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Comparisons of Recent Estimates of Agricultural Supply Elasticities for the Australian Economy

by

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The Impact Project is a cooperative venture between the Australian Federal Government and the University of Melbourne, La Trobe University, and the Australian National University. By researching the structure of the Australian economy the Project is building a policy information system to assis others to carry out independent analysis. The Project is convened by the Industries Assistance Commission on behalf of the participating Commonwealth agencies (the Industries Assistance Commission, the Australian Bureau of Agricultural and Resource Economics, the Bureau of Industry Economics, the Department of Employment, Education and Training, the Bureau of Immigration Research and the Department of the Arts, Sport, the Environment, Tourism and Territories).

Watts, G. and Quiggin, J. (1984), 'A Note on the Use of a Logarithmic Time Trend', *Review of Marketing and Agricultural Economics* 52(2), 91-9.

Wicks, J.A. and Dillon, J.L. (1978), 'APMAA Estimates of Supply Elasticities for Australian Wool, Beef and Wheat', *Review of Marketing and Agricultural Economics* 46(1), 48-57.

Abstract

The supply behaviour of the agricultural exporting industries is a crucial element in making judgements 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. The purpose of this paper is to compare recent efforts to quantify the supply response of agricultural industries in the Australian economy. Our attention is particularly focused upon estimates of short-run elasticities of agricultural commodity supply. Included in this survey is recent work by Adams (1988), Dewbre, Shaw, Corra and Harris (1985), Fisher and Munro (1983), McKay, Lawrence and Vlastuin (1983), and Wicks and Dillon (1978). Possible reasons for differences among these estimates are discussed. Finally, some areas for future research are identified.

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distinguishing feature of the supply system in EMABA is its explicit treatment of livestock inventory dynamics. Such an approach might be regarded as preferable to the alternative treatment, adopted in ORANI and by MLV, which accommodates inventory changes by defining livestock output variables to represent output whether actually sold or in the form of a change in inventories. However, past empirical efforts to model the complex dynamics of livestock inventory changes have suffered from serious statistical problems.[6] Can EMABA track inventory dynamics without such problems? If so, can this feature be incorporated into a more tightly constrained supply system, like that of ORANI?

6 Some of the statistical problems that have arisen are discussed in Rucker, Burt and La France (1984).

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unconstrained by such restrictions. They rely instead on sample data to provide enough information for determining which explanatory variables to use out of a larger set of variables which economic logic suggests should by important. Differences in data, another possible reason for disparity among 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.

3. *Areas of Future Research*

From Section 2 several areas of future research can be identified. Firstly, the supply response systems in EMABA, ORANI and MLV's model 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, at the time of writing this paper, the BAE is gradually reducing the size of its survey samples. Does this represent a threat to the maintenance of the current Australia-wide agricultural 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 FM and WD? 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 output' (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, then their usefullness as tools for policy analysis is somewhat limited. Finally, a

Table 2.2: COMPARISON OF THE PRINCIPAL FEATURES OF SUPPLY STUDIES[(a)]

	Adams	FM	MLV	WD	DSCH
Level of aggregation					
Unit (agents)	Zone (3 industries)	Region (3 representative farms)	All agriculture (1 producer)	Locality (521 representative farms)	Enterprise (4 industries)
Commodities (unit)	3, 6 or 4 (composite commodity)	4 (single commodity)	3 (composite commodity)	3 (single commodity)	3, 6, 1 or 1 (single 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 (quadratic in prices)	linear supply functions for 4 enterprises
Data	'typical' Input/ Output data for 1977-78 plus BAE survey data	FM'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
Econometric Approach	FIML	OLS	Restricted GLS	OLS on synthetic data from 521 LPs	OLS
Adjustment period allowed	about 2 years	about 3 years	about 1 year	n.a.	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.
n.a. not available.

Comparisons of Recent Estimates of Agricultural Supply Elasticities for the Australian Economy

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Philip D. Adams*

1. *Introduction*

The supply behaviour of the agricultural exporting industries is a crucial element in making judgements 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. The purpose of this paper is to compare recent efforts to quantify the supply response of agricultural industries in the Australian economy. Our attention is particularly focused upon estimates of short-run elasticities of agricultural commodity supply.

The plan for the remainder of this paper is as follows. In Section 2, elasticity estimates derived in Adams (1988) (hereinafter, just Adams), Dewbre, Shaw, Corra and Harris (1985) (DSCH), Fisher and Munro (1983) (FM), McKay, Lawrence and Vlastuin (1983) (MLV), and Wicks and Dillon (1978) (WD), are compared. Possible reasons for differences are then discussed. In Section 3, some areas for future research are identified.

* Impact Project Research Centre, University of Melbourne. The author wishes to thank Alan A. Powell for many helpful comments.

2. *Comparisons*

Estimates of short-run elasticities of agricultural commodity supply derived in Adams, DSCH, FM, MLV and WD are compared in Table 2.1 for the three most important agricultural commodities in Australia; namely, wool, wheat and meat cattle. Upon inspection of Table 2.1, significant discrepencies 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 Adams are based on the multi-level industry production system developed for the ORANI model of the Australian economy.[1] The principal agricultural industries in this model produce multiple products using a technology which assumes strong separability between input and output decisions. Inputs are regarded as non-specific to outputs. Each supply response equation is a solution to a revenue maximization problem subject to a CRETH (constant ratios of elasticities of transformation, homothetic) function with given prices for inputs and outputs, a given (scalar) capacity for production, and with land and capital treated as fixed. On the input side, each firm

1 A full description of the ORANI computable general equilibrium model is provided in Dixon, Parmenter, Sutton and Vincent (1982).

in EMABA consists of equations for eleven commodities (six crop and five livestock).[5] The livestock supply system contains a set of loosely constrained behavioural equations explaining slaughterings, retentions, deaths and yields; and 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 total area of land to land devoted to crops and to land devoted to 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 in OLS using annual data from Australian Bureau of Statistics and BAE surveys. The time profile for the short-run elasticities reported in Table 2.1 is 'unambiguously time dimensioned' as the response after 5 years.

The salient features of each author's approach are contrasted in Table 2.2. The major causes of disparity appear to be differences in the level of disaggregation and in the specification of the production system. The supply systems of EMABA and ORANI employ relatively fine commodity specifications compared to those used in MLV, WD and FM. The production systems employed by Adams, MLV and (to a somewhat lesser extent) WD make extensive use of *a priori* theoretical information. These systems rely on cross parameter constraints which force certain homogeneity and symmetry restrictions upon their parameters. By contrast, the production systems used by FM and DSCH are relatively

5 There is a twelth commodity called 'live sheep exports'. However, in the present version of the model, live sheep exports are treated as exogenous.

'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. 33).

The approach taken by WD to estimate their supply elasticities differs markedly from that taken by all other authors cited. Use is made of a simplified version of the finely disaggregated APMAA model.[4] This model consists of a system of 521 linear programs, each embodying data for a firm representing a given location. The simplified APMAA model is 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 are then used to estimate (by ordinary least squares) a quadratic supply function which provides the information necessary to calculate the elasticity estimates. A time dimension for these elasticities is not available.

The elasticity estimates reported in DSCH come from the Econometric Model of Australian Broadacre Agriculture (hereinafter EMABA). EMABA has been developed within the BAE to depict the determination of demand, supply and prices in the cattle, sheep and crops industries. A unique feature of the model is its separation of livestock output response from changes in livestock inventories. In the view of the authors this is essential for modelling price determination in those industries and allows meaningful interpretation of the model's output projections. The supply system

4 APMAA is an acronym for Aggregate Programming Model of Australian Agriculture. An overview of the APMAA model is given in Walker and Dillon (1976).

Table 2.1: ALTERNATIVE ESTIMATES OF SHORT-RUN OWN AND CROSS PRICE ELASTICITIES OF AGRICULTURAL COMMODITY SUPPLY[(a)]

Responses in the output of	Study	Product whose expected price changes		
		Wool	Wheat	Meat cattle
Wool	Adams (1988)	0.4591	-0.0068	0.0937
	Fisher and Munro (1983)			
	Southern Tablelands	0.26		
	South-West Slopes	0.28		
	Western Division	0.52		-0.99
	McKay, Lawrence and Vlastuin[(b)] (1983)	0.72	0.15	0.08
	Wicks and Dillon (1978)	0.25	-0.20	-0.18
	Dewbre, Shaw, Corra and Harris (1985)	0.39	0.16	-0.12
Wheat	Adams (1988)	0.0195	0.7408	-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
	Dewbre, Shaw, Corra and Harris (1985)	0.33	0.92	0.14
Meat cattle	Adams (1988)	0.1760	-0.1159	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
	Dewbre, Shaw, Corra and Harris (1985)	-0.14		0.34

(a) The source for some of the estimates attributed to Dewbre, Shaw, Corra and Harris (1985) was personal communication with the authors. 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 sheep and wool, 'crops', and cattle and 'other', respectively.
(c) The elasticity of 'crops' with respect to the price of sheep and wool, 'crops', and cattle and 'other', respectively.
(d) The elasticity of cattle and 'other' with respect to the price of sheep and wool, 'crops', and cattle and 'other', respectively.

chooses its mix of primary factors and material inputs to minimize costs subject to a nesting of production functions embodying both fixed coefficient (Leontief) and CES (constant elasticity of substitution) technologies. Again, all prices and the capacity for production are treated as exogenous, and land and capital are assumed to be fixed. Data employed to estimate this system consist of Input/Output data which reflect an agricultural sector in a recent 'typical year', and values for CRETH and CES parameters that are 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 total expected change in a commodity's output resulting from a change in expected prices. Within the ORANI model, complete adjustment is estimated to have taken place no later than 2 years after the initial change in expected prices.[2]

Compared with the elasticities derived by Adams, those estimated by FM are based on a rather loosely specified production function. FM regress cross sectional data for intended sheep numbers, intended cattle numbers, intended breeding ewe numbers and intended wheat plantings for each of three regions in New South Wales, on corresponding data for current output, data for the expected prices of the commodities produced in the region concerned, and data for a variable measuring the proportion of improved pasture in that region. The current output of the commodity, whose expected numbers/plantings is to be explained, is

2 The time dimensioning of 2 years for each elasticity is an estimate based upon the work of Cooper (1983) and Cooper, McLaren and Powell (1985). Two years is the calendar time calculated to be the 'short-run' in a typical ORANI short-run simulation.

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 are 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, 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' (FM, p. 2). The time profile of each elasticity is approximately 3 years.

The elasticities derived by MLV are based on a more tightly constrained theoretical framework than those of FM. MLV's approach appeals to the theory of duality (see Blackorby, Primont and Russell (1979)) and employs a variable profit function with a transcendental logarithmic specification. Thus, unlike the ORANI production system, a particular functional form for the firm's production function is never postulated. MLV claim that their system is not limited by the ORANI restriction of input-output separability (i.e., in the MLV system, inputs can be regarded as specific to outputs). All commodities are defined on a composite rather than individual basis and time is used as a proxy for technology.[3] The system is 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

3 The use by MLV of a logarithmic time trend as a proxy variable for changes in technology is criticised in Watts and Quiggin (1984). Watts and Quiggin point out that the parameter estimates of MLV's system (and other similar systems) are extremely sensitive to the essentially arbitrary choice of starting date for the time trend.