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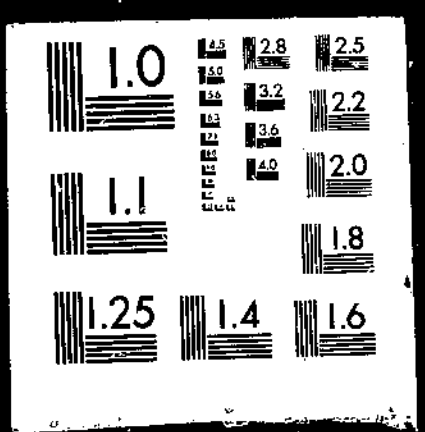

BEEF VERSUS WOOL PRODUCTION IN AUSTRALIA

by Lynn A. Austin

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BEEF VERSUS WOOL PRODUCTION IN AUSTRALIA. By Lynn A. Austin, Foreign Demand and Competition Division, Economic Research Service, Foreign Agricultural Economic Report No. 130.

ABSTRACT

In this study to determine the competitiveness of wool and beef production in Australia, weather and the size of the beef herd were the key variables influencing the number of sheep shorn. Small improvements in the weather produced substantial increases in the number shorn, while relatively large gains in the beef herd had the opposite effect.

The output of beef was positively affected by the beef herd size, as expected. But rising beef prices caused a reduction in production, an effect attributed to herd buildup.

KEYWORDS: Australia, beef, wool, regression analysis, supply function.

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FOREWORD

This study estimates the effects of certain factors on wool and beef production in Australia. It is part of a continuing effort to keep abreast of and understand developments in Australian agriculture.

The analysis involves testing the fit of various lagged beef and wool prices. The best equations are verified by extrapolating beyond the sample data and comparing with actual data.

Results of this study will be useful in understanding and predicting changes in Australian beef and wool output—a topic of interest to U.S. beef and sheep producers, importers, and policymakers.

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CONTENTS

Note: All tonnages in this report are metric.

SUMMARY

In times of relatively high prices, beef cattle producers in Australia have tended to build herds instead of selling their cattle, and thus, may have been forced to sell at times when prices have fallen. High beef prices and large beef herds have resulted in a drop in the number of sheep shorn, although the competition between beef and sheep for pasture is not as strong as has been thought.

These are the results of two econometric models calculated to quantify the effects of certain variables on the number of sheep shorn and the quantity of beef produced in Australia. Least squares regression was used for estimating the parameters. Several time lags were tested for price and herd variables. Proxies for technology and weather were incorporated.

The results also support the hypothesis that the number of sheep shorn is positively responsive to technology, good weather, the size of the sheep herd, and price of wool lagged 1 year.

Technology, the size of the beef herd, and the price of wool lagged 2 years were directly related to beef production, while the price of beef and input prices lagged 3 years were inversely related.

All estimated parameters had "t" values over 1 and the coefficients of determination exceeded 0.95. No significant autocorrelation was found in the residuals. Projections based on both *ex ante* and *ex post* models were made. The accuracy of the *ex ante* models will be highly dependent on the accuracy of forecasts of weather and beef prices.

BEEF VERSUS WOOL PRODUCTION IN AUSTRALIA

By
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INTRODUCTION

This study estimates causal relationships between changes in prices of beef and wool in Australia and subsequent shifts in the level of output of these commodities. Both direct and cross price coefficients are calculated to show the effects of beef and wool price changes on production.

Australia is the seventh largest producer of beef and veal in the world[1] with about 30 million head of beef cattle. Beef production per person is higher than in any other major producing country (and 10 times the world average), and Australia is the world's largest beef exporter. For the period 1970 to 1974, Australia's share of world beef exports was 28 percent. Second place Argentina had 19 percent (*3*).[2]

Australia's pasture-grown beef is shipped to more than 40 countries, but primary markets during 1970/71-1974/75[3] were the United States (62 percent), Japan (12 percent), and the United Kingdom (11 percent) (*3*). Exports to the Middle East increased drastically in 1975.

Australia produces more wool than any other country, accounting for 30 percent of world production during 1971/72-1975/76. The Soviet Union, the second largest producer, accounted for 17 percent during the same period. In 1975/76, Australia produced 791,000 tons of wool (greasy basis). Practically all was exported. The two major importers during 1970/71-1974/75 were Japan (46 percent) and the European Community (43 percent).

From 1960/61 through 1971/72, beef production increased at an average annual rate of 7 percent, and relative prices remained fairly constant.[4] In 1972/73, output jumped 23 percent, partly as the result of a 13-percent increase in relative prices that year. From 1972/73

[1]Hereafter "beef" is used to refer to both beef and veal.
[2]Italicized numbers in parentheses refer to literature listed at the end of this report.
[3]Split years are July-June unless otherwise stated.
[4]Prices of beef relative to the consumer price index (CPI).

through 1975/76, average annual beef production remained 27 percent above the 1971/72 level, despite a 66-percent drop to historic depths in the relative beef price in 1974/75. Little price increase occurred in 1975/76, although production was up an estimated 11 percent.

The wool industry had been faced with declining prices during the 1960/61-1971/72 period. Relative prices[5] hit a low of 57 cents/kg[6] in 1970/71—one-half of the price of the early 1960's. Prices edged up to 61 cents/kg in 1971/72. Production during 1960/61-1971/72 was essentially stagnant, varying little around a mean of 818,000 tons.

LITERATURE REVIEW

The basic concept upon which the analysis rests is the law of supply—more units will be offered for sale at high prices than will be offered at low prices. Simple supply models assume all things are constant except price and quantity. Since this study is a long-term analysis, this assumption is relaxed. Australia's beef and wool industries are assumed to be sufficiently free of barriers to entry to force the long-run industry supply curve to approximate the long-run average cost curve. This implies adjustment in both the size and number of firms in the industry.

The principal factors that determine the quantity of a commodity produced are costs of production, technology, goals of producers, prices of other competing or complementary commodities, and the price of the commodity itself.

It is further assumed that agricultural industries are cost increasing; that is, as production increases, the marginal cost increases because of employment of less productive resources and higher opportunity costs. Consequently, long-term supply curves are expected to have positive slopes.

A 1971 study by the Australian Bureau of Agricultural Economics (BAE) (*1*) to estimate a long-term wool supply function used sheep shorn as the dependent variable. Sheep shorn was employed instead of wool production to avoid the problem of fluctuations in fleece weights in determining supply response. Independent variables were wool prices, wheat prices, and area of improved pasture. The goodness-of-fit for the best equation estimated for the period 1946/47 through 1964/65 was over 98 percent. Price elasticities were estimated as 0.05 in the short run, 0.16 in the intermediate run, and 1.1 in the long run.

The study produced in 1968 by Gruen, *et al.* (*10*) used a simple linear trend to project the number of sheep in Australia for 1970 and 1975. In neither case was the actual number within two standard deviations of the projection. The R^2 was an impressive 0.979.

[5]Price of wool relative to the CPI.

[6]Australian dollars are used throughout. See app. table 1 for exchange rates.

Dalton and Lee (*6*) related the number of sheep shorn in Australia to an expected price of wool in the current period, the consumer price index lagged one period, farm prices paid lagged one period, a price fluctuation index in the current period, and the number of sheep shorn lagged one period. They used an upward biological restraint on animal changes in the number of sheep shorn. An attempt to account for seasonal factors was made. After being unable to find any cross price relationships, they rationalized that woolgrowers were slow to respond to the change in the prices of competitive commodities. The rather complex set of equations was able to estimate sheep shorn relatively well (R^2 was 0.9163).

One of the most rigorous treatments to date of supply in the Australian beef and wool industries was that executed by Freebairn (*9*). He calculated the direct and cross price elasticities for beef, lamb, mutton, and wool, using independent equations and incorporating 10 exogenous variables. His results showed that a rise in the price of beef relative to wool and lamb prices reduced beef production in the current period but the resulting larger herd increased beef output in successive years. Wool production was augmented by higher wool and lamb prices, but higher cull sheep and beef prices reduced wool output.

Another study by the BAE (*2*) used an expected wool price, the price of lamb lagged 1 year, the price of wheat lagged 2 years, and time to estimate Australian wool production. The coefficient of determination (R^2) was 98 percent).

Davidson (*7*) recognized beef price as a relevant variable, but estimated wool production simply by using the price of wool as the predictor. Assuming constant beef prices, he projected Australian wool production and herd sizes for both beef and sheep. An extrapolation from his study puts the 1975 beef herd at 34 million head, which compares with the actual herd of 29 million head. Extrapolated, the 1975 sheep herd would be 92 million, versus 153 million actual. No allowance was made for the possible expansion of both herds.

Easter (*8*) estimated Australian wool production based on the trend in sheep numbers and stated that the "wool price seems to have little statistically measurable effect in explaining wool production..." (p. 43). Easter's satisfaction with only an implicit wool price in his demographic model is difficult to explain in light of the studies reviewed above.

McCarron (*11*) pointed out that the sheep and cattle industries in Australia changed considerably from 1969 to 1972. The shift was from sheep-only operations to beef-only or combined sheep-beef operations. The implied reason was to increase output flexibility.

The BAE (*4*) explained that the response of Australian beef producers to the drop in beef prices was to retain more animals in hopes of higher prices. Estimates for the total cow herd size (beef and dairy) were 34 million for March 1975 and 39 million for March 1976. The actual figures were 32.8 million and 33.4 million, respectively.

PROCEDURES

Model Construction

Theoretical

The simplest theoretical model to estimate the response of beef and wool production to price changes is:

$$Y_i = f(P_i) \qquad (1)$$

where: Y = production
P = price
i = wool or beef

This model assumes all other factors to be constant. Obviously there are several other phenomena that impinge upon production. Therefore, only by "holding" other variables constant (via a statistical algorithm) can the effect of prices alone be estimated. A more complete model is:

$$Y_i = f(P_i, X_j) \qquad j = 1, 2, 3, ..., n \qquad (2)$$

where X = factors other than price that affect the production of wool and beef.

The opposite problem arises in (2), namely, *n* is an unmanageably large number. Because of practical considerations, the following basic model specifies *a priori* some of the main factors (based on economic and biological theory) which affect production and assumes the others to be insignificant or mutually offsetting:

$$Y_i = f(P_i, X_{1i}, X_{2i}, X_{3i}, e) \qquad (3)$$

where: X_1 = cost of production
X_2 = technology
X_3 = beginning herd (flock) size
e = stochastic error term

Technology is assumed to be increasing at a constant rate. Herd size is a proxy for production capacity, an important determinant of output in the short run.

For wool production, the signs on the coefficients are expected to be positive for the price of wool, technology, weather, and the sheep herd size. Negative signs are anticipated for the price of beef, the beef herd size, and the cost of production. The latter relationships assume competition for the same resources (primarily grazing land). The beef production coefficients are expected to have the following signs: Positive for the price of beef, technology, weather, and the beef herd size; and negative for the price of wool, the cost of production, and the sheep flock size.

To account for delays in the effect of changes in the independent variables, all of the following time lags were tested:

Variable	Time lag in years
Price	0, 1, 2, 3, 4, 5
Cost of production	0, 1, 2, 3, 4, 5
Herd size	0, 1, 2, 3, 4, 5

Lags for wool production are expected to be shorter than those for beef because of the shorter reproductive cycle of sheep.

Statistical

A linear model was proposed to estimate the parameters of the theoretical model. The form for the linear equation to be estimated by ordinary least squares regression techniques is:

$$Y_i = B_i X_i + e \qquad (4)$$

where Y = production
X = independent variables
B = estimated parameters
e = error term

The criteria for accepting the estimated parameters were as follows:

1. Expected sign.
2. Stability of the estimate given changes in the sample size.
3. The estimated t-value is equal to or greater than one.

Assumptions

Other than the assumptions mentioned above, the following general assumptions apply:

1. The relationships in the period analyzed are expected to remain constant during the predicted period.

2. Omitted variables will not significantly mask the effects of the variables used (*ceteris paribus*).

Data Collection

The data for this study (see app. table 2) were taken from various Australian published sources.

ANALYSIS

Estimating the Parameters

After estimating various equations using 0 to 5-year lags for price, cost of production, and herd size, the equations below were found to be the most reliable for estimating wool and beef production.

Wool

$$Y_{w,t} = B_0 + B_1P_{w,t-1} + B_2P_{b,t} + B_3H_{s,t} + B_4H_{b,t} + B_5T + B_6W_t \quad (5)$$

where:
- Y_w = wool production, thousands of sheep shorn.[7]
- P_w = average annual price of all wool sold at auction, cents per kilogram.
- P_b = average annual price of beef at Homebush (representative market), cents per kilogram dressed weight, steers and/or heifers (295-318 kg), first and second export quality.
- H_s = size of sheep herd, million head.
- H_b = size of beef cattle herd, million head.
- T = technology proxy
- W = weather proxy, yield of wool per sheep.

Beef

$$Y_{b,t} = B_7 + B_8T + B_9P_{w,t-2} + B_{10}P_{b,t} + B_{11}H_{b,t} + B_{12}C_{t-3}$$

where:
- Y_b = beef and veal production, 1,000 tons, carcass-weight basis.
- C = cost of inputs, prices paid by farmers.

Testing the Model

To test the models, various projections were made from the equations estimated from three samples: 1955/56-1973/74, 1955/56-1974/75, and 1955/56-1975/76. The projections were compared with actual or estimated 1974/75 and 1975/76 figures, and determined as feasible or infeasible for 1976/77.

In projecting the number of sheep shorn from the three samples (*ex ante*), it was assumed that the beginning sheep and beef herd sizes were known (as of Mar. 31), that the weather would be normal, and that the price of beef would continue at the previous year's level. The results are shown in table 1.

All projections underestimated the number of sheep shorn. The reasons offered are: (1) The 2 abnormally good years of weather experienced in 1974/75 and 1975/76; and (2) the halving of beef prices, which caused an increase in the number of sheep shorn.

[7]The average fleece weight varied between 4.14 and 4.40 kilograms during 1970/71-1973/74, averaging 4.25 kilograms. It should be noted that sheep are sometimes shorn twice in one year.

Table 1—Projections for number of sheep shorn and beef produced, using *ex ante* models, Australia, 1974/75—1976/77

Item	Sheep shorn			Beef produced		
	Projected	Actual	Error	Projected	Actual	Error
	— Million head —		*— Percent —*	*— 1,000 tons —*		*— Percent —*
Equation 1						
1974/75	145.4	161.5	−10.0	1,515	1,534	−1.3
1975/76	143.4	159.9	−10.4	1,500	1,784	−18.9
1976/77	156.8			1,458		
Equation 2						
1975/76	145.6	159.9	−8.9	1,507	1,784	−18.4
1976/77	159.1			1,465		
Equation 3						
1976/77	149.2			1,370		
Mean						
1974/75	147.8	161.5	−8.9	1,516	1,534	−1.2
1975/76	144.6	159.9	−9.6	1,498	1,784	−19.1
1976/77	155.1			1,491		

If these two factors could have been estimated accurately over the past 21 years, the accuracy of the projections (*ex post*) would have been inordinately high, as seen in figure 1. Furthermore, if the author's estimates of 'normal' weather, (i.e., 4.15 kilogram fleece average) and 50 cents per kilogram carcass weight for beef are accurate, then the number of sheep shorn during 1976/77 will be 151 million—about 6 percent less than for 1975/76.

The changes in the coefficients (app. table 3) indicate that technology and the price of beef are becoming less important, while the price of wool, the sheep herd size, and weather are becoming more important, as determinants of the number of sheep shorn.

SHEEP SHORN, AUSTRALIA

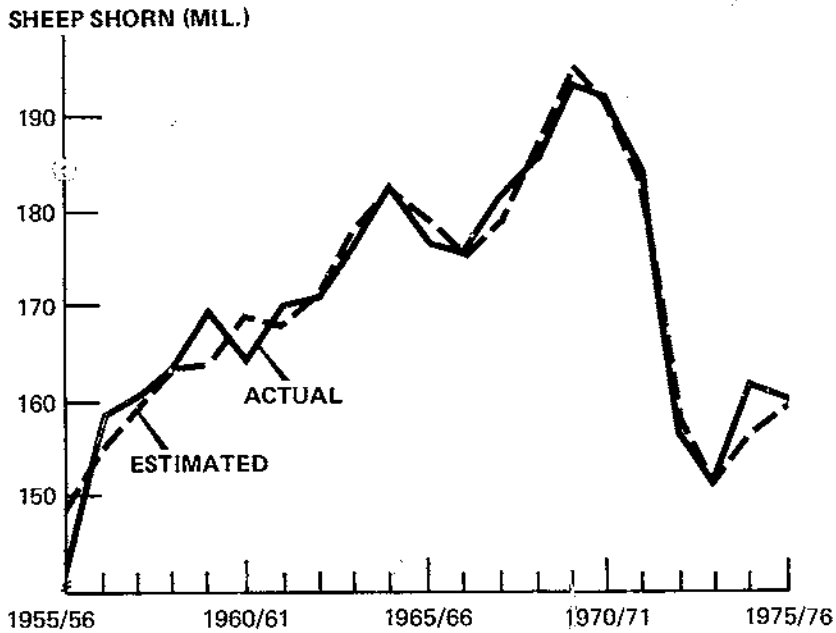

Figure 1

Similarly, in projecting the output of beef with the three (*ex ante*) models, all projections were below the actual beef production (table 1). The projection for 1974/75 was surprisingly accurate, but the unpredictable drop in beef prices in 1975/76 caused the projection to be an unacceptable 19 percent below actual output.

If the *ex post* model is used to estimate beef production over the past 21 years, an impressive tracking of the actual data is seen (fig. 2). Speculating that the price of beef will be 50 cents per kilogram in 1976/77, the projection for beef production in 1976/77 is 1,298,000 kilograms, 27 percent less than during 1975/76.

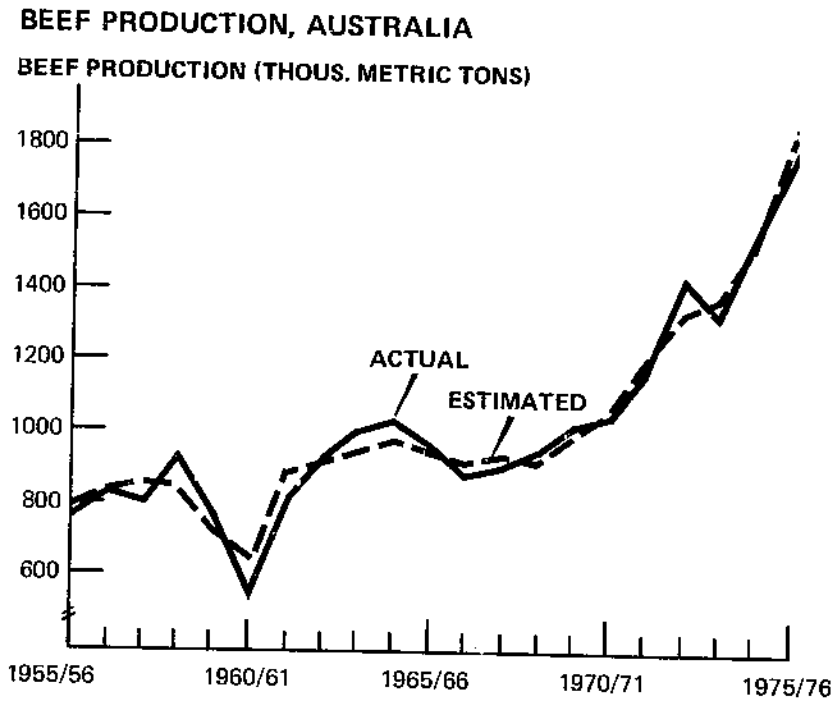

Figure 2

Results

The estimated regression coefficients presented in appendix table 3 are discussed below.

Sheep Shorn. The equations estimate that

Given:	the expected change would be:
each year's research and technological advance	an increase of 1,028,000 in the number of sheep shorn during the current year
a 1-cent-per-kilogram increase in wool prices during the current year	an increase of 154,000 in the number of sheep shorn next year
a 1-cent-per-kilogram increase in the price of beef during the current year	a decrease of 236,000 in the number of sheep shorn during the current year
a 1,000-head increase in the sheep herd size during the previous year	an increase of 1,136 in the number of sheep shorn during the current year
a 1,000-head increase in the beef herd size during the previous year	a decrease of 1,931 in the number of sheep shorn during the current year

Beef production. The equations estimate that

for	the expected change would be:
each year's research and technological advance	an increase in the amount of beef produced by 52,432 tons during the current year
each 1-cent-per-kilogram increase in the price of wool during the current year	an increase in the amount of beef produced by 923 tons in 2 years
each 1-cent-per-kilogram increase in the price of beef during the current year	a decrease in the amount of beef produced by 7,248 tons during the current year
a 1,000-head increase in the beef herd during the previous year	an increase in the amount of beef produced by 66,620 tons during the current year
a 1-point increase in the prices paid by farmers index during the current year	a decrease in the amount of beef produced by 20,517 tons in the third year

The estimated coefficients are consistent with basic economic theory in terms of sign and magnitude, or agree with specialized conditions prevailing in Australia.

In reference to sheep shorn, one item seems noteworthy. The estimated coefficient of substitution between sheep and beef is less than the six-to-one thumb-rule size. This is explained by noting that total forage area is expanding and consequently a pure substitution effect is not being measured.[8]

A few beef production coefficients require explanation. The positive relationship between the price of wool (in period t-2) and the production of beef is explained by producers trying to change the size of their beef herd to react to the change in profitability of sheep.

The negative coefficients on the price of beef indicate that as the price of beef increases, producers attempt to increase their productive capacity—that is, their herds. The increased animal retention causes a reduction in production in the short run. This phenomenon is a modified example of the cobweb theorem.

Implications

Of particular importance is the negative effect that changes in beef price have on beef production in the short run. This implies that producers may not be taking advantage of high prices to sell their output. Instead, they build herds and may be forced to sell at a time when prices have fallen (e.g., due to high production or a recession in other countries). In the very short run, it appears that the quickest way to increase beef production is to increase wool prices and decrease beef prices.

The output mix of wool and beef is also affected by increasing costs. Generally, increasing costs shift production toward wool production from beef.

It appears that sheep and beef cattle are indeed competitive, but not as competitive as earlier expected. Although the usual equivalent measure is that six sheep are equal to one head of cattle, for each head of cattle increase on Australian ranches there was only about a two-head decrease in the number of sheep.

An accurate projection of the beef price into the next year is highly critical in estimating the future output of both wool and beef.

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[8]Acknowledgement is made to John W. Freebairn, The Australian National University, Canberra, for this explanation.

LITERATURE CITED

1. Bureau of Agricultural Economics
A Study of Supply Relationships in the Australian Sheep and Wool Industry, Wool Economic Research Report Number 19, Canberra, Australia, Feb. 1971.

2. _____
Analysis of Wool Price Fluctuations, Wool Economic Research Report Number 23, Canberra, Australia, 1973.

3. _____
Meat—Situation and Outlook, Canberra, Australia, 1976.

4. _____
The Australian Beef Cattle Industry—An Examination of the Current Situation, Future Prospects and Possible Policy Options, Occasional Paper No. 25, Canberra, Australia, 1975.

5. _____
The Wool Outlook, Canberra, Australia, Dec. 1975.

6. Dalton, M. E., and L. F. Lee
"Projecting Sheep Numbers Shorn-An Economic Model," *Quarterly Review of Agricultural Economics*, Vol. 28, No. 4, Canberra, Australia, Oct. 1975.

7. Davidson, B. R.
"The Relationship Between the Price of Wool and the Relative Profitability of Sheep and Cattle Grazing in Australia and Its Possible Effect on the Future Supplies of Wool and Beef," *Review of Marketing and Agricultural Economics*, Vol. 41, No. 1 Syndey, Australia, Mar. 1973.

8. Easter, C. D.
The Australian Pastoral Industry in 1980: A Consideration of Structural Change and Sheep Industry Output, Occassional Paper No. 26, Canberra, Australia, 1974.

9. Freebairn, J. W.
"Some Estimates of Supply and Inventory Response Functions for the Cattle and Sheep Sector of New South Wales," *Review of Marketing and Agricultural Economics*, Vol. 41, Nos. 2 and 3, Sydney, Australia, June and Sept. 1973.

10. Gruen, F. H., and others
Long-Term Projections of Agricultural Supply and Demand, Australia, 1965 and 1980, Department of Economics, Monash University, Clayton, Victoria, Australia, May 1968.

11. McCarron, A. C.
"The Changing Structure and Economic Situation of the Australian Sheep and Beef Cattle Grazing Industry," *Quarterly Review of Agricultural Economics*, Vol. 28, No. 3, Canberra, Australia, July 1975.

Appendix table 1—Exchange rates for Australian currency

Year	U.S. dollars per Australian dollar
1950	1.112
1951	1.112
1952	1.121
1953	1.121
1954	1.112
1955	1.119
1956	1.112
1957	1.121
1958	1.119
1959	1.118
1960	1.119
1961	1.121
1962	1.119
1963	1.116
1964	1.114
1965	1.119
1966	1.114
1967	1.121
1968	1.110
1969	1.118
1970	1.115
1971	1.191
1972	1.275
1973	1.488
1974	1.327
1975	1.257

Source: *International Financial Statistics* (various issues), International Monetary Fund.

Appendix Table 2—Data used in the analysis

July—June year	Sheep and lambs shorn[1]	Beef and veal production	Index of prices paid by farmers	Technology	Wool clip per sheep	Herd size		Price	
						Sheep[2]	Beef[3]	Wool[4]	Beef[5]
	-Million head-	*-1,000 tons-*	*1960/61 — 62/63 = 100*		*-Kg-*	*-Million head-*		*-c/kg-*	
1950/51	120.8	662.0	61	1950	3.86	112.9	9.7	264.91	21.83
1951/52	121.9	591.2	79	1951	3.71	115.6	10.4	133.05	31.31
1952/53	131.5	685.6	83	1952	4.03	117.7	10.3	150.29	27.56
1953/54	132.6	715.6	84	1953	3.89	123.1	10.5	149.74	29.76
1954/55	137.0	731.5	85	1954	3.88	126.9	10.7	130.23	34.08
1955/56	141.5	763.2	88	1955	4.18	130.9	10.9	112.92	31.09
1956/57	158.4	827.7	91	1956	4.17	139.1	11.4	146.34	30.20
1957/58	160.1	804.2	95	1957	3.73	149.8	12.1	114.73	36.82
1958/59	162.8	920.9	94	1958	4.06	149.3	11.9	89.22	37.92
1959/60	169.5	763.9	96	1959	4.09	152.7	11.4	106.15	46.96
1960/61	163.6	543.0	99	1960	4.08	155.2	11.6	95.64	50.49
1961/62	169.8	803.8	100	1961	4.13	152.7	12.4	99.45	37.70
1962/63	170.4	928.6	101	1962	4.04	157.7	13.0	108.31	39.84
1963/64	176.1	1,001.3	101	1963	4.20	158.6	13.5	128.04	39.64
1964/65	182.3	1,026.3	104	1964	4.05	164.9	14.1	105.45	45.66
1965/66	176.1	946.3	110	1965	3.87	170.3	14.0	110.41	56.70
1966/67	175.5	878.6	114	1966	4.14	157.6	13.2	104.46	56.97
1967/68	180.7	903.9	118	1967	4.03	164.2	13.7	92.04	58.00
1968/69	185.5	934.8	120	1968	4.34	166.9	14.7	98.48	58.89
1969/70	192.7	1,010.5	121	1969	4.35	174.6	16.3	82.78	57.81

Footnotes at end of table.

Continued—

Appendix table 2—Data used in the analysis—continued

July—June year	Sheep and lambs shorn[1]	Beef and veal production	Index of prices paid by farmers	Technology	Wool clip per sheep	Herd size		Price	
						Sheep[2]	Beef[3]	Wool[4]	Beef[5]
	-Million head-	*-1,000 tons-*	*1960/61 — 62/63 = 100*		*-Kg-*	*-Million head-*		*-c/kg-*	
1970/71	191.8	1,047.2	126	1970	4.18	180.0	17.9	64.68	61.20
1971/72	183.7	1,167.9	133	1971	4.22	177.8	20.3	75.25	62.06
1972/73	156.2	1,437.9	143	1972	4.14	162.9	23.4	183.77	74.56
1973/74	150.4	1,310.0	165	1973	4.40	140.0	25.1	161.16	80.34
1974/75	161.5	1,533.8	215	1974	4.48	145.2	27.1	126.99	78.90
1975/76	159.9	1,784.0	245p	1975	4.30	151.7	29.1	143.41	31.70
1976/77	150.8p	1,631.9p	n.a.	1976	n.a.	149.1	29.7	n.a.	n.a.

p = projected by ERS.
n.a. = not available.

[1]Data collected are not on a uniform basis prior to 1965/66; from 1965/66 onward, July–June year is appropriate (some animals are shorn twice).

[2]Total number of sheep as of March 31 of the first year shown.

[3]Total number of animals for meat production as of March 31 of the first year shown.

[4]Average annual price, greasy basis.

[5]Average annual price at Homebush, steers and heifers, 295–318 kgs., first and second export quality, dressed weight.

Sources: Australian Bureau of Statistics, *Livestock Slaughtered and Meat Produced, Rural Industries,* and *Sheep Numbers, Shearing and Wool Production;* Australian Meat Board, *Annual Review, Australian Meat Board Statistical, Review of Livestock and Meat Industries;* Bureau of Agricultural Economics, *Statistical Handbook of the Sheep and Wool Industry, The Wool Outlook, Index of Prices Paid by Farmers: Australia;* National Council of Wool Selling Brokers of Australia, *Wool Review.*

Appendix table 3—Statistics of best equations to estimate number of sheep shorn and quantity of beef produced, Australia

Statistic	Sheep shorn equations			
	1	2	3	Mean
Estimated regression coefficients:				
Intercept	-2,655.215	-2,258.709	-1,408.645	-2,107.523
Technology	1.321	1.105	0.658	1.028
Weather	22.214	25.331	28.148	25.231
Sheep herd, t	1.085	1.133	1.190	1.136
Beef herd, t	-2.085	-1.807	-1.902	-1.931
Price of wool, t-1	0.133	0.161	0.167	0.154
Price of wool, t-2	—	—	—	—
Price of beef, t	-0.295	-0.287	-0.125	-0.236
Input prices, t-3	—	—	—	—
Coefficient of determination (R^2)	0.960	0.953	0.951	0.955
Standard error of the estimate	3.427	3.631	3.612	3.560
Durbin-Watson statistic	2.484	2.326	2.649	2.489
Sample size	19	20	21	20

Footnote at end of table.

Continued—

Appendix table 3—Statistics of best equations to estimate number of sheep shorn and quantity of beef produced, Australia—continued

Statistic	Beef equations			
	1	2	3	Mean
Estimated regression coefficients:				
Intercept	-100,827.066	-100,413.166	-100,720.095	-100,653.442
Technology	52.515	52.293	52.485	52.431
Weather	—	—	—	—
Sheep herd, t	—	—	—	—
Beef herd, t	66.689	66.756	66.416	66.620
Price of wool, t-1	—	—	—	—
Price of wool, t-2	0.905*	0.951	0.914	0.923
Price of beef, t	-7.617	-7.615	-6.512	-7.248
Input prices, t-3	-20.233	-20.090	-21.229	-20.517
Coefficient of determination (R^2)	0.935	0.956	0.973	0.955
Standard error of the estimate	57.321	55.242	53.887	55.426
Durbin-Watson statistic	2.189	2.315	2.229	2.245
Sample size	19	20	21	20

*t — statistic of less than 1.0
— = not included in equation

END

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