SUPPLY PROJECTIONS FOR THE AUSTRALIAN BEEF INDUSTRY

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Between 1968 and 1971 beef cattle numbers in Australia expanded by 38 per cent compared with an increase in production of about 14 per cent. This paper presents projections to 1976 for beef and veal production. The projections indicate an expansion of 70 per cent in beef production by 1976 and are not sensitive to assumptions about the future rate of increase in cattle numbers. Supplies available for export will approximately double unless there is an increase in domestic consumption. It is concluded that the increased supplies will result in considerable downward pressure on beef prices unless export outlets expand more rapidly.

1 INTRODUCTION

Between 1969 and 1971 beef cattle numbers in Australia increased by 38 per cent. This increase in numbers has not been accompanied by an increase in production and, as a result, large increases in the supply of beef are inevitable in the short to medium term. Coutts and Fernon [6] in a comprehensive study of the Australian beef industry concluded that output seems likely to rise faster than the trend of market growth, with consequential lower beef prices.

Supply functions for livestock are inherently complex partly because of the influcnce of price expectations on the use of breeding stock as either a unit of input or output. Reutlinger [11] from an analysis of the United States beef industry estimated a positive supply elasticity for steer slaughter and a negative supply elasticity for cows. Gutman [7] from an analysis of slaughterings, cattle numbers and beef prices in New South Wales derived evidence of the workings of a cattle cycle. However, Patterson [9] showed that fluctuations in Australian beef cattle numbers closely followed fluctuations in Queensland cattle numbers over the period 1890-1955. Using a weighted rainfall index for Queensland, Patterson showed that rainfall was the major factor causing fluctuations in beef cattle numbers.

Ideally, a short-run supply of livestock for slaughter function should incorporate a number of variables, particularly price expectations and drought effects. Powell and Gruen [10] have incorporated price expectations in a beef supply model. The short-run supply response to drought has altered in recent years and this increases the difficulty of deriving the supply response from limited historical data. In Queensland, drought conditions now produce a larger short-run increase in production and this response can be attributed to improvements in transportation and the availability of markets for lean beef [12].

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2 THE PROJECTION EQUATIONS

2.1 THE RATIONALE

The change in a population for any time period, excluding migration, equals births minus deaths. For the cattle industry, the following identity can be written:

(1) $S + I = B - M$

where

S = number slaughtered

I = increase in cattle numbers

B = births

M = mortalities

The number of slaughterings plus increase are thus equal by definition to births minus mortalities. For a constant difference between births and mortalities, slaughterings can be increased by decreasing the rate of increase in cattle numbers. Births can be expected to be positively correlated with prior seasonal conditions and mortalities negatively correlated with seasonal conditions, with perhaps a shorter lag than for births. Thus slaughterings plus increase should be highly correlated with seasonal conditions.

Other factors, particularly the age and sex distribution of a cattle herd influence the number of births and, to a lesser extent, mortalities; but compared with seasonal conditions, other factors should only produce secular trends.

The allocation of the population change resulting from the excess of births over mortalities between slaughterings and the net increase in the herd depends on factors additional to seasonal conditions and the age and sex distribution. In particular short and long term price expectations are important. But because of the complex of factors influencing annual slaughterings, a satisfactory prediction equation could not be developed. The approach adopted instead was to develop an equation based on slaughterings plus increase on the assumption that the only predictor variables necessary were a seasonal index plus a secular trend variable. The rate of increase in total cattle numbers is then treated as an exogenous variable so that slaughterings can be estimated.

2.2 THE DATA SERIES

Because of difficulties involved in isolating the contribution of the Australian dairy industry to total beef and veal production, total cattle and total slaughterings were used in constructing the data series.

Total beef and veal production is by definition the product of the total number slaughtered by the average slaughter weight. To produce a more stable structural relationship, slaughterings were expressed as a percentage of total cattle in the previous year as in equation (2). In addition, to avoid the problem of predicting slaughterings of calves separately, the number of slaughterings was redefined to include only adult cattle and the average slaughter weight was replaced by a slaughter index. With these adjustments, the identity for total beef and veal production can be expressed as follows:

(2) $Q_t = C_{t-1}\,(A_t/C_{t-1})\,(Q_t/A_t)$

where

Q_t = Beef and veal production in year t ending 30th June, in tons.

C_{t-1} = Total number of cattle at 31st March in year $(t-1)$.

A_t = Total adult cattle slaughtered in year t ending 30th June.

Equation (2) can be rewritten as follows:

(3) $Q_t = C_{t-1}\,S_t\,W_t$

where

S_t = Total adult cattle slaughtered as a percentage of total cattle in the previous year.

W_t = A slaughter index in tons determined by dividing total beef and veal production by the total number of adult cattle slaughtered.

The data series for the four items in equation (3) are presented in table 1.

TABLE 1

Australian Cattle and Beef Production Statistics, 1954–55 *to* 1970–71

Year	Total cattle (31st March)	Percentage of total cattle at 31st March in previous year			Slaughter† index	Production of beef and veal (carcass weight) (30th June)
		Increase in total cattle (31st March)	Adult cattle slaughtered (30th June)	Mortalities* (31st March)		
	'000				tons	'000 tons
1954–55 ..	15,836	1·5	20·2	3·7	0·228	719·9
1955–56 ..	16,457	3·9	20·1	3·4	0·236	751·1
1956–57 ..	17,257	4·9	30·6	3·5	0·240	814·6
1957–58 ..	16,892	—2·1	20·7	6·0	0·222	791·5
1958–59 ..	16,257	—3·8	24·8	5·4	0·216	906·4
1959–60 ..	16,503	1·5	21·1	4·4	0·219	751·8
1960–61 ..	17,332	5·0	17·5	4·8	0·219	632·8
1961–62 ..	18,033	4·0	20·7	4·4	0·220	791·1
1962–63 ..	18,549	2·9	23·7	4·2	0·214	913·9
1963–64 ..	19,055	2·7	25·1	4·0	0·212	985·5
1964–65 ..	18,816	—1·3	25·9	4·0	0·204	1,010·1
1965–66 ..	17,936	—4·7	24·5	7·5	0·202	931·4
1966–67 ..	18,270	1·9	22·8	4·4	0·211	864·7
1967–68 ..	19,218	5·2	22·7	3·2	0·215	889·6
1968–69 ..	20,606	7·2	22·3	3·6	0·214	920·0
1969–70 ..	22,162	7·6	23·2	4·2	0·208	995·5
1970–71 ..	24,372	10·1	22·1	4·0	0·209	1,023·0
Means ..	18,444	2·7	22·2	4·4	0·217	864·3

Source: All data excluding Mortalities [5] and 1970–71 data are from, or calculated from, data of Coutts and Fernon [6].

The 1970–71 figures for Mortalities, Slaughterings and Production were estimated by the author.

* Mortalities are calculated from an incomplete data series and are used only as a seasonal index.

† Calculated by dividing beef and veal production by the number of adult cattle slaughtered.

2.3 THE REGRESSION EQUATIONS

To calculate beef and veal production in any year, the three items on the right-hand side of equation (3) have to be estimated. Percentage slaughterings are estimated indirectly from the estimate of slaughterings plus increase. The regression equation for slaughterings plus increase is as follows:

$$(4)\quad (S_t + I_t) = 30{\cdot}12 + \underset{(0{\cdot}076)}{0{\cdot}459\, T_t} - \underset{(0{\cdot}328)}{2{\cdot}156\, M_t}$$

$$R^2 = 0{\cdot}858$$

$$D.W. = 1{\cdot}58$$

where

$(S_t + I_t)$ = Slaughterings plus increase in total cattle in year t both as a percentage of C_{t-1}

T_t = Year t (ending 30th June) minus 1954

M_t = Mortalities in year t as a percentage of C_{t-1}

The percentage mortalities is used only as an index of seasonal conditions. The data from which percentage mortalities were calculated were incomplete [5]. Northern Territory figures were only available for some years. The addition of mortalities as a lagged variable did not significantly improve the regression.

Actual slaughterings plus increase are shown graphically in figure 2, together with calculated values from the regression equation. The magnitude and patterns of the residuals indicate that the equation is suitable for prediction.

The time trend in the equation of approximately 0·5 per cent per year can be attributed to a number of factors. The decline in the proportion of dairy cattle in total cattle produces an upward trend because of the relatively lower but probably increasing contribution of dairy cattle to beef production. Hardman [8] estimated that the dairy industry contributed 11·3 per cent of Australian beef and veal production for the period 1962–64. Over this period dairy cattle averaged 27 per cent of total cattle. The number of calves slaughtered as a percentage of dairy cattle has declined in recent years, indicating an expansion in dairy-beef production [4]. In addition, slaughterings plus increase is an indicator of reproductive performance which can be expected to show an increase with time, particularly because of the increasing proportion of cattle in southern Australia. Survey results [1] show beef cattle brandings as a percentage of cows and heifers over one year at 55·4 per cent in Queensland compared with 72·0 per cent in New South Wales and 68·4 per cent in Victoria.

The regression equation developed for slaughter weight with the variables as previously defined is as follows:

$$(5)\quad W_t = 0{\cdot}2616\, T_t \underset{(0{\cdot}0085)}{- 0{\cdot}0448} \quad \underset{(0{\cdot}0302)}{- 0{\cdot}0683\, M_t}$$

$$R^2 = 0{\cdot}742$$

$$D.W. = 1{\cdot}207$$

Mortalities were used again as a seasonal index and reflect the decline in slaughter weight in drought years because of forced sales. The decline in the index of slaughter weight with time is attributable to decreased age of slaughter outweighing the effect of a decline in the proportion of calves in total slaughterings [4]. The Durbin Watson statistic is in the intermediate range, indicating possible incipient autocorrelation.

3 PROJECTIONS

3.1 METHODOLOGY

The biological characteristics of the beef supply relationships allow short-term projections of potential supply to be made independent of demand. In the medium term, price expectations, both absolute and relative to alternative feasible enterprises, determine whether surplus breeders are used to increase cattle numbers or to increase slaughterings. In short, with medium term supply projections there is generally an implicit assumption of constant prices compared with approaches which simultaneously estimate supply and demand.

In this study, the key exogenous variable is the rate of increase assumed for total cattle numbers, because slaughterings can then be estimated from equation (4) for the assumed rates of increase. Beef production was estimated for a range of constant future rates of increase in total cattle numbers. The estimates showed that the projected beef and veal production for 1976 was virtually the same for a wide range of constant rates of increase in cattle numbers. This occurs because low rates of increase are associated with high turnoff from fewer numbers, and vice versa. Thus, 1976 was adopted as the terminal date for the projections of production on the assumption that changes in price expectations in the intervening years will not seriously invalidate the 1976 projection, although the time path will be altered.

3.2 PROJECTIONS TO 1976

Three specific projections based on differing assumptions are presented. The projections P4 and P8 assume uniform rates of increase of 4 per cent and 8 per cent in total cattle numbers. The projection PD arbitrarily simulates a drought in 1974 and 1975.

The 4 per cent and 8 per cent rates were selected by observation from figure 1 and correspond approximately to the upper envelope rates before and after 1965. The projection PD is based on the pattern, but not the severity of the 1964–65 drought. A reduced severity was assumed because the return period for a drought of the severity of the 1964–65 drought is large; because the proportion of total cattle in the relatively low rainfall variability area of southern Australia is increasing; and because of improvements in drought technology.

Assumptions relating to rates of increase in total cattle numbers determine C_{t-1} in equation (3). The second term, S_t, was obtained by subtracting the assumed rate of increase, I_t, from $(S_t + I_t)$ calculated by equation (4). The third term, W_t, was estimated using equation (5). Values of

M_t, for 1972 to 1976, for use as the seasonal index in equations (4) and (5) were estimated using a trend determined for the decline with time of mortalities in Queensland [12].

The results of the projections of total beef and veal production are listed in table 2, together with assumed and calculated values for items in equations (3), (4) and (5). Trends and projections of slaughterings, increase in total cattle, slaughterings plus increase and mortalities, all as a percentage of total cattle in the previous year, are shown graphically in figures 1 and 2. Trends and projections of beef and veal production are shown graphically in figure 3. In figure 3, beef and veal production is also disaggregated into exports and other (mainly domestic consumption). A 2 per cent per annum increase, based on population growth and assuming constant prices, has been projected for other production to derive the potential expansion in supplies available for export.

TABLE 2

Projections of Australian Beef and Veal Production, 1972–1976

Item*	Projection†	Year ending 30th June and 31st March				
		1972	1973	1974	1975	1976
Rate of increase in cattle numbers (per cent)	P4	4	4	4	4	4
	P8	8	8	8	8	8
	PD	8	4	0	4	8
Mortalities (per cent) ..	P4 and P8	3·9	3·8	3·7	3·6	3·5
	PD	3·9	3·8	6·0	4·5	3·5
Cattle slaughterings, plus increase in cattle numbers (per cent)	P4 and P8	30·0	30·6	31·3	32·0	32·7
	PD	30·0	30·6	26·4	30·1	32·7
Cattle slaughterings (per cent)	P4	26·0	26·6	27·3	28·0	28·7
	P8	22·0	22·6	23·3	24·0	24·7
	PD	22·0	26·6	26·4	26·1	24·7
Slaughter index (tons) ..	P4 and P8	0·209	0·209	0·209	0·209	0·209
	PD	0·209	0·209	0·202	0·206	0·209
Total cattle numbers ('000) (31st March previous year)	P4	24,372	25,347	26,361	27,415	28,512
	P8	24,372	26,322	28,428	30,702	33,158
	PD	24,372	26,322	27,375	27,375	28,470
Projected beef and veal production‡ ('000 tons carcass weight)	P4	1,324	1,409	1,504	1,604	1,710
	P8	1,121	1,243	1,333	1,540	1,712
	PD	1,121	1,463	1,460	1,472	1,470

* All percentage items relate to total cattle numbers at 31st March in the previous year.

† P4 and P8 projections assume a uniform annual rate of increase in total cattle numbers of 4 per cent and 8 per cent from 31st March, 1971. PD simulates a drought in 1974 and 1975.

‡ Beef production is the product of total cattle numbers, per cent slaughterings and slaughter index.

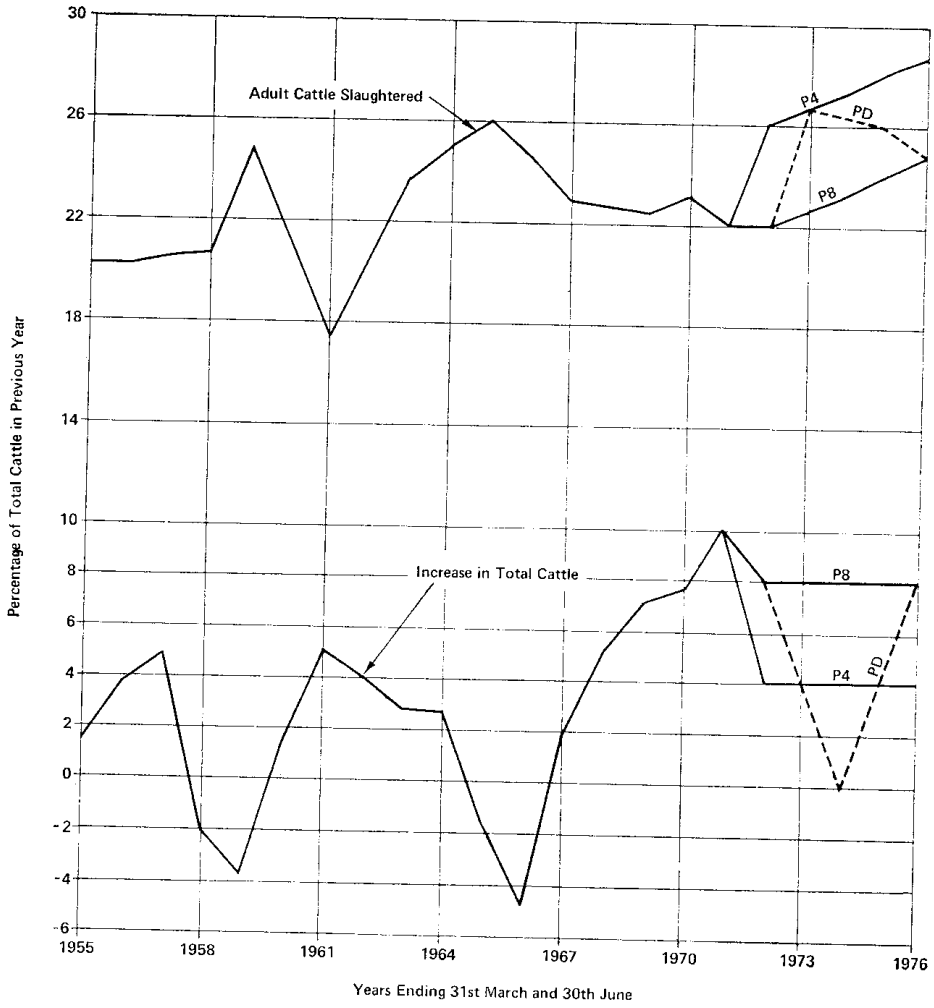

FIGURE 1: *Trends* 1955–71 *and Projections* 1972–76 *of Slaughterings and the Rate of Increase for the Australian Cattle Industry.*

(P4 and P8 projections assume a uniform annual rate of increase in total cattle numbers of 4 per cent and 8 per cent from 1971; PD simulates a drought in 1974.)

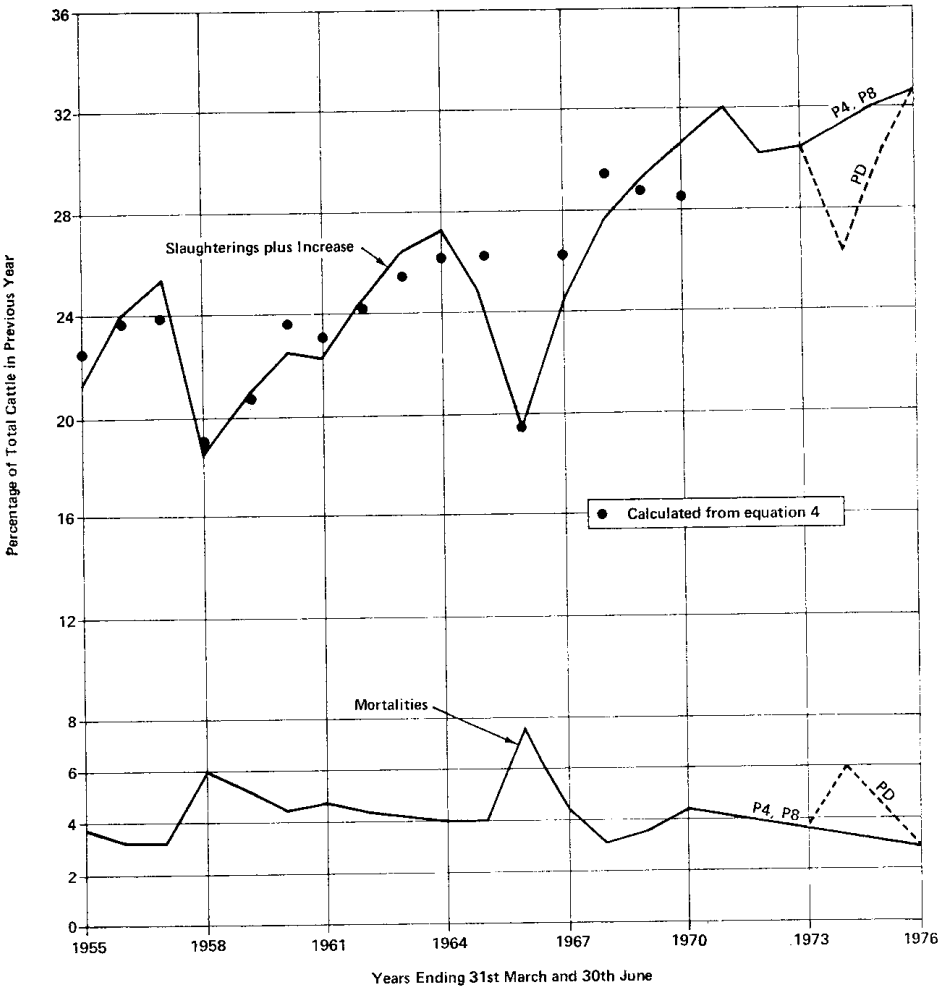

FIGURE 2: *Trends* 1955–71 *and Projections* 1972–76 *of Productivity for the Australian Cattle Industry.*

(P4 and P8 projections assume a uniform annual rate of increase in total cattle numbers of 4 per cent and 8 per cent from 1971; PD simulates a drought in 1974.)

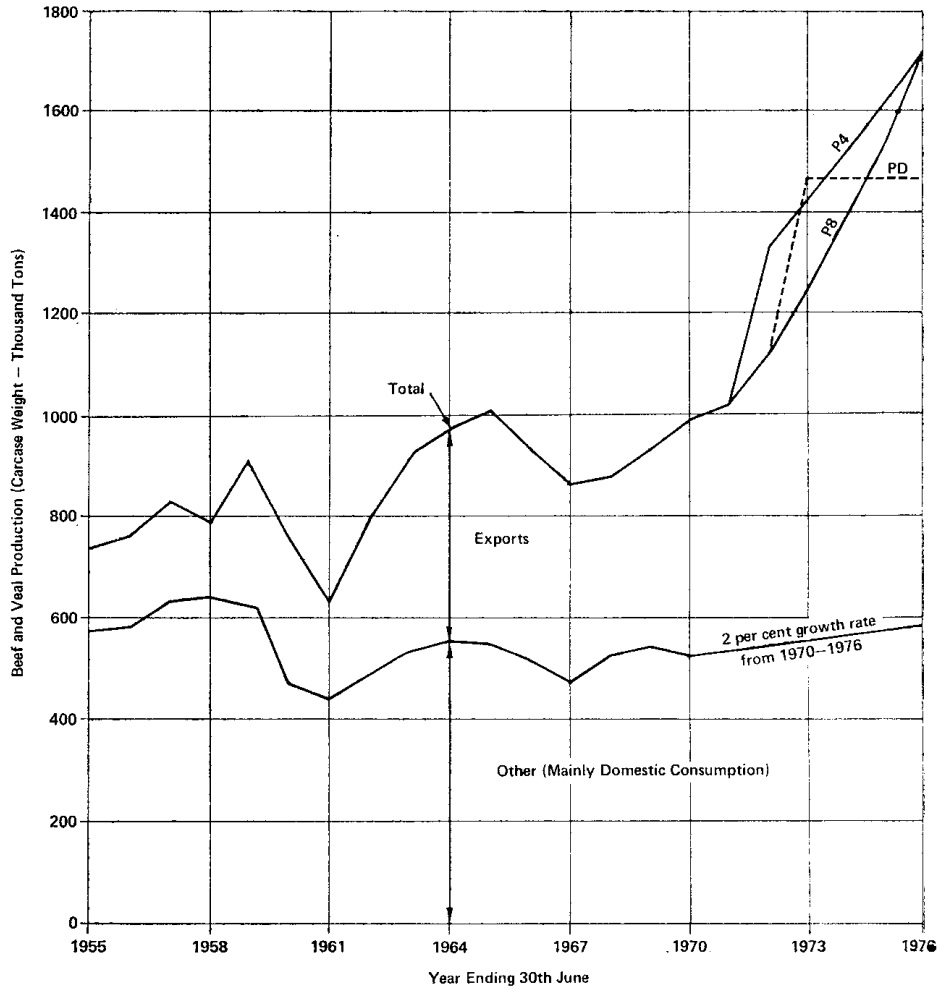

FIGURE 3: *Trends* 1955–71 *and Projections* 1972–76 *of Australian Beef and Veal Production.*

(P4 and P8 projections assume a uniform annual rate of increase in total cattle numbers of 4 per cent and 8 per cent from 1971; PD simulates a drought in 1974.)

3.3 DO-IT-YOURSELF PROJECTIONS

The techniques involved in the projections are sufficiently simple to suggest that potential users should have an opportunity to participate and derive personal projections by substituting their subjectivity for that of the author.

An illustration of the technique follows. Projected beef production is calculated using equation (3).

To estimate total cattle numbers at the 31st March in year $(t-1)$, C_{t-1}, assumptions have to be made for growth rates from the 31st March, 1971, figure of 24,372,000. For example, to estimate beef production in the year ending June, 1973, cattle numbers as at 31st March, 1972, could be assumed to be 5 per cent above the 1971 figure.

Thus

$$C_{1972} = C_{1971} \times 1{\cdot}05$$
$$= 25{,}591{,}000$$

The next step is to calculate per cent slaughterings in 1973. This can be done by selecting a per cent slaughterings plus increase value guided by figure 2. Assuming a figure of 30 per cent, the assumed rate of increase in cattle numbers for 1973—say 3 per cent—is deducted to give a per cent slaughterings of 27 per cent.

$S_{1973} = 27$ per cent

The last item required is the slaughter index. The values of slaughter index in table 1 suggests a reasonable value for 1973 of 0·210 tons. Beef and veal production for 1973 is then calculated as follows:

$$Q_{1973} = 25{,}591{,}000 \times 0{\cdot}27 \times 0{\cdot}210$$
$$= 1{,}450{,}000 \text{ tons carcass weight}$$

Alternatively, the components of equation (3) can be calculated by using the regression equations (4) and (5) for per cent slaughterings plus increase and the slaughter index. The time path can then be constructed as in table 2.

4. DISCUSSION

The specific projections presented in table 2 and figure 3 show a very rapid rate of increase in beef production. The projections, P4 and P8, show the dependence of the time path of production on the rate of growth assumed in cattle numbers. For constant rates of growth, the 1976 projected production is not very sensitive to the rate chosen. For example, with no further growth in cattle numbers after 1971 and retaining the other assumptions used for the P4 and P8 projections, production rises to 1,530,000 tons in 1972 and 1,668,000 tons in 1976, compared with 1,712,000 for P8 in 1976.

The prediction PD, which simulates drought during 1974 and 1975, shows that, despite lower reproductive performance, the short-run response to drought conditions is a large increase in production. By altering the assumption of a pre-drought drop in the rate of increase in cattle num-

bers, the short term increase in production becomes greater and there is a post-drought decline rather than a plateau as in PD in figure 3. The real significance of the drought projection is that it shows that, whatever realistic assumptions are made, the only situation in which there could be a drop in the rate of increase of beef production would be after a rapid increase has occurred, for example, after the 1964–65 drought, as shown in figure 3.

It has been demonstrated that, for all feasible assumptions, a very rapid increase in beef and veal production is inevitable in either the short or medium term. If high rates of increase in cattle numbers are maintained for the next few years, the rapid rate of increase of production phase will be delayed. It is difficult to envisage the rapid rates of increase in total cattle numbers for the years 1968-1971 being maintained. Over this period sheep numbers have remained almost stationary, so that the national stocking rate has increased considerably, although cattle are generally non-competitive with sheep up to a level which is conventionally assumed in the Queensland sheep areas to be about 30 cattle per 1,000 sheep. The area of sown grasses and clovers has increased from 54 million acres, the 1966-67 to 1968-69 averages, to 61·6 million acres for 1970-71 [3]. Seasonal conditions over the period 1968-1971 may also have contributed significantly to the rapid expansion of cattle numbers in southern Australia, although in Queensland the 1969-70 drought retarded the expansion of the Queensland beef industry.

Because the expansion of cattle numbers has been much more rapid in southern Australia, most of the expansion in beef supply will be quality beef. Projections of beef production in Queensland, where a larger proportion of production is manufacturing beef, indicate a 25 per cent expansion in beef production over the period 1971-1976 [12]. This compares with the expansion for Australia for P4 and P8 projections of 67 per cent for the same period. Thus, excluding Queensland, beef and veal production for the rest of Australia is forecast to approximately double by 1976. Another result of the large inter-regional differences in the rate of expansion will be the modification of the seasonality in beef production which is more marked in northern Australia than in southern Australia [2].

Although this article is concerned with supply projections, a brief consideration of the demand situation is warranted. The projections P4 and P8 show that, unless there is a major expansion in domestic consumption, exports will have to approximately double by 1976. This does not appear feasible at current prices and with quotas operating on the U.S.A. and Japanese markets. The Meat Export Diversification Scheme, introduced by the Meat Board in 1968, by which exporters must ship meat to other markets to earn the right to export to the U.S.A., aims to develop alternative markets.

Overall, it seems that because of the magnitude of the projected increase in beef production in relation to demand, considerable downward pressure on beef prices must eventuate, with consequent increased domestic consumption of beef, which will be mainly at the expense of other meats.

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