ECONOMY-WIDE EFFECTS OF AGRICULTURAL POLICIES IN OECD COUNTRIES: SIMULATION RESULTS WITH WALRAS

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CONTENTS

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INTRODUCTION

Agricultural policies in OECD countries have come under increasing scrutiny and criticism in recent years in line with growing imbalances in the markets for the main agricultural products and soaring budgetary support costs. Two recent OECD (1987a, 1987b) reports have indicted national farm-support policies as the root cause of the imbalances'. The effects of policies have not been confined to domestic agricultural markets; they have drained resources from other sectors and agricultural market imbalances have spilt over into international trade. The result has been to reduce economic efficiency and consequently aggregate real incomes, to destabilise world markets, to exacerbate tensions between OECD countries, and to threaten progress towards further multilateral trade liberalisation under the Uruguay Round. Hence, the economic returns from reforming existing agricultural policies could be substantial[2].

Quantifying the economic consequences of agricultural policies has thus been an important objective in OECD work to guide discussion of agricultural policy issues. Applied general equilibrium (AGE) models are a natural vehicle for this since they incorporate the main linkages between agriculture, the resources it uses (land, labour, capital) and the non-agricultural sectors, thereby permitting the analyst to take account of spillover and feedback effects in a consistent manner[3]. This paper reports the results of various scenarios with an AGE model, the WALRAS model, which was specially developed by the Economics and Statistics Department of the OECD with the aim of quantifying the *long-run* effects of agricultural policies on resource allocation between the farm and non-farm sectors, on economic welfare, on factor returns, and on world trade volumes and prices. It should be emphasised at the outset that the simulations are intended to give an overall assessment of the economic effects of agricultural policies and to illustrate the workings of the linkages incorporated in the model. They have not been designed to predict the likely impacts of any multilateral agreement on agricultural reform which might be negotiated as part of the Uruguay Round.

The paper is in five parts. The first section reviews briefly some of the main channels through which agricultural policies can be expected to affect the non-agricultural sectors and the advantages and disadvantages of using AGE models to address this issue. Section II presents the detailed simulation results for the six main OECD agricultural trading countries/regions – Australia, Canada, EC, Japan,

New Zealand and the United States – and compares them with those from other AGE models. This is followed by a section which illustrates the sensitivity of the results to alternative characterisations of policies in the model – more extensive sensitivity analysis is reported in the paper by van der Mensbrugghe *et al.* in this volume. Section IV presents a range of policy-relevant simulations designed to highlight certain aspects of the current debate on agricultural reform, in particular the benefits of multilateral as opposed to unilateral initiatives. The final section summarises the main results and draws some conclusions.

I. ECONOMIC EFFECTS OF AGRICULTURAL PROTECTION

The pure theory of international trade suggests that protecting one sector will lead to a shift in production towards that sector as it draws in resources from the rest of the economy in response to the shifts in relative prices arising from protection. Consumers, in turn, will shift their demands away from the relatively more expensive protected goods. Hence, protection is likely to distort the inter-sectoral allocation of resources and consequently to impose social (or "dead-weight") costs on society. It may also affect the terms of trade, thereby giving rise to additional welfare gains or losses.

Some of these possibilities can be illustrated in terms of a simple general equilibrium model of a three-sector economy, which produces two traded goods, food and industrial output, and a non-traded good, services. Outputs of agriculture and industry are traded at given world prices, while the price of the non-traded good is fully flexible. Land is assumed to be specific to agriculture which also uses capital and labour. Labour and capital are used in both industry and services. All three primary factors are in fixed supply to the total economy.

If agriculture is now protected or subsidised, its domestic price will either rise relative to the domestic price of industry and services or its production costs will decline relative to the other sectors. As a result, agricultural production becomes more profitable, and the value of the marginal products of capital and labour will rise in agriculture relative to the other two sectors. Hence, some capital and labour previously employed in industry and services will be attracted into agriculture. This will tend to lower output in both industry and services. But this is not the end of the story. Suppose that the capital-labour ratio is highest in agriculture, followed by industry and is lowest in services – this ranking of sectoral factor intensities is supported by the evidence for many OECD countries. In this case, at given prices and ignoring income effects, the output of industry will fall and the output of services will rise[4]. Hence, supporting agriculture by protection or subsidies leads to de-industrialisation in this particular case. When one allows for

income effects and other changes in assumptions, the situation is more complicated, but the basic presumption that agricultural protection acts as an export tax on other traded industries still holds.

Farm-support policies are unlikely to lead to higher wages and returns to capital in agriculture than in other sectors in the long term since labour and capital are likely to be reasonably mobile between sectors. Instead, they are likely to be capitalised into higher land prices since land is essentially a fixed factor whose price is bid up in response to higher agricultural output prices. To the extent that agricultural policies take the form of supply controls, these are likely to lead to a capitalisation of quota rents into higher land values and/or market values of the quotas.

The analysis *so* far assumes that the economy faces given terms of trade. If this assumption is relaxed, as it is in WALRAS, a country may be able to raise its real income compared with the free trade level by imposing optimal import or export taxes on agriculture. However, this "optimal tariff" result is crucially dependent on the assumption of no retaliation by trading partners and the degree to which domestic goods are imperfect substitutes for foreign goods on home and world markets.

AGE models aim to elaborate and quantify these abstract mechanisms emphasised by the traditional two- or three-sector general equilibrium models of pure trade theory. They do *so* by specifying in considerable detail the structure of production and consumption, the role of the government, foreign trade flows, and the transformation of savings into investment which increases the stock of capital. Based on equilibrium assumptions – prices adjust to clear markets, *so* that supply always equals demand – these models simulate the allocation of resources, given the available factor endowments, technologies and consumer tastes. Whenever the government intervenes, by introducing taxes or subsidies, by erecting barriers to foreign trade or by any other intervention in markets, a reallocation of resources occurs across all markets and not just in those affected directly, often with significant efficiency and distributional consequences.

The main strength of AGE models is their emphasis on the interdependence of the decisions taken by all economic agents. Within the AGE framework, the decisions of the various agents interact to determine how the behaviour of one agent affects the options available to others, and hence the allocation of resources. Thus, if agricultural policy encourages the agricultural sector to use more resources than would be the case in the absence of intervention, the AGE model will describe where those resources come from, what implications the policy has for the rest of the economy and to what extent the feedbacks from other sectors will impact on agriculture.

At the same time, the results from any AGE modelling exercise are subject to several major caveats and need careful interpretation. Simulation results, such as

those discussed in the next three sections, are sensitive to the structure imposed on the model, the choice of values for key exogenous parameters and the ways in which the complexity of real-world policies must be simplified in order to integrate them into the model. For this reason, it is standard practice for AGE modellers to undertake extensive sensitivity analysis in order to assess the robustness of key results.

II. SIMULATION RESULTS

Before discussing the simulation results, it is helpful to bear in mind the relative sizes of the various sectors and the structure of agricultural support in each economy. The "benchmark" year in the WALRAS model, for which the economies being modelled are assumed to be in equilibrium, is 1980 or 1981, depending on the country or region[5]. Data on output, employment and trade shares in the benchmark year for the four broad sectors – agriculture, food processing, other industry and private services – are shown in Table 1[6]. The proportion of gross output in the private sector accounted for by agriculture and food processing ranges from 7 per cent in Japan to 20 per cent in New Zealand. Trade patterns are also very different for these two sectors. Agriculture and food processing account for one-third or more of total exports in Australia and New Zealand, and 15 per cent of U.S. exports. While these two sectors have a negligible proportion of total Japanese exports, their share of imports is much larger. In both the EC and Japan, imports of agriculture and food account for 13 per cent of total imports.

Table 2 presents information on 1986-88 average levels of support in the agricultural and food-processing sectors – see the paper by Lienert in this volume for a description of the agricultural policy regimes in each country/region. These data illustrate how the systems of protection differ across the six countries/regions, depending upon the net trade position of the country in question with respect to agricultural and food products. In particular, the large food importers, the EC and Japan, tend to support both their agricultural and food-processing sectors whereas the other countries mainly support their agricultural sectors. As will be apparent later, the simulation results are influenced strongly by the interaction between the levels and composition of support and the structure of the economy.

Finally, the nature of the simulation results presented in this paper should be underlined. AGE models are not forecasting models. Instead, they are simulation models designed to answer "what if" questions. In terms of this paper, the following kind of question is posed: "What would be the long-term impact on

Table 1. Sectoral output, employment and trade shares for the countries/regions in the WALRAS model[a]

Per cent

	Australia	Canada	EC	Japan	New Zealand	United States
Agriculture's share in:						
Gross output	4.5	4.1	4.1	2.2	9.1	3.5
Employment[b]	5.3	1.3	2.5	2.2	7.8	2.0
Exports	15.9	6.5	1.7	0.1	8.7	10.1
Imports	0.8	2.1	7.9	6.5	1.2	1.1
Food processing's share in:						
Gross output	7.0	5.6	7.3	4.7	10.9	4.9
Employment6	4.2	3.2	4.1	2.1	7.4	1.9
Exports	17.2	4.7	7.6	1.2	35.1	5.1
Imports	3.0	3.8	4.8	6.0	3.7	4.7
Other non-food industries' share in:						
Gross output	39.0	46.4	49.1	52.8	38.6	43.8
Employment[6]	29.2	41.3	46.5	37.0	34.7	39.0
Exports	42.8	75.9	66.7	79.4	28.6	62.3
Imports	88.5	86.3	77.9	75.5	74.0	91.1
Private services' share in:						
Gross output	49.6	43.9	39.5	40.3	41.4	47.7
Employment[b]	61.3	54.1	46.8	58.7	50.1	57.1
Exports	24.1	12.9	24.0	19.3	27.6	22.5
Imoorts	7.6	7.8	9.4	12.0	21.1	3.1

a) For the purposes of this table, "agriculture" corresponds to industries 1 and 2 in the WALRAS model—livestock and other agricultural products; "food processing" is the total of industries 4, 5, 6 and 7—meat, dairy, other food products and beverages; "other non-food industries" are industries 3, 8 to 1l—mining and quarrying, chemicals, petroleum, other manufacturing industries and construction; and "private services" are industries 12 and 13—wholesale and retail trade and other private services. All figures refer to shares relative to the total *private* sector.

b) Employment is in efficiency units and is measured by the remuneration of labour employed in each of the sectors. Government employment is excluded.

Sources: Input-Output tables of the various countries. See Burniaux *et al.* (1988), Annex II for details.

OECD countries if all their farm-support policies were eliminated, given full adjustment in all product and factor markets, but no change in any other model parameters or exogenous variables?" In addition, WALRAS is a comparative static model with a long-run focus; it does not capture any dynamic effects on savings and investment which might arise as a result of agricultural policies. Thus, it is unable to quantify the adjustment paths which OECD economies might follow in response to any particular scenario of agricultural reform. Instead, the results

Table 2. **1986-88 average levels of agricultural support in the six countries/regions**

	Small exporters		Large exporters		Large importers	
	Australia	New Zealand	Canada	United States	EC[a]	Japan
PSE[b]	12	18	46	39	50	76
Distribution of support by sector:						
Agriculture	78.9	99.0	89.4	83.7	42.4	68.6
Food processing	21.1	1.0	10.6	16.3	57.6	31.4
Distribution of support by instrument:						
import taxes	2.1	0.7	3.9	6.0	25.2	55.1
Export subsidies	19.3	0.3	10.6	8.2	43.7	1.5
Production subsidies	78.6	99.0	85.5	79.7	25.7	42.5
Consurnotion subsidies	..	..	..	6.1	5.4	0.9

a) The EC was a net importer of agricultural commodities and a net exporter of food in 1980 (the benchmark year).

b) Net total PSEs for all commodities as a per cent of adjusted production. See the paper by Cahill and Legg in this volume for a description of the definition and coverage of net PSEs.

have to be interpreted as showing how economies might look different in the long-run if policies are changed, rather than remaining as they were in the base year. The time horizon is one that is long enough to allow shifts in relative prices to be fully reflected in the structure of production, the allocation of capital, labour and land and patterns of consumption in all countries. This process could take many years before it is completed.

A. Removal of the 1986-88 levels of agricultural support

This simulation involves a full multilateral removal of the average 1986-88 levels of agricultural assistance (including the elimination of the U.S. land set-asides and supply controls in the Canadian and EC dairy sectors) in the six countries/regions, assuming no change in support in their non-agricultural sectors and no change in support in the rest of the world **(ROW).** The standard **WALRAS** closure rule is applied, namely no change in either the government balance or the current account – for a discussion of this, see the paper by Burniaux et al. in this volume. The imputed tax rates on consumers' incomes are varied in order to maintain the given levels of the government balance. Equilibrium factor prices – or, equivalently, real exchange rates – adjust to keep current accounts unchanged'.

A summary of the main results of eliminating the **1986-88** levels of agricultural support is presented in Tables 3a to 3c[8]. While any numerical estimate is subject to uncertainty, the WALRAS results suggest that **OECD** agricultural support has significantly distorted long-run resource allocation and that it has generally served as an implicit export tax on non-food industries and services. Indeed, for the **OECD** area as a whole, household real incomes are raised by almost **1** per

Table 3a. Economy-wide and sectoral effects from complete elimination of 1986-88 levels of agricultural support in OECD countries

Per cent changes compared with benchmark year[a]

	Australia	Canada	EC	Japan	New Zealand	United States	OECD[b]
Aggregate effects							
Household real income	0.8	1.3	1.4	1.1	2.7	0.3	0.9
Real exchange rate[c]	1.5	-1.9	-2.9	-2.2	3.9	-1.6	-2.1
Terms of traded	4.1	-0.7	-3.0	-3.6	10.6	-0.2	-0.8
Total exports'	3.0	3.4	7.6	10.9	-0.4	4.0	6.5
Total imports[e]	6.9	6.9	14.9	17.2	9.7	4.6	11.3
Labour re-allocation'	1.3	0.8	1.3	0.8	2.3	0.4	0.8
Consumer prices[g]	0.2	1.5	-0.6	-1.9	-1.6	1.0	-0.0
Sectoral effects							
Agriculture							
Output[h]	4.4	-16.7	-18.7	-24.2	7.9	-7.0	-13.6
Producer prices[g]	11.1	9.8	-4.6	-6.9	20.3	4.2	-0.0
Imports[e]	51.0	27.9	-17.4	24.8	48.4	1.7	-4.9
Exportse	-30.8	-42.5	-59.7	109.2	-58.2	-5.7	-21.6
Food processing and beverages							
Output[h]	14.6	1.0	-21.3	-13.9	18.9	-2.8	-11.9
Producer prices[g]	5.0	4.0	-1.3	-3.1	10.0	1.8	-0.0
Imports[e]	37.5	156.1	389.5	275.8	16.8	114.7	267.6
Exportse	71.1	70.8	-79.6	158.0	42.3	28.8	-20.4
Non-food industries and private services							
Output[h]	-0.7	0.9	2.1	1.2	-2.4	0.4	1.1
Producer prices'	-0.4	2.3	1.5	0.7	-2.7	0.9	1.1
Imports[e]	5.0	0.2	-2.9	-1.0	8.9	-0.1	-1.1
Exports[e]	-7.4	2.6	13.4	9.1	-18.1	3.0	8.3

a) The benchmark year for the WALRAS model is 1980 or 1981, depending upon the country/region in question. The per cent changes in the variables when the 1986-88 farm-support policies are removed are measured relative to the 1980 (or 19811 levels.
b) Total of the six countries/regions.
c) Defined as the weighted average of domestic factor prices relative to world prices in domestic currency.
d) Export prices including agricultural export subsidies divided by import prices excluding agricultural import taxes.
e) Volumes.
f) Proportion (in per cent) of total labour (in efficiency units) shifting from one sector to another.
g) Deflated by the GDP deflator at factor cost.
h) Value-added including government.

Table 3b. **Effects on factor and product prices of complete elimination of 1986-88 levels of agricultural support in OECD countries**

Per cent changes compared with benchmark year[a]

	Australia	Canada	EC	Japan	New Zealand	United States	OECD[b]
Capital rental in agriculture[c]	1.4	-9.6	-8.8	-17.5	4.4	-4.4	-8.9
Wage rate in agriculture[c]	2.8	-8.4	-4.1	-17.0	14.3	-4.7	-5.9
land rental'	4.4	-53.0	-40.3	-44.3	38.7	-41.2	-39.6
Capital rental in non-agricultural sector[c]	-0.5	1.9	0.7	0.7	-2.9	1.0	0.8
Wage rate in non-agricultural sector[c]	-0.1	2.5	1.8	0.8	-3.3	0.8	1.2
Import prices.	-1.8	3.9	5.4	4.6	-5.2	1.9	3.8
Export prices.	2.2	3.2	2.2	0.9	4.9	1.6	1.9
Domestic food consumption prices.	5.2	1.6	-3.0	-5.3	5.8	2.0	-1.6

a) The benchmark year for the WALRAS model is 1980 or 1981, depending upon the countrylregion in question.
b) Total of the six countries/regions.
c) Deflated by the GDP deflator at factor cost.

Table 3c. **Effects on the rest of the world of complete elimination of 1986-88 levels of agricultural support in OECD countries**

Per cent changes compared with benchmark year[a]

	Terms of trade	Rest of the World (ROW)	
		Import volumes	Export volumes
Agriculture	-1.0	-6.8	5.3
Food processing	-2.4	-16.7	134.4
Other non-food industries and private services	0.8	4.3	-3.6
Total	0.8	2.7	1.6

cent in the simulation as a result of multilateral liberalisation. Given that agriculture and food processing only account for about 6 per cent of total OECD output, this represents a significant gain in efficiency.

The rest of this sub-section highlights the main interactions which occur when agricultural support is eliminated, beginning with the impact on world prices and trade volumes and tracing this through the domestic production structure to the estimated welfare gains:

a) World prices and trade volumes

The impact of agricultural liberalisation on world trade volumes and prices depends on the net outcome of shifts in supply and demand. Shifts in supply arise when export and production subsidies are abolished; this raises equilibrium producer prices and hence export prices, thereby tending to reduce agricultural output and trade. Shifts in demand occur in response to the removal of import barriers; this lowers consumer prices, thereby tending to raise agricultural output and trade. Therefore, the net effect on world trade volumes of eliminating agricultural support can be positive or negative. Both these effects should tend to raise world market prices, although the magnitude of this effect will be influenced strongly by the elasticity of agricultural supply in the rest of the world (ROW).

The simulation results show that removal of agricultural support leads to rises in world market prices and trade volumes of most agricultural and food products. In particular, the removal of the very large import taxes on dairy and on meat products has a major impact on world trade volumes and prices of these products (Chart A). World trade volumes of meat and dairy products expand by over 140 and 240 per cent, respectively, and world market prices rise by almost 10 and 14 per cent. The only sector where trade volumes decline is other agriculture (mainly grains). Most support to grain producers takes the form of deficiency payments which are modelled as production subsidies in WALRAS. When this support is eliminated, the negative supply effect dominates and equilibrium producer and export prices rise.

The main beneficiaries from these changing patterns of world trade in agriculture and food are the small food-exporting countries in the OECD area and ROW. Australia makes major gains on world markets for meat products: its exports increase by 215 per cent. New Zealand benefits from exploiting its comparative advantage in dairying: its exports increase by 190 per cent. ROW is also a major gainer on world markets: its exports of agricultural and food products rise by 5 and 134 per cent, respectively.

b) Output in the agricultural and non-agricultural sectors

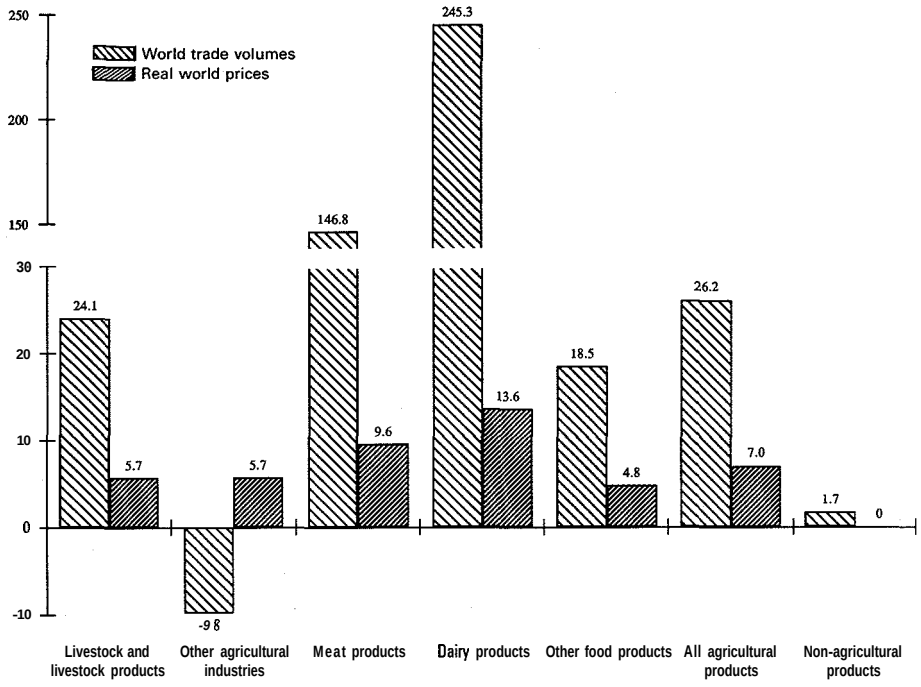
In four of the six countries/regions, the agricultural sector contracts as a result of agricultural liberalisation, while it expands in the two small food-exporters, Australia and New Zealand. The output contraction in the two farm sectors is over 13 per cent on average in the six countries/regions. Japan experiences the largest contraction in its agricultural sector followed by the EC and Canada. The U.S. agricultural sector shows a smaller contraction of 7 per cent.

The large output declines in EC and Japanese agriculture are not surprising given the very high levels of border protection enjoyed by their farmers in 1986-88. The much larger decline in Canadian agriculture compared with its

CHART A

Effects on world trade volumes and real world prices of multilateral elimination of the 1986-88 levels of agricultural support by sector (1)

Per cent changes compared with benchmark year



1. World trade volume changes by sector are calculated as the percentage change of post-simulation aggregate export volumes compared with benchmark aggregate volumes. The sectoral world price changes are calculated as the per cent change in world imports valued at post-simulation prices compared with aggregate world imports valued at benchmark prices.

U.S. counterpart is, at first sight, a more surprising result given relative support levels in the two countries. To understand the reasons for it, one has to look at the structure of agricultural support as it is modelled in WALRAS. Canada, like the United States, relies very heavily on direct and indirect income supports to farmers – assistance which is modelled as a production subsidy in WALRAS. But production subsidy rates in the two Canadian farm sectors in **1986-88** were twice as high as the U.S rates, especially in the other agriculture sector – see Table 3 in the paper by Lienert in this volume. When these subsidies are eliminated, equilibrium producer prices rise sharply in Canada – by almost 10 per cent for the agricultural sector compared with 4 per cent in the United States. As a

result, export prices increase and Canadian exporters lose world market shares: exports of other agriculture decline by almost **50** per cent. In addition, the rise in U.S. producer prices consequent upon the removal of output subsidies is partly offset by a specific element of U.S. policies: the abolition of the land set-asides brings idled land back into production, thereby mitigating the decline in output and exports.

However, the magnitude of the decline in Canadian agricultural output may be overstated here since all non-price support included in the PSE has been treated as "permanent". It has been argued that a significant proportion of the rapid increase in support to Canadian grain producers since **1983** is essentially temporary, related to a collapse of world prices: the percentage PSE for wheat rose from **21** per cent in **1983** to a peak of **53** per cent in **1986,** before falling back to **46** per cent in **1988.** For coarse grains, the PSE rose from **18** per cent to a peak of **67** per cent before declining to 41 per cent over the same period. Using an average of **1986-88** levels of support smooths these swings somewhat, but, to the extent that this average still includes some "temporary" support, the long-term contraction in the grains sector may be overstated[9]. This issue is discussed further in the next section.

The OECD average decline of **12** per cent in output of the food-processing sector is almost as great as that in the agricultural sector, but the variance of gains and losses is wider across countries. In Australia and New Zealand, the sector expands significantly in response to agricultural liberalisation. The main declines are concentrated in the EC and Japan, whereas this sector declines by less than **3** per cent in the United States and even expands slightly in Canada[10]. These patterns are explained by the way in which agricultural support is distributed between cereals and other products, such as sugar, meat and dairy products, which need further processing before they are traded. In both Canada and the United States, almost all of the support is given to the two farm sectors and only between **10** and **16** per cent of support goes to the three food-processing sectors – as shown in Table **2.** In Japan, and especially in the EC, although support applies at the farm gate, it benefits the food-processing industries more.

As capital and labour flow out of agriculture and food processing in the EC, Japan, Canada and the United States in response to falling relative prices, outputs of the non-agricultural sectors expand in these countries/regions. The converse occurs in Australia and New Zealand, where resources flow out of the non-agricultural sectors into agriculture and food-processing in response to improvements in their terms of trade. In countries where the agricultural and food-processing sectors contract, the non-food manufacturing sector typically benefits more than private services from this intersectoral adjustment. Export-oriented industries such as chemicals, petroleum and coal products and other manufacturing are the main gainers. The percentage increases in output in these three sectors are as follows:

	Chemicals	Petroleum and coal products	Other manufacturing
Canada	**– 0.4**	**0.6**	**1.4**
EC	**4.9**	1.2	**3.7**
Japan	**2.1**	**0.9**	2.4
United States	0.2	**0.6**	**0.7**

The magnitude of labour reallocation necessitated by these intersectoral shifts is quite small. One summary measure of this – which is defined as the number of jobs (in labour efficiency units) which are lost and replaced by jobs in another sector as a result of agricultural liberalisation, expressed as a proportion of total economy-wide employment in the benchmark year – shows that only 1 per cent or less of jobs in all countries/regions except New Zealand are shifted in the long run. Given normal labour turnover, this would have a negligible impact on labour markets.

c) Factor prices

Along with these changes in output and trade patterns, the model yields significant changes in factor prices and income distribution. Not surprisingly, there are large changes in the rental value of agricultural land, which is assumed to be specific to the two farm sectors. This declines by 40 to 50 per cent in the EC, Japan, the United States and Canada. The magnitude of the fall in land rentals is correlated directly with both the size of the output contraction in agriculture and the land share in value added. On the other hand, land rentals increase in the small food-exporting countries, especially in New Zealand.

However, the magnitude of long-run changes in land rents, which are likely to be capitalised in land prices, in response to multilateral liberalisation is somewhat overstated by these results since, as presently specified, the model makes no allowance for alternative uses of land outside the agricultural sector. Sensitivity analysis with allowing land to move between agricultural and non-agricultural uses has been performed with the Japanese country model – see the paper by van der Mensbrugghe *et* al. in this volume. The results suggest that the falls in land rentals reported in Table 3b could be considerably overstated, depending on the extent to which agricultural land can be used as an input by the non-agricultural sector.

In those countries where the agricultural sector contracts, returns to labour and capital in this sector also fall, though by much less than the returns to land. The assumption of partial factor mobility is important here since it means that real returns to all three factors in agriculture will fall in those countries where the sector contracts in response to a decline in relative product prices. The wage rate

and the capital rental in the non-agricultural sectors rise in all countries except New Zealand and Australia, in line with the expansion in industry and private services.

d) The terms of trade

Changes in the terms of trade (and the real exchange rate) play an important role in determining the outcomes. Under the assumption of an unchanged current account, sharp rises in net imports of agricultural and food products in North America, Japan and the EC have to be counterbalanced by a rise in their net exports of non-agricultural goods to Australia, New Zealand and ROW. Faced with downward-sloping export demand curves, their terms of trade (and real exchange rates) fall; the largest decline is in Japan and the least in the United States. On the other side of the coin, the terms of trade improve for New Zealand, Australia and for ROW.

e) Real income

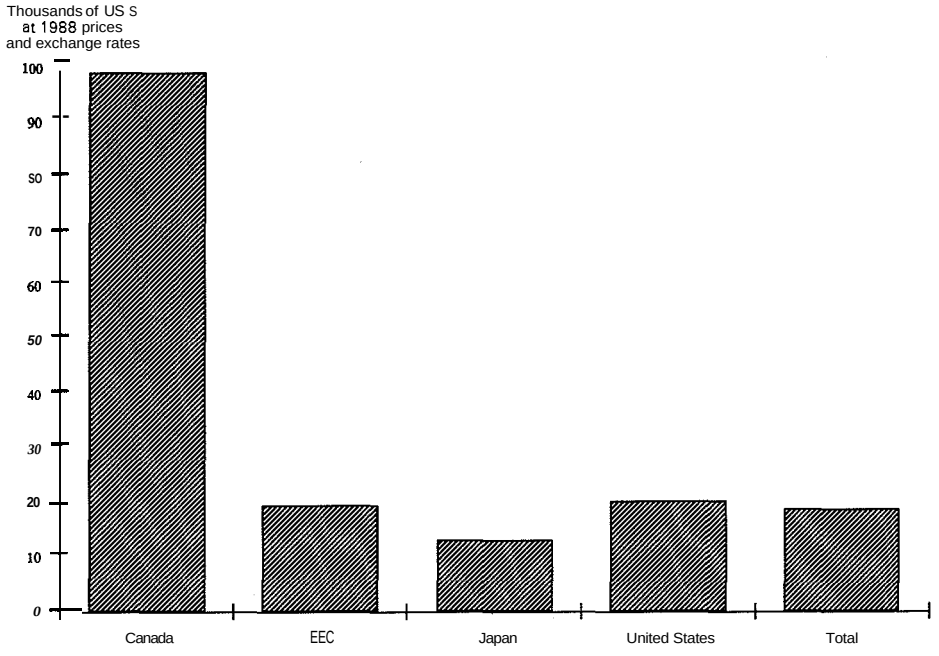
In order to provide a summary indicator of the impact of agricultural liberalisation on consumer welfare, a measure of the change in household real income – the so-called "Hicksian equivalent variation" – has been computed. This is the increase in income that a consumer would need before agricultural liberalisation to allow him to reach the welfare levels he actually achieves after agricultural liberalisation. It is defined in terms of the utility function of the representative private consumer in the model; government is excluded. The theoretical merits and shortcomings of this measure as an indicator of social welfare are well known and will not be discussed here".

In the model, the main sources of the real income effects for households from agricultural liberalisation are three-fold. First, where support has expanded the agricultural and food-processing sectors, countries realise efficiency gains as factors move out of these sectors into non-agricultural sectors. Second, when tariffs and subsidies are eliminated, consumers in previously protected markets switch their demands towards relatively cheaper food products. Third, the terms of trade worsen in countries whose net agricultural exports contract in order to maintain the current account at its reference level. This brings a real income loss for domestic households which has to be set off against the efficiency gains. Conversely, the terms of trade improve for countries with increased net agricultural exports, adding to household real income gains. Efficient food-exporting countries are thereby able to exploit their comparative advantage more fully.

The results suggest that multilateral liberalisation would improve welfare by almost 1 per cent on average in the six countries/regions, ranging from 0.3 per cent in the United States to 2.7 per cent in New Zealand. To put these welfare

CHART B

Costs of farm-support per job "saved" in agriculture and food processing in selected OECD countries/regions (1)



1. The change in household real income for each country/region is from the multilateral simulation of a removal of the average 1986-88 levels of agricultural support, see Table 3a. (The benchmark year data are expressed in $ 1980 prices and exchange rates). The Simulated change in labour use is applied to levels of employment in agriculture and food processing in the base year (Source: OECD. *National Accounts,* Vol. II) to get an estimate of the number of jobs "saved. The real income gain is then divided by the change in jobs in agriculture and food processing and the result expressed in $ at 1988 prices and exchange rates.

gains into context, they imply that agricultural support in 1986-88 cost the OECD countries $72 billion (measured at 1988 prices and exchange rates) in lost income. For the world as a whole, this welfare loss is an underestimate of the waste involved in OECD farm-support policies since it takes no account of the high levels of agricultural support in other Member countries which are not modelled specifically, such as the EFTA countries. It also takes no account of any favourable effects on household welfare from falling land prices in urban areas, although sensitivity analysis with the Japanese model suggests that the net welfare effect of this may not be very significant. Finally, it overlooks the welfare gains which many developing countries would realise if OECD countries were to open their markets for agricultural and food products[12].

These aggregate real income gains from multilateral liberalisation can also be expressed in terms of how much agricultural support costs each economy per "job saved" in agriculture and food processing. Chart B shows that the cost per job saved by the 1986-88 levels of support in the EC, Japan, Canada and the United States ranged from $13 000 in Japan to almost $100 000 in Canada, over and above the income transfers to farmers[13]. The jobs "saved" in agriculture and food processing at this cost to society do not represent employment gains to the economy in the long run. Rather they come at the expense of jobs in the non-agricultural sectors. In Australia and New Zealand, employment in the agriculture and food-processing sectors is smaller than it would be if agricultural support in the rest of the OECD were removed.

B. Cost of increased agricultural support in the 1980s

OECD farm support has increased sharply in the 1980s. An assessment of the economy-wide consequences of this increase is obtained by comparing Tables 4a to 4c, which present the results of a simulation of multilateral liberalisation of the average 1979-81 levels of agricultural support in the six OECD countries/regions, with Tables 3a to 3c.

The results in Tables 3 and 4 suggest that the ***increase*** in OECD farm support in the 1980s has been costly, amounting to a real income loss of one-third of a percentage point for the average of all the countries/regions. This is in addition to the simulated welfare cost of 0.6 per cent due to the 1979-81 levels of policies. To put this figure into some context, it implies that the expansion in agricultural support between 1979-81 and 1986-88 cost the OECD countries $24 billion (in 1988 prices and exchange rates) in lost output. All countries/regions shared in this growing waste, but the largest increases were in Canada (+ 0.7 per cent), Japan (+ 0.5 per cent), New Zealand (+ 0.4 per cent) and the EC (+ 0.3 per cent).

These results reveal a one-to-one relationship between the increasing welfare costs of agricultural support in the 1980s and increases in support to the farm sector, as measured by the PSE, which increased by 50 per cent between 1979-81 and 1986-88 for the OECD area. This exact proportionality arises from the fact that the ***composition*** of agricultural support has remained very stable when averaged over the six countries/regions. Border measures – import tariffs, quotas and export subsidies – are more costly than domestic supports because they distort consumer choices as well as production decisions. But border measures accounted for 40 per cent of total support to the agricultural sector in 1979-81 compared with 42 per cent in 1986-88 – see Table 5 in the paper by Lienert in this volume.

Table 4a. Economy-wide and sectoral effects from complete elimination of 1979-81 levels of agricultural support in OECD countries

Per cent changes compared with benchmark year[a]

	Australia	Canada	EC	Japan	New Zealand	United States	OECD[b]
Aggregate effects							
Household real income	0.5	0.6	1.1	0.6	2.3	0.1	0.6
Real exchange rate[c]	1.9	−1.0	−2.1	−2.2	2.3	−0.9	−1.5
Terms of traded	3.5	−0.3	−2.1	−2.4	8.7	−0.4	−0.6
Total exports[e]	3.4	2.3	5.3	9.5	−0.4	4.5	5.4
Total imports[e]	6.3	3.9	11.2	12.1	8.0	5.9	9.0
Labour re-allocation[f]	1.1	0.4	0.9	0.8	1.8	0.2	0.6
Consumer prices[g]	0.0	0.6	−0.3	−0.4	−0.3	0.1	−0.1
Sectoral effects							
Agriculture							
Output[h]	3.5	−7.5	−15.3	−21.8	4.7	−4.0	−10.4
Producer prices[g]	9.1	4.6	−1.5	1.1	18.8	2.4	1.1
Imports[e]	49.8	3.9	−10.1	3.1	37.5	−2.8	−5.8
Exports[e]	−31.0	−3.7	−22.2	−95.8	−55.1	13.5	0.1
Food processing and beverages							
Output[h]	17.3	−3.5	−15.2	−16.5	14.6	−4.3	−10.2
Producer prices[g]	4.2	1.7	−0.0	−0.1	9.7	0.9	0.5
Imports[e]	20.3	92.7	284.5	213.5	30.2	145.9	213.0
Exports8	83.6	24.9	−63.2	35.3	33.9	23.0	−16.9
Non-food industries and private services							
Output[h]	−1.0	0.4	1.6	1.2	−1.6	0.2	0.8
Producer prices[g]	−0.5	0.9	1.1	0.8	−1.6	0.2	0.6
Imports[e]	5.1	0.1	−2.0	−0.9	6.7	−0.0	−0.8
Exports[e]	−8.5	1.2	9.3	9.3	−13.5	2.1	6.1

a) The benchmark year for the WALRAS model is 1980 or 1981, depending upon the country/region in question. The per cent changes in the variables when the 1979.81 farm-support policies are removed are measured relative to the 1980 (or 1981) levels.

b) Total of the six countries/regions.

c) Defined as the weighted average of domestic factor prices relative to world prices in domestic currency.

d) Export prices including agricultural export subsidies divided by import prices excluding agricultural import taxes.

e) Volumes.

f) Proportion (in per cent) of total labour (in efficiency units) shifting from one sector to another.

g) Deflated by the GDP deflator at factor cost.

h) Value-added including government.

Table 4b. **Effects on factor and product prices of complete elimination of 1979-81 levels of agricultural support in OECD countries**

Per cent changes compared with benchmark year[a]

	Australia	Canada	EC	Japan	New Zealand	United States	OECD[b]
Capital rental in agriculture[c]	1.3	-2.4	-7.3	-15.2	2.7	-1.1	-6.8
Wage rate in agriculture[c]	3.1	-3.0	-3.1	-14.7	8.3	-1.2	-3.9
land rental[c]	5.4	-18.5	-34.2	-39.4	22.2	-10.3	-19.2
Capital rental in non-agricultural sector[c]	**-0.5**	0.8	0.4	0.6	-1.8	0.2	0.4
Wage rate in non-agricultural sector[c]	-0.2	0.9	1.3	0.7	-2.2	0.2	0.7
Import prices.	-2.3	1.7	3.8	3.7	-3.4	1.1	2.6
Export prices.	1.1	1.4	1.7	1.2	5.0	0.7	1.3
Domestic food consumption prices[c]	4.5	0.6	-1.2	-1.9	7.5	0.6	-0.6

a) The benchmark year for the WALRAS model is 1980 or 1981, depending upon the countrylregion in question.
b) Total of the six countries/regions.
c) Deflated by the GDP deflator at factor cost.

Table 4c. **Effects on the rest of the world of complete elimination of 1979-81 levels of agricultural support in OECD countries**

Per cent changes compared with benchmark year[a]

	Terms of trade	Rest of the World (ROW)	
		Import volumes	Export volumes
Agriculture	0.1	0.7	4.7
Food processing	-1.7	-12.6	107.3
Other non-food industries and private services	0.6	3.1	-2.6
Total	0.6	2.2	1.4

a) The benchmark year for the WALRAS model is 1980 or 1981, depending upon the countrylregion in question.

C. Comparison with similar studies

While there is a large literature using partial- or general-equilibrium models to analyse the costs of agricultural protection, there have only been a few studies which have examined this issue within the framework of a world AGE model like WALRAS. Burniaux (1988) used the RUNS model – developed by Burniaux and Waelbroeck (1985) – to analyse the effects of the Common Agricultural Policy. The International Institute for Applied Systems Analysis (IIASA) has developed a

very ambitious **AGE** model to analyse the interactions between the developed and less-developing countries – see Fischer ***et al.*** **(1988)** for details[14].

Both the **RUNS** and **IIASA** models have been applied to assess the consequences of a multilateral reform of OECD farm-support policies[15]. However, before comparing results, it is important to note some major differences between the specifications of the three models. First, since **WALRAS** uses the PSE/CSE measures, together with instruments designed to capture the main supply controls, it is able to accommodate a much richer treatment of agricultural policies compared with the other two models which rely upon a simple nominal tariff rate as their sole policy instrument. Second, **WALRAS** is a comparative static long-run model whereas the **IIASA** and **RUNS** models are multi-period, dynamic models with a medium-run focus. Third, in both the **IIASA** and **RUNS** models, factor shifts between farm and non-farm sectors are subject to rigidities based on medium-term econometric estimates; the degree of factor immobility is significantly more constraining than those introduced in **WALRAS.** Fourth, the **IIASA** and **RUNS** models also take account of price rigidities for food products, reflecting government action in stabilising basic commodity prices. Fifth, the **IIASA** and **RUNS** models consider agricultural commodities as homogeneous whereas **WALRAS** treats them as imperfect substitutes. Sixth, neither the **IIASA** nor the **RUNS** model are based on explicit input-output tables; hence, unlike **WALRAS,** they are unable to quantify the key inter-sectoral linkages between the farm sectors and the food-processing industries. Finally, the three models apply different closure rules.

Table 5 compares the results for three key variables: world market prices, agricultural output and real income.

a) World market prices

The three models suggest that, although world prices would increase by non-negligible amounts, the increases are far less than the corresponding levels of support prior to reform – initial nominal protection ratios range from **18** per cent (coarse grains) to **197** per cent (milk) in **1978/80** and from **43** per cent (coarse grains) to **242** per cent (sugar) in **1984-86.** However, over a period of five to ten years, the **IIASA** and **RUNS** models suggest that world market reactions are likely to compensate farmers, at least partially, for the losses incurred from the removal of the support. The corresponding figures from **WALRAS** suggest that these compensations are likely to be smaller in the long run than they would be over the short to medium term, especially as far as livestock products are concerned.

b) Agricultural output

The simulated changes in agricultural output highlight the differences in the specification of agricultural supply between the models. In comparison with the

Table 5. Effects on selected variables of multilateral liberalisation of agricultural support in OECD countries: comparison between the WALRAS, IIASA and RUNS models[a]

Per cent changes

	WALRAS	RUNS	IIASA
Real income[b]			
OECD	0.9	1.6 - 2.7	0.6
EC	1.4	2.9 - 6.2	0.3
Japan	11	n.a.	11
United States	0.3	1.1 - 0.7	0.0
Canada	1.3		-0.1
New Zealand	2.7		0.0
Australia	0.8		-0.1
World agricultural prices			
Wheat	[17][c]	24	18
Coarse grains		8	11
Rice		14	21
Meats	10	21	31
Milk	14	n.a.	31
Sugar	n.a.	60	n.a.
Agricultural output			
OECD	-13.6	-4.9	n.a.
EC	-18.7	-17.8	-7.1
Japan	-24.2	-9.2	-5.2
United States	-7.0	11.0	1.8
Canada	-16.7		16.6
New Zealand	7.9		14.0
Australia	4.4		2.5

a/ The WALRAS figures refer to the long-term effects of the elimination of the 1986-88 levels of support; the RUNS results refer to the period 1983-95; and the IIASA results refer to the period 1980-2000.

b/ WALRAS and IIASA figures report household income equivalent variations; RUNS figures are GDP at market prices deflated by the consumer price index.

c/ Extrapolated from the world price change in the "other agriculture" sector, given that cereals represent one-third of the total world trade volume for "other agriculture" commodities.

IIASA model, WALRAS reports larger cuts in agricultural output in the major food-importing countries, namely Japan and the EC, but lower increases in the small food exporters, like Australia and New Zealand. This reveals how the assumed degree of supply responsiveness in non-OECD countries influences the simulated outcomes. Whereas agricultural output in the non-OECD countries is roughly

estimated to increase by almost **9** per cent in WALRAS, corresponding changes reported by the other two studies are in the **2-3** per cent range only (with the larger increases being in Latin America: **6** per cent in RUNS, almost 5 per cent in IIASA). As a consequence, in WALRAS less of the additional demand for agricultural products is directed towards more efficient food exporters within the OECD area, and the output cuts incurred by the highly protected farm sectors in Japan and the EC are larger.

The more important differences between the three models relate to the simulated outcomes in Canada and the United States. Part of the explanation for the differences reflects the fact that the RUNS and IIASA models simulate removal of support levels around **1980-83,** while the WALRAS figures refer to **1986-88** levels of support. However, using the **1979-81** figures from WALRAS only goes part of the way towards reconciling the different results from the three studies: WALRAS still indicates cuts in farm output of 7 per cent in Canada and 4 per cent in the United States, whereas the RUNS and IIASA models both predict increases. Differences in measurement of the levels of support are one important factor: namely, by not using PSEs/CSEs, the IIASA and RUNS models incorporate significantly lower measured levels of support in Canada and the United States. The WALRAS results for the United States are corroborated by the findings of three other AGE models of the U.S. economy which have focused on the issue of agricultural liberalisation, using a variety of policy instruments to characterise the policy regime[16].

c) Real incomes

Real income gains in WALRAS are in line with those from RUNS as far as food-exporting countries are concerned while they exceed significantly the IIASA figures. The IIASA model exhibits a lower overall level of factor mobility than either the WALRAS or RUNS models; hence, it shows lower efficiency gains and even a slight welfare loss in Canada. On the other hand, the small food exporters benefit from terms-of-trade improvements and increasing world demand. In the IIASA model, this latter source of welfare gains is completely offset by sharp increases in real food prices as a result of the assumed supply rigidities in the farm sectors. Hence, while household welfare is unchanged, the IIASA results show GDP increases by **1.6** and 0.3 per cent in New Zealand and Australia, respectively.

Estimates of the gains to the EC from the RUNS model are much larger than from the other models, amounting to a **6.2** per cent increase in real income after twelve years. The explanation for this result is that RUNS allows non-agricultural labour demand to vary endogenously in line with an assumed degree of real wage rigidity. As real food prices decrease with the removal of agricultural protection, so does the pressure to increase nominal wages, and the equilibrium level of

output gets closer to the transformation possibility frontier. These real wage rigidities are partial and assumed to fade out gradually in the longer run. However, the short-run gains induced by these rigidities tend to improve long-run growth as increased saving adds to the capital stock in future periods.

III. SENSITIVITY OF RESULTS TO ALTERNATIVE CHARACTERISATIONS OF AGRICULTURAL POLICIES

It is standard practice in AGE modelling to undertake sensitivity analysis in order to assess the robustness of simulation results to a variety of factors. The effects of changes in model specification and values of key exogenous parameters on the WALRAS results are discussed in detail in the paper by van der Mensbrugghe *et al.* in this volume. This section focuses specifically on the effects of changing the characterisation of agricultural policies in WALRAS.

A. "Temporary" vs. "permanent" levels of agricultural support

It is difficult to disentangle temporary influences from trend changes in farm-support policies. For this reason, three-year averages of the policy instruments were used in Section II; full details on the calculations are reported in the paper by Lienert in this volume. Nevertheless, use of a three-year average may not eliminate all "temporary" influences. In order to pin this down more precisely, simulations were run with five- and ten-year averages of the policy instruments. The results of these simulations are compared with those using the 1986-88 averages in Table 6.

The main points from this comparison are as follows. First, the broad pattern of results is very robust to the choice of period averages. All countries/regions record real income gains from multilateral liberalisation and the ranking of countries remains unchanged, whichever of the three periods is selected. Not surprisingly, the magnitude of the real income gain is somewhat smaller when the ten-year average is used; this is to be expected in the light of the upward trend in farm-support policies for most of the 1980s.

Second, the ranking of countries by output changes in the agricultural and food-processing sectors always remains the same: the largest contraction occurs in Japan, followed by the EC, Canada and the United States in that order. Use of the 1986-88 policies increases the size of agricultural gains to New Zealand as compared with Australia; with the other two periods, the increases in output in the agricultural and food-processing sectors are almost as large in Australia or even larger than in New Zealand.

Table 6. A comparison of WALRAS results using alternative averages of the policy instruments

Per cent changes compared with benchmark year

	Australia	Canada	EC	Japan	New Zealand	United States	Total OECD[a]
Real income							
1979-88	0.7	1.0	1.0	0.7	2.5	0.2	0.6
1984-88	0.7	1.3	1.1	1.0	2.6	0.3	0.8
1986-88	0.8	1.3	1.4	1.1	2.7	0.3	0.9
Terms of trade							
1979-88	3.8	-0.4	-2.3	-2.8	8.6	-0.5	-0.7
1984-88	3.8	-0.5	-2.6	-3.2	9.5	-0.6	-0.8
1986-88	4.1	-0.7	-3.0	-3.6	10.6	-0.2	-0.8
Agricultural output							
1979-88	3.3	-10.8	-15.9	-21.6	3.2	-4.6	-11.1
1984-88	3.6	-14.4	-16.7	-22.2	5.3	-6.2	-12.2
1986-88	4.4	-16.7	-18.7	-24.2	7.9	-7.0	-13.6
Food-processing output							
1979-88	14.4	1.6	-17.6	-15.1	12.7	-5.1	-11.2
1984-88	13.2	3.9	-19.4	-13.7	15.1	-5.6	-11.9
1986-88	14.6	1.0	-21.3	-13.9	18.9	-2.8	-11.9
Other non-food industries and private services output							
1979-88	-0.7	0.5	1.8	1.1	-1.0	0.3	0.9
1984-88	-0.7	0.6	1.9	1.1	-1.5	0.4	1.1
1986-88	-0.7	0.9	2.1	1.2	-2.4	0.4	1.1

a) Total of the six countries/regions.

B. PSE-based vs. budgetary-based estimates of export subsidies

The estimates of the policy instruments used in the simulations *so* far have been based on OECD data on PSEs/CSEs. The rationale for this choice is that the PSE/CSE method brings together a very wide range of direct and indirect farm-support policies into a single measure of assistance. Second, these data now play a leading role in the monitoring of agricultural policy reform in OECD countries and it is only natural to use them as the main source of information on agricultural policies for the **WALRAS** model.

Nevertheless, it is not a simple matter to adapt the PSE/CSE data to derive estimates of the policy instruments which are consistent with the structure of **WALRAS. As** Borges **(1986,** p. 28) puts it:

"Inserting a policy decision into a general equilibrium model always involves some simplification and adaptation to the structure of the model."

Sector	Canada		United States	
	PSE-based	Budget-based	PSE-based	Budget-based
Livestock	1.4	0.0	1.0	0.4
Other agriculture	4.4	5.1	3.3	4.3
Meat	9.4	0.0	27.7	2.7
Dairy	148.8	123.3	114.2	0.0
Other food	0.4	0.0	0.0	0.0

The latter result was not entirely unexpected since, as the most recent OECD monitoring report on agricultural policies points out:

"... the methods used to calculate the market price support element of the beef and milk [PSE/CSE] calculations are still the subject of study and examination" (OECD, 1989, p. 67).

In order to assess the impact of this factor, the simulation of a multilateral liberalisation of 1986-88 levels of farm-support policies was re-run, replacing the PSE-based estimates of export subsidy rates by the budget-based equivalents for all sectors and countries (see Table 7).

The first point to note is that the estimated real income gains from multilateral liberalisation are virtually identical with either set of export subsidies. A similar conclusion also holds for the pattern of sectoral outputs in the EC, Japan, Australia and New Zealand, but not for Canada or the United States. In the latter two countries, when the budget-based export subsidies are eliminated, the resulting declines in agricultural output are much smaller than when the PSE-based subsidies are removed. Output in the food-processing sector also expands strongly, especially in Canada, when the budget-based subsidies are used, whereas it declines slightly in the United States and shows only a slight increase in Canada when the PSE-based estimates are used.

Detailed investigation of these differences revealed that they are almost entirely due to the meat sector. The budget-based estimates suggest that there

Table 7. A comparison of WALRAS results using the PSE-based and budgetarybased estimates of export subsidies[a]

Per cent changes compared with benchmark year

	Australia	Canada	EC	Japan	New Zealand	United States	Total OECD[b]
Real income							
PSE-based	0.8	1.3	1.4	1.1	2.7	0.3	0.9
Budget-based	0.8	1.5	1.5	1.2	2.4	0.4	1.0
Terms of trade							
PSE-based	4.1	−0.7	−3.0	−3.6	10.6	−0.2	−0.8
Budget-based	4.0	−0.3	−2.7	−2.7	9.3	0.2	−0.7
Agricultural output							
PSE-based	4.4	−16.7	−18.7	−24.2	7.9	−7.0	−13.6
Budget-based	4.2	−7.8	−19.5	−23.7	6.7	−2.6	−11.8
Food-processing output							
PSE-based	14.6	1.0	−21.3	−13.9	18.9	−2.8	−11.9
Budget-based	21.0	12.8	−20.8	−13.5	16.6	2.2	−9.4
Other non-food industries and private services output							
PSE-based	−0.7	0.9	2.1	1.2	−2.4	0.4	1.1
Budget-based	−1.2	0.4	2.1	1.1	−2.0	0.3	1.0

a) Both simulations refer to a full multilateral elimination of all farm-support policies in 1986-88 in the six countries/regions.
b) Total of the six countries/regions.

are almost no export subsidies in North America in this sector whereas the PSE-based calculations show export subsidies of 9 and 28 per cent, respectively, in Canada and the United States. When the budget-based subsidies are used, multilateral liberalisation leads to smaller increases in U.S. and especially Canadian export prices compared with world export prices. As a result, the United States and Canada increase their world market shares in this sector at the expense of ROW and Australia. This in turn has a favourable effect on the livestock sector through the strong input-output linkages between the meat and livestock sectors.

While it is difficult to deny that the market-price support component of the PSE for beef is less than satisfactory, especially for Canada and the United States, the budget-based estimates presented here cannot be judged more satisfactory either. First, as was pointed out above, not all export subsidies are likely to be captured by this approach in the absence of a very detailed examination of each country's policies and budget documents – a task which was beyond our resources. Second, it is not satisfactory to combine the budget-based export subsidies with other instruments, such as import tariffs and production subsidies, which are based on the PSE data. Using budgetary expenditures to characterise agricultural policies is a different approach to one based on the PSEs/CSEs. In order to ensure a consistent treatment, the budgetary approach would need to be applied to *all* the instruments, not just to export subsidies alone. This would represent a vast enterprise and serious problems would still remain, e.g. how to deal with non-tariff barriers and supply controls, where the budgetary approach would capture only part of the support and in particular ignore the support paid by consumers.

The PSEs/CSEs have the twin advantages of a) covering a very wide range of agricultural policies in a comparable way; and *b)* of having achieved a wide degree of acceptability through their use in the monitoring of OECD agricultural policies. For this reason, they are the main source of data on the policy instruments used in WALRAS, supplemented by direct data on supply controls. Nevertheless, as the results in Tables 6 and 7 indicate, the appropriate characterisation of agricultural policies in the model is a delicate issue and, while this makes little difference to the estimated welfare gains, it does have a more significant impact on sectoral output responses, especially in Canada and the United States.

IV. POLICY-RELEVANT SIMULATIONS

This section presents the results of various policy-relevant scenarios, with the aim of showing how WALRAS can contribute to the debate on agricultural reform.

A. Unilateral vs. multilateral liberalisation

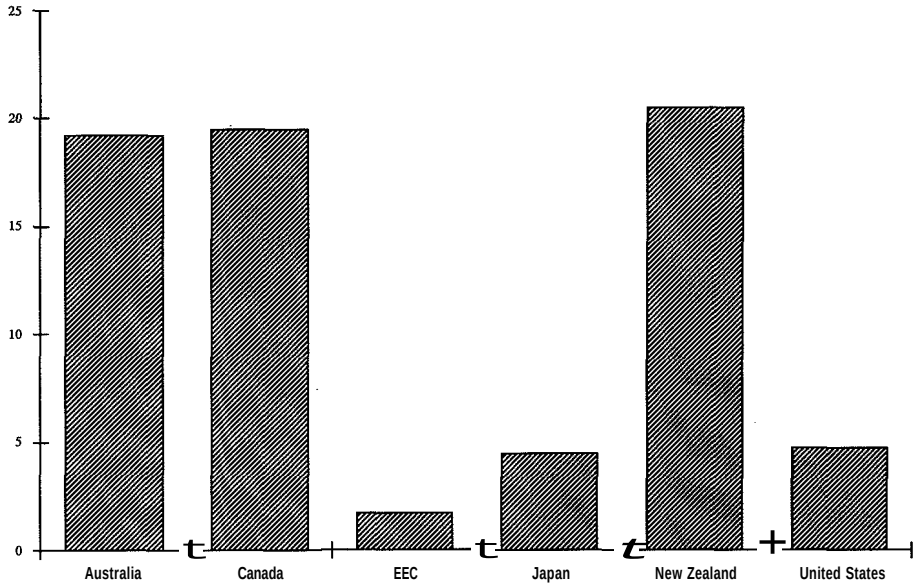
The emphasis in the two previous sections was on multilateral actions by all six countries/regions since this appears to be politically the most relevant scenario. It is of interest, however, to assess how the economy-wide effects of unilateral actions by individual countries to eliminate their agricultural support compare with the outcomes of multilateral action. In order to do this, six separate simulations were run, in which the 1986-88 levels of farm support were removed in one country at a time, while all other countries/regions maintained their existing levels of agricultural support.

The declines in output of the agriculture and food-processing sectors in North America, Japan and the EC are less under multilateral liberalisation as compared with unilateral liberalisation (Chart C), suggesting that multilateral

CHART C

Differences in output outcomes in agriculture and food processing under multilateral as compared with unilateral liberalisation of average 1986-88 support levels (1)

Differences in outcomes as per cent of benchmark year



1. The results show how the simulated change in output of agriculture and food processing differs under multilateral liberalisation as compared with unilateral action. For example. the figure of 4.5 per cent for Japan implies that the decline in output of agriculture and food processing is 4.5 per cent less when all six countries/regions liberalise together as compared with the outcome when Japan alone liberalises its agricultural support.

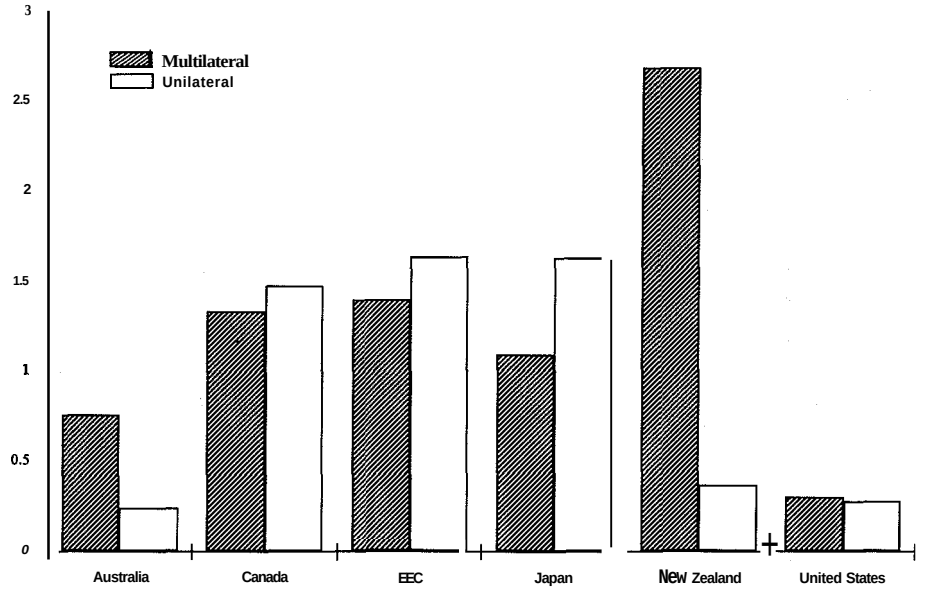
action could cushion the farm sector in OECD countries from part of the adjustment to changing world prices – a result which, as was shown in Section II.C, is borne out by other studies. This result arises from the fact that world prices rise more under multilateral liberalisation than they do under any unilateral liberalisation. Output in these two sectors in Australia and New Zealand would increase under a multilateral scenario, whereas it would contract under unilateral liberalisation.

The corollary of multilateral liberalisation serving to offset part of the contraction in the two farm sectors is somewhat lower efficiency gains in the EC, Japan, Canada and the United States. In addition, all four countries/regions suffer larger terms-of-trade losses in a multilateral scenario. As a result, their welfare gains are slightly less under a multilateral liberalisation. Chart D shows that the differences in real income gains between unilateral and multilateral liberalisation are very small in Canada, the EC and the United States. The difference is larger for

CHART D

Real income effects of unilateral and multilateral liberalisation of average 1986-88 levels of agricultural support (1)

Per cent changes compared with benchmark year



1. Equivalent variation as a percent of real disposable income.

Japan: the gain for Japanese households under a unilateral liberalisation is 1.6 per cent compared with 1.1 per cent from multilateral liberalisation. This difference is explained partly by the larger deterioration in the Japanese terms of trade under a scenario of multilateral liberalisation – with unilateral liberalisation the terms of trade deteriorate by only 1.1 per cent compared with 3.6 per cent under multilateral action. Not surprisingly, Australia and New Zealand are the main beneficiaries under a multilateral liberalisation: their welfare gains are 0.5 and 2.3 percentage points, respectively, compared with the outcomes of unilateral action. ROW also benefits from multilateral action by the OECD countries in terms of a larger terms-of-trade gain.

It is also of interest to assess which country makes the biggest single contribution to increasing welfare in the other countries by unilaterally dismantling its 1986-88 levels of agricultural support. The results suggest that unilateral action by the EC would make the biggest impact: by itself, this produces a welfare gain for the six countries/regions combined of almost 0.7 per cent. The next largest impact comes from Japan (+0.3 per cent), followed by the United States. Country size is also a key determinant of what happens to world trade volumes and prices when agricultural support is removed. The small food-exporting countries (Australia, New Zealand) and Canada have a marginal impact on world prices and trade volumes (see Chart E), except for dairy products. Most of the export losses incurred by ROW as a result of OECD agricultural support are due to policies in the major food-importing countries (Japan, EC), and in the United States via its domestic supply management policies.

In sum, these results can be seen as providing support for the view that reductions in OECD farm-support policies might be most achievable through multilateral rather than unilateral actions. Multilateral liberalisation would produce virtually the same welfare gains as unilateral liberalisation in most countries while, at the same time, it would impose smaller adjustment burdens on the farm sectors in all OECD countries.

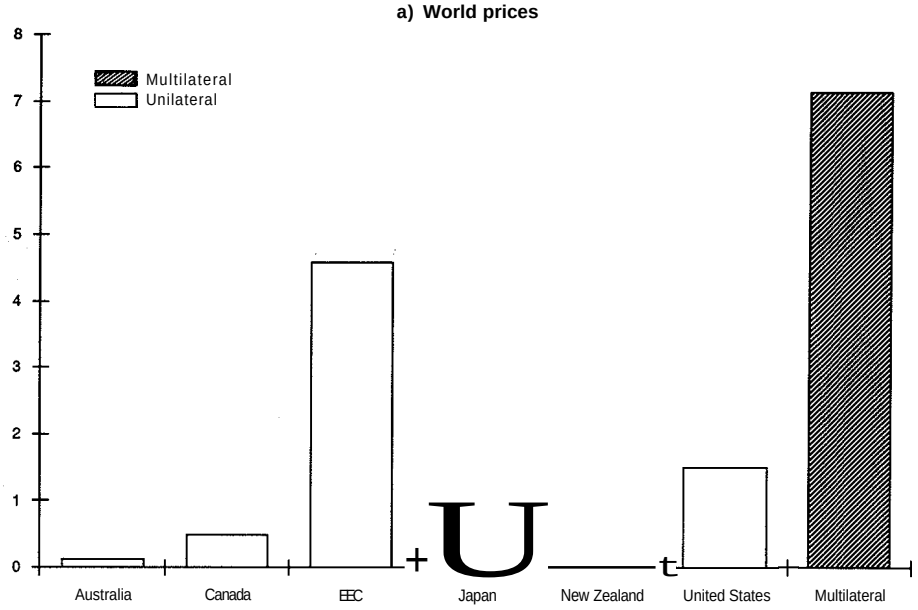
B. Sectoral liberalisation

The simulations presented *so* far have involved liberalisation of a// agricultural and food products, whether on a multilateral or a unilateral basis. It is also of interest to assess the effects of some partial actions, in which the liberalisation is confined to a single sector. This was implemented by running a series of simulations in which support in a given sector was eliminated in all countries while maintaining the 1986-88 levels of support in the other sectors. In setting up these simulations, some of the policy instruments – production subsidies, quota rents and land set-asides – had to be reallocated across sectors in order to achieve a more consistent sectoral breakdown.

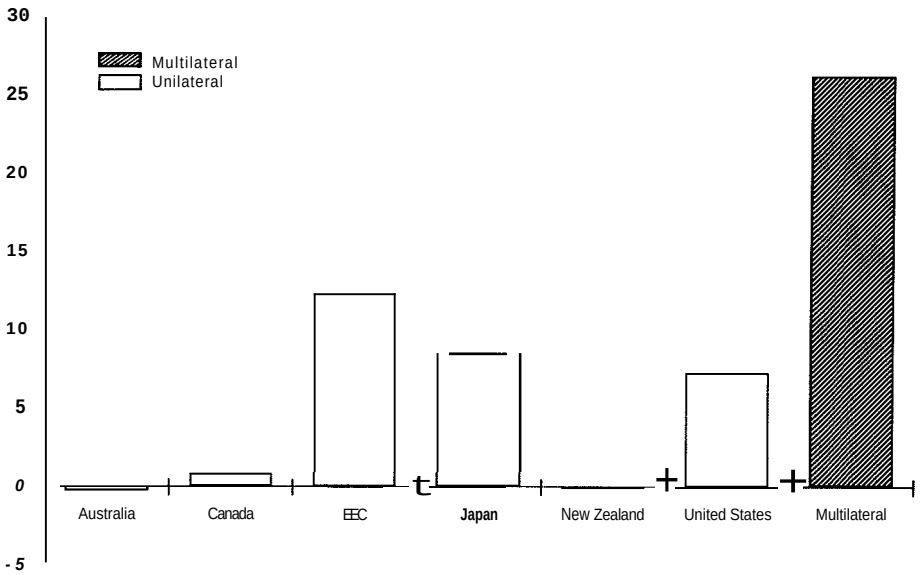
CHART E

Effects on world agricultural and food prices and trade volumes of unilateral and multilateral liberalisation of 1986-88 levels of agricultural support

a) World prices



b) World trade volumes

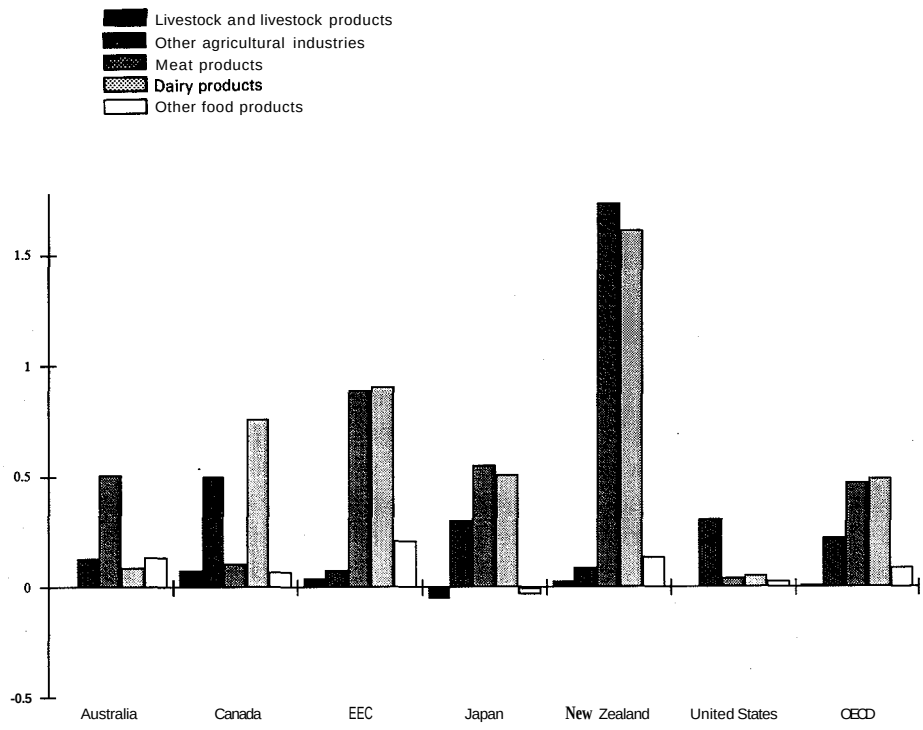


Note: For definition of world prices and trade volumes, *see* note 1 to Chart A.

CHART F

Effects on real income of multilateral liberalisation by sector (1)

Per cent changes compared with benchmark year



1. The figures refer to the results of five separate simulations in which the 1986-88 levels of agricultural support in a given sector were eliminated in all six countries/regions, while support in the other sectors was maintained unchanged.

Chart F shows that liberalising support in the meat and dairy sectors would have produced the largest welfare gains for all countries/regions except the United States: each of these sectoral liberalisations would have added 0.5 per cent to household real income for the total of the six countries/regions[17]. Japan, New Zealand and the EC would benefit most from eliminating farm supports in these two sectors. Canada would gain almost 0.8 per cent in real income from multilateral liberalisation in the dairy sector but only 0.1 per cent from liberalisation in meat products. On the other hand, the main gains to Australia would come from multilateral elimination of support in meat products. Liberalisation in the other agricultural sector would also add 0.2 per cent to household real income in the six countries/regions. Canada and the United States, and to a lesser extent

Japan, would be the main beneficiaries from elimination of all farm-support policies in this sector.

The differences in the distribution of welfare gains from liberalisation in various sectors suggest that more progress could be made in pursuing agricultural reform with a multisectoral approach than if each sector were to be considered separately in multilateral negotiations. In this way, a larger constituency of countries with a shared interest in reform can be created.

C. Supply control measures

In recent years, there has been increasing use of supply management as a policy instrument for curbing imbalances and capping budgetary expenditures. Such measures include quotas on production, restrictions on inputs such as land, and incentives to encourage diversion away from commodities in excess supply to other products. They have become most prominent in the dairy sector in the EC and Canada, and in cereals in the United States.

But supply controls, whatever their short-term value in curbing excess production, may prove extremely costly in the long run. They give rise to rents, which tend to get capitalised into the price of land or the value of the quota if it is tradeable. The producers who get the rents from such controls have strong incentives to lobby for their continuation.

In the light of these considerations, it is important to assess the effects of an expansion of such policies, in particular a combination of land set-asides and production quotas, which seems a realistic option. In setting up such a scenario, an attempt was made to design it to be in line with actual policy decisions or options which are under discussion in the EC and the United States[18].

In February 1988, the EC agreed to introduce a ***land set-aside*** programme which is compulsory for Member States but optional for producers. Under the scheme, a producer must set aside at least 20 per cent of arable land for five or more years in return for a per hectare payment. Estimates suggest that this could lead to eventual reductions ranging from 2 to 12 million hectares before the end of the century. Taking an average estimate of 6 million hectares, this represents 4.7 per cent of actual cropland acreage in the Community. When this estimate was adjusted for the below-average productivity of idled land using the U.S. adjustment factor (see the paper by Lienert in this volume), and assuming it applies to both farm sectors, this gave a **3.3** per cent reduction in total effective EC acreage which was applied as part of the shock to the model.

In addition, it was assumed that sector-specific ***supply controls,*** combined with the above-mentioned land set-asides, will be needed to curb output of cereals and oilseeds below the Maximum Guaranteed Quantities (MGQ) which have been decided through 1995 as part of the stabiliser concept. These controls

correspond to a cut of 4.6 per cent in the output of the other agriculture sector. These output quotas are binding in the model only if the land set-asides do not succeed in stabilising output supplies. No additional supply cuts were simulated in the livestock and dairy sectors since medium-term forecasts (OECD, 1989) indicate that imbalances between supply and demand are unlikely to grow in these sectors if current policies are unchanged.

For the United States, further ***acreage reductions*** were decided in 1987. These are likely to depend mainly on further participation in the Conservation Reserve Program (CRP) launched in 1986. Nearly 23 million acres were included in the CRP in 1987 and the upper limit of the program has been set at 45 million acres. This implies a further cut of 22 million acres to be achieved through 1990, which represents 6.7 per cent of the actual total acreage. After an adjustment for the below-average productivity of this land, this amounts to a cut of 2.5 per cent in the total agricultural land supply[19].

The simulation results in Table 8 show what would have occurred if these additional supply controls were applied on top of the 1986-88 levels of farm support (including supply controls). It should be emphasised that these extra supply controls are very moderate relative to those already in place. The results suggest that such an extension of supply controls would cut agricultural output in both the EC and the United States by 2.2 and 1.2 per cent, respectively. There would also be slight declines in the output of the food-processing sector. The counterpart to these cuts in agricultural production in the EC and the United States would be a slight expansion in agricultural output in other exporting countries, such as Canada, Australia, New Zealand and ROW. There would be

Table 8. Effects from an extension of supply controls in the EC and the United States[a]

Per cent changes compared with benchmark year

	Australia	Canada	EC	Japan	New Zealand	United States	OECD[b]
Real agricultural incomes[c]	1.2	1.6	−0.2	**0.0**	1.4	0.1	0.1
Real non-agricultural incomes[c]	**−0.1**	−0.1	−0.0	**−0.0**	−0.3	−0.0	**−0.0**
Domestic food prices	0.2	0.3	**0.5**	−0.1	0.1	**0.5**	0.4
output							
Agriculture	0.3	0.5	−2.2	0.1	0.4	−1.2	−1.3
Food processing and beverages	0.5	0.4	−0.1	0.1	0.7	−0.2	−0.1
Other non-food industries and private services	−0.1	−0.1	0.1	0.1	−0.1	0.0	0.1

a) The additional supply controls are applied on top of the 1986-88 levels of agricultural support in these countries/regions. See the text for details of how these additional supply controls were implemented.
b) Total of the six countries/regions.
c) Factor incomes plus quota rents deflated by the GDP deflator at factor cost.

almost no impact on Japan, given that its system of agricultural support effectively insulates its domestic farm sector from world market prices. The impact of these additional supply controls on household welfare (not shown) would be negligible in all countries/regions.

While real agricultural incomes in both the EC and the United States show little change, this masks a shift within the farming sector. For the EC, the production quota in the grain and oilseed sectors creates rents. The real value of the quota amounts to 3.4 per cent of total agricultural value added – and 4 per cent of the value of other agriculture production – at the expense of real returns for capital and labour which decrease by 3.3 and 4.7 per cent, respectively. The rents also tend to get capitalised into land prices, which rise in both the EC and the United States by almost 1 and 4 per cent, respectively. This would once again make it difficult politically to reverse course as landowners and quota holders would seek to protect these gains.

D. Shifting the composition of agricultural assistance away from border measures to deficiency payments

The scenario of a multilateral removal of recent levels of OECD agricultural support revealed that while all countries would reap welfare gains, there would be significant declines in agricultural output compared with the benchmark year in the major OECD countries, ranging from 7 per cent in the United States to 24 per cent in Japan. Declines in agricultural production on such a scale and the associated cuts in farm incomes call into question the political feasibility of such a reform. Indeed, policy discussion has focused on ways to reduce the economic costs of current policies, while still providing some underpinning of incomes for those now engaged in agriculture. Hence, it is important to quantify the costs and benefits of alternative policy reforms.

Some commentators have argued for shifting the composition of farm support away from border measures towards deficiency payments to farmers. It is claimed that such a shift could be less costly to the economy. The underlying logic is most clearly demonstrated by comparing an output subsidy – deficiency payments are treated as an output subsidy in WALRAS – with an import tariff that induces the same expansion in domestic output. While an output subsidy will involve a social cost by driving a wedge between the price paid to producers and the world price, it will not, unlike the tariff, involve an additional cost to consumers in terms of higher prices for the goods they consume.

In order to quantify some of these costs, the model was simulated, assuming that the 1986-88 budgetary costs of farm support were maintained in all countries/regions but a// trade measures (import tariffs and export subsidies) were replaced by output subsidies. Output subsidies in the two farm sectors are

Table 9. Economywide and sectoral effects from a shift of 1986-88 levels of agricultural support in OECD countries away from border measures to output subsidies

Per cent changes compared with benchmark year

	Australia	Canada	EC	Japan	New Zealand	United States	OECD[a]
Household real income	0.5	0.8	1.3	1.2	2.0	0.0	0.8
Terms of trade[b]	3.4	−0.3	−2.3	−3.0	9.6	−0.2	−0.6
Consumer prices[c]	−0.7	−1.3	−1.2	−2.2	−3.2	−0.1	−0.9
Domestic food prices[c]	2.8	−3.1	−5.9	−6.2	2.9	−1.0	−4.2
Real agricultural incomes[d]	15.1	2.6	−20.9	−31.9	37.3	−1.2	−13.1
Output							
Agriculture	7.4	−0.6	−14.3	−23.2	10.6	−2.2	−9.0
Food processing and beverages	15.8	3.7	−18.7	−13.8	21.5	−2.4	−10.4
Non-food industries and private services	−1.1	−0.3	1.8	1.1	−3.1	0.1	0.8

a) Total of the six countries/regions.
b) Export prices including agricultural export subsidies divided by import prices excluding agricultural import taxes.
c) Deflated by the GDP deflator at factor cost.
d) Factor incomes including quota rents deflated by the GDP deflator at factor Cost.

endogenised in this simulation in order to maintain the real agricultural budget at its base level. This implies that the effective level of support provided to farmers has been lowered in some countries even though the magnitude of the government budget commitment to support agriculture remains unchanged".

The results in Table 9 suggest that such a shift in the policy mix would produce welfare gains for consumers in most countries/regions. At the same time, it would yield a different pattern of sectoral gains and losses. In particular, a comparison of Tables 3a and 9 shows that the simulated shift to deficiency payments would yield much smaller declines in agricultural output and in farm incomes in Canada and the United States, whereas there would be little change in the EC and Japan.

In North America, levels of support differ widely across agricultural products. This is not the case in the food-importing countries/regions, like the EC and Japan, where variable levies and high tariff rates are applied fairly evenly across almost all agricultural products. In the EC and Japan, a shift towards deficiency payments means effectively switching their protection from highly competitive world markets to less elastic domestic farm-gate markets[2]. The simulation results suggest that increased deficiency payments would prove to be ineffective in avoiding large reductions in agricultural output and farm incomes in both the EC and Japan.

In Canada, where border protection is concentrated in the dairy sector, the policy shift allows the other agriculture and meat sectors to expand as the dairy sector contracts. In the United States, a similar resource transfer takes place from livestock towards crops production. In both cases, the policy shift effectively switches budgetary transfers and factors towards more world-market-oriented sectors and total agricultural output is only marginally affected. The corollary of this is that the welfare gains are significantly lower **(0.8** per cent instead of 1.3 per cent for Canada, zero instead of 0.3 per cent in the United States).

This scenario illustrates how a major shift in the composition of agricultural policies away from border measures to deficiency payments, keeping fixed the budgetary costs of agricultural support, could generate non-negligible global welfare gains. In addition, this policy-mix scenario indicates one possible approach to agricultural reform, combining agricultural trade liberalisation with more balanced and politically-acceptable income redistribution in the agricultural sector in some countries. However, before embarking on such a course, due weight would have to be given to the costs of continuing with large budgetary transfers to farmers.

V. SUMMARY AND CONCLUSIONS

While any AGE estimates of the economy-wide effects of agricultural support are subject to some uncertainty, simulation results with the OECD's WALRAS model suggest that existing levels of agricultural assistance in OECD countries are costly, both to the OECD countries themselves and to many non-OECD countries too. These costs arise because agricultural assistance:

- wastes resources by over-expanding output in the agricultural and food-processing sectors at the expense of other industries and services;
- tends to push up land rents, which then get capitalised into higher land prices;
- increases food prices to OECD consumers;
- tends to widen the dispersion of wedges between domestic and world prices for many agricultural and food items:
- worsens the terms of trade for many food-exporting countries.

The WALRAS results suggest that the average **1986-88** levels of agricultural support could have cost the six OECD countries/regions as a whole almost 1 per cent in lower real household income ($72 billion in **1988** prices and exchange rates), with even greater relative losses in Canada, the EC, Japan and New Zealand. This waste of resources has also to be judged against the small share of agriculture and food processing in most economies: their combined value

added accounts for about **6** per cent of total **OECD** GDP. One way of summarising these economy-wide costs of farm-support policies is to express them in terms of an indicator such as **''**dollars per job saved in agriculture and food processing**''**. Such costs are significant: they range from **$13** 000 (at **1988** prices and exchange rates) in Japan, $20 000 in the **EC** and the United States, to almost $100 000 in Canada. Hence, the economic returns from reforming present policies are potentially large. While the farming sector gains from agricultural support at the expense of capital and labour employed in industry and services, most of these gains accrue as rents to landowners.

However, while the non-agricultural sectors in many **OECD** countries would benefit from agricultural liberalisation, the farm sector would be worse off in North America, Japan and the **EC,** where support has been greatest. In spite of rising world prices for agricultural goods when all farm-support policies are removed, agricultural incomes are simulated to fall in these **OECD** countries/regions. Agricultural sectors would expand and farm incomes rise in Australia, New Zealand and the rest of the world.

Levels of agricultural support in **1979-8**1 were estimated to have cost these six countries/regions on average **0.6** per cent in lower real household income. Thus, the expansion in farm support between **1979-8**1 and **1986-88** cost the six countries/regions one-third of a percentage point or $24 billion (at **1988** prices and exchange rates) in real household income.

A comparison **of** these WALRAS results with those from two other world AGE models shows a reasonable concordance between them once account is taken of differences in time horizons between the models – WALRAS focuses on the long-run effects – and the way in which agricultural policies are modelled. Sensitivity analysis with the characterisation of agricultural policies in WALRAS indicates that the estimated welfare gains are very robust. But the magnitudes of the intersectoral effects, especially in Canada and the United States, are more sensitive to how agricultural policies are incorporated in WALRAS, even though the country rankings remain unchanged.

A simulation suggests that, if the average level of a// border measures in **1986-88** were removed and the same levels of budgetary support given to farmers via direct payments, such a shift in the composition of farm-support policies could yield gains to consumers – the estimate for the six countries/regions as a whole is **0.8** per cent of their real income – while at the same time cushioning the impact on the farm sector in some, but not all, countries. However, a full assessment of such a policy switch would have to take account of the costs arising from continuing with large budgetary transfers to farmers.

Supply controls are seen in certain quarters as an important element in any reform of agricultural policies and they have been more widely used in recent years, especially in Europe and North America. In order to quantify the costs and benefits of such policies, the model was simulated for a hypothetical expansion of

land set-aside policies and production quotas in both the EC and the United States, over and above those supply controls already in place in 1986-88. The results suggest that an expansion of supply controls, operational problems aside, could cut back supply imbalances. But the simulation also highlights the fact that supply controls create rents within the agricultural sector itself which tend to be capitalised into higher land prices and/or the market value of the quotas. This would create vested interests in the maintenance of such controls once in place, thereby making it more difficult to remove them.

Simulations comparing the benefits from unilateral liberalisation with those flowing from multilateral liberalisation show that both scenarios produce very similar welfare gains for almost all OECD countries/regions. But multilateral liberalisation would impose a smaller adjustment burden on farm sectors. Simulations were also run in which liberalisation was confined to one sector at a time in all countries. These results suggested that the reform process would be strengthened if it were undertaken on a multilateral, multisectoral basis.

It is often argued that real income losses along the lines cited in this paper are not waste. Rather they represent the price which OECD countries are willing to pay for achieving via existing agricultural policies a range of "non-economic" objectives such as the preservation of rural communities, ensuring a fair standard of living for the agricultural community, security of food supplies and *so* on. While it is not the purpose of this paper to assess these arguments, which are dealt with in the paper by Winters in this volume, the estimates presented here suggest that a high price is being paid for such "non-economic" objectives. There may also be adverse demonstration effects from providing such large transfers to a single, rather small, sector, notably in terms of encouraging similar pressures for assistance from other declining sectors.

NOTES

1. See OECD (1989) for a detailed discussion of recent trends in agricultural assistance.
2. There have been many partial equilibrium studies of the impact of farm-support policies on agricultural output, trade and welfare. See Winters (1987) for a comprehensive survey of this literature.
3. See Borges (1986) for a thorough survey of the utility of AGE models for determining the long-run effects of changes in trade or taxation policy.
4. This result follows directly from the well-known Rybczynski theorem of pure trade theory.
5. Full details on the country-specific data sources together with the various adjustments made to ensure consistency in the WALRAS data base, are described in Burniaux *et* a/. (1988), Annex II.
6. Employment in WALRAS is measured in terms of efficiency units for reasons which are explained in Burniaux *et* a/. (1988). This measure gives a much lower employment share for agriculture and food processing than one based on numbers of people employed in each sector.
7. The "real exchange rate" in WALRAS is defined as the weighted sum of domestic primary factor prices divided by the average of all world prices expressed in domestic currency. The terms of trade are defined as the ratio of average export prices (including export subsidies) to average import prices (excluding tariffs), as seen from the perspective of the home country. The terms of trade are directly related to the real exchange rate. See the paper by Burniaux *et* a/. in this volume for a discussion of the relationship between these two concepts.
8. The benchmark data year is 1980 or 1981 and the policies refer to actual 1986-88 support levels. This merging of two sets of data referring to different periods introduces a technical inconsistency. The ideal procedure would be to have a fully consistent data set for the benchmark year. Unfortunately, more up-to-date input-output tables which are the essential data source for this work, are not available yet for all six countries/regions so this solution was ruled out. In any event, the procedure we have adopted is common practice in AGE modelling. Since the structure of most OECD economies changes slowly over time, the degree of bias in the simulation results should be relatively small.
9. A reasonable criterion for "unanticipated temporary policies" is that they be announced after a crop season is terminated. On this basis, the Special Canadian Grains Program could be removed from support levels in 1986 and 1987. It could be argued, however, that some element of the 1987 support was anticipated by farmers in the light of the special payments made for the 1986 crop. If payments under this scheme are excluded in both years, the estimated production subsidy for the other agricultural sector in Canada declines from 23.8 to 20.8 per cent. When this estimate was used in another simulation of the removal of the 1986-88 levels of agricultural protection, the resulting per cent changes in sectoral outputs (compared with benchmark) in Canada were:

Agriculture	– 14.6
Food processing	**1.5**
Other industries and private services	0.7

This change had almost no effect on the magnitude of the welfare gain.

10. While Canadian exports of dairy products are eliminated, this is more than offset by gains in world export shares for other food products and especially for meat products.

11. See Jeon and von Furstenberg **(1986)** for a comprehensive and up-to-date review of this literature.

12. Food-importing developing countries and the East European bloc might well suffer welfare losses from OECD liberalisation. On the other hand, liberalisation of agriculture in the developing countries themselves might well have more favourable effects on their welfare. For some scenarios to this effect, see World Bank **(1986)** and Tyers and Anderson **(1986).**

13. The estimate of **$20 400** for the United States can be compared with a similar estimate of **$17** 000 (in **1982** dollars) derived from an AGE model developed by the U.S. Department of Agriculture. See Kilkenny and Robinson **(1989).** Hertel et al. **(1989)** report another U.S. estimate of **$28 700** (in **1987** dollars) per farm job saved.

14. Frohberg **(1989)** reports results of a simulation of multilateral liberalisation of agricultural protection by the OECD countries using the IIASA model.

15. The Australian Centre for International Economics (CIE) has recently completed a project in which it brought together general equilibrium modellers from various countries to assess the economy-wide effects of farm-support policies. Unlike the IIASA, RUNS or WALRAS models, no attempt was made to standardise the country models nor was any account taken of international linkages. For a summary of the main results of this project, see CIE **(1988);** the individual country studies are published in Stoeckel et a/. **(1989).**

16. See Hertel et a/. **(1989).** Robinson *er* a/. **(1989)** and Kilkenny and Robinson **(1989).**

17. Because WALRAS is a non-linear model, the sum of real income gains for each country/region over the separate sectoral liberalisations is not identical to the real income gain from a complete multilateral liberalisation of agricultural support in a// sectors simultaneously – as is reported in Table **3a.**

18. No additional supply controls were applied in the other countries. The Japanese rice land diversion programme only serves to shift land from rice production to other activities within the other agriculture sector in the model. Similarly, it did not appear appropriate to assume that further major changes would be made in Canadian milk quotas.

19. Since the land included in the CRP is low quality, a productivity weight of 0.5 was applied instead of the factor of **0.72** used for the standard set-aside scheme. When one allows for the weight of cropland in total US agricultural land use (0.74), this gives a cut of **2.5** per cent.

20. The agricultural budget in Japan is mainly financed by tariff revenues while export subsidies are negligible. To make up for the loss of these revenues when tariffs are eliminated, an arbitrary offset of about **$2.3** billion was added to the agricultural budget in Japan.

21. Assuming equivalent protection across all agricultural products, a switch towards deficiency payments implies shifting protection from transformed products to raw material sectors which are characterised by a lower level of both tradability and consumer demand elasticity.

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