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Quantifying the Economy-Wide Effects of Agricultural Policies: A General Equilibrium Approach

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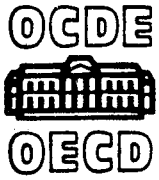
by

Jean-Marc Burniaux, François Delorme, Ian Lienert, John P. Martin and Peter Hoeller*

Growth Studies Division
Country Studies I Division*

July 1988



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This paper presents a progress report on the Economics and Statistics Department's applied general equilibrium model -- the WALRAS model. This model has been developed with the explicit objective of quantifying the economy-wide effects of agricultural policies in OECD countries. The common specification of the model for the major OECD agricultural trading countries/regions (Australia, Canada, EEC, Japan, New Zealand and the United States) is described in detail. Results are presented for some preliminary simulations of the effects of removing the 1979-81 levels of agricultural assistance in these countries/regions. The initial results relate only to unilateral liberalisation experiments with the unlinked country/region models, with no account being taken of feedback effects through changes in world agricultural prices and trade volumes.

* * *

Ce document décrit l'état d'avancement du modèle d'équilibre général développé au Département de Statistique et d'Economie dans le cadre du projet WALRAS. Le but explicite de ce projet est de quantifier les effets macro-économiques des politiques agricoles dans les pays de l'OCDE. Les principaux partenaires commerciaux de l'OCDE (Australie, Canada, EEC, Japon, Nouvelle-Zélande et les Etats-Unis) sont représentés à l'aide d'une spécification commune qui est décrite en détail. Le texte présente également les résultats d'un certain nombre de simulations préliminaires relatives à l'élimination des niveaux de protection agricole qui prévalaient dans ces pays/régions en 1979/81. Ces résultats initiaux se rapportent exclusivement à des scénarios de libéralisation unilatérale réalisés à l'aide de modèles non intégrés qui ne peuvent donc tenir compte des interférences induites par les variations des prix et des volumes des transactions sur les marchés internationaux agricoles.

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The authors owe a special debt of gratitude to Antonio Borges, who acted as consultant to the WALRAS project. Helpful comments and advice were received from John Fallon, Kumiharu Shigehara, Jeffrey Shafer and Carmel Cahill.

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QUANTIFYING THE ECONOMY-WIDE EFFECTS OF AGRICULTURAL POLICIES: A GENERAL EQUILIBRIUM APPROACH

I. INTRODUCTION

1. In recent years the growth in agricultural support in many OECD countries has become a major policy concern. Much of the attention so far has, not surprisingly, concentrated on the impact of agricultural support on agricultural trade. This was the main focus of OECD (1987), based on an analysis of the levels of agricultural support prevailing in 1979/81. Since then, nearly every OECD country has increased protection of its agricultural sector; in 1986, assistance to OECD agriculture accounted for 47 per cent of the total value of agricultural output compared with 32 per cent in 1979-81.

2. The effects of such high and rising levels of agricultural support are not confined to the agricultural sector itself. It draws resources into the agricultural and food sectors from other, less-protected sectors, with spillovers onto world markets for agricultural and food products. Production costs for other sectors are raised through the upward pressure put on the prices of primary factors and other inputs. In addition, the rapid escalation in public expenditures devoted to agricultural assistance has brought them to such a scale in a number of countries that they might reasonably be expected to have discernible economy-wide effects. Thus, any attempt to assess the effects of current agricultural policies or proposals for their reform should take into account their various economy-wide implications.

3. Applied general equilibrium (AGE) models are the most suitable vehicle for examining such issues (1). Such models describe the way a market economy operates by specifying in considerable detail the structure of production, consumption, government revenue and expenditure, foreign trade flows, and the transformation of savings into investment. The main strength of AGE models is their emphasis on the interdependence of the decisions taken by all economic agents. Whenever the government intervenes in agriculture, by introducing taxes or subsidies, or by erecting barriers to foreign trade flows, a re-allocation of resources occurs across all markets and not just in the agricultural sector, with significant efficiency and distributional consequences. 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.

4. In order to examine the intersectoral consequences of agricultural policies in OECD countries, the Economics and Statistics Department has developed a set of AGE models for the major OECD agricultural trading countries/regions: Australia, Canada, EEC, Japan, New Zealand, and the United States. The project is called the World Agricultural LibeRAlisation Study (hereafter referred to as the WALRAS model).

5. This paper describes the current structure of the WALRAS model and reports some preliminary simulation results. The simulations are based on

levels of agricultural assistance prevailing around 1980, as measured by OECD data on Producer Subsidy Equivalents (PSEs) and Consumer Subsidy Equivalents (CSEs). The simulation results for each country/region relate to unilateral liberalisation of agricultural protection, taking world trade prices as given, and maintaining existing levels of protection in non-agricultural sectors.

6. The structure of the paper is as follows. Section II provides a non-technical overview of the WALRAS model. Section III and Annex I describe the detailed specification of the model; this section may be skipped by readers who are not interested in the technical aspects of the model. The common framework for the underlying data sets -- relating to around 1980 -- is outlined in Section IV. Country-specific data adjustments are discussed in Annex II. The calibration of the model on the benchmark year and its parameterisation are discussed in Section V. The modelling of agricultural policies is outlined in Section VI, with country-specific details relegated to Annex III. Section VII discusses the solution method of the WALRAS model. Some preliminary simulation results are presented in Section VIII. The aim is to highlight the key mechanisms in the model; further refinements are needed before the model can make a useful contribution to the policy debate on agricultural reform. The concluding section outlines some such refinements which are being envisaged in the on-going work on the WALRAS model.

II. OVERVIEW OF THE WALRAS MODEL

7. In the first phase of the project, the main focus of the analysis is on the domestic intersectoral effects of agricultural policies. The domestic importance of agriculture in each of the six countries or regions under study varies widely: agriculture and food processing accounted for 20 per cent of gross output in 1980 in New Zealand, 11 1/2 per cent in Australia and the EEC, and under 10 per cent in North America and Japan. The share of agricultural products in exports and imports also varies widely between these countries.

8. Given that the overriding concern of the project is with the inter-sectoral effects of agricultural policies and not merely with the impact on the agricultural sector itself, the model does not aim to describe in detail the structure of the agricultural sector. The disaggregation chosen reflects, however, the main links relevant in a study of the economy-wide effects of agricultural policy, distinguishing between sectors closely related to agriculture and the rest of the economy.

9. The model is purely static: its results represent the long-run outcomes based upon a comparison between an initial equilibrium (i.e. with current policies) and a counterfactual equilibrium computed with changed policies, after these policy changes have been fully absorbed in the structure of the economy. The adjustment path towards this long-run equilibrium is not dealt with, nor is any allowance made for a growing labour supply and changes in the economy's total capital stock due to the accumulation of net saving.

10. The model can be subdivided into five sub-models, each one dealing with the major blocks in the structure of the economy. These are briefly described below. Much more detail together with a full listing of all the equations, functional forms, variables and parameters, is provided in Section III.

1. Production

11. Table 1 lists the thirteen sectors of the production sub-model. These were chosen so that the two main agricultural sectors -- livestock and other agriculture (mainly grains) -- plus three food-processing industries -- meat, dairy and other food products -- are treated separately. The remaining eight sectors comprise various manufacturing and service industries.

12. For each sector, a production function describes the technology available to the industry. Given the standard assumptions of optimal cost-minimizing behaviour, producers choose inputs of primary factors and intermediate goods (domestic and imported) as a function of their relative prices. Once the optimal combination of inputs is determined, sectoral output prices are calculated assuming competitive supply conditions in all markets. Since each sector supplies inputs to other sectors, output prices -- which are the cost of inputs for other sectors -- and the choice of the optimal combination of inputs are determined simultaneously for all sectors.

13. Some simplifying assumptions are used in the specification of the production functions. All non-agricultural sectors are assumed to operate under constant returns to scale, which permits the determination of output prices independently of the level of activity. As in many AGE models, the primary factors of production are assumed to be in fixed supply to the total economy; they are also assumed to be fully employed and mobile between sectors. Labour and capital are thus allocated to each industry according to demand, and are paid in every sector a price that just equates total demand with total supply. Land is assumed to be a mobile factor of production in the two agricultural sub-sectors only at this stage of the development of the model; it is not modelled as a factor of production in the non-agricultural sectors. This treatment of land implies that the two agricultural sectors are implicitly characterised by decreasing returns to scale.

14. Another element of simplification is the assumption of fixed intermediate inputs per unit of output in all sectors of production. There are, however, two important elements of flexibility in the choices available to producers:

i) the optimal combination of capital and labour -- and land in the two agricultural sectors -- is variable and depends on the relative prices of these inputs, assuming substitutability between them; and

ii) for each intermediate input, producers have the option of buying domestically or importing depending on relative prices.

2. Consumption

15. A single representative consumer is assumed to choose between ten consumer goods (see Table 1). The ten consumer goods are different from the outputs of the thirteen sectors of production, and correspond more closely to the standard groups of products which consumers demand. A simple matrix of fixed coefficients -- a so-called "transition matrix" -- is used to convert goods and services in the production-sector classification into consumer goods and services. Using this matrix, producer prices are translated directly into

Table 1

THE STRUCTURE OF INDUSTRIES AND DEMAND IN THE WALRAS MODEL

	The thirteen industries		The fourteen demand components (a)
1.	Livestock and livestock products	1.	Food and non-alcoholic beverages
2.	Other agricultural industries	2.	Alcoholic beverages
3.	Other primary industries (b)	3.	Tobacco
4.	Meat products	4.	Clothing and footwear
5.	Dairy products	5.	Gross rents, fuel and power
6.	Other food products	6.	Household equipment and operation
7.	Beverages	7.	Medical care
8.	Chemicals	8.	Transport and communication
9.	Petroleum & coal products	9.	Education and recreation
10.	Other manufacturing industries	10.	Miscellaneous goods and services
11.	Construction	11.	Gross private fixed investment
12.	Wholesale & retail trade	12.	Change in stocks
13.	Other private services	13.	Government expenditure (c)
		14.	Exports of goods and services (d)

a. The first ten items are components of private consumption
b. Forestry, fishing, mining and quarrying.
c. Includes government investment.
d. Includes re-exports.

prices for consumer goods, and the demands for consumer goods can be immediately transformed into demands for producer goods.

16. It is well known that the demand for certain goods -- and in particular for food -- does not increase with income as rapidly as for other goods. The model of consumer behaviour chosen starts from an assumption of linear expenditure growth, but with different marginal propensities to spend on different goods and services.

17. Consumers are assumed to have the option of importing the commodities they want to buy. Their optimising decisions are thus separated in two stages: first, given their total income and the prices of consumer goods, they decide how much they want to spend on each type of good or service; and second, they decide, for each of these, what proportions to buy domestically and to import, as a function of relative prices.

18. Consumers obtain their income from the returns to supplying primary factors of production and government transfers. After paying income taxes, their disposable income is either spent on the purchase of goods and services or saved. Saving is assumed to take the form of purchases of investment goods; financial intermediation is not incorporated in the model.

3. The role of the government

19. In the model, the government collects taxes on incomes, intermediate use, outputs, and consumer expenditures, as well as on imports. It also subsidises exports, especially of agriculture and food. All of these taxes and subsidies influence the decisions of economic agents, by changing prices and/or by reducing incomes. Most of the taxes are modelled as simple ad valorem rates. Income taxes, however, are treated as progressive, with a marginal tax rate specified for each country which is higher than the average tax rate for personal income. Tax revenues collected by the government are a function of the level of economic activity and are therefore calculated endogenously.

20. Government expenditure is not constrained to be constant at its base-period level or necessarily to be equal to revenues. Once the total level of spending is decided, the government allocates it to transfers, which are exogenous, or to the purchase of goods, services, capital and labour. Non-transfer expenditures are functions of relative prices, obtained from an assumption of optimising behaviour by the government.

4. Foreign trade

21. The foreign trade sub-model includes trade volumes and prices of each of the thirteen sectors. Imports have already been mentioned above in the context of producer and consumer behaviour. Given exogenously determined import prices and tariffs, the decisions to import by producers and consumers are part of their optimising behaviour.

22. Export demand is determined by domestic prices relative to foreign prices. At this stage, fixed world market prices for competing goods of other ccountries are assumed. Hence, the only way a country can export more is by lowering its export price relative to the world price.

23. Goods are nationally differentiated in the sense that each country is assumed to face a downward-sloping demand curve for its exports. The underlying rationale is that goods from different countries are never treated as perfect substitutes by consumers. For example, they are assumed to regard U.S. cars as imperfect substitutes for Japanese cars. This assumption is quite a general one for agricultural and industrial products, especially the latter. Due to the relatively more homogeneous nature of many agricultural products as compared with manufactures, they could be treated as perfect substitutes. However, at the high levels of industrial aggregation used in the model, there are considerable inter-country differences between broad categories such as "livestock" or "meat products". The capacity to take account of imperfect substitutability therefore seems desirable.

24. As a result, domestic export prices for any commodity may differ from world prices, and a country may (and in general will) both export and import goods in a given sector. In this way the model captures the phenomenon of intra-industry trade. This represents a significant departure from the "small country assumption" of traditional trade theory in which countries can export any amount at a given price and nothing at a higher price.

25. Given the separate treatment of exports and imports, countries may run current-account surpluses or deficits. The counterpart of these imbalances is a net outflow or inflow, respectively, of capital, which is subtracted or added to the domestic flow of saving (2). At this stage of development of the model, however, no account is taken of net income flows associated with stocks of foreign assets or liabilities.

26. Finally, the model includes a nominal exchange rate. Its role is important and needs to be carefully interpreted. First, the nominal exchange rate serves to translate world prices into domestic prices. Second, it serves as an equilibrium mechanism to obtain balance between the value of imports and exports. The model also includes a measure of the "real exchange rate", which is defined as the weighted average of domestic factor prices relative to the given world price. Changes in this relative price play a key equilibrating role in the model; as will be seen in Section VIII, there is a relationship between the real exchange rate and the terms of trade.

5. Investment and saving: closing the model

27. To complete the model, an investment equation is specified. Since there are no financial assets in the model, net saving is allocated directly to investment goods, and thus the specification of investment is greatly simplified. Savings come from three main sources: i) private savings, as determined by consumer behaviour; ii) public savings, which correspond to the net budget position; and iii) foreign savings, arising from a current account deficit.

28. It is important to note that all income generated by economic activity is assumed to be distributed to consumers. Therefore, corporate saving is treated as part of household saving and is dealt with in the consumer sub-model. One closure rule is to allow government and foreign saving to be determined endogenously. A government budget deficit, or a capital outflow as a counterpart of a current account surplus, represent applications of savings, which reduce the amount available for domestic investment. Although the model does not include any specific treatment of the financial mechanisms that

determine the allocation of saving to its various applications, overall consistency is obtained by making total domestic investment identical to net national savings plus net capital inflows.

29. In the simulations reported in Section VIII, an alternative closure rule is adopted: the initial levels of both the government budget and foreign balances are assumed to be exogenous. Budgetary savings associated with a change in agricultural policy are therefore offset by lowering the marginal rate of private income taxation to keep the balance constant.

III. TECHNICAL SPECIFICATION OF THE WALRAS MODEL

30. A full description of all the variables and parameters in the model is contained in the glossary in Annex I.

1. Price specification

31. Prices are equal to total costs divided by quantity. The consumer demand functions are assumed to be non-negative, continuous and homogeneous of degree zero in all prices, i.e. doubling all prices (and income) does not change the quantities demanded. Hence, by an arbitrary choice of units, all prices can be set equal to one. As a corollary, this means that only relative prices are relevant in the model. In this way, the benchmark data set may be constructed in value terms and there is no need to specify underlying data in quantity terms.

32. The assumption that all factor prices are normalized on one in every sector is clearly in contradiction with the reality of a dispersion of wage and rental rates for labour and capital services across sectors. However, quantities are adjusted accordingly such that the ratio of factor prices across sectors translates into a ratio of quantities used which differs from the observed physical units. This implies that factors are measured in efficiency units. Since all prices are equal to one, any differences observed in reality correspond to different efficiencies. As a result, changes in quantities must be interpreted as changes in efficiency units.

33. In agriculture there are large distortions in the price mechanism because of tariffs, quantitative restrictions, taxes and subsidies. The relevant prices for obtaining a base-year equilibrium are the market prices at which transactions take place. In the model, it is therefore necessary to distinguish between before- and after-tax prices. It is assumed that the unitary prices are inclusive of any taxes and subsidies, implying that agricultural policies have distorted the optimal decisions of economic agents in both agricultural and non-agricultural sectors.

34. The key prices in the model are the following:

w: aggregate wage rate

r: rental rate of capital

rm: rental rate of land

P^d_{ij}, P^I_{ij}: price of domestic and imported intermediate input j used by industry i (net of taxes, tariffs and subsidies).

ER: the nominal exchange rate

35. These prices, inclusive of taxes and subsidies, are integral components of equilibrium producer prices (P_i)

$$P_i = f(P) \tag{1}$$

where P denotes the factor-price system for the thirteen industries. The determination of producer prices is discussed below.

36. In order to include taxes (t_{ji}) and tariffs (τ_j) on intermediate inputs in an ad valorem form, the price definitions are expanded as follows:

$$PT^d_{ji} = P_j(1 + t^d_{ji}) \tag{2}$$

$$PT^I_{ji} = P_w(1 + t^I_{ji})(1 + \tau_j).ER \tag{3}$$

where the world price (P_w) is treated as exogenous.

37. The conversion of producer prices into consumer prices is straightforward. Each column of the domestic transition matrix defines for each domestic consumer good the weight that corresponds to each producer good. Thus, the price of each domestic consumer good (including consumption taxes) will be a weighted average of the prices of producer goods, the weights being the column shares from the domestic transition matrix:

$$P^d_{cg} = \sum_i \xi^d_{gi} P_i(1 + t^d_{ci}), \tag{4}$$

where $\sum_i \xi^d_{gi} = 1$ (5)

Prices for imported consumer goods (gross of tariff rates) can be defined in a similar way:

$$P^I_{cg} = \sum_i \xi^I_{gi} P_w(1 + t^I_{ci})(1 + \tau_i).ER \tag{6}$$

where $\sum_i \xi^I_{gi} = 1$ (7)

The determination of composite consumer prices is discussed below. Export prices are defined as the producer price inclusive of any export taxes (subsidies):

$$P_{Ei} = P_i(1+t_{Ei}) \qquad (8)$$

2. Production structure: intermediate demand and value-added

38. The overall production structure of the model is depicted in Figure 1. A variety of specifications could have been chosen. In the WALRAS model, as with all AGE models, there is a trade-off between tractability and complexity. Weak separability is assumed to characterise the relationship between intermediate demand and value added (3).

39. For intermediate inputs, a Leontief (fixed coefficient) specification has been adopted. Using the assumption that production prices are normalized on one as described above, total intermediate output of each industry can be obtained from the benchmark data set in value terms. Let each element of the transaction matrix X_{ji} of input-output tables represent the quantity sold by sector j and purchased by the ith sector, before taxes or subsidies. The column sums of the transactions table are equal to quantity of total intermediate inputs of a given sector. The technical coefficients can then be determined immediately:

$$a_{ji} = X_{ji}/Q_i, \quad \text{where } Q_i \text{ is total gross output of sector i.} \qquad (9)$$

40. The coefficients corresponding to capital (K), labour (L) and land (M) per unit of output can be obtained by a similar procedure. If a matrix is defined for the primary factor coefficients, then:

$a_{Li} = L_i/Q_i$ where L_i are total gross wages paid by sector i

$a_{Ki} = K_i/Q_i$ where K_i is the (gross) capital remuneration of sector i;

$a_{Mi} = M_i/Q_i$ and M_i is the return to agricultural land.

It should be noted that the sum of all technical coefficients for the ith sector is not equal to one:

$$\sum_{j=1}^{n} a_{ji} + a_{Ki} + a_{Li} + a_{Mi} \neq 1 \qquad (10)$$

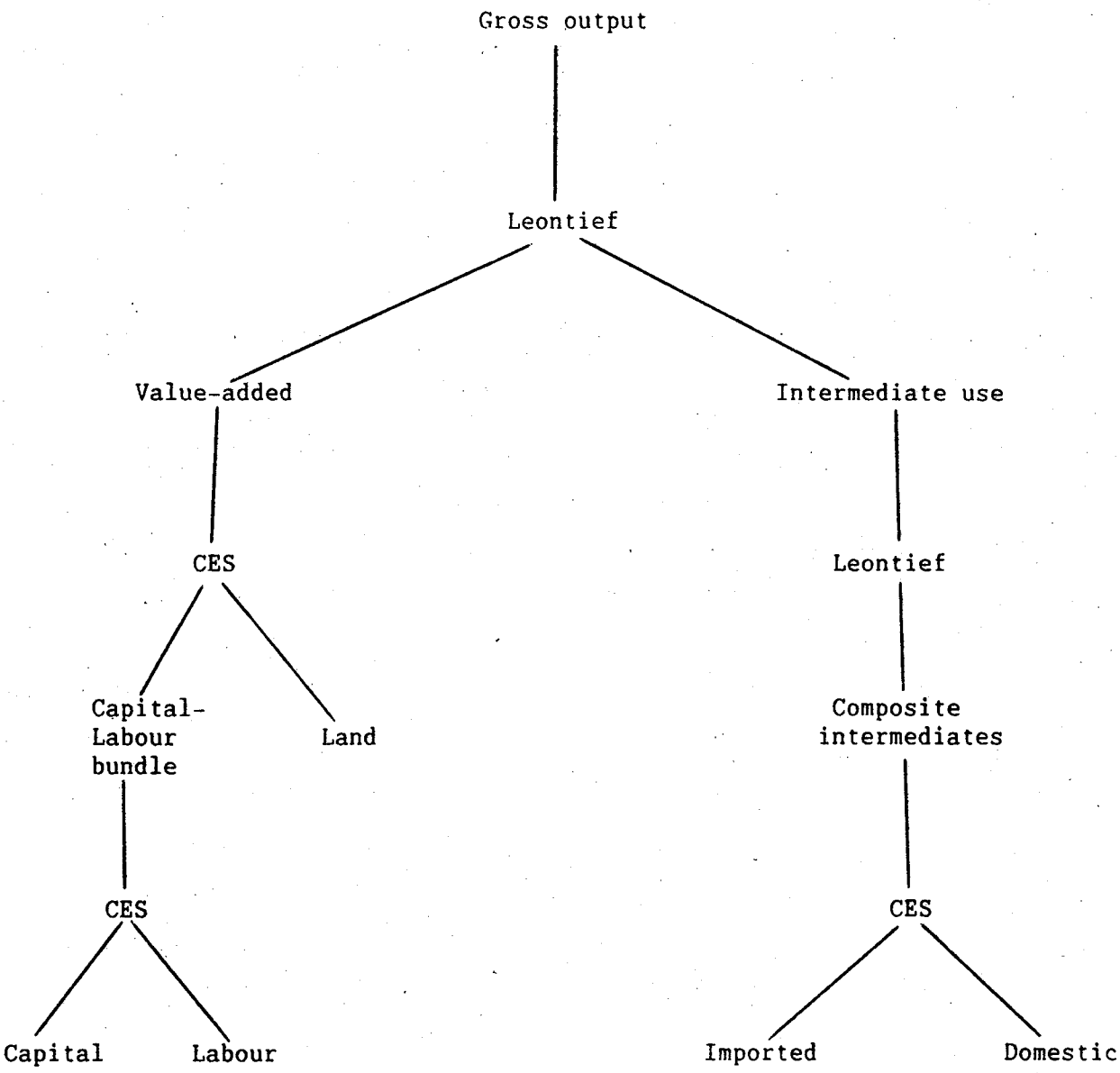
This occurs because total output Q_i is measured by the value of production at market prices (inclusive of taxes and subsidies). Since intermediate and primary factor use, net of taxes and subsidies, are less or more than the market value of the output, the input-output coefficients are not equal to one.

41. Each of the thirteen industries produces an output Q_i using primary factors of production according to a neo-classical production function exhibiting constant returns to scale, and 13 intermediate inputs (X_{ji}) used in fixed proportions to gross output. The sum of primary factors across industries constitutes the economy's given factor endowments.

42. Value-added is modelled via a nested CES function; in the outer nest, capital and labour are aggregated to form a capital-labour bundle which is combined with land in the inner nest. There is assumed to be no scope for

Figure 1

THE PRODUCTION STRUCTURE OF THE WALRAS MODEL



substitution possibilities between intermediate inputs since these are specified by a fixed-coefficient (Leontief) system). However, substitution is possible between domestic and foreign intermediate inputs.

43. Thus, technology is characterised by a Leontief system combined with a nested CES production function that generates value-added. The production function for industry i can be written as:

$$Q_i = \min(VA_i, \sum_j X_{ji}) = \min[F(G(K_i,L_i),M_i), \sum_j X_{ji}] \quad (11)$$

$$\sum_j X_{ji} = \min(X_{ji}/a_{ji}) \quad (12)$$

$$VA_i = \left[\alpha_{Hi} H_i^{(\rho-1)/\rho} + \alpha_{Mi} M_i^{(\rho-1/\rho)} \right]^{\rho/(\rho-1)} \quad (13)$$

$$H_i = \left[\alpha_{Ki} K_i^{(\sigma-1)/\sigma} + \alpha_{Li} L_i^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)} \quad (14)$$

where the α_i are the distribution parameters; and ρ and σ are sector-specific elasticities of substitution.

44. Producers in the model are assumed to minimize their after-tax costs of production; taxes, subsidies and tariffs distort factor input decisions. The producer's optimisation problem is formulated in two steps. First, the producer minimizes the unit cost of purchasing the capital-labour bundle and land. Formulating the Lagrangian yields:

$$V^* = h_i H_i + rm_i M_i + e\{[\alpha_{Hi} H_i^{(\rho-1)/\rho} + \alpha_{Mi} M_i^{(\rho-1)/\rho}]^{\rho/(\rho-1)} - 1\} \quad (15)$$

Deriving the first-order cost-minimization conditions yields:

$$h_i/rm_i = \alpha_{Hi} H_i^{(-1/\rho)} / \alpha_{Mi} M_i^{(-1/\rho)} \quad (16)$$

Substituting equation (15) in the unit value-added function yields the optimal technical coefficients for H_i and M_i:

$$a_{Hi} = \alpha_{Hi}^{\rho} h_i^{-\rho} [\alpha_{Hi}^{\rho} h_i^{1-\rho} + \alpha_{Mi}^{\rho} rm_i^{1-\rho}]^{\rho/(1-\rho)} * VA_i/Q_i \quad (17)$$

$$a_{Mi} = \alpha_{Mi}^{\rho} rm_i^{-\rho} [\alpha_{Hi}^{\rho} h_i^{1-\rho} + \alpha_{Mi}^{\rho} rm_i^{1-\rho}]^{\rho/(1-\rho)} * VA_i/Q_i \quad (18)$$

In the second stage, the producer is assumed to minimize capital and labour costs subject to the value-added sub-function (13). This yields the optimal capital and labour technical coefficients:

$$a_{Ki} = \alpha_{Ki}^{\sigma} r_i^{-\sigma} [\alpha_{Ki}^{\sigma} r_i^{1-\sigma} + \alpha_{Li}^{\sigma} w_i^{1-\sigma}]^{\sigma/(1-\sigma)} * H_i/Q_i \quad (19)$$

$$a_{Li} = \alpha_{Li}^{\sigma} w_i^{-\sigma} [\alpha_{Ki}^{\sigma} r_i^{1-\sigma} + \alpha_{Li}^{\sigma} w_i^{1-\sigma}]^{\sigma/(1-\sigma)} * H_i/Q_i \quad (20)$$

Given the Leontief specification, intermediate input requirements (a_{ji}) are independent of relative prices. By contrast, the optimal combination of primary factors depends on prices (including taxes) since producers minimize their after-tax production costs for primary inputs.

45. The final step consists in specifying the substitution possibilities between traded intermediate inputs. Within the fixed requirement, the producer is allowed to choose the optimal composite between domestic and imported intermediate inputs using a CES aggregation function. The complete formulation of intermediate input requirements is then written as:

$$a_{ji} = [\gamma^{d}_{ji}(a^{d}_{ji})^{(\eta-1)/\eta} + \gamma^{I}_{ji}(a^{I}_{ji})^{(\eta-1)/\eta}]^{\eta/(\eta-1)} \tag{21}$$

$$X_{ji} = a_{ji}Q_i \tag{22}$$

The solution of the cost-minimisation problem yields the optimal input-output coefficients for domestic and intermediate inputs:

$$a^{d}_{ji} = (\gamma^{d}_{ji})^{\eta}(PT^{d}_{ji})^{-\eta}[(\gamma^{d}_{ji})^{\eta}(PT^{d}_{ji})^{1-\eta} + (\gamma^{I}_{ji})^{\eta}(PT^{I}_{ji})^{1-\eta}]^{\eta/(1-\eta)} \tag{23}$$

$$a^{I}_{ji} = (\gamma^{I}_{ji})^{\eta}(PT^{I}_{ji})^{-\eta}[(\gamma^{d}_{ji})^{\eta}(PT^{d}_{ji})^{1-\eta} + (\gamma^{I}_{ji})^{\eta}(PT^{I}_{ji})^{1-\eta}]^{\eta/(1-\eta)} \tag{24}$$

46. Once all technical coefficients are known, we can derive equilibrium producer prices from factor prices and factor demands:

$$P_i = h_i a_{hi} + rm_i a_{mi} + \sum_j a^{d}_{ji}PT^{d}_{j} + \sum_j a^{I}_{ji}PT^{I}_{j} \tag{25}$$

where

$$h_i = \left(\alpha^{\sigma}_{Ki} r_i^{(1-\sigma)} + \alpha^{\sigma}_{Li} w_i^{(1-\sigma)}\right)^{1/(1-\sigma)} \tag{26}$$

is the dual of (13). The column vector of production prices (P) can be expressed in matrix form as:

$$P = P^0 * D^* * (I-A^d)^{-1} \tag{27}$$

where A^d is the Leontief matrix of domestic intermediate transactions inclusive of taxes, I is the identity matrix, P^o is a vector of imported intermediate inputs and primary factor prices, defined as:

$$P^0 = [PT^{I}_{ji},\ r_i,\ w_i,\ rm_i] \qquad j = 1, \ldots.13 \tag{28}$$

Finally, D^* is a partitioned matrix of imported inputs excluding taxes (a^{I}_{ji}) and primary factor coefficients (D):

$$D^* = \begin{bmatrix} I \\ A \\ -- \\ D \end{bmatrix} \tag{29}$$

and D is defined as:

$$D = \begin{bmatrix} a_{Ki} \\ a_{Li} \\ a_{Mi} \end{bmatrix} \tag{30}$$

47. Factor demands are derived from the components of final demand. Starting with consumer demands for domestic and imported goods obtained from the consumption submodel described below, these are converted into demands for producer goods using the transition matrix. From the definition of the elements of this matrix,

$$PC_i = [\ \Xi\ ]\ C_g \tag{31}$$

where PC_i is private consumption matching the 13 producer-good classification and C_g is the vector of demands for the 10 consumer goods. Once the remaining domestic components of final demand (investment, change in stocks, government expenditure and exports) are added to the domestic component of PC_i, the final demand vector (FD_i) can be obtained. Using the inverse of the domestic Leontief matrix, gross output requirements are defined as:

$$Q = [I - A^d]^{-1} (PC^d + INV^d + DSTOC^d + GOV^d + E^d) \tag{32}$$

and finally, factor demands are obtained from:

$$\begin{bmatrix} K \\ L \\ M \end{bmatrix} = [\ D\ ]\ Q \tag{33}$$

3. Consumption

48. Consumer demand in each country model is characterised by a single representative consumer. The selection of the appropriate functional form for the utility function is problematic. A Cobb-Douglas specification imposes constant expenditure shares, unitary income elasticities, uncompensated own-price elasticities equal to one and zero cross-price elasticities. The CES specification relaxes some of these constraints by assuming a constant but non-unitary own-price elasticity. At the same time, however, it maintains the unitary income elasticity restriction and also imposes a constant elasticity of substitution for all goods. The Linear Expenditure System (LES) relaxes the unitary income elasticity assumption.

49. The specification of consumption is illustrated in Figure 2. It is a relatively flexible specification in which the non-unitary income elasticity property of the LES approach is combined with a nested CES structure. Incorporating savings in the model leads to the Extended Linear Expenditure System (ELES) which is adopted in the WALRAS model, being defined over the ten consumption goods and savings.

50. The utility function is defined as:

$$U = \sum_{g+1} \theta_{g+1} \ln(C_{g+1} - F_{g+1}) \tag{34}$$

where g is the number of consumption goods, θ_g is the marginal budget share of commodity g, C_g is the quantity consumed of good g and F_g is the minimum or so-called "subsistence" level of consumption. In equation (34) it is assumed that the good g+1 represents savings, adding the additional restriction:

$$F_{g+1} = 0 \tag{35}$$

51. Commodity demand functions are derived by constrained maximization of the utility function subject to the budget constraint, defined as the sum of rental income from capital and land, wage income from labour and transfer income from the government minus depreciation, after deduction of personal income taxes.

$$Y = (r\bar{K} + rm\bar{M} + w\bar{L} - DEPR + T_G) \tag{36}$$

$$YD = (1 - t_y)Y - \mu \tag{37}$$

All disposable income is assumed to be spent on consumer goods or saved:

$$YD = \sum_{g} P_{cg} C_g + SV \tag{38}$$

52. Personal consumption expenditures are allocated among domestic and imported goods. Foreign and domestic consumer goods are assumed to be imperfect substitutes following Armington (1969), thereby accomodating the phenomenon that a country both imports and exports the same commodity. The Armington commodities can then be aggregated through a CES function as follows:

$$C_g = [\omega_g^d C_g^{d\,(\beta-1)/\beta} + \omega_g^I C_g^{I\,(\beta-1)/\beta}]^{\beta/(\beta-1)} \tag{39}$$

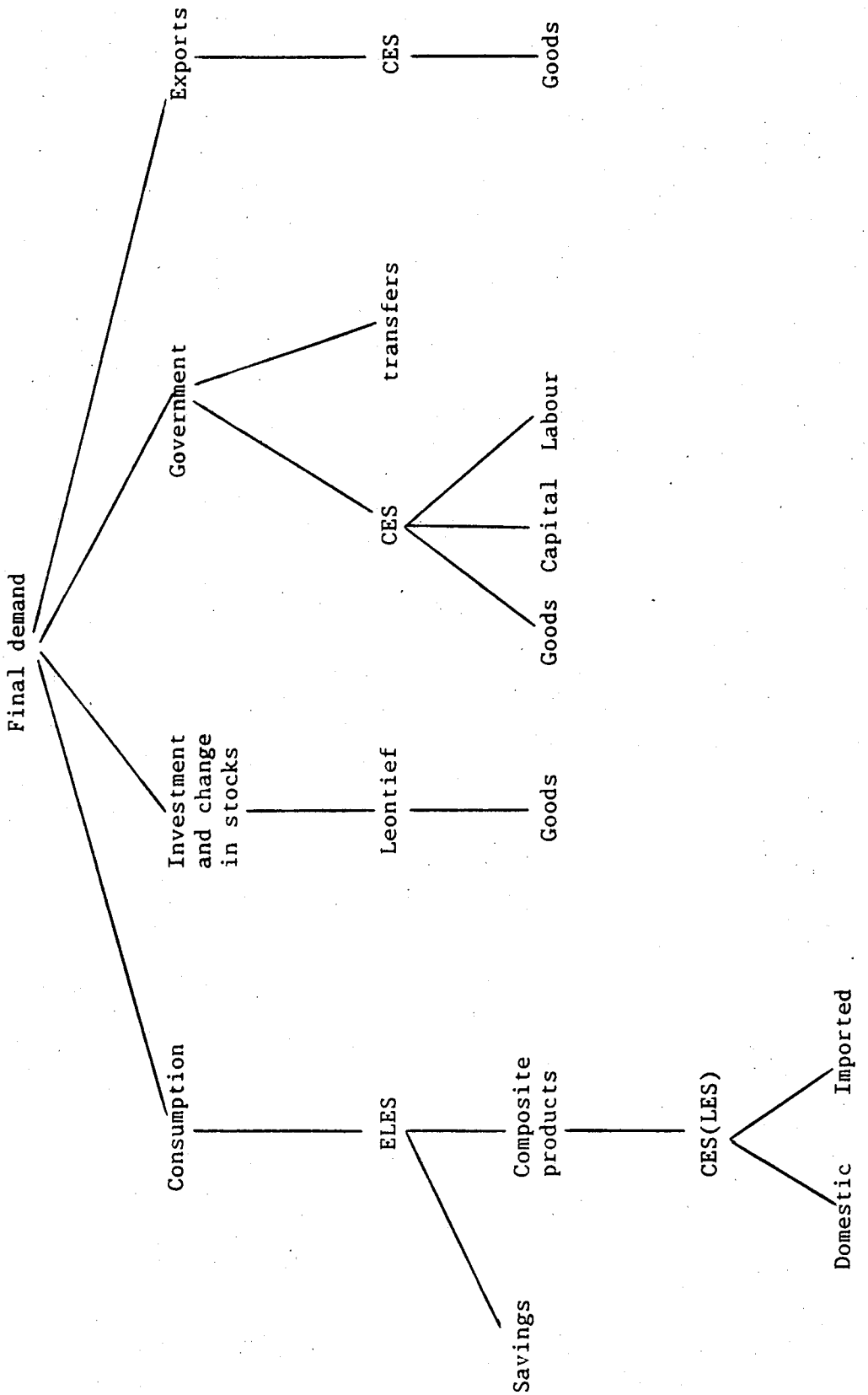
Prices of the composite consumer goods are calculated as the dual of equation (39):

$$P_{cg} = [(\omega_g^d)^{\beta} (P_{cg}^d)^{(1-\beta)} + (\omega_g^I)^{\beta} (P_{cg}^I)^{(1-\beta)}]^{1/(1-\beta)} \tag{40}$$

53. Consumers determine their optimal demands in two steps. First, they choose a composite consumption bundle by solving their utility function

Figure 2

THE FINAL DEMAND STRUCTURE OF THE WALRAS MODEL



subject to their budget constraint. The resulting optimal demand functions are given by:

$$C_g = F_g + [\theta_g (Y - \sum_h P_{ch} F_h)]/P_{cg} \quad (41)$$

$$SV = \theta_{g+1}(Y - \sum_h P_{ch}F_h) \quad (42)$$

where θ_{g+1} represents the marginal propensity to save out of current disposable income. The definitions of the income and own-price (uncompensated) elasticities of demand for domestic consumption goods are given by:

$$\iota_g = (\theta_g/P_{cg})\{Y/[F_g + (\theta_g/P_{cg})(Y - P_{ch}F_h)]\} \quad (43)$$

$$\lambda_g = (F_g/C_g)(1 - \theta_g) - 1 \quad (44)$$

54. In the second stage, consumers select the optimal mix of domestic-foreign bundles for each composite commodity that minimizes the purchasing cost of C_g. Maximizing (39) subject to the constraint of a fixed amount of expenditure on the gth domestic-imported composite, C_g $(= P^d_{cg}C^d_g + P^I_{cg}C^I_g)$, yields the following optimal conditions:

$$C^I_g/C^d_g = [(\omega^I_g/\omega^d_g)(P^d_{cg}/P^I_{cg})]^\beta \quad (45)$$

55. To solve explicitly for the demand equations for C^d_g and C^I_g, we substitute equation (45) into (39). This yields:

$$C^d_g = (\omega^d_g)^\beta C_g/(P^d_{cg})^\beta \; [(\omega^d_g)^\beta (P^d_{cg})^{(1-\beta)} + (\omega^I_g)^\beta (P^I_{cg})^{(1-\beta)}] \quad (46)$$

$$C^I_g = (\omega^I_g)^\beta C_g/(P^I_{cg})^\beta \; [(\omega^d_g)^\beta (P^d_{cg})^{(1-\beta)} + (\omega^I_g)^\beta (P^I_{cg})^{(1-\beta)}] \quad (47)$$

4. Investment and change in stocks

56. Total private investment is derived residually from savings and the fiscal and external imbalances (See equation (57) below). The distribution of investment by sector is modelled using a fixed-coefficient (Leontief) specification:

$$\Gamma_i = INV_i/\Sigma INV_i \quad (48)$$

57. A similar specification is used for the sectoral distribution of the change in total stocks (which are assumed to be exognous):

$$\Omega_i = DSTOC_i/\Sigma DSTOC_i \quad (49)$$

In equations (48) and (49) the Leontief specification applies to both domestically-produced and imported investment and stockbuilding.

58. At this stage, the formulation of investment is static: there is no link between increased savings today and additional investment in a subsequent time period. These intertemporal features can be very important; in a dynamic model, a policy which has a negative impact on welfare in the current period may yield substantial welfare gains in the long run (4).

5. Government

59. The government is assumed to use tax and tariff revenues for transfer payments (which are not assumed to be taxed), subsidy expenditures and purchases of primary inputs. Government expenditures (including public investment) are assumed to be exogenous but expenditures excluding transfers are derived from a CES government utility function defined over a composite of all non-wage producer goods, capital and labour. The government sector is therefore modelled as if it consisted of an aggregate public sector "consumer".

60. The government utility function is specified as follows:

$$U_G = [\phi_G G^{(\psi-1)/\psi} + \phi_K K_G^{(\psi-1)/\psi} + \phi_L L_G^{(\psi-1)/\psi}]^{\psi/(\psi-1)} \qquad (50)$$

Maximization of this utility function subject to the government budget constraint for non-transfer expenditures

$$Z_G = P_G G + wL_G + rK_G \qquad (51)$$

yields the following optimal government demands for goods, capital and labour:

$$G = (\phi_G)^{\Psi} Z_G / P_G^{\Psi} \left[\phi_G^{\Psi} P_G^{(1-\Psi)} + \phi_k^{\Psi} r^{(1-\Psi)} + \phi_L^{\Psi} w^{(1-\Psi)} \right] \qquad (52)$$

$$K_G = (\phi_K)^{\Psi} Z_G / r^{\Psi} \left[\phi_G^{\Psi} P_G^{(1-\Psi)} + \phi_K^{\Psi} r^{(1-\Psi)} + \phi_L^{\Psi} w^{(1-\Psi)} \right] \qquad (53)$$

$$L_G = (\phi_L)^{\Psi} Z_G / w^{\Psi} \left[\phi_G^{\Psi} P_G^{(1-\Psi)} + \phi_K^{\Psi} r^{(1-\Psi)} + \phi_L^{\Psi} w^{(1-\Psi)} \right] \qquad (54)$$

61. Total government revenue can be expressed as the sum of tariff (τ) and tax (t) revenues net of subsidies, which are expressed as negative tax rates:

$$\begin{aligned} R_G = {} & \sum_{ij} a^d_{ji} X^d_{ji} P^d_j t^d_{ji} + \sum_{ij} a^I_{ji} X^I_{ji} P_W ER (t^I_{ji} + \tau_i + t^I_{ji}\tau_i) \\ & + \sum_{gi} C^d_g \xi^d_{gi} P_i t^d_{ci} + \sum_{gi} C^I_g \xi^I_{gi} P_W ER (t^I_{ci} + \tau_i + t^I_{ci}\tau_i) \\ & + \{\sum_i INV^d_i P_i + [\sum_i INV^I_i P_W ER (1 + \tau_i)]\} t_{Ii} + \sum_i INV^I_i P_W ER \tau_i \\ & + \{\sum_i GOV^d_i P_i + [\sum_i GOV^I_i P_W ER (1 + \tau_i)]\} t_{Gi} + \sum_i GOV^I_i P_W ER \tau_i \end{aligned}$$

$$+ \{\sum_i DSTOC_i^d \, P_i + [\sum_i DSTOC_i^I \, P_W \, ER \, (1 + \tau_i)]\} \, t_{si} + \sum_i DSTOC_i^I \, P_W^I \, ER \, \tau_i$$

$$+ \sum_i E_i \, P_{Ei} \, t_{Ei} - \sum_i s_{Qi} \, P_i \, Q_i + (\tau_y + t_y \, Y) \qquad (55)$$

6. Foreign trade

62. The single-country approach to the modelling of the foreign trade sector in this version of the WALRAS model represents a point of departure, as it ignores the linkage effects between countries. At this stage, a common specification of the unlinked trade flows is applied to all countries. As mentioned above, the import content of intermediate demand follows a CES system. Imports are thus sensitive to price variations. The demand for imported intermediate input j by industry i depends upon the given imported input-output coefficients and output in the ith sector, which in turn is a function of all primary inputs used in that industry. The final demand for imports is derived from the CES Armington function by minimizing the cost of purchasing the domestic-imported mix of the gth good, subject to a CES aggregation function between the domestic and the imported good.

63. Use of the Armington specification represents a major departure from the typical Heckscher-Ohlin framework since it assumes that similar products from different trading areas are viewed by consumers as different goods. One drawback, however, with the use of the Armington specification in AGE models is that it often leads to strong terms-of-trade effects following trade experiments (5). In such a framework, welfare losses due to the imposition of tariffs may be compensated for by terms-of-trade gains.

64. The demand for exports is modelled by constant price elasticities ε:

$$e_i = \delta_i (p_{ei} / p_w . ER)^{\varepsilon} \qquad (56)$$

this specification allows us to vary the price sensitivity of export demand. a value of $\varepsilon = -\infty$ would represent the "small country" case.

7. Closure rule

65. The reconciliation of all sectoral financial balances in any AGE model is known as the "closure rule"; and the way this is specified has a critical bearing on simulation results. In the WALRAS model, various closure rules may be selected. The fundamental closure relationship is defined as follows:

$$INV^T = SV + \zeta r\bar{K} + (R_G - Z_G - T_G) - DSTOC^T - (E^T - IMP^T . ER) \qquad (57)$$

where E^T and IMP^T are total exports and total imports, respectively. Equation (57) states that total private investment is determined residually as the sum of savings, depreciation, change in stocks and the net position of the government and foreign sectors.

66. The closure rule in the WALRAS model can be varied for different simulations. In the long-term simulations reported in Section VIII, it is assumed that the initial government deficit and base-year foreign trade

imbalance do not change. Given a change in agricultural policy, the government's deficit could be expected to change. In the model, the marginal income tax rate can be adjusted to restore the initial government deficit/surplus position. Revenue-neutrality is considered the appropriate closure to apply to the government sector for long-term simulations. Similarly, it would be unreasonable in the long-run to have a changing foreign balance. In the model, the nominal exchange rate is the mechanism which restores the initial balance-of-payments position. In the case of exogenous government and foreign trade imbalances, the model is almost entirely savings driven. If these constraints are relaxed, changes in the fiscal and external imbalances would be expected to have crucial effects on the aggregate savings-investment picture.

8. Equilibrium conditions

67. Once fully specified, the model is solved by using a numerical solution method described in Section VII. The solution algorithm reaches an equilibrium by iterative evaluation of the excess-factor demand system, assuming demands equal supplies -- equations (59) to (61) -- for all products and each industry meets a zero-profit condition representing the absence of supernormal profits in equation (62). Once these conditions are satisfied, equation (57) guarantees the closure of the entire system. Thus, we have to find the set of factor prices and a nominal exchange rate such that:

$$Q_i = \sum_j X_{ij} + FD_i \tag{58}$$

$$\bar{K} = \sum_i K_i + K_G \tag{59}$$

$$\bar{L} = \sum_i L_i + L_G \tag{60}$$

$$\bar{M} = \sum_i M_i \tag{61}$$

$$P_i Q_i (1-s_{Qi}) = \sum_j P_j (1+t_{ji}) X_{ji} + r K_i + w L_i + rm M_i \tag{62}$$

IV. MICRO-CONSISTENT DATA SETS

1. Introduction

68. As with all AGE models, constructing the benchmark data set of the WALRAS model involved a major investment in data collection, which needed to be adjusted to ensure consistency and to fit the model's sectoral disaggregation. Input-Output (I-O) tables provided the essential source, supplemented by data from other sources, including OECD National Accounts and foreign trade statistics. Additional information was required to split value added into the returns to each primary factor of production distinguished in the model.

69. 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. This choice was governed by the availability of the latest I-O tables for the countries in question. The basic I-O tables were supplied by national statistical agencies. Full details on the country-specific data sources, together with a description of the various adjustments made to ensure consistency, are presented in Annex II.

2. The input-output framework

70. The accounting framework underlying the typical AGE model consists of a record of all the commodity transactions occurring in the different markets that comprise the economy. I-O tables, constructed as part of the National Accounts framework, represent the most detailed set of demand and production accounts available. In particular, the I-O tables provide the data for the thirteen industries on the production side as well as for the components of final demand. The three primary factors -- labour, capital and land -- are also derived from value-added data, as measured in the I-O tables. Finally, the current account balance is defined as exports minus imports; these data are taken direct from the I-O tables and net investment income from non-residents is disregarded in the model.

71. The basic framework for which data are required for all countries is laid out in Figure 3. The common data adjustments to the four main blocks of the I-O tables are now described in turn.

3. Intermediate transactions

72. Each national inter-industry set of intermediate demand tables is transformed into a 13 x 13 transaction matrix which shows the amounts of the output of industry i that are used by industry j. For each country, the transaction matrix is split between domestic and imported intermediate inputs.

4. Final demand block

73. In addition to the inter-industry flows, data are required for final demand, split between domestically-produced and imported components. In the WALRAS model, final demand is disaggregated into ten private consumption goods, private investment, the change in stocks, government expenditures and exports (See Table 1). The transition matrix, which has 13 producing sectors and 10 private consumption categories (see Figure 3), is used to resolve the incompatibility between the different classifications on the production and consumption sides of the model. Each coefficient of the transition matrix represents the amount of each industry's output used in producing each consumer good.

5. Value-added sector

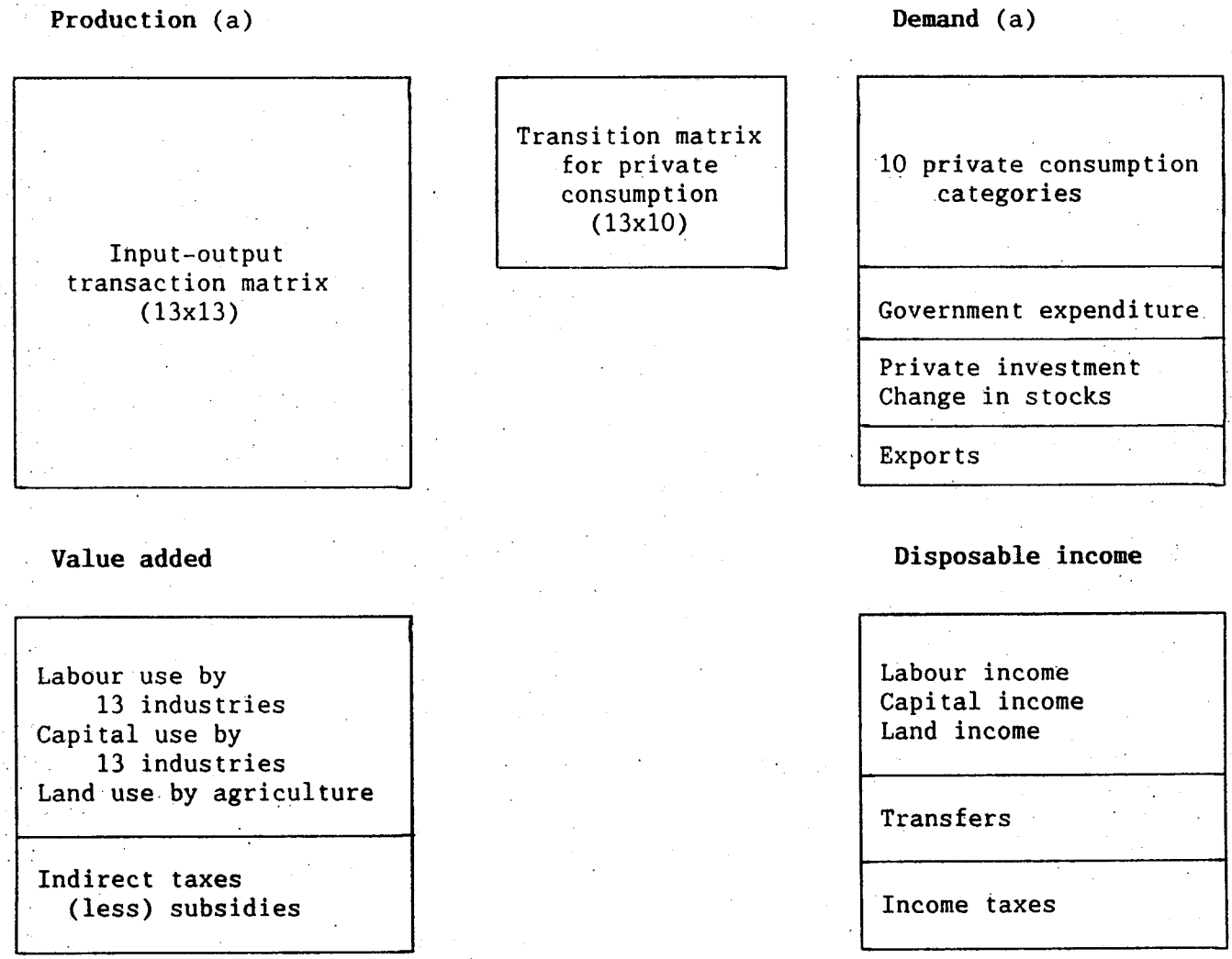
74. Value added at market prices in each industry is split into five components, resulting in a 5 x 13 matrix:

a) Return to labour

This is the sum of employee compensation plus an imputed wage income for the self-employed.

Figure 3

SCHEMATIC REPRESENTATION OF DATA REQUIREMENTS



a) Both the production and final demand matrices are split between imports and locally-produced commodities.

b) Return to capital

This consists of the portion of self-employed income which is imputed to capital, plus the other components of "operating surplus", and the depreciation of fixed capital.

c) Return to land

The initial two-way split of the factors of production is further disaggregated for the two agricultural industries between labour, capital and land. Since land is not assumed to be a primary factor in the non-agricultural sectors, the return to urban land is ignored.

d) Indirect taxes and subsidies

The final two components of value added at market prices are indirect taxes and subsidies.

6. Personal incomes and savings

75. Personal disposable income is defined such that personal consumption plus savings plus government transfers to the household sector equals GDP at factor cost minus consumption of fixed capital (depreciation) and personal income taxes. The necessary exogenous data for depreciation, general government transfers to households and net lending of general government are taken from the standardized OECD National Accounts. All the other data are from the I-O tables.

V. CALIBRATION AND PARAMETERISATION

1. Introduction

76. The equations of the WALRAS model are not estimated econometrically, instead the model is calibrated on the benchmark year, which is taken to be 1980 or 1981, depending on the country. The basic assumption underlying the calibration procedure is that the economy is in equilibrium in the base-year. This means that in each country/region prices of all goods and factors of production are such that:

1. Demands (household, industries, investment, government and exports) equal supplies of all commodities;

2. Profits are zero in all industries;

3. All domestic agents have demands which satisfy their budget constraints.

77. Calibration consists of adjusting certain parameters to make the model fit the benchmark data, given the model's behavioural assumptions, its accounting identities and exogenous values for selected parameters. The exogenous parameters are often taken from the econometric literature, usually based on time-series analysis. As will be seen below, a literature survey

revealed a wide range of estimates for the exogenous parameters. Given the uncertainty surrounding these key parameter values, it is important to subject the results of model simulations to extensive sensitivity analysis.

2. The calibration procedure

78. The calibration procedure proceeds in two stages: pre-calibration and calibration. At the pre-calibration stage, some variables are computed from the basic data without any explicit assumptions about exogenous elasticity values. In the WALRAS model, gross output, factor income, indirect tax rates and tax revenue are examples of variables calculated at the pre-calibration stage. Variables computed at the pre-calibration stage are also used for calibration.

79. In the WALRAS model, the following parameters are determined by the calibration procedure:

- -- the distribution parameters of the production functions;
- -- the distribution parameters of the private consumption and government utility functions;
- -- the intercept term of the tax function;
- -- the parameter of the export function;
- -- the minimum level of consumption expenditures.

3. Parameterisation

80. The following key parameters are exogenous in the WALRAS model:

- -- Elasticities of substitution between labour and capital
- -- Elasticities of substitution between land and the labour-capital bundle
- -- Price elasticities for imports
- -- Price elasticities for exports
- -- Income elasticities for consumer goods
- -- Marginal tax rates on household incomes
- -- Elasticity of substitution between types of government expenditure.

81. A large number of studies were reviewed in the search for plausible values for these elasticities. At this stage of the project, identical values for all substitution elasticities in production and trade elasticities were taken for all countries (Table 2). For the income elasticities of demand for the various consumer goods, it was felt that more reliance could be placed on literature-based estimates. Each of these elasticities are now presented in turn.

4. Elasticities of substitution between labour and capital

82. The Caddy (1976) survey, although rather old, is still a widely-used source of empirical estimates for AGE modellers, who generally use elasticities in the 0.5 to 1.0 range. For agriculture, Caddy's review suggests that elasticities are lower than in the manufacturing sector. Ballentine, Thirsk and Dean (1978) found the reverse in a review of the literature for Canada. In a more recent study of sector-specific elasticities, Harrison, Jones, Kimbell and Wigle (1987) were unable to obtain

Table 2

PARAMETERS VALUES USED FOR BASELINE SIMULATIONS

(All Countries)

Sector:	Substitution elasticities between		Price elasticities for:	
	Labour and Capital	Land and Labour/Capital Bundle	Imported Intermediate Demand	Export Demand
Livestock	0.8	0.5	-2.0	-2.0
Other agriculture	0.8	0.5	-3.0	-3.0
Other primary industries	0.8	..	-0.1	-0.3
Meat products	0.9	..	-3.5	-3.0
Dairy products	0.9	..	-3.5	-3.0
Other food products	0.9	..	-3.0	-3.0
Beverages	0.9	..	-2.5	-2.5
Chemicals	1.1	..	-2.5	-2.5
Petroleum & coal products	0.9	..	-2.5	-2.5
Other manufacturing	1.0	..	-2.5	-2.5
Construction	1.0	..	-0.1	0.0
Wholesale & retail trade	1.0	..	-2.5	-2.5
Other private services	1.0	..	-1.5	-1.5

Consumer goods:	Price elasticity of import demand
Food and non-alcoholic beverages	-3.0
Alcoholic beverages	-2.5
Tobacco	-2.5
Clothing and footwear	-2.5
Gross rents, fuel and power	-0.5
Household equipment and operation	-2.5
Medical care	0.0
Transport and communication	-2.0
Education and recreation	-0.1
Miscellaneous goods and services	-2.0

Elasticity of substitution between types of government expenditure (wage, non-wage and investment)	0.75

a satisfactory estimate for the substitution elasticity prevailing in agriculture.

83. Based on the literature, it was decided to use an elasticity of 0.8 for agriculture and 0.9 to 1.1 for non-agricultural sectors.

5. Elasticity of substitution between land and the labour-capital bundle

84. We were unable to find any studies which explicitly estimate this substitution elasticity. The available literature relates to the partial elasticities between land and other inputs to agricultural production (see Vincent (1978) for Australia; Lopez (1984) for Canada; Kako (1978) and Kuroda (1987) for Japan; and Binswager (1974) and Capalbo (1986) for the United States. The results suggest a wide variation in estimated elasticity values, even within a given country, from below 0.1 to well over 1.0. The diversity of results reflects different data for labour (often it is confined to hired labour), capital, land and other inputs, and also different estimation methods. Some U.S. studies for show that both land and labour, and land and agricultural equipment, are complements rather than substitutes. The land set-aside scheme may have importantly influenced this empirical result. The literature also points to changes over time in the substitutability (or complementarity) of agricultural inputs.

85. Partly based on the above literature, a value of 0.5 was assigned for all countries' elasticity of substitution between land and the labour-capital bundle.

6. Price elasticities of import demand

86. Substitution elasticities between imports and domestically produced goods are required, at both the intermediate and final demand levels. These can be derived from estimated price elasticities of import demand. However, the available estimates of price elasticities are based on imports classified by broad SITC groups and do not distinguish imports by end-use. Moreover, the SITC classifications do not correspond with the industrial classification in the WALRAS model. For example, the food category (SITC section 0) includes both unprocessed and processed foods, i.e. it corresponds to industries 1,2,4,5 and 6 in the WALRAS model. Thus, it is not possible to identify separate elasticities for the two agricultural sectors and the three food processing industries.

87. Estimates of import price elasticities are generally derived from time-series regressions; the estimates vary substantially according to the income and relative price measures used. Econometric estimates are also affected by the functional form, the level of aggregation, the simultaneity between import and export volume and price determination, the stability of the relationship over time, and the assumed time lags (6).

88. In general, disaggregated studies show quite high long-run elasticities. This is not a surprising result, since disaggregated commodities are likely to be more homogeneous across countries, more substitutable and therefore more sensitive to relative price changes. In a classic study, Orcutt (1950) showed that in aggregate trade equations, goods with relatively low price elasticities can display the largest variation in prices and therefore bias downwards the estimated aggregate price elasticity.

89. Another important consideration is that most estimated import price elasticities have been calculated over periods during which quantitative restrictions, especially for agricultural products, have been in force or even strengthened. Weights given to restricted items in aggregate price and volume indices are therefore zero or much smaller than those which would prevail under free trade, thereby distorting econometric estimates. This problem may be particularly acute in Japan, which maintains quantitative import restrictions for important food items such as beef and rice. It is probably for this reason that estimated values of the price elasticity for food imports in Japan are generally rather low.

90. The Ministerial Trade Mandate (MTM) model constructed by the OECD Directorate for Food, Agriculture and Fisheries -- see OECD (1987, Annex IV) -- incorporates estimates of medium-term supply and demand elasticities for agriculture for a wide range of OECD countries. With a little manipulation it is possible to derive estimates of import and export price elasticities from estimates of domestic supply and demand elasticities (7). For example, using the domestic demand and supply elasticities from the MTM model, together with 1980 values for agricultural demand, supply and imports from the Japanese I-O tables, the implied value of the import price elasticity for agricultural products is 3.7. This elasticity is significantly higher than any of the values for Japan reported in the econometric literature, even though the MTM elasticities were deliberately chosen to be medium-term (3 to 5 years) rather than long-term values.

91. The following conclusions affected the choice of the elasticities shown in Table 2:

i) There is little to indicate that literature-based elasticity estimates have changed radically since the classic survey by Stern et al. (1976).

ii) Disaggregated price elasticities should be higher than estimates at a more aggregate level.

iii) The available literature does not provide estimates which correspond exactly to the level of sectoral disaggregation of the WALRAS model.

iv) Econometric estimates of price elasticities for agricultural and food products as a group appear to be lower than those for manufactured products, even though the latter are rather heterogeneous. This finding, which is contrary to a priori expectations, may simply reflect the fact that much of agricultural trade between OECD countries is subject to a wide variety of trade barriers.

v) Implicit estimates of import elasticities derived from domestic demand and supply elasticities give much higher values than direct estimates based on time-series analysis.

92. For total exports, Stern et al. (1976) conclude that it may be reasonable to work with elasticities in the range of -0.5 to -2.0, slightly higher than the range cited for total imports (-0.5 to -1.5). The OECD Secretariat has also found that export price elasticities for manufactures

(-1.0 to -2.0) generally exceed those of imports (-0.7 to -1.2). Goldstein and Khan (1985) also come to the same conclusion.

93. In the Stern et al. review, the United States is the only country for which they report a set of disaggregated price elasticities:

SITC category:	Range	Best (Median estimate)
0+1 Food	-0.38 to -2.09	-0.85
2+4 Raw materials	-0.31 to -3.10	-0.86
5-9 Manufactures	-0.56 to -2.62	-1.24

94. In the ORANI model for Australia, export price elasticities are given a value of 20 for many agricultural products (See Dixon et al. (1982). The rationale for such high values is based on an accounting identity which expresses a given country's export elasticity as a function of the own-price elasticities of demand and supply in partner countries, together with the transmission of the exporting country's export prices into partner countries' consumer and producer prices. Given differing assumptions about partner countries' elasticities, derived export price elasticities can vary between values of less than 5, through to values of 50 or more (See Cronin (1979) for details).

95. The following considerations were relevant when deciding the base-case values for export elasticities shown in Table 2:

i) The literature is often confined to studies of total exports or exports of manufactures only; reported estimates generally tend to fall within in the -1.0 to -2.0 range.

ii) The little information available in the literature on price elasticities of demand for food exports suggests that values are lower than for manufactures. No account of the high degree of product substitutability within food sub-categories has been allowed for in drawing up this table.

iii) Using an alternative approach to direct econometric estimation -- based on plausible assumptions on trading countries domestic demand and supply elasticities -- much higher export price elasticities can be derived.

8. Income elasticities for consumer goods

96. As with the foreign trade elasticity estimates, the income elasticities of consumer demand depend critically on a priori specifications. Many studies use the Linear Expenditure System (LES) specification. Within the LES framework, a simultaneous proportional decrease in the price of one good and an increase in total expenditures has the same net effect on the demand for another good, irrespective of which good has its price decreased. Moreover, the LES system does not allow for complementarity between goods. With the exception of Flood et al . (1984), all the income elasticities reported in Table 3 use the LES framework.

97. Based on the literature search reported in Table 3, we assigned country-specific values for each consumer good (see Table 4), bearing in mind the following considerations:

i) The literature rarely employs a uniform commodity breakdown, and none fits exactly the commodity disaggregation used in the WALRAS model.

ii) For all countries, estimated income elasticities for expenditures on food, beverages and tobacco are much smaller than 1.0. Services categories generally have values slightly above unity (except for transportation and communication where the estimated elasticities are considerably higher).

iii) It is necessary to ensure that the values chosen yield realistic marginal savings propensities for the private sector.

9. Marginal tax rates on household incomes

98. The marginal tax rates on household income are also shown in Table 4. The rates are those applying to the taxable income of an average production worker, defined as an employee in manufacturing with the average earnings of the sector in 1981 (8). The rates applying to single people and to a married person with two children were averaged. Direct taxes paid to Central and State governments, and the social security contributions paid by both employees and employers, are included. Where applicable, allowance is made for the tax deductibility of social security contributions. The effect of indirect taxes is not included, as these are modelled separately in the WALRAS system.

10. Elasticities of substitution between types of government expenditure

99. It is assumed that the government substitutes between non-wage, wage and capital expenditure (transfers are exogenous). We were unable to find any empirical estimates of CES substitution elasticities for these expenditures. In the WALRAS model an elasticity of substitution of 0.75 in all countries has been assumed. This is the same value as that used by Damus (1986).

VI. MODELLING AGRICULTURAL POLICIES

100. Agricultural policies in OECD countries are extremely complex, comprising a mix of price-support policies, input subsidies, direct and indirect income payments to farmers, and various supply-management policies. The balance between these measures differs widely across countries. Hence, it is not easy to design a set of policy variables for an AGE model which can capture all the elements of agricultural policy in a realistic way.

101. A common approach in the AGE literature has been to represent agricultural policies as a set of "subsidy-equivalent" measures or ad valorem wedges between producer and consumer prices. Specifically, we decided to represent agricultural policies in the WALRAS model in terms of a set of

Table 3

LITERATURE SURVEY OF INCOME ELASTICITIES

	Australia		Canada					EEC			Japan	New Zealand	United States			
	Lluch-Powell (1975)	Chung-Powell (1987)	Powell (1965)	Goldberger-Gamaletsos (1971)	Wales (1971)	Hassan (1974)	McIntosh (1974)	Goldberger-Gamaletsos (1971) (a)	Lluch-Powell (1975) (b)	Lluch-Powell-Williams (1977)(b)	Flood-Finke-Theil (1984)	Jackson (1983)	Goldberger-Gamaletsos (1971)	Lluch-Powell (1975)	Lluch-Williams (1975)	Lluch-Powell-Williams (1977)
Food and non-alcoholic beverages	0.4	0.4	0.6	0.7	0.3	0.5	0.4	0.7	0.6	0.6	0.6	0.4	0.3	0.3	0.4	0.3
Alcoholic beverages			0.8	–			–	–				1.1	–		–	
Tobacco				–			–	–					–			
Clothing and footwear	0.5	0.7	0.7	0.3	0.3	1.0	0.5	0.9	0.9	0.9	0.6	0.7	0.6	1.1	0.9	1.1
Gross rents fuel and power	1.9	0.9	0.5	1.9	1.1	0.8	1.3	0.7	1.1	1.1	1.7	1.5	1.5	1.0	1.1	0.9
Household equipment and oper.	1.0	1.9	2.1	1.3		1.0		2.4	1.4	1.6		0.9	0.8	1.8	1.5	1.4
Medical care	2.2	1.3	–	–	(c)	0.6	–	–	1.3	1.2	1.4	(c)	–	1.4	1.1	1.7
Transport and communications	1.6		2.3	0.9	–	1.2	1.4	1.0	2.0	1.8		1.3	1.3	1.4		1.1
Education and recreation	0.4		–		1.7	1.3	1.2		1.1	1.0		1.5		1.1		1.2
Miscellaneous	1.1		1.0				1.4		1.7	1.7				1.4		2.3

a) Average of Belgium, France, Ireland, Italy and the United Kingdom.

b) Average of Ireland, Italy, United Kingdom and Germany.

c) This item is merged with the "Education and recreation" and "Miscellaneous" categories.

Table 4

INCOME ELASTICITIES AND MARGINAL TAX RATES IN WALRAS MODEL

	Australia	Canada	EEC	Japan	New Zealand	United States
Income elasticity of demand for:						
Food & non-alcoholic beverages	0.4	0.5	0.4	0.5	0.5	0.3
Alcoholic beverages	0.4	0.5	0.5	0.5	1.1	0.3
Tobacco	0.4	0.5	0.5	0.5	1.1	0.3
Clothing & footwear	0.6	0.6	0.6	0.5	0.7	0.6
Gross rents, fuel and power	1.4	1.1	1.2	1.3	1.3	1.2
Household equipment & operation	1.5	1.4	1.5	1.3	0.9	1.4
Medical use	1.7	0.6	0.6	1.2	1.4	1.1
Transport and communication	1.5	1.3	1.5	1.1	1.2	1.0
Education and recreation	0.8	1.0	1.2	1.1	1.3	1.0
Miscellaneous goods & services	1.2	1.2	1.4	1.2	1.3	1.4
Marginal tax rate in 1981 (per cent)	34.5	30.7	50.8	37.4	45.2	45.1

Sources: Table 3 (for income elasticites); Tables 6 and 7 of McKee, Visser and Saunders (1986), (for tax rates).

import tariffs, export subsidies, input subsidies and consumption taxes/subsidies. The ad valorem price wedge approach has three advantages:

a) It is relatively transparent;

b) It is easy to incorporate into the structure of AGE models;

c) It permits use to be made of the detailed data on Producer (or Consumer) Subsidy Equivalents (PSEs and CSEs) which have been prepared by the OECD Directorate for Food, Agriculture and Fisheries for key temperate-climate agricultural products.

102. The use of ad valorem price wedges to represent agricultural policies is not without problems (9). First, it is extremely difficult to quantify the tariff equivalents of import quotas and other non-tariff barriers to agricultural trade, partly because of the uncertainty over who reaps the benefits from the quotas (10).

103. Second, domestic supply management programmes such as production quotas and land set-asides, are also difficult to model. In the case of land set-asides in the United States, a farmer's decision on whether or not to participate depends on the programme's impact on farm profitability. This participation decision has important implications for output, prices and welfare (11).

104. In the context of the WALRAS model, we were not faced with the problem of integrating supply controls into the equilibrium framework, since some of the major supply-reducing policies were not operative in our 1981 base-year. One simple way of modelling restrictions on farm inputs is to assume that endowments of land or farm livestock are changed by specific policies such as set-asides or whole herd buyout schemes.

1. OECD data on PSEs/CSEs

105. The PSEs and CSEs are designed to encapsulate in a single aggregate measure the effect of a wide range of agricultural policies on producers and consumers. PSEs attempt to measure the payment that would be required to compensate farmers for the loss of income resulting from the removal of all forms of support for a particular commodity at existing production levels. The CSE corresponds to the implicit tax on consumers resulting from a given policy measure, the product price support element of the PSE, allowing for any subsidies to consumption.

106. Four broad types of policy measures are covered in the PSE calculations: i) market price supports; ii) direct income support; iii) indirect income support; and iv) other support. Market price supports include direct price supports, import tariffs and quotas, and export subsidies (12). Direct and indirect income supports cover measures which raise the effective income of producers but do not increase consumer prices. They include deficiency payments, storage payments, input subsidies, disaster relief and producer levies. Other budgetary support includes expenditures on research and development, inspection, processing and marketing, transport concessions and some tax expenditures.

107. PSEs/CSEs for the years 1979-81 were calculated for 14 commodities and a range of OECD countries -- Australia, Austria, Canada, the EEC, Japan, New Zealand and the United States. Full details are available in the country-studies which were published together with OECD (1987). However, several adjustments had to be made before these data could be used as ad valorem price wedges in the WALRAS model.

2. Adjustments to the PSEs/CSEs data

108. The total value of assistance to producers of a given commodity -- total PSE -- is measured as follows:

$$\text{Total PSE} = Q.(P_d - P_w) + D - L + B \qquad (63)$$

where Q = volume of domestic output;
P_d = domestic producer price;
P_w = world (or reference) price;
D = direct payments to producers;
L = producer levies;
B = other budget payments.

109. Estimates of implicit import taxes and export subsidies were derived from the price-comparison component of the PSE (PCPSE), the differential between domestic producer prices and world prices. The PCPSE is derived by the value of the price differential as a ratio of the value of production excluding direct and indirect payments:

$$\text{PCPSE} = [Q.(P_d - P_w)]/Q.P_d \qquad (64)$$

$$= (1-P_w/P_d) \qquad (65)$$

The extent to which domestic prices exceed world prices (P_d/P_w) is given by $1/(1 - \text{PCPSE})$. This price ratio is exactly analogous to a nominal import tariff or export subsidy.

110. Since the PSEs are calculated for individual commodities, it is necessary to aggregate them according to the sectoral split in the WALRAS model. The first step in this process is to establish a correspondence between the fourteen commodities used in the PSE calculations and the sectoral breakdown of agriculture and food processing industries of the WALRAS model (Table 5). Then, using import/export weights taken from the 1981 FAO Trade Yearbook, the implicit nominal tariff/export subsidy in each WALRAS sector can be calculated.

111. The PSE calculations do not cover all agricultural commodities. On average, the included commodities accounted for around 70 per cent of total agricultural production in 1979-81 in the countries included in the exercise. The excluded commodities were treated as follows. For meat and dairy products, it was assumed that the commodities for which PSEs were calculated were representative of the price differentials applicable to the entire sector. In contrast, for "other agriculture" and "other food", those commodities not covered by the PSE calculations were implicitly assumed to have zero protection in the base year. Thus, the support given to these two sectors is almost certainly underestimated (13).

Table 5

CORRESPONDENCE BETWEEN THE PSEs BY COMMODITY AND THE SECTORAL DISAGGREGATION IN THE WALRAS MODEL

PSE commodity	WALRAS sector
Wheat (all countries)	Other agriculture
Coarse grains	Other agriculture
Barley (most countries) Corn/maize (Canada, EEC, United States) Rapeseed (Canada, EEC) Sorghum (United States)	
Wool (Australia, New Zealand)	Other agriculture
Soyabeans (EEC, Japan, United States)	Other agriculture
Sugar (a)	Other food products
Raw (United States) Beet (Canada, EEC, Japan) Cane (Australia, Japan)	
Rice (a) (Australia, EEC, Japan, United States)	Other food products
Beef and veal, Pigmeat, Poultry meat } (all countries)	Meat products
Sheepmeat (Australia, EEC, New Zealand)	Meat products
Dairy (Milk) (all countries)	Dairy products

a) In countries where assistance was separately identified for both producers and processors, the latter were allocated to "other food". Subsidies to producers were classified under "other agriculture".

112. The non-price components of the PSEs were treated as an input subsidy to production for the "livestock" and "other agriculture" sectors, and are expressed as a percentage of gross output in each of these two sectors. The non-price components of the CSEs are transfers to consumers. In some cases domestic producers receive a much higher price than that paid by domestic consumers. If the domestic price comparisons in the PSE and CSE calculations were not identical, their differential was modelled as a consumer subsidy or tax.

113. Estimates of the base-year levels of implicit import taxes, export subsidies, production input subsidies and consumer subsidies for all countries are given in Table 6. Details of the calculations are given in Annex III. For some sectors the price wedges are extremely large. However, the value of flows in the "livestock" and "other agriculture" sectors far exceed those of "meat products" and "dairy products". For example, the 5 to 6 per cent input subsidies (deficiency payments, grain-stocking policies etc.) in the United States are quantitatively far more important than the 65 per cent import tariff-equivalent in the dairy product sector. To obtain a better appreciation of the quantitative importance of each policy instrument in the five agricultural and food-processing sectors, the percentage price wedges in Table 6 should be compared with the output, import and export weights shown in Table 7.

114. The relative weights of border measures and input subsidies in the total level of agricultural support vary across the countries. In Australia, Canada, New Zealand and the United States, direct and indirect income supports to producers account for the vast bulk of agricultural support. In Japan and the EEC, on the other hand, border measures account for a significant proportion of total assistance to the agricultural sector.

VII. MODEL SOLUTION

115. A variety of different iterative solution algorithms can be used to solve AGE models. While some of them, such as Scarf's or Merrill's algorithm, explore the unit simplex of factor prices when searching for the equilibrium solution, others, such as Newton-type methods or Kimbell and Harrison's factor price revision rule, move from the base equilibrium to the solution by adjusting the equilibrium prices according to the excess demands observed at each iteration. The former set of solution methods has the theoretical advantage of guaranteeing convergence but the latter methods are becoming increasingly popular because of their relative simplicity and flexibility. Another class of solution algorithms, which rely on successive linear approximations to the non-linear equilibrium levels -- Johansen-type methods -- are also popular because of the speed of convergence and the ease with which such a method can be pre-programmed on mini-computers (14).

116. In the WALRAS model, a tâtonnement procedure based on the Gauss-Siedel algorithm was chosen for its practical advantages in solving non-linear models. First, the set of equilibrium prices is not constrained to sum to unity so that the prices are less interdependent. Second, the solution path is continuous, making simultaneity problems easy to solve without adding

Table 6

ESTIMATES OF POLICY INSTRUMENTS (a)

(Per cent)

Sector	Australia (1980/81)				Canada (1981)				EEC (1979/81)				
	Import tax	Export subsidy	Production input subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production input subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production input subsidy	Subsidy on consumption	
												Inter-mediate	Food
Livestock	0.0	0.0	5.3	0.0	0.0	0.0	11.4	0.0	0.0	0.0	6.8	0.0	0.0
Other agriculture	0.0	-3.8 (b)	2.6	0.0	0.3	0.1	10.3	0.0	2.7	6.6	2.2	0.0	0.0
Meat products	0.0	0.0	0.0	0.0	3.5	0.6	0.0	0.0	55.1	49.6	0.0	0.0	0.0
Dairy products	2.5	0.0	0.0	0.0	37.4	37.4	0.0	0.0	114.1	114.1	0.0	3.7 (c)	1.3
Other food	0.0	-1.3 (b)	0.0	0.0	1.9	0.0	0.0	-0.3	3.2	16.7	0.0	0.6 (c)	0.0

Sector	Japan (1980)				New Zealand (1981-82)				United States (1981)			
	Import tax	Export subsidy	Production input subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production input subsidy	Subsidy on food consumption	Import tax	Export subsidy	Production input subsidy	Subsidy on food consumption
Livestock	0.0	0.0	8.6	0.0	0.0	0.0	15.0 (d)	0.0	0.0	0.0	4.8	0.0
Other agriculture	4.7	0.0	10.8	4.1	0.0	0.0	0.0 (d)	0.0	0.5	0.0	5.8	0.0
Meat products	27.5	27.5	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.6	0.0	5.8
Dairy products	184.9	184.9	0.0	0.5	0.0	0.0	0.0	6.2	65.3	65.3	0.0	6.0
Other food	26.7	21.5	0.0	3.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0

a) This table has been prepared on the basis of producer and consumer subsidy equivalents (PSE/CSEs), published in Table 2 of Annex II of OECD (1987). The import taxes and export subsidies have been derived from the price components of PSEs: the percentage by which domestic producer prices exceeded world prices in the base-year was multiplied by the sectoral weight of the commodities for which PSEs are available. Input 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 (taxes if a negative sign) to consumers are government budget payments to consumers, expressed as a percentage of domestic food consumption of the sector. For further details, see Annex III.

b) The negative sign reflects the tax on sugar producers and millers, whose producer price for domestic consumption was only 62 per cent of world prices in 1980/81.

c) Reflects compensatory aids to food processors.

d) The input subsidy to wool and crops is applied to the "livestock" sector in the New Zealand case, since all mixed farming is included there.

Table 7

STRUCTURE OF AGRICULTURE AND FOOD PROCESSING SECTORS (a)

(Per cent)

	Australia	Canada	EEC	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	7.8	0.2
Other agriculture	9.1	5.7	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	3.7
Share of imports						
Livestock	0.0	0.4	0.9	0.5	0.2	0.2
Other agriculture	0.8	1.7	7.0	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 products	2.2	2.5	3.2	3.7	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 Annex II for details.

further dimensions to the equilibrium price set, as would be the case with Merrill's algorithm or Newton-type methods.

117. In non-technical terms, the solution method is as follows. At the beginning of each iteration, factor prices and the nominal exchange rate are set to one. The model first uses these prices to solve for the technical coefficients used in each production sector and to obtain producer prices (see Figure 4). Using the transition matrix, producer prices can be converted to consumer good prices. Primary factor prices also determine the income of consumers, under the assumption that all factors are fully employed. Once both consumer incomes and consumer prices are determined, it is possible to calculate the demands for consumer goods, the most important component of final demand.

118. Government spending is fixed exogenously and is allocated to various goods and services as a function of factor and producer prices. Stock changes are also exogenous. Exports are determined by producer prices relative to foreign prices. To determine the level of investment -- the remaining component of final demand -- it is necessary to know imports and government revenue, so that foreign and public saving can be calculated. But these variables depend on the level of production, and thus cannot be obtained without prior knowledge of final demand. To avoid this simultaneity problem, the model uses values for these missing variables calculated in the previous iteration as a proxy for their values in the current one. With these and private saving, the level of investment can be calculated, and assigned to the purchase of goods and services from each sector of production, as a function of producer prices. The closer the model is to solution, the smaller is the bias introduced by using previous iteration values for some variables.

119. When all components of final demand are known, the production sub-model is used to determine total output required to meet demand, and subsequently imports, labour, capital and land demands. Government revenue from all types of taxation can then be obtained.

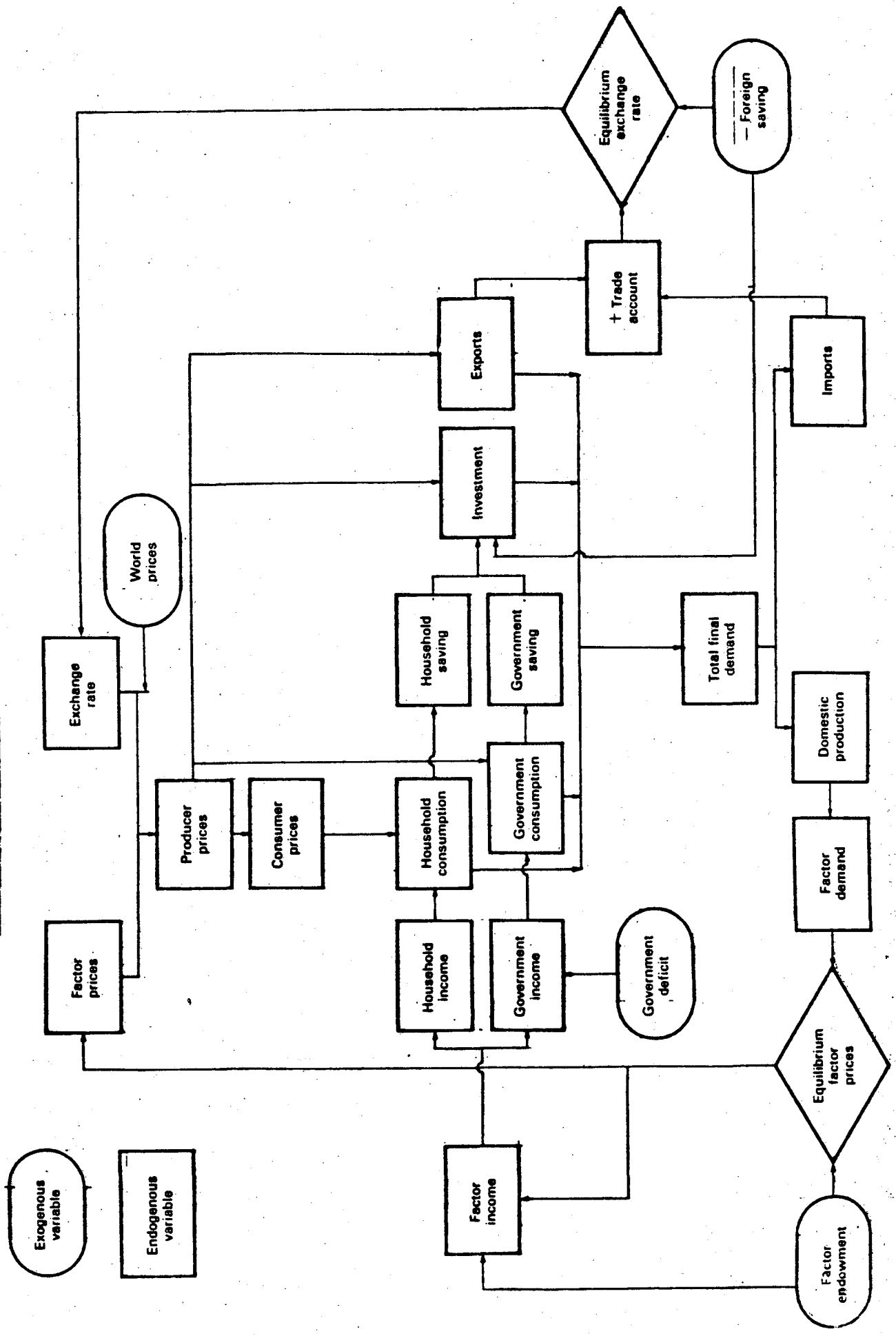
120. It is now possible to verify whether these values correspond to an equilibrium solution. Labour, capital and land demands are compared with the total supply of each of these factors of production, and imports are compared with exports. If all of these values are balanced, a baseline equilibrium solution and allocation of resources is obtained. Otherwise, a new iteration starts, with adjustments being made to the three primary factor prices and the nominal exchange-rate variable.

VIII. INITIAL RESULTS

121. In presenting results, an arbitrary choice has to be made concerning the numeraire price, since only relative prices are important in an AGE model. The price of domestic value added at factor cost -- the weighted average of the prices of labour, capital and land -- was chosen as the numeraire. This allows us to define a real exchange rate, which is equal to the weighted sum of domestic primary factor prices i.e. the numeraire, divided by the world price expressed in domestic currency. Since world prices are exogenous in simulations, changes in world prices in local-currency terms are equal to

Figure 4

FLOW CHART OF THE WALRAS MODEL



changes in the nominal exchange rate. Thus, the real exchange rate reported below is simply equal to the numeraire deflated by the nominal exchange rate.

122. As will be seen, the terms of trade have an important effect on the simulation results. The terms of trade are defined as the ratio of average export prices to average import prices, as seen from the perspective of the home country. Thus, export prices are measured inclusive of export subsidies on agricultural goods, whereas import prices are measured excluding tariffs and variable levies. It can be shown that the terms of trade are directly related to the real exchange rate as defined above, the difference between the two concepts being mainly due to the structure of protection in each economy and its influence on the real exchange rate (15).

123. Before discussing the results it is helpful to bear in mind the relative sizes of the agricultural and non-agricultural sectors in each economy. Data on some structural indicators for the four broad sectors -- agriculture, food processing, other industry and private services -- are shown in Table 8.

1. The base-case simulation

124. For the base-case (Scenario 1 in Tables 9 to 14) a full unilateral removal of agricultural assistance from the levels prevailing around 1980 is simulated for each country, assuming that world trade prices are given and there is no change in protection in the non-agricultural sectors. The closure rule for this simulation is no change in both the government balance and the current account. For the government account, the tax rate on private incomes is changed in order to maintain the given level of the government balance. The nominal exchange rate adjusts to keep the current account unchanged.

125. The upper part of each country table provides information on the long-run intersectoral effects flowing from agricultural liberalisation. In each country, the agricultural and food-processing sectors contract while other industry and services expand. The size of the output contraction in agriculture varies across the countries, ranging from almost 12 per cent in Japan, through 7-8 per cent in New Zealand, Canada and the EEC to only 3 per cent in the United States. As would be expected, the decline is larger in the two agricultural sectors than in the food-processing sector where the output decline ranges from 7-8 per cent in Japan and New Zealand to less than 2 per cent in the United States. Other industry, which includes the rest of manufacturing, construction and other primary industries, expands by around 1 per cent or more in all countries except the United States where agricultural protection in the bench-mark year was not particularly high, in part because of the dollar's strength in 1981.

126. Given the assumptions about factor mobility, there is relatively little change in the prices of labour and capital, the factors that are mobile between sectors. The main burden of adjustment to agricultural liberalisation falls on the price of land. The land price is simulated to decline by more than 25 per cent in Japan, 20 per cent in Canada and New Zealand, by 15 per cent in the EEC and 10 per cent in the United States. The magnitude of this decline depends crucially on the substitution possibilities between land on the one hand, and labour and capital on the other. If capital and labour were assumed to be less substitutable with land, the simulated contraction of the agricultural sector would be less and the price decrease would be smaller.

Table 8

STRUCTURAL INDICATORS IN OECD COUNTRIES (a)

(per cent)

	Australia	Canada	EEC	Japan	New Zealand	United States
Agriculture's share in:						
Gross output	4.5	4.1	4.1	2.2	9.1	3.5
Exports	15.9	6.5	1.7	0.1	8.7	10.1
Imports	0.6	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
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 industries' share in:						
Gross output	39.0	46.4	49.1	52.8	38.6	43.8
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 service's share in:						
Gross output	49.6	43.9	39.5	40.3	41.4	47.7
Exports	24.1	12.9	24.0	19.3	27.6	22.5
Imports	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 (see Table 1), "food processing" is the total of industries 4, 5 and 6; "other industries" are industries 3, 7 to 11; and "services" are industries 12 and 13.

Sources: Input-Output tables of the various countries. See Annex II for details.

Table 9

SUMMARY OF RESULTS FOR COMPLETE ELIMINATION OF AGRICULTURAL SUPPORT: AUSTRALIA (a)
(per cent changes compared with baseline)

Sector (b)	Gross output	Employment	Factor income (c,d)	Producer prices (d)	Export volumes	Import volumes	Export price (d)	Import price (d)
Agriculture								
Scenario 1	-1.8	-1.5	-1.4	4.2	-0.8	5.6	1.4	0.6
Scenario 2	0.8	1.8	2.6	1.0	3.6	3.7	-1.3	-0.2
Scenario 3	-2.7	-3.2	-3.7	3.4	-4.7	2.2	3.1	0.9
Scenario 4	-2.8	-2.2	-2.0	4.0	-0.9	11.8	0.8	0.5
Food and beverages								
Scenario 1	-1.6	-1.0	-1.0	1.9	-3.0	3.1	1.6	0.4
Scenario 2	-0.3	-0.1	-0.2	0.3	-0.0	1.9	-0.2	-0.4
Scenario 3	0.3	0.3	0.4	0.3	0.9	-0.8	0.3	0.9
Scenario 4	-2.6	-1.4	-1.4	1.8	-5.8	7.3	1.5	0.3
Other industry								
Scenario 1	0.2	0.2	0.2	0.2	0.6	-0.5	0.2	0.6
Scenario 2	-0.1	-0.1	-0.2	-0.1	-0.2	0.1	-0.1	-0.2
Scenario 3	0.3	0.3	0.4	0.3	0.9	-0.8	0.3	0.9
Scenario 4	0.4	0.3	0.4	0.2	1.0	-0.9	0.2	0.5
Private services								
Scenario 1	0.2	0.2	0.2	0.1	0.9	-0.5	0.1	0.6
Scenario 2	0.0	-0.0	-0.1	-0.1	-0.2	0.2	-0.1	-0.2
Scenario 3	0.3	0.3	0.4	0.2	1.3	-0.8	0.2	0.9
Scenario 4	0.2	0.3	0.3	0.1	1.6	-1.1	0.1	0.5

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Producer prices (d)	0.4	-0.0	0.5	0.4
Consumption prices (d)	0.4	-0.0	0.4	0.4
Wage rate (d)	0.0	-0.1	0.1	0.0
Price of capital (d)	0.0	-0.1	0.2	0.1
Land price (d)	-0.7	5.5	-4.8	-1.1
Real exchange rate (e)	-0.6	0.2	-0.9	-0.5
Terms of trade (f)	-0.0	-0.1	0.0	-0.1
Export volumes	-0.2	0.5	-0.6	-0.3
Import volumes	-0.4	0.2	-0.7	-0.6
Income taxes (d)	-0.9	0.3	-1.2	-0.8
Real income (g)	0.2	-0.0	0.3	0.1

a) Scenario 1: Full liberalisation of agricultural support with both the current account and the government deficit unchanged.
Scenario 2: Abolition of border measures with both the current account and the government deficit unchanged.
Scenario 3: Removal of input subsidies with both the current account and the government deficit unchanged.
Scenario 4: Scenario 1 with all trade elasticities doubled.

b) Agriculture refers to sectors 1 and 2 in the WALRAS model; food and beverages refer to sectors 4 to 7; other industry refers to sector 3 and sectors 8 to 11; and private services refers to sectors 12 and 13. For further details, see Table 1 of Annex II.

c) Total factor remuneration.

d) Deflated by the GDP deflator at factor cost.

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

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

g) Hicksian equivalent variation as a per cent of real disposable income.

Table 10

SUMMARY OF RESULTS FOR COMPLETE ELIMINATION OF AGRICULTURAL SUPPORT: CANADA (a)
(per cent changes compared with baseline)

Sector (b)	Gross output	Employment	Factor income (c,d)	Producer prices (d)	Export volumes	Import volumes	Export price (d)	Import price (d)
Agriculture								
Scenario 1	-7.6	-11.3	-15.3	9.1	-13.5	12.1	7.0	1.3
Scenario 2	-0.8	-1.2	-1.6	-0.3	1.1	2.0	-0.2	-0.1
Scenario 3	-6.9	-10.3	-14.0	9.4	-14.6	10.3	7.2	1.3
Scenario 4	-11.2	-16.3	-21.2	7.1	-17.2	19.8	4.9	1.1
Food and beverages								
Scenario 1	-3.7	-3.4	-2.7	4.1	-8.7	13.2	5.1	-2.3
Scenario 2	-1.4	-1.2	-1.1	-0.2	-4.2	8.0	2.1	-3.4
Scenario 3	-2.5	-2.3	-1.7	4.3	-5.5	4.7	3.3	1.3
Scenario 4	-6.2	-5.5	-4.6	3.4	-11.6	30.6	4.4	-3.8
Other industry								
Scenario 1	0.8	0.7	1.2	0.7	1.6	-0.7	0.7	1.6
Scenario 2	0.1	0.1	0.1	0.1	0.2	-0.1	0.1	0.2
Scenario 3	0.6	0.5	1.0	0.6	1.2	-0.5	0.6	1.3
Scenario 4	1.3	1.1	1.7	0.7	2.4	-1.0	0.8	1.4
Private services								
Scenario 1	0.3	0.1	0.6	0.6	1.6	-0.9	0.6	1.6
Scenario 2	-0.0	-0.0	0.0	0.0	0.2	-0.1	0.0	0.2
Scenario 3	0.3	0.1	0.6	0.6	1.2	-0.7	0.6	1.3
Scenario 4	0.4	0.1	0.8	0.7	2.4	-1.3	0.7	1.4

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Producer prices (d)	1.2	0.0	1.1	1.1
Consumption prices (d)	1.1	-0.0	1.1	1.1
Wage rate (d)	0.5	0.1	0.5	0.7
Price of capital (d)	0.2	0.0	0.1	0.2
Land price (d)	-21.7	-1.6	-20.5	-29.5
Real exchange rate (e)	-1.4	-0.1	-1.2	-1.2
Terms of trade (f)	-0.3	-0.1	-0.2	-0.2
Export volumes	0.2	0.1	-0.1	0.6
Import volumes	0.1	0.3	-0.1	0.6
Income taxes (d)	-3.5	-0.0	-3.6	-3.4
Real income (g)	0.2	0.0	0.2	0.2

a) Scenario 1: Full liberalisation of agricultural support with both the current account and the government deficit unchanged.
Scenario 2: Abolition of border measures with both the current account and the government deficit unchanged.
Scenario 3: Removal of input subsidies with both the current account and the government deficit unchanged.
Scenario 4: Scenario 1 with all trade elasticities doubled.

b) Agriculture refers to sectors 1 and 2 in the WALRAS model; food and beverages refer to sectors 4 to 7; other industry refers to sector 3 and sectors 8 to 11; and private services refers to sectors 12 and 13. For further details, see Table 1 of Annex II.

c) Total factor remuneration.

d) Deflated by the GDP deflator at factor cost.

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

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

g) Hicksian equivalent variation as a per cent of real disposable income.

Table 11

SUMMARY OF RESULTS FOR COMPLETE ELIMINATION OF AGRICULTURAL SUPPORT: EEC (a)
(per cent changes compared with baseline)

	Gross output	Employment	Factor income (c,d)	Producer prices (d)	Export volumes	Import volumes	Export price (d)	Import price (d)
Agriculture (b)								
Scenario 1	-7.0	-7.3	-13.3	3.7	-9.8	5.8	7.5	0.5
Scenario 2	-5.1	-4.9	-10.8	-0.7	-5.8	1.0	5.0	-0.1
Scenario 3	-1.8	-2.2	-2.8	4.6	-4.3	3.9	2.2	0.5
Scenario 4	-12.3	-12.3	-20.1	2.5	-16.1	11.3	6.5	0.00
Food and beverages								
Scenario 1	-6.4	-6.0	-5.5	1.9	-51.7	47.7	39.4	-17.4
Scenario 2	-5.3	-5.0	-4.6	-0.3	-50.3	41.4	37.5	-17.2
Scenario 3	-1.0	-1.0	-0.9	2.0	-5.1	2.6	3.1	0.5
Scenario 4	-11.4	-10.8	-10.1	1.1	-65.4	123.7	37.7	-24.6
Other industry								
Scenario 1	1.1	0.9	1.5	0.9	4.7	-1.8	0.9	2.8
Scenario 2	0.8	0.7	1.2	0.7	3.8	-1.5	0.7	2.3
Scenario 3	0.2	0.2	0.3	0.2	0.8	-0.3	0.2	0.5
Scenario 4	1.8	1.6	2.4	0.8	7.6	-2.7	0.9	2.4
Private services								
Scenario 1	0.4	0.1	0.7	0.6	4.2	-2.6	0.6	2.8
Scenario 2	0.3	0.1	0.6	0.4	3.4	-2.2	0.4	2.3
Scenario 3	0.1	0.0	0.2	0.2	0.7	-0.4	0.2	0.5
Scenario 4	0.7	0.3	1.2	0.6	6.9	-4.1	0.6	2.4

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Producer prices (d)	0.9	0.4	0.5	0.8
Consumption prices (d)	1.0	0.3	0.6	0.8
Wage rate (d)	0.6	0.5	0.1	0.8
Price of capital (d)	0.1	0.1	0.0	-0.1
Land price (d)	-15.1	-10.9	-4.2	-25.5
Real exchange rate (e)	-2.8	-2.3	-0.5	-2.4
Terms of trade (f)	-0.4	-0.1	-0.2	1.3
Export volumes	1.7	1.0	0.4	3.4
Import volumes	1.1	0.7	0.2	4.4
Income taxes (d)	-2.0	-0.7	-1.2	-2.1
Real income (g)	0.1	0.1.	-0.0.	0.3

a) Scenario 1: Full liberalisation of agricultural support with both the current account and the government deficit unchanged.
Scenario 2: Abolition of border measures with both the current account and the government deficit unchanged.
Scenario 3: Removal of input subsidies with both the current account and the government deficit unchanged.
Scenario 4: Scenario 1 with all trade elasticities doubled.

b) Agriculture refers to sectors 1 and 2 in the WALRAS model; food and beverages refer to sectors 4 to 7; other industry refers to sector 3 and sectors 8 to 11; and private services refers to sectors 12 and 13. For further details, see Table 1 of Annex II.

c) Total factor remuneration.

d) Deflated by the GDP deflator at factor cost.

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

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

g) Hicksian equivalent variation as a per cent of real disposable income.

Table 12

SUMMARY OF RESULTS FOR COMPLETE ELIMINATION OF AGRICULTURAL SUPPORT: JAPAN (a)
(per cent changes compared with baseline)

Sector (b)	Gross output	Employment	Factor income (c,d)	Producer prices (b)	Export volumes	Import volumes	Export price (d)	Import price (d)
Agriculture								
Scenario 1	-11.9	-14.7	-17.4	8.2	-10.1	19.6	7.7	-0.4
Scenario 2	-5.1	-5.7	-7.3	-1.4	11.8	-0.2	-1.4	-1.9
Scenario 3	-6.2	-8.6	-10.1	9.9	-20.1	19.9	9.4	1.4
Scenario 4	-20.4	-24.5	-28.4	5.5	-9.4	29.6	4.8	-1.3
Food and beverages								
Scenario 1	-8.1	-8.2	-7.8	1.5	-39.9	76.9	25.6	-21.1
Scenario 2	-5.9	-6.1	-5.8	-1.5	-37.8	68.4	22.4	-22.3
Scenario 3	-1.6	-1.5	-1.3	3.2	-4.2	5.3	2.8	1.4
Scenario 4	-15.4	-15.6	-15.0	0.4	-59.4	161.9	24.2	-20.8
Other industry								
Scenario 1	1.4	1.2	1.4	0.9	7.9	-0.9	0.8	3.9
Scenario 2	0.8	0.7	0.8	0.4	5.1	-0.6	0.4	2.4
Scenario 3	0.5	0.4	0.5	0.4	2.4	-0.3	0.4	1.4
Scenario 4	2.3	2.0	2.3	0.7	12.4	-1.0	0.6	3.0
Private services								
Scenario 1	0.1	0.1	0.3	0.5	6.1	-4.4	0.5	3.9
Scenario 2	0.0	-0.0	0.1	0.2	3.9	-2.9	0.2	2.4
Scenario 3	0.1	0.1	0.3	0.3	1.9	-1.4	0.3	1.4
Scenario 4	0.3	0.2	0.5	0.5	9.4	-6.5	0.5	3.0

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Producer prices (d)	0.9	0.2	0.7	0.7
Consumption prices (d)	1.0	-0.2	0.9	0.5
Wage rate (d)	0.2	0.1	0.1	0.3
Price of capital (d)	0.2	0.1	0.1	0.3
Land price (d)	-27.0	-11.0	-16.4	-42.8
Real exchange rate (e)	-3.7	-2.3	-1.4	-2.9
Terms of trade (f)	-3.2	-2.4	-0.7	-1.5
Export volumes	7.1	4.5	2.2	11.2
Import volumes	4.6	3.2	1.2	10.0
Income taxes (d)	-1.4	0.5	-1.6	-1.3
Real income (g)	-0.4	-0.2	-0.1	-0.2

a) Scenario 1: Full liberalisation of agricultural support with both the current account and the government deficit unchanged.
Scenario 2: Abolition of border measures with both the current account and the government deficit unchanged.
Scenario 3: Removal of input subsidies with both the current account and the government deficit unchanged.
Scenario 4: Scenario 1 with all trade elasticities doubled.

b) Agriculture refers to sectors 1 and 2 in the WALRAS model; food and beverages refer to sectors 4 to 7; other industry refers to sector 3 and sectors 8 to 11; and private services refers to sectors 12 and 13. For further details, see Table 1 of Annex II.

c) Total factor remuneration.

d) Deflated by the GDP deflator at factor cost.

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

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

g) Hicksian equivalent variation as a per cent of real disposable income.

Table 13

SUMMARY OF RESULTS FOR COMPLETE ELIMINATION OF AGRICULTURAL SUPPORT: NEW ZEALAND (a)
(per cent changes compared with baseline)

Sector (b)	Gross output	Employment	Factor income (c,d)	Producer prices (d)	Export volumes	Import volumes	Export price (d)	Import price (d)
Agriculture								
Scenario 1	-8.5	-10.3	-12.9	14.2	-15.8	4.6	13.9	4.4
Scenario 2	..	..	..	..	..	..	..	..
Scenario 3	-8.4	-10.1	-14.8	14.3	-15.9	2.8	13.9	4.4
Scenario 4	-13.1	-15.6	-19.7	12.2	-24.0	9.3	11.3	4.1
Food and beverages								
Scenario 1	-6.9	-7.4	-6.3	8.0	-13.0	1.7	9.3	4.4
Scenario 2	..	..	..	..	..	..	..	..
Scenario 3	-6.7	-7.2	-8.4	8.0	-13.2	0.7	9.4	4.4
Scenario 4	-10.7	-11.6	-10.1	7.1	-21.2	4.3	8.2	4.1
Other industry								
Scenario 1	1.4	1.5	2.1	2.2	5.0	-2.3	2.3	4.4
Scenario 2	..	..	..	..	..	..	..	..
Scenario 3	1.4	1.4	-0.3	2.2	5.0	-2.3	2.3	4.4
Scenario 4	3.0	2.7	3.7	2.2	8.6	-4.1	2.3	4.1
Private services								
Scenario 1	1.5	1.8	2.3	1.5	5.4	-3.5	1.5	4.4
Scenario 2	..	..	..	..	..	..	..	..
Scenario 3	1.5	1.8	-0.1	1.5	5.4	-3.5	1.5	4.4
Scenario 4	2.1	2.5	3.2	1.6	9.2	-6.4	1.6	4.1

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Producer prices (d)	3.5	..	3.5	3.2
Consumption prices (d)	2.9	..	2.7	2.8
Wage rate (d)	0.5	..	0.5	0.7
Price of capital (d)	1.1	..	1.1	1.5
Land price (d)	-20.4	..	-20.2	-31.0
Real exchange rate (e)	-4.0	..	-4.0	-3.7
Terms of trade (f)	0.7	..	0.7	0.3
Export volumes	-3.0	..	-3.1	-4.4
Import volumes	-2.3	..	-2.4	-4.1
Income taxes (d)	-11.8	..	-11.3	-11.2
Real income (g)	0.8	..	0.8	0.7

a) Scenario 1: Full liberalisation of agricultural support with both the current account and the government deficit unchanged.
Scenario 2: Abolition of border measures with both the current account and the government deficit unchanged.
Scenario 3: Removal of input subsidies with both the current account and the government deficit unchanged.
Scenario 4: Scenario 1 with all trade elasticities doubled.

b) Agriculture refers to sectors 1 and 2 in the WALRAS model; food and beverages refer to sectors 4 to 7; other industry refers to sector 3 and sectors 8 to 11; and private services refers to sectors 12 and 13. For further details, see Table 1 of Annex II.

c) Total factor remuneration.

d) Deflated by the GDP deflator at factor cost.

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

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

g) Hicksian equivalent variation as a per cent of real disposable income.

Table 14

SUMMARY OF RESULTS FOR COMPLETE ELIMINATION OF AGRICULTURAL SUPPORT: UNITED STATES (a)
(per cent changes compared with baseline)

Sector (b)	Gross output	Employment	Factor income (c,d)	Producer prices (d)	Export volumes	Import volumes	Export price (d)	Import price (d)
Agriculture								
Scenario 1	-3.0	-5.1	-7.1	5.4	-9.8	10.3	4.5	0.5
Scenario 2	-0.3	-0.3	-0.7	-0.1	0.8	1.3	-0.1	-0.2
Scenario 3	-2.5	-4.5	-6.1	5.6	-10.4	8.6	4.7	0.7
Scenario 4	-4.9	-7.7	-10.6	4.3	-13.6	14.7	3.4	0.5
Food and beverages								
Scenario 1	-1.5	-1.2	-1.1	2.3	-7.7	12.2	4.5	-2.7
Scenario 2	-0.5	-0.4	-0.4	-0.1	-4.2	7.6	2.4	-3.3
Scenario 3	-0.7	-0.5	-0.4	2.4	-3.8	2.7	1.9	0.7
Scenario 4	-2.7	-2.2	-2.0	1.8	-10.0	37.1	4.1	-9.0
Other industry								
Scenario 1	0.2	0.2	0.3	0.3	1.7	-0.8	0.3	1.0
Scenario 2	0.0	0.0	0.1	0.0	0.4	-0.2	0.0	0.2
Scenario 3	0.2	0.2	0.3	0.2	1.2	-0.6	0.2	0.7
Scenario 4	0.4	0.4	0.6	0.3	2.9	-1.1	0.3	0.9
Private services								
Scenario 1	0.1	0.1	0.2	0.2	1.4	-1.0	0.2	1.0
Scenario 2	0.0	0.0	0.0	0.0	0.3	-0.3	0.0	0.2
Scenario 3	0.1	0.1	0.0	0.2	1.0	-0.7	0.2	0.7
Scenario 4	0.1	0.1	0.3	0.2	2.4	-1.6	0.3	0.9

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Producer prices (d)	0.5	0.0	0.5	0.5
Consumption prices (d)	0.6	0.0	0.4	0.6
Wage rate (d)	0.1	0.0	0.1	0.2
Price of capital (d)	0.2	0.0	0.1	0.2
Land price (d)	-9.7	-0.5	-8.7	-14.6
Real exchange rate (e)	-0.9	-0.2	-0.7	-0.8
Terms of trade (f)	-0.2	-0.1	-0.0	0.2
Export volumes	0.0	0.3	-0.3	0.6
Import volumes	-0.0	0.2	-0.3	0.9
Income taxes (d)	-2.2	-0.0	-1.7	-2.1
Real income (g)	0.1	-0.0	0.1	0.1

a) Scenario 1: Full liberalisation of agricultural support with both the current account and the government deficit unchanged.
Scenario 2: Abolition of border measures with both the current account and the government deficit unchanged.
Scenario 3: Removal of input subsidies with both the current account and the government deficit unchanged.
Scenario 4: Scenario 1 with all trade elasticities doubled.

b) Agriculture refers to sectors 1 and 2 in the WALRAS model; food and beverages refer to sectors 4 to 7; other industry refers to sector 3 and sectors 8 to 11; and private services refers to sectors 12 and 13. For further details, see Table 1 of Annex II.

c) Total factor remuneration.

d) Deflated by the GDP deflator at factor cost.

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

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

g) Hicksian equivalent variation as a per cent of real disposable income.

127. Cutting agricultural assistance unilaterally leads to a fall in agricultural and food exports and a rise in agricultural and food imports in all countries, particularly in Japan and the EEC where tariffs and non-tariff barriers are very high. Under the assumption of an unchanged current account, the increase in imports of agriculture and food has to be counterbalanced by a rise in exports of non-agricultural goods. As labour and capital move out of agriculture and food processing into the rest of the economy and consumers substitute towards cheaper imports in response to the change in relative prices, the supply of non-agricultural goods to the rest of the world increases. Faced with a downward-sloping demand curve for exports, the real exchange rate has to fall. The extent of this fall is shown in the lower half of Tables 9 to 14. It ranges from around 4 per cent in Japan and New Zealand to under 1 per cent in the United States.

128. In order to provide a rough summary measure of the welfare impact of full agricultural liberalisation, a measure of the change in real income -- the so-called "equivalent variation" -- has been computed. This is the increase in income that a consumer would need before the change in prices 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 shortcomings of this measure as an indicator of social welfare are well known and will not be discussed here (16).

129. Domestic households are simulated to have a real income gain in five of the six countries/regions from a unilateral liberalisation of agriculture, by an amount ranging from 0.1 per cent of household disposable income in the United States to almost 1 per cent in New Zealand. Japan is the only country which is simulated to suffer a loss amounting to 0.4 per cent of household disposable income. These calculations take no account of any favourable effects on households' welfare arising from falling land prices.

130. The main sources of the real income effects for households are three-fold in the model. First, each country realises efficiency gains as factors move out of agriculture and food processing into non-agricultural sectors. Second, the terms of trade worsen in most countries -- New Zealand is the sole exception in this simulation -- to maintain the current account at its reference level (17). This is a real income loss for domestic households as a consequence of unilateral liberalisation which has to be set off against the efficiency gains. Third, the tax burden on households is reduced following the elimination of all agricultural support; this effect is significant in countries which rely heavily on income supports.

131. The real level of income taxes is simulated to decline by between 1 and 3.5 per cent in Canada, the EEC, Japan and the United States, and by almost 12 per cent in New Zealand. In all countries except Japan, the simulated efficiency gains plus the lower tax burden are large enough to outweigh the negative terms-of-trade effects, hence real income of domestic households improves. In Japan, on the hand, the terms-of-trade loss of 3.2 per cent dominates in this simulation. This result is conditioned heavily by the assumed values of the foreign trade elasticities.

132. The result that a unilateral liberalisation may not be welfare-improving due to terms-of-trade losses is a common one in many AGE models -- see Brown (1987) for references. It arises from the assumption that

countries face downward-sloping demand curves for their exports. If the terms-of-trade effects are large enough, unilateral liberalisation may not lead to net benefits for a country. Cutting agricultural protection in such a case would only be attractive if it occurred on a multilateral basis, i.e. if other countries reciprocated by cutting their protection and subsidies on both agricultural and non-agricultural goods too.

2. Simulations of border liberalisation versus elimination of input subsidies

133. The base case simulates the unilateral removal of all assistance to agriculture. But, as highlighted in Section VI, the respective weights of border measures and income supports in total agricultural support vary greatly across countries. Hence, it is helpful to understand the base-case results by running two additional simulations. The first simulates the removal of all import taxes and export subsidies, assuming that countries maintain the base-year level of input subsidies. The results of this simulation are shown as Scenario 2 in Tables 9 to 14. Scenario 3 simulates the removal of all input subsidies, assuming that countries maintain the base-year import taxes and export subsidies.

134. As one would expect, the results of Scenario 2 show marginal impacts for all countries except the EEC and Japan, where the simulation shows significant effects on sectoral outputs, trade volumes and the real exchange rate. In the EEC, where border measures accounted for 80 per cent of total agricultural support in 1979-81, their abolition causes food imports to rise significantly. In order to restore the current account to its reference value, the real exchange rate has to depreciate by more than 2 per cent. Non-agricultural exports become cheaper, production in other industry and services increases but imported goods in other sectors are more expensive. As a result, the increase in consumer's real income is relatively small. In Japan, border measures accounted for at least 50 per cent of total agricultural support in 1980. As a result, imports of food are simulated to rise significantly under Scenario 2, and the real exchange rate depreciates by 2.3 per cent and the terms of trade worsen by a similar magnitude. At the same time, the fall in food prices contributes to a slight decline in consumer prices. This in turn weakens the negative effect of the terms of trade loss on household real income, which nonetheless declines slightly.

135. In the other countries, the bulk of assistance to agriculture is provided through direct and indirect income support. Unlike Scenario 2 where the removal of border measures has a deflationary effect on producer prices in agriculture and food processing because of substitution towards cheaper imports, Scenario 3 shows that cutting input subsidies leads to a direct increase in equilibrium producer prices (i.e. actual producer prices net of support -- target and threshold prices in operation in some of these countries are not modelled explicitly) in order to cover higher input costs.

3. "Higher" foreign trade price elasticities

136. In order to test the sensitivity of the base-case results to the exogenous values of the key foreign trade elasticities, the values of all foreign trade elasticities in Table 2 were doubled. The results of this run are shown as Scenario 4 in Tables 9 to 14.

137. With greater sensitivity to relative price changes, the quantity adjustments are larger. Agricultural output is simulated to decline by almost 14 per cent in Japan and New Zealand, 12 per cent in the EEC and Canada, and 3 per cent in the United States. The counterpart of this is somewhat larger increases in output and employment in non-agricultural sectors. The declines in land prices are also much larger under this scenario, ranging from over 40 per cent in Japan to almost 15 per cent in the United States.

138. Raising the values of import and export price elasticities should weaken the negative terms-of-trade effects since it implies that domestic goods and foreign goods are closer substitutes. This intuition is borne out by the results which show smaller depreciations of the real exchange rate in all cases. The terms-of-trade effects are also generally weaker. This is so because the decrease in export prices necessary to raise non-agricultural export volumes (in order to maintain the current account unchanged) is lower, the higher the export elasticity of demand. Real income gains are now somewhat larger in the EEC and New Zealand, while the loss for Japan becomes smaller. In another simulation (not shown), in which the values of the foreign trade elasticities in the base case were tripled instead of doubled, Japanese households recorded a real income gain of 0.4 per cent from unilateral agricultural liberalisation.

4. Alternative closures

139. Finally, the base case was also re-run under different assumptions regarding the "closure" of the model, i.e. how investment is determined.

140. The first variant assumes an endogenous government deficit. Under this closure rule, the government does not change the marginal income tax rate to maintain the budget deficit unchanged. Instead it is assumed to make use of the induced savings to improve its own budgetary situation. In this case, consumers are always worse off relative to the base case since they do not benefit from tax reductions. It follows that investment (as opposed to consumption) is more directly stimulated under this closure. But the potential benefits coming from a growing capital stock, and eventually, higher output growth, are not incorporated in the present model.

141. The second variant consists of running the base-case scenario, assuming the current account is endogenous. In this case, a current account deficit is assumed to be financed by a capital inflow. The absence of an induced depreciation of the real exchange rate under this scenario results generally in a slight improvement in consumers' real income gain. Japanese households also gain under this scenario.

IX. FUTURE DIRECTIONS OF WORK ON THE WALRAS PROJECT

142. The WALRAS project is an on-going one: the results reported here serve to illustrate the direction of the economy-wide effects of unilateral liberalisation of agricultural policies in OECD countries. The simulated outcomes on real outputs, trade volumes and prices are not consistent across countries because each country/region is assumed to take world prices as given and no account is taken of potentially important feedbacks through

international trade. It is unrealistic to expect each country's terms of trade and real exchange rate to depreciate if they all liberalised agricultural policies simultaneously. The simulation results at this stage, therefore, cannot and should not be used for policy debate.

143. Further analysis of the economy-wide effects of current agricultural policies and possible multilateral reform packages will be enriched when the country models are linked internationally. The next version of the model will take account of the important feedbacks via international trade flows and model the response of world agricultural prices to changes in agricultural protection. It will also enable us to quantify the effects of possible reforms in one country or groups of countries on other countries.

144. Further refinements to the modelling of agricultural policies are also under consideration. The use of ad valorem price wedges for modelling all agricultural policies has drawbacks, particularly when supply management policies are operative. For land set-asides, the assumed initial land endowment can simply be increased when agricultural policies which include farm-land set-asides are reversed. Possible improvements to the modelling of quantitative import restrictions are also being investigated.

145. Besides refining the modelling of agricultural policies, the policy instruments need to be updated to a year representative of the increased support now prevailing in OECD countries. The OECD Directorate for Food, Agriculture and Fisheries has already updated its data on PSEs and CSEs until 1986 (18). These new data will provide the main input for updating the agricultural policy instruments for simulations of the intersectoral and world trade effects of liberalising recent levels of support to agriculture.

146. In parallel to the development of a linked version of the WALRAS model, the possibility of refining the individual country models is also being investigated in several areas:

i) Scale economies. The present model implicitly assumes that there is an unspecified number of farms, each of optimal size and efficiency. It is obvious that distortionary agricultural policies affect the number of farms, their average size and their techniques of production (in particular the amount of labour and capital input per unit of output). Research relating to the industrial sector has shown that the biggest potential gains from trade liberalisation come not from resource reallocation but rather from a restructuring of industries towards their optimal size (19). Research on incorporating increasing returns to scale in the agricultural and food processing sectors is underway.

ii) Alternative uses for land. At present land is a factor of production in the agricultural sector and is assumed not to change to other uses such as housing, urban development or recreation. The sharp falls of farm land prices following liberalisation of agricultural policies could be expected to have direct repercusssion on urban land values, especially in land-scarce countries such as Japan.

iii) Partial mobility of capital and labour between sectors. While it is acceptable to assume that labour and capital are fully mobile between some sectors, it would be desirable to introduce some short-run specificity of factors to deal with imbalances that exist in factor market.

iv) Develop a dynamic version of the model. The current version of the model is a static one. It would be possible to incorporate some simple dynamics to reflect a) changes in the capital stock due to net savings and b) a growing labour force.

147. Finally, this paper reports the results of some very limited sensitivity analysis. It would be highly desirable to undertake much more systematic sensitivity analysis in order to assess the robustness of the simulation results of the world version of the model to the key parameter values (20).

NOTES

1. See Borges (1986) for a detailed discussion of the strengths and weaknesses of AGE models for analysing policy issues.

2. Net factor income from abroad is treated as exogenous in the model.

3. This hypothesis has only weak empirical support -- see Berndt and Wood (1975), Denny and May (1977), Delorme and Lester (1986) -- but it has the advantage of being tractable.

4. For a good discussion of dynamic AGE models, see Fullerton, Shoven and Whalley (1983), Fullerton, Henderson and Shoven (1984) and Auerbach and Kotlikoff (1987).

5. See Shoven and Whalley (1984), Harris (1986), Mercenier and Waelbroeck (1986) and Brown (1987) for a discussion of the role of terms-of-trade effects in AGE models which adopt the Armington specification.

6. See Goldstein and Khan (1985) for a full discussion of these issues.

7. The import demand elasticity (η_m) =

$$DD/M.\eta_d - DS/M.\varepsilon_s$$

where DD = domestic demand; DS = domestic supply; M = imports; η_d = elasticity of domestic demand; and ε_s = elasticity of domestic supply.

8. Since 1981 there have been major tax reforms in several of the countries under study, particularly the United States, Japan, Italy, Canada and New Zealand, and to a lesser extent in Germany, France and Australia. These changes have lowered marginal tax rates relative to their 1981 levels, in some cases very significantly.

9. See the discussion in OECD (1987, Annex II) on the difficulties of integrating quantitative restrictions into the PSE/CSE framework.

10. Dewbre and Harris (1985) show that in the case of VERs on beef exports to the United States, the exporters reaped most of the rents.

11. Whalley and Wigle (1987) attempt to model explicitly the effects of U.S. wheat price supports and land set-asides on the farmer's participation decision.

12. Although it is stated in OECD (1987) that production/acreage controls are included among the list of measures of market price support, in practice they are treated as direct income support measures.

13. In any event, the use of actual trade flows to aggregate the implicit nominal tariffs/export subsidies also underestimates the degree of assistance since it gives little or no weight to very high or prohibitive border protection.

14. For an exhaustive review of the comparative advantages of different solution methods to AGE models, see Harris (1988).

15. The real exchange rate (RER) is defined as:

$$RER = [Pf/P_w.NER]$$

where Pf is a composite price for primary inputs, P_w is the world price, and NER the nominal exchange rate. The RER is directly related to the terms of trade (TOT):

$$TOT = [b + (1-b)\ RER](1+t)$$

where b is the proportion of imported intermediate inputs in total cost of production, and t is an ad valorem policy instrument applied to the producer price (e.g. a subsidy to inputs or to exports). For a given change in the policy instrument t, the change in the terms of trade is equal to:

$$dTOT/dt = (1-b)(1+t)dRER/dt + b + (1-b)RER$$

Since in the base year, RER=1 and t=0, the equation simplifies to:

$$dTOT = (1-b)dRER + dt$$

As can be seen, the two variables TOT and RER need not move necessarily in the same direction. The final outcome depends on the importance of the depreciation ($dRER < 0$) necessary to re-adjust the external balance to its predetermined value on the one hand and on the structure of protection in each country on the other.

16. For a good review of the recent literature on measuring the welfare effects of protection, see Jeon and von Furstenberg (1986).

17. As pointed out in note 15, it is possible for a depreciation of the real exchange rate to co-exist with a gain in the terms of trade -- this result occurs in Scenario 3 for Australia, Scenario 4 for the EC and the United States and Scenarios 1, 3 and 4 for New Zealand. This result arises because i) export prices are defined in the model as producer prices inclusive of any taxes or subsidies (see equation (8) in Section III); and ii) each country is assumed to be facing a downward-sloping demand curve for its exports. Taking the definition for the change in the terms of trade given in note 15 and applying it to New Zealand, it can be seen that the depreciation of the real exchange rate is not sufficient to outweigh the importance of the input subsidy resulting, therefore, in a gain in the terms of trade. A similar reasoning applies to the case of an export subsidy. Nevertheless, in most of the simulation results reported in Tables 9 to 14, the real exchange rate and the terms of trade both move in the same direction.

18. Estimates for 1987 are planned to be completed in the second half of 1988.

19. For a theoretical discussion of the effects of scale economies on international trade, see Helpman and Krugman (1985). An empirical assessment of the importance of returns to scale in a trade liberalisation context using AGE models can be found in Harris (1984), Horridge (1987) and Nguyen and Wigle (1987).

20. Harrison et al. (1987) favour systematic sensitivity analysis of policy results over a wide range of parameter values and combinations of these parameters as opposed to the standard practice of undertaking limited sensitivity analysis of the results to changes in only a few key parameters

ANNEX I

GLOSSARY OF VARIABLE AND PARAMETER NAMES

List of variables

Mnemonic	Description	Main equation number (see Section III)
a_{Hi}	Unit physical requirement of the capital-labour bundle in industry i	(17)
a_{ji}	Unit physical requirement of total intermediate input j used by industry i	(21)
a^{d}_{ji}	Unit physical requirement of domestic input j used by industry i located	(23)
a^{I}_{ji}	Unit physical requirement of imported intermediate input j used by industry i	(24)
a_{Ki}	Unit physical requirements of capital of industry i located	(19)
a_{Li}	Unit physical requirements of labour of industry i located	(10)
a_{Mi}	Unit physical requirements of land of industry i located	(18)
A^{d}	Domestic Leontief matrix of intermediate transactions including taxes	(27)
A^{I}	Imported Leontief matrix of intermediate transactions excluding taxes	(29)
C_g	Consumption expenditure on good g	(39)
C^{d}_g	Consumption expenditures on domestic good g	(46)
C^{I}_g	Consumption expenditures on imported good g	(47)

List of variables

(continued)

Mnemonic	Description	Main equation number (see Section III)
D	Matrix of technical coefficients for primary inputs	(30)
D^*	Partitioned matrix of intermediate and primary input technical coefficients	(29)
DEPR	Depreciation of capital stock	(36)
$DSTOC^d$	Total domestic change in stocks	(32)
$DSTOC_i^d$	Expenditure on domestic inventory good i	(54)
$DSTOC_i^I$	Expenditure on imported inventory good i	(55)
$DSTOC^T$	Total change in stocks	(57)
e	Lagrange multiplier	(15)
E_i	Exports of good i	(56)
E^d	Total domestic exports	(32)
E^T	Total exports valued at domestic prices (includes re-exports)	(57)
ER	Exchange rate (expressed in units of foreign currency per unit of domestic currency)	(3)
F_g	Minimum requirements of consumer good g in Klein-Rubin utility function	(34)
FD_i	Final demand expenditures on production good i	(58)
G	Government expenditure on production goods	(52)
GOV^d	Total domestic government expenditures on production goods	(32)

List of variables

(continued)

Mnemonic	Description	Main equation number (see Section III)
GOV_i^d	Expenditure by government on domestic good i	(55)
GOV_i^I	Expenditure by government on imported good i	(55)
h_i	Price of the capital-labour bundle used by industry i	(16)
H_i	Capital-labour CES bundle used by industry i	(14)
I	Identity matrix	(27)
IMP^T	Total imports valued at world prices	(57)
INV_i^d	Expenditure on domestic investment good i	(55)
INV_i^I	Expenditure on imported investment good i	(55)
INV_i	Expenditures on investment good i	(48)
INV^D	Total domestic investment expenditures	(32)
INV^T	Total investment expenditure	(57)
$\bar{K}$	Capital endowment of consumers	(36)
K_i	Capital input to industry i	(11)
K_{Gi}	Government spending on capital	(53)
$\bar{L}$	Labour endowment of consumers	(36)
L_{Gi}	Government spending on labour	(54)
L_i	Labour input to industry i	(11)

List of variables

(continued)

Mnemonic	Description	Main equation number (see Section III)
M_i	Land input to industry i	(11)
$\bar{M}$	Land endowment of consumers	(36)
$\bar{P}$	Vector of the factor price system	(1)
P^0	Vector of imported intermediate inputs and primary factor prices	(27)
P_i	Producer price of domestic commodity i	(1)
P_{cg}	Composite consumer price of commodity g	(40)
P_{cg}^d	Consumer price of domestic commodity g	(4)
P_{cg}^I	Consumer price of imported commodity g	(6)
PC_i	Total personal consumption of ith industry's output	(31)
PC^d	Total domestic personal consumption of domestic goods	(32)
P_{ji}^d	Net-of-tax price of domestic intermediate input j used by industry i	(25)
P_{Ei}	Export price of commodity i	(8)
P_G	Composite price of government expenditure on production goods	(51)
P_{ji}^I	Net-of-tax price of imported intermediate input j used by industry i	(25)

List of variables

(continued)

Mnemonic	Description	Main equation number (see Section III)
PT^{d}_{ji}	Gross-of-tax price of domestic intermediate input j used by industry i	(28)
PT^{I}_{ji}	Gross-of-tax price of imported intermediate input j used by industry i	(28)
P_{Wi}	Exogenous world price of industrial good i	(11)
Q_i	Gross output of industry i	(15)
r_i	Price of capital in industry i	(16)
r	Aggregate price of capital	(62)
rm_i	Price of land in industry i	(15)
r_m	Aggregate price of land	(62)
R_g	Total revenues of the government	(55)
s_{Qi}	Production subsidy rate for industry i	(55)
SV	Total personal savings	(38)
t^{d}_{ci}	Commodity (ad valorem) tax rate on domestic consumption good i	(55)
t^{I}_{ci}	Commodity (ad valorem) tax rate on imported consumption good i	(55)
t_{Ei}	Export (ad valorem) tax rate	(55)
t_{Gi}	Commodity (ad valorem) tax rate on government	(55)

List of variables

(continued)

Mnemonic	Description	Main equation number (see Section III)
t_{Ii}	Commodity (ad valorem) tax rate on investment good i	(55)
t_{ji}^{d}	Ad valorem rate of sales tax on domestic intermediate use of input j used by industry i	(55)
t_{ji}^{I}	Ad valorem rate of sales tax on imported intermediate use of input j used by industry i	(55)
t_{si}	Commodity (ad valorem) tax rate on inventory good i	(55)
t_y	Marginal income tax rate paid by consumers	(55)
T_g	Lump-sum government transfers	(36)
U	Consumer utility function for consumption and savings	(34)
$\bar{U}_G$	Government utility	(50)
V^*	Lagrangian function	(15)
VA_i	Value added of industry i	(13)
w_i	Wage rate of industry i	(19)
w	Aggregate price of labour	(62)
X_{ji}	Intermediate use of input j by industry i	(22)
X_{ji}^{d}	Intermediate use of domestic input j by industry i	(55)
X_{ji}^{I}	Intermediate use of imported input j by by industry i	(55)

List of variables

(continued)

Mnemonic	Description	Main equation number (see Section III)
Y	Total income of the representative consumer	(36)
YD	Disposable income of the representative consumer	(37)
Z_G	Total government expenditure	(51)
Γ_i	Unit physical requirement of investment expenditure on production good i	(48)
ξ^d_{gi}	Typical element of domestic transition matrix	(5)
ξ^I_{gi}	Typical element of imported transition matrix	(7)
Ξ	(i x g) fixed coefficient transition matrix linking the g consumer good classification to the i producer good classification	(31)
τ_i	Tariff rate on commodity i	(6)
Ω_i	Unit physical requirement of expenditure on change in stocks on production good i	(49)

List of parameters

Mnemonic	Description	Main equation number (see Section III)
α_{Hi}	Distribution parameter representing capital-labour share in value-added function for industry i	(13)
α_{Ki}	Distribution parameter representing capital share in value-added sub-function for industry i	(14)
α_{Li}	Distribution parameter representing labour share in value-added sub-function for industry i	(14)
α_{Mi}	Distribution parameter representing land share in value-added function for industry	(13)
β_g	Elasticity of substitution in Armington CES consumption function of good g	(39)
η_i	Elasticity of substitution between domestic and imported unit physical requirements of intermediate inputs used by industry i	(21)
δ_i	Parameter of the export demand function for good i	(56)
ε_i	Price elasticity in foreign demand for exports of good i	(56)
ζ	Depreciation rate	(57)
ϕ_G	Distribution parameter for non-wage current expenditure in the government utility function	(50)
ϕ_L	Distribution for labour in the government utility function	(48)
ϕ_K	Distribution for capital in the government utility function	(48)

List of parameters

(continued)

Mnemonic	Description	Main equation number (see Section III)
γ_{ji}^{d}	Distribution parameter for domestic intermediate input j used by industry i	(21)
γ_{ji}^{I}	Distribution parameter of imported input j used by industry i	(21)
θ_g	Distribution parameters of commodity g in utility function of the representative consumer	(34)
ι_g^d	Income elasticity of demand for commodity g	(43)
ρ_i	Elasticity of substitution between the capital-labour bundle and land in the CES value-added function of industry i	(13)
σ_i	Elasticity of substitution between capital and labour in industry i	(14)
ω_g^d	Distribution parameter of domestic goods in Armington CES consumption function of good g	(39)
ω_g^I	Distribution parameter of imported goods in Armington CES consumption function of good g	(39)
λ_g	Own-price (uncompensated) elasticity for commodity g	(44)
ψ	Elasticity of substitution between expenditure categories in government utility function	(50)
μ	Intercept in the linear personal income tax schedule	(55)

Annex II

COUNTRY-SPECIFIC DATA ADJUSTMENTS

1. The correspondence between the thirteen production sectors of the WALRAS model and the classification of industrial sectors in each country's input-output tables is shown in Table 1.

1. Australia

1.1 A brief introduction to the Australian I-O tables

2. In the Australian I-O tables (1), indirect taxes are fully identified: the valuation is at "basic values" instead of at producer prices, as in several other countries. It is also the only country that prepares tables on the basis of both direct and indirect allocation of imports. Nonetheless, some further data adjustments were required for the purposes of creating the WALRAS data set.

3. The Australian I-O structure consists of four quadrants (in some of the other countries the fourth quadrant is absent):

-- a matrix of intermediate usage (Quadrant 1)
-- a matrix of final demand (Quadrant 2)
-- a matrix of primary inputs to production (Quadrant 3)
-- a matrix of primary inputs to final demand (Quadrant 4).

4. At the most detailed level there are 108 industries and about 1500 commodities; the latter are aggregated to 108 commodities for publication. The basic transaction matrix is therefore 108 x 108; the various matrices were aggregated by the Australian Bureau of Statistics to match the sectoral classification of the WALRAS model.

1.2 Adjustments to intermediate transactions

5. The item "sales by final buyers" (P5 of the primary input quadrants) was re-allocated to the sector "other manufacturing".

6. The transactions of government (public administration, defence, health and education -- industries 7101 to 8201 respectively) were removed from the rows and columns of this matrix.

1.3 Adjustments to final demand

7. Government expenditures also include the columns and (negative) rows which were removed from the transaction matrix.

1.4 Adjustments to value added

8. The gross operating surplus had to be split between returns to labour, capital and land. First, the income of unincorporated enterprises was identified using data from the Australian National Accounts (Table 21 of Catalogue No 5204.0, Canberra, 1986). An imputed wage income was calculated for each of the available sectors assuming that proprietors' average wage

Table 1: INDUSTRY AGGREGATION FOR THE WALRAS MODEL

	AGE Aggregation	ISIC code (4-digit)	AUSTRALIA I/O, 108-sector, 1980/81	CANADA I/O, 191-sector, 1981	EEC (a) I/O, 59-sector, 1980	JAPAN I/O, 164-sector, 1980	NEW ZEALAND (l) I/O,25-sector, 1981/82	UNITED STATES I/O, 366-sector, 1981
Livestock and livestock products	1	1110-1120	01.01,01.03-01.05	1.1 (b)	010 (c)	0016	1,2 (d)	1.01-1.03
Other agriculture	2	1110-1120	01.02,01.06,02.00	1.2 (b)	010 (c)	0011-0015, 0017-0020	3,4	2.01-2.07,4.00 (e)
Other primary industries	3	1130-2909	03.00-16.00	2-15	010 (c), 030-071, 075 (f)	0211-1990	5-9	3.00,5.00-10.00
Meat products	4	3111	21.01	16,17	310	2011,2012	10-12	14.01
Dairy products	5	3112	21.02	18	330	2020	13-15	14.02-14.06
Other food products	6	3113-3122	21.03-21.08	19-28	350	2030-2092	16-25	14.07-14.20,14.23-14.32
Beverages	7	3131-3134	21.09-21.11	29-32	370	2110-2140	26-28	14.21,14.22
Chemicals	8	3511-3529	27.01-27.07	123-130	170	3111-3192	55-60	27.01-30.00
Petroleum & Coal products	9	3530-3540	27.08	121,122	073	3210,3291	61-62	31.01-31.03
Other Manufacturing Industries	10	3140-3420, 3551-3909	22.01-26.05, 28.01-34.05 (g)	33-120 131-137	110-150, 190-290, 390-510	2200-3000, 3310-3990	29-54, 63-94 (h)	13.01-13.07,15.01-26.08, 32.01-64.12,81 (i)
Construction	11	5000	41.01-41.02	138-146	530	4001-4009	98-101	11.01-12.02
Wholesale & Retail Trade	12	6100-6200	47.01-49.02	164,165	570	6110,6120	102	69.01,69.02
Other Private Services (j)	13	0000,4101-4200, 6310-9600	36.01-37.01, 51.01-93.01	147-163, 166-191 (k)	090,550, 590-930	5110-5300, 6200-9000	95-97, 103-128	65.01-68.03, 70.01-79.03

a) The EEC covers the following eight countries: Denmark, Germany, France, Italy, Netherlands, Portugal, Spain, and United Kingdom.
b) Based on the new Statistics Canada Input-Output L-aggregation level (unpublished).
c) Individual Input-output tables for five European countries (Denmark, Germany, France, Netherlands and United Kingdom) are used to split forestry and fishing (which are classified under "other primary industries") from agriculture (industries 1 plus 2). Then, the European Commission's RICA system is used to split "livestock" and "other agriculture".
d) Isolation of grain, fodder, crop and seed growing from "Agriculture and Livestock Production" is not possible at the 128x128 aggregation level.
e) Services to fishing and forestry, and agriculture, which are not individually disaggregated (even at the 6-digit 537 industry level), are arbitrarily included under "other agriculture".
f) Individual Input-Output tables for five countries are used to isolate "refined petroleum". The latter is re-allocated to "Petroleum and Coal".
g) "Sales to final buyers" (Line P5, Primary inputs to production matrix) is also included here.
h) The item "Second-hand assets", shown as a primary input, is transferred to "Other Manufacturing".
i) For the United States, five Special Industries are identified. The category "Scrap, used and secondhand goods" is allocated to other manufacturing. "Government industry" becomes part of "Compensation of employees". The remaining three industries: "Rest of World industry", "Houshold industry" and "Inventory valuation adjustment" are ignored.
j) See the descriptions of the adjustments to the data-sets for each country, to observe how the government sector was treated.
k) The industries "Office Laboratory and Food operating Services (184-186,188,191), Travel and Advertising (189,190) and Transportation Margin (187) are re-allocated to "Other Private Services".
l) The detailed 128x128 inter-industry tables are only available for 1976-77; only a 25-sector disaggregation is available for 1981-82. The detailed 1976-77 tables were used to disaggregate the 25-sector tables.

income is equal to that of employees in the sector. This wage income was added to "compensation of employees". Second, the remaining part of the operating surplus was deemed to be the return to capital, except for the two agricultural sectors, where the initial "capital" income was split between capital and land. Different ratios were used for livestock and non-livestock, on the basis of the capital and land rentals incorporated in the ORANI model (2).

2. Canada

2.1. A brief introduction to the Canadian I-O tables

9. In the Canadian I-O tables (3), the inputs and output of industries are presented in separate tables and classified by commodity. The number of commodities is greater than the number of industries, yielding a rectangular format instead of the traditional square matrices for intermediate transactions.

10. The Canadian I-O structure consists of five main matrices:

-- a matrix of the values of outputs (Make matrix V)
-- a matrix of the values of intermediate inputs (Use matrix U)
-- a matrix of the values of commodity inputs of final demand (Final demand matrix F)
-- a matrix of the values of primary inputs of industries (matrix YI)
-- a matrix of the values of primary inputs of final demand categories (YF).

At the most detailed level (the L aggregation), there are 191 industries, 595 commodities, 7 primary inputs and 136 final demand categories. Statistics Canada aggregated the data from the 1981 table in line with the sectoral aggregation chosen for the WALRAS model.

2.2. Adjustments to intermediate transactions

11. In order that each element of the 13 x 13 transaction table corresponds to the amount of output of industry j that is used as an intermediate input by industry i, the initially rectangular USE matrix must be multiplied by the normalized Make matrix.

2.3. Adjustments to final demand

12. In the final demand matrix, a negative cell occurs in the "government expenditure" column when government sales exceed total expenditures. An excess supply variable is created to overcome this problem. This item becomes an additional component of final demand in order to preserve the totals.

2.4. Adjustments to value added

i) Split of "net income of unincorporated business"

This item is allocated between labour and capital income using the respective shares of "wages, salaries and supplementary labour income" and "other operating surplus" in the total of these two items.

ii) Split of "other operating surplus" between capital and land in the two agricultural sectors

Data on book values of "land and depletable assets" and other capital were obtained for agriculture from Statistics Canada, Corporation Financial Statistics, Catalogue #61-207, 1981, from which the ratio of land to total fixed assets is calculated. This ratio was then used to split "other operating surplus" between capital and land in each of the two agricultural sectors.

3. EEC

3.1. A brief introduction to the EEC I-O tables

13. I-O tables for 1979-80 have been published by the national statistical offices in eight EEC Member states. There are significant differences between these national tables with respect to their sectoral classifications as well as the treatment of value-added taxes. Since no I-O tables for 1979-80 are available for Belgium, Luxembourg, Ireland and Greece, the EEC aggregate in the model is restricted to only eight Member states: Denmark (DK), France (FR), Germany (DEU), Italy (IT), the Netherlands (NTH), Portugal (POR), Spain (SP) and the United Kingdom (UK).

14. The Statistical Office of the European Communities (EUROSTAT) has harmonized and published the eight available tables using a common sectoral breakdown (4); it also makes available a 44-sector aggregated table (EUR 8), net of value-added taxes, expressed in ECU. This aggregated table was chosen as the appropriate starting point from which to calculate the EEC data set, in spite of the fact that it has several limitations for this purpose:

i) When aggregating the national tables, intra-Community imports and exports should offset one another as they are, in theory, equal. In practice, this is not the case because our EEC aggregate excludes four Member states in addition to other statistical discrepancies. The residual net exports was added to exports to the rest of the world.

ii) The 44-sector breakdown is insufficient for the sectoral specification of the WALRAS model. For example, sector 9 in the WALRAS model (refined petroleum products: NACE.CLIO 140) is aggregated to the R.44 branch 070 and had to be extracted by extrapolating from the national tables for which such a disaggregation is available (DK, FR, IT, NTH, UK). The agricultural sector in the EUROSTAT table includes fisheries and forestry. These activities were separated out and added to sector 3 (other primary industries) by extrapolating from the national tables which provided such a split (DEU, DK, FR, IT, UK). In addition, the agricultural sector had to be split between livestock and other agricultural products. Only the Italian table provides this kind of breakdown. For the other countries, other data sources (see below) had to be used.

iii) The French I-O table compiled by EUROSTAT does not include any breakdown of value-added at market prices into its usual components. Also for some countries, the consumption of fixed

capital is not subtracted from the operating surpluses (DK, POR, SP, UK). Adjustments for these factors were made by referring back to the national I-O tables published by the national statistical offices. Where such publications are not available, estimates were made by extrapolating data from the OECD National Accounts.

3.2. The disaggregation of agricultural inputs and outputs

15. This proved to be the most difficult task in setting up the EEC database. Several data sources exist which can possibly provide such a disaggregation; the problem is that they are not consistent with the I-O tables.

16. The output side was disaggregated by using the Supply Utilisation Accounts (SUA) and producer prices published by the Food and Agriculture Organisation (FAO). These databases report for each agricultural product a supply-demand balance including trade, seed and feed uses, processing and industrial uses, food consumption and other uses. However, merging this information into the existing I-O framework raised further difficulties:

i) The allocation between final and intermediate expenditures does not correspond to the I-O table definitions. Consistency was imposed by using an iterative RAS procedure.

ii) The SUA are reported in metric tons. Aggregation over products was carried out using FAO data on producer prices for home-produced goods, f.o.b. prices for exports and c.i.f. prices for imports. These latter prices were derived from the FAO Trade Yearbooks.

iii) The FAO balance sheets refer to a given product level which may not match the product level implied by the I-O table. This gave rise to some discrepancies between trade figures. For example, the I-O output for bovine meat includes live animals for export or slaughter. The corresponding balance sheet, however, is expressed in terms of meat products. This makes little difference so far as domestic output is concerned. But while the I-O trade data refer only to live animals, the balance-sheet trade figures include fresh, chilled and frozen meats, canned and other prepared meats, etc. The solution adopted was to start with the supply-demand balance sheets and then to replace the trade figures by those extracted from the FAO Trade Yearbooks which refer only to the non-transformed products (grains, live animals, fresh fruits, vegetables and milk).

17. The input-side disaggregation of agriculture was based on data from the RICA network which was supplied to the OECD by the EEC Commission (5). These data relate to 1980/81 and cover six Member states (DEU, DK, FR, IT, NTH, UK). They are based on a sample of over 26 000 commercial holdings from a population of almost 2.5 million farms. The total output yielded by extrapolating the average output from the observed sample to the entire population accounts for 69.5 per cent of the actual total output for the six Member states in question. The remaining 30.5 per cent of agricultural output, however, is produced by farms, whose technology differs significantly

from those covered by the RICA sample. Once again, the solution adopted to incorporate these differences was to merge together the information from the RICA database and from the I-O tables using a RAS adjustment.

3.3. Adjustments to intermediate demand

18. In addition to these adjustments, the government sector was extracted from intermediate demand and treated as final consumption. This covers the following NACE-CLIO codes: general public services 91+92A+96A+97A; non-market services of education and research 93A+93B+94A+94B; non-market services of health 95A+95B; and non-market services n.e.c. 96B+97B+99.

3.4. Adjustments to final demand

19. Transition matrices linking the production and consumption classifications are available only for five EEC Member states (DK, DEU, FR, NTH, UK). The row sub-totals for the other three countries were computed by using data from the OECD National Accounts. Consistency between these sub-totals, the aggregated transition matrix and total household consumption from the aggregate I-O table was then achieved by using a RAS adjustment.

3.5. Adjustments to value-added

20. It was necessary to split the net operating surplus into labour and capital remuneration. This was based on the employment figures published in the OECD National Accounts, by imputing to the self-employed the same average wage rate as for employees.

21. As for the two agricultural sub-sectors, the RICA database produces estimates for hired labour, land and capital. Farm net value added is then calculated as the difference between the value of total output and the value of total expenditure including indirect taxes and subsidies. This net profit is finally imputed to land, capital and labour remuneration on the basis of the average returns to capital, land and average paid wages, respectively. These returns are also derived from the RICA database.

4. Japan

4.1. A brief description of the Japanese I-O tables

22. The most detailed I-O tables for 1980 consist of 541 rows and 406 columns. The Administrative Management Agency of the Government of Japan supplied the 164 x 164 tables to the OECD who aggregated them to match the specification of the WALRAS model. The output table, which shows the amount of goods and services produced by the row sectors and sold to the column sectors, was taken as the basis for the aggregation.

23. The inclusion of the item "consumption expenditure outside households", which is part of both value added and final demand in the Japanese I-O tables, represents a slight departure from the standardized I-O tables. These are expenditures which are similar to normal household outlays but are paid for by Japanese firms; they include social expenditures e.g. for sports, leisure activities and medical needs of employees. As a result of including these expenditures, gross domestic product in the I-O tables is 4 per cent higher than GDP as measured in the National Accounts.

24. The valuation of domestic outputs is at producers' market shipment prices. Since this valuation includes certain indirect taxes which increase selling prices, it is not possible to identify fully indirect taxes on commodity outputs. Subsidies are, however, excluded from this valuation.

4.2. Adjustments to intermediate demand

25. Government transactions are removed from the transaction matrix. However, identification of all government activities is not possible at the 164 x 164 level. For the purposes of this exercise, the following government activities are removed:

i) Public administration (industries 8101 and 8102);
ii) Part of Education (industry 8210);
iii) Part of Health and Social Insurance (industry 8250);
iv) Other public services (industry 8290).

4.3. Adjustments to final demand

a) Transition matrix for private consumption

26. The Japanese authorities were unable to provide the required 10-good split of private consumption consistent with the 13-sector industry classification. A breakdown of total private consumption is available from Volume II of the OECD National Accounts and submissions to the OECD Purchasing Power Parity Study for 1980. Data from the annual Japanese household expenditure survey enabled an initial matching of food consumption with individual industry outputs. For the other nine items of household consumption, an initial split by industry was obtained by imposing the pattern observed in the U.S. I-O data. Since many of the individual cells are zero, this procedure yielded a reasonable first allocation of the industrial origin of consumer goods. These manipulations resulted in an initial 13x10 matrix which was inconsistent (row totals did not add to the I-O industrial outputs bought by Japanese consumers in 1980). Consistency was then imposed on the row and column totals by using the iterative RAS procedure.

27. Since most of the expenditures of the "consumption outside households" item are for recreation, this column was allocated to the ninth private consumption category: "recreation, entertainment, education and cultural services".

b) Government expenditure

28. Government expenditures also include the columns and (negative) rows which were removed from the transaction matrix (see above).

4.4. Adjustments to value added

29. Returns to labour are equal to the sum of compensation of employees (which includes bonuses and other supplementary payments), consumption outside households and the operating surplus of private unincorporated enterprises. The latter are taken from Table IV.2 of the Japanese National Accounts, and is only split between agriculture, forestry and fishing on the one hand, and the remaining sectors on the other. In each of these two sub-sectors, the imputed wage income of the self-employed was in excess of the reported gross operating

surplus of unincorporated enterprises. Because of this, the operating surplus of unincorporated enterprises was allocated entirely to labour. The additional allocation to the thirteen WALRAS sectors is on the basis of value added.

30. Remuneration of capital is initially defined as the sum of the remainder of the operating surplus and depreciation of fixed capital. For the two agricultural subsectors, this initial capital income is further split between (final) capital and land remuneration, on the basis of land and non-land assets of farms on 1st April, 1980 (6).

5. New Zealand

5.1 A brief description of the New Zealand I-O tables

31. The New Zealand I-O tables for 1981-82 provide a disaggregation into only 25 industries (7). They are a first step towards publication of more detailed 128 x 128 inter-industry tables which have not yet been completed. Nevertheless, 128 x 128 inter-industry tables are available for 1976-77 and these were used to disaggregate the 25 x 25 tables available for 1981-82. The New Zealand tables do not provide a split of indirect taxes across industries in the transactions and final demand matrices; instead they are identified as a row in the matrix of primary inputs of industries and final demand.

5.2 Adjustments to intermediate transactions

32. In order to arrive at the required aggregation scheme, rows and columns for several industries in the 1981-82 tables were adjusted by assuming that ratios between industries on the more disaggregated 1976-77 basis had not changed. The following industries in the 25 x 25 sector tables required further disaggregation:

a) Industry 1 (agriculture)
b) Industry 5 (food, beverages and tobacco)
c) Industry 9 (chemicals, petroleum, rubber and plastics)
d) Industry 16 (trade, restaurants and hotels)
e) The rows and columns of the government sector (the two industries central and local government) were substracted and added respectively to the "government" column in the final demand sector.

5.3 Adjustments to final demand

a) The 10-good split of private consumption is not available even in the 1976-77 tables. Row totals of the initial breakdown of total consumption were obtained by using information in the submissions to the 1985 OECD Purchasing Power Parity Study and the 1981/82 New Zealand Household Expenditure and Income Surveys. Imports were allocated first. Their row totals enabled the determination of category totals for domestic consumption. Individual cells were filled for most categories using the detailed tables from the above-mentioned sources. For the allocation of wholesale and retail trade output among individual categories, no information is available and it was determined largely as the residual industry;

b) Government investment, which is included in total fixed investment, was reallocated to government expenditure taking National Accounts estimates for 1981/82.

5.4 Adjustments to value added

33. Remuneration of capital is initially defined as the sum of operating surplus and depreciation of capital. Income of the self-employed was subtracted from capital remuneration and added to compensation of employees. The imputed wage income of the self-employed was calculated by multiplying the numbers of self-employed by average compensation of employees. For the two agricultural subsectors the remaining capital income was further split between capital and land using a ratio of 0.5, in line with calculations made by the Directorate for Food, Agriculture and Fisheries.

6. United States

6.1. A brief description of the U.S. I-O tables

34. The most detailed I-O tables for 1981 contain 537 commodities and industries; an 85-sector summary was published in 1987 (8). The 1981 tables are partly based on the detailed tables for 1977, since the former incorporate more information derived from a quinquennial economic census. For the purposes of the WALRAS model database, the U.S. Department of Commerce aggregated the 6-digit industry tables according to the chosen aggregation schemes.

35. The published 1981 tables are incomplete on two counts. First, imports for intermediate and final demand components are not identified. For our purposes the Department of Commerce estimated import flows at the 6-digit level on the assumption that the ratio of total imports to the sum of intermediate and final demand for a given commodity was identical in each 6-digit industry. The import matrices were then re-aggregated to our 13-industry classification. Second, value added is not split into its components; this problem is discussed in Section 6.4 below.

36. The U.S. tables are on a GNP basis, and contain five special industries. For our purposes, three of these industries were eliminated. One of these is "rest of the world industry" (9); its omission changed the I-O data base to a GDP basis, thereby aligning the U.S. model with the accounting base used for the other countries/regions of the WALRAS model.

6.2. Adjustments to intermediate demand

37. A fourth special industry, "scrap", was included under the industry "other manufacturing". The final special industry, "government industry", as well as Federal, State and Local enterprises (industries 78 and 79 in the 85-sector tables) was removed from the intermediate transactions matrix and re-allocated to final demand. This enables the government wage bill to be identified once only, as a component of value added which enters final demand directly.

6.3. Adjustments to final demand

a) Private consumption

38. Eliminating the "rest of world" industry resulted in I-O private consumption being less than the published total for personal consumption spending, since the item "foreign travel and other" was excluded.

b) Government expenditure

39. The columns and rows of the government sectors which were removed from the transactions matrix were added to and subtracted from the final demand column "government expenditure".

c) Change in stocks

40. The removal of the special industry "inventory valuation adjustment" changed the valuation of inventory change to that at book values.

6.4. Creation of a value-added matrix

41. As noted above, the 1981 I-O tables only give total value added in each of the thirteen industries. The Commerce Department's National Income and Product Accounts (NIPA) provide a breakdown of value added (10). For the more important components, there is a relatively detailed sectoral breakdown of each item. Where the sectoral split was inadequate for our purposes, the share of I-O value added in the sector was taken. (This was the case mainly within the two agricultural subsectors and within the food processing industries.) The initial split of value added was as follows:

Value-added component	Basis for sectoral split (National Accounts table numbers)
Compensation of employees	Table 6.4B
Proprietors' income	Tables 1.14 and 6.14B
Rental income of persons	1981 I-O value added
Corporation profits	Table 6.19B
Net interest	Table 6.17B
Capital consumption allowances	Tables 6.15B and 6.24B
Indirect business taxes	The 1977 I-O tables
Subsidies	
Total GNP (NIPA)	

42. The initial sectoral split was for the 13 industries plus the rest of the world transactions (which are important in corporation profits and net interest). Once these transactions were removed and allowance was made for the other two special industries of the I-O tables which were excluded, the resulting GDP total was very close to that measured in the I-O tables. The remaining discrepancy, which mainly reflects data revisions since the 1981 National Accounts were prepared, was allocated to capital consumption allowances (11). This gave an 8x13 matrix where the row totals (i.e the I-O sectoral split of value added) equalled the column totals (i.e. the adjusted NIPA split of GNP). The RAS procedure was used to ensure that all rows and columns added to their respective totals.

43. The eight rows of the above matrix were then put into their final form as follows:

Return to labour	Compensation of employees Part of Proprietors' income
Return to capital	Part of Proprietors' income Rental income Corporation profits Net interest Capital consumption allowances
Indirect business taxes (less) subsidies	Indirect taxes Subsidies

Proprietors' income was split between labour and capital on the assumption that an average proprietor's wage income is equal to the average income earned by a wage-earner in the sector.

44. Finally, for the two agricultural sub-sectors, the return to capital was further divided between capital and land, on the basis of the share of non-land and land assets of the farm business sector in total tangible assets (12).

NOTES

1. Australian Bureau of Statistics (1987), Australian National Accounts, Input-Output Tables 1979-80 and 1980-81, Canberra, Australia.

2. The correspondence between the two agricultural sectors in the WALRAS model and the eight agricultural industries of the ORANI model was made on the basis of Table 28.1 from Dixon P.B., B.R. Parmeter, J. Sutton and D.P. Vincent (1982), ORANI: A Multisectoral Model of the Australian Economy, North-Holland, Amsterdam.

3. Statistics Canada (1982), The Input-Output Structure of the Canadian Economy, Catalogue No. 15-201 (April).

4. EUROSTAT (1986), National Accounts ESA, Input-Output tables 1980, Luxembourg.

5. Commission of the European Communities (1986), The Farm Accountancy Data Network: Farm Accounts Results 1982/83-1983/84.

6. See Ministry of Agriculture, Forestry and Fisheries (1985), Abstract of Statistics on Agriculture, Forestry and Fisheries, Tokyo, Table 2.(1).g.

7. Department of Statistics (1984), Provisional New Zealand Input-Output Tables 1981-1982, Wellington, (November).

8. See U.S. Department of Commerce (1987), Survey of Current Business, Washington, D.C. (January).

9. The other two industries which were eliminated are "Household industry" and "Inventory valuation adjustment".

10. U.S. Department of Commerce (1986), The National Income and Product Accounts of the United States, 1929-1982, Statistical Tables, Washington, D.C. (September).

11. Due to the incorporation of more recent information, 1981 GNP in the I-O tables is $3.6 billion higher than the total in the NIPA.

12. The data source is the Board of Governors of the Federal Reserve System (1987), Balance Sheets for the U.S. Economy, 1947-86, Distribution of Tangible Assets by Sector, p. 10, Washington, D.C. (May).

Annex III

DERIVATION OF AGRICULTURAL POLICY INSTRUMENTS BASED ON THE PSEs and CSEs

1. This Annex describes in more detail, country by country, how the estimated ad valorem price wedges, reported in Table 6, are calculated using the data on PSEs and CSEs published in the individual country studies prepared in conjunction with OECD (1987). The individual country studies provide a wealth of detail on agricultural policies and the basic PSE and CSE calculations, commodity by commodity.

1. AUSTRALIA (1981-81)

Import taxes

2. Although in 1980/81 Australia prohibited imports of cereals, sugar and filled milk (skimmed milk with vegetable oil added), maintained tariffs on several agricultural products, had a VER (voluntary export restraint) agreement with New Zealand for dairy products, and maintained quarantine and standardized packaging (e.g. for butter), their combined impact is likely to be minor and they are not included in the PSE calculations. The only import tax incorporated in the model is the 0.97 cent/kg tariff on imported cheese which was included in the CSE calculation.

Export taxes

3. Australia operates a home-consumption scheme for several commodities, whereby domestic producers are forced to give priority to sales on the domestic market. In the case of sugar, there are supply management policies to enforce the system: cane may only be grown on assigned land, and raw sugar must be delivered to pre-assigned mills. Prices are controlled by the Queensland Sugar Board; a two-tier system operates, distinguishing between sales on the domestic market and exports. In 1980/81, export prices for sugar were 62 per cent higher than the price for domestic consumption. In line with the PSE calculation, it has been assumed that two-thirds of this export tax was borne by the producers (classified under "other agriculture") and one-third by the millers (classified under "other food"). In the case of rice, domestic prices were 57 per cent above export prices in 1980/1981. Since production quantities are small, the value of this price wedge is negligible in the "other agriculture" sector.

Input subsidies

4. Most of the assistance to Australian agriculture takes the form of input subsidies. In most sectors, taxation concessions, subsidisation of rural interest rates, fertilizer subsidies, and research and development are important. For dairy, an important component is the policy of setting a higher price for milk destined for human consumption as compared with milk for manufacturing dairy products (the price differential was 82 per cent in 1980/81). For beef and sheepmeat, export inspection services are the largest single items, and for wool, government assistance towards the cost of wool promotion is the most important component.

2. **CANADA** (1981)

Import taxes

5. The major wedge between domestic producer prices and import prices occurs in the dairy sector which is protected by tariffs on all products and quantitative restrictions for cheese. The import prices of New Zealand skimmed milk powder and butter were used to establish a milk-equivalent import price for the PSE calculations in OECD (1987).

6. Although Canada is a major exporter of grains, there was a 2 per cent import tariff on corn in 1981. For meat, Canadian poultry producers were protected from cheaper U.S. chicken imports in 1981 by tariffs and an import quota equal to 6.3 per cent of the previous year's production. Beef and veal imports were subject to a 1.3 per cent tariff in 1981 and this is included in the import tax for the meat sector.

Export subsidies

7. For the dairy sector, it is assumed that all products destined for export are subsidised by the extent of the same price differential identified in the calculation of the import tax for the sector. The small export subsidies for "other agriculture" and meat are due to the small domestic/world price differentials for corn and beef, respectively.

Input subsidies

8. The major subsidy for "other agriculture" is the reduced freight rates on grain for export. Deficiency payments are relatively important for dairy producers who are subject to a supply management scheme. The PSE is reduced by the amount of levies paid by dairy producers who exceed output quotas. On the other hand, producers who have purchased quotas for the production of fluid milk receive a substantial premium over those who have quotas for the production of milk for industrial uses.

9. Provincial support, research and advisory services are also included in the PSEs. Inspection services are not insignificant for beef, veal and pigmeat production.

Tax on food consumption

10. The only tax additional to those included above is the 1c/lb tariff on refined sugar.

3. **EEC** (1979-81)

Import taxes

11. Import protection in the EEC is based on a variable levy which is the difference between a threshold price and the corresponding world market price. Given that the threshold price reflects the target price, the variable levies fluctuate widely over time in response to changes in world prices and exchange rates, and have become negative on occasions. For beef and veal imports, 80 per cent are subject to concessionary agreements involving quotas and preferential ad valorem duties. VERs govern imports of sheepmeat together with a reduced ad valorem duty of 20 per cent.

12. The price-support component of the PSEs integrates import quotas as well as domestic supply management policies by assuming that their impact is captured in the price differential between domestic and world market prices. In 1980, actual receipts from agricultural import taxes to the Community budget amounted to 2 billion ECUs. This is less than the total revenues allocated to agricultural producers, the difference being the imputed rent arising from quantitative restrictions.

Export subsidies

13. Apart from sheepmeat exports, all EEC agricultural exports are subject to export refunds which cover the difference between the domestic and world market prices. The price-support component of the PSEs has been calculated in such a way that it captures the effects of both the export refunds and the intervention purchasing arrangements.

Production subsidies

14. The major component relates to national public expenditures on agriculture which are aimed at reducing agricultural costs in the longer run (structural improvements, research and advisory services, processing and marketing, etc.). Other policies modelled as production subsidies include deficiency payments to rapeseed and sheepmeat producers.

Consumer subsidies

15. For final demand, these comprise the school and welfare milk subsidies and the subsidy granted to Christmas butter. For intermediate demand, the subsidies include price compensating aids to starch producers who use EEC wheat and maize, and to producers of concentrated feedstuffs for buying EEC skim milk powder.

4. **JAPAN** (1980)

Import taxes

16. The wedge between world prices and domestic producer prices was modelled as an import tax for all products except non-rice grains. Import prices were generally not measured by taking a representative world price and adding transportation costs, as was done for the PSE calculations for most other countries. Instead, the Food Agency's purchase price of imports (c.i.f.) was chosen as the reference price for most commodities.

17. For meat, the implicit import tax may be underestimated, since world beef prices have been multiplied by a factor of 1 2/3 in the PSE calculation. The rationale for this was to make imported beef more comparable in quality to Japanese beef.

18. In the "other food" sector, which includes rice production, the calculated import tax is also underestimated for two reasons. First, in the PSE calculation, world rice prices were raised by 50 per cent to make Thai rice comparable in quality to Japanese rice. Second, because of quantitative import restrictions on all rice imports, the weight of protected commodities in total imports of the "other food" sector is smaller than that which would prevail under free trade.

Input subsidies

19. These include all budgetary expenditures, the main one being "assistance on inputs and structural measures", which is an estimate of agriculture-specific measures of the rural infrastructure budget. Unlike the PSE data for some other countries, expenditures at levels of government lower than Central Government were not identified. Besides infrastructure expenditures, crop insurance and the Paddy Field Reorientation Programme are included as input subsidies. Deficiency payments are also included; such a scheme operates in Japan for soyabeans. For wheat and barley, the value of the price differential between domestic and world prices was also treated as a deficiency payment since the high producer price (over three times the world price in 1980) is not reflected in a correspondingly high consumer price. Finally, the policy of selling imported barley for feed at less than world market prices to livestock producers was also modelled as an input subsidy.

Consumer subsidies

20. Domestic consumer prices for rice, wheat, barley and sugar are below domestic producer prices. To capture the cost of this to the government, the value of the differential between the two domestic prices is modelled as a consumption subsidy to the "other agricultural" and "other food" sectors, depending on the commodity. The School Lunch programme for rice and milk is also included. Partially offsetting these subsidies are tariffs on imported cheese (for quantities in excess of the tariff quota) and maize, and an excise tax on refined sugar.

5. **NEW ZEALAND** (1981-82)

21. It should be noted that since 1984-85 most of the input subsidies have been phased out. Government departments now charge farmers for most of their services at a full-cost recovery basis.

Import restrictions

22. Tariffs are imposed on a number of agricultural products. For most of them imports are nil or negligible. For the products covered in the PSE analysis, import quotas and automatic licensing exist for cereals (with the exception of wheat), poultrymeat and sugar. The effect of these measures, together with sanitary regulations is small because New Zealand is self-sufficient in most of these products. No attempt has been made to quantify the effects of these import restrictions.

Input subsidies

23. The Supplementary Minimum Prices (SMP) scheme guaranteed farmers higher prices in a time of low world prices. The deficiency payments in 1981/82 were large for mutton, wool, beef and veal products. Also important were fertilizer subsidies, subsidised government services, e.g. for research, quarantine, animal health and inspection and interest concessions. Special tax concessions for the agricultural sector were also taken into account in the PSE calculation. For milk, a special subsidy existed in 1981/82 to cover the extra cost of providing towns with milk.

Food subsidies

24. The administered price for town milk paid by consumers did not cover the production price plus margins. This price differential is the only component of the food subsidy bill.

6. **UNITED STATES** (1981) (1)

Import taxes

25. The main border protection to U.S. agriculture is in the dairy sector, for which both tariffs and quantitative restrictions are maintained. The latter are allowed under a waiver of the GATT Articles, and have by far the largest impact on the PSE for dairy products. For example, U.S. cheese prices exceeded the landed price of New Zealand cheese by over 60 per cent in 1981, whereas the tariff is only 6.25 per cent. Imports of butter were restricted to 0.2 per cent of domestic consumption in 1981.

26. In contrast, for meat, no voluntary export restraints were negotiated in 1981 (they were incorporated in the 1979 PSE); the price component of the PSE is equal to the tariff on beef and veal only. For raw sugar, domestic spot prices in New York exceeded world prices by 8.5 per cent in 1981. In the PSE calculation, it is assumed that producers received 60 per cent of the value of the subsidy and processors received the remainder; the relevant proportions were distributed to "other agriculture" and "other food", respectively.

Export subsidies

27. In the case of meat, the value of the domestic/world price differential was weighted by beef and veal exports in total meat exports (no differential exists for pigmeat and poultry). For dairy products, it is assumed that any commodities which are exported are protected to the same extent as domestically-produced milk.

Input subsidies

28. Deficiency payments in the grain sector (including rice) play a major role in filling the gap between world prices and the target price; they are the largest element of the implied production subsidies. Storage payments, crop insurance, interest subsidies, fuel and transportation subsidies, taxation concessions and various State programmes have also been incorporated. For meat producers, inspection services are non-negligible. In 1981 no acreage reductions were in force under set-aside schemes.

Food subsidies

29. The estimated effects of two major food programmes were incorporated in the published CSE calculations: i) the School Lunch (and Breakfast) scheme, and ii) the Food Stamp programme.

NOTE

1. Since OECD (1987) was published, some methodological changes have been made to the measurement of PSEs/CSEs. For 1981, the item "Government Inventory Cost", which proxied the price-support component of government stock acquisition and disposal activities has been replaced by "market price support", based on the difference between the market price and the loan rate. This was judged to be zero in 1981 as the market price was above the loan rate for all crops. For CSEs, the additionality concept associated with the Food Stamp and School Lunch programmes has now been replaced by the value of commodity donations, either from surplus stocks or those purchased by government agencies with a view to fulfilling price support functions.

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