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THE SHORT-RUN BEHAVIOUR OF AGRICULTURAL INDUSTRIES IN ORANI 78 - METHODOLOGICAL OVERVIEW AND ANALYSIS OF BASE YEAR DATA

by

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Bureau of Agricultural Economics

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THE SHORT-RUN BEHAVIOUR OF AGRICULTURAL INDUSTRIES IN ORANI 78 - METHODOLOGICAL OVERVIEW AND ANALYSIS OF BASE YEAR DATA*

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1. INTRODUCTION

An analysis of the short-run responses by agricultural industries to policy and other shocks using the ORANI model (see Dixon, Parmenter, Sutton and Vincent (1982) -- hereafter DPSV) requires solutions for industry output by commodity and returns to primary factors employed in each industry. However, in the basic and back solutions of an ORANI 78 short-run simulation, regardless of the closure employed, no such solutions are provided (although some authors have reported their values, they have done so with little comment on their derivation (see for example Dixon, Parmenter, Powell and Vincent (1983, p. 268)). In this paper we describe how they can be computed using the values of basic and back solution variables from an ORANI 78 short-run simulation with the aid of 'external' share and parameter estimates. Furthermore, we develop a procedure to compute short-run own and cross price elasticities of supply for each agricultural commodity. This will help us establish the extent to which particular

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* The author is indebted to both Alan Powell and Peter Higgs for their assistance with the preparation of this paper.

patterns of behaviour are imposed on agricultural industries in ORANI 78 by the base year data base employed. Comparisons can then be made with the work of other authors who have estimated similar elasticities based on different data sets and alternative specifications of the production technology.

The remainder of this paper is organised as follows. In sections 2 and 3 respectively procedures which allow the derivation of percentage changes in agricultural industry outputs by commodity, and of percentage changes in total returns to primary factor inputs employed in each agricultural industry, are detailed. In section 4 the procedure to calculate the transformation components of short-run own and cross price elasticities of agricultural commodity supply, which are based on the assumption of a fixed transformation frontier, is derived and applied to the 1974-75 base-year data base. In section 5 the assumption of a fixed transformation frontier is replaced with an assumption allowing its movement, but precluding any changes in the production mix. A procedure to calculate these expansion components of short-run own and cross price elasticities of supply is then developed, and the section concludes with comparisons of elasticity estimates of other authors. Some brief concluding remarks are offered in section 6.

identify the major sources of discrepancy between the approach followed in this paper and the impressively disaggregated approach used in the APMAA model. Our preliminary conjecture is that the primary source of the difference may be the 'flip flop' problem which characterizes most linear programming based studies of the type undertaken by W&D. This problem stems from the piecewise linear nature of the transformation frontiers assumed in such studies which often produce very large transformation effects in response to a change in relative output prices. The comparatively large negative cross price elasticities obtained by W&D provide evidence which supports our view.

The final remarks concerns the work of MLV and in particular their use of only three broadly defined commodity groupings. In the light of their claim that the CES/CRETH model '.. is flexible enough to accommodate joint production but is unnecessarily restrictive in assuming that no input has a comparative advantage in the production of any particular output' (MLV p. 323), it would be of interest to establish whether their technique, which is free from such restriction, is sufficiently robust to handle the more finely defined 10 commodity production system identified in ORANI 78. In other words, if MLV had been required to estimate the 100 elasticities of Table 5.5, would their results have been more, or less, similar to ours?

6. CONCLUDING REMARKS

The initial aims of this paper were twofold. The first was to set out detailed procedures which derive, from solutions to short-run ORANI 78 simulations, both the output response of, and the real return to all primary factors employed in, each agricultural industry. These procedures are summarized, respectively, by equations (2.2a), (2.2b) and (2.3), and by equation (3.5). The second aim was to estimate, and compare with alternative estimates, the implicit short-run own and cross price elasticities of agricultural commodity supply implied by the 1974-75 ORANI 78 data base. This was achieved using equations (4.10), (5.1) and (5.7).

A consequence of addressing the initial aim of this paper has been the identification of three important areas for future research. The first involves the basic input-output data from which all base period production and cost shares necessary for the implementation of the procedures set out in sections 2 and 3 are estimated. The need here is for data, which with a reasonable degree of confidence, can be called representative of the agricultural sector in a 'typical year.'

The second area for future research concerns the treatment of owner-operators' labour. The need is for a method by which the purely physical component of an owner-operator's effort can be estimated before being added to hired labour in order to form a truly homogeneous 'agricultural worker' service flow.

The third area concerns unresolved discrepancies in econometric estimates of supply elasticities. In particular, it would be helpful to

2. COMMODITY RESPONSES OF AGRICULTURAL INDUSTRIES IN SHORT-RUN ORANI 78 SIMULATIONS WITH THE 1974-75 DATA BASE

The specification of ORANI 78 (DPSV) makes allowance for the multiproduct nature of Australian agriculture. The three largest agricultural industries distinguished in ORANI 78, namely, the Pastoral Zone, the Wheat-Sheep Zone and the High Rainfall Zone, are modelled as multiproduct industries producing in total nine separate commodities. These three Zonal industries are geographically defined, aggregating enterprises faced with similar climatic/technological conditions. The basis of the zonal classification is that adopted by the Bureau of Agricultural Economics (BAE) in its Australian Sheep Industry Survey (see BAE (1976)). A fourth industry, Northern Beef, is also geographically defined. It consists of specialist enterprises producing beef cattle in the Kimberley region of Western Australia, the Northern Territory and the Coasted Central and Peninsular and Gulf regions of Queensland (regions as defined in BAE (1974a and b)).

There are four non-geographically defined industries. We assume that the first of these, the Milk Cattle and Pigs industry, produces two commodities (Beef Cattle, and Milk Cattle and Pigs) in fixed proportions. The remaining three industries, Other Farming Export (henceforth OFE), Other Farming Import Competing (henceforth OFM) and Poultry, each are modelled as producing a single commodity.

The Pastoral, Wheat-Sheep and High Rainfall Zonal industries each produce nine commodities with technologies illustrated respectively in Figures 2.1, 2.2 and 2.3. The basic assumption underlying technology of this

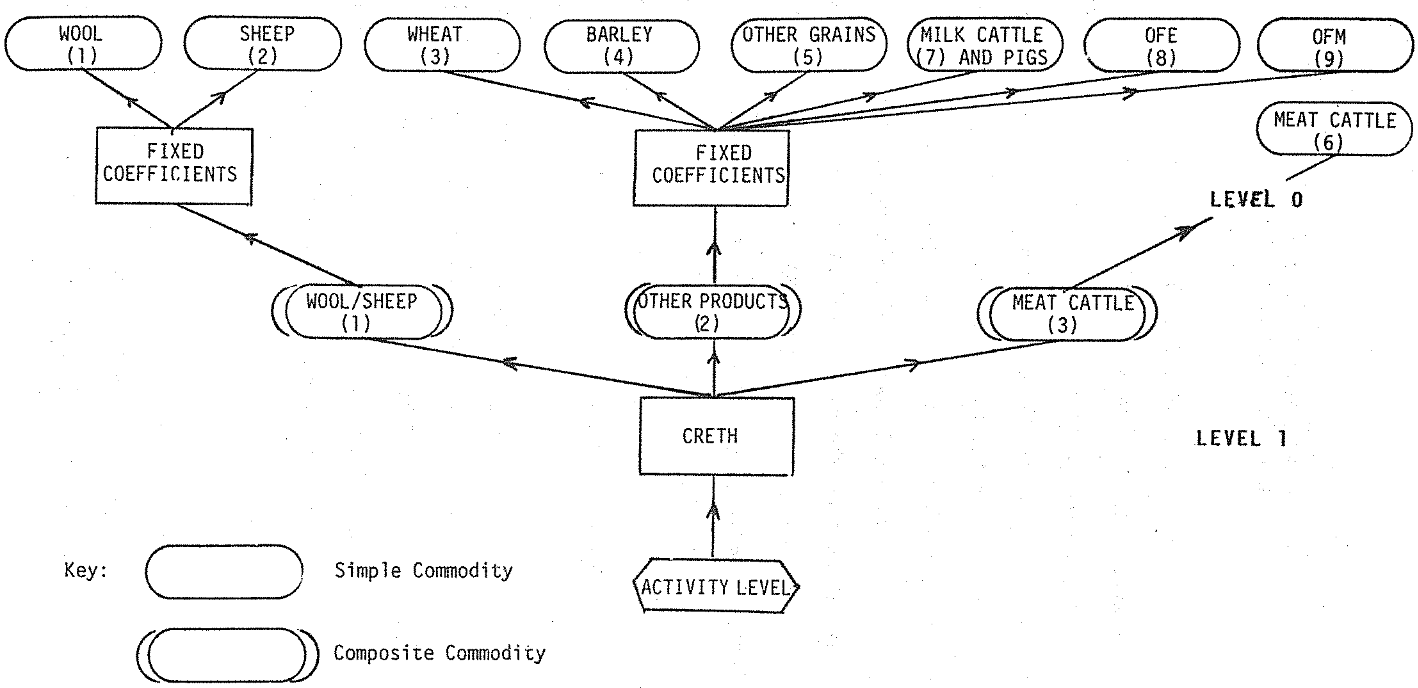

FIGURE 2.1: OUTPUT TECHNOLOGY FOR THE PASTORAL ZONE INDUSTRY

TABLE 5.7 : COMPARISON OF PRINCIPAL FEATURES OF RECENT SUPPLY STUDIES

	This Study(a)	F & M	MLV	W & D
Level of Aggregation				
Agents (unit)	3 industries (zone)	3 regions (representative farm)	1 (all agriculture)	521 localities (representative farm)
Commodities (unit)	3, 6 or 4 (composite commodity)	4 (simple commodity)	3 (composite commodity)	3 (simple commodity)
Specification of Production System	CES-CRETH at zonal level	linear supply functions for 3 regions	translog variable profit function	aggregate of 521 linear programs
Data	ABS Input-Output data for 1974-75 plus BAE surveys	F & M's surveys of 62, 61, & 32 properties in S. Tablelands, S.W. Slopes & W. Division of N.S.W.	BAE surveys	APMAA survey data
Econometric Approach	FIML	OLS	Restricted GLS	OLS on synthetic data from 521 LPs
Adjustment Period Allowed	about 2 years	about 3 years	about 1 year	n.a.

(a) For greater comparability with the other studies, this table covers only the Pastoral, Wheat-Sheep and High Rainfall Zones of ORANI.

The elasticities in MLV are based on a more tightly constrained theoretical specification than those of F&M. MLV's system was derived from a variable profit function which had a transcendental logarithmic functional form. All commodities were defined on a composite rather than a simple basis and time was used as an explanatory variable for technology. The system was estimated by the restricted Aitken estimator developed in Byron (1970) using annual data from BAE's Australian Sheep Industry survey for the 25 year period 1952-53 to 1976-77. The time profile of each elasticity is 'sufficiently long for producers to adjust the composition of their outputs and variable inputs but is too short for them to adjust their endowments of relativity fixed inputs' (MLV (p. 330)).

The approach taken by W&D to estimate their supply elasticities is different from that taken by ourselves and all other authors. Use was made of a simplified version of the finely disaggregated APMAA model (fully described in Walker and Dillon (1976)). This model consists of a system of 521 linear programs, each embodying data for a farm firm representing a given location. The simplified APMAA model was used to generate hypothetical data on outputs for the three commodities Wool, Wheat and Meat Cattle for a total of 125 parametric variations in the three product prices. These synthetic data were then used to estimate (by ordinary least squares) a quadratic supply function which provided the information necessary to calculate the elasticity estimates.

The salient features of each author's approach are contrasted in Table 5.7.

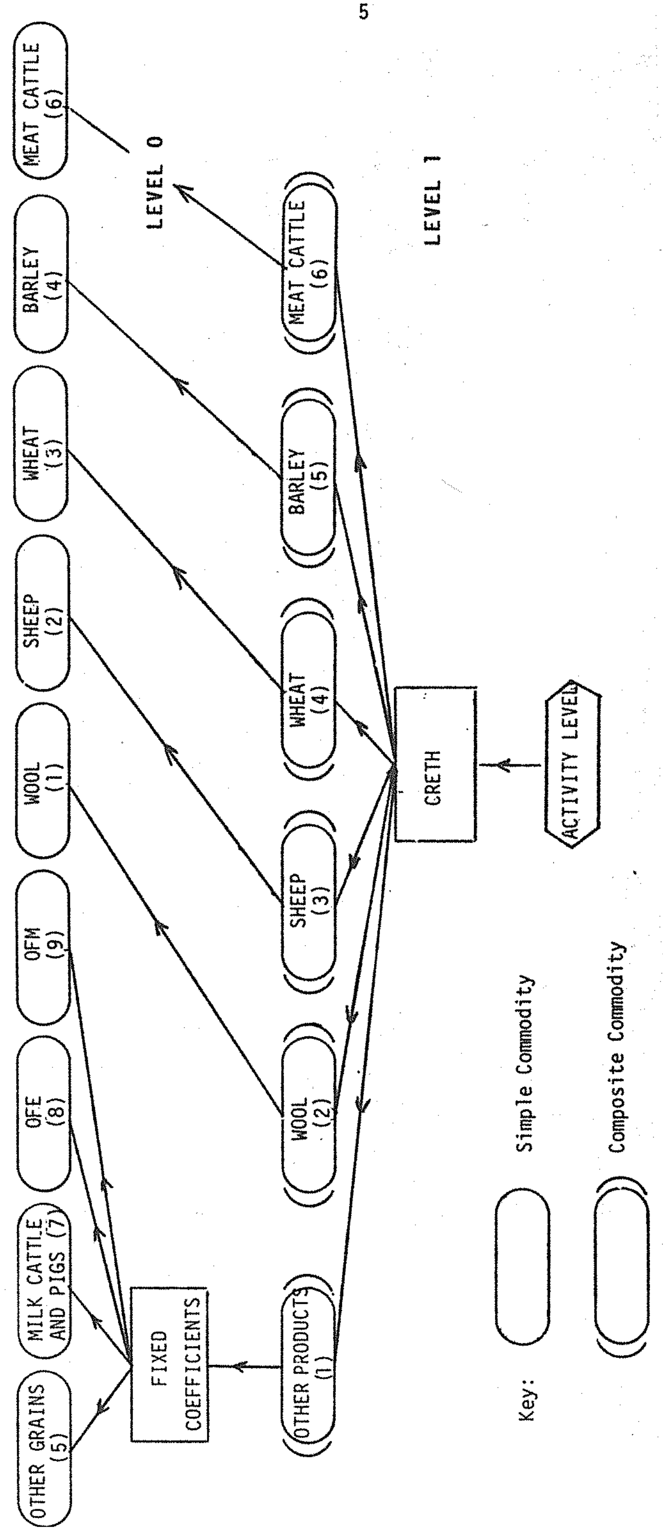

FIGURE 2.2: OUTPUT TECHNOLOGY FOR THE WHEAT-SHEEP ZONE INDUSTRY

The estimates derived in this paper are based on a tightly constrained CES/CRETH production system. The data employed to estimate this system consist primarily of 1974-75 input output data, assembled by the Australian Bureau of Statistics, which is mapped into the required 10 agricultural commodity by 8 agricultural industry format with the help of information contained in BAE survey statistical reports. Values for the CRETH parameters were econometrically estimated using the Full information maximum likelihood technique applied to data from BAE survey reports (see Vincent, Dixon and Powell (1980)). Each total elasticity refers to the expected change in a commodity's output around 2 years after the expected price change has taken place (see DPSV (p. 339)).

The elasticities estimated by F&M were based on a rather loosely specified production function. They regressed time series data for intended sheep numbers, intended cattle numbers, intended breeding ewe numbers and intended wheat plantings respectively on corresponding data for actual values of these variables and the expected prices of the commodities produced in the region concerned, plus a variable measuring the proportion of improved pasture. The current value of each dependent variable was used as an explanator to introduce a degree of dynamics into the system via a partial adjustment process towards an expected short-run equilibrium. All required data were obtained from a survey based on a random sample of properties carrying 200 or more merino sheep as at 31 March 1978 in three regions of NSW; namely, the Southern Tablelands, the South-West Slopes, and a portion of the Western Division. 'These regions correspond to the BAE's High Rainfall, Wheat-Sheep and Pastoral Zones, respectively' (F&M (p. 2)). The time profile of each elasticity is approximately 3 years.

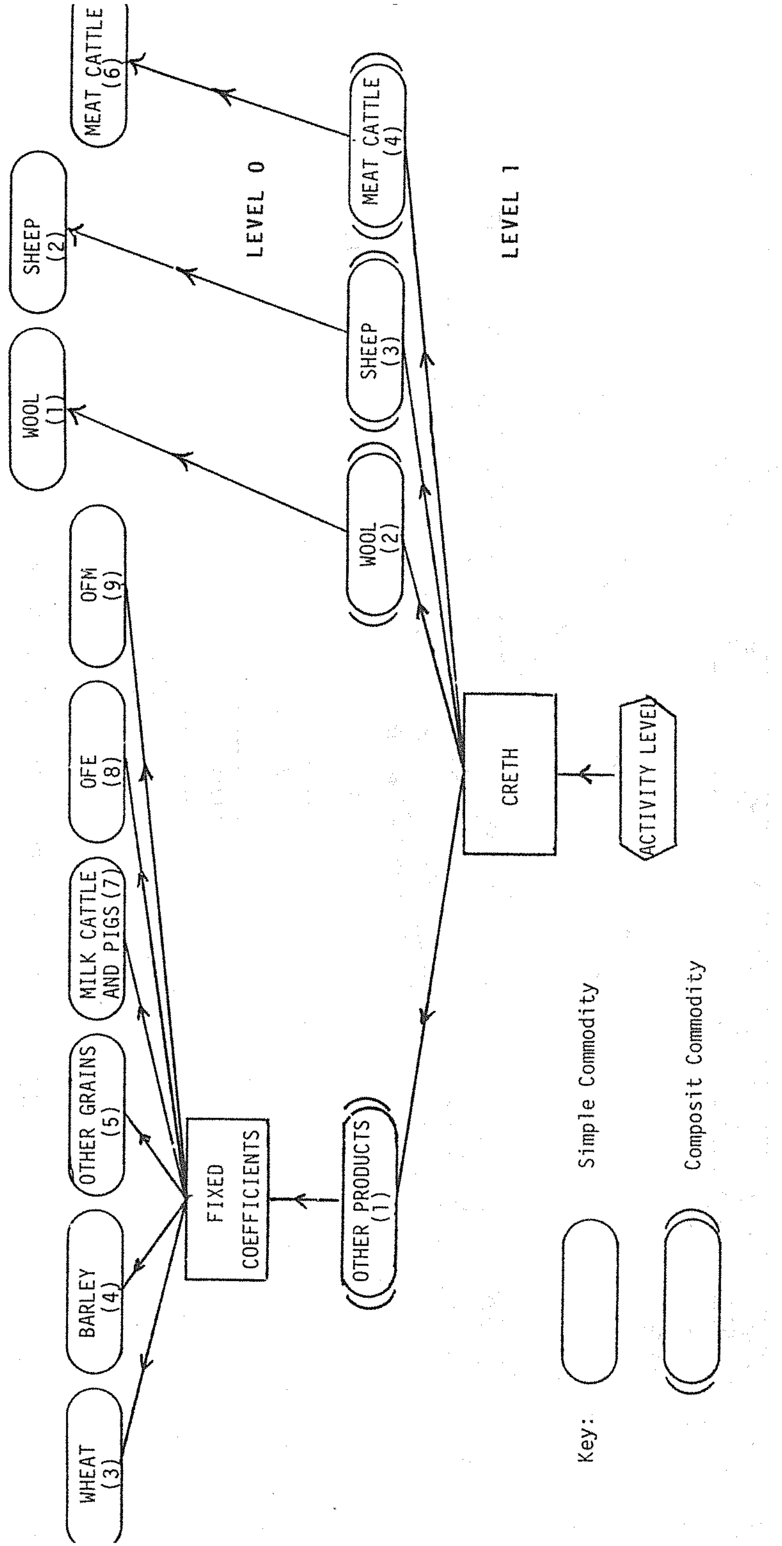

FIGURE 2.3: OUTPUT TECHNOLOGY FOR THE HIGH RAINFALL ZONE INDUSTRY

(iv) the cross price elasticity of Wheat with respect to the price of Meat Cattle is -0.02 in this paper, but -0.42 and -0.21 according to MLV and W&D respectively;

(v) the cross price elasticity of Meat Cattle with respect to the price of Wool is put at 0.44 by this paper or 0.25 by MLV, but by F&M at -0.83 and -1.27 respectively for the South-West Slopes and Western Division of NSW, and at -0.38 by W&D;

(vi) the cross price elasticity of Meat Cattle with respect to the price of Wheat is estimated in this paper as -0.07, by MLV as -0.48, and by W&D as -0.44;

and

(vii) the estimated own price elasticity of Meat Cattle varies from 1.09 (this paper), 0.70 (F&M) South-West Slopes), 0.69 (W&D), 0.40 (F&M Western Division), to 0.12 (MLV).

The discrepancies noted above result primarily from differences in the approach taken by each author with respect to:

(i) the form and level of disaggregation assumed for the agricultural production system;

(ii) the data from which each elasticity is constructed;

and

(iii) the choice of estimation framework.

type is known as 'input-output separability' (see Hasenkamp (1976, p. 19)). Under this assumption an industry's input and output decisions can be treated separately, thereby yielding relatively simple supply response equations of the form:

$$(2.1) \qquad Y_i(j) = g_{ij}\,(P_1, P_2, \ldots, P_U, Z_j) \qquad (j=1,\ldots, G; i=1,\ldots,U),$$

where $Y_i(j)$ is the output of commodity i by industry j, P_i is the price of the domestic commodity i net of the cost of product specific inputs (Dixon, Parmenter, Powell and Vincent (1983, pp. 250-251)) and Z_j, a scalar, is the activity level of industry j. In ORANI 78 the function g_{ij} is determined as the solution to the problem of maximizing an industry's revenue subject to a CRETH (constant ratios of elasticities of tranformation, homothetic) production technology with given product and input prices, and with land and capital treated as fixed (Dixon, Parmenter, Powell and Vincent (1983, p. 251)). Where possible, partial elasticities of transformation were estimated econometrically. In the three Zonal industries, it was necessary to aggregate a number of products of relatively minor importance in the particular Zone concerned, into a miscellaneous 'Other Products' category. The composition of these residual categories is assumed to be invariant under product price changes (see the 'Fixed Coefficient' allocations in Figures 2.2 and 2.3, and the relevant such allocation in Figure 2.1). These three 'Other Products' categories constitute the first type of 'composite commodity' distinguished in the model. The others involve the wool/sheep mix in the Pastoral Zone (see Figure 2.1) in which mutton is essentially a by-product, and the product mix in the Milk Cattle and Pigs industry, which is assumed to produce the commodity 'Milk Cattle and Pigs' and the commodity 'Meat Cattle' in fixed proportions.

The functions g_{ij} take the following form when the variables are expressed as percentage changes:

$$(2.2a) \qquad y_i(j) = \tilde{y}_r(j) \qquad (i \in r, j=1,\ldots,8) ,$$

where

$$(2.2b) \qquad \tilde{y}_r(j) = z_j + \phi_r(j)(p_r(j) - \sum_q R^*_q(j)p_q(j)) \qquad (j=1,\ldots,8;\ \text{all } r) ,$$

in which

$$(2.2c) \qquad \phi_r(j) \geq 0 .$$

In these equations the lower case Roman letters signify percentage changes in the variables indicated by the corresponding upper-case letters. $Y_i(j)$ and $\tilde{Y}_r(j)$ respectively are the output levels by industry j of simple commodity i (i=1,...,10) and composite commodity r ($r \in [1,3]$ when j=1 indicating the Pastoral Zone; $r \in [1,6]$ when j=2 indicating the Wheat-Sheep Zone; $r \in [1,4]$ when j=3 indicating the High Rainfall Zone; and r=1 when j=5 indicating the Milk Cattle and Pigs industry). $P_r(j)$ is the price index for the r^{th} composite commodity produced by industry j. In percentage change form this is simply a weighted average of the percentage changes in the component simple commodity prices:

$$(2.3) \qquad p_q(j) = \sum_t H_{tq}(j)p_t \qquad (j=1,\ldots,8;\ \text{all } q) ,$$

where the weight $H_{tq}(j)$ is the share of simple commodity t in the total value of output of composite commodity q for industry j, and p_t is the percentage change in the price of simple commodity t (see equation 2.1). In equation (2.2b) z_j, $\phi_r(j)$ and $R^*_q(j)$ respectively are the percentage change in the output of industry j, a transformation parameter reflecting the general ease of transformability of other composite commodities produced in industry j into composite commodity r, and a parameter reflecting the share

TABLE 5.6 : ALTERNATIVE ESTIMATES OF SHORT-RUN OWN AND CROSS PRICE ELASTICITIES OF AGRICULTURAL COMMODITY SUPPLY*

Response in the output of	Product Whose Expected Price Changes:		
	Wool	Wheat	Meat Cattle
Wool			
This paper	*0.8382*	*0.1773*	*0.2492*
Fisher and Munro (1983)			
Southern Tablelands	0.26		
South-West Slopes	0.28		
Western Division	0.52		
Dahlberg (1964)	0.08		-0.99
Dalton and Lee (1975)	0.08-0.09		
Gruen et al (1967)	0.05	-0.04	0.00
Malecky (1971)	0.05-0.17		
McKay, Lawrence and Vlastuin[(a)] (1983)	0.72	0.15	0.08
Powell and Gruen (1967)	0.0698	-0.0521	0.00
Wicks and Dillon (1978)	0.25	-0.20	-0.18
Wheat			
This paper	*0.1379*	*0.8608*	*-0.0220*
Fisher and Munro (1983)			
South-West Slopes		2.05	
Gruen et al (1967)	-0.11	0.18	0.00
McKay, Lawrence and Vlastuin[(b)] (1983)	0.43	0.50	-0.42
Powell and Gruen (1967)	-0.1071	0.1808	0.00
Wicks and Dillon (1978)	-0.21	1.10	-0.21
Meat Cattle			
This paper	*0.4370*	*-0.0732*	*1.0885*
Fisher and Munro (1983)			
South-West Slopes	-0.83		0.70
Western Division	-1.27		0.40
Gruen et al (1967)	0.00	0.00	0.16
McKay, Lawrence and Vlastuin[(c)] (1983)	0.25	-0.48	0.12
Powell and Gruen (1967)	0.00	0.00	0.16
Wicks and Dillon (1978)	-0.38	-0.44	0.69

* A blank indicates that the elasticity was either not estimated or, in the view of the author(s), had no statistical significance.

(a) The elasticity of Sheep and Wool with respect to the price of respectively Sheep and Wool, 'Crops', and Cattle and 'Other'.

(b) The elasticity of 'Crops' with respect to the price of respectively Sheep and Wool, 'Crops', and Cattle and 'Other'.

(c) The elasticity of Cattle and 'Other' with respect to the price of respectively Sheep and Wool, 'Crops', and Cattle and 'Other'.

(1967), Wicks and Dillon (1978), Fisher and Munro (1983), and Mackay, Lawrence and Vlastuin (1983) form the source from which Table 5.6, which collects alternative estimates of short-run own and cross price elasticities, was constructed.

The substantial variation in estimated elasticities for each of the three most important commodities in Australian agriculture presented in Table 5.6 is indicative of the current lack of consensus concerning their values. This degree of variation makes comparisons between our estimates and those of other authors very difficult. To alleviate this difficulty we confine ourselves in the remainder of this section to a discussion of the three most recent estimates, namely those of Fisher and Munro (1983) (hereafter F & M), McKay Lawrence and Vlastuin (1983) (hereafter MLV) and Wicks and Dillon (1978) (hereafter W & D). These studies obtained results on the whole closer to ours than those obtained in the earlier studies. In spite of this relatively closer agreement, substantial anomalies remain. Notable among these are:

(i) the cross price elasticity of Wool with respect to the price of Wheat is estimated in this paper as 0.18, by MLV as 0.15, but by W & D as -0.20;

(ii) the cross price elasticity of Wool with respect to the price of Meat Cattle as estimated in this paper is 0.25, but 0.08 according to MLV and -0.18 according to W & D;

(iii) our estimate of the own price elasticity of Wheat is 0.86, wheras F & M obtain 2.05 for the South-West Slopes of NSW;

of composite commodity q in total revenue of industry j. $R^*_q(j)$ is related to the transformation parameters $\{\phi_r(j)\}$ and the shares $\{R_s(j)\}$ of composite commodities in j's total revenue, by:

$$R^*_q(j) = \phi_q(j)\, R_q(j) / \sum_s [\phi_s(j)\, R_s(j)] \qquad (j=1,\ldots, 8;\ \text{all } q) \quad . \tag{2.4}$$

From equations (2.2b) and (2.3) it is clear that the reliability of a commodity response projection retrieved from the solution to an ORANI 78 short-run simulation depends upon values assigned to the parameters $\phi_r(j)$, $H_{tq}(j)$ and $R^*_q(j)$. If for example the assigned values of H and R* were taken from a period of (say) a record wheat harvest or of drought-related shortfalls in production, the consequent projection would only pertain to an agricultural sector with that atypical degree of profitability and/or mix of outputs. It is clear that in order to achieve maximum robustness, projections must be based on a representation of the agricultural sector which succeeds in capturing a 'typical' year. For this to be achieved typical-year estimates for the parameters are necessary.

Estimates of the transformation parameter $\phi_r(j)$ for the three Zonal industries are presented in Dixon, Parmenter, Powell and Vincent (1983, p. 257). Since they are based on econometric work using data spanning the period 1952-53 to 1973-74, these estimates (which are tabulated in Table 2.1) can be considered 'typical'.

As yet no 'typical year' values for the modified shares $R^*_q(j)$ and the shares $H_{tq}(j)$ have been adopted as standard in ORANI 78 simulations. Current work is aimed at producing time series from which

TABLE 2.1 : VALUES FOR TRANSFORMATION PARAMETERS*, $\phi_r(j)$

Industry								
j = 1 Pastoral Zone			j = 2 Wheat-Sheep Zone			j = 3 High Rainfall Zone		
	Composite Commodity	$\phi_r(j)$		Composite Commodity	$\phi_r(j)$		Composite Commodity	$\phi_r(j)$
r = 1	Wool-Sheep	0.1041	r = 1	Other Products	1.3158	r = 1	Other Products	3.8462
2	Other Products	4.5455	2	Wool	0.2976	2	Wool	0.0631
3	Meat Cattle	1.6129	3	Sheep	0.2342	3	Sheep	0.1153
			4	Wheat	1.6129	4	Meat Cattle	0.3745
			5	Barley	0.5208			
			6	Meat Cattle	0.5181			

Source : Dixon, Parmenter, Powell and Vincent (1983, p. 257).

* The parameter $\phi_r(j)$ indicates the general ease within industry j of transforming (composite) commodities other than r into (composite) commodity r.

TABLE 5.5 : TOTAL OWN AND CROSS PRICE ELASTICITIES OF SUPPLY IMPLIED BY THE 1974-75 DATA BASE FOR EACH AGRICULTURAL COMMODITY IN ORANI 78

Repsonse in the Planned Output of Commodity (i)	Commodity (t) Whose Expected Price Changes: Wool	Sheep	Wheat	Barley	Other Grains	Meat Cattle	Milk Cattle and Pigs	Other Farming (Export)	Other Farming (Import Competing)	Poultry
Wool	0.8382	0.1724	0.1773	0.0531	0.0533	0.2492	0.0251	0.0063	0.0138	-0.0000
Sheep	0.6621	0.3323	0.1783	0.0560	0.0536	0.2502	0.0260	0.0060	0.0142	-0.0000
Wheat	0.1379	0.0360	0.8608	0.0116	-0.0499	-0.0220	-0.0180	-0.0107	-0.0318	-0.0000
Barley	0.2059	0.0562	0.0608	0.5389	0.0283	0.0390	0.0128	0.0039	0.0100	-0.0000
Other Grains	0.3143	0.0822	-0.3361	0.0424	0.5510	0.0304	0.1915	0.1114	0.1970	-0.0000
Meat Cattle	0.4370	0.1142	-0.0732	0.0110	-0.0020	1.0885	0.2836	-0.0056	-0.0789	-0.0000
Milk Cattle and Pigs	0.0313	0.0084	-0.0635	-0.0098	0.0258	0.2004	2.1956	0.0046	-0.2822	-0.0000
Other Farming (Export)	0.0131	0.0033	-0.0152	0.0018	0.0264	0.0004	0.0090	1.1705	-0.0146	-0.0000
Other Farming (Import Competing)	0.0782	0.0206	-0.0232	0.0094	0.0506	0.0148	0.0201	0.0031	1.0904	-0.0000
Poultry	-0.0000	-0.0000	-0.0333	-0.0142	-0.0210	-0.0000	-0.0000	-0.0000	-0.0000	2.4299

TABLE 5.4 : EXPANSION COMPONENTS OF OWN AND CROSS PRICE ELASTICITIES OF SUPPLY IMPLIED BY THE 1974-75 DATA BASE FOR EACH AGRICULTURAL COMMODITY IN ORANI 78

Repsonse in the Planned Output of Commodity (i)	Commodity (t) Whose Expected Price Changes									
	Wool	Sheep	Wheat	Barley	Other Grains	Meat Cattle	Milk Cattle and Pigs	Other Farming (Export)	Other Farming (Import Competing)	Poultry
Wool	0.6729	0.1712	0.2916	0.0628	0.6680	0.2573	0.0306	0.0093	0.0240	0.0000
Sheep	0.6577	0.1744	0.2753	0.0671	0.0719	0.2586	0.0334	0.0093	0.0312	0.0000
Wheat	0.2201	0.0542	0.4179	0.0803	0.0479	0.0697	0.0159	0.0094	-0.0016	-0.0000
Barley	0.2399	0.0663	0.3922	0.0832	0.0525	0.0854	0.0198	0.0094	0.0074	-0.0000
Other Grains	0.3925	0.1062	0.3483	0.0775	0.0598	0.1491	0.0249	0.0094	0.0165	-0.0000
Meat Cattle	0.4512	0.1181	0.1499	0.0344	0.0392	0.7254	0.2973	0.0029	-0.0438	-0.0000
Milk Cattle and Pigs	0.0381	0.0108	-0.0056	-0.0073	-0.0148	0.2101	2.1816	-0.0038	-0.2984	-0.0000
Other Farming (Export)	0.0167	0.0043	0.0176	0.0036	0.0026	0.0061	0.0010	1.1656	-0.0023	-0.0000
Other Farming (Import Competing)	0.0898	0.0256	0.0243	0.0085	0.0101	0.0375	0.0052	-0.0049	1.0679	-0.0000
Poultry	-0.0000	-0.0000	-0.0333	-0.0142	-0.0210	-0.0000	-0.0000	-0.0000	-0.0000	2.4299

suitably typical average values can be derived. In the meantime estimates of $R_q(j)$, $R^*_q(j)$ and $H_{tq}(j)$ are presented on the basis of data employed in the 1974-75 ORANI data base (see Adams and Higgs (1983)). These values provide interim estimates which serve to illustrate how the proposed back-solution procedures in ORANI would work and are presented respectively in Tables 2.2, 2.3 and 2.4.

TABLE 2.2 : THE SHARE OF COMPOSITE COMMODITIES IN THE TOTAL REVENUE OF EACH ZONAL AGRICULTURAL INDUSTRY, $R_q(j)$

Industry					
j = 1 Pastoral Zone		j = 2 Wheat-Sheep Zone		j = 3 High Rainfall Zone	
Composite Commodity	$R_q(j)$	Composite Commodity	$R_q(j)$	Composite Commodity	$R_q(j)$
q=1 Wool-Sheep†	0.5494	q=1 Other Products†	0.1072	q=1 Other Products†	0.2060
2 Other Products†	0.3123	2 Wool	0.1775	2 Wool	0.4633
3 Meat Cattle	0.1383	3 Sheep	0.0504	3 Sheep	0.1323
		4 Wheat	0.5009	4 Meat Cattle	0.1984
		5 Barley	0.1044		
		6 Meat Cattle	0.0596		
Sum	1.0000		1.0000		1.0000

† For the composition of this composite commodity, see Table 2.4.

Source : ORANI 78 1974-75 data base.

TABLE 5.3 : THE SHARE OF COMMODITY t IN THE TOTAL COST OF INTERMEDIATE INPUTS TO CURRENT PRODUCTION BY INDUSTRY j, $S_t^M(j)$

ORANI 78 Industry	Share in the Total Costs of Intermediate Inputs of (t=):									
	1 Wool	2 Sheep	3 Wheat	4 Barley	5 Other Grains	6 Meat Cattle	7 Milk Cattle and Pigs	8 Other Farming (Export)	9 Other Farming (Import Competing)	10 Poultry
j=1 Pastoral Zone	0.0000	0.0000	0.0207	0.0092	0.0132	0.0000	0.0000	0.0068	0.0711	0.0000
2 Wheat-Sheep Zone	0.0000	0.0000	0.0122	0.0054	0.0078	0.0000	0.0004	0.0039	0.0471	0.0000
3 High Rain-fall Zone	0.0000	0.0000	0.0227	0.0101	0.0145	0.0000	0.0006	0.0081	0.0932	0.0000
4 Northern Beef	0.0000	0.0000	0.0257	0.0109	0.0162	0.0000	0.0000	0.0095	0.1069	0.0000
5 Milk Cattle and Pigs	0.0000	0.0000	0.0291	0.0127	0.0184	0.0000	0.0097	0.0041	0.2711	0.0000
6 Other Farm-ing (Export)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0148	0.0536	0.0000
7 Other Farm- (Import Com-peting)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0148	0.0536	0.0000
8 Poultry	0.0000	0.0000	0.0187	0.0080	0.0118	0.0000	0.0000	0.0000	0.0000	0.0000

Source: 1974-75 ORANI Data Base.

TABLE 5.2 : THE SHARE OF PRIMARY INPUTS IN THE TOTAL COST OF CURRENT PRODUCTION BY INDUSTRY j, $S_p(j)$

ORANI 78 Industry	Primary Inputs Shares in Total Costs
j=1 Pastoral Zone	0.589
2 Wheat-Sheep Zone	0.648
3 High Rainfall Zone	0.562
4 Northern Beef	0.535
5 Milk Cattle and Pigs	0.535
6 Other Farming (Export)	0.628
7 Other Farming (Import Competing)[(a)]	0.628
8 Poultry	0.268

Source: 1974-75 ORANI 78 Data Base.

(a) This share has been constrained to that of the Other Farming (Export) Industry.

TABLE 2.3 : THE MODIFIED SHARE PARAMETERS $[R^*_q(j)]$ SHOWING THE WEIGHTS (FOR THE PURPOSES OF CALCULATING SUPPLY RESPONSES) OF COMPOSITE COMMODITIES IN THE TOTAL REVENUE OF EACH ZONAL AGRICULTURAL INDUSTRY*

Industry					
j = 1 Pastoral Zone		j = 2 Wheat-Sheep Zone		j = 3 High Rainfall Zone	
Composite Commodity	$R^*_q(j)$	Composite Commodity	$R^*_q(j)$	Composite Commodity	$R^*_q(j)$
q = 1 Wool-Sheep†	0.0336	q = 1 Other Products†	0.1322	q = 1 Other Products†	0.8696
2 Other Products†	0.8352	2 Wool	0.0479	2 Wool	0.0321
3 Meat Cattle	0.1312	3 Sheep	0.0107	3 Sheep	0.0167
		4 Wheat	0.7334	4 Meat Cattle	0.0816
		5 Barley	0.0493		
		6 Meat Cattle	0.0265		
Sum	1.0000		1.0000		1.0000

* See equation (2.2b).

† For the composition of this composite commodity, see Table 2.4.

Source : ORANI 1974-75 data base and Dixon, Parmenter, Powell and Vincent (1983, p. 237).

TABLE 2.4 : THE 1974-75 SHARE OF THE SIMPLE COMMODITY t IN THE TOTAL VALUE OF OUTPUT OF COMPOSITE COMMODITY q BY INDUSTRY j $H_{tq}(j)$

Industry								
j = 1 Pastoral Zone			j = 2 Wheat-Sheep Zone			j = 3 High Rainfall Zone		
CCI	Simple Commodity	$H_{tq}(j)$	CCI	Simple Commodity	$H_{tq}(j)$	CCI	Simple Commodity	$H_{tq}(j)$
q = 1	t = 1 Wool	0.8575	q = 1	t = 5 Other Grains	0.5389	q = 1	t = 3 Wheat	0.1022
	2 Sheep	0.1425		7 Milk Cattle and Pigs	0.1796		4 Barley	0.1305
2	3 Wheat	0.8461		8 OFE	0.1132		5 Other Grains	0.2385
	4 Barley	0.0416		9 OFM	0.1682		7 Milk Cattle and Pigs	0.1206
	5 Other Grains	0.0818	2	1 Wool	1.0000		8 OFE	0.0341
	7 Milk Cattle and Pigs	0.0024	3	2 Sheep	1.0000		9 OFM	0.3741
	8 OFE	0.0255	4	3 Wheat	1.0000	2	1 Wool	1.0000
	9 OFM	0.0025	5	4 Barley	1.0000	3	2 Sheep	1.0000
3	6 Meat Cattle	1.0000	6	6 Meat Cattle	1.0000	4	6 Meat Cattle	1.0000

Abbreviations : OFE = Other Farming (Export); OFM = Other Farming (Import Competing); CCI = Composite Commodity identifier (see Table 2.3 for key).

Note : The indexing of $H_{tq}(j)$ in the table follows Figures 2.1, 2.2 and 2.3. Note however that any commodity bearing the same name in two or more columns is one, single, ORANI 78 commodity. Thus, e.g., the total output of Meat Cattle is obtained in ORANI 78 by adding the outputs of this commodity in the three Zonal industries in Table 2.2 to the output of the specialist Northern Beef industry and the Meat Cattle component of the Milk Cattle and Pigs industry output.

Source : ORANI 1974-75 data base.

TABLE 5.1 : THE FIXED FACTOR (LAND AND FIXED CAPITAL) SHARE IN THE TOTAL PRIMARY FACTOR COSTS OF INDUSTRY j, $S_f(j)$

	ORANI 78 Industry	Fixed Factor Share in Total Primary Factor Costs
j=1	Pastoral Zone	0.320
2	Wheat-Sheep Zone	0.478
3	High Rainfall Zone	0.250
4	Northern Beef	0.324
5	Milk Cattle and Pigs	0.264
6	Other Farming (Export)	0.393
7	Other Farming (Import Competing)[a]	0.393
8	Poultry	0.434

Source: 1974-75 ORANI 78 Data Base .

(a) This share has been constrained to that of the Other Farming (Export) Industry.

using equations (5.1) and (4.10) we can derive the expression for $\eta^E_{i,\tau}$

$$(5.8) \qquad \eta^E_{i,t} = \sum_{j=1}^{8}\left\{S_i(j)\left[\frac{\sigma(1 - S_f(j))}{S_f(j)}\left[\frac{t_{R(j)}t_{H(j)}}{S_p(j)} - S^M_t(j)\left(\frac{1}{S_p(j)} - 1\right)\right]\right]\right\}$$

$$(i,t=1,\ldots,10).$$

Data from the 1974-75 ORANI 78 Data Base for the shares $S_f(j)$, $S_p(j)$, and $S^M_t(j)$ respectively are contained in Tables 5.1, 5.2 and 5.3. These data and 1974-75 data contained in Tables 2.1, 2.2, 2.4 and 4.1 form the required input which allows $\eta_{i,\tau}$ for all i and τ to be calculated. These values are presented in Table 5.4. Values for $\eta_{i,\tau}$ calculated as the sum of $\eta^E_{i,t}$ and $\eta^T_{i,t}$ for all i and τ are contained in Table 5.5.

The elasticities presented in both Tables 4.2 and 5.4 refer to percentage changes in planned commodity outputs in response to expected price changes under the respective assumptions that z_j for all j remains constant and there are no movements around the transformation frontier in response to the relative price change. Planned outputs may differ from actual outputs due to factors such as drought, etc. Furthermore, setting p_τ to one represents, in the mind of the producer, a permanent increase in the expected price of that commodity t. Therefore, the total production response $\eta_{i,t}$ of good i, though constrained by the short-run assumption of a constant stock of fixed capital, may be greater than would be the case if p_t was considered to be only transitory.

In a recent article (Easter and Paris (1983)) a compendium of estimates of agricultural commodity supply response elasticities by various authors is presented. This and reports of work contained in Powell and Gruen

3. REAL RETURNS TO PRIMARY FACTORS EMPLOYED IN EACH AGRICULTURAL INDUSTRY IN SHORT-RUN ORANI 78 SIMULATIONS WITH THE 1974-75 DATA BASE

The ORANI 78 model identifies three classes of primary factors employed in agricultural industries; Labour (including hired labour, unpaid helpers and owner-operators); Fixed Capital (buildings, plant and machinery) and Agricultural Land. In the base year value added in industry j, which is the total return to all three primary factors employed therein, may be written as:

$$(3.1) \qquad FR(j) = L(j)P_\ell(j) + K(j)P_k(j) + V(j)P_v(j) \qquad (j=1,\ldots,8)\ ,$$

where L(j), K(j) and V(j) respectively are the base year number of units of Labour, Fixed Capital and Agricultural Land employed in agricultural industry j, and $P_\ell(j)$, $P_k(j)$ and $P_v(j)$ respectively are the (imputed) base year prices paid per unit by industry j for its labour in general, rental of capital and rental of agricultural land.

In real terms, total factor returns in industry j is defined as FR(j) deflated by the Consumer Price Index (hereafter CPI; in the base year CPI = 1.00). Movements in FR(j)/CPI reflect changes in the purchasing power commanded by the total return to primary factors in industry j and may be written in percentage change form as:

$$(3.2) \qquad (fr(j) - cpi) = S_\ell(j)\ (\ell(j) + p_\ell(j) - cpi) + S_k(j)\ (k(j) + p_k(j) - cpi) + S_v(j)\ (v(j) + p_v(j) - cpi) \qquad (j=1,\ldots,8)\ ,$$

where $S_\ell(j)$, $S_k(j)$ and $S_v(j)$, respectively, are the base year shares of the total return to primary factors in industry j devoted to Labour, Fixed Capital and Land, and lower case characters denote variables in percentage changes.

In ORANI the neo-classical short-run is defined as being only long enough for domestic suppliers of commodities to hire labour and to expand output with their existing plant and agricultural land (see DPSV, p. 65). Therefore, in ORANI short-run simulations, k(j) and v(j) (for all j) will always be zero. Furthermore, since effective final demand equations ($x_n(j)$ for n = k and v) take the form (see DPSV, p. 88):

(3.3) $$x_n(j) = z_j - \sigma (p_n - \sum_{m=v,k,\ell} S_m(j) p_m(j) \qquad (n=k \text{ and } v \; ; \; j=1,\ldots,8) \; ,$$

where z_j is the percentage change in the activity level of industry j and σ is the elasticity of substitution between primary factors; then $p_k = p_v$ as from above $x_v(j) = x_k(j) = 0$ in all short-run simulations. Equation (3.2) therefore reduces to:

(3.4) $$(fr(j) - cpi) = S_\ell(j)\,(\ell(j) + p_\ell(j) - cpi) + (S_k(j) + S_v(j))\,(p_h(j) - cpi) \qquad (j = 1,\ldots,8) \; ,$$

where $p_h(j) = p_k(j) = p_v(j)$ for all j.

The preceding analysis assumes that the category labour (or more explicitly 'agricultural workers'), one of nine labour occupation categories identified in ORANI, is homogenous. That is each component of the aggregate

(5.5) $$p_m(j) = \sum_{u=1}^{115} S_u^M(j) p_u \qquad (j=1,\ldots,8) \; ,$$

where $S_u^M(j)$ is the share of the effective commodity u, in the total cost of effective intermediate inputs to the current production of industry j and p_u is the basic price of effective commodity u. (Effective commodities are CES aggregates of local and imported goods of the same name.)

Substitution of equations (5.4) and (5.5) into equation (5.3) yields:

(5.6) $$y_i = \sum_{j=1}^{8} \Bigg\{ S_i(j) \left[\frac{\sigma(1 - S_f(j))}{S_f(j)} \left[\left\{ \sum_q R_q(j) \sum_t H_{tq}(j) p_t \right\} \frac{1}{S_p}(j) - \sum_{u=1}^{115} S_u^M(j) p_u \left\{ \frac{1}{S_p}(j) - 1 \right\} - p_\ell(j) \right] + i_\phi(j) \left[\sum_t H_i^t(j) p_t - \sum_q R_q^*(j) \sum_t H_{tq}(j) p_t \right] \right] \Bigg\} \qquad (i=1,\ldots,10) \; .$$

To derive an expression for $\eta_{i,\tau}$ we set $p_\tau = 1$ for one value of t on the right of equation (5.6), and $p_{t*} = 0$ for all other values $(\tau * \neq \tau)$. Under these constraints the term contained within [ ] reduces to $t_{H(j)}(\delta_{i,t,j} - {}^{t}R^*(j))$, where the notation is as explained for equation (4.10). Similarly $\sum_q R_q(j) \sum_t H_{tq}(j) p_t$ becomes $t_{R(j)} {}^{\tau}H(j)$ and $\sum_{u=1}^{115} S_u^M(j) p_u$ becomes $S_t^M(j)$. In this analysis the labour wage $p_\ell(j)$ is treated as a simple price variable; consequently it is set to zero. The total price elasticity $\eta_{i,t}$ can now be written:

(5.7) $$\eta_{i,t} = \sum_{j=1}^{8} \Bigg\{ S_i(j) \left(\frac{\sigma(1 - S_f(j))}{S_f(j)} \left(\frac{t_{R(j)}\, t_{H(j)}}{S_p(j)} - S_t^M(j) \left(\frac{1}{S_p}(j) - \right. \right. \right. + i_\phi(j) \left\{ t_{H(j)} \left(\delta_{i,\tau,j} - t_{R*(j)} \right) \right\} \Bigg) \Bigg\} \qquad (i,t=1,\ldots,1($$

where z_j is generalized output of industry j (see equation (2.1)); σ is the elasticity of substitution between primary factors (assumed to be 0.5 for all industries, see DPSV, p. 189); $S_f(j)$ is the fixed factor (land and fixed capital) share in industry j's total primary-factor costs; $p_o(j)$ is the percentage change in the basic price of j's output. $p_m(j)$ is the average percentage change in the prices paid by industry j for intermediate inputs; $S_p(j)$ is the share of primary inputs in j's total costs; and $p_\ell(j)$ as in equation (3.1), is the percentage change in the money wage rate. Substitution of equation (5.2) into equation (4.8) yields:

(5.3)
$$y_i = \sum_{j=1}^{8}\left\{ S_i(j) \left[\frac{\sigma(1 - S_f(j))}{S_f(j)}\left[p_o(j)\frac{1}{S_p(j)} - p_m(j)\left(\frac{1}{S_p(j)} - 1\right) - p_\ell(j)\right] + {}^{i}\phi(j)\left\{\sum_t H_i^t(j)p_t - \sum_q R_q^*(j)\sum_t H_{tq}(j)p_t\right\}\right]\right\}$$

(i=1,...,10) .

For each of the eight agricultural industries, $p_o(j)$ can be written as:

(5.4)
$$p_o(j) = \sum_q R_q(j) \sum_t H_{tq}(j) p_t ,$$

where the notation is as explained in section 2. Equation (5.4) can be interpreted in the following way.. For each j, $p_o(j)$ is equal to the revenue weighted average (with weights $R_q(j)$) of the prices of each composite commodity q produced by j. In turn the price of each composite commodity is equal to a revenue weighted average (with weights $H_{tq}(j)$) of the basic prices of each simple commodity q produced by j.

The price $p_m(j)$ can be written as:

'agricultural workers' is viewed by the producer as being a perfect substitute for any other component. In the current specification of ORANI 78 there are three components: hired workers, unpaid helpers and owner-operators. Unfortunately this specification fails, in light of the assumption above, to take into account the fact that the labour of owner-operators itself consists of two components, one being physical and the other managerial. While the degree of substitution between the labour of hired workers, unpaid helpers and the physical component of owner-operators labour can be expected to be high, that between hired workers, unpaid helpers and the managerial component of owner-operators' labour, cannot. Therefore, the current specification of 'agricultural workers' is invalid.

A solution to the problem above would be to remove the managerial component from owner-operators' labour (and therefore from the category of 'agricultural workers') and to specify it as a separate primary factor of production. Unfortunately, due to a lack of information on the flows of managerial and of labourer-type services supplied by owner-operators, such respecification is currently impossible. Therefore, for the purposes of this section we have decided to remove all of owner-operators' labour from the category of 'agricultural workers' and treat it as a separate primary factor. To do this, equation (3.4) is rewritten as:

(3.5)
$$\begin{aligned}(fr(j) - cpi) &= S_{\ell h}(j)\,(\ell_h(j) + p_\ell(j) - cpi)\\ &+ S_{\ell o}(j)\,(\ell_o(j) + p_\ell(j) - cpi)\\ &+ (S_k(j) + S_v(j))\,(p_h(j) - cpi) \qquad (j=1,\dots,8) ,\end{aligned}$$

where $\ell_h(j)$ and $\ell_o(j)$ respectively are percentage changes in the number of units of hired workers and unpaid helpers, and owner-operators employed in industry j. $S_{\ell h}(j)$ and $S_{\ell o}(j)$ are respectively shares of hired workers and unpaid helpers, and owner-operators in total labour employed in industry j. We have assumed equality between the percentage changes in the imputed cost of an unit of owner-operators' labour and in the weighted combinations of actual and imputed costs of a unit of hired workers and unpaid helpers.

The one remaining task is to find appropriate values for the four shares in equation (3.5). In section 2 a desirable property of all base period agricultural shares, namely that they reflect a typical year, was explained. The shares from the 1974-75 data base examined in that section did not have this property. Unfortunately, this is also true of the shares $S_{\ell h}$, $S_{\ell o}$, S_k and S_v. The latest available data for shares in total returns devoted to 'agricultural workers', fixed capital and agricultural land are found in the 1974-75 ORANI 78 data base (although preliminary estimates for 1977-78 have recently been published (Adams and Higgs 1983)).

To split S_ℓ into its two components the following two-step method was employed. First, information from BAE survey statistical reports was utilized to split the series of "Total Wage" calculated by Stevenson (1982), Table 6) for the six ORANI 77 agricultural industries (ORANI 77 is fully described in Dixon, Parmenter, Ryland and Sutton (1977)) into its two components, returns to hired workers and unpaid helpers, and returns to owner-operators. Specifically, the share of total labour supplied by 'owner-operator/management', and by 'other' labour was obtained from BAE (1983a) to split Stevenson's estimates for the Sheep, Cereal Grains and Meat

5. EXPANSION COMPONENTS OF OWN AND CROSS PRICE ELASTICITIES OF AGRICULTURAL COMMODITY SUPPLY AS IMPLIED BY THE 1974-75 DATA BASE

In the previous section we defined the 'expansion effect' to be that part of the output response by agricultural industries attributable to movements of the transformation frontier. In this section we develop a measure of this effect, namely the expansion component of aggregate own and cross price elasticities of agricultural commodity supply. To enable estimation of this component (hereafter denoted $\eta^E_{i,t}$ for agricultural commodity i's response to a one per cent increase in the price of commodity t assuming no movement around the transformation frontier) for each of the ten agricultural commodities identified in ORANI 78, we first derive an expression explaining the total elasticity (hereafter denoted $\eta_{i,t}$ for agricultural commodity i's response to a one per cent increase in the price of commodity t allowing both movements around and of the transformation frontier). The expansion component will be then formed as the difference between the total and the transformation component; i.e.,

(5.1) $$\eta^E_{i,t} = \eta_{i,t} - \eta^T_{i,t} \qquad (i,t=1,\ldots,10) \;.$$

The derivation of $\eta_{i,t}$ begins with the elimination of z_j for all j from equation (4.8). To do so we use the following form of the short-run industry supply function used in ORANI 78 based on CES (constant elasticity of substitution) specified primary factor nests (see DPSV, p. 309):

(5.2) $$z_j = \frac{\sigma(1 - S_f(j))}{S_f(j)} \left[p_o(j)\,\frac{1}{S_p(j)} - p_m(j)\left(\frac{1}{S_p(j)} - 1\right) - p_\ell(j) \right] \qquad (j=1,\ldots,8) \;,$$

TABLE 4.2 : TRANSFORMATION COMPONENTS OF OWN AND CROSS PRICE ELASTICITIES OF SUPPLY IMPLIED BY THE 1974-75 DATA BASE FOR EACH AGRICULTURAL COMMODITY IN ORANI 78*

Response in the Planned Output Of Commodity (i)	Commodity (t) Whose Expected Price Changes: Wool	Sheep	Wheat	Barley	Other Grains	Meat Cattle	Milk Cattle and Pigs	Other Farming (Export)	Other Farming (Import Competing)	Poultry
Wool	0.1653	0.0015	-0.1143	-0.0098	-0.0155	-0.0081	-0.0055	-0.0031	-0.0102	0.0000
Sheep	0.0044	0.1579	-0.0970	-0.0111	-0.0182	-0.0084	-0.0074	-0.0033	-0.0169	0.0000
Wheat	-0.0822	-0.0182	0.4430	-0.0687	-0.0978	-0.0917	-0.0338	-0.0201	-0.0302	0.0000
Barley	-0.0340	-0.0100	-0.3314	0.4558	-0.0242	-0.0463	-0.0070	-0.0055	0.0027	0.0000
Other Grains	-0.0782	-0.0239	-0.6844	-0.0351	0.4912	-0.1186	0.1666	0.1021	0.1805	0.0000
Meat Cattle	-0.0142	-0.0038	-0.2232	-0.0234	-0.0412	0.3631	-0.0137	-0.0085	-0.0352	0.0000
Milk Cattle and Pigs	-0.0068	-0.0024	-0.0579	-0.0025	0.0406	-0.0096	0.0140	0.0084	0.0161	0.0000
Other Farming (Export)	-0.0036	-0.0010	-0.0328	-0.0019	0.0238	-0.0057	0.0080	0.0050	0.0083	0.0000
Other Farming (Import) Competing	-0.0115	-0.0050	-0.0475	0.0009	0.0405	-0.0228	0.0149	0.0079	0.0226	0.0000
Poultry	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

* The elasticities refer to changes in planned outputs in response to expected price changes under the assumption that the scale of activity (Z_j) remains constant in all industries j.

Cattle industries. Similar information from BAE (1983b), BAE (1983c) and BAE (1974c) was used to split Stevenson's estimates for the Milk Cattle and Pigs, and the Poultry and Other Farm industries respectively. Results of this first step are tabulated in Table 3.1. The second step used the 'Column Manipulator' contained in Bright (1982), in the way described by Adams and Higgs (1983, pp. 19-28), to proportion the data in Table 3.1 across the eight agricultural industries identified in ORANI 78. Final estimates for all four shares are shown in Table 3.2.

TABLE 3.1 : THE 1974-75 SHARES OF PAYMENTS TO OWNER-OPERATORS, AND UNPAID HELPERS AND HIRED WORKERS, IN TOTAL PAYMENTS TO LABOUR BY EACH AGRICULTURAL INDUSTRY IN ORANI 77*

ORANI 77 Industry	The Share of Total Returns to Labour Devoted to:	
	Owner-Operators	Unpaid Helpers and Hired Workers
Sheep	0.4336	0.5664
Cereal Grains	0.4336	0.5664
Meat Cattle	0.4336	0.5664
Milk Cattle and Pigs	0.4881	0.5119
Poultry	0.4341	0.5659
Other Farm	0.2942	0.7058
All Agriculture	0.4033	0.5967

* Derived from data in Stevenson (1982, Table 6), BAE (1974c) and BAE (1983 a, b, and c).

$$\eta^T_{i,t} = \sum_{j=1}^{8} S_i(j)\ {}^i\phi(j)\,{}^tH(j)(\delta_{i,t,j} - {}^tR^*(j)) \qquad (i,t=1,\ldots,10)\ . \tag{4.10}$$

It is worthwhile to note that even though own price elasticities calculated according to equation (4.10) are constrained to be positive, there is no negativity constraint on the cross price elasticities as is the case at the composite commodity level. Consider a particular industry with a two-level technology of the type depicted in Figures 2.1, 2.2 and 2.3. A _ceteris paribus_ increase in the price of one simple commodity, and therefore in the CRETH modified price (eqn. (2.3)) of the composite commodity containing that simple commodity, will lead to an increase in the production of that composite commodity and therefore to _all_ simple commodities contained therein. Take for example a _ceteris paribus_ unit increase in the price of the commodity Wool. This will lead via the process outlined above to an increase in production by the Pastoral Zone of both of the simple commodities Wool and Sheep. On the other hand, since Sheep and Wool occur in different composites in each of the High Rainfall and Wheat-Sheep Zones, the unit increase in the price of Wool leads to declines in the output of Sheep in these two industries. Depending on the values of the parameters $S_i(j)$, ${}^i\phi(j)$, ${}^tH(j)$, $\delta_{i,t,j}$ and ${}^tR^*(j)$, for j = 1,2,3, i = 2, and t = 1, an overall increase in the production of the commodity Sheep may eventuate, thus implying that $\eta^T_{2,1}$ is positive.

Estimates of $\eta^T_{i,t}$ for all i and t, based on data contained in Tables 2.1, 2.3, 2.4 and 4.1 are presented in Table 4.2. In light of the preceding paragraph it is interesting to note that a total of 16 significant positive cross price elasticities occur (for example the cross price elasticity of the commodity Wool with respect to the price of the commodity Sheep is .0015).

TABLE 4.1 THE 1974-75 SHARE IN THE TOTAL PRODUCTION OF COMMODITY i CONTRIBUTED BY INDUSTRY $j, S_i(j)$

ORANI 78 Industry j	Share of Industry in the Total Production of (i =): (1) Wool	(2) Sheep	(3) Wheat	(4) Barley	(5) Other Grains	(6) Meat Cattle	(7) Milk Cattle and Pigs	(8) OFE	(9) OFM	(10) Poultry
1 Pastoral Zone	0.2050	0.1308	0.0828	0.0196	0.0562	0.1056	0.0004	0.0039	0.0004	
2 Wheat-Sheep Zone	0.4456	0.4859	0.9058	0.9100	0.7565	0.2477	0.0615	0.0370	0.0530	
3 High Rainfall Zone	0.3494	0.3833	0.0114	0.0704	0.1873	0.2624	0.0231	0.0062	0.0659	
4 Northern Beef						0.2684				
5 Milk Cattle and Pigs						0.1159	0.9150			
6 Other Farming (Export)								0.9529		
7 Other Farming (Import Competing)									0.8807	
8 Poultry										1.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

TABLE 3.2 : 1974-75 PRIMARY FACTOR SHARES IN TOTAL FACTOR PAYMENTS OF AGRICULTURAL INDUSTRIES IN ORANI 78*

ORANI 78 Industry	The Share of Total Returns Devoted to: Hired Workers and Unpaid Helpers ($S_{\ell h}$)	Owner-Operators ($S_{\ell o}$)	Fixed Capital (S_k)	Agricultural Land (S_v)
j=1 Pastoral Zone	0.385	0.295	0.143	0.177
2 Wheat-Sheep Zone	0.297	0.225	0.191	0.287
3 High Rainfall Zone	0.429	0.320	0.118	0.132
4 Northern Beef	0.383	0.293	0.177	0.147
5 Milk Cattle and Pigs	0.377	0.359	0.092	0.172
6 Other Farming (Export)	0.423	0.184	0.157	0.236
7 Other Farming (Import Competing)+	0.423	0.184	0.157	0.236
8 Poultry	0.321	0.245	0.434	0
All Agriculture	0.363	0.244	0.166	0.227

\+ Shares $S_{\ell h}$ and $S_{\ell o}$ constrained to be equal to those of the Other Farming (Export) industry.

Source : ORANI 1974-75 data base; and derivations based on Table 3.1.

4. TRANSFORMATION COMPONENTS OF OWN AND CROSS PRICE ELASTICITIES OF AGRICULTURAL COMMODITY SUPPLY AS IMPLIED BY THE 1974-75 DATA BASE

The response of Zonal agricultural industries in ORANI 78 to a change in relative output commodity prices can be separated into two components. The first results from the movement around the tranformation frontier (denoted the transformation effect), and the second from the movement of the frontier itself (denoted the expansion effect). The nature and direction of both effects are illustrated in Figure 4.1.

In Figure 4.1, the curve TT_1 represents a transformation frontier for a hypothetical industry which produces two commodities identified as Y_1 and Y_2. The position and shape of the curve is dependent respectively on the value for Z (the industry's generalised capacity to produce, a concept introduced in equation (2.1)), and the particular production technology employed by the industry. An increase in Z will be depicted as an outward movement in TT_1 and vice-versa for a decrease in Z. All points in the region bounded by the curve TT_1 and the two axes form the set of currently feasible production combinations of Y_1 and Y_2. The straight line PP_1 is the gross revenue line for given prices of commodities one and two (respectively denoted by P_1 and P_2) and level of gross revenue (denoted by R). For given values of Z, P_1 and P_2, the firm will produce a bundle of goods represented by point A (a_1, a_2), on the assumption that the firm at all times seeks to maximize revenue and sells each commodity at exogenous prices. This point A, which is identified as the point of tangency between the curve TT_1 and the line PP_1, represents that bundle of commodities which equates the ratio of each commodity's marginal rate of transformation with the negative of the inverse ratio of prices.

can be written in percentage change form as:

$$(4.7) \qquad y_i = \sum_{j=1}^{8} S_i(j) y_i(j) \qquad (i=1,\ldots,8) \quad ,$$

where $S_i(j)$ is the base period share contributed by industry j to the total production of commodity i. Values of $S_i(j)$ derived from the 1974-75 ORANI 78 data base are contained in Table 4.1.

Equation (4.1), after the notational changes introduced above, can now be substituted into (4.7) to yield:

$$(4.8) \qquad y_i = \sum_{j=1}^{8} \left\{ S_i(j) \left(z_j + {}^{i}\phi(j) \left(\sum_t H_i^t(j) p_t - \sum_q R_q^*(j) \sum_t H_{tq}(j) p_t \right) \right) \right\} \qquad (i=1,\ldots,10) \quad .$$

To derive an expression to explain $\eta_{i,t}^{T}$ we set $z_j = 0$ for all j and $p_t = 1$ for one value of t on the right of equation (4.8), and $p_{t^*} = 0$ for all other values ($t^* \neq t$). The share $H_i^t(j)$ is non-zero if and only if t belongs to the composite commodity which contains commodity i in industry j. Furthermore, since there is only one value of the composite commodity index q (say q*) to which commodity t belongs, the term $\sum_q R_q^*(j)\ H_{tq}(j)$ reduces to:

$$(4.9) \qquad R^*_{q^*}(j)\ H_{tq^*}(j) = {}^{t}R^*(j)\,{}^{t}H(j) \qquad (j=1,\ldots,8) \quad .$$

Define $\delta_{i,t,j}$ as unity when commodities i and t are both contained within the same composite commodity in industry j, and as zero otherwise. Then $H_i^t(j) \equiv \delta_{i,t,j}\,{}^{t}H(j)$. Therefore, from equation (4.8), the price elasticity of supply of commodity i with respect to the price of commodity t when generalised output is held constant in each industry, is:

In words these four symbols may be explained as follows:

(i) $^{i}\phi(j)$ is the CRETH transformation parameter pertaining to the composite commodity r, produced by industry j, to which the simple commodity i uniquely belongs within j;

(ii) $^{t}H(j)$ is the share of simple commodity t produced by industry j, within the total value of the composite commodity r to which t uniquely belongs within j;

(iii) $H_i^t(j)$ is the share of the simple commodity t within the composite commodity r produced by industry j, to which simple commodity i uniquely belongs within j;

and

(iv) $^{t}R^*(j)$ is the modified share for the composite commodity r produced by industry j which uniquely contains the simple commodity t within j.

For instance we could write $^{2}\phi(1)$ to replace $\phi_1(1)$ on the right of (4.1). Where appropriate this is the convention adopted from here on.

The total production of agricultural commodity i (denoted by Y_i) can be expressed as :

(4.6) $$Y_i = \sum_{j=1}^{8} Y_i(j) \qquad (i=1,\ldots,10) \ ,$$

where $Y_i(j)$ is the output of commodity i by industry j. Equation (4.6)

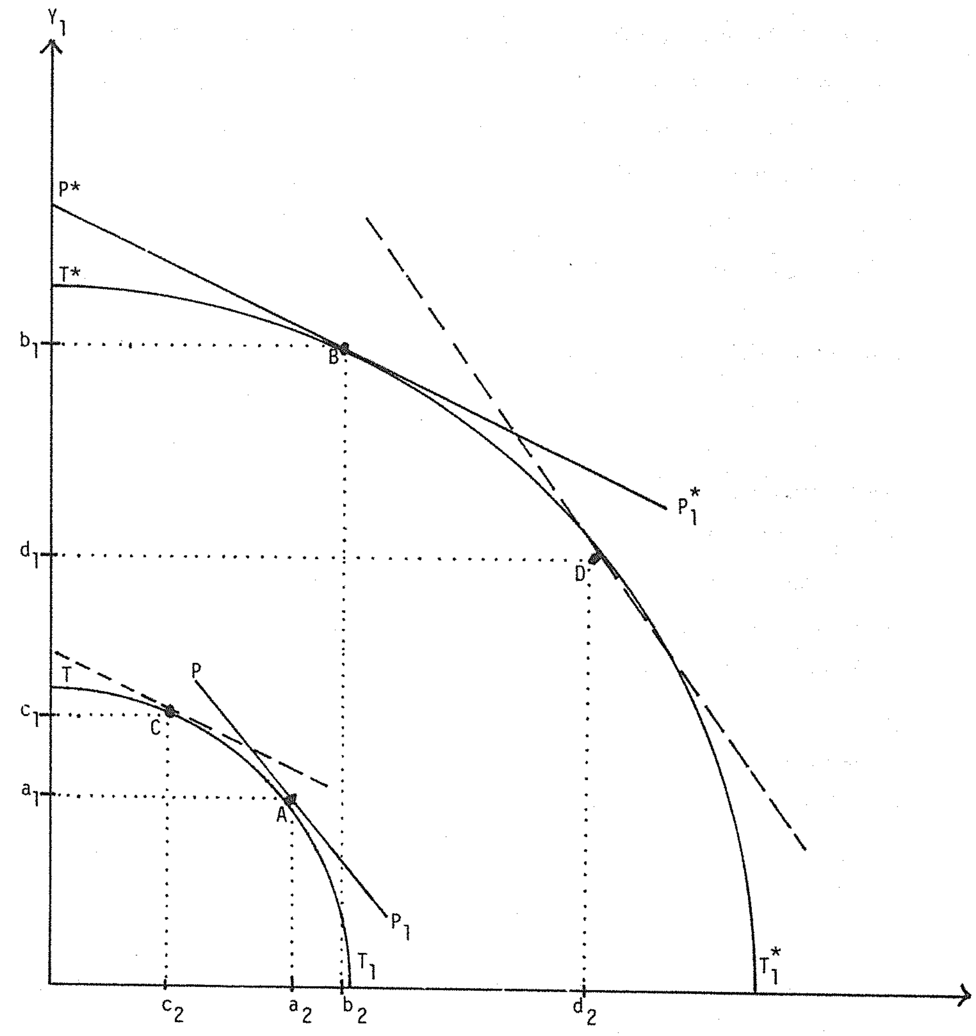

FIGURE 4.1 : THE TRANSFORMATION AND EXPANSION EFFECTS OF A CHANGE IN RELATIVE COMMODITY PRICES

The firm's response to an increase in the price of (say) commodity 1 will be a consequence of the following. First, the gross revenue line will move around and out to $P^*P_1^*$ reflecting a change in both its gradient (the gradient is equal to the price of commodity 2 relative to the price of commodity 1) and its point of intersection with the Y_1 axis (the point of intersection is equal to the level of gross revenue divided by the price of commodity 1). Second, if we assume that the production frontier was formed by a homothetic production function (which imposes the restriction that the transformation frontier shifts out in a product-neutral way), then TT_1 will expand to $T^*T_1^*$, reflecting an increase in Z caused by the firm's increased profitability. The desired output combination of Y_1 and Y_2 now is given by point $B(b_1, b_2)$ showing, as a result of an increase in P_1, that the production of both commodities has increased. The transformation effect associated with the given increase in P_1 is illustrated in Figure 4.1 by the move from A to the point $C(c_1, c_2)$, the point of tangency between the old transformation frontier and an artificial gross revenue line based on the new ratio of prices. The movement from A to C occurs if and only if the price increase does not affect Z. In contrast the expansion effect, which is depicted as a move from A to $D(d_1, d_2)$, is the effect of the increase in Z alone, while holding the ratio of prices constant.

To measure the size of the transformation effect imposed on ORANI 78 agricultural industries by the base year data base, we introduce the concept of the transformation components of aggregate own and cross price elasticities of supply, for each of the ten agricultural commodities identified in ORANI 78. (This concept is identical to that used in an unpublished IAC Research Memorandum by Thompson (1982). However, her analysis was restricted to own price elasticities.) To enable us to estimate

such components (hereafter denoted by $\eta_{i,t}^T$ for agricultural commodity i's reponse to a one per cent increase in the price of commodity t assuming zero change in Z) we first note that equation (2.2b) can be modified, by the use of equation (2.2a) and (2.3), to substitute out $\tilde{y}_r(j)$, $p_r(j)$ and $p_q(j)$, yielding:

(4.1) $$y_i(j) = z_j + \phi_r(j) \left(\sum_t H_{tr}(j) p_t \right) - \left(\sum_q R_q^*(j) \sum_t H_{tq}(j) p_t \right) \qquad (i\in r, j=1,\ldots,8) \quad ,$$

where the notation is as explained in section 2.

A weakness of the use in (4.1) of the previous notation is that the variable on the left contains no composite commodity subscript r, whereas this subscript appears on the right. In any given industry j any commodity i is produced in at most <u>one</u> composite commodity r. For instance, when j=1 (the Pastoral Zone) and i=2 (Wool), the only permissable value of r is 1, indicating the Pastoral Zone-specific composite whose components are the ORANI simple commodities 'Wool' and 'Sheep'. It is therefore desirable to have notation that excludes the subscript r. To achieve this objective we can devise four new symbols:

(4.2) $${}^{i}\phi(j) = \{ \phi_r(j) : i\in r \} \qquad (j=1,\ldots,8) \quad ,$$

(4.3) $${}^{t}H(j) = \{ H_{tr}(j) : t\in r \} \qquad (j=1,\ldots,8) \quad ,$$

(4.4) $$H_i^t(j) = \{ H_{tr}(j) : i\in r \} \qquad (j=1,\ldots,8) \quad ,$$

and

(4.5) $${}^{t}R^*(j) = \{ R_r^*(j) : t\in r \} \qquad (j=1,\ldots,8) \quad .$$