SOME QUANTITATIVE RELATIONSHIPS IN MEAT MARKETING

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1. INTRODUCTION AND SUMMARY

This article represents the early stages of a broad enquiry into the marketing of meat. As such the results are tentative only and often uncompleted.

To date the work has been concerned mainly with fat lamb prices and supply although a number of side excursions have been made. It has been calculated that total expenditure on meat at the retail level has kept pace with the growth of money income ; in other words, when money income inrceased by, say, one per cent, consumers spent one per cent more on meat (lamb, mutton, beef and pork).

While the total quantity consumed per year per caput has not risen substantially considerable shifts have occurred in the consumption of different types of meat and, in particular, the consumption of lamb has increased at the expense of beef consumption. The changes in consumption of these two commodities are closely associated with changes in the price ratio of these two commodities and income.

Before considering wholesale prices some attention was given to the margin between retail and wholesale prices. Because of lack of data, an absolute margin would be extremely hazardous to calculate ; however, a comparison of movements in the index of retail prices and wholesale prices provides an indication of how margins have changed.

Briefly, whilst distributors absorbed some of the rise in wholesale prices of beef and lamb during the late 'forties, this was reversed during the 'fifties, when margins rose not only absolutely but also relative to the whole-

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sale price. A sharp rise in beef prices in the late 'fifties and a fall in lamb prices apparently provided distributors with the opportunity of increasing margins on lamb and reducing margins on beef with the result that retail prices of both commodities were much more sluggish than wholesale prices.

Changes in the wholesale price of lamb are apparently closely associated with changes in supply and income. However, the price of beef does not seem to be an important factor. Simultaneous solution of a model explaining the wholesale price of lamb by its supply and the price of beef and the supply of lamb by its price and by the number of lambs marked at the beginning of each season, was not successful. The problem was, however, included in the article as it is hoped that further work along these lines will lead to results which are significant.

Next, the supply of fat lamb was considered. Changes in supply in any one year were associated with price changes two years previous and changes in the wool price in the previous year. This relationship indicates that producers "chase the market" and it gives rise to a cobweb type of fluctuation around the price trend.

Seasonal fluctuations were of a fairly regular pattern but in this case it might be difficult for producers to take advantage of high price periods and to avoid the troughs, due to higher costs of feeding and lower fertility.

As stated above, the findings in this article are tentative only. It is, nevertheless, hoped that they may be of some use in providing the basis for further discussion and work.

2. THE DATA

The following data have been used:—

Retail Expenditure and Prices—Retail prices collected by the Commonwealth Bureau of Census and Statistics in Sydney have been used for the retail price series. These data, except for lamb, have been incorporated in the C Series Retail Price Index. Yearly average retail prices have been arrived at by calculating an arithmetic average of the prices reported.[1] For instance, for beef, the average refers to the price of 1 lb. each of sirloin, rib, rump steak and beef sausages. In the case of total per caput expenditure, these yearly averages for each type of meat, viz., lamb, mutton, beef and pork, have been multiplied by per caput annual consumption of each of these meats, a figure also published by the Commonwealth Statistician. It will be clear that the average price and therefore total expenditure are little more than indices.

Wholesale Prices—Wholesale prices relate to prices collected by the Division of Marketing and Agricultural Economics of the New South Wales Department of Agriculture at the Homebush Livestock markets. During the auction sales the recording officer estimates the price per lb. carcase weight and from these daily averages an arithmetic yearly average price has been calculated.

[1] cf. Commonwealth Bureau of Census and Statistics, *Labour Report,* (annual).

It must be noted that straight arithmetic averages have been used and that prices have not been weighted by the quantities on the markets. Whilst for some purposes this might be more useful, in particular for income studies, the latter was thought to be unnecessary in this case.

Production and Consumption. Although it is hoped to extend this study at a later stage, to date only data of production in New South Wales have been used. Whilst this limits the validity of the results, it proved necessary as relationships between Sydney prices and Australian production proved unsatisfactory. Consumption data, however, are only available on an Australian wide basis. Data published by the Commonwealth Statistician relating to production and consumption have been used throughout.

Income. Data from the National Income and Expenditure Papers have been used. Income has been calculated by subtracting income tax and estate and gift duties from the total of personal income and in order to arrive at per caput income this figure has been divided by the average population in the financial year.

3. RETAIL EXPENDITURE ON MEAT

In line with overseas experience it may be expected that consumer expenditure on meat is closely associated with income. Usually this relationship is expressed in terms of real income and actual consumption. Whether or not real income in Australia has risen to any great extent during the post-war period is debatable. However, as can be ascertained from Table 1, consumption per head per annum in terms of carcase weight, which averaged 253.0 lb. in 1936-37 to 1938-39 and which dropped as low as 201.7 lb. in 1947, has not risen to the pre-war level yet.[2]

During an inflationary period, such as has been experienced in Australia in the post-war years, it must be expected that expenditure on various consumer goods is not only a function of real income and price but that there are also other factors influencing expenditure which could be grouped together under the term "inflation illusion". Whilst real income rises only slowly or not at all, an increased money income will create an illusion which will cause people to demand more luxuries, even to the extent of substituting these for "inferior" goods. To some extent this has probably happened in Australia where real expenditure on food seems to have decreased somewhat.[3]

Of foodstuffs in general, meat is probably least regarded as "inferior" and it is to be expected, therefore, that expenditure on meat will keep pace with the rise in money income.

[2] L. Reynolds estimates that real wages in Australia increased by four per cent in the period from 1948 to 1957, whilst the gross national product per caput increased by only one per cent. ("Have Living Standards Improved?", *The I.P.A. Review*, Vol. 14, No. 3 (July-September, 1960), p. 83.)

[3] *Ibid.*

TABLE 1

Annual Consumption of Meat per Caput

Class of Meat	Average 1936-37 to 1938-39	Year Ended June											
		1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960*
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Beaf and Veal (Bone-in Weight)	144·1	121·3	124·3	131·6	118·9	119·7	114·6	116·5	119·1	128·9	124·4	117·5	100·9
Mutton (Bone-in Weight)	59·8	44·9	45·7	38·4	40·9	49·5	51·4	52·1	49·1	46·8	51·7	55·1	62·0
Lamb (Bone-in Weight) ..	15·0	28·2	27·4	24·6	24·0	28·8	26·9	26·0	26·2	27·7	28·4	31·9	37·8
Pork (Bone-in Weight) ..	10·4	7·4	7·2	6·8	7·3	5·8	7·7	10·2	9·7	8·7	11·2	10·7	10·8
Offal	8·4	8·4	9·6	8·8	9·1	10·3	10·6	10·7	10·2	10·4	11·5	12·0	11·5
Canned Meat (Canned Weight)	†	2·4	3·6	3·2	2·5	2·0	2·0	3·0	3·4	3·5	4·0	4·7	3·2
Bacon and Ham (Cured Weight)	10·2	10·4	9·6	8·3	7·2	7·3	7·2	7·9	7·5	6·8	7·0	7·1	6·7
Total (In terms of Carcase Weight)	253·0	228·1	232·9	226·6	214·8	227·7	223·5	231·6	231·6	237·4	243·6	239·8	232·9

* Subject to Revision.

† Included under Fresh Meat.

Source: Commonwealth Bureau of Census and Statistics.

In Figure 1 per caput expenditure on meat (lamb, mutton, beef and pork) and per caput income are depicted. The points representing the years 1948-49 to 1950-51 are somewhat separate, from 1951-52 onwards the points lie on a line which can be described as

$$Y_1 = \frac{Y_2^{0\cdot913}}{6\cdot26} \;;\; r = 0\cdot944 \;;\; s_b = 0\cdot121$$

where Y_1 represents the expenditure in shillings on all meats and Y_2 annual income per caput in shillings. In other words, as the coefficient of Y_2 does not differ significantly from one, an increase in income of, say, one per cent

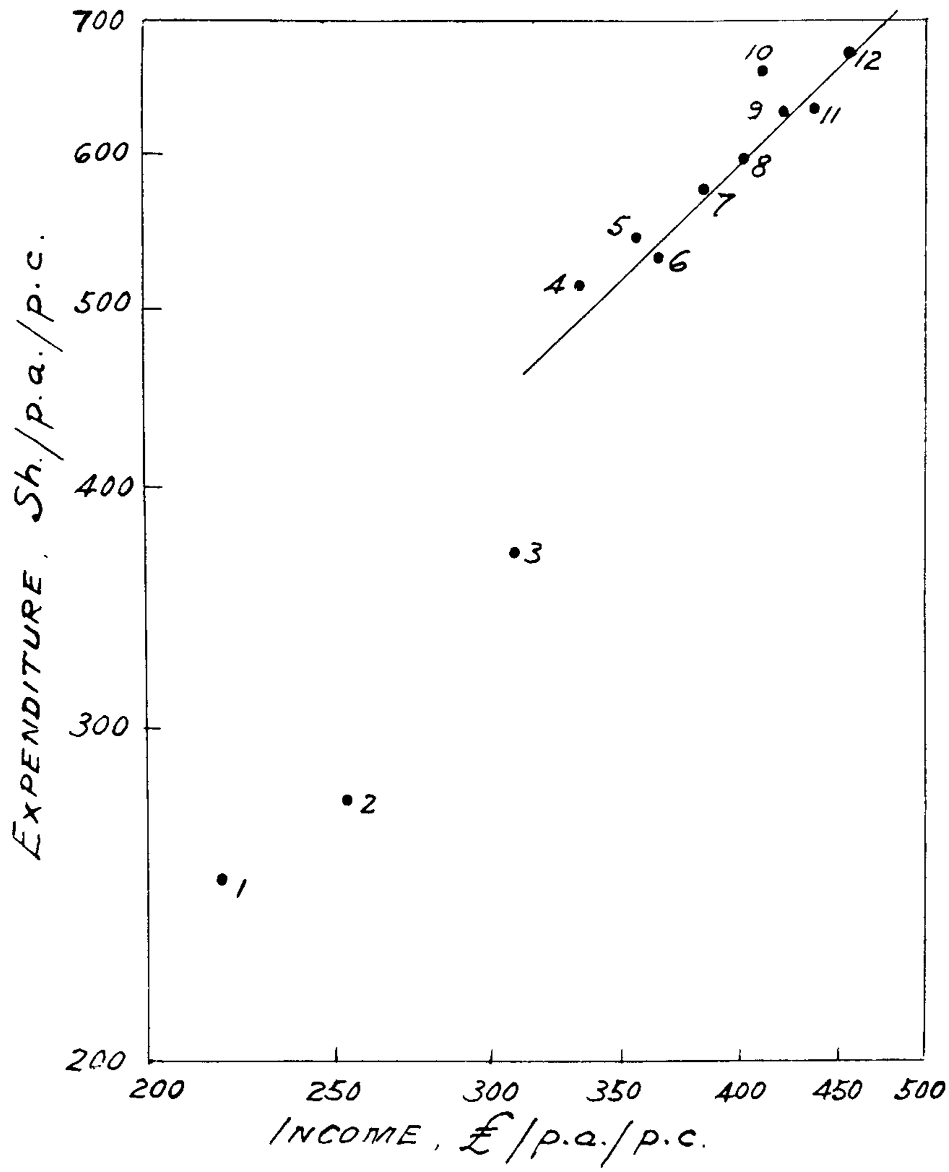

Fig. 1. Expenditure on All Meats per Caput, per Annum in Shillings and per Caput Income in £ on log. scale. The numbers represent years, viz. 1 = 1948-49 to 12 = 1959-60.

has been associated with a similar increase in expenditure; the expenditure on meat therefore seems to have kept pace with increases in money income.

The amount spent on all meat tells us little, however, about the quantities of particular types of meat consumed. Reference to Table 1 will show that, whilst total meat consumption has changed relatively little, the composition of meat consumption has undergone considerable change; the consumption of lamb has increased at the expense of beef and mutton.

4. CONSUMPTION OF LAMB AND BEEF

The following notation has been used in this section:—

p_1 and p_2 respectively, retail prices of lamb and beef.

q_1 and q_2 respectively, per caput consumption of lamb and beef.

Q_1 and Q_2 aggregate consumption in Australia of lamb and beef.

y income.

All data are in logarithmic form.

The consumer shopping for meat is faced with a price structure on which, as an individual, he cannot exert any influence. The quantities of lamb and beef bought by him can, therefore, be expected to be determined mainly by three factors, namely the price of the commodity, the price of competing commodities and income.

In a least square single equation analysis it was found that the consumption of lamb is influenced significantly by the price of beef and the consumption of beef by the price of lamb. Attempts were made to introduce other variables relating to prices of other meats (poultry in particular) but no significant improvements were noticeable when this was done.

The following equation, obtained by least squares analysis, represented the relationship between the consumption of lamb and its price, the price of beef and income.[4]

$$q_1 = 1{\cdot}52045 - \underset{(0{\cdot}01250)}{1{\cdot}18406\, p_1} + \underset{(0{\cdot}04000)}{0{\cdot}91264\, p_2} + \underset{(0{\cdot}07550)}{0{\cdot}22529\, y}\ ; \quad R = 0{\cdot}970.$$

The figures in brackets indicate the standard errors of the regression coefficients. The co-efficient of p_1 and p_2 are significant at the one per cent level ($|t|$ resp. 94.7 and 22.8) and of y at the two per cent level ($|t| = 2.981$).

[4] Problems raised by collinearity have been ignored at this stage.

In Table 2 actual consumption is compared with consumption calculated by the above equation.

TABLE 2

Actual and Calculated Annual Consumption of Lamb, per Caput, 1948-49 *to* 1959-60

Year ended June	Consumption	
	Actual	Calculated
	lb.	lb.
1949	28·2	28·9
1950	27·4	26·4
1951	24·6	24·5
1952	24·0	24·2
1953	28·8	28·4
1954	26·9	25·6
1955	26·0	26·6
1956	26·2	26·9
1957	27·7	28·2
1958	28·4	27·9
1959	30·8	32·1
1960	37·8	36·7

The same type of relationship can be calculated for beef and is expressed by the following equation:—

$$q_2 = 1{\cdot}90612 + \underset{(0{\cdot}01719)}{0{\cdot}48582\, p_1} - \underset{(0{\cdot}05499)}{0{\cdot}71458\, p_2} + \underset{(0{\cdot}10386)}{0{\cdot}40038\, y}\ ; \quad R = 0{\cdot}817.$$

All regression coefficients are significant at the one per cent level. Table 3 compares actual with calculated beef consumption.

TABLE 3

Actual and Calculated Annual Consumption of Beef, per Caput, 1948-49 *to* 1959-60

Year ended June	Consumption	
	Actual	Calculated
	lb.	lb.
1949	121	118
1950	124	129
1951	132	131
1952	119	120
1953	120	114
1954	115	122
1955	116	120
1956	119	121
1957	129	121
1958	124	117
1959	114	114
1960	101	105

While the least squares single equation approach provides us with the best means of prediction, there is a possibility that the coefficients are biased due to the fact that the quantities of each commodity available affect both prices simultaneously. In order to solve the equation simultaneously it is necessary to build a model with:—

$$Q_1 = b_{11}\, p_1 + b_{12}\, p_2 + c_{11}\, y, \quad \text{and}$$
$$Q_2 = b_{21}\, p_1 + b_{22}\, p_2 + c_{21}\, y$$

As the quantities consumed are considered as predetermined variables (at a later stage this assumption will have to be relaxed) the two equations are just identified.[5] When the two endogenous variables p_1 and p_2 are expressed as functions of the exogenous or predetermined variables, we obtain the two reduced form equations which can be fitted by the least squares methods and have the following form:—

$$p_1 = B_{11}\, q_1 + B_{12}\, q_2 + C_{11}\, y$$
$$p_2 = B_{21}\, q_2 + B_{22}\, q_2 + C_{21}\, y$$

Expressed as deviations from the mean the equations become:—

$$p_1 = -0{\cdot}78675\, Q_1 - 0{\cdot}56957\, Q_2 + 1{\cdot}79232\, y; \quad R = 0{\cdot}985$$
$$p_2 = -0{\cdot}16982\, Q_1 - 0{\cdot}76974\, Q_2 + 1{\cdot}83669\, y; \quad R = 0{\cdot}984$$

If the B matrix is inversed the b coefficients are found to be as follows:—

$$b_{11} = -1{\cdot}51264$$
$$b_{12} = 1{\cdot}11927$$
$$b_{21} = 0{\cdot}333743$$
$$b_{22} = 1{\cdot}54606$$

These coefficients may be compared with those arrived at by the single equation least square method where:—

$$b_{11} = -1{\cdot}44824$$
$$b_{12} = 1{\cdot}00585$$
$$b_{21} = 0{\cdot}27392$$
$$b_{22} = -0{\cdot}56647$$

As can be seen, three of the coefficients are very similar, the exception being the b_{22} coefficient.

Tentatively it may be assumed that a change of ten per cent in the quantity of lamb on the market has been associated with a change in price of between seven and eight per cent, whilst a ten per cent change in the quantity of beef was associated with a five per cent change in the price of lamb (both in the opposite direction as sign is negative).

In the case of beef the relations are, at present, less clear. Apparently a change of ten per cent in the lamb price has led to a change in the quantity of beef consumed of about three or four per cent. The b_{21} coefficients, however, differ considerably and at this stage it is impossible to arrive at even tentative conclusions. The same remark may be made regarding income elasticities. Apart from attempts to obtain more reliable basic data, future work will be directed towards the building of better models and the introduction of lagged variables.

[5] A considerable amount of literature on simultaneous equations is available. A good introduction may be found in Gerhard Tintner, *Econometrics* (New York: John Wiley & Sons Inc., 1952), Ch. 7.

5. RETAIL AND WHOLESALE PRICES

Before examining the wholesale prices of lamb during the post-war period it might be appropriate to consider the spread between wholesale

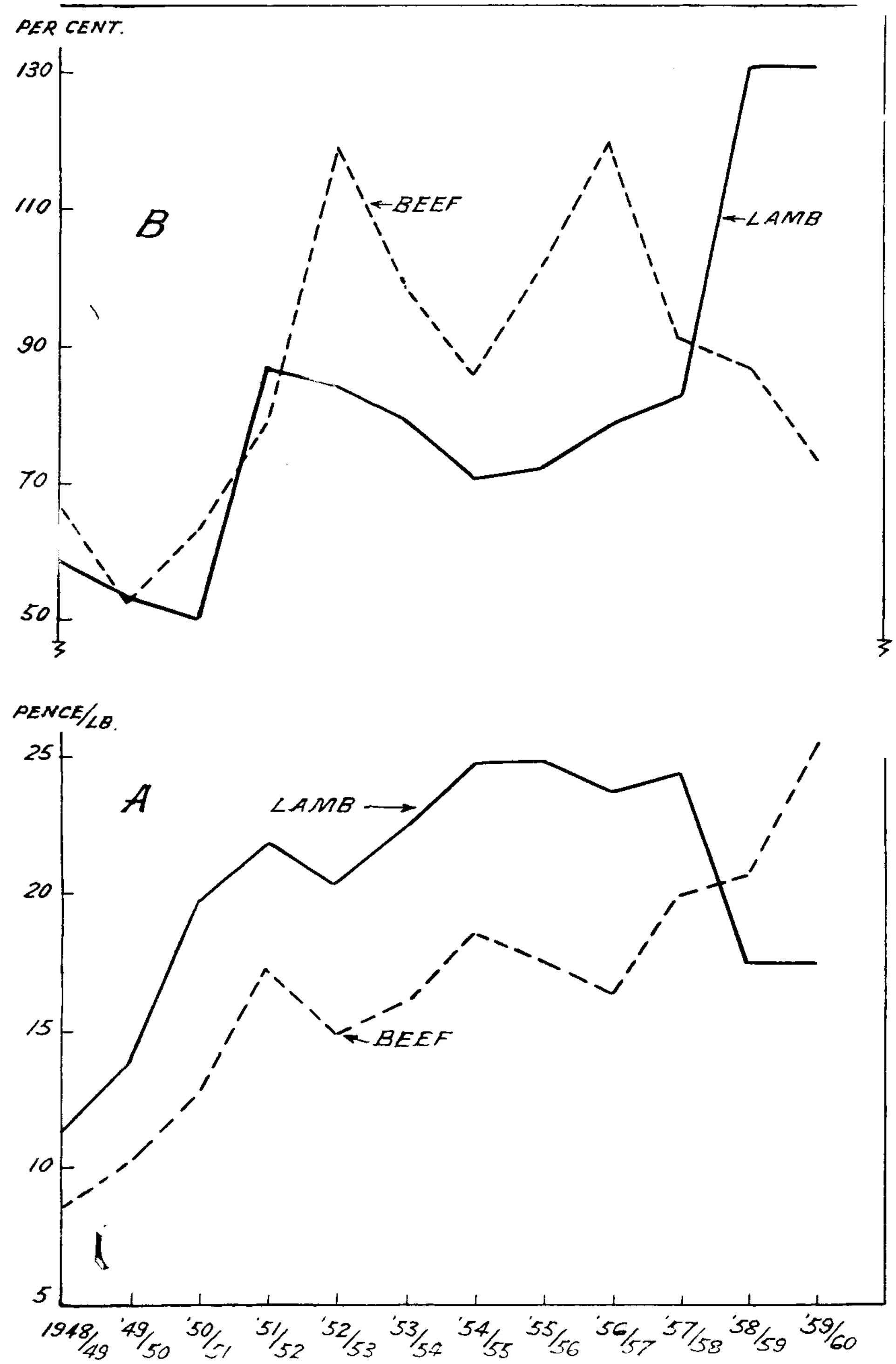

Fig. 2. Average Wholesale Prices, Pence per lb. of Beef (Steer) and Lamb (A) and Margins Between Average Annual Wholesale and Retail Prices of Beef and Lamb Expressed as a Percentage of the Wholesale Price (B).

and retail prices. Although no appropriate absolute figures are available, an indication of the trend in margins may be obtained by comparing retail prices with wholesale prices over a number of years. The margins thus arrived at are not valid in an absolute sense but are useful to compare changes from year to year.

In figure 2 the wholesale prices (in pence per lb.) of beef and lamb (A) and the margins (B) have been graphed. Apparently margins decreased relatively when prices rose during the late 'forties, but as further price rises occurred margins increased sharply, particularly for beef. In the late 'fifties, with the price of beef rising and the price of lamb falling, margins for beef fell sharply but lamb margins rose. To some extent, then, these margins are witness of (*a*) the rigidity of prices at the retail level in the comparative short run and (*b*) the ability of the trade to pass on rising wholesale prices plus increased costs of distribution if the series is taken as a whole. The graph also suggests that during the last few years distributors have been able to compensate themselves for the low margin they could obtain on beef by increasing the margin on lamb.

This impression is further strengthened when the absolute figures are observed. Year to year percentage fluctuations in wholesale prices have been of a greater magnitude than fluctuations in retail prices. When price fluctuations over two-year periods are considered, however, fluctuations in retail prices have been greater.

6. THE WHOLESALE PRICE OF LAMB

The wholesale price of lamb and New South Wales production of lamb are shown in Figure 3. This graph is self-explanatory; there was an increase in price despite an increase in production in the middle 'forties; then production fell as producers turned temporarily to wool, while prices kept on rising; a period of relative stability in the mid 'fifties was followed by sharp changes, both in price and production.

When a trend line is drawn in these graphs[6] and the deviations from this trend are plotted (Fig. 4) a fairly regular pattern appears. This, and the movement of the trend line suggest that changes in the wholesale price are closely associated with changes in supply and income. When the data are processed the following equation is arrived at:—

$$X_1 = 12{\cdot}82 + \underset{(0{\cdot}00537)}{0{\cdot}06413}\, X_2 - \underset{(0{\cdot}05187)}{0{\cdot}30549}\, X_3 \; ; \; R = 0{\cdot}961,$$

where X_1 = wholesale price of lamb in pence per lb.

X_2 = per caput income £ per annum.

X_3 = N.S.W. production of lamb '000 tons.

The figures in brackets under the regression coefficients are the respective standard errors. Both coefficients are significant at the one per cent level. Actual prices and prices calculated by means of the above equation are shown in Table 4.

[6] The trend lines are represented by:
$Y_1 = 8.54 - 0.41\,X + 0.48\,X^2 - 0.03\,X^3$ and
$Y_2 = 23.74 + 13.55\,X - 2.12\,X^2 + 0.10\,X^3$ where Y_1 and Y_2 are respectively the trend values for price and production and X is the year, 1945-46 = 1.

TABLE 4

Actual and Calculated Wholesale Prices of Lamb, 1945-46 *to* 1959-60

Year ended June	Wholesale Price	
	Actual	Calculated
	Pence Per Pound	
1946	9	10
1947	10	10
1948	11	12
1949	11	10
1950	14	12
1951	20	20
1952	22	23
1953	20	20
1954	22	22
1955	25	23
1956	25	24
1957	24	24
1958	24	24
1959	18	21
1960	18	18

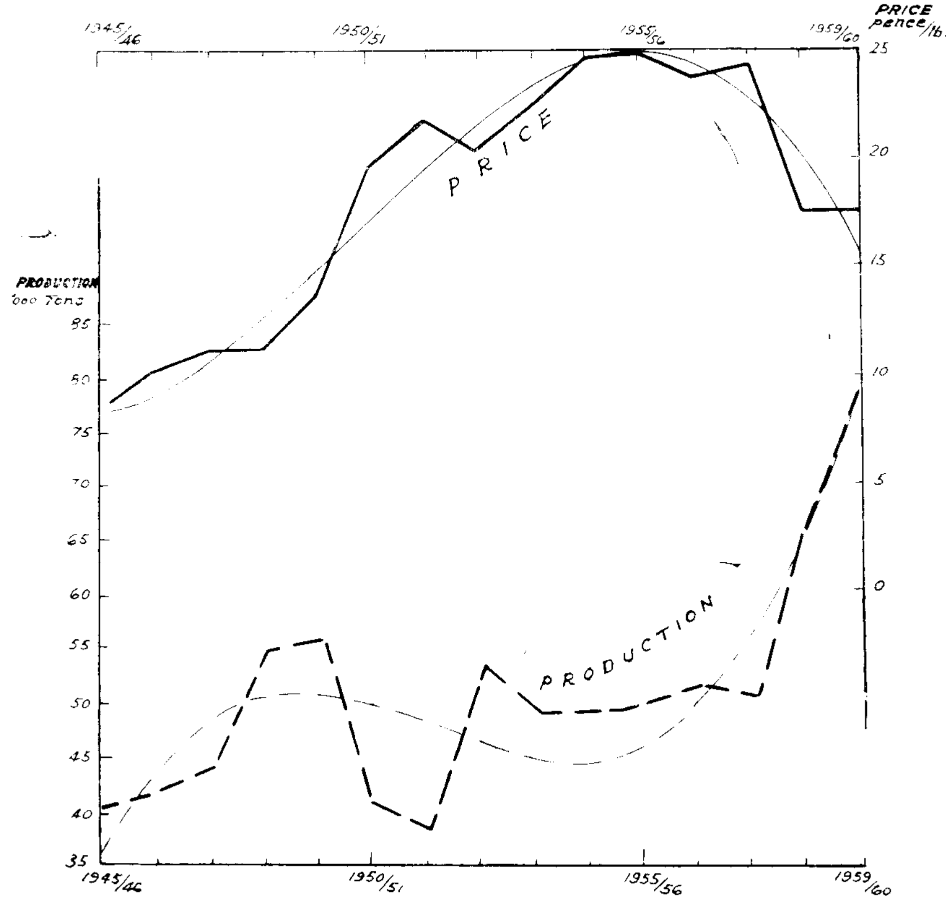

Fig. 3. Wholesale Prices of Lamb, Pence per lb. and New South Wales Production in '000 tons, 1945-46 to 1959-60.

The graph showing the deviations from the trend also suggests that there is a fairly regular price-production cycle with a duration of four years. This cycle was, however, disturbed during the middle and late 'fifties. Some of this apparent disturbance must be attributed to the fact that any calculated trend suffers from the defect that it "cuts corners", when sharp changes occur in the data. The graph suggests, in any case, that prices of fat lamb have some influence on the supply, with a lag of one to two years. However, before any significant conclusions can be drawn from this further research is necessary.

As the data has not been analysed in terms of logarithms the regression coefficients give no indication of elasticity and indeed it can be shown that elasticity has changed during the period. The partial derivatives of the function are $\frac{d\,X_1}{d\,X_2} = 0{\cdot}06413$ and $\frac{d\,X_1}{d\,X_3} = 0{\cdot}30549$ and the partial elasticities:

$$\text{(1) for income:}\quad \frac{EX_1}{EX_2} = \frac{0{\cdot}06413X_2}{12{\cdot}82 + 0{\cdot}06413X_2 - 0{\cdot}30549X_3}$$

and

$$\text{(2) for supply:}\quad \frac{EX_1}{EX_3} = \frac{-0{\cdot}30549X_3}{12{\cdot}82 + 0{\cdot}06413X_2 - 0{\cdot}30549X_3}$$

These equations can be solved for different points on the curve. If we use the data of the 1959-60 period, $X_2 = 460$, $X_3 = 70$ we obtain

$$\text{(1)}\ \frac{EX_1}{EX_2} = 1{\cdot}4$$

$$\text{(2)}\ \frac{EX_1}{EX_3} = -1{\cdot}0$$

An interpretation of the foregoing is that at the given levels of supply and income:

(1) a 1 per cent change in income will be associated with a change in price of approximately 1.4 per cent, and

(2) a 1 per cent change in supply will be associated with a change in price of approximately 1 per cent (in the opposite direction as the sign is negative).

For data applying about 1955, viz.:

$X_2 = 400$, $X_3 = 50$ the elasticities are

(1) income 1.1

(2) supply —0·66

and about 1950, $X_2 = 300$, $X_3 = 40$:

(1) income 0·97

(2) supply —0·62

Throughout most of the period, then, increases in income of a certain magnitude have been accompanied by increases in prices of about the same magnitude or, in other words, prices and therefore gross returns to fat lamb producers, have kept pace with increases in the money income of the population in general if supply is kept stable. Price elasticity with regard to supply, however, has changed considerably as supplies increased. Early in the 'fifties an increase in supply led to a proportionally smaller fall in price, with the result that total gross returns increased. At present, however, gross returns cannot be increased by greater output and if this trend continues it may pay lamb producers as a whole not to expand output any further as this will result in a curtailment of total returns.

There is a possibility, however, that elasticities arrived at by the single equation approach are biased in this case as the supply of lamb in any one year might be influenced by current price. Although it is unlikely that prices would influence supply to any great extent, it might be sufficient to upset any ideas formed on the basis of a simple equation. Therefore, besides the introduction of lagged values, which to date has not been done, a simultaneous approach must be attempted. Considerably more work in this direction will have to be done but at present no satisfactory results of this model building have been achieved.

The basic model which might prove the most promising for further investigation is, in its simplest form, as follows:

(1) demand curve: $p = a + by$

(2) supply curve: $q = a'p + b'n$.

Where: p = adjusted price of lamb, q = quantity of lamb supplied, y = adjusted price of beef and n = number of lambs marked at the beginning of the year. No account has been taken of export as relatively little lamb or beef is exported from New South Wales. Prices of lamb and beef have been adjusted by means of money income in order to reduce the number of variables as much as possible. When these two equations are solved by the least square method, they become:

(1) demand: $P = 12{\cdot}53 - 0{\cdot}109\ Q + 0{\cdot}228\ Y$; $R = 0{\cdot}949$.
(2) supply: $Q = 72{\cdot}45 - 5{\cdot}484\ P + 1{\cdot}801\ W$; $R = 0{\cdot}955$.

In case of the demand curve the standard errors of the coefficients of q and y are respectively 0.013 and 0.194. This already augurs ill, for the coefficient of y is not significant. If we nevertheless persist and solve the two equations simultaneously we arrive at the following results:—

Let us denote lamb price by x_1, lamb supply by x_2, beef price by n, and lambs marked by v_1. The demand equation then can be expressed by $b_1x_1 + b_2x_2 + c_1 u_1 = \varepsilon$. The means are:—

$$\begin{aligned} \varepsilon \text{ of } x_1 &= 8{\cdot}5067 \\ x_2 &= 50{\cdot}9400 \\ u_1 &= 6{\cdot}6667 \\ v_1 &= 13{\cdot}9549 \end{aligned}$$

and the product moment matrix.

	x_1	x_2	u_1	v_1
x_1	21·63	—175·34	—2·78	—31·48
x_2	....	1,702·04	42·60	327·73
u_1	....	....	8·13	6·11
v_1	....	....	....	86·08

The reduced form equations are:—

$$x_1 = -0{\cdot}07083\ u_1 - 0{\cdot}36071 v_1$$

and

$$x_2 = -2{\cdot}51250\ u_1 + 3{\cdot}62848 v_1.$$

The estimated structural coefficient is:

$$-0{\cdot}36071\ b_1 + 3{\cdot}62848 b_2 = 0$$

Normalize by $b_1 = -1{\cdot}00000$
then $b_2 = 0{\cdot}09412$

C_1 can then be calculated as 0.30730, and the structural equation:

$$X_1 = 0{\cdot}09412\ x_2 + 0{\cdot}30730\ u_1$$

If we assume that the best fit passes through the means, and introducing the original notation, the demand function becomes:

$$P = 1{\cdot}67 + 0{\cdot}094\ Q + 0{\cdot}307\ Y$$

Although the coefficient of Y now differs little from that calculated by the single equation method (0.307 as against 0.228) the coefficient of Q has changed its sign and has now become positive, which intuitively seems wrong.

From the preceding paragraphs it may be gathered that considerably more work has to be done on this problem. It seems safe to assume that the main factor which has contributed to the decline in wholesale prices over the past few years has been the increase in supply and that producers as a whole have benefited little by this increase in production as prices have declined proportionally. On the other hand, it seems safe to conclude that limiting production also will have little effect unless the marginal cost of production is fairly high.

7. THE SUPPLY OF LAMB

In the attempt to explain long run fluctuations in the supply of fat lambs, attention was paid mainly to changes in the price of fat lamb, the wool price and the price of wheat. Whilst the deviations from the trend in price and production in the same year were highly correlated in the period

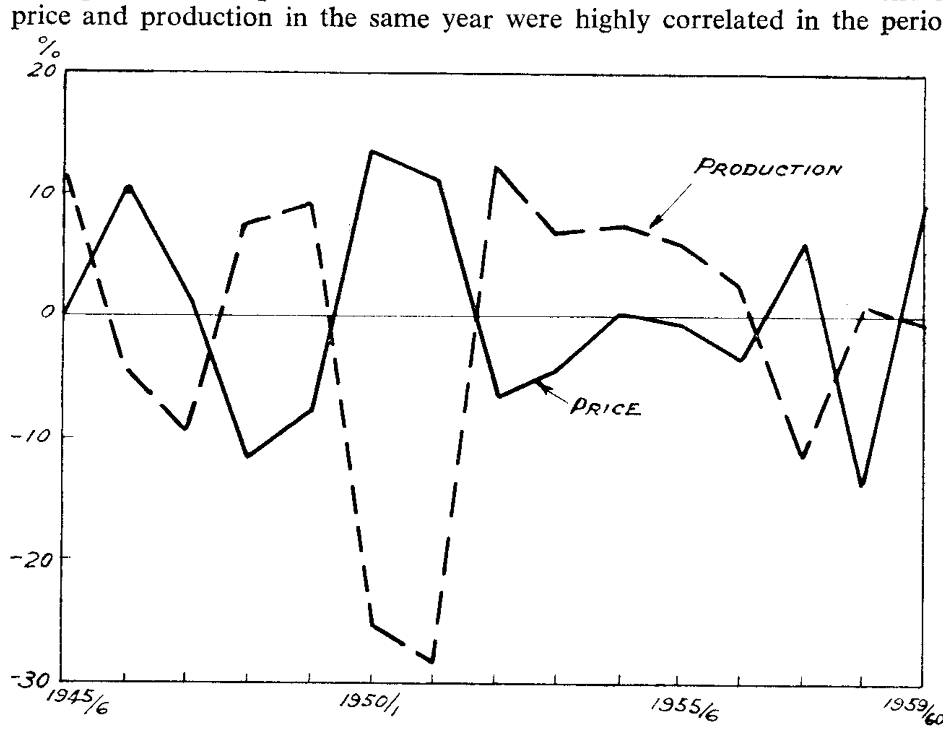

Fig. 4. Deviations from the Trend of Wholesale Prices of Lamb and Production, 1945-46 to 1959-60.

1945-46 to 1959-60 (r — 0.717, 1 per cent significance) a highly significant correlation (0.664, 1 per cent) could also be established between deviations from the price trend in period t and deviations from the production trend in period t_{+2}. For example, a price above the trend in 1946-47 was followed by production above the trend in 1948-49, etc. This can be seen from Figure 4.

Although at this stage no definite relationship between the wheat price and the fat lamb supply can be established, in the case of wool this is different.

In Figure 5 are graphed the percentage changes in the price of wool, 1925-26 to 1958-59, and these changes are compared with the percentage change in fat lamb production in the year following; the war years and the immediate post-war period have been ignored. With the exception of the fall in the price of wool in 1926-27, which was followed the next year by a fall in fat lamb supply, and the late 'thirties, a change in the price of wool has usually been followed the next year by a change in fat lamb supply in the opposite direction.

For the post war period this association can be expressed by the equation:[7]

$$X_1 = 0{\cdot}166 - 0{\cdot}640\ X_2,\ r = -0{\cdot}873$$

Where X_1 represents the logarithm of the percentage change in lamb supply in the year t_{+1} and X_2 represents the logarithm of the wool price in the year t. The fact that these changes are marginal only is, of course, not surprising. A hard core of wool producers and of fat lamb producers exists and only the fringe of these two types of producers will (or can) shift production from wool to fat lamb and vice versa.

The one year lag was the only relevant association that could be established and the following are correlation coefficients with different lags:—

no lag	0.143
one year	−0.873
two years	0.114

The absence of any association if no lag is assumed would suggest that it takes producers some time to react to a change in wool price. This point has been in dispute, some observers having been under the impression that the diversion of lambs either to future wool production or to fat lamb production was immediate.

The introduction of other years, besides the lagged year, does little to improve the correlation coefficient. For instance, for the whole series from 1925-26 onward the correlation coefficient between changes in wool price in period t and the change in fat lamb production t_{+1}, r—0.522 (1% significant); if the wool price t_{+1} is also introduced the correlation coefficient, R= 0.525, is not substantially higher.

[7] Negative observations have been transformed as if the observation was positive and then the sign was appended. In transforming results the reverse procedure must be followed. E.g. — 1, should be transformed to — 10, *not* to 0.1. This procedure was thought simpler than using $\sinh^{-1}x$.

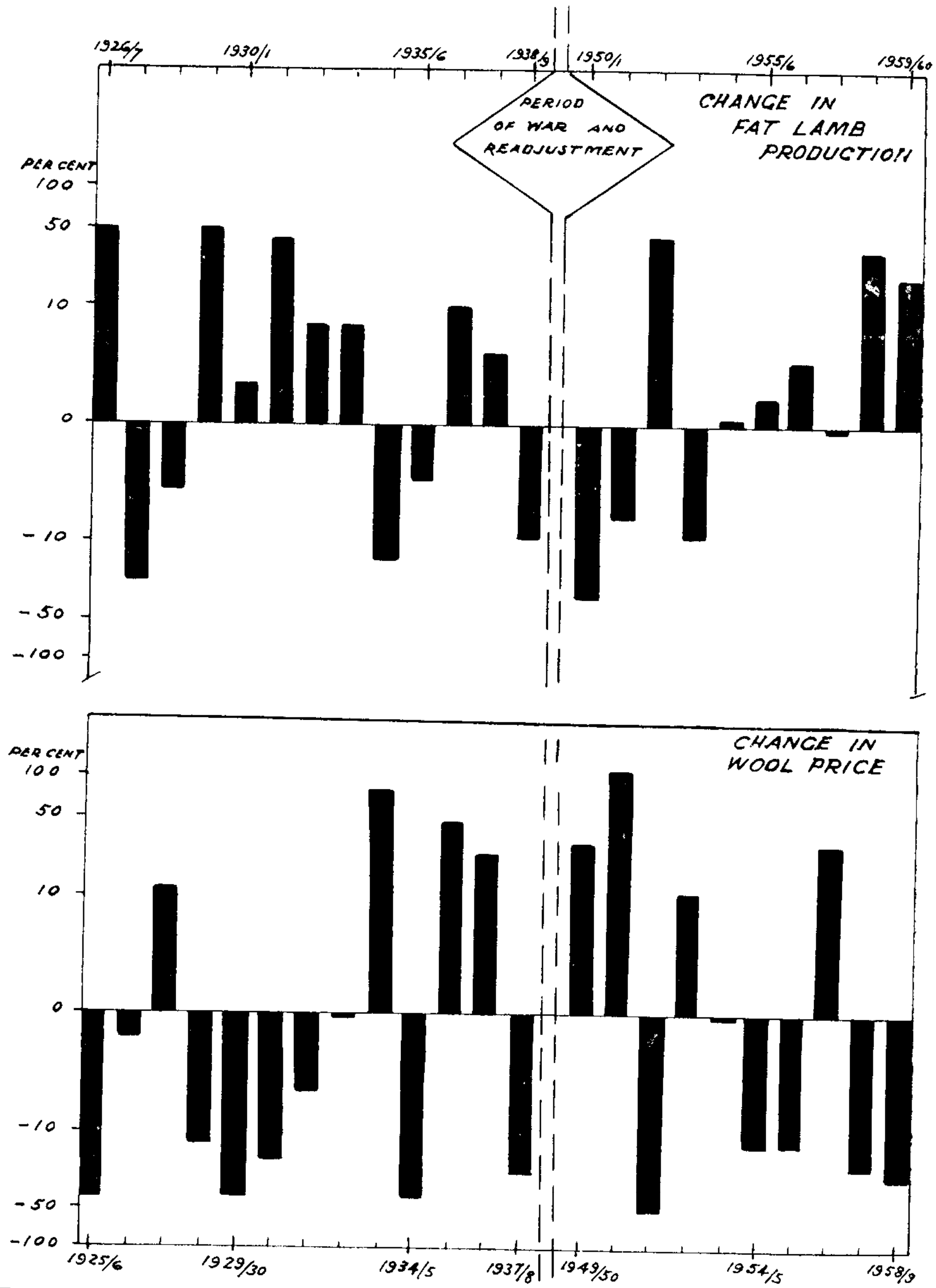

Fig. 5. Percentage Change in the Price of Wool (Sydney Index) 1925-26 to 1958-59 and Percentage Changes in Fat Lamb Production 1926-27 to 1959-60.

8. SEASONAL LAMB PRICE FLUCTUATIONS

Wholesale prices of fat lamb as observed at the Homebush auction sales follow a fairly regular seasonal pattern. Although, at present, such a pattern has been established for the carcase only, it may be expected that a similar pattern exists for the whole animal as skin values do not seem to be subject to any regular seasonal change. In Figure 6 the seasonal price pattern (expressed as percentage deviations from the trend established by the moving average method) has been graphed. Although monthly supply data are rather difficult to obtain, it may be expected that these price fluctuations are narrowly associated with seasonal fluctuations in supply. They conform to expectations based on supply fluctuations, with a period of high supply and low prices during the late spring-early summer months and a relative shortage of supply during the late summer months and again in late winter. These fluctuations mirror the availability of feed and periods of lambing. To what extent the producer is able to take advantage of the high price period and can avoid the troughs is outside the scope of this enquiry. The possibilities of doing so will vary from district to district and even from property to property in any one area.

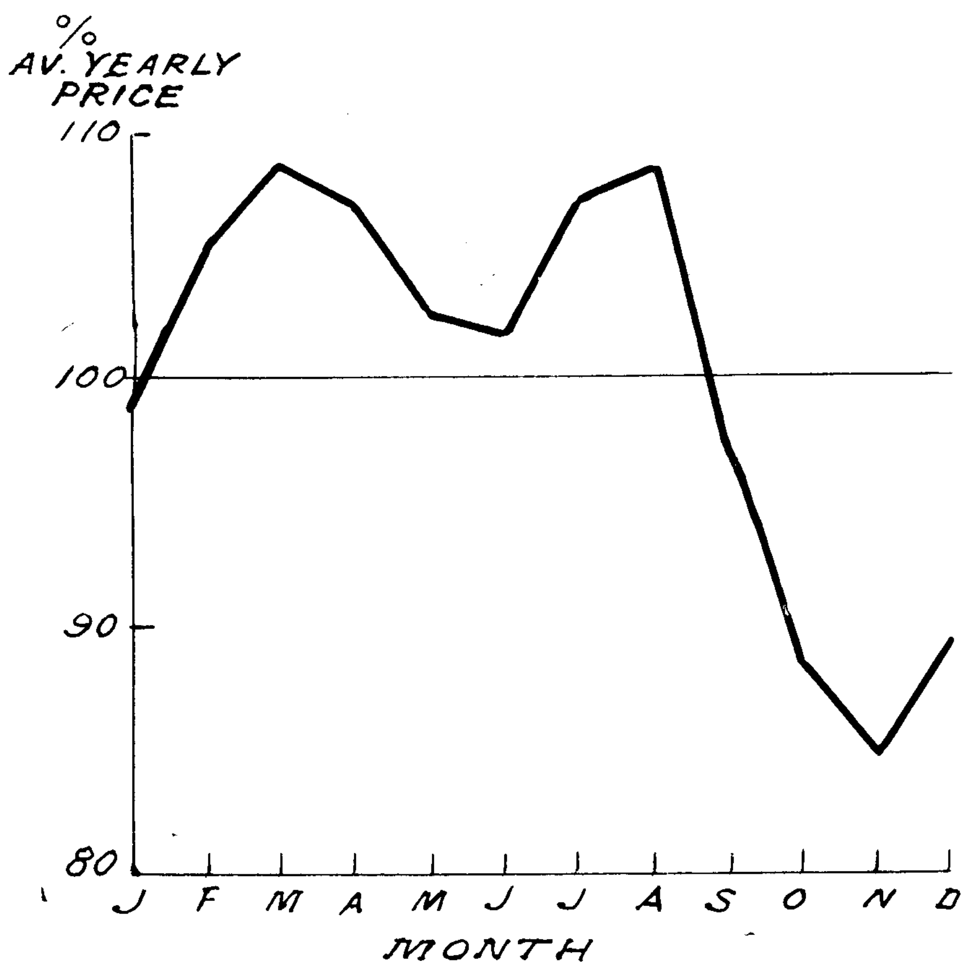

Fig. 6. Seasonal Pattern of Lamb Prices at Homebush Auction Sales, 1946 to 1960. Average Percentage Deviation per Month from Moving Average Trend.

It might be expected that, to a considerable extent, the higher price will be absorbed by higher costs of feeding and lower fertility. However, only from experimental data could a firm conclusion be drawn as to what extent these higher costs would offset price increases.

The seasonal price pattern is well established as the analysis of variance below shows:—

Sources of variation	*D.f.*	*Sum of Squares*	*Mean Square*
Between means of years	13	4183	....
Between means of months	11	387	35·18
Remainder	143	1059	7·41
Total	167	5629	33·71

F = 4·748 and significant at the one per cent level.