock products, and other food products represent about 13 per cent of Japan's total imports.

Lower import prices for these products result in lower domestic prices and hence a reduction in the economy's total cost structure. This is reflected in a decline in the consumer price index of 2.9 per cent and in the GDP deflator of 2 per cent, the result for the former reflecting the importance of food prices in household expenditure. This enhances the international competitiveness of export-oriented sectors and to a lesser extent import-competing sectors outside agriculture. Under the assumption of fixed nominal wages the resultant improvement in aggregate export earnings of 3.2 per cent is insufficient to match the

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Consider for example i = 1 (agricultural crops). From Table 1 P_{2i}/Pm_i = 420 per cent. Hence t = 3.2 or 320 per cent. For complete removal of t the required percentage change in $1 + t_i$ and hence the percentage change in P_{2i} is $- 100 (t_i/1+t_i) = - 76.19$ per cent.

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Table 2 **Projections of the short-to-medium term impact of removing agricultural protection (per cent[a])**

Variable	Scenario A: Constant nominal wages and aggregate real domestic expenditure			Scenario B: Constant aggregate employment demand and balance of trade		
	Remove subsidies	Remove border protection	Total[e]	Remove subsidies	Remove border protection	Total[e]
Macro-economic						
Real GDP[b]	-0.07	-0.24	-0.31	0.00	0.12	0.12
Real domestic expenditure	0.00 (Ex)	0.00 (Ex)	0.00 (Ex)	-0.00	0.02	0.02
Aggregate exports (foreign currency)	-0.08	3.24	3.16	0.43	5.66	6.09
Aggregate imports (foreign currency)	0.37	5.07	5.44	0.39	5.20	5.59
Balance of trade[c]	-0.07	-0.31	-0.38	0.00 (Ex)	0.00 (Ex)	0.00 (Ex)
Consumer price index	0.16	-3.05	-2.89	0.05	-3.57	-3.52
GDP deflator	0.10	-2.10	-2.00	-0.03	-2.70	-2.73
Labour market						
Aggregate labour demand	-0.11	-0.61	-0.72	0.00 (Ex)	0.00 (Ex)	-0.00 (Ex)
Nominal wage	0.00 (Ex)	0.00 (Ex)	0.00 (Ex)	-0.18	-0.88	-1.06
Real wage (CPI deflated)	-0.16	3.05	2.89	-0.23	2.70	2.47
Labour's share of national income	-0.20	2.68	2.48	-0.23	2.58	2.35
Industry outputs						
1 Agricultural crops	-2.00	-16.49	-18.49	-1.95	-16.26	-18.21
2 Livestock	-1.21	1.31	0.10	-1.16	1.56	0.40
3 Forestry, fishing	-0.24	0.18	-0.06	-0.18	0.43	0.25
4 Mining	-0.02	0.32	0.30	0.07	0.79	0.86
5 Crude oil	-0.02	0.31	0.29	0.11	0.96	1.07
6 Livestock products	-1.13	-0.09	-1.21	-1.08	0.19	-0.89
7 Other food products	-0.39	5.14	4.75	-0.36	5.28	4.92
8 Textiles	-0.03	1.84	1.81	-0.01	1.98	1.97
9 Pulp, paper etc	-0.01	-0.12	-0.13	0.03	0.13	0.16
10 Chemical products	-0.11	2.15	2.04	0.12	3.21	3.33
11 Petroleum products	-0.05	0.13	0.08	0.08	0.77	0.85
12 Mineral and metal products	-0.04	0.53	0.49	0.10	1.07	1.27
13 Machinery	-0.04	0.51	0.47	0.12	1.30	1.42
14 Transport equipment	-0.03	0.73	0.70	0.19	1.80	1.99
15 Other industrial	-0.03	0.36	0.33	0.10	1.00	1.10
16 Construction	-0.00	-0.02	-0.02	-0.00	0.01	0.01
17 Transport and communication	-0.01	0.00	-0.01	0.19	1.06	1.25
18 Government services	0.04	-0.69	-0.65	0.06	-0.52	-0.46
19 Private services	-0.00	-0.37	-0.37	0.05	-0.14	-0.09

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Table 2 (continued)

Variable	Scenario A Constant nominal wages and aggregate real domestic expenditure			Scenario B Constant aggregate employment demand and balance of trade		
	Remove subsidies	Remove border protection	Total[e]	Remove subsidies	Remove border protection	Total[e]
Major exports						
10 Chemical products	-0.14	19.12	19.26	1.06	25.09	26.15
12 Mineral and metal products	-0.06	1.90	1.84	0.33	3.78	4.11
13 Machinery	-0.09	2.22	2.13	0.41	4.55	4.96
14 Transport equipment	-0.09	2.30	2.21	0.35	4.39	4.74
15 Other industrial	-0.08	3.30	3.22	0.41	5.67	6.08
16 Transport and communications	-0.29	8.24	7.95	1.54	16.97	18.51
Major imports						
1 Agricultural crops	4.32	89.19	93.51	4.24	88.81	93.05
4 Mining	-0.04	0.34	0.30	0.07	0.85	0.92
5 Crude oil	-0.04	0.07	0.03	0.08	0.63	0.71
6 Livestock products	3.30	19.25	22.55	3.04	18.09	21.13
7 Other food products	1.48	-5.95	-4.47	1.16	-8.12	-6.96
Price of land						
1 Agricultural crops	-7.41	-61.06	-68.47	-7.42	-61.07	-68.49
2 Livestock	-1.57	1.70	0.13	-1.69	1.16	-0.53
Agricultural employment						
1 Agricultural crops	-7.41	-61.06	-68.47	-7.24	-60.19	-67.43
2 Livestock	-1.57	1.70	0.13	-1.51	2.04	0.53
Real net farm income[d]						
1 Agricultural crops	-7.57	-58.01	-65.58	-7.37	-57.60	-64.97
2 Livestock	-1.73	4.75	3.02	-1.74	4.73	2.99

a All projections represent the percentage deviation from the level that would have been reached assuming agricultural protection remained unchanged.

b Calculated from the expenditure side and includes terms of trade effects.

c Expressed as a percentage of base period GDP.

d Calculated as the return to land, labour and capital employed in agriculture deflated by the consumer price index.

e Since the model is linear in percentage changes the total effect is simply the sum of the separate effects of removing subsidies and border protection. Projections of the separate effect of removing subsidies and border protection are available from the author.

(Ex) Denotes variable set exogenously.

additional expenditure on agricultural imports such that the balance of trade is projected to worsen by about 0.4 per cent of base period GDP. With fixed aggregate domestic spending this implies a fall in real GDP of about the same amount and a decline in aggregate labour demand of about 0.7 per cent.

However, because of the decline in the consumer price index, real wages measured in terms of their purchasing power rise by 2.9 per cent such that the share of national income accruing to labour increases by about 2.5 per cent.

At the sector level the outcome is particularly adverse for the heavily protected agricultural crops industry. As a result of the 94 per cent increase in competing imports, domestic output of agricultural crops is projected to decline by 18 per cent and industry employment by 67 per cent. Real net farm income in agricultural crops is projected to decline by 66 per cent.

It is interesting to note that within the agricultural sector the outcome for the livestock industry is slightly favourable. While the removal of protection to livestock products results in increased imports of livestock products at the expense of output and employment in the domestic livestock product industry, the removal of protection to agricultural crops results in the domestic livestock industry paying considerably less for its livestock feed inputs. Livestock production in Japan relies heavily on purchased feed inputs. About 15 per cent of the value of livestock production is represented by inputs of sector 1 (agricultural crops) and a further 43 per cent by sector 7 (other food products) which in turn is heavily reliant on inputs of agricultural crops. Our results suggest that assistance provided to the livestock sector via farm subsidies and protection against the imports of livestock products more or less compensates the sector for the tax levied on it through assistance provided to agricultural crops.[13]

The results clearly demonstrate the way in which protection to domestic agriculture acts as a tax on the economic performance of Japan's export-oriented manufacturing sectors. Exports of machinery, transport equipment, other industrial and transport and communication are projected to expand by 2.1, 2.2, 3.2 and 8.0 per cent respectively. These collectively account for 63 per cent of Japanese export earnings. The expansion in exports in this part of the economy leads to enhanced output growth and employment prospects in Japanese manufacturing.

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13 This result may in part follow from the lack of a detailed disaggregation of inputs to agriculture and livestock. In particular, livestock feed inputs are classified in the Japanese input output tables as being part of agricultural crops and part of other food products. Hence, in the model they incur the same level of protection as the average for the sector in which they are classified. In reality some livestock feed inputs are not subject to border protection.

As a result of the elimination of agricultural protection, the price of agricultural cropping land is projected to decline by 68 per cent. This would have significant ramifications for the prices of those items of Japanese consumption expenditure such as housing and recreation which are intensive in their use of land. The cost of providing these goods can be expected to fall appreciably if agricultural protection were removed.

In the above results the assumption of constant nominal wages is critical. With domestic prices, especially the prices paid by household consumers, projected to fall significantly as a consequence of the removal of agricultural protection, much of the gains accrue to those currently in employment through higher real wages.

Suppose for example that real wage stability was considered a better way of describing the functioning of the Japanese labour market over the short-to-medium term adjustment horizon. Then the removal of agricultural protection, by slowing the underlying rate of increase in domestic prices in the Japanese economy would act to slow the rate of increase in nominal wages by the same amount. Our projections indicate the following consequences: the reduction in the consumer price index would be much larger (7.2 per cent) leading to greatly enhanced international competitiveness; aggregate exports would grow by around 23 per cent, significantly outweighing the increase in import penetration; there would be a net improvement in the balance of trade equivalent to about 2.2 per cent of base period GDP and, with fixed real domestic expenditure assumed, an equivalent gain in real GDP and a 4 per cent improvement in aggregate employment demand.

At the sector level the boost to exports, output and employment in Japan's manufacturing industries would be considerably larger. Industries supplying inputs to these activities would also gain.

Scenario B – constant aggregate employment demand and balance of trade

Under this scenario wages in the labour market are assumed to adjust to hold employment demand constant. Similarly, real aggregate expenditure is assumed to adjust to match the economy's real aggregate income such that the outcome for the balance of trade remains unchanged.

As with scenario A the effects of removing agricultural subsidies are minor relative to the effects of removing border protection. The overall pattern of results is also similar to that observed in scenario A. As a result of removing both subsidies and border protection, the consumer price index is projected to fall by 3.5 per cent and the GDP deflator by 2.7 per cent. The improvement in international competitiveness that this entails ensures sufficient growth

in exports to pay for the increased imports. Aggregate foreign currency exports and imports increase by about 6 per cent.

The outcomes for aggregate real domestic expenditure and real GDP are largely unchanged.[14] To maintain the total demand for labour requires a fall in nominal wages of about 1 per cent. Since, however, the removal of agricultural protection is projected to reduce consumer prices, real wages, deflated by the consumer price index, rise by 2.5 per cent. Hence the share of national income accruing to labour increases by the same amount.

At the sector level, agricultural imports are projected to expand by 93 per cent and livestock product imports by 21 per cent. Imports of other food products fall, somewhat reflecting the improved competitiveness of the domestic industry through being able to obtain its agricultural inputs at considerably cheaper prices. As a result of increased import penetration agricultural output is projected to decline by 18 per cent and employment in this sector by 67 per cent.

The increased agricultural imports are financed by an expansion of manufactured exports which are now considerably more competitive. Export growth of about 4 to 6 per cent in the machinery, transport and other industrial categories is projected. This leads to output gains of about 1 to 2 per cent in the sectors supplying these products and employment gains of about 2 to 6 per cent.

As was the case in scenario A the major losers from the removal of agricultural protection are the owners of rural land. The rental price of agricultural land is projected to decline by 68 per cent. As a result of this and the heavy exodus of labour from farming to be re-employed in manufacturing activities real net farm income in the agricultural crops sector is projected to decline by 65 per cent.

Longer term effects

The longer term effects of agricultural protection under scenario B, assuming that capital is mobile between sectors, are broadly similar to those described above. Aggregate exports and imports are projected to expand by about 8 per cent. The gain in real GDP is a little larger

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14 That is, according to the model the aggregate welfare gains, in terms of the addition to aggregate real income, from the removal of agricultural protection are small over the short-to-medium term. The pure efficiency gains are somewhat larger, being offset by terms of trade losses because of the assumed less-than-perfect elasticity of world demand for Japan's major exports. World prices for Japan's major exports are projected to decline by around 1 per cent.
It is well known, however, that comparative-static general equilibrium models of this type capture only the allocative gains from assistance reform. They do not provide a treatment of the major source of welfare gains – the so-called dynamic gains.

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(0.4 per cent) and the improvement in the economy-wide real wage is 2.4 per cent.

At the sector level the contraction in agricultural crops output is larger (25 per cent) as are the gains in manufacturing output. For example, output expansions of 2, 3, and 1.8 per cent respectively are projected for the large export-oriented sectors of machinery, tranport equipment and other industrial. Because capital leaves agriculture the reduction in real net income of the farm sector is slightly less (58 per cent).

IV Agricultural protection and Japan's aggregate trading performance

As noted in Section I, Japan's international trading performance over recent years has been heavily in surplus. In 1986, for example, export earnings represented about twice the expenditure on imports in 1986, a balance of trade surplus in excess of 4 per cent of GNP. The results in Table 2 under scenario A suggest that if agricultural protection were removed this would lead over the short-to-medium term, assuming no adjustment of nominal wages, to growth in aggregate imports of about 5 per cent. Nearly all of this is from agricultural products and livestock products – imports of which are projected to increase by 94 and 23 per cent respectively. On its own this would reduce the trade surplus by about one-quarter to one-fifth of the current surplus of exports over imports. However, the results in Table 2 also show that protection to domestic agriculture, as well as restraining aggregate imports, also acts as a sizeable tax on export performance. The removal of agricultural protection is projected to lead to an increase in aggregate foreign currency export earnings of 3 per cent. If constant real rather than nominal wages are assumed the growth in aggregate export earnings from the removal of agricultural protection would exceed the growth in aggregate import expenditure.

The clear conclusion from these results is that agricultural protection does not exert much influence on Japan's net trading performance. In fact, its removal may well enhance Japan's trade surplus. The role of agricultural protection is to influence the composition of both exports and imports. Imports are biased heavily against agricultural and livestock products and reduced as a share of GDP. Exports are also reduced as a share of GDP.

The cause of Japan's net trade imbalance is a surplus of national income over national expenditure or, alternatively, domestic savings in excess of that required to finance domestic investment. The appropriate set of policies to reduce this imbalance involves those which discourage domestic saving and hence encourage aggregate spending relative to income. There are a range of policy instruments which can achieve this. Each will have different outcomes for other aspects of macro-economic performance and involve different relative incentives to industry growth prospects.

In Table 3 we illustrate this by investigating the implications for the level and distribution of economic activity of a balanced increase in real domestic spending (equi-proportional changes in aggregate household consumption, private investment and government spending).

Table 3 **Projections of the short to medium term impact of a balanced increase in domestic expenditure (per cent[a])**

Variable		Balanced increase in real domestic spending of 5.58 per cent
Macro-economic		
Real GDP[b]		1.14
Real domestic expenditure		5.58 (Ex)
Aggregate exports (foreign currency)		-25.05
Aggregate imports (foreign currency)		3.75
Balance of trade[c]		-4.00
Consumer price index		6.09
GDP deflator		6.68
Labour market		
Aggregate labour demand		1.93
Nominal wage		6.09
Real wage (CPI deflated)		0.00 (Ex)
Labour's share of national income		6.88
Industry outputs		
1	Agricultural crops	-0.67
2	Livestock	0.31
3	Forestry, fishing	0.52
4	Mining	-0.61
5	Crude oil	-2.99
6	Livestock products	-0.14
7	Other food products	0.90
8	Textiles	3.88
9	Pulp, paper etc	2.76
10	Chemical products	-7.35
11	Petroleum products	-1.68
12	Mineral and metal products	-2.88
13	Machinery	-4.01
14	Transport equipment	-7.12
15	Other industrial	-2.32
16	Construction	5.29
17	Transport and communication	-4.65
18	Government services	5.07
19	Private services	2.51
Major exports		
10	Chemical products	-64.49
12	Mineral and metal products	-21.31
13	Machinery	-23.87
14	Transport equipment	-21.09
15	Other industrial	-24.55
17	Transport and communications	-86.79

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Table 3 (continued)

Variable		Balanced increase in real domestic spending of 5.58 per cent
Major imports		
1	Agricultural crops	9.31
4	Mining	-0.84
5	Crude oil	-0.96
6	Livestock products	15.53
7	Other food products	20.02
Price of land		
1	Agricultural crops	3.62
2	Livestock	6.50
Agricultural employment		
1	Agricultural crops	-2.47
2	Livestock	0.41
Real net farm income[d]		
1	Agricultural crops	-2.47
2	Livestock	0.41

a All projections represent the percentage deviation from the level that would have been reached in the absence of the stimulus to domestic expenditure.
b Calculated from expenditure side and includes terms of trade effects.
c Expressed as a percentage of base period GDP.
d Calculated as the return to land, labour and capital employed in agriculture deflated by the consumer price index.

We assume that aggregate spending is raised sufficiently to cause the balance of trade to decline by 4 per cent of GDP, which approximates Japan's current trade surplus. We further assume that the gains to the labour market from this increased domestic spending are taken in the form of increased employment at a constant real wage. An alternative and equally viable assumption would be that the labour market gains accrue as higher real wages to those currently in employment. Finally, we assume that the rate of protection, expressed in ad valorem terms, provided to Japanese agriculture and other sectors remains constant. That is, to the extent that the increased domestic spending worsens the competitive position of domestic agriculture, the adjustment is through increased agricultural imports rather than through an increase in the implicit rate of protection provided to agriculture by quotas holding import volumes constant.

There are a range of domestic policy instruments which could be involved to achieve the required increase in domestic spending. We do not specify a particular set.

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The results indicate that a 5.6 per cent increase in real domestic spending is required to wipe out a trade surplus of 4 per cent of GDP. The increase in domestic spending acts to revalue the real exchange rate between Japan and the rest of the world as seen by the 6.7 per cent increases in the GDP deflator and more or less constant world prices. As a result exports become less competitive and domestic industries, including agriculture, lose market share to competing imports. The required balance of trade turnaround is achieved by a 25 per cent drop in aggregate export earnings and a 3.8 per cent increase in aggregate expenditure on imports.[15]

The domestic contractionary effect of reduced export sales and increased import penetration is more than outweighed by the expansion in domestic expenditure such that real GDP increases by 1.1 per cent and aggregate labour demand by 1.9 per cent.

At the sector level there is a reorientation of economic activity away from traded activities, especially those producing exports to activities whose sales pattern is oriented to the domestic economy. Import-competing activities gain from the expansion in the size of the domestic market for their products (the expansion effect) but lose from their reduced competitiveness vis-a-vis imports in obtaining domestic market share of this expanded market (the substitution effect). In the case of the major part of Japanese agriculture (incorporated within the agricultural crops sector) the income elasticity of demand is low. These activities hence benefit only a little from the 5.6 per cent expansion in aggregate real household consumption expenditure. The benefits are outweighed by the reduction in competitiveness against imports. As a result imports of agricultural crops are projected to expand by 9.3 per cent resulting in a 1.4, 2.5 and 2.5 per cent reduction in the sector's output, employment and real net farm income respectively. Imports of livestock products are also projected to expand by 16 per cent and those of other food products by 20 per cent, thereby reducing the demand for domestically produced livestock which is sold as inputs to these sectors.[16]

The major gainers from the expansion in aggregate spending are those sectors which (a) face little or no competition from imports and (b) rely heavily on domestic consumption and investment for their sales. Examples are the services sectors 16 (Construction) and 18 (Government services).

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15 The weights in the model's balance of trade equation refer to 1980, in which Japan's net trade was close to zero. The aggregate responses, especially with respect to exports and imports, would differ somewhat if 1988 balance of trade weights were used, though the broad pattern of results would remain unchanged.

16 According to the Japanese input-output tables the livestock sector makes small sales to industry 8 (textiles), industry 19 (private services) and to investment. The size of each of these markets is projected to expand. This is sufficient to compensate the sector for the reduced sales opportunities available to it from the downstream livestock product and food product sectors such that the output of livestock expands slightly.

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The conclusion from Tables 2 and 3 is that while protection of agriculture appears to have little to do with Japan's balance of trade surplus, the elimination of this surplus through balanced increases in domestic spending will retard the performance of the major part of Japanese agriculture. Put another way, the continuation by Japan of a trade surplus is beneficial to Japanese agriculture in the sense that if this surplus were eliminated either Japanese agriculture would contract or, to prevent this contraction taking place, the rate of protection required by Japanese agriculture would need to be increased.

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Agricultural protectionism and the less developed countries: The relationship between agricultural prices, debt servicing capacities and the need for development aid

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Summary

In this paper we present calculations which demonstrate that there are substantial gains which will accrue to the world, and can be shared between developed nations and less developed ones, as a result of reducing agricultural subsidies and import barriers in the developed world. We consider several policy experiments. First, we examine how liberalization and holding foreign aid and debt servicing constant could contribute to raising the standard of living in less developed countries.

Then we analyze how freeing up such trade will enhance the capacity of less developed countries to service their international debt or substitute for foreign aid. In both cases we find that liberalization tends to redistribute income to labour and especially to labour in the agricultural sector in LDCs, which is important on equity grounds since rural real wages are generally lower than their non-agricultural counterparts. While foreign aid also tends to redistribute income toward labour and from labour in general to agricultural labour, these effects are considerably weaker than is the case for increases in agricultural export prices. We find that these comparative income-distributional effects, combined with tax policies which typically discriminate against agricultural production in less developed countries and the efficiency cost of raising government revenue, combine to make agricultural liberalization by developed countries a particularly beneficial policy.

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I Introduction *

Agricultural protectionism is an issue of critical importance to less developed countries, since most of them are net exporters of agricultural commodities[1] and have the potential to export considerably more, should developed countries liberalize their agricultural export policies. But the importance to them of liberalized agricultural markets extends beyond a casual glance at the numbers describing their trade and production. Anne Krueger (1983) and the World Development Report (1986) (among others) both document that less developed countries typically tax their agriculture through export taxes and the activities of agricultural marketing boards, and subsidize their industry through trade, tax and credit market policies which bestow high effective rates of protection on them. Krueger argues that in addition to imposing an efficiency cost, such policies also serve to worsen the income distribution, because the poorest members of LDCs are typically those employed in agriculture. These observations have important implications for the effects of agricultural policy liberalization by developed countries.

All of these factors mean that extra earnings of foreign exchange via increased agricultural production is a particularly effective way of generating resources for less developed economies. The reasoning is the following. The taxation of the agricultural export sector means that in agriculture considerably less than a dollar's worth of resources at domestic prices is required to earn a dollar's worth of foreign currency at the margin, whereas the subsidization of industry means that in industry considerably more than a dollar's worth of resources at domestic prices is required to save a dollar's worth of foreign exchange. Thus, if resources are drawn from industry into agriculture in order to meet increased external demand, for each extra dollar earned, considerably less than a dollar's worth of resources needs to be transferred into agriculture, and the transfer of these resources costs the industrial sector considerably less than a dollar of increased industrial imports to make up for the lost domestic production. The result is a considerable increase in foreign exchange earnings, due both to the terms of trade improvement that generated the resource movement as well as the increase in net foreign exchange earnings at given world prices.[1] Moreover, the rise in both imports of industrial goods and exports of agricultural goods means that government tariff and export tax revenues rise. To the extent that this enhanced revenue enables governments to reduce the level of distorting taxes and/or tariffs, there will be a further gain in economic efficiency, which raises the standard of living. In subsequent sections we further develop this argument using a computable general equilibrium model.

1 See for example Table 1, Column 24.

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This is of course, only one possible way to close the model, showing the effect of reduced agricultural protectionism in the developed world. Another possibility is to use the additional resources to foster economic growth. Alternatively, the additional resources made available to the economy could be used to service international debt. Or as yet an additional alternative, the increased standard of living and resources generated internally to fund economic growth could enable the developed world to cut its development aid to LDCs.

To the extent that LDCs use their increased resources to repay debt, failure rates for developed countries' banks will fall. Consequently, fewer banks will need government bail-outs. This will restore resources to the developed world. It will also save on the legal resources associated with rescuing failing banks and eliminate some of the deadweight loss in the developed world associated with the need to use tax revenues collected via distorting taxes to rescue failing banks. Similarly, if the resources made available are used to reduce foreign aid, each dollar collected by LDCs because of additional exports may reduce the amount of aid needed by more than a dollar. Finally, this aid reduction will reduce the amount of revenue needed in the donor countries and will reduce the deadweight loss due to tax collection in the donor countries.

In the rest of the paper we show that these points are valid and calculate how important they are.

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II Dividing up the less developed world

In this paper we construct a model and calibrate it for representative members of six different types of LDCs. These groups reflect the system of aggregation used in the *World Development Report* (1987) (hereafter *WDR*).

Group I is low-income economies other than China and India;

Group II is India;

Group III is lower middle-income developing economies;

Group IV is upper middle-income developing economies;

Group V is oil-exporting developing economies;[2]

Group VI is highly indebted countries;[3]

For each group of countries data were aggregated, and the model was calibrated.[4]

2 These are middle-income developing countries with exports of petroleum and gas, including re-exports, accounting for 30 per cent or more of merchandise exports: Algeria, Egypt, Cameroon, Ecuador, Gabon, Indonesia, Iraq, Mexico, Nigeria, Oman, Congo, Syria, Trinidad and Tobago, and Venezuela.

3 These are countries which are 'deemed to have encountered severe debt-servicing difficulties: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ivory Coast, Ecuador, Jamaica, Mexico, Morocco, Nigeria, Peru, Philippines, Uruguay, Venezuela, and Yugoslavia.' This and the immediately preceding footnotes are drawn from page xi of the *WDR*.

4 While the focus in this study is on the effects of developed country agricultural protection on the LDCs, the model could be used to analyze various cost-benefit ratios of interest associated with liberalization and tax reform by each of the groups of LDCs.

III Modelling a representative less developed country

Table 1 presents the data used in calibrating our model with all figures except for those for effective rates of protection taken from the *WDR* (1987) and designed to describe LDCs in 1985. Figure 1 presents the model which describes the structure of each of the economies we consider. We assume four sectors. In each sector constant returns to scale are assumed to prevail and we assume that the production process is nested, with factor proportions dependent on relative prices. The agricultural sector uses imported materials (Za) plus land (T) to produce an agricultural composite (Tz) which is combined with labour services (La) to produce agricultural output (A), some of which is exported (Ax) and some of which (Ac) is combined with imports, [typically of cereals] (C) to produce a composite commodity called food (F) which is consumed domestically. The industrial sector uses labour (Li) and capital (K) to produce an industrial composite which in combination with imported materials (Zi) is used to produce the industrial good (I), some of which is exported (Ix), and some of which is combined with final good imports (J) to produce a good which we refer to as merchandise (M). The mining and petroleum sector (hereafter oil) uses natural resource endowments which we refer to as deposits (D) along with labour (Ld) to produce a natural resource composite which is combined with imported materials (Zd) to produce oil output (Dx), all of which is exported. Finally, the services sector uses labour to produce services (S), all of which are consumed domestically.

Consumption is also nested with consumption proportions depending on relative prices. Merchandise and food combine to produce a goods composite (G) which is consumed along with services.

Labour is assumed to be homogeneous when measured in efficiency units and is assumed to be imperfectly mobile between agriculture, industry, services and oil. It is assumed to move between sectors in response to changes in the wage in each sector relative to the average economy-wide wage. We assume that the elasticity of supply of labour to each sector, except services, with respect to the wage in that sector relative to the economy-wide average is 2, with the elasticity of supply of labour to services determined as a residual.

All world prices are assumed to be exogenous. Thus any change in the terms of trade is assumed to be brought about by changes in foreign agricultural protection levels. Imports are assumed to be financed by exports plus an exogenously determined level of foreign aid net of debt servicing. Thus the trade deficit equals foreign aid net of debt-servicing requirements.

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Table 1 Basic data on groups of LDC's

Group [2]	Taxes on International Trade as % of Total Revenue RTS	Current Total Revenue as % of GNP R	Effective Rate of Protection (%) For Agriculture Domestic ERPAD	Effective Rate of Protection (%) For Agriculture Export ERPAX	Effective Rate of Protection (%) For Industry Domestic ERPIX	Effective Rate of Protection (%) For Industry Export ERPID	GNP Per Capita (dollars)	GDP (Billions of dollars)	Distribution of Gross Domestic Product (%) Agriculture AV	Distribution of Gross Domestic Product (%) Industry [3] IDV	Distribution of Gross Domestic Product (%) Services S
I Low Income (Other than China and India)	29.0	15.6	-20	-40	100	0	200	146	36	19	45
II India	24.4	14.0	0	-5	50	20	270	176	31	27	42
III Lower Middle Income	14.3	20.9	0	-30	55	0	820	510	22	32	46
IV Upper Middle Income	7.9	23.6	0	-20	25	0	1,850	930	10	35	55
V Oil Exporters	8.7	24.8	0	-33	59	9	1,060	533	17	36	47
VI Highly Indebted Countries	8.0	20.8	0	-31	30	0	1,410	779	15	33	52

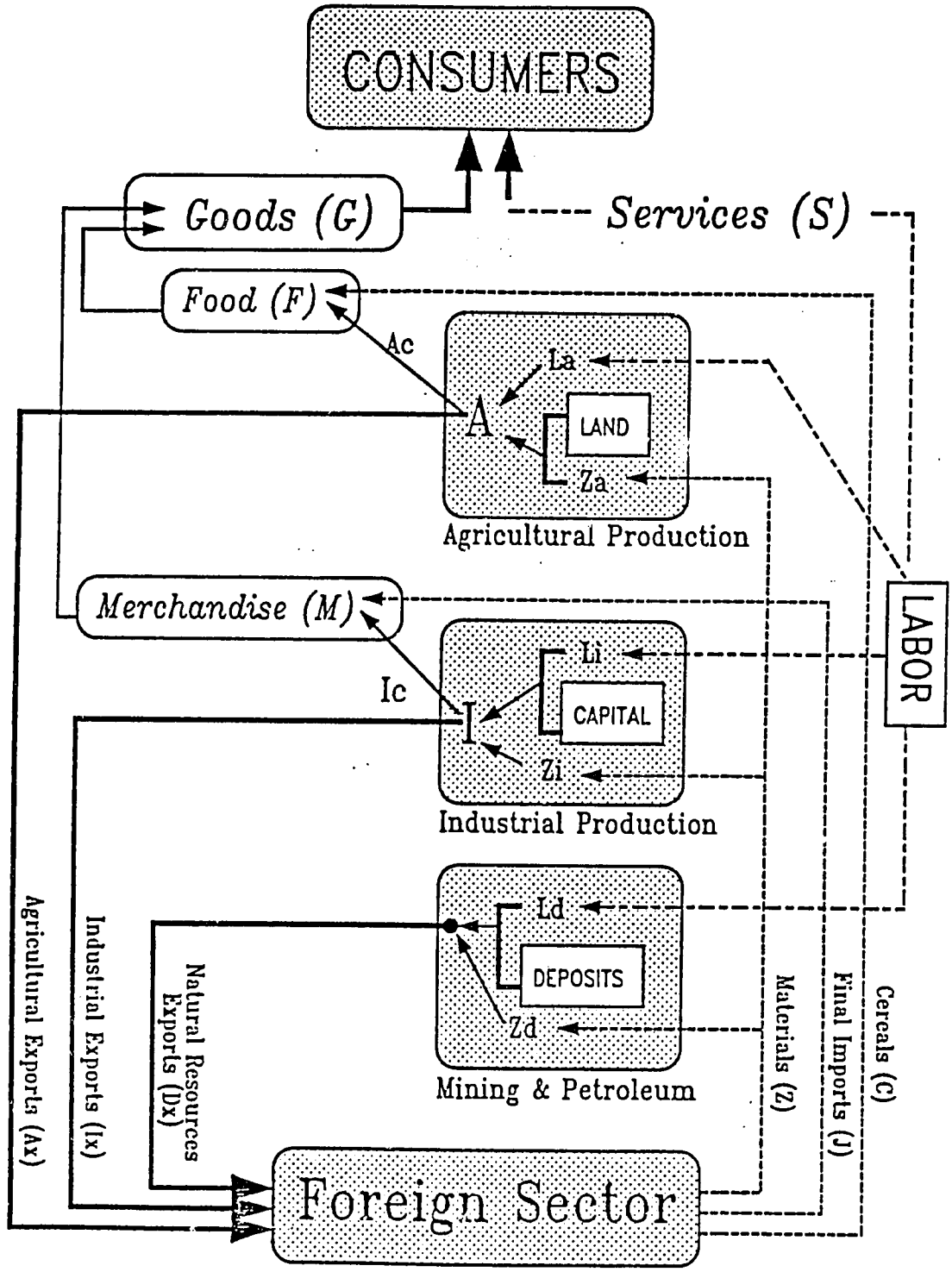
continued

Table 1 (continued)

Group	X	AID	% Share of Merchandise Exports: AxPa*	% Share of Merchandise Exports: DXS	% Share of Merchandise Exports: IXS	% Share of Merchandise Imports: CMS	% Share of Merchandise Imports: ZMS	% Share of Merchandise Imports: JMS	Labor's Share in Manufacturing Value-Added $(1-\theta\kappa)$	External Public Debt (% of GNP)	Public Debt Service as % of GNP	Public Debt Service as % of Exports	Net Exports of Agricultural Goods (% of GNP)
I Low Income (Other than China and India)	1[illegible]	-9	53	23	24	17	32	30	.32	40.5	2.9	18.4	3.5
II India	8	-3	26	25	49	13	31	34	.49	13.5	1.0	9.3	.4
III Lower Middle Income	23	-1	29	51	20	13	34	34	.30	41.4	5.7	22.9	3.5
IV Upper Middle Income	28	4	16	37	47	10	40	33	.32	36.3	5.7	21.0	2.1
V Oil Exporters	21	3	7	84	9	16	42	35	.32	34.5	5.9	25.6	-1.4
VI Highly Indebted Countries	17	5	26	46	28	12	36	31	.31	39.1	5.1	27.8	2.0

1 All data, except those on effective rates of protection, are taken from *WDR* 1987.
2 Country Groups are defined on page xi of *WDR* 1987 (see footnotes 4 - 8).
3 Industry includes 'Fuels, Minerals and Metals'.

Figure 1 A schematic model of a representative LDC



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Flexible wages and prices maintain full employment. All disposable income is spent, so that the trade deficit is equal to the government deficit. We assume that the proportions in which various goods and services are consumed domestically are invariant to the income distribution. Also, we assume that the government's consumption function is identical to that of the private sector and that it responds to the same tax-inclusive prices that the private sector does. Thus, we assume that the government adjusts taxes in order to enable it to finance its initial real consumption level with available tax revenues plus foreign aid net of debt-servicing requirements.

We postulated that the only taxes are those on agricultural exports, agricultural production for domestic consumption imports and exports of the final industrial good and consumption of the composite good. Services are assumed to be tax free. We also recognize that the imported final industrial good is subject to quota protection, where we assume that the ad valorem equivalent of the quota protection is constant. We calibrated these taxes as follows.

We determined the four effective rates of protection (ERPs) indicated in Table 1 by drawing on information contained in *WDR* (1986, 1987) and asking experts from the World Bank and elsewhere for their best informed guesses. Our figures for ERPs reflect the facts which emerge in *WDR* (1986,1987) that the poorer the country is, the lower its ERP for agricultural exports (ERPAX) and the higher its ERP on import competing industry (ERPID) tend to be. We then determined the ad valorem tax on agricultural exports, at that rate which would set Erpax at its exogenously determined level given in Table 1. We then set the ad valorem equivalent of tariff plus quota protection on the imported final industrial good (J) at that rate which would set ERPID at its exogenously determined level. We assumed the subsidy rate on industrial exports and the tax on the production of agricultural goods for domestic consumption which set the corresponding ERPs, ERPIX and ERPAD equal to their predetermined levels. Data on tax revenues arising out of international trade are presented in the *WDR*. We then divided up the protection on J into a tariff and a quota component so that trade tax revenues in the benchmark equilibrium equalled this figure. We postulated that all mining and petroleum exports were taxed via 20% of royalties paid to the fixed factor, and that no additional taxes were levied on this sector. The remaining tax revenues indicated in the *WDR* were assumed to be collected via a uniform excise tax on the composite consumption good.

We wished to model the excise tax so that the marginal welfare cost of tax collection (MWC) from adjusting this tax was consistent with evidence from other sources. To accomplish this, we assumed that there are efficiency costs associated with collecting this tax which are greater than would appear from just looking at the tax wedge. In reality these consist of administrative costs of tax collection, resources used up in tax avoidance, tax compliance and

tax evasion, and resource misallocation costs. To keep the modelling simple, we have modelled these as leakages in the tax collection process. We assumed that the excise taxes paid exceed the tax revenue accruing to the government by a factor consisting of bribes to the tax collector and issuers of licences.[5] The magnitude of this leakage is determined so as to set the MWC equal to our best guess of what the MWC is in LDCs. Picking an appropriate level for the MWC is tricky, because all governments are currently imposing some taxes with very high MWCs like tariffs, licensing fees and the inflation tax. Moreover, they have the capacity to collect taxes with negative MWCs like those on pollution or by charging for import licences and thereby diminishing socially counterproductive rent-seeking behavior. We noted the Ballard et al (1982) estimate of 79 per cent for the MWC for the US and the corresponding figure of 24 per cent of Charles Stuart (1984). We also asked two leading practitioners of tax reform in LDCs who estimated 30per cent and 50 per cent respectively for the MWC via the kinds of tax increases that are likely to occur in LDCs. Drawing on this information, we based all of our calculations on a MWC of 40 per cent, except in Table 4, where we addressed the importance of the assumption about the MWC for our principal calculations.

We calibrated all flows to correspond to those indicated in Table 1. We treated the imports of fuels and other primary goods and machinery and transport equipment as intermediate inputs into the three sectors, and apportioned them in proportion to value added in those sectors. All production was assumed to exhibit constant returns to scale and variable proportions. The elasticities of substitution assumed are indicated in Appendix 2. We assumed elasticities of substitution in production and consumption of 1.

5 Conrad (1986, p11) writes 'A 1970 study by Jap Kim Sinug (1971) estimated that in 1971 the total burden of taxes (including side payments) in Indonesia was 18 per cent of GDP compared with only 9 per cent of GDP reported to the Tax Department'.

IV The simulations and results

Three simulations of the model were performed. In each case we assume that the excise tax on domestic consumption of goods is adjusted to keep government revenues at their exogenously determined levels. In the first simulation we increase the exogenously determined level of government real revenues under the assumption that all revenue is returned to the private sector as a lump sum subsidy. This is done in order to assess the marginal welfare cost of tax collection in the model. In the second simulation, we assume that foreign aid is exogenously increased, and in the third simulation all world agricultural prices are exogenously increased. In each simulation, the excise tax is adjusted to maintain real government revenue collection at its exogenously determined level.

Now we discuss how each of our economies respond to the disturbances considered. The model is described analytically in Appendix 1, which also defines the notation used in Appendix 3 where the multipliers for each of the exogenous variables are presented. Tables 2 to 7 present various cost/benefit indicators and policy implications which we have constructed from the multipliers.

4a. Increased real revenues

First, consider the case of an exogenous increase in the need for real government revenues. For each of our economies, the increase in real revenues was accomplished by a tax increase that increased the consumer price index (CPI). The higher price of goods caused consumers to switch from consuming goods to services. This reduced the consumption and output of each of the goods and raised the quantity of services provided. The reduced efficiency of the economy shrank aggregate real income as well as the real rental and wage rates for each of the groups in the economy.

4b. Increased foreign aid

Next consider the effects of an increase in the provision of foreign aid, which permits the economy to run a correspondingly larger trade deficit. Since the foreign aid is assumed to take the form of foreign currency which is delivered to the government, when the government sells the foreign currency to the private sector it generates tax revenues which enable it in each case to reduce its excise tax. Consequently, the CPI falls in each case. The reduced taxation of goods caused consumers to switch at the margin from consuming services to

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consuming goods so that service consumption fell, while goods consumption, output of each sector and the labour employed in it rose at the expense of labour employed in the service sector. Imports of all goods rose, while exports of industrial and agricultural goods fell, with exports of mining and petroleum rising. Also, aggregate real income rose, along with all real wages and rentals.

4c. Increased world agricultural prices

An increase in world agricultural prices in each case increased revenues associated with import and export taxes, which made it possible to reduce the excise tax rate. In each case there was an increase in real income, the average real wage, and the agricultural real wage. Not surprisingly agricultural production and agricultural exports both rise along with agricultural employment, while outputs of and employment in industry and mining and petroleum decline.

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Table 2 **General equilibrium price elasticities for agriculture[a]**

Group	I	II	III	IV	V	VI
1. Agricultural production	.7	.4	.7	.9	.6	.6
2. Agricultural consumption	.0	-.3	-.3	-.6	-.4	-.4
3. Agricultural exports	6.2	16.9	5.2	4.5	18.5	4.9

a Calculated as the per cent response per 1 per cent increase in the world price of all agricultural goods, Pa, holding foreign aid, debt repayment, and the trade balance constant. Since the relative prices of all agricultural goods are held constant and the agricultural consumption function is homothetic, agricultural imports rise by the same proportion as agricultural consumption does.

Our results depend on the extent to which LDC agriculture responds to prices. Therefore, Table 2 presents the general equilibrium elasticities of responses of agricultural production, consumption and exports to changes in world agricultural prices. The elasticity of agricultural production varies from .4 to .9, while the income and substitution effects with their contradictory pulls cause the consumption elasticity to lie between .0 and -.6. The assumption that agricultural goods produced for the domestic market can be transformed at constant rates into those for the foreign market implies high elasticities of agricultural exports: between 4.5 and 18.5.

Table 3 presents four sets of cost/benefit ratios. Row 1 is the change in LDC real income per unit increase in foreign aid or decrease in debt repayment. We see that a dollar's worth of foreign aid is worth roughly one to two dollars to the recipient country, where the change in real income is the change in consumption at consumer prices. In a non-distorted economy this figure would be one. However, the taxes which raise consumer prices above world levels and the excise tax cut in response to the increased government revenues provided by foreign aid cause this figure to be above unity in each case.

Row 2 is the increase in real income per unit transfer to the LDC which is brought about by higher agricultural prices, where the transfer is defined as the terms-of-trade effect, consisting of the LDC's initial level of net agricultural exports multiplied by the percentage increase in agricultural prices. If the LDC were undistorted this figure would also be unity.

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Table 3 **Trade versus aid**

Group		I	II	III	IV	V	VI
1.[a]	dY/dAID	1.23	1.95	1.73	2.05	1.85	1.79
2.[b]	dY/dTR	7.87	27.29	6.69	4.55	-12.31	5.90
3.[c]	d[-AID]/dTR	6.38	14.01	3.86	2.21	...	3.30
4.[d]	dYrow/dTR	7.93	18.61	4.40	2.10	...	3.61

a Row 1 is the change in LDC real income, dY, per unit increase in foreign aid or decrease in debt repayment, dAID.

b Row 2 is dY per unit transfer to the LDCs via an increase in world agricultural prices, dTR.

c Row 3 is Row 2/Row 1. It is the decrease in AID made possible by a unit increase in TR (holding LDC real income constant).

d Row 4 is the real income gain to the rest of the world, ROW (i.e. the LDCs' trading partners) made possible by a unit increase in TR (holding LDC real income constant), assuming no initial domestic distortions in ROW agriculture and a 40 per cent marginal welfare cost of raising AID revenue in the ROW. (Row 4 = 1.40 * [row 3] - 1)
This figure would be precisely correct if developed economies protected their agriculture with given-away import licenses which caused the initial volume of trade to differ infinitesimally from free trade levels. To the extent that agricultural subsidies involve a budgetary cost and initial import restrictions cause a non-infinitesimal distortion of trade from free trade levels the figures in row 4 are biased downward.

However, because of the discrepancy in ERPs and the distorting taxes that can be reduced as result of the increased collection of trade taxes brought about by the increased volume of trade, this figure greatly exceeds unity for all countries except the oil exporters, lying between 4.55 and 27.29 for them. This is to say, for these economies the higher agricultural prices interact favourably with existing distortions to generate a marked gain in real income. If the LDCs' trading partners were undistorted, these figures would imply that each one dollar's loss of standard of living which they sacrifice through worsened agricultural terms of trade, could increase LDCs' living standards by between $4.55 and $27.30. The one outlier is the group of oil exporting countries which exhibits a negative figure. These countries are net importers of agricultural goods. Had they been undistorted, we would have expected agricultural price hikes to shrink their real incomes, but we find that the movement of their resources into agriculture, and the reduction of their excise tax which the increased agricultural prices brings about, is enough to increase their real incomes by $12.31 for every dollar which is implicitly transferred to their trading partners through higher agricultural prices. Yes, Virginia, there is a free lunch! But then free lunches abound in distorted economies, for that is what Pareto improvements are all about.

Row 3 shows the reduction in foreign aid or increased debt repayment which would be

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possible per unit increase in the transfer via increased agricultural prices to the relevant country group while leaving LDC real income unchanged. It leads to the conclusion that one dollar's worth of transfer via trade liberalization by the LDCs' trading partners is worth between $2.21 and $14.01 worth of explicit foreign aid. Thus, reducing protection of agricultural goods exported by LDCs is an effective way of subsidizing LDCs relative to foreign aid.

Row 4 shows the increase in the real income of the rest of the world that would be made possible per dollar transferred to the relevant LDC group via higher agricultural prices if aid or debt repayment were adjusted to leave real income in the relevant LDC group unchanged, all assuming that the marginal welfare cost of tax collection to pay foreign aid or to bail out the banking system is 40 per cent. Each dollar transferred via higher agricultural prices increases rest-of-world real income by between $2.10 and $18.61.

We now turn to Table 4. For each country group the top two rows show how the first three multipliers calculated in Table 3 depend on the elasticity of supply of labour to agriculture, industry, and mining and petroleum (holding the rate of leakage to tax collectors constant). We take this elasticity, which measures labour mobility, as a proxy for the time elapsed since the disturbance. The next two rows for each country group show how these same multipliers depend on MWC, the marginal welfare cost of tax collection, which we allow to vary from a high of 140 per cent to a low of between 4.6 per cent to 14.1 per cent, where the low figures are those which applied when a zero leakage to the tax collectors was assumed. We find that for every country group and for every set of parameter values, agricultural price hikes are at least 1.97 times as effective a way to transfer real resources to LDCs as is explicit foreign aid. This ratio is quite insensitive to the assumed MWC, which reflects the fact that both perturbations of the system contribute to government revenue. For each group we find that in the long run the efficacy of explicit aid is larger than in the short run. This reflects the greater ability of the economy to respond to changed incentives in the long run. For each group the same is true of transfers via agricultural price hikes, except for Group IV.[6] The major conclusion which we draw from the table is that our finding that trade is considerably more effective than aid is quite robust.

6 For Group IV, in the long run relative to the short run agricultural exports increase by more, but labour moves into untaxed services out of industry and mining and petroleum which causes goods consumption and imports of final industrial goods to rise by less. The fact that these latter two flows across tax distortions are lower in the long run shrinks the long-run real income gain below the short-run gain.

Table 4 **Trade versus aid in the long and short runs with varying efficiency of tax collection**

Group	es[a]	MWC(%)[b]	dY/dAID	dY/dTR	dAID/dTR
I	0	.511	.98	6.37	6.47
	4	49.7	1.29	8.24	6.37
	2	140	2.00	12.3	6.15
	2	8.59	.94	6.18	6.58
II	0	.550	1.24	12.14	9.79
	4	47.4	2.02	31.8	15.76
	2	140	3.46	46.3	13.4
	2	4.17	1.25	18.3	14.7
III	0	.660	1.48	5.96	4.04
	4	49.4	1.81	6.95	3.85
	2	140	3.00	10.7	3.57
	2	9.95	1.21	4.95	4.11
IV	0	.824	1.78	4.99	2.80
	4	45.8	2.10	4.50	2.15
	2	140	4.08	8.05	1.97
	2	14.1	1.51	3.62	2.40
V	0	.606	1.58	-8.60	-5.43
	4	48.8	1.91	-13.4	-7.04
	2	140	3.33	-21.9	-6.57
	2	12.8	1.33	-9.03	-6.77
VI	0	.697	1.55	4.44	2.86
	4	49.8	1.86	6.43	3.45
	2	140	3.24	10.0	3.09
	2	13.3	1.30	4.45	3.41

a The elasticity of labour supply to agriculture, industry and mining and petroleum as a function of the wage in that sector relative to the average wage in the economy.

b MWC is the assumed marginal welfare cost of taxation.The last row for each country group is the simulation which assumes a tax leakage of zero.

The first row of Table 5 indicates the implicit transfer to LDCs due to higher agricultural prices per increase in the LDCs' net agricultural exports. While not interesting in itself, it is used in rows 2-4 to calculate the changes in LDC real income, AID saved and rest-of-world real income per unit of increased net agricultural exports absorbed by the rest-of-world. These benefit/cost ratios are relevant to the extent that policy makers or their constituencies subscribe to the mercantilistic view that increased imports are a cost or to the extent that

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Table 5 **Effects per unit of increased net agricultural exports from LDCs**

Group		I	II	III	IV	V	VI
1.[a]	TR/dNAE	.076	.015	.099	.095	-.050	.134
2.[b]	dY/dNAE	.599	.399	.660	.434	.613	.788
3.	d[-AID]/dNAE	.486	.205	.381	.211	.332	.440
4.	dYrow/dNAE	.604	.272	.435	.200	.514	.482
5.[c]	dNNAM/dNAE	1.076	1.015	1.099	1.095	.950	1.134

a Row 1 is the change in TR per unit increase in NAE due to an increase in world agricultural prices, where dNAE is the change in the LDCs' net agricultural exports (valued at initial prices).

b Rows 2-4 of this table are calculated as the corresponding row in Table 3 multiplied by row 1 of this table. Thus, these rows measure effects per unit increase in NAE.

c Row 5 is the increase in LDCs' net non-agricultural imports, NNAM, per unit increase in NAE, assuming no change in aid or debt repayment. It is calculated as 1 + row 1.

increased net agricultural imports are perceived to disrupt markets. Row 5 is the increased non-agricultural net exports from the rest-of-world that are made possible by its increased net agricultural imports, assuming that LDCs hold their trade balances constant. Note that the figures in this row all exceed unity for the net importers of agricultural goods, since in this calculation agricultural trade is valued at initial prices and the trade balance is kept constant.

Row 2 states that each dollar's worth of net agricultural exports from LDCs' (NAE) that enters developed economies increases LDC real income by \$0.40 to \$0.7 if aid and debt repayment levels are unchanged. From row 3,each dollar's worth of NAE could be accompanied by between \$0.21 and \$0.49 of reduced aid or increased debt repayment without reducing LDC real income, and (from row 4) if this is done it should increase the rest of the world's real income by between \$0.20 and \$0.60 assuming a marginal cost of raising aid revenue or funds to bail out the banking system equal to 40 per cent. Finally, each additional dollar's worth of NAEs (at initial prices) makes possible between \$0.95 and \$1.13 worth of increased net industrial exports to the LDCs, assuming no change in LDC debt repayment or foreign aid.

Since agricultural workers tend to be the poorest in LDCs, equity is served by redistributing income to agricultural workers. Table 6 establishes that for each country group, transfers via the implicit transfer due to an agricultural price hike explicit aid, raise labour's

Table 6 **Income distribution: trade versus aid[a]**

Group	I	II	III	IV	V	VI
For all labour	5.7	13.6	3.7	2.5	-8.8	3.6
For agricultural labour	5.9	24.0	4.1	2.4	-12.5	5.7
For the agricultural sector	10.0	37.2	9.5	14.3	-21.9	10.0

a The increase in real income of labour, the initial agricultural labour force and those factors initially employed in the agricultural sector generated by an implicit transfer due to higher agricultural prices relative to that due to an explicit AID transfer of the same size.

real wage, agricultural labour's real wage and the real income of those factors initially employed in agriculture by more than an equivalent transfer through AID.[7] Only the figures for the agricultural sector as a whole exceed the corresponding figures in row 3 of Table 3 for all groups. Thus, in countries where the agricultural workers themselves have claims to the fruit of the land, the income distributional effects of agricultural price hikes are particularly salutary relative to those of AID transfers, but even when that is not the case, the implicit transfer through agricultural price hikes still have an absolute advantage in increasing labour's real wage and agricultural labour's real wage relative to an AID transfer of the same size.

Table 7 analyzes the effects of a 10 per cent increase in world agricultural prices, which is a reasonable guess for the change that one might expect to observe as a consequence of liberalized agricultural markets in the developed countries. We find that for all LDC's real income rises by 25.9 billion dollars. This could result in an increased flow of resources to the developed world of 14.8 billion dollars when the LDC real income is held at its initial level, or an increase in developed country real income of 16.6 billion dollars.[8] Finally, such an improvement in the agricultural terms of trade would be enough to pay off 4.8 per cent of the public debt of poorest (Group I) LDCs each year.[9]

7 The figures for country Group V indicate that the implicit transfer away from that group due to higher agricultural prices will raise real income of the relevant factor of production by more than an explicit AID transfer of the same size to that group.

8 This is $69.36 per citizen of the USA or .416 per cent of US GNP.

9 It is interesting to compare these results with two sets of results on pp. 128-130 of the 1986 *WDR*.

Results from a study by Valdes and Zietz (1980) presented in Table 6.6 finds that a 50% decrease in OECD agricultural tariff rates in 1975-77 would result in efficiency gains of 922 millions of 1980 dollars. This is considerably less than the figure that we obtain.

Anderson and Tyers in their background paper for the 1986 *WDR* find that liberalization of markets in the

Table 7 **The effects of a 10% increase in world agricultural prices**

Group	I	II	III	IV	V	VI	All LDCs
1. % Increase in Y[a]	2.10	.790	1.69	.715	1.27	1.37	1.11
2. delta Y ($billions)[b]	3.52	2.08	11.6	8.68	8.90	13.3	25.89
3. delta [-AID] ($b.)	2.86	1.07	5.70	4.22	4.82	7.42	14.85
4. delta Yrow ($b.)	3.55	1.42	7.65	4.00	7.47	8.13	16.62
5. delta [-AID]/Debt (%)[c]	4.82	4.01	3.31	1.27	2.72	2.44	2.38

a Row 1 is the per cent increase in LDC real income.
b Rows 2-4 correspond to the same entries in Tables 3 and 4.
c Row 5 is the per cent of external public debt which could be repaid each year by the increase in agricultural prices, holding LDC real income constant.

main temperate zone agricultural products by the industrial countries would result in worldwide efficiency gains of 25.6 billions of 1980 dollars, with a gain of 48.5 billions accruing to the industrial market economies, a loss of 11.8 billions accruing to the developing countries and a loss of 11.8 billions accruing to the East European nonmarket economies.

In a subsequent draft we will further explore the differences between our studies and theirs.

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VI Conclusion

Our calculations indicate that agricultural liberalization on the part of the developed world is an effective way to transfer resources to the less developed world relative to foreign aid. Moreover, the income distributional effects are more salutary. The flip side of this point is that better agricultural export prices for the less developed world can substantially enhance their ability to repay debt without necessitating a lowering in their standard of living. Finally, it is important to note that, particularly for less developed countries, spending on imports is constrained by export earnings, so to the extent that developed countries accept more LDC exports, LDCs will increase their net imports of other goods. Thus developed country policies which restrict LDC agricultural exports in effect also restrict developed country exports of industrial goods - a result that no one should find surprising.

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Appendix 1 The geometry of a simple version of the model, and the welfare impact of resource shifts in the presence of differential effective rates of protection

1a. The Geometry

The basic idea behind the analysis presented in this paper, namely that foreign exchange will be saved or earned when resources move from protected industry into negatively protected agriculture, is easily demonstrated within the context of a simple specific factors model, which is presented in Figure 4. The economy's labor stock is measured as 00′ on the horizontal axis, with employment in agriculture measured from the left hand axis and employment in industry measured from the right hand axis. The value of the marginal product of labor (VMPL) in agriculture at initial world prices is A*a. Since there is an export tax on agriculture, the domestic agricultural price is less than the world price. Consequently, the VMPL in agriculture at domestic prices lies below the corresponding curve at world prices and is given by Aa. The VMPL in industry at world prices is given by I*i. Since the industrial good is subject to an import tariff, the domestic price exceeds the world price. Thus the VMPL in industry at domestic prices exceeds that at world prices and is given by I*i. The equilibrium wage is given by the common VMPL where the two VMPLs at domestic prices intersect at e. Thus, initially, L_a units of labor is employed in agriculture while L_i units are employed in industry. An increase in world agricultural prices raises the agricultural VMPL at world prices to A*′a, which raises the agricultural VMPL at domestic prices to A′a, and moves the new equilibrium to e′. Consequently, an amount of labor dL shifts from industry to agriculture. If we suppose that consumption of the agricultural good is fixed at c, and that consumption of the industrial good is fixed as well, the country will earn increased foreign exchange equal to the slashed area which is the transfer due to the terms of trade effect plus the shaded area, which is the increased foreign exchange earnings due to the shifting of labor from positively protected industry into negatively protected agriculture. The ratio of the foreign exchange which can be released as reduced foreign aid or increased debt repayment to the agricultural transfer is the sum of the two areas divided by the slashed area. Obviously, if c is close to x, this ratio will be very large, and if c lies to the right of x, the ratio may even be negative, which demonstrates the point mentioned in the text that a negative terms of trade may be accompanied by a release of foreign exchange by the LDC and still leave LDC real income unchanged.

1b. Resource Shifts and Differential ERPs

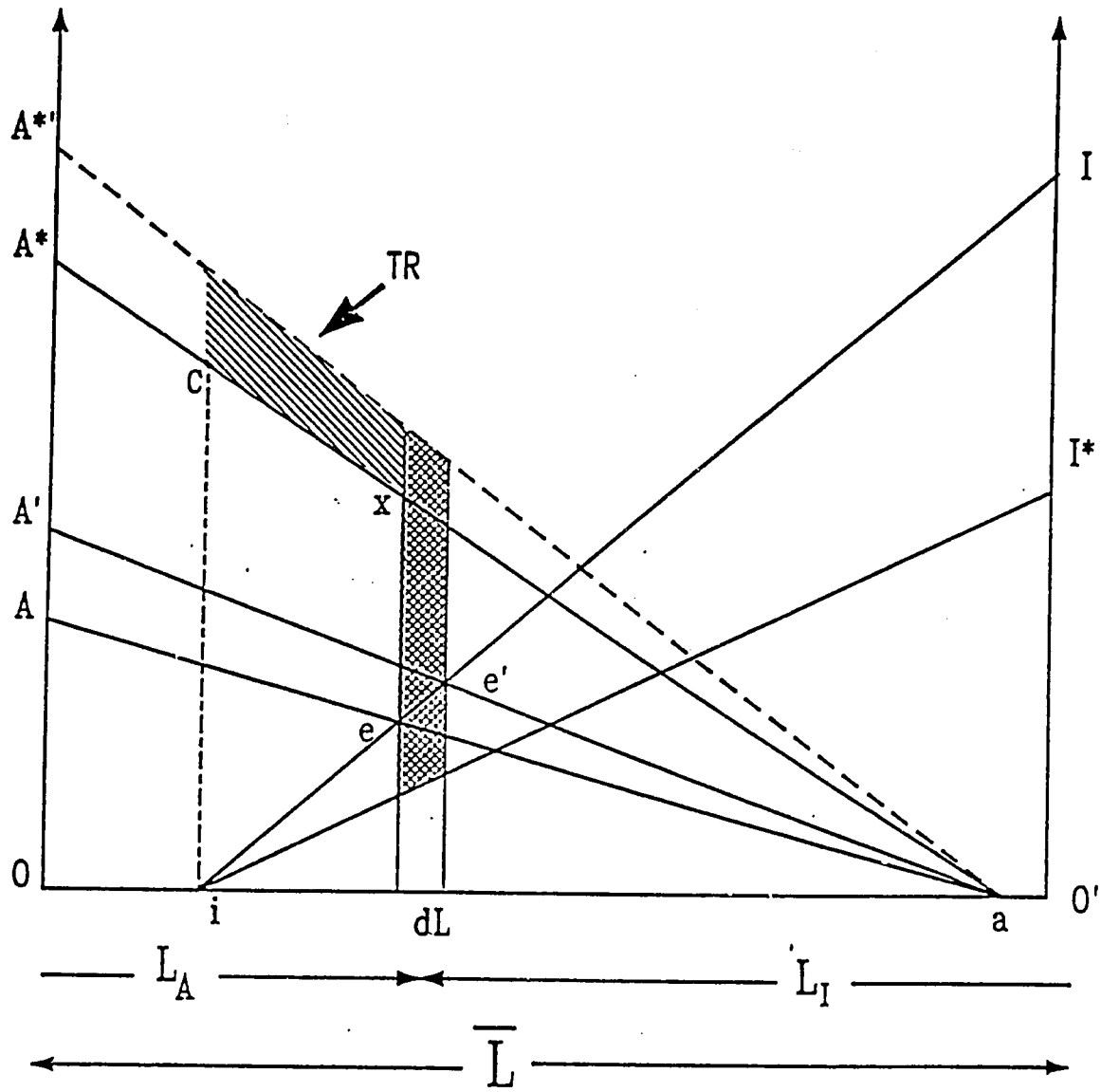
When intermediate inputs are used along with primary factors to produce outputs, the essential logic is the same as above, but the concept of the ERP is useful to see what drives the results. Now we explain using the ERP. The ERP coefficient for a sector, which is defined as 1 + ERP, measures the payments to primary factors (land, labour and capital) in that sector at domestic prices, divided by the net output produced by the sector measured at world prices, ie divided by the foreign exchange saved or earned. Thus, its reciprocal measures the foreign exchange saved or earned per dollar paid to primary factors in the sector. If primary factors are combined with constant returns to scale to produce a value-added composite good which is combined with intermediate inputs in fixed proportions and constant returns to scale to produce an output where both the intermediate input and the output are traded at fixed world prices, the reciprocal of the ERP coefficient measures the foreign exchange earned or saved by a dollar's worth of any primary factor. Competition assures that each factor will be paid the same in each sector. Thus, when agricultural prices rise, so that a dollar's worth of labour shifts from industry to agriculture, the resource shift from sector I to A will result in increased net foreign exchange earnings equal to

$$1/[1 + ERP_a] - 1/[1 + ERP_i]$$

$$= [ERP_i - ERP_a]/\{ [1 + ERP_a] [1 + ERP_i] \}.$$

Thus any policies which drive primary factors from sector I to A will be beneficial if A has the lower ERP. For example, using the figures for our low income countries, each dollar's worth of labour which is driven by higher agricultural prices from import competing industry with its ERP of 100 per cent into export agriculture with its ERP of -40 per cent, (with imported final industrial goods replacing the reduced industrial production) will raise net foreign exchange earnings by $0.50. Moreover, this extra foreign exchange will accrue to the government through its structure of trade taxes. Consequencely, better agricultural price bestows a welfare gain on the country even before labour moves, due to the increase in foreign exchange earned and trade taxes collected on the increased value of initial exports, and this welfare gain is further augmented by the increased foreign exchange earning and tax collection due to the labour mobility. Since we assume that intermediate inputs are combined with the value added composite in variable proportions to produce outputs, this story is a simplified version of the one we have told, but it highlights the mechanisms at work. It also shows how to use ERPs for measuring the benefits associated with altered economic efficiency and tax collection arising out of resource shifts.

Figure 2 The geometry of a simple version of the model



Appendix 2 The model described analytically

In this appendix we present the equations which make up the model described in Section 3. The reader should review Section 3 and read this Appendix in conjunction with Figure 1. The mathematics of all the equations which make up the model are explained in the chapter supplements of Caves and Jones (1985) and Tower (1984, Chapter 2). We start at the top of Figure 1 and work downward. Throughout the paper we use hats, '^,' to denote proportional changes.

There are two consumers in the model with identical and homothetic tastes: the private sector, under which we lump both consumption and gross investment and the government, which is assumed to face the same prices as the private sector.

The proportional change in the price level to these final demanders, $\widehat{CPI}$, is given by the sum of the share-weighted proportional changes in the prices of the two items consumed, services and goods:

$$[\widehat{CPI}] = \phi_s \hat{W}_s + [1 - \phi_s]\, \hat{P}_{gb} \tag{1}$$

where ϕ_s is the share of income spent on services, which are assumed to be produced using labour alone, so that W_s is both the wage in services and the price of a service, and P_{gb} is the price of the other item, 'goods,' to buyers. Goods are themselves a composite of various other items, as we shall see. Services correspond to 'services' in the national income accounts presented in the *World Development Report 1987*. They are assumed to be untaxed and are produced using labour alone. Thus they can be thought of as the consumption of leisure, except to the extent that they are purchased by the government.

Defining a unit of real income as the extra utility generated by the expenditure of a unit of domestic currency at constant prices of goods and services and assuming competition and utility maximization so that the marginal utility of money spent is the same in all uses yields

$$\hat{Y} = \phi_s \hat{S} + [1 - \phi_s]\hat{G} \tag{2}$$

where Y is the economy's real income and S and G are its final demands for services and goods. In what follows we will hold the government's 'real income' constant although we will permit the bundle of goods and services which it consumes to alter in accordance with changed relative prices. Thus $\hat{Y}$ represents the change in the private sector's real income as a proportion of the economy's real income.

The bundle of goods and services in final demand is assumed to depend on relative prices in accordance with

$$\hat{G} - \hat{S} = \sigma_s[\hat{W}_s - \hat{P}_{gb}] \tag{3}$$

where σ_s is the elasticity of substitution in consumption between the two items, and as we know from the hat calculus, $\hat{G} - \hat{S} = \widehat{G/S}$.

We denote the equations which we used in solving the model with numbers alone, and the equations which are used to derive them we denote with numbers followed by letters. The price of goods to sellers is denoted by P_g. The excise tax on consumption of goods is denoted by $[1 + \gamma]t$, where a fraction $\gamma > 0$ of these tax revenues are assumed to leak out as bribes to the tax collectors or as payment for licenses, so that only the fraction t of the value of the sales prices of goods consists of government revenues.

$$P_{gb} = 1 + [1 + \gamma]t/P_g\,. \tag{4a}$$

Consequently,

$$\hat{P}_{gb} = \gamma dt/(1 + [1 + \gamma]t)\hat{P}_g\,. \tag{4}$$

Goods are assumed to consist of a composite generated from two items: merchandise and foods. We denote quantities and prices of these items as M, F, P_m and P_f, with the elasticity of substitution between them as σ_f. Throughout the paper, production is assumed to be characterized by constant returns to scale and variable proportions. This gives us three more equations, which are analogous to (1), (2) and (3):

$$\hat{P}_g = \theta_m\hat{P}_m + [1 - \theta_m]\hat{P}_f\,, \tag{5}$$

$$\hat{G} = \theta_m\hat{M} + [1 - \theta_m]\hat{F}\,, \tag{6}$$

and

$$\hat{M} - \hat{F} = \sigma_f[\hat{P}_f - \hat{P}_m] \tag{7}$$

where θ_m is the share of output of G which is spent on inputs of M.

Food is a composite of imported agricultural items we refer to as cereal and denote by C and domestically produced agriculture. Cereals are not taxed in the home economy, so P_c denotes their price both on world markets and to buyers. An amount A_c of the home-produced agricultural good is used in food production to be consumed at home and an amount A_x of it is exported. Its price to home buyers for use as food is denoted by P_{ab}. Defining θ_a

as the share of home agriculture in food production and σ_{ac} as the elasticity of substitution between agriculture and cereals gives us

$$\hat{P}_f = \theta_a \hat{P}_{ab} + [1 - \theta_a]\hat{P}_c , \tag{8}$$

$$\hat{F} = \theta_a \hat{A}_c + [1 - \theta_a]\hat{C} , \tag{9}$$

and

$$\hat{A}_c - \hat{C} = \sigma_{ac}[\hat{P}_c - \hat{P}_{ab}] . \tag{10}$$

Production of the agricultural good, A, with price P_A, uses agricultural labour, L_a, with wage, W_a, and a composite, T_z, with price P_{tz}. P_{ab} exceeds P_a by a constant ad volorem tax rate. Defining the elasticity of substitution between these two inputs as σ_a and labour's share in A as θ_L yields

$$\hat{P}_a = \theta_L \hat{W}_a + (1 - \theta_L)\hat{P}_{tz} , \tag{11}$$

$$\hat{A} = \theta_L \hat{L}_a + [1 - \theta_L]\hat{T}_z , \tag{12}$$

and

$$\hat{L}_a - \hat{T}_z = \sigma_a(\hat{P}_{tz} - \hat{W}_a) . \tag{13}$$

The agricultural composite is produced with a fixed amount of land, T, whose rental is denoted by N and the imported material input, Z_a, whose price is frozen by its fixed world price. Denoting the share of Z_a in the agricultural composite by θ_{za} and the elasticity of substitution between the two inputs as σ_{za} yields

$$\hat{P}_{tz} = [1 - \theta_{za}]\hat{N} , \tag{14}$$

$$\hat{T}_z = \theta_{za}\hat{Z}_a , \tag{15}$$

and

$$Z_a = \sigma_{za}\hat{N} . \tag{16}$$

Merchandise, M, is produced using a quantity I_c of the domestically-produced industrial good, with price, P_i, and a quantity, J, of the imported final good with price to the buyer of P_j. Denoting the share of I_c in M by θ_i and the elasticity of substitution between the two items by σ_i gives

$$\hat{P}_m = \theta_i\hat{P}_i + [1 - \theta_i]\hat{P}_j , \tag{17}$$

$$\hat{M} = \theta_i\hat{I}_C + [1 - \theta_i]\hat{J} , \tag{18}$$

and

$$\hat{I}_C - \hat{J} = \sigma_i[\hat{P}_j - \hat{P}_i] . \tag{19}$$

Output of the industrial good, I, is produced using a value added composite, V, with price P_v and imported intermediate inputs, Z_i, with a price that is fixed by world markets. The composite's share of I is θ_v and the elasticity of substitution is σ_v, so we have

$$\hat{P}_i = \theta_v\hat{P}_v , \tag{20}$$

$$\hat{I} = \theta_v\hat{V} + [1 - \theta_v]\hat{Z}_i , \tag{21}$$

and

$$\hat{Z}_i - \hat{V} = \sigma_v\hat{p}_v . \tag{22}$$

The industrial composite is produced using labour, L_i, with wage W_i and a fixed capital stock with rental rate R. Capital's share is θ_k and the elasticity of substitution between the two factors is σ_k, so

$$\hat{P}_v = \theta_k\hat{R} + [1 - \theta_k]\hat{W}_i , \tag{23}$$

$$\hat{V} = [1 - \theta_k]\hat{L}_i , \tag{24}$$

and

$$\hat{L}_i = \sigma_k[\hat{R} - \hat{W}_i] . \tag{25}$$

The imported final good is subject to both tariff and quota restrictions which result in its price to buyers P_j exceeding its fixed world price, which is defined equal to unity, by a proportion t_j which we refer to as the tariff-quota wedge. Thus

$$P_j = (1 + t_j) \tag{26a}$$

so

$$\hat{P}_j = dt_j/(1 + t_j) . \tag{26}$$

The mining and petroleum sector produces output, D_x, all of which is exported and sold at a fixed world price of unity. It uses a composite D_V with price P_{dv} in combination with a

quantity of imported intermediates given by Z_d, whose price is fixed on the world market at unity. Denoting the composite's share in D_x by θ_{zd} and the elasticity of substitution by σ_d yields

$$0 = \hat{P}_{dv}[1 - \theta_{zd}] , \tag{27}$$

$$\hat{D}_x = \theta_{zd}\hat{Z}_d + [1 - \theta_{zd}]\hat{D}_v , \tag{28}$$

and

$$\hat{Z}_d - \hat{D}_v = \sigma_{zd}\hat{P}_{dv} . \tag{29}$$

The mining and petroleum composite is produced using labour, L_d, with wage W_d and a fixed factor denoted by D for deposits with rental price R_d. Deposit's share is θ_d and the elasticity of substitution is σ_d. Thus

$$\hat{P}_{dv} = \theta_d\hat{R}_d + [1 - \theta_d]\hat{W}_d , \tag{30}$$

$$\hat{D}_v = [1 - \theta_d]\hat{L}_d , \tag{31}$$

and

$$\hat{L}_d = \sigma_d[\hat{R}_d - \hat{W}_d] . \tag{32}$$

The balance of payments equation is given by

$$D_x + I_x + A_xP^*_A + [AID] = CP_c + J + Z_a + Z_d + Z_i , \tag{33a}$$

where all world prices except for those of the two agricultural goods are fixed at unity; D_x, I_x, and A_x are respectively, exports of the mining, industrial, and agricultural good; AID is the balance of trade deficit, and the right hand side of the equation represents the value of imports. Differentiating yields

$$D_x\hat{D}_x + I_x\hat{I}_x + A_xP^*_a[A_x + P^*_a] + [AID]\hat{AID}$$
$$= C\hat{C} + C\hat{P}_c + J\hat{J} + Z_a\hat{Z}_a + Z_d\hat{Z}_d + Z_i\hat{Z}_i . \tag{33}$$

Material balance in industry implies

$$I_c + I_x = I \tag{34a}$$

so

$$I_c\hat{I}_c + I_x\hat{I}_x = I\hat{I} . \tag{34}$$

Similarly, material balance in agriculture implies

$$A\hat{A} = A_c\hat{A}_c + A_x\hat{A}_x . \tag{35}$$

Government revenue, [REV], is the sum of revenue plus foreign aid. It is given by

$$[REV] = tP_gG + rt_jJ + t_{ax}P^*_aA_x + t_{ac}P_aA_c + t_dDR_d + [AID] , \tag{36a}$$

where r is the fraction of the tariff-quota wedge, t_j, which is accounted for by the tariff on j, and r is assumed to be constant; t_{ax} is the ad valorem export tax on agricultural exports, expressed as a proportion of world price, P^*_a; t_{ac} is the ad valorem tax imposed on home consumption of domestically produced agricultural goods; t_d is the share of payments to the 'fixed factor' in mining and petroleum that accrue as taxes to the government; D is the stock of the 'fixed factor' in mining and petroleum (the rate at which ore is mined); and R_D is the royalty payments per unit of ore. Conceptually, DR_d also includes payments for reproducible capital located in mining and petroleum. Letting δ be the proportional increase in real tax revenues, which we include in order subsequently to calculate the marginal welfare cost of tax collection, we have .

$$\delta = \{P_gGdt + [\hat{P}_g + \hat{G}] + P_gG + rJdt_j + t_jrJ\hat{J} + t_{ax}P^*_aA_x[\hat{P}^*_a + \hat{A}_x] - s_{ix}I_x\hat{I}_x$$
$$+ t_{ac}P_aA_c[\hat{P}_a + \hat{A}_c] + t_dR_dD\hat{R}_d + [AID][\hat{AID}]\}/[REV] - [\hat{CPI}] . \tag{36}$$

We assume that labour is homogeneous when measured in efficiency units. We denote labour's share in the ith sector in economy-wide labour earnings as λ_i. Thus the proportional change in the average wage paid in the economy is given by

$$\hat{W} = \lambda_s\hat{W}_s + \lambda_a\hat{W}_a + \lambda_i\hat{W}_i + \lambda_d\hat{W}_d . \tag{37}$$

Full employment dictates

$$0 = S\hat{S} + L_a\hat{L}_a + L_i\hat{L}_i + L_d\hat{L}_d . \tag{38}$$

The elasticity of supply of labour to the various sectors with respect to the wage in each sector relative to the average is denoted by e_i, so

$$\hat{L}_a = e_a(\hat{W}_a - \hat{W}) , \tag{39}$$

$$\hat{L}_i = e_i(\hat{W}_i - \hat{W}) , \tag{40}$$

and

$$\hat{L}_d = e_d(\hat{W}_d - \hat{W}) \tag{41}$$

where we have suppressed the corresponding equation for the agricultural sector, because it is redundant.

The agricultural tax rates are frozen, so the proportional changes in all agricultural prices are identical. This means that

$$\hat{P}_{ab} = \hat{P}_a = P^*_a = \hat{P}_c . \qquad (42) - (44)$$

The industrial export subsidy is fixed as is the world price of the industrial export. Consequently

$$\hat{P}_i = *0 . \qquad (45)$$

Quota rents collected on the import of J are denoted by Q, and they are assumed to constitute a fixed fraction (1 - r) of the price differential on the trade in J. Thus

$$Q = t_j J(1 - r) \qquad (46a).$$

so

$$\hat{Q} = \hat{J} + (dt_j/t_j) . \qquad (46)$$

Finally, denoting real factor returns with "*'s" gives us a set of equations for proportional changes in real wages and rentals:

$$\hat{W}^* = \hat{W} - [\hat{CPI}] , \qquad (47)$$

$$\hat{W}^*_a = \hat{W}_a - [\hat{CPI}] , \qquad (48)$$

$$\hat{W}^*_d = \hat{W}_d - [\hat{CPI}] , \qquad (49)$$

$$\hat{W}^*_i = \hat{W}_i - [\hat{CPI}] , \qquad (50)$$

$$\hat{R}^* = \hat{R} - [\hat{CPI}] , \qquad (51)$$

$$\hat{R}^*_d = \hat{R}_d - [\hat{CPI}] , \qquad (52)$$

$$\hat{N}^* = \hat{N} - [\hat{CPI}] , \qquad (53)$$

and

$$\hat{Q}^* = \hat{Q} - [\hat{CPI}] . \qquad (54)$$

These (54) equations constitute our model in (4) exogenous equations, $\hat{P}_a$, P_c, δ and $\widehat{AID}$ and (54) endogenous variables.

Finally, we used the following sets of values for our constants:

$$\sigma_f = 1 ,$$

$$\sigma_a = \sigma_{ac} = \sigma_i = \sigma_k = \sigma_s = 1 ,$$

$$\sigma_d = \sigma_v = \sigma_{za} = \sigma_{zd} = 1 ,$$

$$\theta_t = 1/3 ,$$

$\theta_d = \theta_k$ which is defined as [1 - labour's share in industry], where labour's share is read in from the data on the various country group's labour share in manufacturing, and

$$e_s = e_i = e_d = 2 .$$

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Var	Country 1 AID	Country 1 DELTA	Country 1 Pa	Country 2 AID	Country 2 DELTA	Country 2 Pa	Country 3 AID	Country 3 DELTA	Country 3 Pa	Country 4 AID	Country 4 DELTA	Country 4 Pa	Country 5 AID	Country 5 DELTA	Country 5 Pa	Country 6 AID	Country 6 DELTA	Country 6 Pa
A	0.10006	-0.2740	0.72314	0.04333	-0.2257	0.39660	0.00937	-0.2901	0.71917	-0.0455	-0.3031	0.80673	-0.0261	-0.3214	0.62864	-0.0476	-0.3152	0.59170
Ac	0.17540	-0.2000	0.04227	0.00301	-0.1600	-0.3096	0.02175	-0.1929	-0.3022	-0.1216	-0.2502	-0.6002	-0.0716	-0.2290	-0.3633	-0.1361	-0.2359	-0.3970
Ax	-0.5148	-0.8787	6.28008	-0.8279	-1.4496	15.5982	-0.0462	-0.7267	5.30409	0.14250	-0.7112	4.57750	0.80170	-1.9068	18.6689	0.34208	-0.6646	4.91420
C	0.17540	-0.2008	2.04227	0.00301	-0.1600	1.69033	0.02175	-0.1929	1.69777	-0.1216	-0.2502	1.39171	-0.0716	-0.2298	1.63660	-0.1361	-0.2359	1.60292
CPI	-0.3699	0.83147	-0.3406	-0.1720	0.71214	0.25425	-0.0367	0.81565	-0.1133	0.16300	0.91990	-0.0345	0.10604	0.88026	-0.0606	0.18150	0.80424	0.00550
Ov	0.04091	-0.1124	-0.0407	0.01632	-0.0050	-0.1332	0.00354	-0.1096	-0.0455	-0.0106	-0.1567	-0.0235	-0.0104	-0.1290	-0.0577	-0.0181	-0.1200	-0.0637
Ox	0.04091	-0.1124	-0.0407	0.01632	-0.0050	-0.1332	0.00354	-0.1096	-0.0455	-0.0106	-0.1567	-0.0235	-0.0104	-0.1290	-0.0577	-0.0181	-0.1200	-0.0637
F	0.17540	-0.2000	0.19529	0.00381	-0.1600	-0.2391	0.02175	-0.1929	-0.0560	-0.1216	-0.2502	-0.1973	-0.0716	-0.2298	-0.0976	-0.1361	-0.2359	-0.2101
G	0.17540	-0.2000	0.49723	0.08301	-0.1600	0.19230	0.02175	-0.1929	0.37930	-0.1216	-0.2502	0.23227	-0.0716	-0.2298	0.33762	-0.1361	-0.2359	0.32575
I	0.05748	-0.1579	-0.0572	0.02293	-0.1194	-0.1871	0.00499	-0.1547	-0.0642	-0.0261	-0.2202	-0.0331	-0.0147	-0.1012	-0.0811	-0.0255	-0.1690	-0.0898
Ic	0.17540	-0.2000	1.04227	0.08301	-0.1600	0.69033	0.02175	-0.1929	0.69777	-0.1216	-0.2502	0.39171	-0.0716	-0.2298	0.63660	-0.1361	-0.2359	0.60292
Ix	-0.5262	0.05408	-5.4997	-0.4009	0.22447	-6.2970	-0.0795	0.03768	-3.9087	0.13438	-0.1698	-0.7472	0.60950	0.35145	-7.9567	0.55035	0.18405	-3.7459
J	0.17540	-0.2000	1.04227	0.08301	-0.1600	0.69033	0.02175	-0.1929	0.69777	-0.1216	-0.2502	0.39171	-0.0716	-0.2298	0.63660	-0.1361	-0.2359	0.60292
La	0.12439	-0.3417	0.30962	0.06334	-0.3299	0.42040	0.01130	-0.3524	0.23475	-0.0405	-0.4003	0.05501	-0.0351	-0.4320	0.44347	-0.0659	-0.4367	0.49101
Ld	0.12787	-0.3512	-0.1274	0.05101	-0.2657	-0.4164	0.01180	-0.3654	-0.1516	-0.0582	-0.4899	-0.0737	-0.0327	-0.4033	-0.1805	-0.0584	-0.3071	-0.2057
Li	0.17962	-0.4934	-0.1789	0.07166	-0.3732	-0.5849	0.01666	-0.5150	-0.2141	-0.0017	-0.6002	-0.1035	-0.0460	-0.5665	-0.2536	-0.0023	-0.5452	-0.2897
M	0.17540	-0.2008	1.04227	0.08301	-0.1600	0.69033	0.02175	-0.1929	0.69777	-0.1216	-0.2502	0.39171	-0.0716	-0.2298	0.63660	-0.1361	-0.2359	0.60292
M	0.17738	-0.4072	3.05457	0.05705	-0.2971	1.03804	0.01694	-0.5245	3.10705	-0.0088	-0.7470	3.68300	-0.0421	-0.5109	2.62960	-0.0732	-0.4846	2.44608
Mx	0.54720	-1.3187	3.39523	0.22909	-1.0093	1.58459	0.05373	-1.3402	3.22116	-0.2518	-1.6677	3.71754	-0.1409	-1.4072	2.65920	-0.2547	-1.2089	2.44137
Pdv	2E-17	-5E-17	2E-17	-6E-18	3E-17	3E-17	2E-18	-3E-17	2E-17	-4E-18	-4E-17	-4E-18	-2E-18	-2E-17	1E-17	4E-18	1E-17	-2E-17
Pf	0	0	0.84698	0	0	0.92940	0	0	0.75384	0	0	0.50906	5E-18	4E-17	0.73426	0	0	0.81304
Pj	0	0	0	0	0	0	0	0	0	0	0	0	8E-18	5E-17	4E-18	0	0	0
Pg	-7E-18	1E-17	0.54504	-2E-18	-6E-18	0.49795	3E-18	-5E-17	0.31847	1E-17	3E-17	0.15944	3E-18	3E-17	0.29898	-1E-17	-5E-17	0.27716
Pgb	-0.4607	0.98475	-0.5597	-0.2125	0.83937	0.16645	-0.0461	0.94749	-0.2403	0.2[illegible]253	1.69904	-0.1257	0.13784	1.04541	-0.2029	0.24763	0.97300	-0.1422
Pm	-2E-17	3E-17	-5E-17	-4E-18	-1E-17	-6E-17	5E-18	-9E-17	6E-17	1E-17	5E-17	-7E-18	2E-18	2E-17	3E-17	-2E-17	-8E-17	4E-18
Ptx	0.10654	-0.2926	1.83460	0.04593	-0.2392	1.48047	0.00992	-0.3073	1.02101	-0.0464	-0.3911	1.92625	-0.0281	-0.3461	1.75395	-0.0512	-0.3335	1.71410
Pv	-1E-17	1E-17	-1E-17	-3E-18	7E-18	7E-17	1E-18	-2E-17	1E-17	-1E-17	-6E-17	-6E-18	-2E-18	-1E-17	1E-18	6E-18	2E-17	2E-17
Q	0.17540	-0.2000	1.04227	0.08301	-0.1600	0.69033	0.02175	-0.1929	0.69777	-0.1216	-0.2502	0.39171	-0.0716	-0.2298	0.63660	-0.1361	-0.2359	0.60292
Qx	0.54530	-1.0323	1.38293	0.25506	-0.6809	0.43600	0.05054	-1.0005	0.81100	-0.2046	-1.1701	0.42625	-0.1784	-1.1181	0.70528	-0.3176	-1.0401	0.59741
R	0.02874	-0.0789	-0.0286	0.01146	-0.0597	-0.0935	0.00249	-0.0773	-0.0321	-0.0130	-0.1101	-0.0165	-0.0073	-0.0906	-0.0405	-0.0127	-0.0845	-0.0449
Rx	0.39064	-0.9104	0.31201	0.18351	-0.7718	-0.3478	0.03929	-0.6330	0.00118	-0.1760	-1.0300	0.01796	-0.1142	-0.9709	0.02809	-0.1942	-0.8007	-0.0504
Rd	0.04091	-0.1124	-0.0407	0.01632	-0.0050	-0.1332	0.00354	-0.1096	-0.0455	-0.0106	-0.1567	-0.0235	-0.0104	-0.1290	-0.0577	-0.0181	-0.1200	-0.0637
Rdx	0.41001	-0.9438	0.29908	0.18037	-0.7971	-0.3875	0.04033	-0.9252	0.06780	-0.1816	-1.0766	0.01094	-0.1173	-1.0173	0.01089	-0.1996	-0.9242	-0.0692
S	-0.0096	0.24624	-0.1419	-0.0456	0.23799	-0.0083	-0.0068	0.21072	-0.0340	0.02144	0.10047	0.01304	0.01838	0.22643	-0.0522	0.02791	0.18479	-0.0400
dt	-0.1970	0.42117	-0.4725	-0.1004	0.42832	-0.1691	-0.0347	0.71302	-0.4265	0.24138	1.19211	-0.3093	0.13162	0.99826	-0.4793	0.24119	0.94847	-0.4005
Tx	0.07084	-0.1946	1.21989	0.01111	-0.0579	0.35837	0.00701	-0.2172	1.20684	-0.0423	-0.3567	1.75674	-0.0140	-0.1728	0.87565	-0.0219	-0.1451	0.73277
V	0.05748	-0.1579	-0.0572	0.02293	-0.1194	-0.1871	0.00499	-0.1547	-0.0642	-0.0261	-0.2202	-0.0331	-0.0147	-0.1012	-0.0811	-0.0255	-0.1690	-0.0898
W	-0.1508	0.41449	0.15035	-0.0601	0.31354	0.49136	-0.0141	0.43050	0.18202	0.06060	0.57811	0.00699	0.03064	0.47591	0.21308	0.06959	0.46070	0.24479
Wx	0.21901	-0.4169	0.49101	0.11185	-0.3985	0.23711	0.02263	-0.3771	0.29533	-0.0943	-0.5417	0.12152	-0.0602	-0.4123	0.28176	-0.1119	-0.3435	0.23328
Wa	-0.0086	0.24363	0.30516	-0.0205	0.14858	0.70161	-0.0084	0.26228	0.29340	0.04442	0.37393	0.11449	0.02107	0.25949	0.43402	0.03661	0.24233	0.49030
Wax	0.28120	-0.5878	0.64502	0.14352	-0.5635	0.44735	0.02832	-0.5533	0.41271	-0.1185	-0.5459	0.14903	-0.0857	-0.6287	0.50350	-0.1448	-0.5619	0.48479
Wd	-0.0069	0.23085	0.08664	-0.0346	0.18068	0.20316	-0.0002	0.25579	0.10618	0.03958	0.33314	0.05013	0.02226	0.27425	0.12279	0.04035	0.26712	0.14194
Wdx	0.20294	-0.5926	0.42730	0.13735	-0.5314	0.02090	0.02053	-0.5598	0.21949	-0.1234	-0.5067	0.00466	-0.0045	-0.6140	0.19147	-0.1411	-0.5371	0.13643
Wi	-0.0610	0.16777	0.06085	-0.0243	0.12691	0.19808	-0.0058	0.10056	0.07495	0.02700	0.23399	0.03521	0.01564	0.19263	0.08624	0.02041	0.18009	0.09994
Wix	0.30082	-0.6637	0.[illegible]0151	0.14768	-0.5852	-0.0553	0.03096	-0.6350	0.10026	-0.1352	-0.6059	0.06974	-0.0912	-0.6956	0.15492	-0.1530	-0.6161	0.09443
Ws	-0.1957	0.53761	0.[illegible]7939	-0.0830	0.43254	0.44719	-0.0175	0.54306	0.16501	0.07041	0.66035	0.08351	0.04783	0.50912	0.18693	0.08355	0.55309	0.22436
Y	0.00454	-0.0476	0.27014	0.04331	-0.0416	0.10450	0.01242	-0.0610	0.24429	-0.0621	-0.0710	0.14109	-0.0406	-0.0727	0.20333	-0.0700	-0.0663	0.17799
Za	0.17730	-0.4072	3.05457	0.05705	-0.2971	1.83804	0.01694	-0.5245	3.10705	-0.0000	-0.7470	3.68300	-0.0421	-0.5189	2.62960	-0.0732	-0.4846	2.44608
Zd	0.04091	-0.1124	-0.0407	0.01632	-0.0850	-0.1332	0.00354	-0.1096	-0.0455	-0.0106	-0.1567	-0.0235	-0.0104	-0.1290	-0.0577	-0.0181	-0.1200	-0.0637
Zi	0.05740	-0.1579	-0.0572	0.02293	-0.1194	-0.1871	0.00499	-0.1547	-0.0642	-0.0261	-0.2202	-0.0331	-0.0147	-0.1812	-0.0811	-0.0255	-0.1690	-0.0898

The i,j th item shows the percentage change in the i'th endogenous variable induced by a 1 % change in the j'th exogenous variable (AID, DELTA, Pa).

Appendix 4 Data on the composition of LDC agricultural trade (× $10,000), 1984 data

	Region I		Region II		Region III	
	Imports	Exports	Imports	Exports	Imports	Exports
A) Food + animal	269512	454337	9231	17325	1158352	1668682
(% of region)	64.6%	74.8%	41.4%	73.4%	66.9%	73.5%
Livestock products	1028	2951	25	872	124023	76685
(% of region)	0.2%	0.5%	0.0%	3.7%	7.2%	3.4%
Cereals	15697	6619	5599	691	601350	195668
(% of region)	3.8%	1.1%	25.1%	2.9%	34.7%	8.6%
Dairy + eggs	2930	18	1234	18	120390	8685
(% of region)	0.7%	0.0%	5.5%	0.1%	7.0%	0.4%
Sugar and Honey	1687	824	1000	981	134953	167431
(% of region)	0.4%	0.1%	4.5%	4.2%	7.8%	7.4%
B) Beverages + tobacco	1300	2060	20	1627	65622	82702
(% of region)	0.3%	0.3%	0.1%	6.9%	3.8%	3.6%
C) Crude materials	3925	14502	1349	3274	333975	413510
(% of region)	0.9%	2.4%	6.0%	13.9%	19.3%	18.2%
D) Animal + veg. oil	9899	1333	11700	1391	173027	105588
(% of region)	2.4%	0.2%	52.5%	5.9%	10.0%	4.7%
Agricultural total	417349	607243	22301	23618	1730976	2270482
(% of world)	1.81%	2.94%	0.10%	0.11%	7.51%	10.99%
Agri + fish + forestry	523790	607400	163830	258020	1741330	2691340
(% of world)	1.7%	2.2%	0.5%	0.9%	5.7%	9.9%
Agri. requisites	10921	2671	12329	140	269647	142642
Total merchandise trade	2019650	1270450	1395300	879300	10416568	9317338

	Region IV		Region V		Region VI	
	Imports	Exports	Imports	Exports	Imports	Exports
A) Food + animal	1458302	2045642	1101015	418799	836158	2207517
(% of region)	51.9%	58.4%	68.6%	59.7%	54.2%	77.5%
Livestock products	213476	314261	117258	20465	64469	199942
(% of region)	7.6%	9.0%	7.3%	2.9%	5.0%	7.0%
Cereals	601350	375311	543309	6952	450447	270944
(% of region)	17.6%	10.7%	33.9%	1.0%	34.6%	9.5%
Dairy + eggs	135429	25649	133092	515	23903	5640
(% of region)	4.8%	0.7%	8.3%	0.1%	1.8%	0.2%
Sugar and honey	99532	170482	90615	13881	68164	133768
(% of region)	3.5%	4.9%	5.6%	2.0%	5.2%	4.7%
B) Beverages + tobacco	141724	190439	55695	26132	55067	95071
(% of region)	5.0%	5.4%	3.5%	3.7%	4.2%	3.3%
C) Crude materials	609717	540097	175807	237509	237795	303916
(% of region)	21.7%	15.4%	11.0%	33.9%	18.3%	10.7%
D) Animal + veg. oil	208101	554670	271823	19002	172826	240804
(% of region)	7.4%	15.8%	16.9%	2.7%	13.3%	8.5%
Agricultural total	2808420	3501809	1604340	701442	1301846	2847308
(% of world)	12.19%	16.95%	6.96%	3.39%	5.65%	13.78%
Agri + fish + forestry	3288070	4692370	1872890	522350	1321490	3146680
(% of world)	10.8%	17.2%	6.2%	1.9%	4.3%	11.5%
Agri. requisites	319157	161304	173605	60647	343313	120930
Total merchandise trade	21240602	22684102	5111544	0600555	8675266	12618677

Source: FAO Trade Yearbook, 1985

Note: Due to unavailability of data, Region 1 omits Benin, Bhutan, Burundi, Guinea, Mozambique, Nepal, Niger, and Rwanda; Region 2 omits Botswana and Mauritania; Region 3 omits Iraq.

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Appendix 5 The country composition of each group of economies

Group I is low-income economies other than China and India. These are economies with 1985 GNP per person of $400 or less. The group consists of Ethiopia, Bangladesh, Burkina Faso, Mali, Bhutan, Mozambique, Nepal, Malawi, Zaire, Burma, Burundi, Togo, Madagascar, Niger, Benin, Central African Republic, Rwanda, Somalia, Kenya, Tanzania, Sudan, Haiti, Guinea, Sierra Leone, Senegal, Ghana, Pakistan, Sri Lanka, and Zambia in increasing order of per person GNP.

Group III is lower middle-income developing economies. These are less developed economies with per person incomes in 1985 between $401 and $1600. This group consists of the following in ascending order of GNP: Mauritania, Bolivia, Lesotho, Liberia, Indonesia, Yemen PDR, Yemen Arab Republic, Morocco, Philippines, Egypt, Ivory Cost, Papua New Guinea, Zimbabwe, Honduras, Nicaragua, Dominican Republic, Nigeria, Thailand, Cameroon, El Salvador, Botswana, Paraguay, Jamaica, Peru, Turkey, Mauritius, Congo, Ecuador, Tunisia, Guatemala, Costa Rica, Columbia, Chile, Jordan, and Syria.

Group IV is upper middle-income developing economies. These are developing economies with per person real incomes in 1985 between $1600 and $7500. They are in ascending order of GNP: Brazil, Uruguay, Hungary, Portugal, Malaysia, South Africa, Poland, Yugoslavia, Mexico, Panama, Argentina, Korea, Algeria, Venezuela, Greece, Israel, Trinidad and Tobago, Hong Kong, Oman, and Singapore.

Group V is oil-exporting developing economies. These are middle- income developing economies with exports of petroleum and gas, including re-exports, accounting for 30 per cent or more of merchandise exports: Algeria, Egypt, Cameroon, Ecuador, Gabon, Indonesia, Iraq, Mexico, Nigeria, Oman, Congo, Syria, Trinidad and Tobago, and Venezuela.

Group VI is highly indebted economies. These are economies which are 'deemed to have encountered severe debt servicing difficulties: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ivory Coast, Ecuador, Jamaica, Mexico, Morocco, Nigeria, Peru, Philippines, Uruguay, Venezuela, and Yugoslavia.' These definitions are drawn from page xi of the WDR.

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Costs of agricultural trade wars

by

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Summary

We have presented an alternative approach to the analysis of the cost of agricultural protection suggested by the notion of retaliation and trade wars. This procedure may be readily applied to consider a number of strategic policy issues that are of interest in agricultural trade policy evaluation. Specifically, existing GE trade models may be used to generate the payoffs for these games. We illustrate these procedures using a global numerical trade model due to Whalley (1985, 1986). We also show the usefulness of the non-cooperative trade war approach as a measure of bargaining strength. The quality of the conclusions of cooperative games depends intimately on the quality of the analysis of the non-cooperative game. We also show that the global costs of an escalation of an agricultural trade war are very high.

The general point that we have illustrated is that the concept of 'self-interest' must be defined and evaluated in a strategic context. The only exceptions are 'degenerate' cases (strategically speaking) in which one or more countries have dominant strategies available.

Our specific quantitative results demonstrate the extreme importance of understanding the 'politico-economic' process that causes governments to consider one policy as better than another. When we substituted domestic agricultural production levels for welfare in the payoffs of our trade war games, we were implicitly making a statement about this process. We recognize that our approach is crude and ad hoc, but so is our perception of the trade policy formation process. Nonetheless, this stylistic characterization of alternative policy objectives starkly shows that governments can be led to take extremely costly policy actions while seeming to act in the 'best interests' of one sectional group of society. This point is not new, but deserves emphasis and further study.

One major implication of our results is that anything that contains the (natural and healthy) strategic lust of the EEC and the US to engage in trade wars is likely to avoid serious disruption to global agricultural markets.

This conclusion reinforces a view of the GATT that is somewhat more charitable than popular economic wisdom. Whalley (1985, p255) suggests that:

> much of the policy activity within forums such as the GATT can be seen as 'accommodation-preserving' activity. Existing cooperative arrangements reduce protection below the levels that would prevail in their absence. The changes that take place from one negotiating round to another may be relatively small, but at

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least they preserve what cooperation has already been obtained. Viewed from this stance, the GATT and other international arrangements as 'process' are significant.

Our results reinforce this view of the importance of the GATT.

I Introduction

It is apparent that an agricultural trade war is currently in progress between the US and the EEC. We examine the game-theoretic aspects of this trade war and attempt to evaluate its welfare costs. An important contribution of our approach is to identify the strategic nature of the 'self-interest' that leads a nation to undertake such retaliatory trade policy actions. We argue that it is fruitless to rely on the self-interest of large nations to stop such trade wars if one does not allow for the threat of retaliation by other nations. This perspective has certain important implications for possible negotiated settlements with regard to international agricultural trade policy.

In Section II we explain and illustrate the game-theoretic notions that we use throughout. The central concept is that of a Nash Equilibrium, which is simply a set of policies for the US and the EEC such that neither country would want to change their policies unilaterally. In other words, each country is selecting its most preferred policies given the policy choices of the other nation. The central idea of this paper, that 'self-interest' cannot and should not be defined independently of the possibility of strategic retaliation by other nations, is explained in this section.

In Section III we apply the concept of a Nash Equilibrium to evaluate the outcome of a strategic trade war in agriculture between the US and the EEC.[1] We use a global numerical general equilibrium model due to Whalley (1985, 1986) to evaluate the payoffs to each nation from alternative policy choices. Details of our computational procedures, which are of independent but technical interest for present purposes, are presented in Harrison and Rutström (1987). The range of policy choices that we consider here allows us to draw some conclusions about the likely outcomes of 'full-blown' trade war.

We consider two types of trade war. The first (Section III) assumes that governments care only about national *welfare* and the second (Section VI) assumes that they care only about domestic *agricultural production*. We interpret the first of these as an efficiency trade war, in the sense that the effect on efficiency is the direct object of concern by the two governments. The second trade war can be interpreted as a non-efficiency trade war, in that

1 There has been a number of previous numerical studies of trade retaliation in the context of simple general equilibrium models: see, for example, Kuga (1973), Hamilton and Whalley (1983), Kennan and Riezman (1984) and Tower, Sheer and Baas (1978). Most of the inspiration for this research can be attributed to the classic study by Johnson (1954), in which he pointed out the possibility of one country being a net gainer in a Bertrand-Nash Equilibrium after retaliation. The general literature on game theory in international economics is well reviewed by McMillan (1986).

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governments do not directly concern themselves with the welfare effects of their agricultural trade policies. This situation could be viewed as the result of a behind-the-scenes lobbying game in which agricultural interests have managed to convince government that the objective of agricultural trade policy should be to protect domestic agricultural production levels.

In Section IV we consider the implications of our basic trade war results for the outcome of a negotiated agreement between the US and the EEC. This agreement would be the outcome of *cooperative* negotiations, such as are occurring on a multilateral basis under the auspices of the GATT, rather than the outcome of a *non-cooperative* trade war. Nonetheless, the outcome of the trade war can have a dramatic impact on the former negotiated agreement by determining the relative threats that each nation can credibly bring to any bargaining table.

In Section V we evaluate the prospects and consequences of an *escalation* of agricultural trade wars. We consider an expansion of the bilateral war between the EEC and US to include Japan, as well as an expansion to non-agricultural trade.

We want to emphasize at the outset that the game-theoretic concepts and computations that we undertake are extremely stylized, in the sense that they should be qualified before our results are applied to policy making. This is more than simply the natural reticence of scholars to take responsibility for the use or abuse of their research: we identify throughout a number of dimensions in which our specific results might properly be questioned. In Section VI we explicitly consider several alterative formulations of the strategic agricultural trade issue. However, the main contribution of our results is to propose and illustrate a conceptual and quantitative approach to strategic trade issues which can be readily extended to deal with such qualifications.

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II Strategic self-interest

Imagine that the US had available to it some policy action that would improve the well-being of all of its citizens. Forget for the moment the unbridled self-interest of sectional lobby groups, or the myopia of politicians: let us assume that transparency reigns such that the political actors can see what is best and have the political willpower to act accordingly if they want to. Should the US pursue this policy action?

Before answering this question we need to know one more piece of information. Will this action lead to any retaliatory policy action from any other nation that could 'hurt' the citizens of the US? Assume that the citizens of the EEC would be hurt by this action of the US if it were carried out. In other words, the citizens of the EEC are assumed to be worse off if the US implements this policy than if it does not. The next question, then, is whether or not the EEC has any policy of its own that can be used to retaliate against the US (or to threaten to retaliate with).

Assume that the EEC does have such a policy. Will they use it? That depends on whether or not the EEC is better off using it or not. If they use it, it will influence and possibly change the initial US policy decision. Thus the self-interest of each nation is linked necessarily to the actions that it expects other nations to take. It is simply impossible to define the self-interest of one nation independently of the self-interest of other nations, unless the actions of one nation have no impact at all on the well-being of other nations *or* if the other nations have no retaliatory threat that would lead the first nation to choose one action over another.

Game theory provides a framework to enable us to untangle this apparent infinite regress of semantics. Specifically, the Nash Equilibrium (NE) concept is a way of predicting what the outcome will be if each *and every* nation pursues its own self-interest while expecting the other nations to do the same. The NE concept does not describe a process of retaliation, but the outcome of such a process.

To illustrate the importance of accounting for strategic retaliation in trade policy, consider the two simple games with payoff matrices shown in Table 1. In each case we have taken the payoffs from policy simulations generated by the global general equilibrium (GE) model of Whalley (1985, 1986). Two agents are considered: the US and the EEC. Each agent has just two pure strategies in each game. In game 1 each agent can do nothing (N) or

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Table 1 **Two simple agricultural trade games**

Game 1

	EEC payoffs			US payoffs	
	US^N	US^A		US^N	US^A
EEC^N	0.0	0.96	EEC^N	0.0	-3.64
EEC^A	-6.97	-6.03	EEC^A	1.53	-2.15

Game 2

	EEC payoffs			US payoffs	
	US^{150}	US^{200}		US^{150}	US^{200}
EEC^{100}	1.16	1.06	EEC^{100}	0.23	0.21
EEC^{200}	1.33	1.22	EEC^{200}	-0.37	-0.36

Note: Payoffs shown are welfare changes compared to benchmark.

can abolish (A) agricultural trade barriers. In game 2 the EEC can increase agricultural protection by 100 per cent or 200 per cent and the US can increase protection by 150 or 200 per cent. We shall consider much more detailed policy options later, but the essential ideas can be understood with just two strategies.

In each game in Table 1 the abolition strategy refers to all tariff and non-tariff barriers, abolished on a non-discriminatory basis. In other words, we are allowing each nation to remove all agricultural protection against imports from all other nations (the alternative would be to have them remove protection only against imports sourced in particular nations). The payoffs shown in the two games are the annual welfare impact, as measured by the equivalent variation in income in billions of 1977 US dollars.

Consider game 1 first. The NE of this game is extremely simple to compute - in fact, it can be read directly from the payoff matrix. If the EEC does nothing, the US has two policy choices available to it with payoffs of 0 and -3.64, respectively. Clearly it is in the self-interest of the US to choose the first policy, which involves it doing nothing. Note that this policy choice is conditional on the assumed behaviour of the EEC.

If the EEC were to abolish protection, the US again has two policy choices available to

it. This time, however, the payoffs to the US from these two actions are 1.53 and -2.15, respectively. Although the values of the payoffs are quantitatively different to the US (depending on what the EEC does), the predicted outcome for the US is the same in each case: to do nothing. Thus the US can be counted on by the EEC to follow the policy of doing nothing. This is called a *dominant strategy* for the US. It is always in the best interest of a country to follow a dominant strategy, irrespective of the actions of the other country. (In this case we have a *strongly* dominant strategy, since the payoffs to the US for the alternative action are strictly lower; *weakly* dominant strategies are defined in an obvious manner).

Now consider the self-interest of the EEC. If the US were to do nothing, it has two policy choices open, leading to payoffs of 0 and -6.97, respectively. In this case it would choose to do nothing. If the US were to abolish agricultural protection, the EEC's two policy choices provide it with payoffs of 0.96 and -6.03, respectively. The EEC would choose to do nothing in this case as well. Thus the EEC also has a (strongly) dominant strategy to do nothing in this particular game. Even if the EEC did not have this dominant strategy, we could have restricted our analysis to the first set of choices for the the EEC, since the EEC could be safe in assuming that the US would do nothing (irrespective of what it, the EEC decided to do).

In game 1, therefore, the NE is trivially for each country to do nothing. Because each country had a dominant strategy available to it, the self-interest of each country could be defined independently of the conjectured retaliation of the other nation.

The NE outcome in game 2 is not quite as simple, however. The best strategy for the US depends on the strategy chosen by the EEC. If the EEC increases protection by 100 per cent the US would prefer to increase protection by 150 per cent; conversely, if the EEC increases protection by 200 per cent the US would prefer to increase its protection by 200 per cent. Which policy is in the self-interest of the US to follow? Fortunately, the EEC will choose to increase protection levels by 200 per cent irrespective of the US choice here, so it is in the self-interest of the US to do likewise and increase protection by 200 per cent (this is the NE of game 2). Our point, however, is that one could not define the self-interest of the US in game 2 without making some conjecture about the behaviour of the EEC.

We shall see in Section III that the payoff structure for trade policy games is not always so simple as in games 1 and 2. If a country does not have a dominant strategy available to it, it will need to form some conjecture as to the likely strategy choice of the other country. We do not explain or analyze this process of conjecture and counter-conjecture. Instead we focus on a set of strategies that are consistent with correct conjectures, a NE.

We would like to stress four obvious but important qualifications to this result and our

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approach, even at this simple illustrative level. First, the welfare or production impacts shown may not be robust to variations in the parameters (or underlying structure) of the GE model. However, even at a casual level we can see that the equilibrium point of game 2 might alter with relatively small changes in the production impacts for either the US or the EEC. These small changes in welfare may, in turn, be generated by small perturbations of key elasticities in the underlying model (eg see Harrison et al, 1987). Thus the robustness of the GE results are essential to the robustness of the game.

The second qualification is that we are considering extreme pure strategies in these two examples. It is quite possible that there exist intermediate pure strategies, involving something less than the total abolition of agricultural trade barriers, such that some US-EEC liberalization would occur *in a non-cooperative equilibrium.* The operationalization of a response to this qualification involves taking finer grids of pure strategies. Our approach is able to do this, subject to familiar constraints on computational expense. We illustrate this point in the next section.

A third, and related, qualification is the proper interpretation of mixed strategies in games with finite pure strategies. In game theory, a mixed strategy involves an agent employing two or more pure strategies with a specific probability of playing any one of them.

An explicit assumption in such games is that only one of the strategies will eventually be played by each player. The expected payoff, for the purposes of pre-move analysis, is therefore *linear* in the pure strategy payoffs, with the mixed strategy probabilities providing the linear weights on the discrete pure strategy payoffs. Thus a 50-50 mix of a zero tariff and a 60 per cent tariff will imply an expected payoff exactly equal to the simple average of the two pure strategy payoffs. However, this should not be confused with the payoff that a GE model implies for a 30 per cent tariff. The implicit function linking strategy values and payoffs is unlikely to be linear, save as an approximation that we will not accept in general (and especially for strategic alternatives that involve major policy changes).

The final qualification is that our analysis of game 1 implies only the absence of a welfare-improving *non-cooperative* outcome. Such a result may therefore point the way towards the necessity of cooperative solutions to the US-EEC agricultural trade policy problem. More importantly, it provides one starting point, the disagreement outcome, in a subsequent analysis of the cooperative game in the sense of Nash (1950, 1953): see Section IV for an illustration.

The point of the above examples is to introduce our general approach. Typically the strategic equilibrium of the trade games implicit in applied general equilibrium models will not be so easily identified. Not only shall we want to consider a wider range of pure strate-

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gies, but we might also need to consider equilibria in mixed strategies. Thus the need for a computational approach, which we now turn to.

Nash (1951) employed non-constructive fixed-point methods to prove the existence of (Nash) equilibrium points for a wide class of n-person non-cooperative games with finite strategies. Harrison and Rutström (1987) review his approach, and present a computational procedure to implement it following Hansen (1974). This procedure is guaranteed to find at least one equilibrium point, possibly in mixed strategies. It can also locate multiple equilibrium points if they exist, although it cannot guarantee to locate more than one point or to locate all points.

In some finite games it is possible to locate an equilibrium in pure strategies, essentially by inspection of all pure strategy combinations (eg see Markusen and Wigle, 1987, or our analysis of games 1 and 2). It is a straightforward computational matter to identify the complete set of pure strategy equilibria by exhaustive inspection of all combinations. However, pure strategy equilibria cannot be guaranteed to exist in all finite games: hence the general need for more powerful computational procedures. We view these procedures as complementary to the identification of possible pure strategy equilibria by means of exhaustive inspection.

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III Agricultural trade wars

We consider a bilateral EEC-US trade war with respect to agricultural protection using the computable GE trade model of Whalley (1985, 1986) to evaluate the payoffs. The actors in this trade war are the EEC and the US. All other nations are assumed to be strategically passive in the experiments. We believe that it is not plausible to expect that any other developed countries (ODC), NICs or LDCs would be able to cooperate as individual blocs in order to retaliate. This point of view is based on casual observation of the increasingly pluralistic nature of GATT negotiations, especially the current round of multilateral talks.

We do not consider retaliation by Japan, on the grounds that she does not appear to be an active player in the current agricultural trade war and does not have great market power compared to the EEC and the US[2]. On the other hand, her levels of protection on agricultural imports are extremely high, which might indicate that it would be worth expanding our trade war to include Japan in future work.

The pure strategies investigated for each nation consist of percentage increases in their existing protection structure for agricultural trade. We include tariffs and non-tariff barriers (NTBs). The latter are clearly much more important than tariffs for most industrial nations, and are incorporated in the GE model in ad valorem equivalent form. In the benchmark the EEC imposes tariff (NTB) protection on agricultural imports at about a 5 per cent (36 per cent) rate, with virtually no differentiation by import source. The US imposes tariff (NTB) protection at rates of 5 per cent (19 per cent), 2 per cent (44 per cent), 5 per cent (31 per cent), 4 per cent (31 per cent), and 2.5 per cent (31 per cent) on imports from the EEC, Japan, Canada, ODC, and the OPEC, NIC and LDC group, respectively. The differences in rates by source arise primarily because the protection considered here is a trade-weighted aggregate of all agricultural commodities. It is clear, then, that all of the action here is in terms of NTBs, with post-Kennedy Round tariff levels being very low for the EEC and the US.

Each nation increases its level of agricultural protection in a non-discriminatory fashion. That is, the EEC increases protection against imports from all sources (rather than just against

2 This latter conclusion is based on the trilateral trade war evaluated in Harrison and Rutström (1987). That trade war considered across-the-board protection levels as the policy instrument, welfare as the payoff, and included Japan as a strategic actor (along with the EEC and US). They found that Japan increased protection in the NE only slightly compared to the US and EEC, and that she had a dominant strategy to stay at that level of protection. We should also note that the computational expense of evaluating the payoff matrix for a trilateral trade war vastly exceeds the expense for a bilateral trade war, although this expense is dependent on the underlying GE model of course.

imports from the US and Japan, for example). The effects of a geographically discriminatory trade war might be quite different.

We assume that the payoffs to each nation are the changes in welfare of the consumers of the country. This is measured in terms of the Equivalent Variation in benchmark dollar terms (the base year is 1977 in this model, and the benchmark monetary measure is the US dollar). This is a standard measure of changes in welfare for models where consumers are homogeneous within each country.

Table 2 shows the stages of the trade war simulations conducted along the lines described above: non-discriminatory, agricultural protection only, and with welfare as the payoff. Each stage represents a choice of five or seven pure strategies by each nation. This restriction to five or seven strategies in each stage is due to the computational expense of solving the GE model used here to evaluate welfare. With two nations each choosing seven pure strategies, we required 49 solutions to the underlying GE model corresponding to the possible configurations of policy settings.

Once the payoffs for each stage had been computed, we solved each stage as a complete game. We computed all pure strategy NE, and then computed as many mixed strategy NE as possible. The strategies with asterisks in Table 2 are those employed by each nation in the NE for that game. As only one NE was found for each stage, the interpretation of more than one strategy having an asterisk is that the nation is pursuing a mixed strategy in the NE. We report the payoffs at the NE in brackets for each stage.

In stage 1, we see that the EEC and the US choose to increase protection by 20 per cent each, which is the maximum allowed increase in this stage. Note that neither nation has any incentive here to adopt the free trade outcome in which both decrease protection by 100 per cent. The EEC gains US$0.42 billion and the US gains US$0.09 billion. This outcome can be understood in the following context: since the EEC and US are both large trading countries, they can depress the price of the goods they buy by imposing protection. This phenomenon is referred to as a terms-of-trade gain.

When we find a NE outcome that employs an extreme pure strategy at a certain stage, we shift the pure strategy space to include that extreme pure strategy setting as an interior point in the strategy set. (An extreme pure strategy is here interpreted as a strategy on the boundary of the strategy set.) We then re-compute 49 (or 25) solutions with the new strategy settings, solve for the NE, and so on. Thus in stage 2 we explore higher levels of protection for the EEC and the US, since they chose extreme values in the NE of stage 1. This process of shifting the strategy space continued in this trade war until stage 2, in which the NE was in

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Table 2 **Stages of the agricultural trade war**

Players: EEC and US

Strategies: percentage increases in existing protection on imports of agricultural goods; non-discriminatory.

Payoffs: change in national welfare, as measured by EV (in 1977 $US billion); NE payoffs in each stage shown in brackets.

Stage	EEC	US
1	20 *	20 *
	0	0
	-20	-20
	-40	-40
	-60	-60
	-80	-80
	-100	-100
	(0.42)	(0.09)
2	600	600
	500	500
	400	400
	300	300
	200 *	200
	100	100 *
	0	0
	(1.46)	(-0.30)
3	200	200
	150 *	150 *
	100	100
	50	50
	0	0
	(1.45)	(-0.04)
4	200	200
	175 *	175 *
	150	150
	125	125
	100	100
	(1.24)	(-0.22)

the interior of the strategy space for both agents. We then refined the grid of pure strategies somewhat to provide a more accurate assessment of the NE. The outcome in Stage 4 that we report as a trade war is the end point of this process.[3]

3 This discrete multistage computational procedure does have some potential problems, which are discussed in Harrison and Rutström (1987). These problems concern the need to assume that payoffs are globally monotonic to ensure that one has found a unique NE with our procedures. In order to ensure that we had not missed a NE at a much higher level of agricultural protection, we also ran an additional stage in which each country could increase protection by 0 per cent, 500 per cent 1000 per cent, 1500 per cent and 2000

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We see from Table 2 that in the final NE the EEC would increase protection 175 per cent for a gain in welfare of US$1.24 billion, and the US would increase protection by 175 per cent for a welfare *loss* of US$0.22 billion. These results again illustrate the basic point that Johnson (1954) was making: that retaliatory trade wars are not always losing propositions for all nations. In this case, we find that the EEC wins and the US loses, relative to the status quo.

Table 3 reports some of the global effects of this agricultural trade war outcome. GNP falls slightly in all countries other than the EEC and the US, as does welfare. These changes are qualitatively consistent with the changes in the (commodity) terms of trade for each country. By improving their terms of trade sufficiently, the EEC is able to gain on balance from the agricultural trade war and the US is able to cut its losses. It is interesting to note that the NICs lose proportionately the most from this trade war with a welfare loss of almost 1 per cent of GNP, and LDCs run a close second. The world welfare loss from this trade war is approximately US$13 billion.

Table 4 shows the impact of the trade war on the global production structure and factor allocation. Agricultural production falls in every country, with Canada and NICs bearing the largest percentage losses. The sectors that gain the most in production from the trade war are the non-traded sectors of the two protagonists: they provide the only immediately safe haven for the factors released by agriculture in these countries. There are several slight expansions of non-agricultural sectors in countries other than the US and EEC.

Table 3 **Effects of trade war on GNP and welfare**

Region	Base GNP	Change in GNP	EV	EV as % of GNP
EEC	1683	0.8	1.24	0.07
US	2031	0.2	-0.22	-0.01
Japan	773	-0.3	-0.27	-0.04
Canada	198	-0.6	-0.69	-0.35
ODC	1900	-2.4	-3.01	-0.16
OPEC	300	-0.4	-0.47	-0.16
NIC	493	-2.6	-4.66	-0.95
LDC	819	-2.5	-4.95	-0.60
World			-13.0	

per cent. The sole NE of this game is for each country not to change protection at all. These values of protection increase were chosen because they span the range of across-the-board protection levels in NE of the trilateral trade between the EEC, US and Japan reported in Harrison and Rutström (1987).

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Table 4 Effects of trade war on global production structure

Region	Sector	Production Base	Production Change	Production Percent Change	Labor Change	Labor Percent Change	Capital Change	Capital Percent Change
EEC	Agriculture	396	-7.7	-1.9	-1.30	-1.9	-0.96	-2.0
	Mining	18	-0.1	-0.6	0.00	0.0	0.00	0.0
	Energy	107	-0.3	-0.3	-0.07	-0.3	-0.05	-0.3
	Non-M. Man.	554	-1.7	-0.3	-0.41	-0.3	-0.20	-0.4
	Mech. Man.	317	-1.3	-0.4	-0.44	-0.4	-0.09	-0.5
	Non-Traded	1558	6.1	0.4	2.22	0.5	1.41	0.3
U.S.	Agriculture	474	-3.8	-0.8	-0.49	-0.9	-0.39	-0.7
	Mining	54	-0.4	-0.7	-0.10	-0.6	-0.07	-0.5
	Energy	18	-0.1	-0.6	-0.01	-0.2	-0.01	-0.5
	Non-M. Man.	832	0.1	0.0	-0.06	-0.0	0.05	0.1
	Mech. Man.	464	-0.4	-0.1	-0.15	-0.1	0.02	0.1
	Non-Traded	2150	3.7	0.2	0.83	0.1	0.79	0.5
Japan	Agriculture	180	-0.3	-0.2	-0.08	-0.2	-0.02	-0.1
	Mining	4	0.0	0.0	-0.01	-0.8	-0.01	-0.7
	Energy	7	0.0	0.0	0.00	0.0	0.00	0.0
	Non-M. Man.	426	-0.1	-0.0	-0.02	-0.0	-0.02	-0.0
	Mech. Man.	219	0.4	0.2	0.08	0.2	0.03	0.2
	Non-Traded	730	0.0	0.0	0.02	0.0	0.01	0.0
Canada	Agriculture	22	-0.8	-3.6	-0.18	-3.2	-0.07	-3.1
	Mining	16	0.2	1.3	0.06	1.2	0.05	1.2
	Energy	8	0.2	2.6	0.03	1.4	0.03	1.6
	Non-M. Man.	132	0.1	0.1	0.03	0.1	0.00	0.0
	Mech. Man.	36	0.3	0.8	0.06	0.7	0.02	1.1
	Non-Traded	200	-0.1	-0.1	-0.01	-0.0	-0.03	-0.1
ODC	Agriculture	983	-2.0	-0.2	-0.37	-0.3	-0.34	-0.2
	Mining	137	0.3	0.2	0.13	0.2	0.04	0.2
	Energy	44	0.1	0.2	0.03	0.2	0.01	0.2
	Non-M. Man.	1456	0.7	0.0	0.07	0.0	0.03	0.1
	Mech. Man.	321	0.4	0.1	0.15	0.1	0.03	0.2
	Non-Traded	1373	0.4	0.0	-0.02	-0.0	0.19	0.1
OPEC	Agriculture	74	-1.1	-1.5	-0.19	-1.4	-0.13	-1.7
	Mining	23	-0.1	-0.4	-0.01	-0.3	-0.05	-0.5
	Energy	205	1.0	0.5	0.01	0.5	0.38	0.5
	Non-M. Man.	113	-0.3	-0.3	0.00	0.0	-0.03	-0.4
	Mech. Man.	13	0.0	0.0	0.01	0.4	-0.01	-0.3
	Non-Traded	171	-0.1	-0.1	0.19	0.4	-0.16	-0.4
NIC	Agriculture	145	-2.9	-2.0	-0.39	-2.0	-0.78	-2.0
	Mining	27	0.3	1.1	0.08	1.3	0.10	1.3
	Energy	10	0.1	1.0	0.02	1.0	0.02	1.0
	Non-M. Man.	290	1.2	0.4	0.22	0.4	0.11	0.4
	Mech. Man.	61	0.3	0.5	0.06	0.5	0.05	0.6
	Non-Traded	402	0.1	0.0	0.01	0.0	0.01	0.0
LDC	Agriculture	491	-2.3	-0.5	-1.20	-0.5	-0.14	-0.6
	Mining	42	0.5	1.2	0.21	1.2	0.10	1.1
	Energy	17	0.1	0.6	0.05	0.8	0.03	0.9
	Non-M. Man.	474	2.1	0.4	0.46	0.5	0.06	0.4
	Mech. Man.	19	-0.2	-1.0	-0.02	-0.8	-0.01	-1.9
	Non-Traded	512	0.7	0.1	0.51	0.2	-0.04	-0.1

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Table 5 shows the effect of the trade war on the structure of global agricultural trade. These results are excerpts from a complete sectoral breakdown of the structure of trade listed in Tables A1 and A2 in the Appendix. The devastating effect that this trade war has on agricultural trade is evident from the negative entries in Table 4. EEC exports to the US , ODC, OPEC and LDCs decline heavily by US$600 million, US$280 million, US$120 million and US$110 million, respectively, for a total decline of US$1170 million. US exports to the EEC decline heavily by US$1410 million, and total exports decline by US$1790 million. Most of the effects on agricultural exports of other countries concern their trade with the US and the EEC.

Tables A3 and A4 in the Appendix report the impacts on producer prices and factor prices in each region.

It is apparent from these results that other nations would have some incentive to retaliate against the two antagonists. Whether or not they could improve their lot by so retaliating is an open empirical question. We do not believe that it is politically feasible for these nations to coordinate their actions in any strategically effective manner, but that is also a matter open for conjecture. These results also point to the basic bargaining strength that these terms-of-trade effects provide for the EEC and the US in global trade negotiations.

Table 5 Effects of trade war on structure of global agricultural trade

Change in gross exports (in $US billions)

	IMPORTING REGION							
REGION	EEC	US	Japan	Canada	ODC	OPEC	NIC	LDC
EEC	0.000	-0.600	-0.020	-0.020	-0.280	-0.120	-0.020	-0.110
U.S.	-1.410	0.000	-0.070	-0.040	-0.030	-0.050	-0.110	-0.080
Japan	-0.030	-0.130	0.000	0.000	0.000	0.000	0.000	0.000
Canada	-0.270	-0.460	0.000	0.000	0.010	0.000	-0.010	-0.030
ODC	-0.840	-0.860	0.000	0.000	0.000	0.010	-0.030	-0.120
OPEC	-0.330	-0.300	0.000	0.000	0.000	0.000	-0.190	-0.220
NIC	-1.570	-1.320	0.040	0.020	0.060	0.060	0.000	0.000
LDC	-2.200	-0.910	0.030	0.000	0.100	0.100	-0.040	0.000

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IV Agricultural trade agreements

The EEC and the US are two of the many actors in a multilateral trade agreement that is currently being launched under the auspices of the GATT: the Uruguay Round. Agriculture is one of the most important topics in these negotiations. We ask here if there are any implications of our non-cooperative trade war results for these cooperative negotiations. For concreteness, we focus on the set of possible bilateral agreements that the EEC and the US could negotiate, keeping in mind the results of their agricultural trade war.

Two possible disagreement points can be considered. One corresponds to the status quo, and thus generates zero welfare or production improvements for each country. We can then identify the Nash (1950) solution to the bargaining problem. An alternative disagreement point could be the non-cooperative NE that was computed earlier; employing this NE as a threat could lead to quite a different outcome of the bargaining problem (in the spirit, if not the letter, of Nash, 1953).[4]

Given the disagreement outcome, it can be shown that the Nash solution (hereafter NS) is the outcome from the feasible set that maximizes the product of the utility gains of each agent relative to the disagreement outcome: see Rapaport (1970, pp104 ff) for an elementary exposition. In our case we identify the utility of an agent with the values of welfare that were employed previously.

The set of possible agreement points will be all of the possible policy settings considered in all stages of each trade war. Thus, rather than viewing these payoff matrices as the normal form of a non-cooperative game (and solving for the NE) we view them as possible agreement points (and solve for the cooperative NS). For simplicity we restrict agreements to the set of pure strategy combinations, and assume that no direct transfers (ie sidepayments) between the two countries are allowed.

If the disagreement point is assumed to be the status quo, leading to a welfare change of zero for both nations, the NS involves the EEC increasing agricultural protection by 50 per cent and the US by 100 per cent, for welfare payoffs of US$0.76 billion and US$0.55 billion,

4 There are many ways to solve bargaining games. We have selected the Nash (1950) solution as the obvious and popular choice for present purposes. An axiomatic solution, such as the Nash solution, has the advantage of attempting to characterize the outcome of a wide range of distinct bargaining processes. Strategic approaches to bargaining games are typically very sensitive to the exact extensive-form representation of the process. Moreover, there are numerous non-cooperative strategic rationalizations of the outcome predicted by the Nash (1950) solution - see, for example, Nash (1953), Harsanyi (1977), Binmore et al, (1986) and van Damme (1986).

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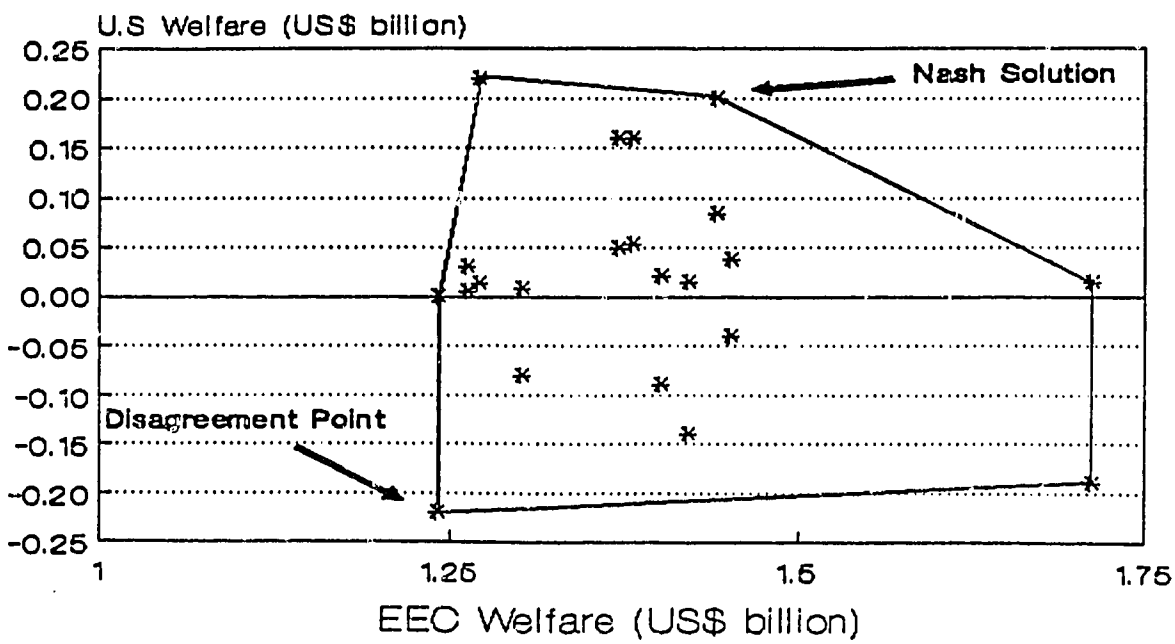
respectively. Note that these cooperative payoffs are much better for the EEC and US than the non-cooperative trade war outcome.

Now assume that the disagreement point is the non-cooperative NE of the entire efficiency trade war considered earlier. This NE leads to a welfare gain of US$1.24 billion for the EEC and a welfare loss of US$0.22 billion to the US. Figure 1 displays the entire feasible set of agreement points, where a feasible point is one that is a Pareto-improvement relative to the disagreement point. Recall that free trade is one of the possible cooperative outcomes considered although it is not feasible in this sense. Note also that many of the feasible agreement points are Pareto-dominated by other agreement points.

The Nash solution is on the frontier of the set of feasible agreement points, and involves the EEC and the US setting agricultural protection 100 per cent higher than currently. In the NS, the EEC gains US$1.44 billion and the US gains US$0.20 billion. The welfare losses for other countries are all less than 1 per cent of their respective GNPs.

Figure 1 **Transparent negotion set: EEC and US**



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V Escalation of agricultural trade wars

The battlelines of the trade war considered so far has been limited in geographic and sectoral terms. Only the EEC and the US are assumed to engage in retaliatory trade policy actions, and the only actions they consider are with respect to agricultural protection. The possibility that such a trade war will escalate is a serious one in the eyes of many commentators, and has clearly added a note of urgency to the need for multilateral consideration of agricultural policies in the Uruguay Round.

Hathaway (1987, p4) argues this point convincingly:

> The experience of the 1980s has shown the extent to which agricultural trade tensions can erupt into wider arenas and other areas of international cooperation. This is not new. Many still remember the famous chicken war between the United States and the European Community (EC) in the 1960s, which threatened all trade and political cooperation among NATO allies. During the 1980s, Japan-US relations have been increasingly strained over agricultural trade issues. In the 1980s we have seen a steady escalation in policy actions designed to offset the actions of others that are asserted to be unfair. Countries too small or too weak economically to engage in trade wars have seen their export earnings plummet and their economies crumble from the side effects of two years of guerrilla trade warfare between the United States and the EC in international grain markets. Unless some kind of permanent settlement can be reached, prospects are that these actions will increase.
>
> However unimportant agricultural trade issues appear to many persons, especially in industrial economies, such chronic difficulties on these issues erode cooperation on other international problems. Australia has questioned its continued commitment to US defence installations because of US agricultural subsidies. US credibility on Caribbean Basin development has been undermined by the US sugar import policy. Just as war is too important to be left to generals, agricultural policy - especially as it affects trade - has become too important to be left to ministers of agriculture. The importance of completing a successful trade round that disarms trade disputes in agriculture extends beyond agriculture.

Hathaway (1987, p21) also argues that the possibility of an agricultural trade war escalation in this manner is one of three major reasons that the new round of GATT negotiations attempt

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some fundamental reform in the area of agriculture.

What would be the effects of a full-blown trade war conducted with across-the-board protection on all imports as the policy variable? Harrison and Rutström (1987) have conducted just such a trade war between the EEC, the US and Japan using the Whalley model employed here. They find that in the NE of this game the EEC would increase protection 1100 per cent for a gain in welfare of US$14.20 billion, the US would increase protection by 1800 per cent for a welfare gain of US$7.44 billion, and Japan would increase protection by only 200 per cent for a welfare loss of US$16.20 billion. These results yet again illustrate the basic point that Johnson (1954) was making: that retaliatory trade wars are not always losing propositions for all nations.

In this NE, GNP falls heavily in all countries other than the EEC and the US, as does welfare. These changes are qualitatively consistent with the changes in the (commodity) terms of trade for each country. By improving their terms of trade sufficiently, the US and EEC are able to gain on balance from the trade war. It is interesting to note that the NICs lose proportionately the most from this trade war, with a welfare loss of over 10 per cent of GNP.

For the purposes of comparison with traditional cost-of-protection measures Harrison and Rutström (1987, Table 3) also report the welfare effects of trilateral and global free trade (across-the-board). The stylized outcome from global abolition is striking. Developing countries are significant losers and developed countries significant gainers. This outcome results from the current high level of trade barriers in place in developing countries. A similarly striking result is obtained when we consider a trilateral abolition of protection by the gang of three, the EEC, the US and Japan. In this case the balance-sheet of gainers and losers is reversed: the developed countries are significant losers and the developing countries significant gainers.

From a global perspective, however, the total effects of the two free trade policies are about the same: the world gains by US$30-40 billion, or 0.3-0.5 per cent of global GNP, from abolishing protection. By comparison, the global effects of protection using the retaliatory NE as the reference point are staggering: the world loses by US$265 billion, or 3.2 per cent of global GNP. These results add force to the argument that escalation of an agricultural trade war could be a very serious matter indeed.

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We appreciate that our approach and our results are not definitive. The question of strategic agricultural trade policy is a complex and subtle one, and we seek only to make a conceptual contribution to the understanding of that question. It is appropriate, therefore, for us to discuss briefly a number of alternative ways in which our approach could be formulated or interpreted.

Alternative payoffs

An alternative exercise to the foregoing would be to study the same kind of trade war using different measures of the payoffs to nations. For example, it is strongly arguable that the US and the EEC are not concerned with broad measures of national welfare when engaging in the current agricultural trade war. Rather, one could imagine that they are concerned with their respective agricultural lobbies. One way to approximate this in the current model is to suggest that governments use the level of domestic agricultural production as the payoff in this agricultural trade war game.[5]

We interpret this substitution as representing the effects of conducting agricultural trade policy on a non-efficient basis: the government ignores the direct effect of its policies on welfare. Table 6 contains the single stage of this game and Tables 7-9 present the effects. The results are staggering, especially in comparison with those of the efficiency agricultural trade war. We locate a NE in which each of the EEC and the US abolish agricultural protection completely. It appears to be in the *strategic* self-interest of each country to do the right thing by the rest of the world. Although the welfare effect on the EEC and the US is minus US$5.92 billion and minus US$2.09 billion, respectively, the global welfare gain is US$7.8 billion.

5 Our approach could also incorporate the treatment of strategic lobbies, political parties and voters that underlie recent models of tariff formation (eg see Rutström 1987 and Young and Magee 1986). We are anxious to construct new GE trade models that explicitly capture the rent-seeking process in a more politically plausible way. To some extent we can consider the effects of alternative payoff measures in trade war games by substituting other measures for national welfare, as we do here, but this is not as satisfactory as we would like.

Table 6 **Stages of the agricultural trade war**

Players: EEC and US

Strategies: percentage increases in existing protection on imports of agricultural goods; non-discriminatory.

Payoffs: domestic production of agriculture and food (in 1977 $US billion); NE payoffs in each stage shown in brackets.

Stage	EEC	US
1	20	20
	0	0
	-20	-20
	-40	-40
	-60	-60
	-80	-80
	-100 *	-100 *
	(401.6)	(477.7)

Table 7 **Effects of the alternative trade war on GNP and welfare**

Region	Base GNP	Change in GNP	Change in GDP	EV	EV as % of GNP
EEC	1683	-7.5	-2.0	-157.34	-9.35
US	2031	-2.1	-1.1	-48.49	-2.39
Japan	773	0.8	0.2	6.02	0.78
Canada	198	4.3	1.5	9.21	4.64
ODC	1900	2.0	0.4	41.98	2.21
OPEC	300	2.9	-1.4	7.42	2.48
NIC	493	5.8	0.0	46.20	9.38
LDC	819	3.9	0.2	54.77	6.69
World				-40.2	

Table 8 **Effects of the alternative trade war on global production structure**

Region	Sector	Production Base	Production Change	Production Percent Change	Labor Change	Labor Percent Change	Capital Change	Capital Percent Change
EEC	Agriculture	396	21.2	5.4	3.49	5.1	2.85	5.9
	Mining	18	1.8	10.1	0.11	9.9	0.30	10.8
	Energy	107	11.2	10.5	2.58	10.4	1.53	10.6
	Non-M. Man.	554	20.4	3.7	4.82	3.5	2.32	4.2
	Mech. Man.	317	25.4	8.0	8.73	7.9	1.66	8.8
	Non-Traded	1558	-52.6	-3.4	-19.74	-4.0	-11.15	-2.5
U.S.	Agriculture	474	39.1	8.3	5.16	9.3	3.97	7.3
	Mining	54	4.2	7.7	1.31	8.2	0.96	7.3
	Energy	18	0.7	4.0	0.23	4.5	0.08	3.9
	Non-M. Man.	832	0.5	0.1	0.98	0.5	-0.55	-1.3
	Mech. Man.	464	1.6	0.3	1.05	0.8	-0.25	-1.4
	Non-Traded	2150	-38.6	-1.8	-8.74	-1.0	-8.32	-4.8
Japan	Agriculture	180	6.1	3.4	1.68	3.4	0.52	3.4
	Mining	4	0.1	2.6	0.03	2.3	0.04	2.6
	Energy	7	-0.1	-1.5	0.00	0.0	-0.01	-0.4
	Non-M. Man.	426	-0.3	-0.1	-0.06	-0.1	-0.01	-0.0
	Mech. Man.	219	-5.4	-2.5	-1.07	-2.5	-0.38	-2.4
	Non-Traded	730	-1.3	-0.2	-0.59	-0.2	-0.17	-0.1
Canada	Agriculture	22	7.6	34.1	1.90	33.9	0.77	34.5
	Mining	16	-2.3	-14.7	-0.73	-14.8	-0.59	-14.7
	Energy	8	-1.2	-15.6	-0.35	-15.8	-0.28	-15.4
	Non-M. Man.	132	-0.8	-0.6	-0.23	-0.7	-0.03	-0.4
	Mech. Man.	36	-2.9	-8.2	-0.70	-8.4	-0.14	-7.9
	Non-Traded	200	0.9	0.5	0.11	0.3	0.27	0.9
ODC	Agriculture	983	23.6	2.4	4.28	2.9	4.03	2.1
	Mining	137	-3.2	-2.3	-1.37	-2.3	-0.47	-2.7
	Energy	44	-0.9	-2.0	-0.36	-1.9	-0.12	-2.2
	Non-M. Man.	1456	-5.9	-0.4	-0.56	-0.3	-0.37	-1.1
	Mech. Man.	321	-4.3	-1.3	-1.65	-1.2	-0.34	-2.1
	Non-Traded	1373	-5.4	-0.4	-0.38	-0.1	-2.19	-1.7
OPEC	Agriculture	74	12.2	16.4	2.04	14.6	1.51	19.2
	Mining	23	1.1	4.9	0.13	3.5	0.54	5.2
	Energy	205	-10.7	-5.2	-0.14	-6.5	-4.03	-5.2
	Non-M. Man.	113	2.5	2.2	-0.01	-0.1	0.32	4.0
	Mech. Man.	13	0.1	0.7	-0.06	-2.3	0.09	2.4
	Non-Traded	171	0.8	0.5	-1.95	-4.4	1.56	4.0
NIC	Agriculture	145	22.4	15.5	3.06	15.6	6.07	15.5
	Mining	27	-2.6	-9.8	-0.59	-9.5	-0.75	-9.5
	Energy	10	-0.7	-6.7	-0.13	-6.8	-0.14	-7.1
	Non-M. Man.	290	-8.8	-3.0	-1.62	-3.0	-0.78	-3.1
	Mech. Man.	61	-2.7	-4.4	-0.52	-4.3	-0.40	-4.5
	Non-Traded	402	-0.6	-0.1	-0.17	-0.1	-0.15	-0.2
LDC	Agriculture	491	19.8	4.0	10.25	3.9	1.19	5.1
	Mining	42	-4.2	-9.9	-1.70	-10.0	-0.86	-9.6
	Energy	17	-1.1	-6.3	-0.40	-6.1	-0.19	-5.8
	Non-M. Man.	474	-18.3	-3.9	-3.92	-4.1	-0.50	-3.0
	Mech. Man.	19	1.5	7.8	0.19	7.4	0.05	9.6
	Non-Traded	512	-6.2	-1.2	-4.36	-1.8	0.31	0.7

Table 9 **Effects of the alternative trade war on structure of global agricultural trade**

Change in gross exports (in $US billions)

	IMPORTING REGION							
REGION	EEC	US	Japan	Canada	ODC	OPEC	NIC	LDC
EEC	0.000	6.550	0.390	0.350	3.490	1.460	0.330	1.640
U.S.	23.590	0.000	0.740	0.430	0.230	0.380	1.180	0.780
Japan	0.220	3.420	0.000	0.000	0.000	-0.010	0.030	0.000
Canada	2.850	4.980	-0.020	0.000	-0.040	-0.020	0.120	0.180
ODC	9.700	9.660	0.120	0.030	0.000	-0.030	0.270	1.120
OPEC	3.580	3.080	0.030	0.010	0.020	0.000	2.130	2.350
NIC	12.560	10.030	-0.300	-0.080	-0.400	-0.470	0.000	0.000
LDC	19.030	7.460	-0.200	-0.010	-0.750	-0.850	0.280	0.000

An alternative strategy

Another alternative to our basic formulation is to analyze the effects of a trade war in which the strategies available to each country are the levels of agricultural production subsidies provided to producers. Given the Armington structure of intermediate production and demand in the GE model we use, tariffs and production subsidies are radically different in their direct effects on producer prices in the country imposing them. For example, a 10 per cent tariff imposed by the EEC on imports of US agriculture will only effect EEC producers' prices to the extent that domestic agricultural goods are good substitutes for imported agricultural goods. In contrast, a 10 per cent production subsidy immediately drives a 10 per cent wedge between the producer price and consumers' prices everywhere in the world.

To illustrate this point we analyzed the effects of offering a 33 per cent production subsidy to EEC agricultural producers. The effects are presented in Tables 10, 11 and 12. One immediately notices two features of these results which contrast with those in which agricultural trade restrictions strategies were changed. First, the EEC suffers a serious welfare loss with the imposition of subsidies to domestic agriculture, whereas it enjoyed a

healthy welfare gain when it (unilaterally) increased agricultural trade restrictions. This result follows from the fact that the production - distorting effects of changes in the production subsidy are much stronger than those for unilateral changes in trade restrictions. In particular, the induced terms of trade effects are swamped by the costs of domestic production inefficiencies.

Table 10 **Effects of EEC production subsidy on welfare and terms of trade**

Region	Welfare (EV)	Terms of trade
EEC	-2.12	0.53
Japan	0.22	0.09
US	0.05	0.04
Canada	0.07	0.12
ODC	-0.80	-0.43
OPEC	-0.64	-0.33
NIC	-0.01	0.12
LDC	-1.91	-0.26
World	-5.10	

Table 11 Effect of EEC production subsidy on global structure of production

Region	Sector	Production Base	Production Change	Production Percent Change	Labor Change	Labor Percent Change	Capital Change	Capital Percent Change
EEC	Agriculture	396	82.3	20.8	14.32	20.8	10.11	20.8
	Mining	18	-0.3	-1.7	-0.01	-0.9	-0.03	-1.1
	Energy	107	-2.3	-2.2	-0.53	-2.1	-0.32	-2.2
	Non-M. Man.	554	-8.7	-1.6	-2.17	-1.6	-0.88	-1.6
	Mech. Man.	317	-8.2	-2.6	-2.87	-2.6	-0.50	-2.7
	Non-Traded	1558	-28.5	-1.8	-8.72	-1.8	-8.28	-1.9
U.S.	Agriculture	474	0.6	0.1	0.08	0.1	0.08	0.1
	Mining	54	-0.1	-0.2	-0.01	-0.1	-0.01	-0.1
	Energy	18	-0.1	-0.6	0.00	0.0	0.00	0.0
	Non-M. Man.	832	0.0	0.0	0.00	0.0	0.00	0.0
	Mech. Man.	464	-0.2	-0.0	-0.05	-0.0	0.00	0.0
	Non-Traded	2150	0.1	0.0	-0.01	-0.0	0.02	0.0
Japan	Agriculture	180	0.0	0.0	0.02	0.0	0.01	0.1
	Mining	4	0.0	0.0	0.00	0.0	0.00	0.0
	Energy	7	0.0	0.0	0.00	0.0	0.00	0.0
	Non-M. Man.	426	-0.1	-0.0	0.00	0.0	-0.01	-0.0
	Mech. Man.	219	0.0	0.0	0.00	0.0	0.00	0.0
	Non-Traded	730	0.0	0.0	-0.01	-0.0	0.00	0.0
Canada	Agriculture	22	0.0	0.0	0.02	0.4	0.00	0.0
	Mining	16	-0.1	-0.6	-0.01	-0.2	-0.01	-0.2
	Energy	8	0.0	0.0	0.00	0.0	0.00	0.0
	Non-M. Man.	132	0.0	0.0	0.00	0.0	0.00	0.0
	Mech. Man.	36	0.0	0.0	-0.01	-0.1	0.00	0.0
	Non-Traded	200	0.0	0.0	0.00	0.0	0.00	0.0
ODC	Agriculture	983	0.2	0.0	0.02	0.0	0.02	0.0
	Mining	137	0.0	0.0	-0.02	-0.0	-0.01	-0.1
	Energy	44	0.0	0.0	-0.02	-0.1	-0.01	-0.2
	Non-M. Man.	1456	-0.3	-0.0	-0.04	-0.0	-0.01	-0.0
	Mech. Man.	321	-0.2	-0.1	-0.08	-0.1	-0.01	-0.1
	Non-Traded	1373	0.3	0.0	0.12	0.0	0.01	0.0
OPEC	Agriculture	74	0.2	0.3	0.03	0.2	0.02	0.3
	Mining	23	0.0	0.0	0.00	0.0	0.00	0.0
	Energy	205	-0.2	-0.1	0.00	0.0	-0.07	-0.1
	Non-M. Man.	113	-0.1	-0.1	-0.01	-0.1	0.00	0.0
	Mech. Man.	13	0.0	0.0	0.00	0.0	0.00	0.0
	Non-Traded	171	0.1	0.1	-0.01	-0.0	0.04	0.1
NIC	Agriculture	145	0.4	0.3	0.05	0.3	0.10	0.3
	Mining	27	-0.1	-0.4	-0.01	-0.2	-0.01	-0.1
	Energy	10	0.0	0.0	0.00	0.0	0.00	0.0
	Non-M. Man.	290	-0.1	-0.0	-0.02	-0.0	0.00	0.0
	Mech. Man.	61	0.0	0.0	0.00	0.0	0.00	0.0
	Non-Traded	402	0.0	0.0	-0.02	-0.0	0.01	0.0
LDC	Agriculture	491	0.3	0.1	0.16	0.1	0.02	0.1
	Mining	42	0.0	0.0	0.00	0.0	0.00	0.0
	Energy	17	0.0	0.0	0.00	0.0	0.00	0.0
	Non-M. Man.	474	-0.1	-0.0	-0.03	-0.0	0.00	0.0
	Mech. Man.	19	-0.1	-0.5	-0.01	-0.4	0.00	0.0
	Non-Traded	512	-0.2	-0.0	-0.11	-0.0	-0.01	-0.0

Table 12 **Effect of EEC production subsidy on global structure of trade percentage change in trade**

EXPORTING REGION and SECTOR	IMPORTING REGION							
	EEC	US	Japan	Canada	ODC	OPEC	NIC	LDC
Exports of EEC		...						
Sector 1:	0.0	19.6	18.6	19.1	17.8	18.0	19.5	19.1
Sector 2:	0.0	-1.3	-1.5	-1.3	-1.5	-1.6	-1.1	-1.7
Sector 3:	0.0	-1.8	-2.0	-1.8	-2.0	-2.0	-1.6	-2.1
Sector 4:	0.0	-1.6	-1.7	-1.5	-1.6	-1.6	-1.3	-1.9
Sector 5:	0.0	-1.9	-2.0	-1.8	-2.0	-2.1	-1.6	-2.1
Capital :	0.0	-2.0	-2.2	-2.0	-2.3	-2.4	-1.8	-2.4
Exports of US		...						
Sector 1:	8.1	0.0	-0.2	0.3	-0.8	-0.7	0.6	0.3
Sector 2:	-0.6	0.0	-0.2	0.0	-0.2	-0.3	0.3	-0.4
Sector 3:	-1.2	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.4
Sector 4:	-0.5	0.0	-0.2	0.0	-0.1	-0.1	0.2	-0.5
Sector 5:	-1.0	0.0	-0.2	0.0	-0.2	-0.3	0.2	-0.3
Capital :	-1.2	0.0	-0.2	0.1	-0.2	-0.3	0.2	-0.3
Exports of Japan		...						
Sector 1:	8.3	0.8	0.0	0.5	-0.7	-0.5	0.7	0.4
Sector 2:	-0.4	0.2	0.0	0.2	0.0	-0.1	0.4	-0.2
Sector 3:	-1.0	0.2	0.0	0.2	0.0	-0.1	0.4	-0.2
Sector 4:	-0.3	0.1	0.0	0.2	0.1	0.1	0.4	-0.3
Sector 5:	-0.8	0.1	0.0	0.2	0.0	-0.1	0.4	-0.1
Capital :	-1.1	0.2	0.0	0.2	-0.1	-0.2	0.4	-0.2
Exports of Canada		...						
Sector 1:	7.9	0.5	-0.3	0.0	-1.0	-0.8	0.4	0.1
Sector 2:	-0.6	-0.1	-0.2	0.0	-0.3	-0.4	0.2	-0.4
Sector 3:	-1.3	-0.1	-0.3	0.0	-0.3	-0.3	0.2	-0.4
Sector 4:	-0.5	-0.1	-0.2	0.0	-0.2	-0.2	0.2	-0.5
Sector 5:	-1.0	-0.1	-0.2	0.0	-0.2	-0.3	0.2	-0.3
Capital :	-1.3	-0.1	-0.2	0.0	-0.3	-0.4	0.2	-0.4
Exports of ODC		...						
Sector 1:	8.3	0.9	0.0	0.4	0.0	-0.5	0.7	0.4
Sector 2:	-0.3	0.3	0.1	0.3	0.0	0.0	0.5	-0.1
Sector 3:	-0.9	0.2	0.0	0.3	0.0	0.0	0.5	-0.1
Sector 4:	-0.2	0.2	0.1	0.3	0.0	0.1	0.5	-0.2
Sector 5:	-0.7	0.2	0.1	0.3	0.0	0.0	0.4	0.0
Capital :	-1.0	0.3	0.1	0.4	0.0	0.0	0.5	0.0
Exports of OPEC		...						
Sector 1:	8.3	0.9	0.0	0.5	-0.7	0.0	0.7	0.4
Sector 2:	-0.3	0.3	0.1	0.4	0.1	0.0	0.6	0.0
Sector 3:	-0.9	0.3	0.1	0.4	0.1	0.0	0.6	0.0
Sector 4:	-0.2	0.2	0.1	0.3	0.1	0.0	0.5	-0.2
Sector 5:	-0.6	0.2	0.2	0.4	0.2	0.0	0.5	0.1
Capital :	-0.9	0.4	0.2	0.4	0.1	0.0	0.6	0.0
Exports of NIC		...						
Sector 1:	7.7	0.4	-0.5	-0.1	-1.1	-1.0	0.0	0.0
Sector 2:	-0.8	-0.2	-0.4	-0.2	-0.5	-0.6	0.0	-0.6
Sector 3:	-1.4	-0.2	-0.4	-0.2	-0.5	-0.5	0.0	-0.6
Sector 4:	-0.7	-0.3	-0.4	-0.2	-0.4	-0.4	0.0	-0.7
Sector 5:	-1.2	-0.3	-0.4	-0.2	-0.4	-0.5	0.0	-0.5
Capital :	-1.5	-0.2	-0.4	-0.2	-0.5	-0.6	0.0	-0.6
Exports of LDC		...						
Sector 1:	8.3	0.9	0.0	0.3	-0.7	-0.5	0.7	0.0
Sector 2:	-0.4	0.2	0.0	0.3	0.0	-0.1	0.5	0.0
Sector 3:	-1.0	0.2	0.0	0.3	0.0	0.0	0.4	0.0
Sector 4:	-0.3	0.2	0.1	0.3	0.1	0.1	0.4	0.0
Sector 5:	-1.1	-0.3	-0.3	-0.2	-0.3	-0.4	0.0	0.0
Capital :	-1.0	0.3	0.1	0.4	0.0	0.0	0.5	0.0

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The second observation relates to the quantitative impacts on trade volumes and production. A 33 per cent subsidy leads to a 28 per cent increase in EEC agricultural production, and an increase of almost 20 per cent in EEC agricultural exports.

The difference in the results of trade restrictions and subsidies is an example of a wider point about our reported results, which was mentioned earlier. Specifically, the results of such Nash games will depend on the instruments which parties are allowed to use. Our results must be interpreted in the light of the fact that countries are assumed to use an instrument which has large terms of trade effects and relatively small domestic distorting effects (due to the fact that protection is implicitly imposed on somewhat different commodities than those produced domestically).

Unilateral versus multilateral perspectives

In the absence of a country having dominant strategies open to it, the strategic approach to trade policy that we adopt necessarily involves taking a multilateral perspective when assessing what policies are in the self-interest of a country. Many people have argued, however, that such a perspective provides individual countries with an excuse not to consider the welfare costs of domestic policies. If liberalization is viewed as a concession to foreigners, then why unilaterally liberalize and forgo the bargaining chip? Now that agriculture is formally slated for discussion during the current GATT multilateral trade negotiations, one might therefore expect countries to be reluctant to liberalize their domestic agricultural policies on a unilateral basis.

Note that there is nothing wrong or irrational with a politician taking this view. We may find the mercantilist underpinning of the argument intellectually unattractive, but if that is the way I expect my negotiating opponents to view things, then I may as well do the best for myself given their attitude. If a country expects to gain more by using the possibility of liberalizing as a bargaining chip than by unilaterally liberalizing, then it would indeed be foolish to liberalize unilaterally.

What is perhaps wrong with this argument is the assessment of the probability of a net gain by using liberalization in the future as a bargaining chip. It will undoubtedly take many years for any type of multilateral agreement to come into effect, so the possible benefits of waiting for that agreement (and the accompanying multilateral liberalization) may not be worth the costs of keeping domestic policies in place in the interim. These are judgments that economists are not yet equipped to make, but should be.

It is important to note also that unilateral liberalization is one of the options that we

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allowed the US and the EEC to adopt in our trade war. We did not take into account the possible future value of non-liberalization as a bargaining chip, and yet we find that these two countries would end up adopting greater agricultural protection than they now do. This result could change, as we have repeatedly indicated, if we were to look at different formulations of the agricultural trade policy game (as we do above).

Different questions

With our trade war simulations we have addressed ourselves to a question of the following kind: If countries non-cooperatively try to improve their own welfare, and are not subject to GATT bindings, what levels of agricultural protection could emerge in a strategic equilibrium? As we know from elementary games such as Prisoner's Dilemma, there is absolutely no presumption that non-cooperative strategic (Nash) equilibria lead to Pareto-efficient outcomes. It is possible for countries to change the rules of the trade liberalization game so as to encourage such efficient outcomes, but those types of changes are not considered here. Indeed one can interpret many of the provisions of the GATT as crude attempts to develop such rules: see, for example, McMillan (1986). Changing the rule of a game so as to bring about certain outcomes that are (socially) preferred is a different question from determining what outcomes could emerge from a certain specified set of rules.

It is also important to realize that we are not 'modelling the way that countries negotiate now'. There are many types of constraints on the propensity of countries to engage in the type of retaliatory policy making that is implied by our trade war. These constraints range from the most mundane of legalities (eg GATT bindings) to grander geopolitical considerations.

Repeated games

We have deliberately chosen to model a very simple game. One feature of the game that might cause some concern about the general validity of our results is the fact that we have analyzed a one shot or static game that is not repeated. How would our results change if we viewed the game analyzed here as just one stage (one year) in a repeated game between the same players over several stages (multiple years)? The theory of single-stage games, and the possible equilibria of the repeated game typically much larger: see Benoit and Krishna (1985), Fudenberg and Maskin (1986) and Abreu (1988) for important contributions.

The so-called 'folk theorem' of repeated games says that many possible equilibrium outcomes are possible in the repeated game that may not be equilibria of the single-stage

game. The essential idea behind this result is that players can devise 'punishment rules' to impose on any player that deviates from any prescribed equilibrium path of the repeated game. The only paths that cannot be protected with these sorts of punishments are paths in which one player gets worse than he could even if all of the other players cooperated in punishing him the most (the player's 'minimax outcome').

The reason that this result is important, in the present context, is that it provides one possible way in which Pareto-preferred multilateral liberalization strategies might come about even if they are not NE in a single-stage game. If one country deviates from this liberalization strategy, the other players enact punishments that make the would-be deviant worse off than if he deviated without any such punishments being invoked. It can be argued that many of the provisions of the GATT can be interpreted in this way as prescribed punishment rules for nations that deviate in certain ways.

Is this another case in which game theory allows one to prove any results one likes, without any possibilities being ruled out? Not quite; for simplicity we concentrate on the case in which the game is to be repeated a finite number of times; this number may be arbitrarily large, but it must be finite.

First it should be noted that one of the equilibria of the repeated game will always be just to repeat the single stage NE. This is called 'the trivial equilibrium' by game theorists, not because it is uninteresting, but because it is stationary and perhaps an obvious equilibrium. However, even though it is obvious from a formal point of view it provides a natural benchmark for analysis.

Second, if the single-stage NE is unique then the only equilibrium of the repeated game is this trivial equilibrium. This is a very important result, emphasized by Benoit and Krishna (1985, p910) and Moreaux (1985). The simple logic behind this result is as follows. In the last period the players will not deviate from the single stage NE, since the only reason to deviate from a NE (in earlier periods) and forgo some expected payoff is to punish some other player for deviating. That is, to threaten to punish someone by undertaking an action that causes me to forgo some expected payoff in the final period, is not credible. When we actually get to the last period you will not expect me actually to undertake my threat, since the game ends in that period. (Formally, we are evaluating perfect equilibria of the repeat game).

Now consider the next-to-last period of the repeated game. What can I use as a threat to stop you deviating in this period? I cannot threaten to punish you in the final period by the above logic and you are aware of that! All I can credibly threaten you with is that I will play my NE strategy in the final period. Hence nobody can be punished if they deviate in the next-to-last period, since it is in nobody else's best interests to punish them in the last period. If no

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player can be punished for a deviation in the NE, each player will do what is in his best interest to do in each period. That is just a definition of the single stage NE. So we have proved the result that the only equilibrium of the repeated game is in fact the trivial NE of the single stage game.

The reason that this argument is so important here is that all of the games that we studied here had unique NE in their single stages. Hence we know that the only equilibrium of the repeated game is the outcome we found as the NE of the single-stage game. (Note that the NE only has to be unique in terms of the payoffs it generates for all players; there could be any number of NE strategy combinations as long as they all generate the same, unique, payoff vector).

We do not want to claim that the only repeated game of interest is the finite horizon complete-information game we study here. If the time horizon is infinite or there exists some uncertainty about the payoffs (for example), the folk theorem does indeed open up a Pandora's box of possible equilibrium outcomes over time. The empirical relevance of these possibilities is not yet established, however, and they provide a flimsy basis for rationalizing a multilateral liberalization strategy as the equilibrium of some repeated game.

Sensitivity analysis

Finally, we can ask how sensitive are our results to the particular model assumed to generate our payoff matrices? Elsewhere we have argued strenuously for the ritual systematic evaluation of the sensitivity of a given model to variations in key parameters, especially elasticities (see Harrison et al, 1987). Conducting such a sensitivity analysis with the model we use would not change our basic qualitative results, although of course the particular numbers would change slightly.

The same logic compels us to examine sensitivity to a complete change in model. There are only two models that come close to providing the multilateral coverage that is needed to generate payoff matrices for the agricultural trade wars that we consider (ie we need to have the US and the EEC modelled explicitly and jointly). Of these two, our scruples allow us to use only one: the agricultural model of Tyers and Anderson (1988a; 1988b).

This model has several advantages for our purposes, not the least being a detailed modelling of agricultural policies and storage activities in an explicit manner. Moreover, it has been widely cited in the current policy debate. It does not model general equilibrium interactions, however, and welfare measures in particular are based on partial equilibrium evaluations of consumer and producer surplus for agriculture only.

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Table 13 presents the payoff matrices for two simple games that are based on simulations reported from Tyers and Anderson (1988a, Table 5). Game 3 uses net economic welfare to measure payoffs, this being their analogue to our welfare measure. Game 4 uses producer welfare to measure payoffs, on the grounds (discussed earlier) that nations are not conducting agricultural policy for the benefit of their citizens but for the narrow benefit of sectional agricultural lobby interests. This measure of producer welfare is in many respects more appropriate than the measure used in the game we studied in Tables 6-9 (we used agricultural production as a proxy for producer welfare). Their simulations refer to the effects on these variables in 1980-1982, expressed in billions of 1985 US dollars.

One important qualification to these results concerns the interpretation of the cell in the payoff matrices corresponding to joint abolition by the US and the EEC. Tyers and Anderson (1988a) report only the results of a multilateral liberalization by all industrial market economies, which includes Japan, EFTA, Canada, and Australia. Therefore this cell will only approximate the correct value roughly.[6]

The NE of these games are transparent. In game 3 the pure strategy NE is for both countries to liberalize, and in game 4 for both countries to do nothing. Note that these are exactly the opposite of the qualitative results that we obtained earlier.

These results do suggest, as we have repeatedly argued, that our results are dependent on the model that one uses and the motivating force behind agricultural policy (broad notions of welfare or narrow sectional notions).

This is not the place to undertake a critical comparative evaluation of the two models used here. Each has its strengths and weaknesses for different questions. To claim that one or the other is more realistic for present purposes is an egregious exercise in polemics. Our contribution to that debate will take the form of constructing new general equilibrium models of global agricultural trade policy that allow for the specific forms of intervention used in agriculture and the lobbying forces that underlie policy formation in this field.

6 In a private communication Rod Tyers has generously provided us with the results of the 'correct' policy simulation for this cell in game 3. The conclusions we draw as to the NE outcome do not change, therefore we use the values that are documented in the published literature. The correct values for the corresponding cell in game 4 are not known at this stage, hence we do not know if our conclusion with respect to it would change.

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Table 13 **Agricultural trade games based on the Tyers-Anderson model**

Game 3: Net economic welfare as the payoff

	EEC payoffs			US payoffs	
	US^N	US^A		US^N	US^A
EEC^N	0.0	-0.9	EEC^N	0.0	3.2
EEC^A	8.9	7.5	EEC^A	-0.1	2.7

Game 2 Producer welfare as the payoff

	EEC payoffs			US payoffs	
	US^N	US^A		US^N	US^A
EEC^N	0.0	5.2	EEC^N	0.0	-16.9
EEC^A	-47.3	-35.3	EEC^A	11.6	0.2

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Appendix Table A1 **Effects of trade war on global structure of trade – Change in trade (in $US billion)**

EXPORTING REGION and SECTOR	IMPORTING REGION							
	EEC	US	Japan	Canada	ODC	OPEC	NIC	LDC
Exports of EEC ...								
Sector 1:	0.000	-0.600	-0.020	-0.020	-0.280	-0.120	-0.020	-0.110
Sector 2:	0.000	0.000	-0.010	0.000	-0.050	0.000	0.000	-0.080
Sector 3:	0.000	-0.010	0.000	0.000	-0.170	-0.010	0.000	0.000
Sector 4:	0.000	-0.060	-0.070	-0.050	-1.150	-0.310	-0.250	-0.600
Sector 5:	0.000	-0.050	-0.040	-0.040	-0.700	-0.380	-0.380	-0.500
Capital :	0.000	0.000	-0.020	-0.010	0.000	-0.090	0.000	-0.010
Exports of US ...								
Sector 1:	-1.410	0.000	-0.070	-0.040	-0.030	-0.050	-0.110	-0.080
Sector 2:	0.040	0.000	-0.060	-0.030	-0.010	0.000	-0.110	-0.160
Sector 3:	0.010	0.000	-0.020	-0.010	0.000	0.000	-0.030	0.000
Sector 4:	0.100	0.000	-0.030	-0.130	-0.080	-0.050	-0.200	-0.100
Sector 5:	0.130	0.000	-0.020	-0.260	-0.100	-0.100	-0.280	-0.110
Capital :	0.000	0.000	-0.050	-0.040	0.000	-0.240	0.000	-0.060
Exports of Japan ...								
Sector 1:	-0.030	-0.130	0.000	0.000	0.000	0.000	0.000	0.000
Sector 2:	0.000	0.000	0.000	0.000	0.000	0.000	-0.010	-0.020
Sector 3:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sector 4:	0.080	0.120	0.000	0.000	0.020	0.020	-0.160	-0.230
Sector 5:	0.180	0.300	0.000	0.000	0.020	0.030	-0.140	-0.050
Capital :	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Exports of Canada ...								
Sector 1:	-0.270	-0.460	0.000	0.000	0.010	0.000	-0.010	-0.030
Sector 2:	0.060	0.130	0.000	0.000	0.010	0.000	-0.020	-0.010
Sector 3:	0.000	0.090	0.000	0.000	0.000	0.000	0.000	0.000
Sector 4:	0.040	0.200	0.000	0.000	0.000	0.010	-0.020	0.000
Sector 5:	0.010	0.260	0.000	0.000	0.000	0.010	-0.010	0.000
Capital :	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Exports of ODC ...								
Sector 1:	-0.840	-0.860	0.000	0.000	0.000	0.010	-0.030	-0.120
Sector 2:	0.310	0.020	-0.010	0.000	0.000	0.000	-0.030	-0.030
Sector 3:	0.070	0.000	-0.010	0.000	0.000	0.000	-0.010	0.000
Sector 4:	1.060	0.130	0.000	-0.010	0.000	0.010	-0.060	-0.060
Sector 5:	0.560	0.080	0.000	0.000	0.000	0.010	-0.070	-0.020
Capital :	0.000	0.000	0.000	-0.010	0.000	0.070	0.000	-0.030
Exports of OPEC ...								
Sector 1:	-0.330	-0.300	0.000	0.000	0.000	0.000	-0.190	-0.220
Sector 2:	0.020	0.010	0.000	0.000	0.000	0.000	-0.080	-0.080
Sector 3:	1.040	0.470	-0.100	-0.020	-0.030	0.000	-0.160	-0.150
Sector 4:	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sector 5:	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Capital :	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Exports of NIC ...								
Sector 1:	-1.570	-1.320	0.040	0.020	0.060	0.060	0.000	0.000
Sector 2:	0.140	0.020	0.030	0.000	0.000	0.010	0.000	0.000
Sector 3:	0.000	0.050	0.010	0.010	0.010	0.010	0.000	0.000
Sector 4:	0.330	0.440	0.050	0.050	0.090	0.030	0.000	0.000
Sector 5:	0.070	0.160	0.010	0.010	0.020	0.010	0.000	0.000
Capital :	0.000	0.000	0.060	0.030	0.000	0.400	0.000	0.020
Exports of LDC ...								
Sector 1:	-2.200	-0.910	0.030	0.000	0.100	0.100	-0.040	0.000
Sector 2:	0.170	0.050	0.050	0.000	0.020	0.050	-0.010	0.000
Sector 3:	0.010	0.000	0.050	0.000	0.000	0.020	0.000	0.000
Sector 4:	0.730	0.350	0.030	0.010	0.160	0.040	-0.010	0.000
Sector 5:	0.020	0.010	0.000	0.000	0.000	0.000	0.000	0.000
Capital :	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Appendix Table A2 **Effects of trade war on global structure of trade – percentage change in trade**

EXPORTING REGION and SECTOR	IMPORTING REGION							
	EEC	US	Japan	Canada	ODC	OPEC	NIC	LDC
Exports of EEC ...								
Sector 1:	0.0	-35.4	-5.9	-6.2	-5.6	-5.6	-9.2	-8.1
Sector 2:	0.0	0.2	-2.2	-2.1	-2.0	-1.9	-5.0	-3.8
Sector 3:	0.0	-0.9	-2.7	-2.6	-2.5	-2.5	-5.4	-4.2
Sector 4:	0.0	-0.6	-3.0	-3.2	-2.6	-2.7	-5.9	-4.9
Sector 5:	0.0	-0.7	-2.7	-2.8	-2.5	-2.3	-5.7	-4.1
Capital :	0.0	-1.1	-2.9	-3.3	-2.9	-2.6	-5.5	-4.4
Exports of US ...								
Sector 1:	-34.7	0.0	-3.4	-3.6	-3.1	-3.1	-6.7	-5.6
Sector 2:	0.9	0.0	-1.7	-1.9	-1.5	-1.5	-4.6	-3.3
Sector 3:	1.3	0.0	-1.7	-1.6	-1.5	-1.5	-4.4	-3.3
Sector 4:	1.2	0.0	-1.8	-1.9	-1.4	-1.5	-4.7	-3.7
Sector 5:	1.5	0.0	-1.6	-1.8	-1.4	-1.2	-4.7	-3.0
Capital :	1.4	0.0	-1.6	-2.0	-1.6	-1.3	-4.3	-3.1
Exports of Japan ...								
Sector 1:	-31.3	-40.5	0.0	-0.2	0.3	0.3	-3.5	-2.4
Sector 2:	2.7	2.4	0.0	0.1	0.2	0.3	-2.9	-1.6
Sector 3:	3.1	1.9	0.0	-0.4	0.2	0.3	-2.8	-1.6
Sector 4:	3.1	2.5	0.0	-0.1	0.4	0.3	-3.0	-1.9
Sector 5:	3.2	2.1	0.0	-0.2	0.3	0.5	-3.0	-1.4
Capital :	3.1	1.9	0.0	-0.4	0.1	0.4	-2.7	-1.5
Exports of Canada ...								
Sector 1:	-31.8	-37.1	0.2	0.0	0.5	0.5	-3.3	-2.2
Sector 2:	3.0	2.8	0.3	0.0	0.6	0.6	-2.6	-1.3
Sector 3:	3.4	2.2	0.3	0.0	0.5	0.6	-2.4	-1.2
Sector 4:	3.2	2.6	0.1	0.0	0.5	0.4	-2.9	-1.8
Sector 5:	3.3	2.2	0.2	0.0	0.4	0.6	-3.0	-1.3
Capital :	3.5	2.3	0.4	0.0	0.5	0.8	-2.3	-1.1
Exports of ODC ...								
Sector 1:	-32.1	-37.0	-0.2	-0.5	0.0	0.2	-3.6	-2.5
Sector 2:	2.5	2.3	-0.1	-0.5	0.0	0.1	-3.0	-1.8
Sector 3:	2.9	1.7	-0.2	0.0	0.0	0.1	-2.9	-1.7
Sector 4:	2.9	2.3	-0.1	-0.3	0.0	0.2	-3.1	-2.1
Sector 5:	3.0	1.9	-0.1	-0.1	0.0	0.3	-3.2	-1.6
Capital :	3.1	1.9	0.0	-0.4	0.0	0.3	-2.7	-1.5
Exports of OPEC ...								
Sector 1:	-31.8	-36.3	-0.5	-0.6	-0.1	0.0	-3.9	-2.8
Sector 2:	2.3	2.0	-0.4	-0.3	-0.2	0.0	-3.3	-2.0
Sector 3:	2.6	1.4	-0.4	-0.8	-0.2	0.0	-3.2	-2.0
Sector 4:	2.6	2.0	-0.4	-0.6	-0.1	0.0	-3.4	-2.4
Sector 5:	2.7	1.7	-0.3	-0.4	-0.2	0.0	-3.5	-1.8
Capital :	2.6	1.4	-0.5	-0.9	-0.4	0.0	-3.1	-2.0
Exports of NIC ...								
Sector 1:	-29.8	-34.4	2.5	2.2	2.8	2.8	0.0	0.1
Sector 2:	5.3	5.0	2.6	2.5	2.8	2.8	0.0	0.9
Sector 3:	5.5	4.3	2.4	2.5	2.6	2.6	0.0	0.8
Sector 4:	5.7	5.0	2.5	2.3	2.9	2.8	0.0	0.5
Sector 5:	5.5	4.4	2.3	2.3	2.5	2.7	0.0	0.8
Capital :	6.1	4.8	2.9	2.5	2.9	3.2	0.0	1.3
Exports of LDC ...								
Sector 1:	-30.4	-34.9	1.6	1.3	1.9	1.9	-1.9	0.0
Sector 2:	4.2	3.9	1.5	1.6	1.7	1.7	-1.5	0.0
Sector 3:	4.5	3.3	1.4	1.0	1.6	1.7	-1.4	0.0
Sector 4:	4.6	3.9	1.5	1.2	1.8	1.8	-1.6	0.0
Sector 5:	3.2	2.1	0.1	0.0	0.3	0.5	-3.0	0.0
Capital :	4.8	3.6	1.6	1.3	1.7	2.0	-1.1	0.0

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Appendix Table A3 **Effect of trade war on global structure of producer prices**

Region	Sector	Producer Prices Base	New	Percent Change
EEC	Agriculture	1.0000	1.0329	3.3
	Mining	1.0000	1.0118	1.2
	Energy	1.0000	1.0137	1.4
	Non-M. Man.	1.0000	1.0166	1.7
	Mech. Man.	1.0000	1.0141	1.4
	Non-Traded	1.0000	1.0149	1.5
U.S.	Agriculture	1.0000	1.0187	1.9
	Mining	1.0000	1.0089	0.9
	Energy	1.0000	1.0089	0.9
	Non-M. Man.	1.0000	1.0095	0.9
	Mech. Man.	1.0000	1.0087	0.9
	Non-Traded	1.0000	1.0093	0.9
Japan	Agriculture	1.0000	1.0030	0.3
	Mining	1.0000	1.0031	0.3
	Energy	1.0000	1.0030	0.3
	Non-M. Man.	1.0000	1.0029	0.3
	Mech. Man.	1.0000	1.0030	0.3
	Non-Traded	1.0000	1.0030	0.3
Canada	Agriculture	1.0000	0.9999	-0.0
	Mining	1.0000	0.9993	-0.1
	Energy	1.0000	0.9993	-0.1
	Non-M. Man.	1.0000	1.0005	0.1
	Mech. Man.	1.0000	1.0007	0.1
	Non-Traded	1.0000	0.9997	-0.0
ODC	Agriculture	1.0000	1.0036	0.4
	Mining	1.0000	1.0038	0.4
	Energy	1.0000	1.0039	0.4
	Non-M. Man.	1.0000	1.0040	0.4
	Mech. Man.	1.0000	1.0042	0.4
	Non-Traded	1.0000	1.0039	0.4
OPEC	Agriculture	1.0000	0.9998	-0.0
	Mining	1.0000	1.0001	0.0
	Energy	1.0000	1.0006	0.1
	Non-M. Man.	1.0000	1.0005	0.1
	Mech. Man.	1.0000	1.0007	0.1
	Non-Traded	1.0000	0.9996	-0.0
NIC	Agriculture	1.0000	0.9902	-1.0
	Mining	1.0000	0.9902	-1.0
	Energy	1.0000	0.9911	-0.9
	Non-M. Man.	1.0000	0.9905	-1.0
	Mech. Man.	1.0000	0.9918	-0.8
	Non-Traded	1.0000	0.9896	-1.0
LDC	Agriculture	1.0000	0.9911	-0.9
	Mining	1.0000	0.9927	-0.7
	Energy	1.0000	0.9931	-0.7
	Non-M. Man.	1.0000	0.9925	-0.8
	Mech. Man.	1.0000	1.0007	0.1
	Non-Traded	1.0000	0.9917	-0.8

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Appendix Table A4 **Effect of trade war on global structure of factor prices**

Region		Base	New	Percent Change
EEC	Capital	1.0000	1.0156	1.6
	Labour	1.0000	1.0138	1.4
U.S.	Capital	1.0000	1.0088	0.9
	Labour	1.0000	1.0091	0.9
Japan	Capital	1.0000	1.0031	0.3
	Labour	1.0000	1.0031	0.3
Canada	Capital	1.0000	0.9988	-0.1
	Labour	1.0000	0.9989	-0.1
ODC	Capital	1.0000	1.0021	0.2
	Labour	1.0000	1.0042	0.4
OPEC	Capital	1.0000	1.0011	0.1
	Labour	1.0000	0.9960	-0.4
NIC	Capital	1.0000	0.9888	-1.1
	Labour	1.0000	0.9890	-1.1
LDC	Capital	1.0000	0.9935	-0.6
	Labour	1.0000	0.9899	-1.0

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AGRICULTURAL POLICIES AND THE NON-FARM ECONOMY

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