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SUPPLY RESPONSE IN THE AUSTRALIAN EXTENSIVE LIVESTOCK AND CROPPING INDUSTRIES: A STUDY OF INTENTIONS AND EXPECTATIONS*

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Most of the supply elasticity estimates reported for Australian agriculture are derived from equations estimated using time series data and incorporating *ad hoc* assumptions about price expectations. The authors' aim is to compare previously obtained supply elasticity estimates with those derived using theoretically more acceptable survey data on both producers' intentions and price expectations. Surveys were conducted in three regions in N.S.W., namely, the Southern Tablelands, the South-West Slopes and a portion of the Western Division centred on Cobar. The results of the research show that there are no major differences between the supply elasticities derived using the traditional time series approach and those obtained using the survey data. This finding is reassuring, given the cost of collecting survey data.

Introduction

Most of the research conducted on agricultural supply response in Australia to date has relied on the use of secondary time series data. This approach has necessitated the use of some assumptions about the way in which expectations are formed and the relationship between actual responses and intentions. In many instances researchers have employed a specification which contained a lagged value of the dependent variable as an explanatory variable (Duloy and Watson 1964; Anderson 1974; Sanderson, Quilkey and Freebairn 1980). This specification is often justified on the basis of the adaptive expectations hypothesis. In addition to the problems associated with the specification of price expectations variables when using secondary time series data, there are likely to be difficulties encountered in the selection of an appropriate response variable. In most cases it is necessary to use actual outcomes rather than intentions to represent supply response because intentions data are collected for relatively few agricultural products.

Given the dearth of expectations data collected on a regular basis for Australian agricultural products, it is important to know how the results from traditional supply response models based on secondary time series data compare with those from models estimated using theoretically more acceptable data. The aim in the present paper is to estimate supply response models for a number of major agricultural products using

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survey data on growers' intentions and price expectations and to compare the elasticity estimates with those obtained in previous studies. The main emphasis is on making qualitative comparisons of elasticity estimates. To this end, the supply response models presented are very similar in specification to those traditionally used.

In order to collect anticipations data, surveys were conducted in three regions of N.S.W., namely, the Southern Tablelands, the South-West Slopes and a portion of the Western Division centred on Cobar. These regions correspond to the BAE's High Rainfall, Wheat-Sheep and Pastoral Zones, respectively. Data on supply intentions, price expectations and farm structure were collected from wool growers and used to estimate a set of direct- and cross-price elasticities for the various products in each region.

The Survey of Wool Growers

Farming in the three regions surveyed is representative of the production systems available to the majority of Australian wool growers. On the Southern Tablelands, sheep grazing is generally carried out in association with beef cattle and fat lamb production and, to a lesser degree, cropping. A large proportion of properties on the South-West Slopes produce wool in combination with cereals (mainly wheat), fat lambs and beef. In the Western Division, the only economic alternative to wool is beef production.

The survey population was defined as graziers with properties carrying 200 or more merino sheep as at 31 March 1978. The Commonwealth Register of Electors was used as the sampling frame. Although the register lists have a number of deficiencies, they constituted the most complete population listing that was available at the time. The major problem was that it was not possible to distinguish woolgrowers from other primary producers without first contacting each individual.

A random sampling technique was used to select the samples drawn in each region. It was possible to stratify according to geographic zones but unfortunately it was not possible to stratify the samples on the basis of sheep numbers on individual properties. In the cases of the Southern Tablelands and the South-West Slopes, samples of size 65 were drawn. These represented approximately five per cent of properties in these areas which carry 200 or more merino sheep. The final sample size of 35 for the Pastoral Zone represented approximately 11 per cent of properties in the region carrying 200 or more merino sheep. During the interviews, which were conducted in late 1978 and 1979, usable data were obtained from 62 growers on the Southern Tablelands, 61 growers on the South-West Slopes and 32 from the Western Division.

As a major part of the survey, data were collected on desired output and on the longer-term price expectations for each commodity produced by individual growers. The time horizon defined as longer-term was three years. The period of three years was chosen because growers interviewed during the pilot survey (conducted in an area around Coonabarabran in North-Western N.S.W.) claimed that such a period corresponded to the time taken to make major changes in enterprise combinations. During the collection of price expectations and output intentions data, care was taken to stress the difference between wishes and expectations. Growers were asked directly for their expectations once the interviewer felt that the concept was fully understood. The questions on intentions were asked toward the end of a long interview during which information was obtained on the physical and financial characteristics of the farm and the grower's sources of management data.[1]

Data on supply response were collected for wool, beef, fat lambs and wheat. The following response variables were chosen: for wool, the number of sheep the grower intended to shear[2]; for beef, the number of beef cattle the grower intended to run; for fat lamb production, the intended mating of ewes, either crossbred or merino, to British breed rams; and for wheat, the area that producers intended to sow.

As mentioned previously, expected prices were collected from each grower for the commodities produced on the farm. The expected prices of wool were expressed in cents per kilogram of greasy wool. Beef and lamb prices were expressed on a per head basis because the majority of producers made forecasts in these terms rather than in terms of cents per kilogram. Because of the operation of the wheat price stabilisation scheme, the wheat price variable relevant to production decisions was difficult to identify. Although the BAE (1978, p. 3) has claimed that the first advance was the only price variable that had a significant effect on wheat supply response in the past, both Anderson (1974, p. 122) and Duloy and Watson (1964, p. 35) have pointed out that the first advance was not the appropriate value to use because it did not reflect the average return to growers for a particular crop.[3] The measure considered to be more appropriate was the total payment (per tonne) to growers. Both Fisher (1975) and Sanderson, Quilkey and Freebairn (1980) have used this measure of wheat price successfully in supply response analyses.

Technological change, as represented by an improved pastures variable, was regarded as important in production decisions. Freebairn (1973), Malecky (1975) and others have found it to be a significant explanatory variable in livestock response studies. The variable was specified as the area of improved pasture currently available as a percentage of the total property area. In addition to the above, data were collected on the actual values of the response variables at the time the intentions were formed.

The samples drawn appear to be representative of the populations. The average farm size of sample properties in each region was in close agreement with the respective average for the survey population as shown in Table 1. The distributions of flock sizes in each sample and survey population were compared using a Kolmogorov test (Conover 1971, pp. 295-8). The population data were those published by the ABS (1979). The results of the Kolmogorov tests indicated that the sample and population distributions did not differ significantly in the sample period, 1978-79.

[1] A detailed outline of the survey method, the questionnaire used and the data obtained can be found in Munro and Fisher (1982) and Fisher and Munro (forthcoming).

[2] The variable 'intended sheep numbers' was used to represent wool supply response rather than intended output because of the difficulty of accounting for the expected effect of changes in seasonal conditions on average fleece weights.

[3] The survey was conducted during the period of operation of the sixth wheat price stabilisation scheme. During that scheme and its predecessors a first advance payment was made to wheat growers immediately after delivery of the crop. In the 1978-79 season the first advance represented approximately 60 per cent of the final realisation.

TABLE 1

Average Property Sizes Observed in the Sample and Population of Wool Growers by Region[a]

Region	Average size of property in sample	Average size of property in survey population
	ha	ha
Southern Tablelands	637	598
South-West Slopes	874	744
Western Division (Cobar area)	22 009	19 705

[a] The data on average farm sizes in the survey population were taken from ABS (1979).

The Supply Response Model

In the past it has been common to incorporate dynamic elements in supply response models in one of two ways. First, they have been included by means of an adjustment process based on the initial assumption that there is a difference between the long-run equilibrium supply toward which producers are assumed to be moving and their current position. The second way is through some description of how expectations are formed. In an effort to make some meaningful comparisons between the elasticity estimates obtained using traditional models based on time series data and those obtained using cross-sectional data, including information on intentions, the basic model chosen for use in the present research contains a variable representing current output as an explanator. Because the effect of price expectations has been included explicitly, and because the dependent variable in each equation is intended output in three years time, the current output variable can be interpreted as representing a partial adjustment process.

On any given area of land, sheep numbers can be expanded by substituting sheep for existing enterprises or by increasing the stocking rate. The potential for adjustment is determined by the overall grazing capacity and the relative and absolute profitability of alternative enterprises. On the Southern Tablelands the most important influences on intended wool supply were considered to be expected prices of wool, fat lambs and beef, and the proportion of improved pastures on the property. Beef and fat lamb supply responses for the Southern Tablelands were defined as functions of expected prices for wool, beef and fat lambs, current proportion of improved pastures and current values of the response variables.

Supply response equations were estimated for wool, fat lambs, beef and wheat for the South-West Slopes. Exogenous variables included the expected prices for wool, lamb, beef and wheat, an improved pasture variable and current values of the response variables. In the Western Division the main influences on intended wool production were thought to be the expected prices of wool and beef, together with current sheep numbers. Technological change in the form of pasture improvement was not considered relevant. Similarly, desired beef output was specified as a function of the expected prices of wool and beef, and current cattle numbers on growers' properties.

The Estimated Regional Models

The Southern Tablelands (High Rainfall Zone)

The ordinary least squares estimates of the coefficients in the supply response equations are presented in Table 2.[4] The expected price of wool was significant in determining intended sheep numbers in this region.[5] The results show that an increase in the expected price of fat lambs resulted in an increase in intended merino numbers. The only explanation for this finding is that producers respond to an increase in expected fat lamb prices accompanied by an expected increase in wool prices by diverting resources into increasing merino ewe numbers. The majority of fat lamb enterprises in this region were based on the sale of first-cross lambs, that is, the sale of progeny from a cross between merino ewes and a British breed ram. When the merino ewe has a dual role of producing wool and a first-cross lamb, prime lamb production is a joint rather than a competitive activity with wool production.

The significant determinants of the decision on intended cattle numbers were current cattle numbers and the proportion of improved pasture. Cattle were often run on the poorer sections of properties in this region. A number of wool growers claimed that they ran cattle to 'keep the rubbish down'. This may account for the negative sign on the improved pasture variable and also for the statistical insignificance of the expected price variables. Many producers indicated that they had decided to reduce the size of their cattle herd to a nucleus of about 20 to 30 cows after the beef price decline in 1974-75.

The expected price of lamb was not found to be an important determinant of producers' decisions to change the number of ewes joined to British breed rams for the purposes of fat lamb production. However, the expected price of wool was significant in this decision, as well as the proportion of improved pasture and current breeding ewe numbers.

Elasticity estimates obtained in the majority of other studies have been derived from equations in which expected price and derived output have been represented by proxy variables. That is, unlike the present study, they have been based on historical data depicting what occurred rather than on actual expectations. An own-price elasticity of supply response of 0.26 for wool as shown in Table 3 compared favourably with the estimates from other regional supply response studies. The APMAA model estimate of the own-price elasticity for wool was 0.32 for the High Rainfall Zone (Wicks and Dillon 1978, pp. 53-5). Freebairn (1973, p. 72), in an econometric model of the N.S.W. livestock sector, obtained a value of 0.37.

The South-West Slopes (Wheat-Sheep Zone)

The estimated supply response equations for the South-West Slopes are reported in Table 4. As was the case for the Southern Tablelands, the expected prices of wool and fat lambs were the only price variables of

[4] In all cases the prices were included in the equations directly and as ratios. The results for equations containing the price ratios were unacceptable and are not reported here. For an explanation of such results, see Chavas (1982).

[5] A coefficient with a t-statistic greater than unity in absolute value was taken to be statistically different from zero. This corresponds approximately to an eighty-five per cent level of confidence.

TABLE 2

Estimated Supply Response Equations for the Southern Tablelands[a]

Regressor	Dependent variable		
	Intended sheep numbers	Intended cattle numbers	Intended breeding ewe numbers
Constant	−1197.20 (−1.38)	1069.05 (0.99)	−515.15 (−1.21)
Current sheep numbers	1.03 (34.57)		
Current cattle numbers		0.82 (16.78)	
Current breeding ewe numbers			1.03 (23.07)
Expected wool price	5.16 (1.76)	−2.24 (−0.61)	1.95 (1.36)
Expected beef price	−0.62 (−0.33)	1.66 (0.67)	0.07 (0.08)
Expected fat lamb price	34.02 (1.24)	−25.20 (−0.74)	3.69 (0.27)
Proportion improved pasture	−281.95 (−0.96)	−476.99 (−1.35)	207.73 (1.45)
$\bar{R}^2$	0.97	0.90	0.94
F	255.84	65.40	199.72

[a] The numbers in parentheses are *t*-statistics.

TABLE 3

Estimated Own- and Cross-Price Elasticities for the Southern Tablelands

Intended response in the output of:	Expected price		
	Wool	Beef	Lamb
Wool	0.26	–	0.15
Beef	–	–	–
Lamb	0.44	–	–

significance in producers' decisions regarding intended sheep numbers. The coefficients on the expected price variables for beef and wheat were not statistically different from zero.

In the estimated equation for intended cattle numbers all of the coefficients on the price variables had the correct signs. However, the coefficient on the expected price of wheat was not significant. Thus, on the South-West Slopes, a decision maker's intention to increase cattle numbers was influenced by the expected price of beef, lamb and wool, by current cattle numbers and by the proportion of improved pasture on the

TABLE 4

Estimated Supply Response Equations for the South-West Slopes[a]

Regressor	Dependent variable			
	Intended sheep numbers	Indended cattle numbers	Intended breeding ewe numbers	Intended wheat plantings
Constant	-2719.77 (-1.67)	1146.96 (0.65)	-701.22 (-0.43)	-999.23 (-2.05)
Current sheep numbers	0.99 (52.45)			
Current cattle numbers		0.71 (12.86)		
Current breeding ewe numbers			1.07 (11.92)	
Current wheat plantings				1.10 (9.02)
Expected wool price	6.83 (1.47)	-7.83 (-1.55)	2.89 (0.61)	-1.15 (-0.84)
Expected beef price	-0.04 (-0.02)	5.29 (2.89)	-0.78 (-0.48)	-0.30 (-0.63)
Expected fat lamb price	39.81 (1.26)	-118.81 (-3.12)	34.89 (1.10)	-1.98 (-0.21)
Expected wheat price	-8.47 (-0.51)	-1.46 (-0.08)	-5.15 (-0.31)	7.64 (1.55)
Proportion improved pasture	390.78 (0.45)	-1678.37 (-2.06)	566.39 (0.82)	31.22 (0.15)
$\bar{R}^2$	0.99	0.95	0.89	0.85
F	522.13	60.62	27.27	19.46

[a] The numbers in parentheses are *t*-statistics.

property. The unexpected negative sign on the pasture variable may be explained by similar reasoning to that presented in the case of the cattle supply response equation for the Southern Tablelands.

The only price variable which was significant in determining the desired number of fat lamb breeding ewes was the expected price of fat lambs. The correlation coefficients between expected price of fat lambs and the other price variables were statistically significant. The size of the estimated standard error for the coefficient on the lamb price variable was reduced markedly when the other price variables were dropped and the equation re-estimated.

Wheat supply response on the sample farms on the South-West Slopes was determined principally by the expected price of wheat and by the current area under wheat. The coefficients on the remaining price variables and the proportion of improved pasture were not statistically significant. Fisher (1975), in estimating regional wheat supply response equations, obtained a similar result for the South-West Slopes and Riverina regions.

The supply elasticity estimates shown in Table 5 compare reasonably well with other estimates reported in the literature. Own-price elasticities derived from the Vincent, Dixon and Powell (1980) CRETH model were reported as 0.26 for wool, 0.48 for beef and 0.77 for wheat. The APMAA short-to-intermediate-run estimates were 0.17 for wool, 0.46 for beef and 1.31 for wheat (Wicks and Dillon 1978). Powell and Gruen (1967, pp. 78-9) estimated a five-year Australia wide supply elasticity for wool of 0.33. Both beef and wheat price elasticities given in Table 5 are somewhat higher than estimates from previous studies. However, it should be noted that the CRETH estimates and the Powell and Gruen (1967) estimate of 0.16 for beef were short-run elasticities. Powell and Gruen did not estimate a long-run beef supply elasticity. An estimate of the own-price elasticity for wheat similar to that reported in Table 5 was obtained by Fisher (1975).

Significant cross-elasticity effects were apparent in the estimates for the South-West Slopes. They indicated competitive relationships; for example, between beef and wool and between beef and fat lambs. In the case of wool and fat lambs, a joint relationship similar to that reported for the Southern Tablelands was apparent. Freebairn (1973), in his study of the N.S.W. livestock sector, also found significant cross-price elasticities between beef and wool, and between beef and lamb, although his estimates were somewhat lower than those reported in Table 5.

The Western Division (Pastoral Zone)

The estimated supply response equations for the Western Division are presented in Table 6. The regression coefficients all exhibited the expected signs. The expected price of wool was significant in determining both intended sheep and cattle numbers. The statistical significance of the coefficients on the current numbers variables in the equations indicated that there was a substantial lag in adjustment towards intended output in both cases. In the Western Division, because the viable enterprises open to the producer were limited to wool and beef production, capital requirements for livestock production were regarded as permanent and necessary fixtures on the properties. Thus, the costs of adjustment were not so much associated with these capital requirements as with the producers' perception of costs related to selling stock which were 'not ready' for market. For example, many producers in this region (as in other regions) had built up cattle numbers in the early 1970s in response to high and expected continuing high beef prices. However, with the beef

TABLE 5

Estimated Own- and Cross-Price Elasticities for the South-West Slopes

Intended response in the output of:	Expected price			
	Wool	Beef	Lamb	Wheat
Wool	0.28	—	0.17	—
Beef	−0.83	0.70	−1.35	—
Lamb	—	—	0.49	—
Wheat	—	—	—	2.05

market collapse in 1973-74 and the firming of wool prices, many producers decided to reduce cattle numbers relative to sheep numbers. When interviewed in mid-1979, a high proportion of producers indicated that it was only in 1978 and 1979 that they had been able to begin to reduce their cattle herd substantially. Previous to this, the stock had been considered not 'finished off' enough for market. The producers were not prepared to sell 'unfinished' stock in order to adjust more rapidly despite the loss in revenue which may have resulted from this lag in adjustment. Decision making behaviour of this type stems from psychological inertia on the part of the producer brought about, among other things, by the lack of flexibility in enterprise combination allowed by the grazing environment in the Western Division, by the lack of control over the environment that can be exercised by the producer, and by the effect that actual weather conditions have on eventual output response.

Given the importance of these modifying factors on response in the Western Division, the price elasticities of supply recorded in Table 7 appear slightly high. The probable explanation lies in the period in time at which the data were collected. The direct observations on current and expected values of variables were obtained in mid-1979, a time when production was in a state of flux on many of the properties in the Western Division. As pointed out previously, producers were at a stage of increasing their sheep numbers having reduced cattle numbers considerably. Data collected during this period would have reflected this state of transition and could have resulted in the high elasticity estimates recorded. Despite this, the estimate of the supply response elasticity for wool obtained in the present study is similar to that obtained in previous work. Malecky's (1975) estimate of the price elasticity of supply for wool corresponding to an intermediate run of five years was 0.35. The

TABLE 6

Estimated Supply Response Equations for the Western Division[a]

Regressor	Dependent variable	
	Intended sheep numbers	Intended cattle numbers
Constant	−3393.98 (−1.83)	4967.25 (3.40)
Current sheep numbers	0.96 (15.49)	
Current cattle numbers		0.78 (9.31)
Expected wool price	17.91 (2.18)	−23.49 (−3.49)
Expected beef price	−5.20 (−1.31)	4.18 (1.31)
$\bar{R}^2$	0.92	0.89
F	80.97	29.35

[a] The numbers in parentheses are t-statistics.

TABLE 7

Estimated Own- and Cross-Price Elasticities for the Western Division

Intended response in the output of:	Expected price	
	Wool	Beef
Wool	0.52	−0.99
Beef	−1.27	0.40

intermediate run own-price elasticity for wool derived from the APMAA model (Wicks and Dillon 1978, pp. 48-57) for the Pastoral Zone was 0.49. This value is close to the estimate reported here (see Table 7). The APMAA model estimate of the elasticity of supply of cattle with respect to wool price was lower than the cross-price elasticity estimate found in the present study.

Concluding Remarks

To summarise the results, the expected price of wool and, to a lesser extent, the expected price of fat lambs, influenced strongly producers' decisions regarding intended merino and breeding ewe numbers. The finding that the prices of beef and wheat were generally unimportant in determining sheep numbers is consistent with the results obtained by Dalton and Lee (1975) and Malecky (1975).

The estimated equations for wheat supply response on the South-West Slopes confirmed the results of a number of previous studies which have found the expected prices of beef, fat lambs and, at times, wool to be unimportant in influencing intended wheat plantings. The important variables determining wheat plantings appeared to be the expected price of wheat and the current level of plantings. The unimportance of the wheat price variable in the alternate product equations suggested that movements in wheat prices do not directly affect livestock production enterprises. A similar conclusion was reached by Reynolds and Gardiner (1980) in their supply study of the Australian sheep industry. They argue that, because of the practice of ley rotation on mixed farms, producers tend to make separate production choices within livestock enterprise combinations and also separate choices within cropping alternatives. That is, they seek to maximise revenue from each of the group of cropping and livestock enterprises separately, in response to changes in individual product prices within each group.

No clear conclusion can be drawn from the cattle supply response regressions, except that, on the South-West Slopes, intended cattle numbers were more responsive to prices of alternatives than in other regions. This response pattern was anticipated. If producers have a number of alternative production possibilities available, then response elasticities with respect to price changes of these products will be higher than when fewer alternatives are available. Own- and cross-price elasticities estimated for the South-West Slopes were higher than those for the Southern Tablelands.

Of major importance is the fact that the elasticity estimates derived in the present study are similar in most cases to those derived using time series data and models which incorporate actual rather than intentions variables. Although some care must be exercised in making generalisations of this nature, it appears that the traditional time series supply response models are fairly robust. This result is important, given the cost of collecting cross-sectional data on intentions and expectations variables and the uncertainty about the validity of the model specifications that have been most often used in the past.

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