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AGRICULTURAL SUPPLY RESPONSE IN ORANI

by

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1. Introduction

A large proportion of Australian agricultural production is sold on overseas markets. In 1982-83, for example, exports of rural origin were estimated to constitute 63.8 per cent of the gross value of rural production (see BAE (1984)). This heavy exposure of Australian agriculture to world trade means that changes in the sector's prosperity are closely linked to changes in its domestic production costs relative to the world price (expressed in Australian dollars) received for its products. Hence, to analyse the effects of government policies on the Australian agricultural sector a model capable of endogenising this cost-price ratio within an internally consistent economy-wide framework is required. Such a framework is provided by the ORANI model of the Australian economy - Dixon, Parmenter, Sutton and Vincent (1982) (hereafter DPSV).

ORANI is a fully computable general equilibrium model of the Australian economy recognising 114 commodities and 112 industries. Features of the model include:

(i) a firm basis in microeconomic theory;

(ii) an allowance for multi-product industries and multi-industry products (of special importance in agriculture); and

(iii) a linear final form achieved using the approach to approximating non-linear systems pioneered by Johansen (1960).(a)

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(a) The Johansen method introduces approximation errors which are negligible for small changes in the exogenous variables. However, for large changes these errors become uncontrollable. In the latter situation an Euler-style large change procedure is employed to derive highly accurate ORANI solutions with minimal additional computing expenses.

Documented applications of the model have provided important contributions to policy debates. In particular, applications to specific issues affecting agriculture have included: Vincent (1980) (the implications for Australian agriculture of prospective growth in trade with newly industrialising countries in Asia); Vincent, Dixon, Parmenter and Sams (1980) (the implications for agriculture of energy price increases); and Dixon, Parmenter and Powell (1982) (the implications of changes in the real exchange rate for agriculture). Conclusions of these studies have generally taken the form: given a policy change A, then in a macroeconomic environment B, variable C would differ in the short-run by x per cent compared with the value it would have had in the absence of the policy change. The time period denoted '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).

The short-run output response of agricultural industries in ORANI to changes in product prices, namely the short-run price elasticity of aggregate agricultural supply, is a function solely of the model's data base (including its parameter data file). This data base, which describes the economy in a hypothetical state of equilibrium immediately prior to a shock (see Adams (1984), p. 2), is regularly updated to reflect the latest available information. An implication of Dixon, Parmenter and Rimmer (1984) is that output projections pertaining to export oriented industries in ORANI are sensitive to values implicitly assigned to the 'micro' (commodity specific) components of the aggregate supply elasticity. Accordingly, the primary aim of this paper is to assess the impact that past changes in the model's data base have had on the values implicitly assigned to these 'micro' elasticities.(b)

(b) In a forthcoming study we examine issues associated with estimating the aggregate elasticity from these micro foundations.

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The initial finding of this paper is that the 'micro' elasticities are extremely sensitive to the data base of the model. In particular, the elasticities are significantly greater if the data reflect an agricultural sector in a low income year. Accordingly, an artificial agricultural data base was constructed. These data, which reflect the agricultural sector in a typical year (see Adams (1984) for full particulars of their derivation), are unaffected by transient disturbances such as drought related shortfalls in production. 'Micro' elasticities derived from these data are our 'preferred estimates'.

The remainder of this paper is organised as follows. In section 2, a brief description of the ORANI agricultural production system is offered. Formulae to allow computation of the components of the price elasticity of supply of the principal agricultural products are presented in section 3. These 'micro' elasticities are defined in terms of the transformation and expansion components of the supply response of a single agricultural commodity to a change in its own price or in that of another agricultural commodity. In section 4, values of 'micro' elasticities implied by the 1968-69 and 1977-78 ORANI data bases are computed. Reasons for divergences between 'micro' elasticities of supply based on these two sets of data are discussed. It is concluded that policy simulations should not be made from historical data from a single (possibly atypical) year; rather they should be based on synthetic data for a 'typical' year such as those constructed by Adams (1984). The preferred values of the 'micro' elasticities of supply, which are based on these synthetic data, are also presented in section 4. In section 5, comparisons are made between the preferred ORANI 'micro' elasticities and recent estimates derived by other researchers. Concluding remarks are offered in section 6.

2. The ORANI Agricultural Production System

The specification of ORANI makes allowance for the multi-product nature of Australian agriculture. The three largest agricultural industries identified in the model, namely, the Pastoral Zone, the Wheat-Sheep Zone and the High Rainfall Zone, are modelled as multi-product industries producing in total nine separate commodities. These three zonal industries are geographically defined, aggregating establishments faced with similar climatic/technological conditions. The basis of the zonal classification is that adopted by the Bureau of Agricultural Economics (hereafter 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 Coastal Central and Peninsular and Gulf regions of Queensland (regions as defined in BAE (1974a and b)).

There are four non-geographically defined industries. The first of these, the Milk Cattle and Pigs industry, is modelled as producing two commodities (beef cattle, and milk cattle and pigs) in fixed proportions. The remaining three industries, Other Farming (Export) (hereafter OFE), Other Farming (Import Competing) (hereafter OFM) and Poultry, each are modelled as producing a single commodity.

The production technology of each industry is illustrated in Figure 2.1. The basic assumption underlying technology of this 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:

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

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 (see Dixon, Parmenter, Powell and Vincent (1983), pp. 250-251) and Z_j, a scalar, is the activity level of industry j. In ORANI the function g_{ij} is determined as the solution to the problem of maximising an industry's revenue subject to a CRETH (constant ratios of elasticities of transformation, homothetic) production technology with given product and input prices, and with land and capital treated as fixed (see 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

ORANI policy simulations reported in the literature have been based on the 1968-69 data base. Recently, however, the 1974-75 data base has been used. It appears that the advantages flowing from the more recent vintage of the latter data may be more than offset by the atypical nature of that year's set of Input-Output accounts for agriculture. The appropriate procedure, then, is to construct synthetic agricultural data for a 'typical year'. These data have been used to generate 'preferred' ORANI supply elasticity estimates. Such estimates have been compared with recent estimates of other researchers to reveal significant disparities.

From section 5 several areas of future research can be identified. Firstly, the supply response systems in EMABA, ORANI and MLV cover producers representative of geographic zones which together encompass the whole of Australia. The only data source of sufficient scope to support such studies is the BAE survey system. However, the BAE is gradually reducing the size of its survey samples. Does this represent a threat to the maintenance of the current Australia-wide supply response models? If so, does the future lie with models employing more detailed, but in terms of geographic area covered, limited, survey data such as that used by F&M and W&D? A second issue for future research is the claim by MLV that their system avoids 'even the CRESH/CRETH assumptions that no input has a comparative advantage in the production of any particular input' (MLV, p. 336). Is this system (and supply systems based on the same philosophy) sufficiently robust to handle as fine a degree of commodity disaggregation as that in the ORANI system? (If not, their usefullness as tools for policy analysis is somewhat limited.) Finally, a distinguishing feature of the supply system in EMABA is its explicit treatment of livestock inventory movements. However, as pointed out in a recent paper by Rucker, Burt and La France (1984), 'empirical modelling efforts have not succeeded in obtaining statistically precise estimates of an equation to quantify the complex dynamics of inventory changes. The weakness is most likely the result of reliance in past studies on only first-order difference equations representing either adaptive expectations or partial adjustment models and on the use of a classical nonautocorrelated error process. If either or both of these assumptions are incorrect, serious statistical problems can arise.' Accordingly, can EMABA track inventory dynamics without the statistical problems spoken of by Rucker, et al.? If so, can this feature be incorporated into the more tightly constrained supply systems of ORANI, MLV and W&D?

Table 5.2: COMPARISON OF THE PRINCIPAL FEATURES OF SUPPLY STUDIES

	This study(a)	F&M	MLV	W&D	EMABA
<u>Level of aggregation</u>					
Agents (unit)	3 industries (zone)	3 regions (representative farm)	1 (all agriculture)	521 localities (representative farm)	1 (all agriculture)
Commodities (unit)	3, 6 or 4 (composite commodity)	4 (single commodity)	3 (composite commodity)	3 (single commodity)	11 (single commodity)
<u>Specification of production system</u>	CES-CRETH at zonal level	linear supply functions for 3 regions	translog variable profit function	aggregate of 521 linear programs	linear supply functions
<u>Data</u>	'typical' Input-Output data for 1977-78 plus BAE survey data	F&M's survey of 62, 61 and 32 properties, respectively, in S. Tablelands, S.W. Slopes and W. Division of N.S.W.	BAE survey data	APMAA survey data	ABS and BAE survey data
<u>Econometric Approach</u>	FIML	OLS	Restricted GLS	OLS on synthetic data from 521 LPs	OLS
<u>Adjustment period allowed</u>	about 2 years	about 3 years	about 1 year	na	5 years

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

na, not available.

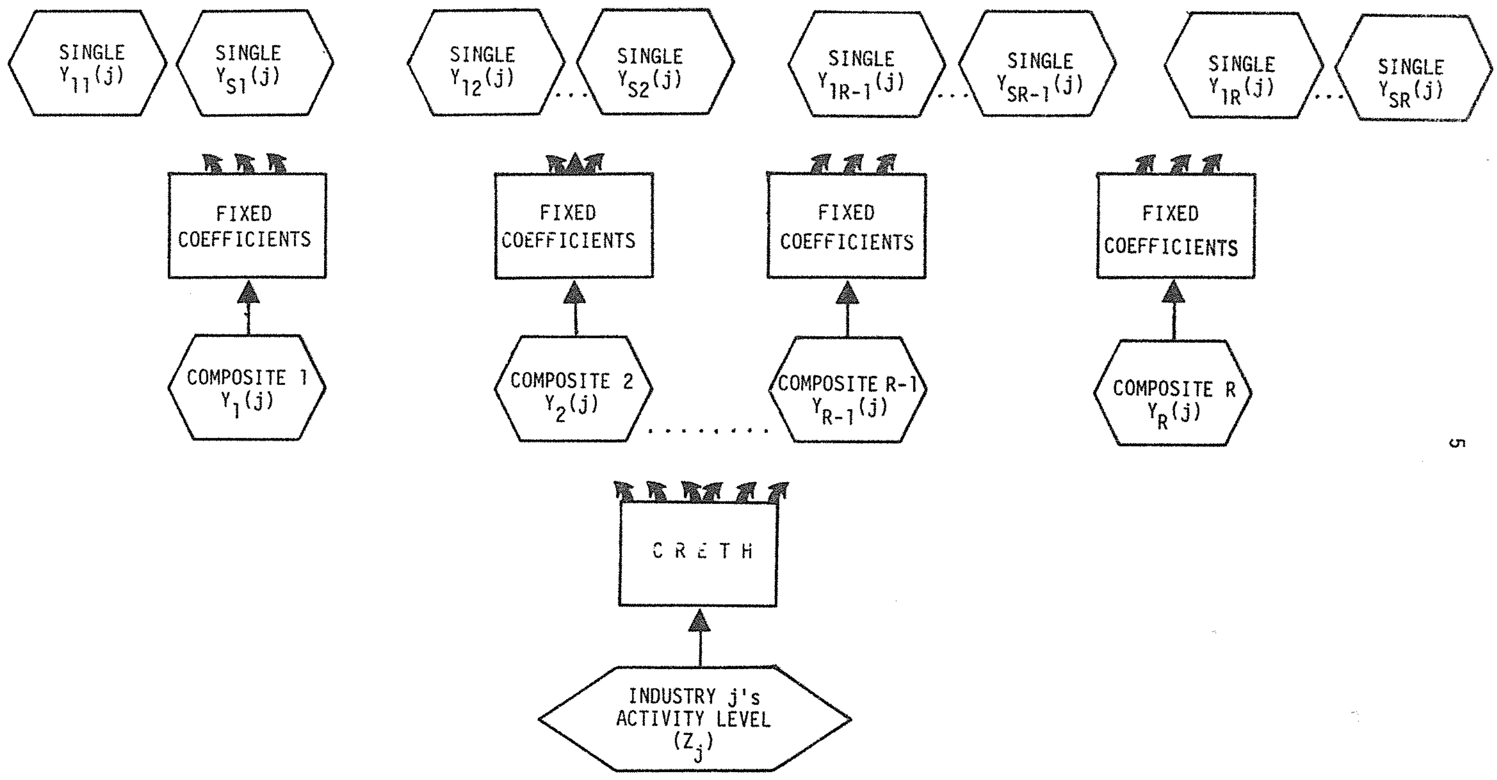

Figure 2.1 : Output Technology for Agricultural Industries in ORANI

categories is assumed to be invariant under product price changes (see the 'Fixed Coefficient' allocations 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 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 expressed in percentage change form:

(2.2a) $y_{ir}(j) = y_r(j)$ $\quad (i \in r,\ j=1,\dots,8)$,

where

(2.2b) $y_r(j) = z_j + \phi_r(j)(p_r(j) - \sum_q R^*_q(j)p_q(j))$ $\quad (j=1,\dots,8;\ \text{all } r)$,

in which

(2.2c) $\phi_r(j) \geq 0$ $\quad (j=1,\dots,8;\ \text{all } r)$.

In these equations the lower case Roman characters signify percentage changes in the variables indicated by the corresponding upper-case letters. $Y_{ir}(j)$ and $Y_r(j)$, respectively, are the output levels by industry j of single commodity i (i=1,...,10) and composite commodity r to which i uniquely belongs within j. $P_r(j)$ is the price index for composite commodity r produced by industry j. In percentage change form this is simply a weighted average of the percentage changes in the component single commodity prices:

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

where the weight $H_{tq}(j)$ is the share of single 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 single commodity t (see equation 2.1). In equation (2.2b) z_j, $\phi_r(j)$ and $R^*_q(j)$, respectively, are the percentage

identities which track inventory dynamics and production outcomes. The crop supply system reflecting 'a sequence of hierarchical 'allocation' decisions', consists of two components. The first allocates the area of total land to land devoted to either crops or livestock production according to the present value of expected real returns accruing to each broadly defined activity. The second component, allocates total crop area amongst the six commodities based upon relative expected returns. Both supply systems are estimated by OLS using annual data from ABS and BAE surveys. The time profile for short-run elasticities reported in Table 5.1 is 'unambiguously time dimensioned' as the response after 5 years.

The salient features of each author's approach are contrasted in Table 5.2. Major causes of disparity appear to be differences in the level of disaggregation and in econometric techniques. The supply systems of EMABA and ORANI employed relatively fine commodity specifications compared to those of MLV, W&D and F&M. The econometric techniques employed for all but the ORANI system involved OLS or a derivative. In contrast, the ORANI system was estimated by FIML. Differences in data, another possible reason for disparity amongst the elasticity estimates, appeared to be only a minor factor. Each study employed data derived from surveys in holdings in geographic areas representative of the BAE's Pastoral, Wheat-Sheep and High Rainfall Zones.

6. Concluding Remarks

The supply behaviour of the agricultural exporting industries is a crucial element in making judgments about diverse policy initiatives, including initiatives having no obvious connection with agriculture. Analysis of the consequences of various policy measures for agricultural industries themselves presupposes a sufficiently accurate knowledge of their supply responses.

It has been shown above that agricultural industries' supply elasticities in the ORANI model are very sensitive to the particular data base employed in preparing simulations. The main cause of this volatility is year-to-year variation in profitability in agriculture. Most of the

The elasticities in MLV are based on a more tightly constrained theoretical specification than those of F&M. MLV's approach appealed to duality and employed a variable profit function which had a transcendental logarithmic form (see Varian (1984), p. 52 for an elucidation of the duality property of a firm's profit function (Hotelling's lemma)). Thus MLV claimed their production system was not limited by the ORANI CES/CRETH restriction that no input had a comparative advantage in the production of any particular output. All commodities were defined on a composite rather than single basis and time was used as a proxy for technology. The system was estimated by the restricted Aitken estimator developed in Byron (1970), using annual data from the BAE's Australian Sheep Industry Survey for the 25 years spanning 1952-53 through 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 relatively fixed inputs' (MLV, p. 330).

The approach taken by W&D to estimate their supply elasticities differs markedly from that taken by ourselves and all other authors cited. 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 EMABA model has been developed within the BAE to depict the determination of demand, supply and prices in the cattle, sheep and crops industries. A feature of the model is its separation of livestock output response from changes in livestock inventories. In the view of authors this is essential for modelling price determination and allows meaningful interpretation of the model's output projections. Accordingly, EMABA's supply system, compared to that of ORANI, is loosely constrained. The supply system consists of equations for eleven commodities (six crop and five livestock). The livestock supply system consists of behavioural equations explaining slaughterings, retentions, deaths and yields; and

change in the output of industry j, a transformation parameter reflecting the ease of transformability of other composite commodities produced in industry j into composite commodity r, and a parameter reflecting the share 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:

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

3. Transformation and Expansion Components of Own and Cross Price Elasticities of Agricultural Commodity Supply in ORANI

The response of multi-product agricultural industries in ORANI to a change in relative output commodity prices can be separated into two components. The first results from the movement around the CRETH transformation 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 3.1.

In Figure 3.1, the curve $T(Z_o)$ 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 are 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 is depicted as an outward movement in the transformation frontier, and a decrease is represented as an inward movement. The shape of the frontier, as depicted in Figure 3.1, is formed from a homothetic production function (which imposes the restriction that the transformation frontier shifts out in a product-neutral way). The straight line $P(R_o)$ is the gross revenue line for given prices of Y_1 and Y_2 (respectively, denoted by P_1 and P_2) and level of a gross revenue (denoted by R).

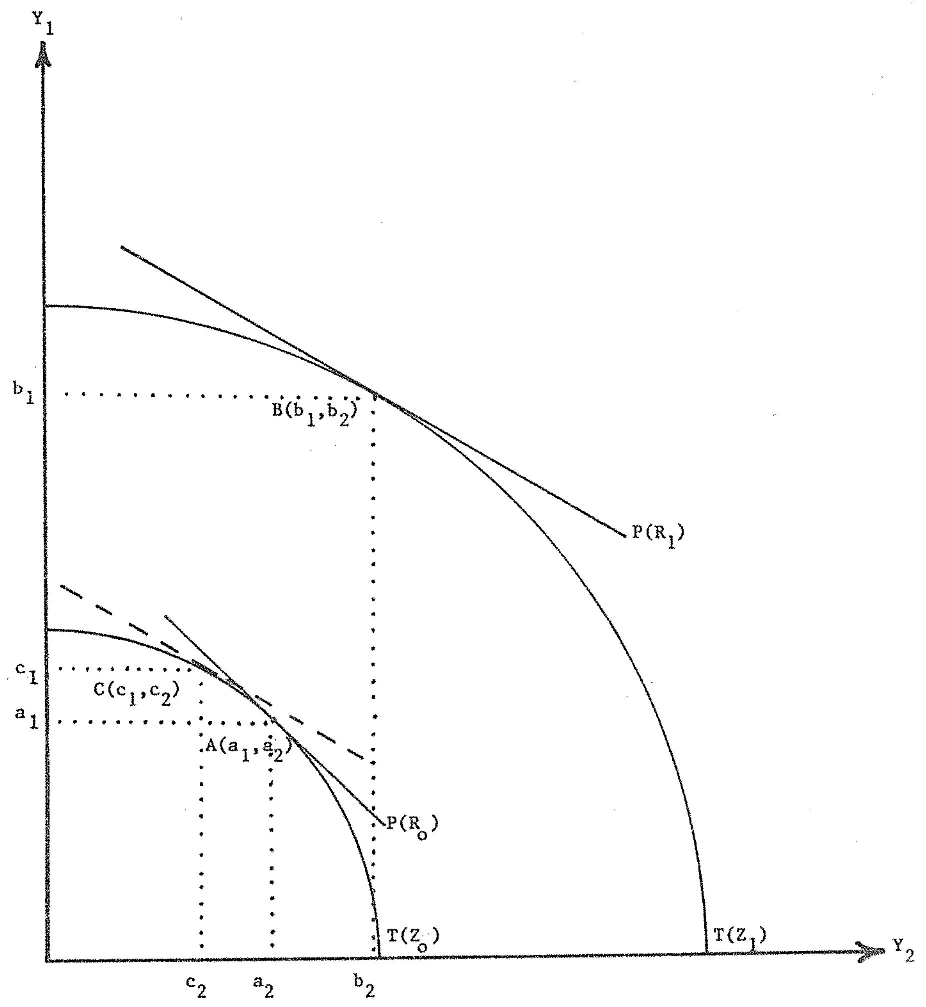

Figure 3.1 : Transformation and Expansion Effects of a Change in Relative Commodity Prices

In Table 5.1 substantial discrepancies are evident. Possible reasons for this disagreement are differences in the approach taken in each study 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.

The preferred elasticity estimates derived in this paper are based on a tightly constrained CES-CRETH production system. Data employed to estimate this system consist of Input-Output data which reflect an agricultural sector in a 'typical year', and values for the CRETH parameters which were estimated econometrically using the full information maximum likelihood technique applied to data from BAE survey reports (see Vincent, Dixon and Powell (1980)). Each 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 cross sectional data for intended sheep numbers, intended cattle numbers, intended breeding ewe numbers and intended wheat plantings, respectively, on corresponding data for current output, the expected prices of the commodities produced in the region concerned, and a variable measuring the proportion of improved pasture. The current output of the commodity, whose expected numbers/plantings is to be explained, 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 New South Wales; 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.

Table 5.1: ALTERNATIVE ESTIMATES OF SHORT-RUN OWN AND CROSS PRICE ELASTICITIES OF AGRICULTURAL COMMODITY SUPPLY(a)

Response in the output of		Product whose price changes		
		Wool	Wheat	Meat cattle
Wool	Our preferred estimates	0.4591	0.0069	0.0937
	Fisher and Munro (1983)			
	Southern Tablelands	0.26		
	South-West Slopes	0.28		
	Western Division	0.52		
	McKay, Lawrence and Vlastuin(b) (1983)	0.72	0.15	0.08
	Wicks and Dillon (1978)	0.25	-0.20	-0.18
	EMABA	0.39	0.16	-0.12
Wheat	Our preferred estimates	0.0196	0.7407	-0.0858
	Fisher and Munro (1983)			
	South-West Slopes		2.05	
	McKay, Lawrence and Vlastuin(c) (1983)	0.43	0.50	-0.42
	Wicks and Dillon (1978)	-0.21	1.10	-0.21
	EMABA	0.33	0.92	0.14
Meat cattle	Our preferred estimates	0.1760	-0.1158	0.6018
	Fisher and Munro (1983)			
	South-West Slopes	-0.83		0.70
	Western Division	-1.27		0.40
	McKay, Lawrence and Vlastuin(d) (1983)	0.25	-0.48	0.12
	Wicks and Dillon (1978)	-0.38	-0.44	0.69
	EMABA	0.14		-0.34

(a) A blank indicates that the elasticity was either not estimated, or in the view of the authors, had no statistical significance.
(b) The elasticity of sheep and wool with respect to the price of respectively sheep and wool, 'crops', and cattle and 'other'.
(c) The elasticity of 'crops' with respect to the price of, respectively, sheep and wool, 'crops', and cattle and 'other'.
(d) The elasticity of cattle and 'other' with respect to the price of, respectively, sheep and wool, 'crops', and cattle and 'other'.

The bundle of commodities (denoted $A(a_1, a_2)$) which maximises the representative firm's revenue for a given level of inputs and input prices, is given as the point of tangency between $T(Z_o)$ and $P(R_o)$, i.e., when

$$(3.1) \quad MRT_{12} = \frac{P_2}{P_1} ,$$

where MRT_{12} denotes the marginal rate of transformation between commodities 1 and 2.

The industry's response to an increase in the price of (say) Y_1 relative to the price of Y_2 is encapsulated in Figure 3.1. As depicted, the change in relative prices causes the gross revenue line to rotate from $P(R_o)$ to $P(R_1)$. The consequent change in industry profitability (and input application) is reflected as an expansion of the production frontier from $T(Z_o)$ to $T(Z_1)$. In Figure 3.1 the new desired output combination of Y_1 and Y_2 is represented by point B (b_1, b_2) showing, as a result of the increase in P_1 that the production of both commodities has increased. The transformation effect associated with the change in relative prices is illustrated in Figure 3.1 by the move from A to the point C (c_1, c_2). This movement reflects the change in production of Y_1 and of Y_2 induced by the change in relative prices if the industry, by accepting a reduction in revenue, is forced to remain on $T(Z_o)$. In contrast the expansion effect, which is depicted as a move from C to B (b_1, b_2), is the effect of the increase in Z alone, while holding the ratio of prices at the new value.

To measure the size of the transformation effect we introduce the concept of the transformation components of aggregate own and cross price elasticities of supply. (This concept is identical to that used in an unpublished Research Memorandum by Thompson (1982). However, her analysis was restricted to own price elasticities.) In Adams (1983), formulae for short-run own and cross price elasticities of agricultural commodity supply were derived in detail. The transformation component of the price elasticity of supply of commodity i with respect to the price of commodity t (denoted η^T_{it}) is a share-weighted sum of the corresponding elasticity components in each of the industries producing that product, i.e.:

$$\eta^T_{it} = \sum_{j=1}^{8} \{S_j(i)\, {}^i\phi(j)\, {}^tH(j)\, (\delta_{itj} - {}^tR^*(j))\} \qquad (i,t=1, \ldots, 10), \tag{3.2}$$

where

$S_j(i)$ is the base period share contributed by industry j to the total production of commodity i;

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

$t_H(j)$ is the base period share of single commodity t produced by industry j, within the total value of the composite commodity r to which t uniquely belongs within j;

δ_{itj} is unity when single commodities i and t are both contained within the same composite commodity in industry j, and is zero otherwise; and

$t_{R^*}(j)$ is the CRETH modified base period share for the composite commodity r produced by industry j which uniquely contains the single commodity t within j.

The expansion component of the price elasticity of supply of commodity i with respect to the price of commodity t (denoted η^E_{it}) is expressed as

$$\eta^E_{it} = \sum_{j=1}^{8} \{S_j(i)[\sigma(S_v(j)/S_f(j))({}^tR(j)\, {}^tH(j)/S_p(j) - S^M_t(j)(1/S_p(j)-1))]\}$$ (3.3)

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

where

σ is the constant elasticity of substitution between primary factors of production (DPSV, p. 189 discusses reasons for abandoning the CRESH input specification in favour of the more restrictive CES specification);

$S_f(j)$ is the base period fixed factor (land and fixed capital) share in industry j's total primary factor costs;

Table 4.5: TRANSFORMATION AND EXPANSION COMPONENTS OF OWN AND CROSS PRICE ELASTICITIES OF SUPPLY IN ORANI 78 AS IMPLIED BY THE 'TYPICAL YEAR' ENHANCED 1977-78 DATA BASE(a)

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	T	0.1548	-0.0019	-0.0947	-0.0086	-0.0147	-0.0149	-0.0075	-0.0010	-0.0115	0.0000
	E	0.3043	0.1064	0.0879	0.0201	0.0216	0.1086	0.0124	0.0003	0.0095	-0.0000
Sheep	T	-0.0048	0.1607	-0.0870	-0.0094	-0.0183	-0.0141	-0.0096	-0.0017	-0.0157	0.0000
	E	0.2775	0.1075	0.0977	0.0220	0.0240	0.1060	0.0140	0.0002	0.0093	-0.0000
Wheat	T	-0.1552	-0.0547	0.5660	-0.0443	-0.0975	-0.1435	-0.0536	-0.0017	-0.0155	0.0000
	E	0.1747	0.0735	0.1748	0.0314	0.0241	0.0577	0.0139	-0.0008	0.0022	-0.0000
Barley	T	-0.0734	-0.0309	-0.2310	0.4404	-0.0057	-0.1271	-0.0047	0.0028	0.0296	0.0000
	E	0.1959	0.0815	0.1579	0.0294	0.0243	0.0686	0.0141	0.0006	0.0038	-0.0000
Other grains	T	-0.1372	-0.0656	-0.5558	-0.0062	0.4807	-0.1980	0.2551	0.0192	0.2079	0.0000
	E	0.2270	0.0958	0.1305	0.0264	0.0253	0.0872	0.0147	0.0004	0.0067	-0.0000
Meat cattle	T	-0.0279	-0.0102	-0.1645	-0.0279	-0.0398	0.3451	-0.0189	-0.0045	-0.0513	0.0000
	E	0.2039	0.0763	0.0487	0.0121	0.0145	0.2567	0.0836	-0.0020	-0.0019	-0.0000
Milk cattle and pigs	T	-0.0115	-0.0056	-0.0501	-0.0008	0.0418	-0.0154	0.0223	0.0017	0.0177	0.0000
	E	0.0191	0.0083	-0.0244	-0.0044	-0.0068	0.0684	0.9465	-0.0111	0.0581	-0.0000
Other farming (export)	T	-0.0012	-0.0007	-0.0013	0.0004	0.0025	-0.0028	0.0013	0.0002	0.0018	0.0000
	E	0.0026	0.0010	-0.0098	-0.0002	-0.0053	0.0011	0.0001	1.5960	-0.0274	-0.0000
Other farming (import competing)	T	-0.0182	-0.0095	-0.0149	0.0054	0.0351	-0.0430	0.0182	0.0023	0.0245	0.0000
	E	0.0343	0.0129	-0.0127	0.0013	-0.0083	0.0134	0.0015	-0.0653	2.6110	-0.0000
Poultry	T	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	E	-0.0000	-0.0000	-0.1823	-0.0341	-0.0587	-0.0000	-0.0000	-0.0000	-0.0000	2.9540

(a) Reading across each row, the first number in each column refers to the transformation component of the elasticity of the commodity identified by that row with respect to the price of the commodity identified by that column. The second number in the column is the corresponding expansion component.

degree of agricultural sector profitability reflected in the Input-Output data. Consequently, if the price of an agricultural commodity increases in a year of low agricultural sector profitability, the ORANI model contends that the aggregate response of agricultural industries will be greater than if the price increase occurred in a relatively profitable year.

To summarise our findings so far: estimates of short-run supply elasticities of agricultural commodities implied by the ORANI model are sensitive to changes in the model's Input-Output data base. The degree of this sensitivity is largely a result of movements in the ratio $S_v(j)/S_f(j)$, which in turn is inversely related to the industry's gross operating surplus.

To isolate our estimates of short-run supply elasticities from the volatile nature of agricultural industry profitability, we have constructed, for the agricultural sector, an artificial Input-Output data file which succeeds in capturing a typical year. Each of its elements is an average of values over the 13 year period 1967-68 to 1979-80 (for comprehensive details see Adams (1984)). These data are therefore unaffected by transient fluctuations such as major droughts that affect agricultural sector profitability. Higgs (1985) has incorporated these data into the current 1977-78 Input-Output data file. Transformation and expansion components of short-run own and cross price elasticities of agricultural commodity supply as implied by the typical year enhanced 1977-78 data base are presented in Table 4.5. These are our preferred estimates.

5. Comparisons with Recent Alternative Studies

Within this section we compare our preferred estimates of short-run elasticities of agricultural commodity supply with those derived in Fisher and Munro (1983), (hereafter F&M), McKay, Lawrence and Vlastuin (1983), (hereafter MLV), Wicks and Dillon (1978) (hereafter W&D), and from the Econometric Model of Australian Broadacre Agriculture (hereafter EMABA) (see Dewbre, Shaw and Corra (1984)). Their estimates and our preferred estimates are compared in Table 5.1 for the three most important agricultural commodities; namely, Wool, Wheat and Meat cattle.

$S_V(j)$ is the base period variable factor (labour) share in j's total primary factor costs;

$t_R(j)$ is the (unmodified) base period share of gross revenue in industry j represented by composite commodity r which uniquely contains the single commodity t within j;

$S_P(j)$ is the base period of primary inputs in j's total costs; and

$S_t^M(j)$ is the base period share of the effective commodity t, in the total cost of effective intermediate inputs to the current production of industry j (effective commodities being CES aggregates of local and imported goods of the same name).

The components of elasticities obtained from equations (3.2) and (3.3) refer to percentage changes in planned commodity outputs in response to expected price changes. The output of agricultural industries is defined as the sum of cash receipts from the sale of agricultural commodities plus the market value of changes in inventories. Changes in the value of inventories are included in this definition because,

> '... the farmer has considerable flexibility over the stage at which products are marketed. For example livestock can be withheld from the market if seasonal conditions are favourable. Such strategies involve changes in inventories which must be accounted for somewhere. Rather than modify the structure of the livestock supply equations to reflect inventory behaviour, we have defined the decision variable to represent output whether actually sold or in the form of a change in inventories.' (Vincent, Dixon and Powell (1980), p. 232.)

Planned outputs may differ from actual outputs due to climatic factors such as drought. Furthermore, setting p_t to x represents, in the mind of the producer, a permanent increase of x per cent in the expected price of commodity t. Therefore, the total supply elasticity (denoted $\eta_{it}(\eta_{it} = \eta^E_{it} + \eta^T_{it})$) 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 x were considered to be only a transitory price change.

4. Values of Supply Elasticities Implied by the 1968-69, 1977-78 and 'Typical Year' ORANI Data Bases

The ORANI data base is organised into two essentially independent files. The larger of these contains Input/Output data supplied by the Australian Bureau of Statistics (hereafter ABS) and manipulated by the Industries Assistance Commission into the format required by the model (involving about 114 commodities and 112 industries). These data have been regularly updated since the original 1968-69 data were derived. The latest data, reflecting the year 1977-78, were introduced in 1984 (see Bruce 1985). Data in the first section of this file provide the basis for computing cost and sales shares. The second section consists of values for miscellaneous parameters (for example the CRETH transformation parameters) that have, where possible, been estimated econometrically and which are updated less frequently than the Input/Output data.

Values for transformation and expansion components of elasticities of agricultural commodity supply for selected commodities as implied by the 1968-69 and 1977-78 data bases, respectively, are presented in Table 4.1. The sensitivity of the expansion components to the data base employed is significantly greater than the sensitivity of the corresponding transformation components (see for example the expansion and transformation components of the own price elasticities for Wool, Wheat and Meat cattle). The relatively insensitive behaviour exhibited by the transformation components was a result of the extensive use of sales share data in their derivation. Of the parameters appearing in equation (3.2), two (namely ${}^{i}\Phi(j)$ and δ_{itj}) are relatively invariant to changes in the ORANI data base. The remaining three parameters ($S_j(i)$, ${}^{t}H(j)$ and ${}^{t}R^*(j)$) are shares formed from a section of the Input/Output data file (known as the Make Matrix) which contains the commodity composition of the output of each agricultural industry. Shares of each commodity in the total value production of each zonal multi-product industry, computed from the two historical data bases, are given in Table 4.2. From this table, it is clear that, with few exceptions the value of each share differs only moderately between the data bases. It is this relative stability that constrains the sensitivity of η^{T}_{it} for all i and t.

Table 4.4: THE RATIO OF THE SHARE OF VARIABLE FACTORS IN TOTAL PRIMARY INPUTS TO THE SHARE OF FIXED FACTORS IN TOTAL PRIMARY INPUTS, COMPUTED FROM THE 1968-69 AND 1977-78 ORANI 78 DATA BASES

ORANI industry	The ratio of variable to fixed factors(a)	
	1968-69	1977-78
Pastoral Zone	0.4817	2.7793
Wheat-Sheep zone	0.3589	2.3322
High Rainfall Zone	0.6644	2.7327
Northern Beef	0.4153	1.6028
Milk Cattle and Pigs	0.4200	1.5927
Other Farming (Export)	0.7612	1.2205
Other Farming (Import Competing)	0.4287	1.2198
Poultry	1.2205	1.5654

(a) Fixed factors here are defined to include only Land and Fixed Capital. As elsewhere in this paper, Owner Operators' labour has been treated as a variable factor.

Source: 1968-69 and 1977-78 ORANI 78 Data Bases.

Table 4.3: THE SHARE OF PRIMARY INPUTS IN THE TOTAL INPUTS TO CURRENT PRODUCTION OF INDUSTRY j, COMPUTED FROM THE 1968-69 AND 1977-78 ORANI 78 DATA BASES

ORANI 78 industry	Shares of primary inputs in total costs ($S_p(j)$)	
	1968-69	1977-78
Pastoral Zone	0.562	0.543
Wheat-Sheep Zone	0.641	0.543
High Rainfall Zone	0.566	0.539
Northern Beef	0.664	0.433
Milk Cattle and Pigs	0.608	0.474
Other Farming (Export)	0.587	0.601
Other Farming (Import Competing)	0.587(a)	0.601(a)
Poultry	0.219	0.324

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

Source: 1968-69 and 1977-78 ORANI 78 Data Bases.

Table 4.1: TRANSFORMATION AND EXPANSION COMPONENTS OF SELECTED OWN AND CROSS PRICE ELASTICITIES OF SUPPLY IN ORANI AS IMPLIED BY THE 1968-69 AND 1977-78 ORANI 78 DATA BASES(a)

Response in the planned output of commodity i		Commodity t whose expected price changes									
		1968-69 data base					1977-78 data base				
		Wool	Sheep	Wheat	Meat cattle	Milk cattle and pigs	Wool	Sheep	Wheat	Meat cattle	Milk cattle and pigs
Wool	T	0.1557	0.0004	-0.1055	-0.0141	-0.0108	0.1603	0.0002	-0.0848	-0.0197	-0.0060
	E	0.1695	0.0467	0.0630	0.0681	0.0150	0.7894	0.3145	0.3550	0.5112	0.0352
Sheep	T	0.0015	0.1572	-0.0987	-0.0137	-0.0150	0.0005	0.1565	-0.0717	-0.0191	-0.0074
	E	0.1583	0.0450	0.0706	0.0652	0.0152	0.7530	0.3145	0.3590	0.5004	0.0384
Wheat	T	-0.1308	-0.0361	0.4838	-0.1307	-0.0525	-0.1229	-0.0434	0.7476	-0.2324	-0.0441
	E	0.0816	0.0269	0.1139	0.0405	0.0116	0.5426	0.2286	0.6238	0.3100	0.0415
Meat cattle	T	-0.0200	-0.0058	-0.1494	0.2697	-0.0289	-0.0190	-0.0077	-0.1551	0.3192	-0.0126
	E	0.0965	0.0273	0.0304	0.1355	0.0697	0.4943	0.2021	0.1842	0.8576	0.1851
Milk cattle and pigs	T	-0.0174	-0.0071	-0.0681	-0.0329	0.0418	-0.0088	-0.0045	-0.0442	-0.0189	0.0107
	E	0.0243	0.0073	0.0077	0.0800	0.2253	0.0517	0.0236	0.0171	0.2794	1.2880

(a) Reading across each row, the first number in each column refers to the transformation component of the elasticity of the commodity identified by that row with respect to the price of the commodity identified by that column. The second number in the column is the corresponding expansion component.

Table 4.2: THE SHARE OF COMMODITY i IN THE TOTAL PRODUCTION OF EACH ZONAL MULTI-PRODUCT INDUSTRY, COMPUTED FROM THE 1968-69 AND 1977-78 ORANI 78 DATA BASES

ORANI industry	Data base	The share in total industry production of commodity									
		Wool	Sheep	Wheat	Barley	Other grains	Meat cattle	Milk cattle and pigs	Other farming (export)	Other farming (import competing)	Poultry
Pastoral Zone	1968-69	0.6177	0.1268	0.0957	0.0008	0.0055	0.1369	0.0000	0.0000	0.0166	0.0000
	1977-78	0.4591	0.1221	0.1279	0.0077	0.0325	0.2445	0.0000	0.0062	0.0000	0.0000
Wheat-Sheep Zone	1968-69	0.2514	0.0883	0.4432	0.0330	0.0457	0.0882	0.0296	0.0099	0.0107	0.0000
	1977-78	0.2232	0.1016	0.3132	0.0793	0.0982	0.1283	0.0213	0.0127	0.0222	0.0000
High Rainfall Zone	1968-69	0.4627	0.1311	0.0314	0.0121	0.0230	0.2292	0.0553	0.0552	0.0000	0.0000
	1977-78	0.3779	0.1729	0.0085	0.0133	0.0525	0.2936	0.0172	0.0046	0.0595	0.0000

Source: 1968-69 and 1977-78 ORANI 78 Data Bases.

To explain the volatile behaviour of expansion components to changes in the data base, we refer to a revised form of equation (3.3) which omits the term $S_t^M(j)(1/S_p(j)-1)$ on the basis that, regardless of which data base is employed, $S_t^M(j)$ is very close to zero for all t, i.e., we replace (3.3) by the approximation:

$$(4.1)\quad \eta_{it}^E \quad \sum_{j=1}^{8} S_j(i) \quad [\sigma S_v(j)/S_f(j)({}^tR(j)\,{}^tH(j)/S_p(j))] \qquad (i,t=1,\ldots,10).$$

In the ORANI parameter file, σ is set at 0.5 for all industries(c), and as previously pointed out, the production shares $S_j(i)$, ${}^tR(j)$ and ${}^tH(j)$ are relatively invariant to changes in the Input-Output data file. The primary factor share $S_p(j)$, with the exception of the Northern Beef and Milk Cattle and Pigs industries, also exhibits little variation across data bases (see Table 4.3). Clearly then, the significant element in the sensitivity of η_{it}^E is the fluctuation in the ratio of the share of variable factors to the share of fixed factors; i.e., in $S_v(j)/S_f(j)$, the volatility of which is demonstrated in Table 4.4. This ratio for any j varies inversely with the Gross Operating Surplus (hereafter GOS) of the industry (see Adams and Higgs (1983)). GOS is the excess of output of the industry over costs incurred in producing that output, but before deducting depreciation provisions, dividends, interest, royalties and land rent payments and direct taxes payable (see ABS (1981), p. 192). It represents a measure of the sum of returns to owners of land, fixed capital and working capital employed in the industry, and the return to the Owner-Operator for entrepreneurial input. It therefore follows from equation (4.1) that η_{it}^E for all i and t will be inversely related to the

(c) The choice of 0.5 was based on a survey and review of the empirical literature by Caddy (1976). Caddy concluded that 'there is little agreement as to the 'true' value of the elasticity of substitution' (Caddy (1976), p. 24), and DPSV, p. 189 state - 'The most that can be said is that time-series studies, at the industry level, have tended to produce estimates centring around 0.5, while cross-sectional estimates have centred around 1.0'.