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**ADDING INPUT DEMANDS TO  
PARTIAL EQUILIBRIUM AGRICULTURAL  
TRADE MODELS**

by

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Contributed Paper to the Thirty-Third Conference of the  
Australian Agricultural Economics Society, Christchurch, New  
Zealand, 7-9 February 1989.

\*The views expressed in this paper do not necessarily reflect  
those of the Industries Assistance Commission.

## 1. INTRODUCTION<sup>1</sup>

There has been a recent proliferation of partial equilibrium multi commodity multi country agricultural commodity trade models (OECD [ 8 ] Tyers and Anderson [ 11 ], and the USDA [ 12 ]). On the production side, these models explain output responses as a function of the prices of outputs and at most a couple of variable input prices. No explicit production technology is specified. Rather output price elasticities with respect to output prices are cobbled together from available sources. These are then taken to provide a local approximation to the underlying output side of the production technology.

Because the models do not attempt to explain the demand for all variable inputs they are deficient from a policy perspective as they can not provide all the information of relevance to the policy debate. There is also the possibility that they may provide misleading insights on policy issues although this prospect seems slight.

In addition to the trade, world price, production and consumption information normally generated from partial equilibrium trade models, information is also required on the impact of policy changes on:

- national farm income;
- labour demand;
- partial equilibrium estimates of economic welfare;
- the budgetary cost of policies; and
- the unit price of fixed and quasi-fixed inputs, eg owner-operator "wage rates" and land prices.

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<sup>1</sup> The theoretical work involved in this note was undertaken at the Agricultural Directorate, OECD, Paris. The application reported in this note was undertaken at the Industries Assistance Commission, Australia. This work has benefitted significantly through valuable contributions and suggestions made by Thomas Hertel, Susan Capalbo, Louis Mahe and Matt Harley. Paul Thomassin of Agriculture Canada provided data in a timely and helpful fashion.

For a model to generate this sort of information a knowledge of the response of variable input demand to price changes is required. In this note a methodology is proposed which enables this sort of information to be added to partial equilibrium trade models at very little additional cost.<sup>2</sup>

In the following section the proposed methodology is outlined while Section 3 provides a worked example of the methodology.

## 2. THE METHODOLOGY

A local approximation to the profit maximising opportunities available to a producer who produces (m) outputs jointly using (n) variable inputs can be represented by a  $(m+n)^2$  matrix of price elasticities of variable commodity supply/demand with respect to variable commodity prices. These elasticities can be split into 4 quadrants as depicted in Figure 1.

FIGURE 1 : GROSS MATRIX OF PRICE ELASTICITIES OF VARIABLE COMMODITY SUPPLY/DEMAND WITH RESPECT TO VARIABLE COMMODITY PRICES

	m Output prices	n Input prices
<sup>m</sup> Output levels	$\eta_{ik}$ (m x m)	$\theta_{il}$ (m x n)
<sup>n</sup> Input levels	$\delta_{jk}$ (n x m)	$\beta_{jl}$ (n x n)

In the upper left hand quadrant the familiar own price elasticities of supply with respect to variable output prices are presented (ie the  $\eta_{ik}$ 's). The majority of the supply elasticities contained in the partial equilibrium trade models are of this type.

2 Horridge and Pearse [13] modified Tyers and Anderson's model by including agricultural good. Unfortunately their interpretation of elasticities precludes the calculation of input effects of policy changes.

The upper right hand quadrant contains the elasticities  $\theta_{il}$ . These capture the impact on variable output level of movements in input prices. Typically, the existing partial equilibrium trade models contain a few of these elasticities - mainly livestock supply elasticities with respect to feed prices (OECD [ 8 ]).

Finally, the bottom two quadrants pick up the effects of output and input price movements on variable input demand, ie the matrices of elasticities  $\delta_{jk}$  and  $\beta_{jl}$  respectively.

When  $(m+n)$  is large and/or available data bases leave something to be desired, it is unlikely that econometric techniques could be used to isolate the required  $(m+n)^2$  elasticities with any degree of precision. A methodology is therefore proposed which enables the  $(m+n)^2$  elasticities to be constructed in a theoretically consistent manner using available information.

To derive the relevant formulae first denote the vector of  $(m + n)$  variable profit shares by;

$$\text{and } \begin{matrix} S_i \\ (m \times 1) \\ S_j \\ (n \times 1) \end{matrix}$$

where a typical element of  $S_i$  is  $P_i^D Q_i / \pi > 0$  and a typical element of  $S_j$  is  $W_j X_j / \pi < 0$  and where  $\pi$  is variable profit.

Also denote the  $(n \times m)$  matrix of compensated input demand elasticities with respect to output levels as  $\lambda_{ji}$ , where a typical element of this matrix measures the percentage change in the compensated demand for input  $j$  with respect to a one per cent movement in the output of commodity  $i$ .

Denote the  $(n \times n)$  matrix of elasticities of compensated input demand with respect to input prices as  $\delta_{ji}^c$ , where a typical element of this matrix measures the percentage change in the compensated demand for input  $j$  with respect to a one per cent change in the price of input  $i$ .

Following Hertel [2], the matrix of gross elasticities of input demand with respect to variable output prices is given by

$$\delta_{jk}^{(n \times m)} = \lambda_{jk}^{(n \times m)} n_{ik}^{(m \times m)}, \quad (1)$$

where  $\lambda_{jk}$  is the matrix of elasticities of compensated demand for inputs with respect to output levels and is evaluated at optimal input levels.

Following Lau [5], output supply is assumed to be homogeneous of degree zero in variable commodity prices ie;

$$n_{ik}^{(m \times m)} 1_m^{(m \times 1)} + \theta_{il}^{(m \times n)} 1_n^{(n \times 1)} = 0_m^{(n \times 1)}, \quad (2)$$

where  $1_m$  and  $1_n$  are summing vectors and  $0_m$  is a  $(m \times 1)$  vector of zeros.

Next, assume that substitution possibilities between inputs and outputs are symmetric, ie:

$$\theta_{il}^{(m \times n)} \text{diag } (S_j)^{-1}^{(n \times n)} = \text{diag } (S_i)^{-1}^{(m \times m)} \delta_{jk}^T^{(m \times n)}, \quad (3)$$

where  $\text{diag } (S_i)^{-1}$  denotes the diagonal matrix with elements equal to the reciprocal of the elements in the  $S_i$  vector and the superscript  $T$  denotes the transposition operation.

To derive the relevant formula, (1) is first substituted into the symmetry constraint (3), which gives:

$$\theta_{il}^{(m \times n)} = \text{diag } (S_i)^{-1}^{(m \times m)} n_{ik}^T^{(m \times m)} \lambda_{jk}^T^{(m \times n)} \text{diag } S_j^{(n \times n)}. \quad (4)$$

Second, (4) is then substituted into the homogeneity constraint (2), which gives:

$$\begin{matrix} n_{ik} & 1_m & + \text{diag}(S_i)^{-1} & n_{ik}^T & \lambda_{jk}^T & \text{diag}(S_j) & 1_n \\ (m \times m) & (m \times 1) & & (m \times m) & (m \times n) & (n \times n) & (n \times 1) \end{matrix} = \begin{matrix} 0_m \\ (m \times 1) \end{matrix} \quad (5)$$

Equation set 5 contain  $m$  equations and can be solved for  $m$  unknowns. In this analysis the unknowns are chosen to be the own price elasticities of supply ie the diagonal elements of  $n_{ik}$ . This leaves  $\frac{1}{2}(m^2-m)$  cross price elasticities to be specified;  $(m+n)$  profit shares; and  $(n \times m)$  compensated input demand elasticities with respect to output levels to be specified. Once these are specified,  $n_{ik}$  can be fully determined by solving (5). Once  $n_{ik}$  is determined,  $\delta_{jk}$  follows from (1),  $\theta_{il}$  follows from (3), and  $\beta_{jl}$  is determined (Hertel [3]) by:

$$\begin{matrix} \beta_{jl} & = & \beta_{jl}^c & + & \delta_{jk} & n_{ik}^{-1} & \theta_{il} \\ (n \times n) & & (n \times n) & & (n \times m) & (m \times m) & (m \times n) \end{matrix} \quad (6)$$

In terms of the decomposition of the gross elasticities given in Figure 1, equation (6) enables the matrix of elasticities,  $\beta_{jl}$ , to be determined. The matrix of elasticities,  $\delta_{jk}$ , is determined by substituting (5) into equation (1), and  $\theta_{il}$  is determined by equation (3). Thus the equations that have been derived enable all of the  $(m+n)^2$  elasticities given in Figure 1 to be derived in a theoretically consistent manner. In the following section this methodology is used to derive a set of elasticities for grain and livestock production in Canadian agriculture.

### 3. An Example

Canadian agriculture was assumed to consist of 3 industries - pig production, poultry production and a multi-product industry producing all other agricultural products. In this section the elasticities for the multi-product industry are calculated. This industry is assumed to produce 5 outputs using 10 inputs. Owner-operator labour is assumed to be the fixed factor of production. The outputs and variable inputs include:

Outputs	Inputs
Milk	Compound Feed
Other Grazing Animals	Wheat
Grains	Coarse Grains
Sugar	Other Feed
Other	Fertilizer
	Other Materials
	Grazing Land
	Cropping Land
	Hired Labour
	Capital

As outlined above, to implement the methodology the following information is required;

- $\frac{1}{2}(m^2 - m)$  cross price elasticities of supply;
- $(n \times m)$  elasticities of compensated input demand with respect to output levels;
- $\frac{1}{2}(n^2 - n)$  price elasticities of input demand with respect to input prices; and
- $(m+n)$  variable profit shares.

This data and their source are detailed in Appendix 1. Applying the data given in Appendix 1 to the formulae derived above gives the gross elasticities given in Table 1. In assessing these elasticities, account needs to be taken of the fact that they are medium term, five-year elasticities, in which production is assumed to be constrained only by the availability of the farmer's labour. With few inputs fixed, Sakai's [ 9 ] restrictions on a "normal" technology should hold. In particular, as noted in Hertel [3, p.10], the following restrictions characterise a "normal" technology:

$$\frac{\partial x_j}{\partial w_k} < 0 \text{ for any } j, k$$

Gross substitution among inputs and outputs is ruled out

$$\frac{\partial Q_i}{\partial p_s} > 0 \text{ for any } i, s$$

$$\frac{\partial x_j}{\partial p_s} > 0 \text{ for any } j, s$$

Regressive relationships between inputs and outputs are ruled out.

$$\frac{\partial Q_s}{\partial w_j} < 0 \text{ for any } j, s .$$

To understand why these restrictions arise consider why joint production arises. Joint production comes about when the cost of producing one commodity is affected by the level of production of another commodity. These cost effects are sometimes described as "economies of scope". They arise from two sources. First, when production is constrained by the presence of a fixed factor of production (in the current study the fixed factor is owner-operator labour) expansion of one commodity will use more of the fixed factor. With less fixed factors available for the production of the other commodities, their production will only be maintained if more variable inputs are used. Hence per unit costs of production of the alternative commodities will rise. If these sorts of "economies of scope" predominate then outputs are more likely to be gross substitutes for one another, ie cross price elasticities of supply will be negative.

In contrast, the second kind of "economies of scope" give rise to gross complementarity between outputs. In the second case, the expansion of one output lowers the cost of producing other commodities. For example, an expansion of dairy production would increase effluent output and this could lead to lower costs for cropping activities as less fertilizer would be used because the effluent could be spread as a fertilizer substitute. When these sorts of economies of scope predominate outputs will be gross complements for one another, ie cross price elasticities of supply will be positive.

Examining the derived elasticities given in Table 1 it can be seen that there are some minor violations of Sakai's restrictions on a normal technology. Some regressive relationships exist between inputs and outputs while some inputs are gross substitutes with one another.

The regressive relationships between inputs and outputs arise because of the existence of gross substitution amongst several outputs. In deriving the output supply elasticities, it was difficult to obtain a relatively large own price elasticity for grain crops without making milk a gross substitute for grain crops. When gross substitution exists a price increase of one commodity will not increase the output of all other commodities. Consequently, the price increase will lead to a contraction of the substitute outputs. The decline in these outputs will cause input use to fall. If this fall outweighs the input expansion caused by the own output increase, regressive relationships between inputs and outputs will arise. This is the case with price increases for milk and extensive grazing which lead to less cropping land being used because less crops are produced (Table 1). Similarly, a grain crop price rise reduces the output of milk and extensive grazing. This reduces the demand for land, some feeds, labour and capital.

Examining the input price elasticities with respect to input prices it can be seen that Sakai's restrictions on a normal technology are also violated in some cases. Here it can be seen from Table 3.6 that some inputs are gross substitutes for one another. This is particularly the case for feed inputs. To understand why this result occurs refer back to equation (6) in Section 2. This equation splits the gross elasticities of input demand into two components. The first term on the right hand side of equation (6) picks up the substitution effects between inputs while the second term on the right hand side of equation (6) picks up the expansion effect of moving input prices. In the case of feed the expansion effects are dominated by the substitution effects so that overall gross substitution prevails. Given the high substitution possibilities between feeds these violations of the restrictions are considered to be valid.

TABLE 1 CROSS PRICE ELASTICITIES OF SUPPLY AND INPUT DEMAND WITH RESPECT TO VARIABLE COMMODITY PRICES

(PRICES)																	
	MILK	WT/GRZ	GR/CRDP	RICE	SUGAR	OTHER	CON/FO	WHT	C/G	OTH/FO	FERT	OTH/MA	LAND 1	LAND 2	LABOUR	CAPITAL	SUM
	0.4331	0.1032	-0.3558	0.0000	0.0001	0.0064	-0.0799	0.0010	0.0028	-0.0837	0.0089	-0.0241	-0.0296	0.0325	-0.0289	0.0141	0.0000
GRZ	0.0995	0.7619	-0.1779	0.0000	0.0001	0.0064	-0.1344	0.0001	-0.0748	-0.1297	-0.0267	-0.2056	-0.0499	0.0160	-0.0565	-0.0386	0.0000
ROP	-0.1930	-0.1032	0.1709	0.0000	-0.0005	0.0032	0.0450	-0.0005	-0.0009	0.0464	-0.0023	0.0245	0.0169	-0.0160	0.0151	0.0004	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R	0.0099	0.0103	-0.0089	0.0000	0.4063	0.0635	-0.0355	0.0002	-0.0001	-0.0355	-0.0333	-0.1034	-0.0011	-0.0317	-0.1201	-0.0405	0.0000
R	0.0099	0.0103	0.0089	0.0000	0.0010	1.6328	-0.1291	-0.0003	-0.0048	-0.1239	-0.1058	-0.4430	-0.0011	-0.1222	-0.5257	-0.2070	0.0000
FD	0.1914	0.3337	-0.1928	0.0000	0.0008	0.1974	-1.4010	0.0094	0.0616	0.5281	-0.0448	-0.0408	0.0428	0.1385	-0.0893	0.2551	0.0000
	-0.1846	-0.0240	0.1496	0.0000	-0.0003	0.0413	0.7221	-1.8128	0.1070	0.4279	-0.0324	0.0932	0.0842	0.1184	0.0020	0.3088	0.0000
	-0.0743	0.1315	0.0425	0.0000	0.0000	0.0810	0.6785	0.0153	-1.7212	0.3844	-0.0376	0.0418	0.0691	0.1253	-0.0262	0.2898	0.0000
FD	0.2238	0.3593	-0.2215	0.0000	0.0009	0.2114	0.5892	0.0082	0.0389	-1.4560	-0.0457	-0.0511	0.0395	0.1401	-0.0970	0.2620	0.0000
	-0.0314	0.0978	0.0145	0.0000	0.0011	0.2383	-1.0660	-0.0006	-0.0050	-0.0604	-0.3632	-0.0872	0.0687	0.1162	-0.1087	0.2660	0.0000
MA	0.0240	0.2122	-0.0437	0.0000	0.0010	0.2815	-0.0170	0.0005	0.0016	-0.0190	-0.0246	-0.0099	0.0590	0.1184	-0.0377	0.2536	0.0000
1	0.2781	0.4859	-0.2631	0.0000	0.0001	0.0069	0.1578	0.0043	0.0246	0.1389	0.1828	0.5565	-0.4151	-0.2937	0.0811	-0.9349	0.0000
2	-0.1640	-0.0838	0.1447	0.0000	0.0016	0.3936	0.2916	0.0032	0.0240	0.2644	0.1660	0.5998	-0.1578	-0.5622	0.0143	-0.9355	0.0000
UR	0.0833	0.1689	-0.0777	0.0000	0.0034	0.9666	-0.1974	0.0000	-0.0029	-0.1046	-0.1540	-0.1089	0.0249	0.0082	-0.9211	0.2214	0.0000
TAL	-0.0204	0.1474	-0.0011	0.0000	0.0006	0.1906	0.1597	0.0024	0.0158	0.1415	0.1087	0.3676	-0.1436	-0.2675	0.1109	-0.8126	0.0000

Turning to a discussion of the magnitude of the elasticities, the overall impression gained is that Canadian agriculture is generally not very responsive to variable price movements. Apart from "other agriculture", output supply elasticities are less than one. The elasticities are however significantly greater than those obtained from econometric techniques. Lopez [ 7 ], for example, obtained estimates of the own price elasticity of supply for crops and animal products of about .01 and .4 respectively.

Given the low value of the supply elasticities obtained in the current study it can be concluded that there are minimal economies of scope in Canadian agriculture. That is, few cost savings arise when one output is expanded. Thus, joint production in Canadian agriculture largely arises because outputs have to compete amongst each other for the limited supply of owner-operators labour.

In contrast to the other elasticities, input price elasticities with respect to input prices are far more price responsive. Feeds exhibit the strongest substitution between one another.

In terms of the production relationships among primary factors, the current study finds that land and capital are gross complements but land and labour and labour and capital are gross substitutes. As in the case of feed, these results are largely determined by the size of Capalbo's estimated substitution elasticities. They dominate the expansion effects implied by the assumed output supply elasticities and compensated input demand elasticities with respect to output levels.

In summary, the elasticities calculated in this study give rise to elasticities with similar overall properties to those obtained from econometric studies of Canadian agriculture. The elasticities imply production is relatively unresponsive to price movements and that there is very little interaction between outputs and inputs. Input use is however more price responsive to input price movements. The elasticities are constructed in a manner consistent with the belief that producers maximize profits. Under these circumstances it is concluded that the calculated elasticities provide a reasonable approximation of the profit maximizing opportunities available to farmers in the grains/grazing sector of Canadian agriculture.

## APPENDIX 1 : SOURCES OF DATA

To calculate the elasticities for the multi-product industry the following base data is required;

- $\frac{1}{2}(m^2-m)$  cross price elasticities of supply;
- $(n \times m)$  elasticities of compensated input demand with respect to output levels;
- $\frac{1}{2}(n^2-n)$  price elasticities of input demand with respect to input prices; and
- $(m+n)$  variable profit shares.

### - $(m+n)$ Variable Profit Shares

The  $(m+n)$  profit shares were derived from the data base of an input/output model of Canadian agriculture [ 10 ]. Variable profit was defined as net income of farm operators plus net rental income. Input use valued at purchasers' prices was divided by variable profit to obtain the profit shares. Input shares are negative and the shares sum to one over both inputs and outputs.

### - $(n \times m)$ Elasticities of Compensated Input Demand with Respect to Output Levels

The database in Agricultural Canada's input/output model was used to obtain the  $(n \times m)$  elasticities of compensated input demand with respect to output levels. Specifically these elasticities are approximated by:

$$\lambda_{jk}^{(n \times m)} = \left( \frac{\partial X_j^c}{\partial Q_i} \right) \left( \frac{Q_i}{X_j} \right) = \alpha_{ji} / \sum_k X_{jk} \quad \begin{matrix} j=1, \dots, n \\ i,k=1, \dots, m \end{matrix} \quad (7)$$

That is, the percentage change in the demand for the  $j$ th input due to a one per cent change in the output of the  $i$ th commodity is equal to a scalar,  $\alpha_{ji}$ , times the share of the input consumed in the production of the  $i$ th commodity. The share data are scaled to incorporate in the elasticities diminishing returns to variable factors which should exist

in the presence of a fixed factor. That is, in the presence of a fixed factor a proportional increase in all outputs should lead to a proportionately greater increase in variable input use. The scalars were obtained from the estimated profit function for the United States provided by Hertel [ 4 ]. They ranged from 1.08 for land up to 1.32 for labour and indicate that labour use intensifies as outputs are expanded, whereas the use of land declines relatively.

The elasticities of compensated input demand with respect to output levels are given in Table A1.

#### - $\frac{1}{2} (m^2 - m)$ Cross Price Elasticities of Supply

The derivation of the  $\frac{1}{2} (m^2 - m)$  cross price elasticities of supply took account of the existing elasticities in the MTM model OECD [ 8 ] and available econometric evidence Lopez [7]. Initial values of the elasticities were chosen and these were altered having regard to the effects of the changes on the signs and magnitudes of the own price elasticities of supply. While there is obviously considerable scope to alter individual elasticities, the process of deriving the elasticities indicated there were definite bounds within which the elasticities had to be set if plausible elasticities were to be obtained. The elasticities finally settled upon are given in Table A2.

#### - $\frac{1}{2} (n^2 - n)$ Price Elasticities of Compensated Input Demand

The  $\frac{1}{2} (n^2 - n)$  input price elasticities were derived by disaggregating the elasticities estimated by Capalbo [ 1 ]. Capalbo estimated various models for Canadian agriculture and the model chosen for this analysis was the specification which closely accords with that of the current study. This model provides estimates of the compensated input demand elasticities for 6 variable inputs with owner operator labour fixed. Her inputs include;

- feed
- fertilizer
- other materials
- land and building
- capital; and
- hired labour.

This input structure was disaggregated into the 10 available inputs specified in the MTM inputs model using the formula proposed by Fuss [ 2 ]. The disaggregated elasticities are given in Table A3.

TABLE A 1 COMPENSATED INPUT DEMAND WITH RESPECT TO OUTPUTS

	MILK	EXT/GRZ	GR/CRO	RICE	SUGAR	OTHER	SUM
COM/ED	0.4379	0.4040	0.1992	0.0000	0.0018	0.1172	1.1600
WHEAT	0.0168	0.1032	1.0169	0.0000	0.0003	0.0228	1.1600
C/G	0.1101	0.2578	0.7445	0.0000	0.0008	0.0457	1.1600
OTH/ED	0.4772	0.4232	0.1321	0.0000	0.0019	0.1257	1.1600
FERT	0.1687	0.1884	0.6266	0.0000	0.0031	0.1432	1.1300
OTH/MAT	0.1981	0.3139	0.4761	0.0000	0.0025	0.1894	1.1600
LAND 1	0.5116	0.5684	0.0000	0.0000	0.0000	0.0000	1.0800
LAND 2	0.0000	0.0000	0.8365	0.0000	0.0042	0.2392	1.0800
LABOUR	0.2486	0.2151	0.2589	0.0000	0.0071	0.5894	1.3200
CAPITAL	0.1758	0.2517	0.6169	0.0000	0.0018	0.1138	1.1600

\*\*\*\*\*

Source ; Agriculture Canada

A discription of all variables included in the tables is given in Table 3 .

TABLE A 2 ASSUMED CROSS PRICE ELASTICITIES OF SUPPLY AND  
CALCULATED OWN PRICE ELASTICITIES OF SUPPLY

	MILK	EXT/GRZ	GR/CROP	RICE	SUGAR	OTHER
MILK	0.4331	0.1032	-0.3558	0.0000	0.0001	0.0664
EXT/GRZ	0.0995	0.7619	-0.1779	0.0000	0.0001	0.0064
GR/CROP	-0.1990	-0.1032	0.1709	0.0000	-0.0005	0.0032
RICE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SUGAR	0.0099	0.0103	-0.0889	0.0000	0.4063	0.0635
OTHER	0.0099	0.0103	0.0089	0.0000	0.0016	1.6328

TABLE A 3 COMPENSATED PRICE ELASTICITIES OF INPUT DEMAND

	COM/ED	WHEAT	C/G	OTH/ED	FERT	OTH/MAT	LAND 1	LAND 2	LABOUR	CAPITAL	SUM
COM/ED	-1.3055	0.0090	0.0630	0.6225	-0.0250	0.1000	0.0727	0.1353	0.0050	0.3230	0.0000
WHEAT	0.6945	-1.8123	0.1084	0.3984	-0.0250	0.1000	0.0727	0.1353	0.0050	0.3230	0.0000
C/G	0.6945	0.0155	-1.7194	0.3984	-0.0250	0.1000	0.0727	0.1353	0.0050	0.3230	0.0000
OTH/ED	0.6945	0.0058	0.0403	-1.3516	-0.0250	0.1000	0.0727	0.1353	0.0050	0.3230	0.0000
FERT	-0.0368	-0.0005	-0.0033	-0.0330	-0.3430	0.0040	0.0727	0.1353	-0.1070	0.3117	0.0000
OTH/MAT	0.0416	0.0005	0.0038	0.0373	0.0011	-0.6770	0.0727	0.1353	0.0680	0.3167	0.0000
LAND 1	0.2850	0.0037	0.0259	0.2555	0.1934	0.6857	-0.3716	-0.3194	0.1280	-0.8862	0.0000
LAND 2	0.2850	0.0037	0.0259	0.2555	0.1934	0.6857	-0.1716	-0.5194	0.1280	-0.8862	0.0000
LABOUR	0.0060	0.0001	0.0005	0.0054	-0.0873	0.1967	0.0393	0.0731	-0.5950	0.3612	0.0000
CAPITAL	0.1945	0.0025	0.0177	0.1744	0.1274	0.4560	-0.1361	-0.2534	0.1810	-0.7670	0.0000

\*\*\*\*\*

COM/ED = Compound feed , WHEAT = Feed wheat , C/G = Feed coarse grains , OTH/ED = All other feeds

FERT =Fertilizer , OTH/MAT = All purchased materials excluding fertilizer and feeds ,

LAND 1 = Service flow from grazing land , LAND 2 = Service flow from cropping land ,

LABOUR = Hired labour , CAPITAL = Service flow from all capital items excluding land , SUM = Sum of

elasticities across a row , MILK = All milk produced , EXT/GRZ = Production of beef &amp; veal , wool and

sheep meat , GR/CRO = Production of wheat , coarse grains , oilseeds and other grains ,

RICE = Rice production , SUGAR = Production of sugar , OTHER = Production of vegetables ,

fruit , tobacco and wine .

## REFERENCES

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  - (3) Hertel, Thomas W., "Applications of Duality and Flexible Functional Forms : The Case of the Multiproduct Firm", Research Bulletin 980, Purdue University, Agricultural Experiment Station, September 1984.
  - (4) Hertel, Thomas W., "An Aggregate Technology for Modelling U.S. Agricultural Policy", Purdue University, Mimeographed.
  - (5) Industries Assistance Commission, The Wheat Industry: AGPS, February 1988, Appendix H.
  - (6) Lau, L., "Applications of Profit Functions", in M. Fuss and D. McFadden (eds), Production Economics : A Dual Approach to Theory and Applications, Vol. I, North Holland : Amsterdam (1978).
  - (7) Lopez, Ramon E., "Estimating Substitution and Expansion Effects Using a Profit Function Framework", American Journal of Agricultural Economics, August 1984.
  - (8) Organisation for Economic Cooperation and Development, "National Policies and Agricultural Trade", Paris 1987.
  - (9) Sakai, Y., "Substitution and Expansion Effects in Production Theory : The Case of Joint Production", Journal of Economic Theory, 9(1974), 255-74.
  - (10) Thomassin, P. and Anderson Allan, "Agricultural Canada's Input-Output Model PART I : Disaggregation of the Agricultural Sector", Agricultural Canada Working Paper 6/87, April 1987.
  - (11) Tyers, R. and K. Anderson, "Distortions in World Food Markets : A Quantitative Assessment", National Centre for Development Studies, Australian National University, January 1986.
  - (12) USDA, see, for example, Dixit, P., V. Ronnigan, J. Sullivan and J. Waino, (1987) Impact of Removal of Support to Agriculture in Developed Countries, International Trade Division, Economic Research Service USDA.
  - (13) Mark Horridge and David Pearce, "Modelling the Effects on Australia of Interventions in World Agricultural Trade", impact Preliminary Working Paper OP-65, October 1988
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**AUSTRALIAN AGRICULTURAL ECONOMICS  
SOCIETY  
1989 ANNUAL CONFERENCE**

**Lincoln College  
6-9 February 1989**

**Sponsored by Reserve Bank of New Zealand**

**PROGRAMME**

**TUESDAY 7 FEBRUARY**

**8.30 - 9.00 pm      REGISTRATIONS**

**9.00 - 10.30 am    OPENING PLENARY PAPER**

**Room 12**

**Bruce Gardner**

**University of Maryland**

**"INTERNATIONAL CONSEQUENCES OF UNITED STATES  
AGRICULTURAL POLICIES"**

**Ivan Roberts**

**Australian Bureau of Agricultural and Resource  
Economics**

**Discussion Opener**

**10.30 - 10.45 am    Tea and Coffee**

**10.45 - 12.30 pm    INVITED PAPERS (Two concurrent sessions)**

**(a) Dairy Trade - Room 1**

**Steve Beare, Lora Domine and Murray Lembit**

**Australian Bureau of Agricultural and Resource  
Economics**

**"TRANS-TASMAN TRADE IN MANUFACTURED DAIRY  
PRODUCTS: A MATHEMATICAL PROGRAMMING MODEL OF  
IMPERFECT SECTORAL COMPETITION"**

**Gary Griffith, Ralph Lattimore and John  
Robbertson**

**New South Wales Department of Agriculture,  
Lincoln College and Virginia Polytechnic and  
State University**

**"CER AND AUSTRALIA-NEW ZEALAND DAIRY PRODUCTS  
TRADE"**

**(b) Stabilisation - Room 2**

**John Quiggin and Brian Fisher**

**University of Sydney**

**"GENERALISED UTILITY THEORIES - IMPLICATIONS  
FOR STABILISATION POLICY"**

**Rob Fraser, R.W.**

**University of Western Australia**

**"ON EVALUATING THE PRODUCER BENEFITS FROM PRICE  
STABILISATION"**

**12.30 - 1.30 pm    Lunch**

**1.30 - 3.30 pm    CONTRIBUTED PAPERS A**

**3.30 - 3.45 pm    Tea and Coffee**

**3.45 - 5.00 pm    PRESIDENTIAL ADDRESS - Room 12**

**7.00 - 7.30 pm    Pre-Dinner Drinks, Oak Room**

**7.30 pm            Conference Dinner, Lincoln Dining Room**

**WEDNESDAY 8 FEBRUARY**

**8.30 - 10.30 am      CONTRIBUTED PAPERS B**

**10.30 - 10.45 am    Tea and Coffee**

**10.45 - 12.30 pm    PLENARY PAPERS  
Room 12**

**Tony Rayner  
Lincoln College  
"THE ROLE OF AGRICULTURAL POLICY IN NEW ZEALAND:  
PAST, PRESENT AND FUTURE"**

**Will Martin  
Australian National University  
"RURAL POLICY: 1983 - 1988"**

**Brian Easton  
Consultant  
"AGRICULTURAL POLICY: THE RATIONALE FOR ONE"**

**12.30 - 1.45 pm    Lunch**

**1.45 - 3.30 pm      CONTRIBUTED PAPERS C**

**3.30 - 4.00 pm      Tea and Coffee**

**4.00 - 6.00 pm      ANNUAL GENERAL MEETING  
Room 12**

**6.00 pm              Depart for Social Evening**

**THURSDAY 9 FEBRUARY**

**8.30 - 10.30 am      CONTRIBUTED PAPERS D**

**10.30 - 10.45 am      Tea and Coffee**

**10.45 - 12.30 pm      INVITED PAPERS (Two concurrent sessions)**

**(a)    *Agricultural Research*  
Room 1**

**Jim Ryan and Jeff Davis  
Australian Centre for International  
Agricultural Research  
"ECONOMIC GROWTH, TECHNOLOGICAL CHANGE AND  
PRIORITY ASSESSMENT IN AGRICULTURAL RESEARCH"**

**Veronica Jardine  
Scobie Economic Research  
"CRISIS IN AGRICULTURAL R AND D IN  
NEW ZEALAND?"**

**(b)    *Macroeconomics*  
Room 2**

**Paul O'Mara  
Australian Bureau for Agricultural and Resource  
Economics  
"EXCHANGE RATES, INTEREST RATE AND AGRICULTURE:  
A MACROECONOMIC VIEW"**

**John Robertson and David Orden  
Virginia Polytechnic and State University  
"A VECTOR ERROR CORRECTION MODEL OF MONEY AND  
PRICE DYNAMICS IN NEW ZEALAND"**

**12.30 - 1.30              Lunch**

**1.30 - 3.15 pm          CLOSING PLenary SESSION  
Room 12**

**Gordon Rausser and Foster W.E.  
University of California, Berkeley  
"POLITICAL PREFERENCE FUNCTIONS AND THE MARKET FOR  
PUBLIC POLICY REFORM"**

**3.15 - 3.30 pm          CONFERENCE CLOSURE**

**3.30 - 4.00 pm          Tea and Coffee**

**4.00 - 6.00 pm          INCOMING COUNCIL MEETING**

Selected and Contributed Papers, Session A  
Thursday 7 February - 1.30 to 3.30 pm

Session A-1, Room 1, Chairperson: Tony Zwart

Chiao, Y.S. MAFCorp and Scobie, G.M. Scobie Economic Research	Eveleens, W.M.; Reynolds, R.G. and Moore, W. MAFCorp	Sandrey, R. and Eveleens, W. MAFCorp
The Cost to Agriculture of Import Protection in New Zealand	Effects of Liberalisation on the Provision of Government Services to Agriculture	New Livestock Industries: The Dynamics and Impacts of Government Policies

Session A-2, Room 2, Chairperson: Carolyn Tanner

Hardaker, J. B.; Fleming, and Patten, H. Louise University of New England	Delforce, Julie University of New England University of Queensland	Qian, Dong; Xiji, A; Drynan, R.G. and Longworth, John
Issues in Food Policies in the South Pacific	Expenditure Patterns of Smallholder Farm Households in Tonga: an Application of the Almost Ideal Demand System	Food Consumption Patterns of Urban Residents in China

Session A-3, Room 3, Chairperson: Ralph Lattimore

McDougall, Robert and Sugden, Craig Industries Assis. Comm.	Dwyer, G.M. and Davidson, Brian University of New England	Topp, V; Williamson, G.; Lenbit, M. and Beare, S. A.B.A.R.E. and Beare, S.
Reforming Trans-Tasman Shipping: An International General Equilibrium Analysis	A Trans-Tasman Trade in Market Milk - A Spatial Equilibrium Approach	The Resource Costs of Blended Milk Pricing in Victoria

Session A-4, Room 4, Chairperson: Anton Meister

Vidler, Peter Duffy, ACT	Campbell, H. and Lindner, R. University of Tas.	Staniford, A.J. Dept of Fisheries, S.A.
An Analysis of Some Aspects of the Australian Domestic Raw Cotton Market, 1968-69 to 1985-86	The Production of Fishing Effort and the Economic Performance of Licence Limitation Programs	Licence Reduction and Gear Restriction Policies in Limited Entry Fisheries: A Bioeconomic Analysis

Session A-5, Room 5, Chairperson: Roy Powell

Battese, George, E.; Colby, T.C. and Coelli, T.J. University of New England	Belete, Abenet; Dillon, John, L. and Anderson, Frank, M. University of New England	Esparon, Nanette, M. and Sturgess, N.H. University of Melbourne
Estimation of Frontier Production Functions and the Technical Efficiencies of Indian Farms Using Panel Data from ICRISAT'S Village Level Studies	The Development of Agriculture in Ethiopia Following the 1975 Land Reform	Technical Efficiency of Rice Production in East and West Java, Indonesia

Session A-6, Room 6, Chairperson: Gordon MacAulay

Brennan, D. and Lindner, R. University of W.A.	Pandey, Sushil University of W.A.	Malcolm, W. and Edwards, R. Melbourne University
The Long-term Peak Load Problem in Grain Storage: An Empirical Analysis	Economics of Wild Oats Control: An Application of a Stochastic Dynamic Programming Model	Judging Crop Sequences for Crop Farm Management

Selected and Contributed Papers, Session B  
Wednesday 8 February - 8.30 to 10.30 am

Session B-1, Room 1, Chairperson: Basil Sharpe

Jakobson, K.M. and  
 Dragan, A.K.  
 La Trobe University

Hertzler, G.L; Lindner  
 R.K. and Pandey, S.  
 University of W.A

Ghadim, Amir K., Abbadi  
 and Pannell, D.J.  
 University of W.A.

The Economics of Species  
 Preservation: Theory  
 and Methodology

Public Policies for Pest  
 Control: Toward an  
 Analytical Framework

Weed Management in  
 Crop-Pasture Rotations

Session B-2, Room 2, Chairperson: Ian Jarratt

Annam, K.A.: Izac, A.M.N;  
 and Fraser, K.I.  
 University of Queensland

Voon, T. and Edwards, G.  
 La Trobe University

Williams, Christine H;  
 Longworth, John W. and Whan Ian F  
 University of Queensland

An Economic Evaluation of  
 Dryland Pasture  
 Improvement Strategies for  
 Beef Cattle Production  
 in Tropical Queensland

Returns to Research for  
 Beef Carcase Quality  
 Improvement in Australia

Pricing Efficiency at South  
 East Queensland Cattle  
 Auctions

Session B-3, Room 3, Chairperson: Sandra Martin

Connolly, G. and Guy, K.  
 ABARE

Griffith, R.R. and  
 Duff, G.L.  
 N.S.W. Ag. & Fisheries

Negendank, O.  
 University of Otago

Tests of the Dynamics and  
 Functional Form of Retail  
 Demand for Clothing and  
 Footwear in Western Europe

The Influence of Shortrun  
 Price Variability on  
 Sydney Pork Price Spreads:  
 A Preliminary Analysis

Forecasting Systems for the  
 Pork Industry - the Role of  
 Producers

Session B-4, Room 4, Chairperson: Bob Townsley

Bennett, Jeff, W.  
 University of N.S.W.

Vidler, Peter  
 Duffy, ACT

Lawrence, Denis and Zeitsch, J.  
 Industries Assis. Com.

Wages Determination in the  
 NSW Black Coal Industry

An Analysis of Trends in  
 Queensland Raw Cotton  
 Production, 1971-72 to  
 1985-87

Production Flexibility  
 Revisited

Session B-5, Room 5, Chairperson: Tim Yapp

Wynen, Els and Kennedy,  
 John  
 La Trobe University

Sappideen, B.  
 Soil Conservation Service,  
 N.S.W.

Policy Options for  
 Chemical Free Agriculture:  
 an LP Approach  
 Farmers

Economic Evaluation of the Yass  
 Salinity Abatement  
 Demonstration Project: A  
 Methodological Framework

Session B-6, Room 6, Chairperson: John Longworth

Wright, Vic.  
 University of New England

Wan, Guang Hua;  
 Griffiths, W.E. and  
 Anderson, J.R.  
 University of New England

Woodford, Keith  
 Queensland Ag. College

Agribusiness Management and  
 Farm Management: Some  
 Parallels and Their  
 Implications

Estimation of Marginal  
 Risks With Seemingly  
 Unrelated Regression  
 and Panel Data

Risk Management in Farming  
 and Some Implications for  
 Agricultural Education

Session C-1, Room 1, Chairperson: John Mullen

Vidler, Peter and Davidson, Brian Duffy, ACT	Kennedy, John and Godden, David La Trobe University and NSW Dept of Agriculture
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Godden, David  
Dept. of Ag., N.S.W.

The Identification of  
Research Issues in the  
Australian Cotton Industry

The Value of Rights in  
New Plant Varieties

Induced Institutional  
Innovation: Plant Variety  
Rights, Patents, Genetic  
Engineering and All That

Session C-2, Room 2, Chairperson: Anthony Chisholm

Johnson, R.W. Massey University	Anderson, K. University of Adelaide
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Vanzetti, David and  
Kennedy, John

The Real Rate of Exchange  
Revisited: Reflections  
on Policies Encouraging  
International Competitiveness

Rent Seeking and Price  
Distorting Policies in  
Rich and Poor Countries

Strategic Trade Policy With  
Competitive Storage

Session C-3, Room 3, Chairperson: Tony Rayner

Corra, G.; Dickson A. and Teal, F. A.B.A.R.E.	Jarratt, Ian S. and Longworth, John University of Queensland
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SriRamaratnam, S.  
MAFCorp

Why has the Supply  
of Beef in Japan Grown  
so Rapidly?

Premiums and Discounts  
for Brands of Imported  
Beef in Japan

Implications of Changes  
in Access to Japanese Beef  
Markets for New Zealand  
Trade

Session C-4, Room 4, Chairperson: Garry Griffith

Muthall, P.L. Lincoln College	Wheatstone, Margaret Lincoln College
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Chiao, Y.S. and Doyle, C.J.  
MAFCorp and AFRC IGAP

Farm Management by  
Computer - Prospects  
and Possibilities

Microdynamics of Farm  
Adjustment

The Effects of Market  
Structure on the Distribution  
of Research Gains in the NZ  
Sheepmeat Industry

Session C-5, Room 5, Chairperson: Ron Sandrey

Zeitsch, John Industries Assis. Comm.	Bouis, H.E. Int. Food Policy Res. Inst.
--	--

Bewley, R. and Elliott, G.  
University of Sydney

Adding Input Demands to  
partial Equilibrium  
Agricultural Trade Models

A Food Demand System  
Based on Demand for  
Characteristics: If There  
is Curvature in the Slutsky  
Matrix, What do the Curves  
Look Like and Why?

The Rejection of Homogeneity  
in Demand and Supply Analysis  
An Explanation and Solution

Session C-6, Room 6, Chairperson: Brian Hardaker

Soe, Tin and Fisher, Brian University of Sydney	Chandra, S. AIDAB
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Enjiang, C.  
University of Melbourne

Burmese Rice Price  
Policies: An Economic  
Analysis of Developments  
Since Independence

Australian Aid Experience  
in the Livestock Sector  
of the Less Developed  
Countries

housing Expenditure and  
Chinese Rural Development  
- Preliminary Results of a  
Survey in Jiangsu Province

Selected and Contributed Papers, Session D  
Thursday 9 February - 8.30 to 10.30 am

Session D-1, Room 1, Chairperson: Robin Johnson

Powell, Roy	Reynolds, R.G.; Chiao, Y.S.	Chisholm, Tony
University of New England	and Robinson, B.R.	La Trobe University
Hite, James; Hendry, Mark	MAFCorp	
Clemson Uni. Sth Carolina		

Rural Regional	Macroeconomic Policies and	Capital Income and Capital
Stabilisation: A Problem and	Agricultural Sector	Gains Taxation in
Some Policy Options	Responses	Agriculture and Forestry

Session D-2, Room 2, Chairperson: Gerald Frengley

Galapitague, D.C.	Yapp, T.P. and Connell, L.J.	Chewings, R.A.
La Trobe University	Soil Conservation Service,	Soil Conservation Service
	N.S.W.	N.S.W.

Alternative Management	A Review of Factors	Economic Evaluation of
Policies for Mountain Ash	Influencing the Adoption	the Gobondery Soil
(Eucalyptus Regnans R Muell)	of Conservation Tillage	Conservation Project
in Victoria		

Session D-3, Room 3, Chairperson: Tony Zwart

Angel, C.; Beare, S.	Martin, W.	Mullen, John D.
and Zwart, A.	ABARE	Dept. of Ag., N.S.W.
ABARE and Lincoln College		Alston, J.H.
		University of California, Davis
		and Wohlgenant, M.K.
		N. Caroline State University

Product Characteristics	Implications of China's	Demand Parameters in the
and Arbitrage in the	Foreign Exchange System	Wool Processing Industry
Australian and NZ Wool	for the Wool Market	
Market		

Session D-4, Room 4, Chairperson: Peter Nuthall

Vishwakarma, Keshav	Wang, K.Mc.; Richmond, G.S.;	Mann, T.G.;
La Trobe University	Hacker, R.B.; Hertzler, G.	Thomas, W.C. and
	and Lindner, B.K.	Musgrave, A.F.
	University of W.A.	University of New England
		and University of Alaska

Optimization Over Time	Grazing Management	Policy Response Functions
for Agriculture and	Decision-making in the	in Spatial Trading Systems
Resource Management	Pastoral Zone of Western	
	Australia: an Application	
	Using Control Theory	

Session D-5, Room 5, Chairperson: Bob Lindner

Deng, Gang	Gyles, Amanda; Hardaker, Brian;
La Trobe University	Kami Viliani and Speijer, Paul
	University of New England

The Role of Books and	Keeping Research Relevant:
Agricultural Development	Experiences with On-Farm
in Traditional China	Trials in Tonga
Classics	