QUANTIFYING AGRICULTURAL POLICIES IN THE WALRAS MODEL

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INTRODUCTION

Agricultural policies in OECD countries are very complex'. They comprise a mixture of price-support policies, and direct or indirect income payments to farmers. For some commodities, there are quantitative controls on output; land set-asides are also used in some countries in an attempt to limit surplus production. Trade barriers are often necessary to support the domestic measures. The balance of these policies varies widely across the six countries/regions that have been selected for the WALRAS project. The objective of this paper is to describe **how** these complex agricultural policy regimes have been integrated into the WALRAS model which is described elsewhere in this volume.

The structure of the paper is as follows. Section I outlines the various policy instruments used in the WALRAS model and discusses how OECD data on Producer Subsidy Equivalents (PSEs) and Consumer Subsidy Equivalents (CSEs) were adapted to derive various price wedges, including those between domestic and world prices. Section II outlines the main features of agricultural policy support, as measured by the instruments used in the WALRAS model (an annex provides country-specific details for each of the six countries/regions). Section III describes how the policy instruments are integrated into the WALRAS model, where world prices for agricultural commodities are endogenous. The final section presents some concluding remarks.

I. POLICY INSTRUMENTS FOR THE WALRAS MODEL

A. Relationship between the PSEs/CSEs and the policy instruments

The estimates of PSEs, calculated by the OECD Directorate for Food, Agriculture and Fisheries, cover support to the producers of thirteen temperate-zone commodities[2], and distinguish the following policies[3]:

- market-price support
- direct payments
- reduction in input costs

- general services and other expenditures
- sub-national expenditures.

In the WALRAS model, pre- and post-tax *cum* subsidy prices are distinguished for import prices, export prices, domestic producer prices and consumer prices. It is therefore appropriate to convert the PSEs into tax or subsidy equivalents, and apply them to either trade prices, or to domestic producer prices. Of the above policies, market-price support is transformed into a set of import taxes and export subsidies, whereas all remaining policies are modelled as production subsidies.

The market-price support element in the PSEs is usually based on a comparison between a domestic support price and an appropriately measured world market price, usually inclusive of the estimated transportation costs to the country in question. Tariff- and subsidy-equivalents can readily be derived from these data, and these price wedges have been modelled in WALRAS as ***import taxes*** and ***export subsidies.*** The differentials between world and domestic prices include the effects of quantitative import restrictions (QRs) or voluntary export restraint agreements (VERs). However, the ***ad valorem*** import taxes in WALRAS do not distinguish between these non-tariff barriers and tariffs, and it is assumed that domestic governments receive the economic rents from QRs and VERs.

In an applied general equilibrium (AGE) framework, it is also necessary to incorporate the implicit income flows associated with domestic ***quantitative restrictions,*** such as land set-asides and milk production quotas which have become increasingly prevalent in the 1980s. Details of how such policies are included in the WALRAS model are presented below. In all cases, it is assumed that domestic governments receive the economic rents from quotas on domestic output.

All non-price support identified in PSEs has been modelled as a ***production subsidy.*** Much of this support boosts farmers' incomes directly (e.g. deficiency payments, disaster relief, marketing aids) although some are tied to specific inputs (e.g. fuel or fertiliser subsidies). The common feature of all of these policies is that they stimulate agricultural production. If these policies were to be removed, agricultural production would decrease and equilibrium producer prices would rise. In the model, these subsidies are applied equally over all primary and intermediate inputs of production.

The PSEs do not distinguish between price and non-price support for sub-national expenditures; the latter are quantitatively important in Australia and Canada. Similarly, there is no disaggregation of EC Member countries' expenditures on agricultural support. All such expenditures have been treated as income support, and are modelled as a production subsidy.

Consumers generally bear a large part of the burden of supporting agriculture through paying higher prices than otherwise would be the case. This phenomenon

is captured in the CSE estimates, which correspond to the implicit tax on consumption resulting from market-price support to producers, offset by any direct subsidies on consumption. To the extent that specific aids to consumers have been identified in the CSEs, these are treated in the WALRAS model as a ***consumer subsidy*** – introducing a wedge between pre- and post-subsidy ***consumer*** prices, as distinct from ***producer*** prices, where the production subsidies are applied.

B. Correspondence between the commodity classification of the PSEs and the sectoral disaggregation in WALRAS

A first step in converting the PSEs into policy instruments for use in the model is to identify the correspondence between the thirteen commodities covered by the PSEs and the five-industry disaggregation of the agricultural and food-processing sectors in WALRAS. This is shown in Table 1.

The income associated with all ***production subsidies*** is assumed to be received by producers in the "livestock" and "other agriculture" sectors – the two farm sectors of the WALRAS model. Part of the non-price support component of the PSEs, which has been classified as a production subsidy in these two sectors, may be received by processors rather than producers (e.g. by abattoirs, milk processing plants) but, in the interests of simplicity, it is assumed that such transfers are negligible. In some instances the transfer to processors has been explicitly excluded from the PSE.

Since international trade in livestock and unprocessed milk is negligible, the ***import taxes*** and ***export subsidies*** for meat and milk products are applied to the WALRAS sectors "meat products" and "dairy products". The import taxes and export subsidies of the "other agriculture" sector relate mainly to price support of wheat, corn, barley and rice. All non-price support for sugar is treated as an output subsidy in the "other agriculture" sector, whereas all price support for sugar is treated as a tariff or export subsidy in the "other food" sector.

C. Adjustments to the PSEs

For ***production subsidies,*** the value of non-price support for a given commodity in a particular year is deflated by changes in the value of production (inclusive of the non-price support) from the benchmark year of the WALRAS model – which is 1980 for the EC and Japan, and 1981 for the other countries. These deflated values are then aggregated into either the "livestock" or the "other agriculture" sectors, according to the classification of Table 1. Finally, the total for a given WALRAS sector is divided by the value of the benchmark gross output (inclusive of the non-price support) obtained from input-output tables,

PSE commodity	Countries for which PSE is measured	WALRAS model sector for applying: Production subsidies	WALRAS model sector for applying: Import taxes, export subsidies and consumer subsidies
Wheat	All countries	Other agriculture	Other agriculture
Coarse grains			
Cornlmaize	Canada, EC, United States		
Barley	All, except New Zealand and United States		
Oats	Australia, New Zealand		
Sorghum	United States		
Rice	Australia, EC, Japan, United States		
Soyabeans	EC, Japan, United States		
Other oilseeds	Canada, EC		
Sugar	All, except New Zealand		Other food
Milk	All countries	Livestock	Milk products
Beef and veal	All countries		Meat products
Pigmeat	All countries		
Poultry	All countries		
Sheepmeat	Australia, EC, New Zealand, United States		
Wool	Australia, New Zealand, United States		Livestock (and livestock products)
Eggs	All countries		

thereby giving an average rate of production subsidy weighted by the benchmark product shares[4].

In measuring ***import taxes*** and ***export subsidies,*** the essential element to isolate in the PSEs is the extent to which domestic prices, p^d, exceed world prices, p^w. The PSE price-support component, PSE^P, has usually been calculated by multiplying the price gap by production, Q, of the commodity in question:

$$PSE^P = (p^d - p^w) * Q$$

Even if the price-support component of the PSE is not measured directly by a price comparison (e.g. for U.S. export subsidies, budgetary expenditure on the Export Enhancement Program has been used), it always represents the wedge between domestic and world prices. Thus, using domestic producer prices and production for each commodity, as recorded in the PSEs, it is possible to calculate the implicit world price confronting the country in question. It is equal to the domestic producer price less price support per unit of output:

$$p^w = p^d - (PSE^P/Q)$$

The tariff-equivalent is the extent by which domestic prices exceed world prices. In percentage form, this is given by:

$$[(p^d/p^w) - 1] * 700 = [(PSE^P/Q)/p^w] * 700$$

This procedure can be applied satisfactorily for an individual commodity. When it comes to aggregating over several commodities, there is a choice of aggregation procedures, just as there is in calculating measures of average tariffs. The "ideal" solution would be to aggregate using free trade weights, but this is impossible. In empirical studies in the tariff literature, the usual approach is to use either trade weights or production weights – both procedures are arbitrary. The former are used here. For import taxes (export subsidies), the tariff-equivalents have been weighted by the share of imports (exports) in the corresponding year, using OECD ***Foreign Trade Statistics.***

A disadvantage with this method is that the weighted tariff-equivalent depends on recorded trade of the commodities in question, whose trade patterns are often distorted by quantitative restrictions. Rice in Japan is one example, as imports are virtually prohibited.

Since PSEs are only calculated for a selected number of commodities, it is necessary to make assumptions concerning commodities not covered by the PSE analysis. In the case of ***meat products,*** the commodities for which PSEs have been estimated are assumed to be representative of protection of the entire sector, since the excluded items (sheepmeat for some countries, offal meat, etc.) are likely to be protected as well, given substitution possibilities in consumption. Moreover, the excluded items only account for a small share of production. A similar assumption is made for ***dairy products,*** where exceptionally, the WALRAS

model estimates do not use the current OECD PSE data[5]. Dairy products such as butter, cheese or skimmed milk powder are currently excluded from the PSE analysis, where the emphasis is on transfers to dairy farmers. In contrast, in the WALRAS model, the main focus is on how policies affect domestic production ***and*** trade flows. It is therefore essential to base the domestic/world price comparison on the main traded dairy products, rather than on unprocessed milk, which is not traded internationally. It is assumed that the trade-weighted tariff-equivalents of these three products are representative of all traded dairy products[6].

The ***other agriculture*** sector includes commodities which are relatively unprotected in most countries (e.g. fruit, vegetables, cotton, nuts). Wool and eggs are the only two commodities included in the PSE analysis which are allocated to the ***livestock*** sector. Similarly, sugar accounts for only a very small portion of traded food products included in the ***other*** food sector. It is therefore inappropriate to assume that the weighted average of covered PSEs is representative of these three WALRAS sectors. For these sectors, the average domestic/world price gap for covered commodities has been scaled down by the share of the value of these commodities' imports (or exports, in the case of export subsidies) in total imports (exports) of the sector. Thus, it is implicitly assumed that commodities which belong to these three sectors, but are not covered by PSEs, have zero protection. In some cases this assumption is incorrect; examples are the seasonal quantitative restrictions on apples imported into the EC or high tariffs on citrus fruits in Japan. The calculated tariff-equivalents for these three sectors are therefore almost certainly underestimated.

Consumer subsidies have been identified in current-price terms from the CSE data. For a given commodity, these values have been deflated by increases in consumption since the benchmark year. Food consumption in WALRAS is disaggregated into four different categories (cereals, meat, milk products and "other food"), and the deflated food subsidies are expressed as a percentage of the appropriate category of food purchased from the corresponding production sector.

D. A caveat on the use of PSE-based instruments

As discussed in the paper by Cahill and Legg in this volume, the market-price support component of the PSE is based on the concept of a wedge between the domestic producer price and a chosen reference price, which represents the world price. It follows that the calculated import taxes and export subsidies do not necessarily match the tariff revenues or expenditures on export subsidies reported in the different national budgets. Hence, in some cases, use of the PSE data lead us to impute import taxes and export subsidies in WALRAS which have no budgetary counterparts in reality.

This problem seems particularly acute for meat and dairy products in Canada and the United States. The PSE/CSE estimates are regularly updated and their calculations are always subject to reappraisal in the light of experience and discussions among the member countries. It appears that the market-price support components of these estimates for beef and milk are candidates for revision and this issue is under review at the moment.

E. Supply controls

In the case of the U.S. ***land set-aside policy,*** the amount of land withdrawn from production has been included directly in the policy simulations. In simulations of the removal of agricultural policies, it is assumed that the rural land endowment is increased, permitting an increment to agricultural production which partly offsets the fall in farm output due to the removal of price and income support. The U.S. country note describes how an adjustment has been made for productivity differentials between idled and retained land (see Annex).

The Paddy Field Reorientation Programme in Japan is not a set-aside scheme: it simply encourages the diversion of land away from rice production towards production of other cereals. Both rice and cereals are included in the "other agriculture" sector in WALRAS.

To incorporate the effects of ***milk quotas*** in the EC, and ***output quotas*** for Canadian milk, poultrymeat and egg production, quotas in the livestock sector are included. Empirical studies, to the extent that they are available, were used to derive the share of the annual quota rent in the domestic producer price of each commodity. These wedges give the difference between the marginal cost of production and the producer price. Country-specific details of the values of quota rents, which have increased in relative importance in Canada during the 1980s, are given in the Annex.

To integrate these wedges into the model, production quotas are treated like a fourth factor of livestock production, with an initial price equal to the quota rent that raises equilibrium producer prices above those determined by marginal costs alone. Unlike the other primary factors – land, labour and capital – the quotas do not affect production quantities directly. In simulations of the removal of supply-management policies, when quota rents are eliminated, farm incomes are simulated to decline. Agricultural output is only affected indirectly through the induced changes in demand in response to changes in relative food prices.

F. "Permanent" versus "temporary" support to agriculture

Support to agriculture, as measured by the PSEs/CSEs, rose dramatically in most OECD countries from 1979 to 1986 before falling back slightly since then.

Some of this increase may have reflected essentially temporary support to producers. If such support was also perceived by farmers as being temporary, it could be argued that it should not be included for the purposes of this exercise.

Given the long-term orientation of the WALRAS model, only "permanent" levels of support (i.e. levels that are expected to persist) should be taken into account since only such aids would be expected to have an impact on the "normal" or equilibrium level of agricultural production. Temporary aids to producers, following this line of argument, would be expected to have little or no effect on normal output levels; instead producers would view them as essentially windfall gains.

However, the issue of "permanent" versus "temporary" supports is not as clear-cut as it might seem. First, and foremost, there is the question of the impact of any support on current and future production decisions. Unless farmers believe that the support is truly temporary, they have a clear incentive to expand production. What is important is the credibility of the government commitment that the support will not be extended beyond a certain time. Second, some "temporary" schemes remain in operation for several years, thereby adding to expectations of continued support. Finally, it is extremely difficult to examine each country's farm-support policies in detail, trying to separate the various components into "permanent" and "temporary" categories.

For the WALRAS model it was concluded that there are no objective criteria for classifying policies in this way across the six countries/regions included in the model. Instead, three-year averages of the policy instruments were used in simulation rather than relying on data for single years. In this way, it was hoped to minimise the effects of temporary fluctuations in support corresponding to transitory shocks. The results of some sensitivity analysis with longer averages of the policy instruments are reported in the paper by Martin et *al.* in this volume.

II. MAIN FEATURES OF THE ESTIMATED POLICY INSTRUMENTS

Using the principles described in the previous section, estimates of the policy instruments for **1979-81** and **1986-88** for all countries and regions are given in Tables 2 and 3 (further details are given in the **Annex**)[7]. Production subsidies in **1986-88** were highest in Canada, a country where income support is high relative to trade protection. In **1986** and **1987,** existing generous support programmes were supplemented by a Special Grains Programme. In Canada agricultural production is more concentrated in commodities covered by the PSE analysis, so that production subsidies may tend to be overestimated relative to other countries[8].

Table 2. Estimates of policy instruments, 1979-81

Per cent

A. PRICE WEDGES[a]

Sector	Australia				Canada								
	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Subsidy on consumption: Intermediate[b]	Subsidy on consumption: Food
livestock	0.0	0.1	7.5	0.0	2.1	1.5	10.3	0.0	0.1	1.4	6.6	0.0	0.0
Other agriculture	0.0	0.2	4.1	0.0	0.1	−0.3	8.4	0.0	5.5	13.1	2.2	0.6	0.0
Meat products	0.0	0.0	0.0	0.0	30.4	12.1	0.0	0.0	60.3	37.5	0.0	0.0	0.0
Dairy products	18.3	22.0	0.0	0.0	99.9	118.4	0.0	0.0	147.6	132.2	0.0	3.7	1.9
Other food	0.0	−2.6	0.0	0.0	1.3	0.2	0.0	0.0	5.9	12.4	0.0	0.0	0.0

Sector	Japan				New Zealand				United States				
	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Stock-building policies[c]	Subsidy on food consumption
livestock	0.7	0.1	8.5	0.0	0.0	0.1	12.0[d]	0.0	3.2	1.3	4.0	0.0	0.0
Other agriculture	5.8	92.2	13.2	0.7	−0.9	−0.0	0.0[d]	0.0	0.0	0.0	3.3	0.3	0.7
Meat products	86.4	33.5	0.0	0.0	31.1	0.8	0.0	0.0	34.9	11.8	0.0	0.0	0.6
Dairy products	128.2	141.3	0.0	1.5	0.0	0.0	0.0	9.3	97.1	90.2	0.0	0.0	2.8
Other food	18.8	1.2	0.0	−0.6	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0	0.0

B. SUPPLY CONTROLS

	Land set-aside[e]	Milk quotas[f]	
	United States	EC	Canada
livestock	1.2	0.0	6.7
Other agriculture	1.2	0.0	0.0

a This part of the table has been prepared using estimates of producer and consumer subsidy equivalents (PSE/CSEs), which are summarised in Part IV of OECD 11989). The import taxes and export subsidies have been derived from the price-support components of PSEs: the percentage by which domestic producer prices exceed world prices. Subsidies to production are mainly direct budget transfers to producers, as a percentage of gross output in each of the two agricultural producing sectors. Subsidies to consumers are government budget payments to consumers, expressed as a percentage of consumer expenditure on the appropriate food category (cereals, meat, dairy products, etc.). All estimates relate to the simple average of 1979, 1980 and 1981.

b/ Reflects compensatory aids to food processors.

c/ Policies which encourage stockbuilding include storage payments. interest rate subsidies and setting the loan rate above market prices; the payment-in-kind programme liquidates government stocks, and is included as negative stockbuilding.

d/ The input subsidies to crops are applied to the "livestock" sector in the New Zealand case, since all farming is included in the underlying database of "livestock".

e/ The per cent by which the quantity of effective land acreage would increase if 1979-81 commodity programmes were to be eliminated.

f/ The per cent by which producer prices are raised due to quota rents accruing to milk producers (EC) or to milk, poultrymeat and egg producers (Canada).

Table 3. **Estimates of policy instruments, 1986-88**

Per cent

A. PRICE WEDGES[a]

Sector	Australia				Canada				EC				
	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Subsidy on consumption	
												Intermediate[b]	Food
Livestock	0.0	0.0	7.4	0.0	3.2	1.4	13.5	0.0	0.1	2.3	5.9	0.0	0.0
Other agriculture	0.2	0.2	7.7	0.0	0.3	4.4	23.8	0.0	7.5	35.7	1.4	0.7	0.0
Meat products	0.0	0.0	0.0	0.0	31.5	9.4	0.0	0.0	88.6	67.0	0.0	0.0	0.0
Dairy products	47.3	46.7	0.0	0.0	159.7	148.8	0.0	0.0	159.5	131.7	0.0	2.8	1.9
Other food	0.0	4.8	0.0	0.0	1.7	0.4	0.0	0.0	25.0	32.6	0.0	0.0	0.0

Sector									*United States*				
	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production subsidy	Stock-building policies[c]	Subsidy on food consumption
Livestock	0.4	0.1	6.1	0.0	0.2	0.0	9.9[d]	0.0	1.5	1.0	6.7	0.0	2.2
Other agriculture	23.7	0.6	7.1	1.0	0.0	0.0	0.0[d]	0.0	0.1	3.3	12.5	1.8	1.6
Meat products	102.5	66.1	0.0	0.0	7.0	0.1	0.0	0.0	27.8	27.7	0.0	0.0	0.9
Dairy products	258.2	241.5	0.0	0.7	0.0	0.0	0.0	0.0	78.4	114.2	0.0	0.0	6.2
Other food	16.7	0.2	0.0	-0.6	0.0	0.0	0.0	0.0	13.7	0.0	0.0	0.0	0.0

B. SUPPLY CONTROLS

	Land set-aside[e]	Milk quotas[f]	
	United States	EC	Canada
Livestock	9.8	2.0	10.8
Other agriculture	9.8	0.0	0.0

a/ This part of the table has been prepared using estimates of producer and consumer subsidy equivalents (PSE/CSEs), which are summarised in Part IV of OECD (1989). The import taxes and export subsidies have been derived from the price-support components of PSEs: the percentage by which domestic producer prices exceed world prices. Subsidies to production are mainly direct budget transfers to producers, as a percentage of gross output in each of the two agricultural producing sectors. Subsidies to consumers are government budget payments to consumers, expressed as a percentage of consumer expenditure on the appropriate food category (cereals, meat, dairy products, etc.). All estimates relate to the simple average of 1986, 1987 and 1988.

b/ Reflects compensatory aids to food processors.

c/ Policies which encourage stockbuilding include storage payments, interest rate subsidies and setting the loan rate above market prices; the payment-in-kind programme liquidates government stocks, and is included as negative stockbuilding.

d/ The input subsidies to crops are applied to the "livestock" sector in the New Zealand case, since all farming is included in the underlying database of "livestock".

e/ The per cent by which the quantity of effective land acreage would increase if 1986-88 commodity programmes were to be eliminated.

f/ The per cent by which producer prices are raised due to quota rents accruing to milk producers (EC) or to milk, poultrymeat and egg producers (Canada).

For some sectors such as meat and dairy products, the import taxes and export subsidies are very large, and have tended to rise in the **1980s** in many countries. Since **1986,** the tariff equivalents for dairy products have fallen, as the introduction of EC milk quotas and the drought in North America resulted in large rises in world prices of traded dairy products in **1988.**

In order to appreciate the potential significance of these price wedges, one needs information on the relative size of the sectors in question. Benchmark data on the output and foreign trade shares of the two farm sectors and the three food-processing industries in the six countries/regions are presented in Table 4. This shows that the dairy products sector, which has the highest tariff equivalents, accounts for only 1 per cent or less of total gross output, except in New Zealand. Thus, although the tariff-equivalents for dairy products are very high, these may be applied to small underlying values. For example, the EC has a

Table 4. Structure of agriculture and food-processing sectors[a]

Per cent

	Australia	Canada	EC	Japan	New Zealand	United States
Share of gross output						
Livestock	2.3	1.8	2.1	0.6	8.1	1.5
Other agriculture	2.2	2.3	2.0	1.6	1.0	2.0
Meat products	2.4	1.5	1.8	0.5	5.0	1.1
Dairy products	0.9	0.8	1.0	0.3	2.6	0.6
Other food products	2.9	2.6	3.5	3.1	2.6	2.5
Share of exports						
Livestock	6.8	0.8	0.2	0.0	1.8	0.2
Other agriculture	9.1	5.1	1.4	0.1	0.9	9.9
Meat products	8.3	0.9	1.6	0.0	20.7	1.0
Dairy products	1.4	0.4	2.2	0.1	10.8	0.3
Other food products	6.9	2.9	2.9	1.0	3.5	3.1
Share of imports						
livestock	0.0	0.4	0.9	0.5	0.2	0.2
Other agriculture	0.8	1.1	1.0	6.1	1.0	0.9
Meat products	0.1	0.5	1.1	1.5	0.5	0.9
Dairy products	0.2	0.2	0.2	0.2	0.1	0.2
Other food oroducts	2.2	2.5	3.2	3.1	2.3	2.6

a) This table shows the shares of the WALRAS model sectors 1, 2, 4, 5 and 6. "Other agriculture" generally includes all grains, cotton, sugar, tobacco, fruit and vegetables; New Zealand is an exception: because of the prevalance of mixed farming, grains are included with "livestock". The data relate to either 1980 or 1981.

Source: National input-output tables. See Burniaux *et al.* (1988), Annex II for details.

160 per cent import tariff for dairy products in 1986-88, but imports of dairy products are only 0.2 per cent of total imports in the benchmark data. The contribution of "dairy products" to total import taxes is only 7 per cent, whereas the "other agriculture", "meat products" and "other food" sectors each contribute around 30 per cent to the total of all import tax revenues.

The relative weights of border measures and production subsidies in the total level of farm support vary across the countries/regions in the model. In Australia, Canada, New Zealand and the United States, direct and indirect income protection accounts for the vast bulk of farm support. Therefore, for these four countries non-price support has played a key role in giving incentives to producers to expand agricultural output and exports. Table 5 shows how the share of production subsidies has increased in three of these countries during the 1980s. The table disguises the very marked increase in the level of such subsidies in North

Table 5. Shares of trade measures and domestic policies

Percentage of all policy instruments"

		Trade measures		Domestic policies	
		Total[b]	*of which:* import taxes	Total[c]	*of which:* production subsidies
Australia	1979-81	5.6	1.6	94.4	94.4
	1986-88	21.4	2.1	78.6	78.6
Canada	1979-81	20.7	7.4	79.3	79.3
	1986-88	14.5	3.9	85.5	85.5
EC	1979-81	54.1	18.6	45.9	38.5
	1986-88	68.9	25.2	31.1	25.7
Japan	1979-81	33.7	30.9	66.3[d]	65.7
	1986-88	56.6	55.1	43.4[d]	42.5
New Zealand	1979-81	3.9	1.6	96.1	89.4
	1986-88	1.0	0.7	99.0	99.0
United States	1979-81	19.6	11.8	80.4	72.3
	1986-88	14.2	6.0	85.8	79.7
Total of above	1979-81	40.0	18.6	60.0	54.3
	1986-88	42.1	19.3	57.9	53.3

a) The total of policy shocks emanating from import taxes, export subsidies, input subsidies, stock changing policies and consumption subsidies. This is equal to the estimated price wedges from Tables 2 and 3 multiplied by the levels of imports, exports, gross output and consumption from the WALRAS data base.
b) The total of import taxes and export subsidies.
c) The total of input subsidies and consumption subsidies, except in the United States, where domestic policies resulting in changes in stocks are also included. The U.S. land set-aside is excluded, as this is not modelled as a price wedge.
d) Includes an excise tax on the consumption of sugar.

America, especially for the "other agriculture" sector, which is dominated by deficiency payments to grain producers and, for **1988,** by large drought relief payments.

In Japan and the EC, on the other hand, border measures – import tariffs and export subsidies – are important: these two countries accounted for **84** per cent of the total value of trade measures in all the modelled countries in **1986-88.** As a proportion of total support, border measures in Japan and the EC accounted for 55 and **68** per cent, respectively, of the total policy support to agriculture. Both countries have been able to reduce the share of non-price support during the **1980s** because of the increasing importance of import levies or, in the case of the EC, increases in export subsidies and in co-responsibility levies imposed on farmers.

In sum, although trade support has become relatively more important in the EC and Japan, this has been offset by sharp increases in direct income payments in North America. As a consequence, the share of trade measures in total support for all six countries/regions has remained broadly constant in the **1980s,** at around **40** per cent.

III. INTEGRATING THE POLICY INSTRUMENTS INTO A WORLD MODEL

Agricultural policy instruments in the previous single-country version of WALRAS were all modelled as constant ad *valorem* price wedges. This is no longer suitable in the present model in which all countries are linked together through trade flows. The WALRAS model assesses how countries would adjust, given their actual protection, when agricultural distortions are removed in one or more countries.

When world prices change, some countries adjust their protection *so* as to keep their internal agricultural prices constant. In this case, domestic agricultural supply no longer reacts to world market signals and budgetary expenditures on agriculture usually bear the main brunt of maintaining the gap between domestic and world prices. The variable import levies and export subsidies in the European Community are classic examples of such systems. Similar insulation of domestic from world prices is achieved by Japanese agricultural protection, and by the use of target prices for determining deficiency payments in the United States.

In order to deal with this, three variable policy instruments were introduced into the model as follows:

- ***Variable import tariffs*** for insulated markets (Japan, EC) as well as quotas which maintain imports at zero or negligible levels (dairy products

in Canada and the United States). The tariff (t_m) is adjusted so that domestic demand does not respond to a change in the world price (p_w):

$\hat{t}_m = -\hat{P}_W$

(where " ^ " stands for a proportional rate of change)

Increasing (decreasing) world prices, therefore, lead to a fall (rise) in import tariffs.

- Variable export subsidies (s_e) for insulated markets (Japan, EC) are specified in such a way that export demand no longer reacts to a change in the average world price[9]:

  $\hat{s}_e = -\hat{P}_W$

  When they are implemented together, both variable import tariffs and export subsidies tend to make domestic output and producer prices insensitive to any changes in world market prices.

- Deficiency payments aim to fill the gap between a given target price and the market-clearing price (or the loan rate in the United States). When world prices change, domestic target prices in the United States do not adjust, as these are fixed ex ante in line with non-market considerations or the evolution of domestic costs. Hence, they have been treated as a variable input subsidy, which moves in line with changes in the world price. This assumption is only appropriate for a large country like the United States, whose domestic price has a strong influence on the world price[10].

In the simulations reported by Martin et al., these modelling changes play no role in simulations of full multilateral removal of agricultural policies in OECD countries. They do, however, come into action in unilateral simulations, or partial liberalisation experiments such as changing the composition of agricultural protection away from trade distortions and towards domestic income support.

IV. CONCLUDING REMARKS

This paper has derived a set of policy instruments to incorporate in an applied general equilibrium model developed at OECD for studying the economy-wide and intersectoral consequences of reforming agricultural policies. The manner in which a diverse set of agricultural policies has been treated has necessarily involved elements of judgement.

First, it has been assumed that all policies have equal weight when it comes to their impact on trade and production. In particular, non-price policies, which

range from those with immediate impact on farm income, to those such as government expenditure on research and development whose long-term production effect is uncertain, have been aggregated together. An alternative approach would have been to disaggregate these policies, giving them unequal weights according to the economic effects associated with them. But such an approach would have introduced a high degree of subjectivity in the estimates.

Second, four major price wedges have been derived. Additional price wedges could have been identified, especially those relating to non-price support. In principle it would have possible to distinguish between general output subsidies and those specific to particular inputs such as capital, land, fuels and fertilisers. Such a disaggregation could be expected to make some difference in simulation results for factor mixes, factor prices and sectoral outputs. In particular, an agricultural input subsidy would have a greater impact on long-run output and exports than would an equal-PSE output subsidy, provided the subsidised input substitutes for agricultural land[11]. Global results for real income and trade volumes are likely to be affected to a lesser extent.

Third, tax instruments could, in principle, be developed in greater detail'[2]. Tax concessions in OECD countries are accorded on agricultural incomes, farm real estate, and farm input purchases. However, neither the underlying databases derived from input-output tables[13], nor the key data inputs for the policy instruments – the PSEs/CSEs – provide coverage of all tax concessions.

Finally, alternative methods and measurement of the supply control instruments could be derived. For example, in order to incorporate the effects of land set-asides in the United States, an alternative to deriving the percentage decline in productivity-adjusted land quantities would be to introduce a "virtual tax" on market prices in order to achieve the desired reduction in output[14]. Other authors, however, have pointed to the need for specifying a policy instrument relating to land quantities rather than prices, and emphasised the necessity to endogenise farmers' decisions to participate in the voluntary set-aside[15].

The policy instruments estimated in this paper are tailor-made for the WALRAS model. Few of the variants outlined above could be introduced into the model in its present state, and these may not make a major difference to the simulation results, which are importantly influenced by the trade price wedges. It is considered that the present set of policy instruments adequately summarise actual agricultural policies in OECD countries, thereby allowing the effects of a major reduction in agricultural assistance to be studied. More sophisticated policy instruments could only be integrated into a model with substantial specification changes. Finally, in a multi-country model like WALRAS, one of the greatest constraints in quantifying policies is obtaining quality data for all countries/regions; future work will continue to be hampered by data shortages or inconsistencies.

NOTES

1. For details, see the country studies accompanying OECD (1987). More recent agricultural policy developments are discussed in detail in OECD (1988) and OECD (1989).
2. See Table 1 for a listing of the thirteen commodities. PSEs are calculated for a given commodity only if its production exceeds 1 per cent of total agricultural output.
3. See the paper by Cahill and Legg in this volume for a full discussion of the PSE/CSE concepts and how they are measured.
4. Let NPS_{it} denote the nominal value of the non-price support to commodity i in a given year t and V_{it} and V_{i0} be market values (inclusive of non-price support) of the production of commodity i in year t and in the benchmark year, respectively. The weighted average subsidy rate S^* is given as a weighted sum of the deflated values devoted to the sector-specific non-price support, such that:

$$S^* = \frac{\sum_i NPS_{it} * (V_{i0}/V_{it})}{\sum_i V_{i0}}$$

After a little rearrangement, this is equivalent to weighting the sector-specific subsidy rates in the current year S_{it} by the benchmark sector shares:

$$S^* = \sum_i S_{it} * V_{i0}/\sum_i V_{i0}$$

5. Milk PSEs are now based on the difference between the New Zealand farm-gate producer price (adjusted for milk-fat content and transportation costs) and the corresponding farm-gate price in the country in question. In OECD (1987), milk PSEs were based on price comparisons for selected dairy products.
6. Using domestic/world price comparisons for traded dairy products represents a return to the method of measuring price support to dairy farmers which was used in OECD PSE calculations prior to 1988.
7. The policy instruments for 1982-85 have also been calculated and are available ftom OECD on request.
8. This is particularly the case for the "other agriculture" sector which is an aggregate of major grains and other commodities such as minor grains (e.g. oats and barley), and fruits and vegetables. All of the latter commodities are assumed to have zero protection.
9. The aim is to simulate the effects of EC export restitutions, the levels of which are calculated in such a way that EC exports are competitive on export markets.
10. Production subsidies in Canada are modelled as a constant price wedge because domestic producer prices are revised frequently in line with previous trends in world market prices.

11. See Hertel (1989).
12. Hertel, Chattin and Tsigas (1989) incorporate a set of estimates of taxes on labour, capital and land services for twelve different farm sectors.
13. The input-output tables of Australia and Canada are the only ones which can provide tax matrices on all intersectoral transactions.
14. This approach has been employed by Hertel and Tsigas (1989).
15. Kilkenny and Robinson (1988) conclude that "the ad *valorem* modelling approach is often not a good substitute for the explicit modelling of agricultural programs. .... land in crop production should be modelled endogenously". Incorporating the explicit modelling of land set-aside participation led Whalley and Wigle (1988) to conclude that the set-aside features of commodity programmes in the United States more than offset production incentives associated with high target prices.

Annex

AGRICULTURAL POLICY INSTRUMENTS BY COUNTRY

This Annex describes for each country the estimates of the policy instruments which are shown in Tables 2 and 3 of the main text. The following notes do not attempt to provide a comprehensive description of agricultural policies in each country – this has been done elsewhere'. Rather, they seek to indicate the major agricultural support measures which are incorporated in each of the policy instruments for the purposes of the WALRAS model.

AUSTRALIA

A. Production subsidies

Income support – which is virtually entirely indirect – represents 80 per cent of all agricultural subsidies in Australia. Various State expenditures constitute the largest component. Federal items of non-price support include assistance for research and development, inspection services, disease control, and rural adjustment. In the 1980s, the diesel tax exemption became increasingly important. In contrast, other tax concessions have fallen sharply, and interest rate concessions and the fertiliser subsidy were phased out completely by 1986.

For livestock, transfers to cattle and sheep farmers account for three quarters of total support. For other agriculture, there was an exceptional A$220 million deficiency payment to wheat growers relating to the 1986/87 growing season, when world prices were exceptionally low. Deficiency payments in Australia are made only if the current season's price falls below the Guaranteed Minimum Price which is based on a fixed percentage of world prices averaged over recent years.

B. Import taxes and export subsidies

There is no direct price support for many commodities, and even for protected products such as milk, sugar and eggs, support has been cut in the 1980s. The discriminatory pricing schemes for rice and sugar are captured in the trade price wedges of the other agriculture and other food sectors respectively. The price support received by sugar millers is excluded from the calculations. In the early 1980s, the obligation to sell sugar to domestic consumers at prices below world levels acted as a tax on exports. For dairy products, Australia has complicated pricing arrangements for industrial and fluid milk. There are levies on milk production and on domestic sales of dairy products, export returns are pooled, and production quotas are established by individual States. The tariff-equivalents for the sector are based on the difference between average export returns for selected dairy products and the average domestic value for levy purposes.

A. Production subsidies

Canada has a large number of direct and indirect income supports to the agricultural sector. For ***livestock,*** around two-thirds of non-price support is composed of the various provincial programmes. Other important items of non-price support include inspection services (not covered by user fees), research and advisory services, and the rebate of excise and sales taxes on fuels. Tax expenditures are excluded from the PSEs in the case of Canada. Deficiency payments, which are relatively unimportant, are paid to dairy farmers. In-quota levies paid by producers of industrial milk cover the cost of subsidising exports of skimmed milk powder.

Policies directed to grain producers in the Prairie provinces are incorporated in the production subsidies of the ***other agriculture*** sector, and include reduced freight rates and the Western Grain Income Stabilization scheme, which is financed jointly by the Federal Government and farmers. Crop insurance and drought relief payments have also been large in some years. In addition to this protection, the Special Canadian Grains Program was introduced for the **1986** and **1987** seasons to cushion farmers' incomes from low world grain prices.

B. Import taxes and export subsidies

The small tariff-equivalent for ***livestock*** is due to the domestic price for eggs being higher than the U.S. price. The import tax for ***other agriculture*** is the weighted average of the tariff-equivalent of wheat, the actual tariff on imported corn, and the assumed zero tariff-equivalents on all other commodities of the sector. Canada has no explicit export subsidies for grains. However, the two-price system for wheat, which is triggered when world prices fall below government-set minima, acts as an export subsidy. Also, the Federal Government meets deficits of the Canadian Wheat Board (CWB) should the world price fall below the guaranteed minimum price for grains: the writing down of the CWB pool deficit for barley acted as an export subsidy in **1985** and **1986.**

Price support for the ***dairy*** sector is based on a comparison between the domestic prices of butter, cheese and skimmed milk powder and the corresponding world price. Transport costs are excluded since Canada is self-sufficient in milk. For ***meat products,*** the import taxes and export subsidies are weighted averages of the tariff-equivalents for beef and poultry, and the zero tariff on pigmeat. Beef price support is measured by a comparison between the domestic beef price and the common world reference price used for all countries' PSEs (the New Zealand export price). This procedure tends to overestimate the protection given by VERs permissible under the Meat Import Law. For poultry, the tariff-equivalent is based on a comparison with domestic chicken and turkey prices in the United States.

C. Supply controls

Canadian supply-management policies have been in place since the early 1970s, and failure to include the impact of output quotas applicable to milk, poultrymeat and eggs, would lead to an overestimate of the fall in livestock production when protection is removed. If milk and poultry quotas had not been implemented, production would have been considerably higher, given that annual total factor productivity growth is around 2½ per cent[2].

In order to incorporate supply controls in the analysis, the gaps between market prices and the marginal costs for these products have been identified. There are a large number of empirical

studies which analyse the impact of supply-managed commodities, but few give direct estimates of the divergence between marginal costs and producer prices which is attributable to quotas[3]. Indirect methods which estimate the size of quota rents show wide variations. The increase in the prices of traded milk quotas in the 1980s was taken into account in the estimates used in the simulations[4]. For 1979-81, the milk quota rent is assumed to be 15½ per cent, and for 1986-88, the following quota rents are assumed: milk, 23½ per cent; poultrymeat, 22 per cent; eggs, 28 per cent. Quota rents for the three products are weighted by the share of their production – around 45 per cent – in total livestock production.

EUROPEAN COMMUNITY

There are two important components of agricultural support in the European Community (EC)[5]. First, at the level of the EC as a whole, the Common Agricultural Policy (CAP) provides fixed guaranteed prices on commodities sold through intervention, at levels considerably above world prices. The second component is national government expenditure on agriculture. In contrast to the CAP, most of the latter is devoted to structural measures, including rural development and farm modernisation; interest rate subsidies; research; advisory services; early retirement allowances; incentives for young farmers; natural disaster relief and marketing aids. Social security expenditure benefiting farmers and tax expenditures in Member countries, which are both important indirect sources of farm income, have not been included in the PSEs.

A. Production subsidies

All Member government expenditures have been allocated to production subsidies, which is by far the largest component of this item. For livestock, producer levies paid by dairy farmers are included as negative income support. Similarly, in the other agriculture sector, the co-responsibility levies on grain and sugar producers are deducted from other non-price support. In contrast, direct aid to small producers, aimed to offset the impact of the co-responsibility levies, adds to the production subsidy, as do deficiency payments which are paid to soyabean producers only.

B. Import taxes and export subsidies

For the import tax of the other agriculture sector, the tariff-equivalents for wheat, coarse grains and rice are weighted by their share of sector imports, which include many duty-free items such as cereal substitutes (soya, manioc, etc.) as well as fruit and vegetables. The tariff-equivalents for these products, when weighted by export values, give an export subsidy which is much larger than the import tax, due especially to large net exports of wheat and barley.

For meat, variable import levies bring world market prices up to domestic levels. Domestic/foreign price differentials are largest for sheepmeat, where producers have a choice between intervention measures or a variable slaughter subsidy. Beef prices were nearly twice the level of world prices in 1986-88; this tariff-equivalent contributes around half the weight of both the import tax and export subsidy of the sector. Protection is much lower for pork and poultrymeat. The trade taxes and export subsidies on dairy products capture import levies, quantitative restrictions and subsidised butter sales to non-EC countries. The increasing protection of sugar, which is both imported and exported from the EC, is the only component of the tax/subsidy of the other food sector.

C. Consumption subsidies

Around two-thirds of consumption subsidies are price-compensation aids paid to producers of animal feed who are reimbursed for purchasing grains and skimmed milk powder at prices above world levels. These subsidies are applied at the level of intermediate consumption in the WALRAS model. The remaining consumption subsidies are various schemes which subsidise milk to final consumers.

D. Supply controls

Quotas were first placed on milk production in 1984. Member countries are given the choice between applying them either at the level of the farm or dairy co-operative. Trading or leasing of quotas is quite recent, and quota markets are as yet rather thin. Moreover, trading across borders is illegal. It is possible to deduce annual quota rents from traded quota values in selected EC countries, but these give a very wide range of estimates: from 10 to 45 per cent of the milk producer price. Estimates in the upper range are inconsistent with the long-term supply elasticity in the WALRAS model: it would be unreasonable to expect a simulated supply shift of over 100 per cent for a quota system that has only been binding for a few years.

Given the high level of uncertainty associated with the milk quota rent, the estimate introduced in WALRAS is based on two different methods. the first calculation is based on the production impact of the quotas since 1984 and the long-term supply elasticity of the WALRAS livestock sector. Assuming an annual total factor productivity gain of around 2 per cent[6], production in 1906-08 in the absence of quotas would have been some 16 per cent higher than the recorded output. Using the long-term supply elasticity of 3.5, the quota rent is the long run is estimated as 4.5 per cent of the milk price. The second method assumes a quota rent for milk of 30 per cent[7]; adjusting the rent for the WALRAS long-run supply elasticity in livestock yields an estimate of around 6 per cent. Averaging and weighting the two different estimates by the share of milk in total livestock production (36 per cent) gives an estimate for the rent of 2 per cent.

JAPAN

A. Production subsidies

In Japan, around half of agricultural support in the 1980s was accounted for by general policies which are treated as a production subsidy. These policies include infrastructure expenditures on irrigation, drainage, reclaiming land and consolidating farms, actual expenditure on interest-rate subsidies for the various infrastructure schemes[8] and marketing, promotion, research and extension expenditures. Municipal policies such as construction of livestock facilities, improved technology, promotion of production of feed crops, and guidance for effective farm management are excluded from the PSEs. Similarly, there has been no attempt to include tax expenditures.

For ***livestock,*** the deficiency payments for dairy farmers are included. The expenditure on the Paddy Field Re-orientation Programme is included in the production subsidy for ***other agriculture.*** The implicit deficiency payments to rice and other grain producers – the government purchase price exceeds the consumer price – are included as part of the production subsidy.

B. Import taxes and export subsidies

Most of the border support is modelled as a tax on imports. Nearly all grains are imported by the State Monopoly, and the import prohibition on rice leads to a prohibitive tariff being placed on this commodity. No attempt has been made to increase rice's contributions to the import tax of the ***other agriculture*** sector, which has large contributions from wheat, barley and soyabeans. Since there are differential pricing policies for imported grains sold to farmers and those bought by other consumers, separate tariff-equivalents have been identified for sub-categories of wheat and barley imports.

The gap between the Japanese domestic wholesale price of butter, cheese and skimmed milk powder, and the average import prices of these products, has been used to derive the weighted average tariff-equivalent of the ***dairy products*** sector. There are strict price controls for the three ***meat products,*** beef, pork and poultry meat, covered in the PSE analysis. In the case of beef, quantitative import restrictions were very severe for most of the 1980s but are now being phased out. Since Japanese agricultural exports are extremely small, the value of export subsidies associated with the large tariff-equivalents is also small.

C. Consumer subsidies

The expenditure on the School Lunch Scheme, which provides subsidised rice and milk to school children, is applied directly as a subsidy on consumer expenditures on "cereals" and "dairy products", respectively. Excise taxes on sugar result in a negative subsidy to the ***other food*** sector.

NEW ZEALAND

A. Production subsidies

In line with a major policy shift in New Zealand in the mid-1980s, which resulted in the withdrawal of nearly all government support to agriculture, the average production subsidy fell from a maximum of 25 per cent in 1983 to 5½ per cent in 1988. The 1986 PSE is heavily dominated by the exceptional write-off in 1987 of the deficit of the sheepmeat income stabilisation account debt and the interest concession on this debt, which was built up during 1983-85. For our purposes, the write-off has been allocated evenly over the five years of deficit (1982-86). It is modelled as a production subsidy, although it could arguably be considered to be a disguised export subsidy.

Apart from the sheepmeat debt write-off, average 1986-88 policy support also includes indirect income support such as interest rate subsidies, reductions in input costs, tax expenditures, and services to agriculture. Since ***other agriculture*** cannot be identified in the underlying data-base, all input subsidies are included under ***livestock.***

B. Import taxes and export subsidies

Price support is minimal, being confined to import protection of pork, poultrymeat and eggs. For ***meat products,*** the prohibitive tariff on poultry receives zero weight in the sector's average import tax. There is no trade protection of the ***dairy products*** sector, and it is for this reason that the New Zealand export price is used in other countries' price comparisons.

C. Consumer subsidies

The consumer subsidy on fluid milk, which exceeded 1 per cent of government consumption expenditure in 1979, was phased out by 1986.

UNITED STATES

A. Production subsidies

The large deficiency payments to grain producers, especially since 1984, are major components of the production subsidy of the other agriculture sector. For livestock. a major portion of the production subsidy is accounted for by general policies such as research and advisory expenditures by the United States Department of Agriculture and other agencies, soil conservation and irrigation programmes, interest-rate concessions, fuel tax concessions and other tax expenditures. State expenditures, which are mostly for market promotion, extension and regulatory activities, are also included. There are no deficiency payments in this sector except for wool. Milk producers pay various levies, the most important being those imposed when the Commodity Credit Corporations' (CCC) purchases exceed pre-determined levels. These are recorded as negative expenditures in both the PSEs and in the production subsidy of the livestock sector.

B. Stockbuilding policies

Part of non-price support is directed towards the accumulation of stocks by the *CCC.* These include storage payments, interest concessions on loans given by the CCC, and the setting of the loan rate above the market price. By artificially propping up demand for forfeited commodities, these expenditures allow market prices to be maintained at levels higher than otherwise. If the CCC were to discontinue its stockholding policies, prices would fall. In contrast, deficiency payments stimulate production; if they were to be eliminated, equilibrium producer prices would rise. In order to minimise undesirable price impacts of stockbuilding in the model, policies which encourage the build-up of stocks have been treated as an exogenous positive shock to stockbuilding. The payment-in-kind programme has the opposite effect, since this policy unloads CCC stocks to farmers when stock levels are too high. In the model, this policy is treated as a negative shock to stockbuilding. Only the net effect is shown in Tables 2 and **3.**

C. Import taxes and export subsidies

The tariff on wool is the only component of trade protection of the livestock sector until 1986. After the 1985 Farm Bill was passed, explicit export subsidisation of eggs began. Also, under the Export Enhancement Program, large export subsidies for wheat began; these are incorporated in the export subsidy of other agriculture.

Poultrymeat export subsidies are captured in the meat products sector. Tariffs on meat products imported into the United States are minimal, but account has to be taken of the existence of VERs. Applying the common world reference price method of measuring support to beef producers may overestimate this protection, especially if supplying countries reap the quota rents from the VERs. The dairy products import tax is based on a comparison with the New Zealand export prices of butter, cheese and skimmed milk powder. The import tax for other

food is dominated by the very high tariff-equivalent for sugar, which has increased sharply in the 1980s, in line with a tightening of import quotas.

D. Consumption subsidies

Subsidies to consumers are measured in the CSEs by taking the value of commodity donations, which are either from surplus stocks or are purchased by government agencies with a view to fulfilling price-support functions. The major donation of food concerns dairy products, although other commodities are included.

E. Land set-asides

In 1987-88, over 75 million acres (representing 19 per cent of total cropland) were idled by the annual crop programmes and the Conservation Reserve Program. In 1986, a smaller amount of land was set-aside. It is necessary to adjust the average decline of 17.7 per cent in 1986-88 for the unequal productivity of idled and retained land. For this purpose, it is assumed that a 10 per cent set-aside raises productivity by 2½ per cent on the retained cropland[10]. Thus, a complete reversal of average 1986-88 land set-asides would lead to an increase in effective cropland of 12.7 per cent.

It is assumed that this withdrawal of cropland is representative of land set-aside from the *other* agriculture sector, which uses 73.5 per cent of all agricultural land in the WALRAS model. Since agricultural land is assumed to be fully mobile between the livestock and crop sectors, it is necessary to scale down further the land set-aside to account for the fact that some cropland may be reallocated to livestock production following agricultural policy liberalisation. Thus, a 9.8 per cent land reduction in 1986-88 is applied equally to both agricultural sectors.

NOTES

1. See references in footnote 1 of the main text.
2. Econometric estimates suggest that total factor productivity in Canadian agriculture has grown by an annual rate of 2.4 per cent over the period 1962 to 1978. See Capalbo and Denny (1986).
3. The studies examined include Barichello (1981 and 1984). Bollman, Smith and Tomiak (1988), Graham et al. (1989), Harling and Thompson (1983), McCabe (1986), Moschini (1987), Saint-Louis and Proulx (1987), Schmitz (1982) and Veeman (1982).
4. For milk, assuming that the quota has a 20-year life and that the discount rate is equal to the prime interest rate, annual quota rents have been calculated. Such estimates for Ontario were found to be consistent with estimates based on other methods. Nation-wide studies indicate that milk quota rents in Ontario are reasonably representative of Canada as a whole.
5. The PSEs for the Community refer to the EC-10 for 1979 to 1985, and to the EC-12 for 1986 to 1988.
6. Total factor productivity growth between 1963 and 1976 was 1.8 per cent per annum. See Behrens and De Haen (1980).
7. This is in line with estimates for the milk quota rent in France reported in Bureau (1989).
8. The PSEs only include central government transfers to special agricultural credit agencies. Implicit subsidies or debt write-offs of the Food Control Rice Sub-account are not estimated.
9. It is possible to make estimates of the free-trade level of rice imports – see Hayami and Otsuka (1985). However, this would introduce new income flows which do not exist in the benchmark data set for Japan.
10. The productivity adjustment factor of 0.72 has been derived from evidence of a U.S. official testifying before an EC committee concerning the normal-year impact of the 1987 wheat set-aside. It is considered that a 27.5 per cent set-aside would lead to a 20 per cent reduction in output. See "The U.S. Experience with Cropland Retirement Programs", memorandum by Mr. R. Anderson, Jr., reported in Evidence Taken Before the EC Sub-Committee D, 24th February 1988. This statement is in line with estimates reported by Ericksen and Collins (1985).

BIBLIOGRAPHY

Barichello, R. R. (1981), "The economics of Canadian dairy industry regulation", Technical Report No. E/I 2, Economic Council of Canada (Ottawa), (March).

Barichello, R. R. (1984), "Analyzing an agricultural marketing quota", Discussion Paper No. 84-06, Department of Agricultural Economics, University of British Columbia (Vancouver), (August).

Behrens, R., and H. De Haen (1980), "Aggregate factor input and productivity in agriculture: A comparison of the EC-member countries, 1963-1976", European Review of Agricultural Economics, 7-2, pp. 109-46.

Bollman, R.D., P. Smith and M. Tomiak (1988), "Farm financial stress and the ability of a farm to sustain a family in Canada", paper presented to the VII World Congress for Rural Sociology (Bologna, Italy), (June).

Bureau, J.-C. (1989), "Coûts marginaux et rendements d'échelle en production laitiere," Text presented to the Société française d'hconomie rurale, (September).

Burniaux, J.M., F. Delorme, I. Lienert, J.P. Martin and P. Hoeller (1988), "Quantifying the economy-wide effects of agricultural policies: a general equilibrium approach", OECD Department of Economics and Statistics Working Paper No. 55 (July).

Cahill, C., and W. Legg (1989), "Estimation of agricultural assistance using producer and consumer subsidy equivalents: theory and practice", *OECD Economic* Studies, this volume.

Capalbo, S., and M. Denny (1986), "Testing long-run productivity models for Canadian and U.S. agricultural sectors", American Journal of Agricultural Economics, Vol. 68, No. 3 (August).

Ericksen, M. H., and K. Collins (1985), "Effectiveness of Acreage Reduction Programs", Agricultural Food Policy Review: Commodity Programme Perspective, ERS Report 530, USDA (Washington, D.C.), (July).

Graham, J., B. Stenner, C. Meilke and G. Moschini (1989). "The effects of trade liberalization on the Canadian dairy and poultry sectors", Working Paper, Policy Branch, Agriculture Canada (Ottawa), (forthcoming).

Harling, K. F., and R. L. Thompson (1983), "The economic effects of intervention in Canadian agriculture", Canadian Journal of Agricultural Economics, (July), pp. 153-176.

Hayami Y., and K. Otsuka (1985), "Goals and consequences of rice policy in Japan, 1965-80", American Journal of Agricultural Economics, (August), pp. 529-583.

Hertel, T. (1989), "Negotiating reductions in agricultural support: implications of technology and factor mobility", American Journal of Agricultural Economics, (August).

Hertel, T., and M.E. Tsigas (1989), "General equilibrium analysis of supply control in U.S. agriculture", internal Working Paper (revised), Agricultural Economics Department, Purdue Universiy (West Lafayette, Indiana), (April).

Hertel, T., B.L. Chattin and M.E. Tsigas (1989), "General equilibrium analysis of producer subsidies for U.S. agriculture", Department of Agricultural Economics, Staff Paper 89-6, Purdue University (West Lafayette, Indiana).

Kilkenny, M., and S. Robinson (1988), "Modelling the removal of production incentive distortions in the U.S. agricultural sector", paper for the XX International Conference of Agricultural Economists (Buenos Aires, Argentina), (June).

Martin, J.P., J.M. Burniaux, F. Delorme, I. Lienert and D. van der Mensbrugghe (1989), "Economy-wide effects of agricultural policies in OECD countries: simulation results with WALRAS", ***OECD Economic Studies,*** this volume.

McCabe, B. (1986), "Economics of quota allocation within supply management: analysis of the present procedures for quota allocation", ***Canadian Journal*** of ***Agricultural Economics,*** 33, pp. 196-220.

Moschini, G. (1987), "The cost structure of Ontario dairy farms: a micro-econometric analysis", Working Paper WP87/7, Department of Agricultural Economics and Business, University of Guelph, (July).

OECD (1987), ***National Policies and Agricultural Trade,*** (Paris).

OECD (1988), ***Agricultural Policies, Markets and Trade, Monitoring and Outlook*** (Paris).

OECD (1989), ***Agricultural Policies, Markets and Trade, Monitoring and Outlook*** (Paris).

Saint-Louis, R., and Y. Proulx (1987), "Canadian supply-managed agricultural sectors revisited", ***American Journal*** of ***Agricultural Economics,*** (December).

Schmitz, A. (1983), "Supply management in Canadian agriculture: an assessment of the economic effects", ***Canadian Journal*** of ***Agricultural Economics,*** 31, (July).

Van Kooten, G.C. (1987), "The economic impacts on consumers of government intervention in the poultry and egg sectors: a comparison of alternative welfare measures", ***Agriculture Canada,*** Working Paper 5/87, (March).

Veeman, M. M. (1982), "Social costs of supply-restricting marketing boards", ***Canadian Journal*** of ***Agricultural Economics,*** 30, (March).

Whalley, J., and R. Wigle (1988), "Endogenous participation in agricultural support programs and ***ad valorem*** equivalent modelling", draft working paper, University of Western Ontario, (Canada).