IMPERFECT COMPETITION AND TRADE REFORMS IN AUSTRALIA AND JAPAN: IMPLICATIONS FOR AGRICULTURE*

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ABSTRACT

Recent research in trade policy analysis suggests that estimates of the effects of reform are sensitive to industry structure and conduct. While most of this work confirms that protection in imperfectly competitive industries causes inefficient entry, particularly in capital-intensive sectors with product differentiation, there is disagreement over whether output or employment in the protected sector actually expands as a consequence. In Australia, since much of agriculture is neither capital intensive nor characterised by substantial product differentiation, these results are important in determining whether protected manufacturing would contract and hence unprotected agriculture would exp[illegible] with reform. In Japan, Australia's most important trading partner, agriculture is also protected [illegible]er complicating the question of its expansion or contraction following reform. This paper [illegible] a computable general equilibrium model with imperfectly competitive production behaviour to obtain preliminary estimates of the effects of broad-based trade reform in both countries.

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Since the work of Harris (1984), there has been a proliferation of research on the implications of trade reform in the presence of imperfect competition[1]. The results are found to be particularly sensitive to the extent of unrealized scale economies and to the assumed behaviour of the imperfectly competitive firms (Hazeldine 1990). This paper grows out of a broader project in which alternative specifications are under investigation in the context of four economies in the Western Pacific Region (Tyers et al. 1992). Specifically, it addresses two elements of the controversy.

First, while Harris found the national income gains from trade reform to be greatly enhanced by consideration of imperfectly competitive behaviour, the use of not-dissimilar models by others has yielded results which differ little from those obtained using the more conventional competitive paradigm. The work of Horridge (1987) on the Australian economy, for example, yields the latter conclusion. The results obtained here confirm the conclusions of Horridge, albeit for an incomplete range of alternative specifications.

Second, the "pro-competitive effect" of trade reform on imperfectly competitive sectors is found by Devarajan and Rodrik (1989a) to be large enough to cause the expansion of such sectors once assistance to them has been removed. This result suggests that the "tariff compensation" debate in Australia (Warr 1978, 1979) may have been ill-informed and that Australian agriculture could shrink following the removal of assistance to manufacturing. A recent reexamination of the issue by Hertel (1991a&b), however, concludes that this outcome stems from the adoption of improbable parameter estimates. Our results support the Hertel conclusion, confirming the earlier presumption that agriculture would gain from trade reform in the Australian context. This is despite substantial differences between Hertel's specification and ours.

In our model, home products in each sector are homogeneous and differentiated from foreign products by Armington subaggregation. The pricing behaviour of oligopolistic firms is based on calibrated conjectural variations and is more collusive than the Cournot or Bertrand behaviour assumed by Hertel and others. Also unlike the Hertel model, intermediate demand is represented, imperfectly competitive sectors export and there are multiple, including sector-specific, primary factors.

Our application to Japan examines the more complex case in which the agricultural sector, while it is competitive in structure, is the most protected of all sectors. There is the potential for a pro-competitive effect in manufacturing to exacerbate any post-reform decline in Japan's agricultural sector. Work which ignores this possibility has suggested, for example, that post-Uruguay Round reforms need not cause any such shrinkage in the sector as a whole (merely slower growth) while at the same time yielding substantial efficiency gains in the Japanese economy (Anderson and Tyers

1992). The results presented here show pro-competitiveness effects from trade reform to be small and hence there is some comparative static shrinkage of value added in agriculture. But, where more competitive behaviour is enforced in manufacturing, input prices fall, leading to expanded agricultural production even following trade reform.

In Part I, to follow, the analytics of the model are described. Part II then outlines the respective structures of the Australian and Japanese economies in the context of the model. Part III presents key results.

I The Model

In order to highlight the role of imperfect competition in the analysis of trade policy, yet keep the model manageable, its structure has been made simpler than many modern computable general equilibrium models.[2] Institutions, including government, are represented by a single consuming household with Cobb-Douglas preferences among types of goods and CES subaggregation of home goods with imports.

Firms in all 12 sectors are oligopolistic in their product pricing behaviour, each holding calibrated conjectural variations. Each also bears fixed capital and skilled labour costs, enabling the representation of unrealised economies of scale. But home products in each sector are homogeneous and output is Cobb-Douglas in variable factors and intermediate inputs. The latter are Cobb-Douglas aggregates of home and imported products.[3] The existence of oligopoly power in product markets notwithstanding, firms are price takers in the markets for both primary factors and intermediate inputs.

The five primary factors are capital, skilled labour, unskilled labour, arable land and mineral/energy resources. Assumptions about their mobility are summarized in Table 1. In the length of run assumed, capital is homogeneous and fully mobile internationally while the domestic endowments of the other factors are fixed. Land and mineral resources are sector-specific in all lengths of run. Domestically-owned capital is fixed in quantity, so that changes in the domestic capital stock affect the level of income repatriated abroad and hence they have implications for the balance of payments. But, depending on the closure chosen, firms need not earn market returns on capital in this model. If, for example, the entry and exit of firms are prohibited (or even if they are costly) then economic profits or losses occur.

The economy modelled is "almost small" following Harris (1984). It has no power to influence the border prices of its imports but its exports are differentiated from competing products abroad and hence face finite-elastic demand. An exchange rate is defined and its value set to balance international payments. The numeraire used is a consumer price index, the quantities in which are drawn from the reference database (social accounting matrix, or SAM). This database is presented in full by Tyers et al. (1992).

The model is solved using two Walrasian tatonement algorithms. If firm entry and exit are

Table 1 Primary factors and their mobility

Factor	Mobility
Capital[a]	intersectoral, international
Skilled labour[a]	intersectoral
Unskilled labour	intersectoral
Agricultural land	sector specific
Mineral/energy resources	sector specific

[a] Firms have fixed capital and skilled labour costs but these factors are acquired at the same rates from the pool of mobile capital and skilled labour.

prohibited, corresponding to the "short run" closure of Harris (1984), the exchange rate and the prices of the four factors which are not internationally mobile are adjusted to remove any payments imbalance and to achieve the appropriate degree of factor market clearance. If firm entry and exit are permitted, this solution is embedded in a second tatonement process which adjusts the numbers of firms in each sector until incentives for entry and exit no longer exist.

The approach used to solve the model is illustrated schematically in Figure 1. First, any counterfactual variations in parameters are made. These might include changes in trade distortions, in the external cost of capital, in technology, as reflected in the parameters of the production functions, or in industry structure, as indicated by the fixed factor requirements of firms and their conjectural variations.

Then initial values are set for the numbers of firms in each industry, reference values for which are derived in Tyers et al. (1992). A "no entry" solution, in which the numbers of firms is held constant, is then derived. This solution iterates on the vector [e,w], comprising the exchange rate, e (expressed as foreign currency units per unit of local currency) and a vector of non-capital factor rewards, w. In the reference equilibrium, all elements of this vector are unity, and the search for counterfactual equilibria generally begins with these values.

Next, product prices and the quantities produced, consumed and traded are calculated, from which are derived any foreign payments imbalance or any non-capital factor market excess demands or supplies. Depending on the closure chosen, acceptably small values may be required for these disequilibria. To achieve these targets, the exchange rate and the factor rewards are adjusted and the no-entry solution recomputed. If firm entry and exit are permitted, the no-entry solution is tested for economic profits or losses in each industry. If these exceed an acceptable tolerance level, the vector of firm numbers in each sector, **n**, is adjusted and a new no-entry solution is sought. This process is repeated until convergence is achieved and no further incentive remains for firm entry or exit, usually within 15 iterations.

The derivation of parameters in the model is detailed in Tyers et al. (1992, Appendix 2). Here we focus on the analytical structure of the model and its solution.

The no-entry solution for given [e,w]:

In this solution $\mathbf{n} = [n_i, i=1,N \text{ sectors}]$ is taken as constant. The price of capital, r, is also exogenous, since capital is homogeneous and internationally mobile. The initial vector of non-capital factor rewards is $w = [w_k, k=1,K \text{ non-capital factors}]$. The steps are as follows:

1. Demand elasticities facing domestic industries, ϵ

These must be calculated first, since oligopoly pricing behaviour depends on them. They depend on many other variables in the model, however, so it is best that their formulation be described once the core equations of the model have been presented. For the present, we take these as given.

2. Mark-ups over marginal (unit variable) cost

We assume constant marginal cost oligopolistic firms in homogeneous product markets. The profit-maximising mark-up is derived by setting marginal revenue equal to unit vairable (or marginal) cost, v. The result is

$$(1) \qquad m_i = \frac{p_i}{v_i} = \frac{1}{1 + \frac{\mu_i}{n_i e_i}} \qquad \forall i$$

Where

$$\mu_i = \frac{\partial Q_i}{\partial q_i}$$

and Q_i and q_i are industry and firm output in sector i, respectively.

Note that $\mu_i = 0,1,n_i$ implies, respectively, perfect competiton, Cournot oligopoly or a colluding cartel.

3. Domestic prices of imported goods

$$(2) \qquad p_i^* = \frac{P_i(1+t_i)}{\theta} \qquad \forall i$$

Where P_i is the (fixed) foreign currency price of imports, and

t_i is the equivalent ad valorem tariff rate.

4. Domestic prices of home products

Production is Cobb-Douglas in variable factors and inputs, with output elasticities α_i for capital, β_{ki} for factors k and γ_{ji} for inputs j. The subaggregation of imported and domestic inputs is also Cobb-Douglas, thus assuming unit elasticities of substitution, with expenditure shares on home inputs τ_{ji}.

First, unit variable costs are calculated as:

$$(3) \qquad v_i = b_i r^{\alpha_i} \prod_k^K w_k^{\beta_{ki}} \prod_j^N [p_j^{\tau_j} p_j^{*(1-\tau_{ji})}]^{\gamma_{ji}} \qquad \forall i$$

Where the scale coefficient, b_i, is calibrated from the SAM, as are all the exponents in the equation.

Then, domestic prices follow as:

(4) $p_i = m_i v_i \qquad \forall\, i$

Together, these yield:

$$\text{(5)} \quad \log p_i = \log b_i + \log m_i + \alpha_i \log r + \sum_k^K \beta_{ki} \log w_k$$

$$+ \sum_j^N \gamma_{ji}\tau_{ji} \log p_j + \sum_j^N \gamma_{ji}(1-\tau_{ji}) p_j^* \qquad \forall\, i$$

This is a set of N linear simultaneous equations in p_i which is readily solved by matrix inversion.

5. Unit factor and input demands

These follow from cost minimization by firms whose production is Cobb-Douglas in variable factors and inputs. Although these firms are oligopolistic in product markets, they are price takers in both factor and input markets.

The unit factor demands for capital and other factors, respectively, are:

$$\text{(6)} \quad u_i^K = \frac{\alpha_i v_i}{r} \qquad \forall\, i$$

$$\text{(7)} \quad u_{ki}^L = \frac{\beta_{ki} v_i}{w_k} \qquad \forall\, k,i$$

The unit input demands are just Leontief input-output coefficients, except that their values depend on product and input prices. For home-produced and imported inputs, respectively, they are:

$$\text{(8)} \quad A_{ji} = \frac{\gamma_{ji}\tau_{ji} v_i}{p_j} \qquad \forall\, i,j$$

$$\text{(9)} \quad A_{ji}^* = \frac{\gamma_{ji}(1-\tau_{ji}) v_i}{p_j^*} \qquad \forall\, i,j$$

6. Prices of home product exports in foreign markets:

These depend on the domestic price, p_i, the ad valorem export subsidy rate (with border price as denominator), s_i and the ad valorem equivalent import tariff rate in foreign markets, t_i^*.

$$(10) \qquad p_i^{*} = \frac{p_i e(1+t_i^{*})}{(1+s_i)} \qquad \forall i$$

7. Exports:

Foreigners subaggregate home exports and foreign products with elasticity of substitution σ_i^{*}. Their demand for product group i has elasticity Ω_i.

$$(11) \qquad X_i = \frac{E_i \theta_i [\theta_i p_i^{*(1-\sigma_i^{*})} + (1-\theta_i) P_i^{(1-\sigma_i^{*})}]^{\rho_i}}{(p_i^{*})^{\sigma_i^{*}}} \qquad \forall i$$

Where

$$\rho_i = \left(\frac{\sigma_i^{*} - \Omega_i}{1 - \sigma_i^{*}} \right)$$

and where θ_i is the calibrated reference share of the home export in total consumption. Note that, when exports are small compared with foreign markets (θ_i is small), foreign demand for home product i has approximate elasticity $-\sigma_i^{*}$, irrespective of foreigners' elasticity of demand for that product group. E_i is also a calibrated constant.

Thus far, we have been able to solve directly for domestic and imported product prices, the volume of exports and unit factor demands. Despite the simplifying dependence of this solution on an exchange rate and factor prices which are (at this stage) exogenous, solving for the other key variables which characterise the equilibrium involves unavoidable simultaneity. The additional relationships on which the simultaneous solution is based are those which follow.

8. Final demand:

Home consumers are assumed to subaggregate home goods and imports with elasticity of substitution σ_i. They have Cobb-Douglas utility and hence expenditure shares across product groups are constant. Final demand for home goods is therefore:

$$(12) \qquad D_i = \frac{a_i Y \delta_i p_i^{-\sigma_i}}{\delta_i p_i^{(1-\sigma_i)} + (1-\delta_i) p_i^{*(1-\sigma_i)}} \qquad \forall i$$

Where a_i is the calibrated reference expenditure share of product group i, δ_i is the corresponding share of home goods in final demand for group i and Y is aggregate income (GNP).

Similarly, final demand for imports is

$$(13) \qquad M_i^D = \frac{a_i Y(1-\delta_i)p_i^{*-\sigma_i}}{\delta_i p_i^{(1-\sigma_i)} + (1-\delta_i)p_i^{*(1-\sigma_i)}} \qquad \forall i$$

Note that, if imports dominate final demand (δ_i approaches zero), the price elasticity of final demand for home goods is approximately $-\sigma_i$. If, on the other hand, home goods dominate the domestic market, the elasticity is approximately -1.

9. Demand for inputs:

This is derived from the input-output coefficients and gross industry output, Q. For home inputs of type j it is

$$(14) \qquad I_j = \sum_{j}^{N} A_{ij} Q_i \qquad \forall j$$

For the corresponding imported inputs it is

$$(15) \qquad I_j^* = \sum_{j}^{N} A_{ij}^* Q_i \qquad \forall j$$

10. Total imports:

This is simply the sum of final demand with intermediate demand for imported goods.

$$(16) \qquad M_i = M_i^D + I_i^* \qquad \forall i$$

11. Gross industry output:

In matrix form, where $Q=[q_i]$, this is

$$(17) \qquad Q = (I - A)^{-1}[D + I + X]$$

Where A is the matrix of home input output coefficients and D, I and X are vectors of final and intermediate demand for home goods and exports.

12. Economic profits or losses:

This is revenue derived from markups over unit variable costs, less total fixed costs. For sector i it is

$$(18) \qquad \pi_i = (p_i - v_i)Q_i - n_i(rf_i^K + w_1 f_i^L) \qquad \forall i$$

Where n_i is the number of firms, f_i^K is the fixed capital requirement per firm and f_i^L is the fixed skilled labour requirement per firm in sector i.

13. National income (GNP):

This is the sum of payments to domestically owned factors, the home share of any profits or losses made, net income from tariffs and export subsidies and the net inflow of unrequited transfers, including financial aid.

$$(19) \qquad Y = rK_D + \sum_{k}^{K} w_k L_k + \left(\frac{K_D}{K_T}\right) \sum_{i}^{N} \pi_i + \sum_{i}^{N} t_i p_i^* M_i - \sum_{i}^{N} p_i X_i \left(\frac{s_i}{1+s_i}\right) + \frac{B}{e}$$

Where B is the (constant) net inflow of aid and other unrequited transfers, measured in foreign currency. K_D is that part of the capital stock which is domestically owned. It is also held constant.

14. Total factor demands:

In the case of capital, which is infinitely elastic in supply at fixed rate r, the capital stock, K_T, is the value of capital demanded.

$$(20) \qquad K_T = \sum_{i}^{N} (u_i^K Q_i + n_i f_i^K)$$

The demand for skilled labour is

$$(21) \qquad L_1 = \sum_{i}^{N} (u_{1i}^L Q_i + n_i f_i^L)$$

and that for the other factors is

$$(22) \qquad L_k = \sum_{i}^{N} u_{ki}^L Q_i \qquad k=2,K$$

15. Calculating imbalances:

Once the above equations have been used to solve recursively for p^*, p, p^e, and X, and simultaneously for D, I, M, Q, π, Y, K_T, and L, any imbalances in foreign payments and domestic factor markets can be calculated.

Inflows and outflows on the balance of payments are calculated in domestic currency. Inflows combine export earnings with net transfers (the latter being constant in foreign currency).

$$(23) \qquad \text{Inflows} = \frac{B}{e} + \sum_{i}^{N} p_i X_i$$

Outflows are repatriated earnings on foreign owned capital, the pre-duty cost of imports and the cost of export subsidies.

(24) $$\text{Outflows} = r(K_T - K_D) + (1 - \frac{K_D}{K_T})\sum_i^N \tau_i + \sum_i^N \frac{p_i^* M_i}{1+t_i} + \sum_i^N p_i X_i\left(\frac{s_i}{1+s_i}\right)$$

The external imbalance is then

(25) $$\Delta_e = \frac{\text{inflows}}{\text{outflows}} - 1$$

The corresponding factor market imbalances follow directly from equations (21) and (22), above. They are

(26) $$\Delta_k^L = \frac{L_k}{\bar{L}_k} - 1 \qquad \forall\ k$$

Where L_k is the full domestic endowment of factor k.

These imbalances enter the algorithm by which the exchange rate and factor prices are adjusted in search of the no-entry general equilibrium.

16. The solution algorithm

The objective is to calculate the vector [e,w], which we shall call ω, yielding a vector of imbalances $\Delta=[\Delta_e,\Delta^L]$ which is suitably close to 0. A variant of Newton's Method is used. Extensive use is made of the above no-entry solution for given ω. At the outset, a matrix of derivatives is calculated by imposing small shocks on ω and calculating the associated changes in Δ. This matrix, H has the following elements:

(27) $$h_{ij} = \frac{\Delta_i^1 - \Delta_i^0}{\left(\frac{\omega_j^1 - \omega_j^0}{\omega_j^0}\right)} \qquad \forall\ i,j$$

Where the superscript 0 indicates reference values and superscript 1 indicates those following s small shock to ω.

In any iteration m,

(28) $$\Delta^m - \Delta^{m-1} = H\left(\frac{\omega^m - \omega^{m-1}}{\omega^m}\right)$$

But the objective is to choose the new values of ω, ω^m, so that $\Delta^m = 0$. Imposing this yields

(29) $$\omega^m = \omega^{m-1}(1 - H^{-1}\Delta^{m-1})$$

Thus, the solution is derived by successive application of (29) until Δ is within a suitable tolerance of 0.

The solution with firm entry and exit

Where firm entry and exit are allowed, a common closure requires that this take place to exhaust all economic profits. The objective is then to calculate the vector **n** which yields $\pi(n) = 0$. The imbalance used in this case is the excess rate of return on capital.

(30) $$\Delta_i^n = \frac{\pi_i}{K_i} \qquad \forall i$$

where K_i is the total demand for capital in sector i.

(31) $$K_i = u_i^K Q_i + n_i f_i^K \qquad \forall i$$

The algorithm used is very similar to that used in the no-entry solution to solve for ω. A matrix of derivatives is approximated by first disturbing elements of the vector **n** slightly and using the complete no-entry solution to calculate the resulting changes in π, and hence in Δ^n. An adjustment rule identical to equation (29) is then applied at each iteration, until Δ^n is within a suitable tolerance of 0.

The elasticity of demand facing domestic industries

The sources of demand for home products are final demand, intermediate demand and export demand. For sector i, the elasticity sought is a composite of the elasticities of all three sources of demand.

(32) $$\epsilon_i = s_i^F \epsilon_i^F + s_i^I \epsilon_i^I + s_i^X \epsilon_i^X \qquad \forall i$$

Where s here designates the volume share of the home product in each source of demand.

Beginning with final demand, differentiating (12) yields

$$\text{(33)} \qquad \epsilon_i^F = -\sigma_i + \left(\frac{p_i D_i}{a_i Y}\right)(\sigma_i - 1) \qquad \forall i$$

Where the share in parentheses is that of home goods in final demand for product group i. Its value in the reference SAM is δ_i.

Turning then to export demand, differentiating (11) yields

$$\text{(34)} \qquad \epsilon_i^X = -\left(\frac{\theta_i \Omega_i p_i^{e(1-\sigma_i^*)} + (1-\theta_i)\sigma_i^*}{\theta_i p_i^{e(1-\sigma_i^*)} + (1-\theta_i)}\right) \qquad \forall i$$

Note that, where θ_i is small, the approximate value of this elasticity is $-\sigma_i^*$.

Finally, turning to intermediate demand, we follow Harris (1984) in approximating this component elasticity on the assumption that gross sectoral output, Q_j, is unaffected by the price of any individual input, i.[4] From (14)

$$\text{(35)} \qquad \frac{\partial I_i}{\partial p_i} = \sum_j^N Q_j \frac{\partial A_{ij}}{\partial p_i} \qquad \forall i$$

Then, expanding A_{ij} using (8) and (3),

$$\text{(36)} \qquad \frac{\partial I_i}{\partial p_i} = \sum_j^N \frac{I_{ij}}{p_i}(\gamma_{ij}\tau_{ij} - 1) \qquad \forall i$$

The elasticity follows as

$$\text{(37)} \qquad \epsilon_i^I = \sum_j^N s_{ij}^I(\gamma_{ij}\tau_{ij} - 1) \qquad \forall i$$

Where s_{ij}^I is the share of industry j in the total intermediate demand for input i.

These component elasticities are assembled using (32). In the solution to the model this is done in such a way as to ensure that all the shares, s_i^F, s_i^I, s_i^X and s_{ij}^I are up-dated at each iteration.

II The Stylized Australian and Japanese Economies

Both economies are represented by social accounting matrices divided into the same 12 sectors and 5 primary factors. Apart from the dominance of services, which supply two-thirds of the value added in both economies[5], the manufacturing sector contributes 90 per cent in Japan. Whereas in Australia, where mining and agriculture remain important industries, manufacturing contributes just 60 per cent. The products of mining and agriculture dominate Australia's exports, while those of manufacturing dominate the exports of Japan. This contrast is demonstrated by their respective shares of world trade, listed in Table 2. Japan's dominance of world markets is the greater of the two, however, particularly in the markets for transport equipment (principally vehicles). Both economies protect industries which are primarily import-competing and hence the contrast extends to the pattern of protection in each (also listed in Table 2). Australia protects its manufacturing industries while Japan protects its agriculture and processed food sectors.

In the model each sector comprises a number of identical oligopolistic firms bearing recurrent fixed costs. Minimum efficient scale (MES) for each is defined (following Harris) as the level of output at which average cost exceeds marginal cost by one per cent. The magnitude of recurrent fixed costs then depends on the MES and the slope of the average cost curve. Our estimates of these parameters also follow the approach adopted by Harris (see Tyers et al. 1992). These estimates are summarized in Table 3. The integration of Japan's manufacturing sector into export markets ensures that most potential for scale economies is exhausted, except in the food processing industry. In Australia, by contrast, substantial unrealized scale economies appear to exist in most manufacturing sub-sectors. Accordingly, fixed factor costs make up a higher proportion of total factor costs in Australia than in Japan.

The corresponding parameters and variables governing firm conduct and performance are summarized in Table 4. Here the most sensitive parameters are the elasticities of substitution between home and imported goods in each sector, σ. For Australia and Japan the values we have chosen for these are based on estimates derived by others (see Tyers et al. 1992 and the survey reported in Industry Commission 1991).[6] As equations (32) to (37) confirm, these have the strongest influence over the elasticities of demand facing firms, ϵ. The latter are smaller in magnitude by virtue of the approximately unit-elastic intermediate component of the demand facing firms.

The key parameter determining the oligopoly mark-up over marginal cost, from equation (1), is the ratio of conjectural variations, μ and the number of firms, n. Since mark-ups are available from the reference SAM and ϵ is calculated separately, μ/n, is readily calibrated. For competitive firms this ratio is zero, for a non-cooperative (Cournot) oligopoly it is $1/n$ and, for perfect collusion (a cartel) it is unity (100 per cent). The results suggest the pricing of manufactures is collusive in both economies, though to an extent well short of cartel behaviour. Nevertheless, mark-ups and economic profit rates are substantial.[7]

III The Results

Seven equilibria are calculated for each country. The first two are the reference and counterfactual (trade reform) equilibria in the perfect competition case. For these the reference SAM is modified so that economic profits are combined with payments to capital and the estimates of the capital stock in each sector are adjusted so that the payments reflect (constant) market returns. Fixed costs are then set to zero for firms in all sectors. This, combined with the modifications to the SAM, ensure that firms behave perfectly competitively in both equilibria.

Table 2 Trade policy and international market power in the Australia and Japan models

Sector	Nominal rate of protection[a], %		Share of exports in world trade, %	
	Australia	Japan	Australia	Japan
Agriculture	7	70	4	-
Mining	0	0	8	-
Services	0	0	6	35
Processed food	8	55	3	1
Textiles	33	11	-	3
Wood & paper prod.	13	3	-	2
Chemicals	10	6	-	6
Petrochem. & coal	0	4	1	2
Mineral products	9	3	2	14
Transport equip.	23	2	1	87
Machinery	16	4	-	16
Misc. manuf.	19	5	-	7

a These rates are maintained by the ad valorem equivalents of both import tariffs and export subsidies, applying simultaneously to each sector.

Source: Tyers et al. (1992)

Table 3 Industry structure variables in the reference equilibria of the Australia and Japan models

Sector	Unrealized scale economies,[a] $\frac{MES*n}{Q}$		Payments to fixed factors as % of total payments to: capital		labour	
	Aust.	Japan	Aust.	Japan	Aust.	Japan
Agriculture	1.0	1.0	0	0	0	0
Mining	1.0	1.0	0	0	0	0
Services	1.0	1.0	0	0	0	0
Processed food	3.0	2.0	55	72	9	12
Textiles	1.5	1.2	31	22	4	4
Wood & paper prod.	5.0	1.1	82	28	14	5
Chemicals	1.7	1.0	34	20	6	3
Petrochem. & coal	1.0	1.0	20	27	3	5
Mineral products	4.0	1.0	55	27	9	5
Transport equip.	5.0	1.0	87	28	15	5
Machinery	3.2	1.0	32	15	5	2
Misc. manuf.	5.0	1.0	61	17	10	3

[a] Minimum efficient scale (MES) divided by average firm output

Source: Tyers et al. (1992)

TABLE 4 - Conduct Variables in the Reference Equilibrium[a]

Sector	Elasticity of substitution in consumption σ_i	Elasticity of demand facing firms ϵ_i		Index of non-competitive pricing[b] $\frac{\mu_i}{n_i}$, %		Mark-up $(m_i - 1)$, %		Economic profit/ loss rate $\frac{\pi_i}{K_i}$, %	
		Aust	Japan	Aust	Japan	Aust	Japan	Aust	Japan
Agriculture	2.8	- 2.7	- 1.9	0	0	0	0	0	0
Mining	2.8	- 3.3	- 2.0	0	0	0	0	0	0
Services	1.9	- 1.8	- 1.8	0	0	0	0	0	0
Food processing	2.2	- 2.4	- 2.0	24	27	11	16	12	33
Textiles	3.0	- 2.6	- 2.3	19	12	8	6	37	8
Wood & paper	2.3	- 2.1	- 1.9	36	15	21	9	14	9
Chemicals	1.9	- 1.8	- 2.0	21	27	13	16	21	20
Petroleum & Coal	2.8	- 2.1	- 2.1	22	35	12	21	23	30
Mineral products	2.8	- 2.4	- 2.2	24	24	11	13	4	16
Transport equipment	5.2	- 3.2	- 3.0	22	27	7	10	- 5	16
Machinery	2.8	- 2.7	- 2.6	18	37	7	16	6	23
Misc. manufacturers	2.8	- 2.2	- 2.0	26	28	14	16	10	24

[a] Except for the elasticities of substitution in consumption, all these variables change in counterfactural experiments.

[b] Values range from zero, where prices are equated with marginal costs, to 100%, where firms price as in a cartel.

Source: Tyers et al. (1992)

Next, imperfect competition is restored and a new reference equilibrium calculated. A no-entry trade reform solution follows. Before solving for the case with free entry and exit, however, a further reference equilibrium is required. This is because the original one has economic profits and losses in most manufacturing sectors and hence it is not a complete entry equilibrium. The reference equilibrium with entry is then compared with the counterfactual trade reform case in which entry and exit are free.

Finally, two additional trade reform equilibria are calculated. In these it is assumed that trade reform is accompanied by a diminution of firms' perceived capacity to collude. That is, in each manufacturing industry the parameter μ is reduced to its non-cooperative (Cournot) value, unity. One possible justification for this, particularly in the Australian case, is that trade reform is part of a wider package of microeconomic reforms which includes more energetic surveillance of trade practices and pricing behaviour.[8] The first of these prohibits entry and exit, and is compared with the original reference equilibrium with imperfect competition. The second permits free entry and exit and is compared with the corresponding free-entry reference equilibrium.

The effects of trade reform on the broad pattern of output in each economy are indicated in table 5. For both countries the pattern which emerges is very similar whether or not imperfectly competitive behaviour is accounted for, so long as firms' propensities to collude are left unchanged. Trade reform, by itself, does not alter the perceived elasticies of demand facing domestic firms, ϵ, sufficiently to cause large changes in their mark-ups. As in the perfectly competitive case, these therefore remain roughly constant and the only substantial difference between the counterfactual equilibria is in the distribution of payments to capital between pure profits and market returns. This is consistent with the positions of Horridge and Hazeldine, which explain the large differences obtained by Harris as due to his peculiar assumption about oligopoly pricing behaviour. In his model prices are set as a simple average of those which would stem from our equation (1) and import parity prices (in our nomenclature, p^*). Since the latter are directly sensitive to changes in trade policy, trade reform reduces mark-ups more substantially than it does in our model.

In the case of Australia, all trade reform equilibria show the expected declines in manufacturing value added. The main beneficiary is the mining sector. It booms in all cases and, unless firms are otherwise forced to behave more competitively, real value added in agriculture does not grow. In the context of this model, there are two reasons why trade reform should favour mining over agriculture. First, agriculture presently receives some assistance (Table 2), which would disappear under such reform. This assistance enhances current exports. The post-reform real devaluation does little more than offset the loss of this assistance to agriculture. And second, per unit of output, the agricultural sector is more heavily dependent on chemical and fuel inputs, the real domestic prices of which rise after reform.

In Japan, again the conventional pattern emerges. The removal of (mainly agricultural) protection causes a substantial decline in agricultural value added and a corresponding expansion in

Table 5 Effects of trade reform on output and sectoral structure (per cent change)

	Output		Value added in:			
	GDP	GNP	Agric.	Mining	Serv.	Mfg.
Australia						
Perfect competition	-1.2	.2	-.3	9.2	.8	-3.1
Imperfect competition						
No entry						
μ const.	-1.2	.2	-	9.2	.8	-3.0
μ -> 1	-.6	1.2	6.0	11.2	3.1	-12.5
Free entry						
μ const.	-1.1	.2	-.5	8.7	1.3	-3.0
μ -> 1	.2	2.1	3.1	10.3	3.3	-7.9
Japan						
Perfect competition	-.4	.1	-5.7	1.4	.6	1.2
Imperfect competition						
No entry						
μ const.	-.1	.4	-5.4	1.4	.8	1.4
μ -> 1	.6	1.0	8.8	41.0	7.1	-13.5
Free entry						
μ const.	-.3	.03	-5.5	1.7	.7	2.0
μ -> 1	1.9	3.3	3.2	13.4	5.3	-4.0

Source: Solutions of the model discussed in the text.

the other sectors. Since the pro-competitive effect of reform in manufacturing (increased ϵ) is very small, the effects of the reform on manufacturing industry structure are slight and hence little additional insight is gained from extending the analysis to include oligopolistic behaviour.

For both countries, the counterfactual equilibria are only slightly different when free entry and exit are allowed. To see why this is so it is useful to consider the case of the textile and garment industry in Australia. Trade reform substantially reduces the home prices of this industry's imported competition. When entry and exit are prohibited, mark-ups fall very little (by less than a per cent of the product price) but cheaper imported inputs reduce variable costs. Consumers substitute away from the home product so that volume is reduced and average fixed costs rise. The net effect is a decline in the real product price of less than five per cent (compared with the fall in the home price of imports of 19 per cent). The rate of return on capital in the industry falls below the market rate by five per cent.

When entry and exit are free the economic losses drive domestic firms from the market, reducing their number (and hence fixed capital in the industry) by seven per cent. But, since perceived elasticities of demand change little, the decline in the number of firms raises optimal mark-ups (equation 1). The net effect of reduced average costs and higher mark-ups returns the industry to market rates of return on capital, albeit at a lower volume of output. The change in the industry's real product price is now -4.5 per cent, very similar to that which occurs in the perfect competition version of the model (-4.1 per cent).

The distributional consequences of the trade reform are summarized in Table 6. In Australia, the major beneficiaries are the recipients of mineral resource rents.[9] No primary factors lose in real terms and full employment is retained. The net effect of cheaper imports and a real devaluation is a decline in the CPI of about three per cent, however, suggesting that nominal wages would need to decline to achieve this equilibrium.[10]

In Japan the major losers are farm land owners. All other factors gain. This is consistent with the results obtained from more conventional models. The corresponding effect of trade reform on Japan's imports is summarized in Table 7. Most prominently, agricultural imports expand by about 70 per cent. After reform, imports provide about a third of final demand for agricultural products and 40 per cent of intermediate demand, compared with 15 and 30 percent beforehand. Mineral imports decline slightly, since the small real devaluation which follows the reform raises import costs.[11]

When firms behave more competitively:

Here we turn to the case in which the trade reform is part of a broader program of microeconomic reform, including more active surveillance of trade practices and pricing behaviour. In theory, at least, it is then possible to substantially reduce oligopoly rents, improving overall efficiency and benefiting factors other than capital. To examine this option, we have combined trade

Table 6 Effects of trade reform on real factor rewards (per cent)

	Change in total pts. (average rate of return)	Change in unit rewards to			
		Skilled labour	Unskilled labour	Agric. land	Mineral resrcs.
Australia					
Perfect competition	.7	1.0	-	-.2	9.0
Imperfect competition					
No entry					
μ const.	.6	1.0	-	-	9.0
μ -> 1	- 6.0	4.6	5.0	5.8	10.7
Free entry					
μ const.	.9	.7	-	-	9.7
μ -> 1	- .3	1.7	4.0	3.3	10.5
Japan					
Perfect competition	.6	.7	.6	- 5.6	.9
Imperfect competition					
No entry					
μ const.	.6	1.0	.8	- 5.3	1.1
μ -> 1	- 23.1	14.6	15.5	8.9	40.6
Free entry					
μ const.	.8	.9	.6	- 5.3	1.1
μ -> 1	- 1.6	2.3	7.3	3.1	12.9

Source: Solutions of the model discussed in the text.

Table 7 Effects of trade reform on Japan's imports[a] (per cent)

	Agriculture	Minerals	Total imports
Perfect competition	70	- 8	9
Imperfect competition			
No entry			
μ const.	71	- 7	9
μ -> 1	135	42	37
Free entry			
μ const.	69	- 8	10
μ -> 1	103	10	21

[a] Proportional changes in the value of imports measured in international currency.

Source: Solutions of the model discussed in the text.

reform with reductions in μ to unity, corresponding with non-collusive oligopoly behaviour.

The results are quite striking, but they need to be viewed with some caution. The changes in oligopoly mark-ups which result depend mainly on changes in the ratio μ/n, which is calibrated from the reference SAM (Table 4). Reducing μ to unity causes a larger proportional reduction in this ratio (and hence a larger reduction in mark-ups) the larger is the reference value of **n**, the number of firms. Unlike the model's characterisation, all firms in each sector are not identical. We have derived **n** from industrial data by selecting the number of large firms which we judge to be capable of influencing the product price.[12] Of course, **n** is a variable in the free entry/exit equilibrium. Reduced mark-ups bring economic losses and firms exit from manufacturing industries (yielding smaller **n**). But the extent of this change depends on the cost structure, in particular the level of recurrent fixed costs per firm.

Reduced mark-ups, combined with trade reform, yield an average rate of return on capital in manufacturing 4 per cent below the market rate (of 13 per cent) in Australia and 3 per cent below the market rate (6 per cent) in Japan. In individual subsectors negative returns are rare, however, occurring only in Australia's transport equipment industry and Japan's food processing industry. Even when these losses are carried (in the no-entry equilibria), substantial gains accrue to the economy as a whole (Table 5).

In both economies, lower prices of manufactures reduce input costs in other sectors and those sectors expand at the expense of manufacturing. The agricultural and mining sectors are particular beneficiaries. Even in Japan, where trade reform alone would reduce agricultural value added, the combined reform would substantially expand it. Correspondingly, all factors other than capital derive considerable benefit, as the former oligopoly rents are redistributed and each economy's overall capital stock falls (Table 6). When entry and exit are prohibited, however, the decline in input costs is partially offset in manufacturing by higher average fixed costs, since output volume shrinks. This effect is summarized in Table 8.

When free entry and exit are permitted, exit from the manufacturing sectors of both economies is substantial. Real value added per firm in manufacturing doubles in Australia and increases five-fold in Japan. This reduces average fixed costs in manufacturing, thus abating the reallocation of mobile factors which had been prominent in the no-entry case for both countries. Agriculture and mining still expand substantially (Table 5) and non-capital factors are still net beneficiaries (Table 6).

A final point of interest concerns Japan's imports. Even though agriculture expands in Japan following the combined reform, the increase in aggregate demand for agricultural products is such that imports more than double.

Table 8 Effects of trade reform on average real value added per firm in manufacturing (per cent)

	Australia	Japan
No entry		
μ constant	-3	1.4
μ -> 1	-12	-14
Free entry		
μ constant	-.5	1.7
μ -> 1	97	554

Source: Solutions of the model discussed in the text.

IV Conclusion

In the analysis of broad-based trade reforms in both Australia and Japan, we find that the representation of manufacturing firms as oligopolistic with unrealized scale economies does not lead to substantial departures from the results obtained using a more conventional approach. Our assumption that products are homogeneous within industries is a limitation, however. In models with differentiated products, trade reform changes product variety, thereby affecting welfare in a way not captured in our analysis (Hertel 1991a).

The inclusion of oligopoly behaviour does enrich the model's usefulness in the analysis of wider microeconomic reforms, however. Results from an experiment in which trade reform is combined with more zealous trade practices surveillance, thereby eliminating any price collusion, yield reduced mark-ups and hence reduced input costs in all sectors. The result is a comparatively large national income gain and a redistribution which favours non-capital factors.

In Australia, the gainers from trade reform alone are the factors specific to the mining sector. Land rents and value added in agriculture are not greatly altered in real terms. When trade reform is combined with more competitive manufacturing prices, however, both agriculture and mining expand and their specific factors are rewarded. In Japan, our results for the case of pure trade reform are conventional. Agricultural value added and land rents diminish and agricultural imports expand substantially. The combined reform reverses this result, however. Increases in real aggregate demand due to cheaper imports and home manufactures raise home value added in agriculture even while they further expand agricultural imports.

FOOTNOTES

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1. For surveys, see Markusen and Venables (1988) and Richardson (1989). Recent contributions include those by Devarajan and Rodrik (1989 a,b), Norman (1990) and Brown (1991).

2. The model is a substantially revised and extended version of that used by Gunasekera and Tyers (1990).

3. Since the elasticities of substitution between home goods and imports in final demand are generally greater than unity, this implies, reasonably, that products are less substitutable as intermediate inputs than in final demand.

4. Analytical expressions for ϵ_i^I, for the case in which this assumption is relaxed, are available on request from the authors. These lengthy expressions have not been used in the current version.

5. As Table 2 suggests, the primary focus of this study is on manufacturing. The disaggregation of the very large services sectors, and the attribution to some subsectors of imperfectly competitive behaviour, is the subject of further work in the same project.

6. The elasticities of substitution in foreign markets are, for the purpose of this analysis, set equal to

those in the home market, thus $\sigma = \sigma^*$.

7. The social accounting matrices for both countries are based on the boom period 1986-87. The allocation of payments to capital between those at market rates of return and economic profits is approximate, depending on the accuracy of estimates of the capital stock in each sector (see Tyers et al. 1992).

8. To examine the breadth of the microeconomic reforms to which the Australian government is committed would require the disaggregation of the services sector. These results apply only to pricing reforms in manufacturing.

9. Communications with Ben Smith suggest this is a crude simplification. In Australia, only a small part of any mineral resource rent is captured publicly. At least part of the rest is dissipated in exploration.

10. A further crude simplification which affects the real wage story is our assumption that wage differentials between industries stem entirely from differences in the skill mix. We have ignored the capture of oligopoly rents by unionized labour.

11. As Table 2 shows, we have assumed the local mineral industry receives no protection. Were this not true, home mineral prices could fall in real terms and imports would increase.

12. Considering the coarse disaggregation we have adopted, our approach is crude at best. It is explained in full in Tyers et al. (1992).

REFERENCES

Anderson, K. and R. Tyers (1992), "Effects of Gradual Food Policy Reforms in the 1990s", *European Review of Agricultural Economics* 19(1) forthcoming, January.

Brown, D.B. (1991), "Tariffs and capacity utilization by monopolistically competitive firms", *Journal of International Economics*, forthcoming.

Devarajan, S. and D. Rodrik (1989a), "Pro-competitive effects of trade reform: results from a CGE model of the Cameroon", NBER Working Paper No. 3176, Cambridge, Massachusetts.

__________ (1989b), "Trade liberalization in developing countries: do imperfect competition and scale economies matter?", *American Economic Review* 79: 283-287.

Gunasekera, H.D.B.H. and R. Tyers (1990), "Imperfect competition and returns to scale in a newly industrializing economy: a general equilibrium analysis of Korean trade policy", *Journal of Development Economics* 34: 223-247.

Harris, R.G. (1984), "Applied general equilibrium analysis of small open economies with scale economies and imperfect competition", *American Economic Review* 74: 1016-1032.

Hazeldine, T. (1990), "Why do the free trade gain numbers differ so much? The role of industrial organisation in general equilibrium", *Canadian Journal of Economics* 23: 491-506.

Hertel, T.W. (1991), "Assessing the effects of trade policy in the presence of imperfect competition: theoretical insights into empirical findings", Impact Project Preliminary Working Paper, University of Melbourne.

_____, Lanclos, K. and M.Thursby (1991), "General equilibrium effects of trade liberalization in the presence of imperfect competition", presented at the XXI International Conference of

Agricultural Economists, Tokyo, August 22-29.

Horridge, M. (1987), "The long-term costs of protection: experimental analysis with different closures of an Australian computable general equilibrium model", unpublished Ph.D. dissertation, University of Melbourne.

Industry Commission (1991), "SALTER: a general equilibrium model of the world economy", draft working document, Canberra.

Markusen, J.R. and A.J. Venables (1988), "Trade policy with increasing returns and imperfect competition: contradictory results from competing assumptions", *Journal of International Economics* 24: 299-316.

Norman, V.D. (1990), "Assessing trade and welfare effects of trade liberalization: a comparison of alternative approaches to CGE modelling with imperfect competition", *European Economic Review* 34: 725-751.

Richardson, J.D. (1989), "Empirical research on trade liberalization with imperfect competition: a survey", *OECD Economic Studies* No.12, Spring.

Tyers, R., P. Gibbard, M. Austria and C.S. Suh (1992), "Imperfect competition and returns to scale in general equilibrium: results for four archetype Western Pacific economies", draft report to the Australian Research Council, Department of Economics, The Faculties, ANU.

Warr, P. (1978), "The case against tariff compensation", *Australian Journal of Agricultural Economics* 22: 85-98.

______ (1979), "Tariff compensation without omnisience", *Economic Record* 55: 20-32.