MARKETING AUSTRALIAN BEEF AND EXPORT DIVERSIFICATION SCHEMES*

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The Australian Meat Board (AMB) can influence the quantities sent to and the prices received for Australian beef and veal in the domestic and various export markets. Through its power to grant export licences and the conditions to be met in obtaining export licences the AMB can adopt the role of a price discriminating monopolist without supply control. This paper evaluates the price, quantity, efficiency and distribution effects of the export diversification scheme introduced by the AMB in 1968, of some modified schemes proposed in 1976, and of an alternative system whereby rights to export to premium export markets with quota restrictions are auctioned.

Market Background

In this section we highlight some findings of previous studies of the market for Australian beef and veal[1] and, in particular, isolate those characteristics which have a critical influence on the need for and the effect of AMB initiatives to influence the level and country distribution of exports. About a half of Australian beef and veal production is sold on the domestic market (Table 1). To a large extent the domestic market can be categorized as a freely competitive market in the senses that individual cattle producers, wholesalers and retailers have insignificant market power and that government policy has little direct effect on the supply of and domestic demand for beef and veal. Studies of the demand for beef and veal show that Australian demand at retail is responsive to its own price;[2] estimates reported in Appendix 1 indicate an own price elasticity greater than unity at relatively high prices (e.g. at 1973 prices) and less than unity at relatively low prices (e.g. at 1975 prices). Griffith's [5] study of meat marketing margins supports the hypothesis of an absolute cost margin between retail, wholesale and auction beef prices,[3] and in this situation the auction or farm price elasticity of demand for beef is much lower than the retail elasticity (Table A1). Studies by Papadopoulos [10] and others find a close correlation between average export and auction beef prices. Hence, sales of beef and veal to the domestic market are responsive to the domestic retail price which is closely related to the average export price.

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[1] For a recent review article see Reeves and Hayman [12].

[2] A survey of previous studies is reported in Reeves and Hayman [12] and in Main, Reynolds and White [7].

[3] Strictly speaking, because of price levelling in the short term—a period of three months as measured by Griffith—the statement is valid only for a longer term and is based on the finding that the sum of the estimated parameters on the current price and lagged price variables is not significantly different from zero.

TABLE 1

*Production and disposal of Australian beef to domestic
and export markets*

	Average 1971-2 to 1973-4		1974-5		1975-6	
	'000 tons	% of production	'000 tons	% of production	'000 tons	% of production
Production	1,305	100	1,534	100	1,784	100
Disposal:						
Domestic Consumption	518	40	868	57.	904	51
Exports	787	60	666	43	880	49
Exports to:						
U.S.A.	468	36	458	30	489	27
Canada	38	3	45	3	56	3
Japan	121	9	24	2	109	6
France, Germany, Italy	5	—	3	—	3	—
U.K.	101	8	26	2	14	1
Other countries	54	4	109	7	208	12

Notes:

1. Quantities in estimated carcase weight. The export figures are recorded in product weight. They have been specified in the Table in carcase weight with one ton product weight approximately equal to 1.6 tons carcase weight equivalent.
2. Figures for 1975-6 are preliminary.
3. *Sources:* Australian Bureau of Statistics, *Overseas Trade,* various issues, and *The Meat Industry* 1974-5, and Bureau of Agricultural Economics, *BAE Trends,* June 1976.

The international market for traded beef is dominated by a few principal exporting and importing countries. Further, because of health regulations Australia and New Zealand are the principal exporters to the important North American and Japanese markets. Beef import demand by the principal importing countries is dominated by national policy objectives rather than by principles of free trade. Particularly during periods of relatively low world export prices access to the import markets is often restricted by quotas and prohibitive tariffs and levies.

Imports to the U.S.A., a market which takes about a third of Australia's production or two thirds of her exports (Table 1), are regulated either directly or under the shadow of the 1964 Meat Import Quota Law. In effect imports have been allowed free entry (subject to a 6.6 cents per kg tariff) up to a quota level which is proportional to the past level of U.S.A. production. The quotas are designed to protect the domestic industry from relatively low priced beef imports. The sive,[5] and probably highly price responsive, in periods of relatively high prices.[4] Thus, the U.S.A. demand for Australian beef is price responsive,[5] and probably highly price responsive in periods of relatively high

[4] For a discussion of how changes in the performance of the U.S.A. livestock sector have been associated with changes in beef import quotas see Rausser and Freebairn [11].

[5] In fact, in this situation the demand for Australian beef probably can be represented by the free trade model of import demand. Even allowing for the fact that imported Australian beef is manufacturing beef, it represents a small portion (less than 15 per cent) of U.S.A. manufacturing beef consumption.

U.S.A. beef prices (e.g. 1973-74) and price unresponsive in times of low and average prices (e.g. between 1968 and 1973 and since 1974).

The nature of Canadian demand for beef imports seems to be similar to that of the U.S.A., though Canadian import policy has not been formalized to the same extent. Canada has operated beef import quotas as a means of protecting its domestic industry and it has expressed concern when beef imports enter the country at significantly lower prices than they enter the U.S.A.

Imports of beef and veal into Japan are strictly controlled by a global Import Quota scheme.[6] The quota level is set primarily with reference to a 'fair' price to producers and to a lesser extent to consumers and to the goal of self sufficiency. Domestic prices have been far in excess of the import parity price—approximate estimates by Longworth [6, pp. 33-35] suggest that 1976 wholesale prices were at least double the import parity price. The import quotas are allocated by the Japanese government to Japanese importers and levies are set to absorb excess profits. On several occasions the Japanese government has noted its desire for the exporting countries to retain their traditional shares of the global quota. For these reasons the Japanese demand for Australian beef and veal is unlikely to be very responsive to the Australian export price.

E.E.C. beef and veal imports are regulated primarily by a system of variable levies although these may be supported by import quotas during periods of excess supplies (as has been the case since 1975).[7] Particularly during periods of relatively low world traded beef prices, prices in the E.E.C. are above import parity prices. Since Australia has to compete against Latin America as well New Zealand exports for access to the E.E.C. market the demand for Australian beef and veal is likely to be price responsive within quantities specified by the aggregate E.E.C. import requirement.

Australian beef and veal exports into other countries (i.e., excluding U.S.A., Canada, Japan and E.E.C.) have been growing in importance and in 1975-6 these markets accounted for an estimated 12 per cent of Australian production (Table 1). While the group includes countries with a diversity of policy arrangements, for the purposes of this paper they are denoted as price responsive beef markets. Crude estimates reported in Appendix 2 of the demand function of these countries for Australian beef suggest a secular expansion in demand (associated with income growth, promotion, taste changes, etc.) and a price responsive demand with an elasticity estimate with respect to average Australian export prices slightly in excess of unity.

To facilitate and to simplify the analysis of the price and quantity effects of alternative export diversification schemes it is convenient to classify the market for Australian beef and veal as being composed of four sub-markets.

[6] For a detailed discussion of the Japanese beef industry see Sault and McCumstie [15] and Longworth [6].

[7] For further details on the EEC beef industry see Roberts and Miller [14] and Reeves and Hayman [12]. Under a GATT arrangement a small quantity of 22,000 tons per annum enters the EEC duty free.

1. The Australian market which is price responsive
$$q_a = f_a (p_a) \qquad (1)$$
where q_a denotes Australian quantity demanded and p_a denotes Australian average price.

2. The U.S.A. market which is not responsive to Australian export prices (except at very high U.S.A. domestic or Australian export prices) and in which Australian quota exports generally receive a higher price than the Australian average price
$$q_u = k_u \text{ and } p_u > p_a \qquad (2)$$
where q_u denotes U.S.A. demand for Australian beef and veal, k_u denotes the quota on Australian exports, and p_u denotes the U.S.A. average price paid for Australian exports. In practice, and in some applications discussed below, it is appropriate to include Canada and Sweden in this sub-market.

3. The Japanese market in which demand for Australian beef is not price responsive and is predetermined by a quota, and in which the Japanese domestic price exceeds the import parity price (i.e. the world traded price) with the difference being absorbed by tariffs and levies.
$$q_j = k_j \text{ and } p_j > p_a \qquad (3)$$
where q_j denotes Japanese demand for Australian beef and veal, k_j denotes the Japanese quota to Australia, and p_j denotes the average Japanese price. On occasions it may be appropriate to include the E.E.C. in this sub-market.

4. A third group of other importing countries in which the demand for Australian beef and veal is responsive to the Australian export price.
$$q_r = f_r (p_r) \qquad (4)$$
where q_r denotes other importing countries demand for Australian beef and veal, and p_r denotes the price paid for Australian beef and veal by other countries.

Clearly the foregoing description of the demand for Australian beef and veal represents a simplification of reality. For example, it is a highly aggregated picture, it ignores transport costs, the role of multi- and bi-national agreements and understandings to provide 'reasonable access' to world markets and the quality differentials of beef and veal. With respect to the latter, while it is true that different markets have different quality requirements, and in some cases different parts of a carcase may be sent to several markets, marginal changes in the market allocation of Australian beef and veal sales may be achieved with small and low cost changes in beef production and processing activities. For the purposes of analysing market diversification schemes the simplified model captures some of the geographical and politically determined segregation of the market for Australian beef and veal, the different demand price response characteristics of these sub-markets, and the nature of and implications of national policies for the demand for beef and veal.

The 1968 Export Diversification Scheme

The 1968 export diversification scheme arose directly from the Australian government's agreement with the U.S.A. government to voluntarily limit Australian meat exports to the U.S.A. rather than

have the U.S.A. implement the 1964 Meat Import Law. The objectives of the diversification scheme as quoted in the 1969 AMB Annual Report (p. 13) were to 'allow exports of Australian meat to the U.S.A. to be regulated so that the danger of quotas being imposed was lessened, and to encourage the further development of alternative and new markets.' For every ton of beef sold to non-U.S.A. export markets Australian exporters earned diversification credits enabling them to send a certain quantity to the more lucrative U.S.A. market.

The diversification factor was determined by an AMB committee after consideration of forecasts of export availability and the voluntary U.S.A. quota. As a result of forecast errors the diversification factor frequently was revised. For instance between March 1969 and March 1973 it was altered 13 times (Table 2). Further, credits to export to

TABLE 2

Export diversification factors—beef and veal

Period of Operation	Ratio of 'Other Market' Exports to Export Permits to U.S.A.
1/11/68 to 14/3/69	1:1·78
15/3/69 to 14/5/69	1:3 ⎫ retrospective
15/5/69 to 8/8/69	1:4 ⎭ to 1/11/68
9/8/69 to 31/12/69	1:2
1/1/70 to 14/3/70	1:1½
15/3/70 to 10/11/70	1:1
11/11/70 to 11/5/71	1:1½
12/5/71 to 22/6/71	1:1¾
23/6/71 to 22/4/72	1:1
23/4/72 to 17/6/72	1:1¼
18/6/72 to 18/7/72	1:1½
19/7/72 to 17/3/73	1:2¼
17/3/73 to 1/4/75	suspended

Source: Australian Meat Board, *Annual Report,* various issues.

the U.S.A. have been frozen and unfrozen periodically thus compounding the degree of uncertainty. This uncertainty was criticized by the exporters who argued that it militated against them planning their operations to the best advantage.

Export entitlements to the U.S.A. market under the 1968 scheme were, in principle, transferable between exporters. In practice no formal market for continuous and organized trading of credits was formed, but there have been a number of company to company transfers of export credits.[8]

To analyse the effects of the 1968 export diversification scheme on the quantities sent to and the prices received for Australian beef and veal in different markets we use the four sub-markets model described in functions (1) through (4). The quantity of Australian beef and veal production, which is denoted as q, is allocated between the markets to satisfy the identity

$$q = k_u + k_j + q_a + q_r \qquad (5)$$

where, as before, k_u and k_j refer to the predetermined U.S.A. and Japanese import quotas, and q_a and q_r refer to sales to the domestic

[8] It has not been possible to obtain data on the number of credits transferred or on the prices paid for credits.

market and to other beef importing countries which are, in part, dependent upon price levels. The 1968 scheme, together with the plausible assumption of competitive profit maximizing behaviour by the wholesalers and exporters of Australian beef and veal ensures that prices in the domestic, U.S.A., Japanese and other importing country markets, p_a, p_u, p_j and p_r, respectively, are related as

$$p_a = [k_u\, p_u + (k_j + q_r)\, p_r]/(k_u + k_j + q_r) \quad \text{and} \quad p_r = p_j \qquad (6)$$

or alternatively as

$$p_u > p_a > p_r = p_j \qquad (7)$$

That is, the average Australian price used in consumption and production decisions equals the weighted average of export prices with the Australian price being less than the U.S.A. price and greater than that received for exports to all other countries.

The foregoing analysis provides a basis for discussing some effects of the 1968 beef export diversification scheme in terms of the scheme's objectives, actual and potential industry returns, and the efficiency of resource usage in Australia.

While the scheme largely achieved its stated objectives one can question the effectiveness with which they were satisfied. Certainly its has regulated sales to the U.S.A. without triggering off the more restrictive quota which otherwise might have operated. However, there have been problems in restricting exporters from circumventing the controls by indirect shipping via Canada and Puerto Rico. Also, frequent revisions of the diversification ratio and the freezing of credits was required to maintain sales within agreed limits. It is questionable how far the scheme has assisted in the development of new markets for Australian beef. It has provided an implicit subsidy for such markets. But the subsidy applied also to established markets, e.g. Canada, and to markets where no expansion was possible, e.g. Japan. Further, the value of the subsidy has been uncertain both because of uncertainty about the size of the U.S.A. market premium and because of uncertainty about the effective size of the diversification factor.

The effect of the 1968 diversification scheme on actual and potential industry returns can be assessed with reference to the AMB's role as a monopolist without control of supply. If a monopolist can separate his markets, as seems partially feasible in the case of beef and veal, and if the demand response to price varies between these markets, as seems to be the case, it pays him to charge differential prices so as to equalize the marginal revenue from the different markets. As noted in (7) the 1968 scheme results in different prices. How do these and alternative price configurations influence returns to the Australian beef and veal industry?

In short, some features of the 1968 scheme operate to increase returns to the Australian industry while others do not. Since the U.S.A. demand for Australian beef is essentially predetermined and independent of the Australian export price, returns are increased by setting the price for exports to the U.S.A. above the Australian price. By the same argument, for other countries such as Canada and Japan in which the relevant demand price response for Australian beef is close to zero the revenue maximizing strategy would be to charge them a price akin to that of the U.S.A. rather than the subsidized price. To this end an

improvement of the 1968 diversification scheme would be to exempt meat exported to price non-responsive markets from earning credits for exports to the more lucrative North American markets. Recent decisions by the AMB to exclude sales to Canada and Sweden from earning export credits is a welcome move in this direction.

The rationale for charging a higher price to Australian consumers than to consumers in price responsive importing countries rests on the argument that demand on the domestic market is more inelastic than on the export markets. The respective estimates reported in Appendices 1 and 2 suggest that this is the case for beef and veal, but it is an area which requires further and more rigorous investigation.

In practice there are limitations on the extent to which the AMB can regulate sales to different markets in a manner which would theoretically maximize industry returns.[9] First, it would be difficult to acquire the necessary knowledge. Second, there are limitations to the extent to which markets can be separated. Third, it may be necessary to reach a high degree of cooperation with alternative exporting countries. Finally, political considerations are likely to impose constraints.

The 1968 beef export diversification scheme incurs distortions in the allocation of resources to both the production and the consumption of Australian beef and veal. However, in the context of other distortions in the economy the net effect of these distortions on social welfare is not entirely clear. Given a competitive, non-tariff distorted economy it can be shown that an optimum allocation of resources will be attained when $p_a = p_r$, i.e. when the domestic production and consumption price and the price received for marginal export sales to the price responsive importing country markets are the same. Then, subject to the above qualification, the export diversification scheme will encourage too much Australian production, too little Australian consumption, and too much non-U.S.A. importing countries consumption.[10] The production expansion effects are not likely to be beneficial in the sense that it seems that more resources would be drawn from the relatively low cost wool and grain industries than from the highly protected dairy and manufacturing industries. Turning to the consumption effects, the beef-lamb and beef-mutton price ratios are likely to be moved away from optimal levels while some less important ratios such as the beef-egg and beef-cheese ratios are likely to be moved closer to optimal levels. On balance, it is tentatively hypothesized that the 1968 beef export diversification scheme distorts the allocation of resources. However, further work is required to reach any estimates of the magnitudes involved.

Proposed 1976 Revision of the Diversification Scheme

In 1976 the AMB initiated formal discussions to revise the 1968 meat diversification scheme because, according to the 1976 AMB Annual Report (p. 45) ' . . . the original diversification scheme was

[9] For an interesting discussion of the limitations of using the united bargaining strength of a nationally organised industry to reap theoretical returns see Ben Smith [16, p. 29-30].

[10] Formally, the situation is akin to that discussed at length by Australian agricultural economists analysing the marketing schemes for Australian butter in the early 1960's, for example, Parish [9].

being operated under conditions which were never envisaged when the scheme was first introduced in 1968'. The changed conditions included greater controls by other (i.e. non-U.S.A.) importing countries on the level and price of Australian beef and veal exports, the expectation of continued excess supplies and low world prices, and dissatisfaction with the increased uncertainty about the earning of and right to use export credits. In July 1976, a proposal was forwarded to the industry for its consideration. The recommendations were [2]:

1. The subsidizing of the sale of beef to non-traditional export markets as the opportunity arises.
2. The imposition of a levy on all beef exports to finance this subsidy.
3. The continuation of the meat diversification scheme subject to the allocation of credits (for export to the U.S.A. market) on the basis of sales performance in the previous year.
4. Minimum price and, if necessary, quantity controls on certain traditional markets where the quantity sold is fixed.

The following discussion focuses on the AMB's last two proposals regarding changes in the regulation of exports to the U.S.A. and to other price non-responsive markets; the imposition of a levy was not acceptable to beef producers and as a result the first two recommendations were dropped. In passing some brief comments will be made also about the 'Mackey' scheme in which it is proposed that export credits be earned partly (50 per cent) on the basis of last year's sales and partly on current sales.

The proposed 1976 scheme will remove many of the administrative difficulties and revisions of the diversification ratio encountered under the 1968 scheme. With last year's sales known and the U.S.A. quota negotiated one year ahead, and since it is likely that quota revisions will be small as they have been in the past, it will be easy to specify and administer the system of export credits to the U.S.A. The proposed scheme, however, requires additional resources to administer the system of minimum price and quantity controls on exports to other markets.

On the other hand the proposed 1976 scheme will cause much uncertainty for exporting companies. The value of current exports depends on two factors, one, the current return, and two, the number of export credits earned and the value of these credits. The second factor will not be known until the following year. Given the frequent freezing and unfreezing of credits earned under the 1968 scheme it is not clear which of the two schemes would create the greater uncertainty.

Uncertainty faced by exporting companies increases their costs and reduces the share of industry returns going to producers. With greater uncertainty companies are less able to or less successful in choosing the most efficient operating procedures. Assuming the companies are risk averters, additional uncertainty will induce them to charge a higher fee for their services.

With respect to the objective of increasing industry returns the recommendations improve upon the 1968 scheme. The suggestion regarding minimum prices recognizes that in certain traditional markets (e.g. Canada and Sweden) competition between Australian exporters

drives down prices while not necessarily increasing the quantities of beef consumed. More importantly it is consistent with revenue maximizing behaviour.[11] Even so, as long as meat exporters gain access to premium markets by exporting to any non-premium markets which are subject to quantitative restrictions, there is an incentive for them to shade conditions of supply so as to earn export credits. While part of this may be remedied by 'minimum price and if necessary quantity controls', there are a great number of conditions of sale which beef exporters can change without infringing the AMB's price conditions but which, in effect, lower prices to importers. These problems could be avoided, for example, by excluding price non-responsive markets from earning credits. Nevertheless, the proposed 1976 scheme would generate a higher level of industry returns as compared to returns under the 1968 scheme.

The proposed 1976 scheme will increase further the production and consumption resource allocation distortions noted for the 1968 scheme. The higher average industry returns will encourage expansion of the cattle industry. Since prices to domestic consumers will continue to be related to average industry returns they also will rise and in turn induce a fall in Australian consumption. As noted before there is a high probability that these production and consumption changes represent, on balance, inefficient use of resources.

A number of comparisons and contrasts between the proposed 1976 scheme and the 1968 scheme bear reiteration. Both schemes limit sales to the U.S.A. and provide an implicit subsidy to sales to other export markets. However, the revisions restrict and perhaps exclude the subsidy to certain traditional markets and they restrict the level of sales to some of these markets. Both schemes result in uncertainty for exporting companies about the value of the subsidy. The proposed scheme will increase returns to the Australian industry and it is likely to cause additional resource misallocations.

Auctioning of Export Rights

An alternative to the use of an export diversification scheme as a means of restricting Australian beef and veal exports to the U.S.A. is a scheme of auctioning off (say quarterly) by the AMB of rights to export to the more lucrative U.S.A. market. The scheme could readily be extended to auctioning of rights to export to other markets. The income from the sale of rights could be used in a variety of ways. For example, it could be used to subsidize sales to what the AMB calls 'opportunity' markets. These need not necessarily be overseas markets. They could be lower grade, e.g. pet food, or institutional domestic markets as well as overseas markets with relatively high price response elasticities. Alternatively, the money could be returned to producers through a subsidy of slaughter or processing costs or of research and promotion grants.

At least in principle there would seem to be no difficulties in introducing an auctioning of export rights scheme. Already some exporters sell diversification credits to each other. An initial extension program

[11] More generally, industry returns will be increased if the demand price elasticity is less in the traditional markets than it is in both the residual importing countries and in the domestic market.

explaining the rights scheme should familiarize other members of the industry with the scheme.

In practice an auctioning of export rights scheme would have similar price, quantity and distributional effects to the diversification schemes. Exports to the U.S.A. market would be limited and the price to U.S.A. importers would exceed the Australian price and the price paid by other importing countries. If the money received from the sale of the rights was used to subsidize 'opportunity' markets the consumers in these markets would gain. Alternatively, if the money was used to subsidize production costs, e.g. through lower slaughter fees, both Australian consumers and buyers in other importing countries would gain from the transfer. Aggregate returns to the Australian industry would be increased as the AMB is able to further disaggregate the market and effectively price meat at high levels in the less price elastic markets and at low levels in the more price elastic markets.

Given the similarity of effects of the auctioning of export rights scheme with the diversification schemes, political objections, both in Australia and overseas, to the former and not to the latter are puzzling. Both schemes incur similar patterns of taxes and subsidies. While they may be more explicit in the case of the auctioning of export rights scheme one wonders whether it is important in a highly informed world.

The auctioning of export rights scheme offers several advantages when compared with the export diversification schemes. First, it is easy to administer. All that is required is knowledge about the import quota to be offered by the U.S.A. (and other markets affected); no longer is it necessary to forecast export availability. Second, it removes some of the uncertainty facing exporting companies with the result that the efficiency of their operations rises. They still have to forecast the value of the export right but no longer do they have to forecast the number of rights. Third, the scheme enables exporters to specialize in sales to those markets in which they have a comparative advantage. Under the diversification scheme, and particularly when export credits are difficult to transfer, firms need to export to both the North American and to other country markets. Fourth, the scheme is flexible and readily extended to other markets, e.g. Canada, Sweden and Japan, and other market situations. Finally, a system of auctioning of export credits together with freedom in using the proceeds to subsidize sales to other markets can be employed to develop 'new' and 'opportunity' markets and to effect price discrimination consistent with increasing, if not maximizing, industry returns.

Conclusions

The need for or desirability of the AMB controlling the level of export sales to different export markets stems from two related sources. Under agreements with some of the principal beef importing countries, initially the U.S.A. and more recently Canada and Sweden, Australia voluntarily agreed to limit the volume òf exports to these countries rather than be confronted with more restricted quota allocations. Second, the partial segmentation of the market for Australian beef and

veal together with significant differences in the price responsiveness characteristics of some of these sub-markets means that significant gains in aggregate industry returns may be had by adopting a price discrimination marketing strategy. There are however political and practical limits to which the latter can be adopted.

Conventional economic analysis suggests that a system of auctioning of rights to export to the premium markets, especially to North America, would be a preferred strategy. The paper has argued that such a scheme is feasible, that some potential political criticisms are of dubious merit, that the scheme could readily be adapted to meet the AMB's goals regarding the control of exports of beef and veal, and that it would facilitate an efficient marketing system.

If the first choice is unacceptable a restructured export diversification scheme is proposed. Beef exported to other premium markets, e.g. Sweden, and to price non-responsive markets, including Japan, would be excluded from earning credits for exports to the more lucrative North American markets. The development of a formal market for the transfer of export credits should be encouraged so as to facilitate efficiency of the meat export activities.

APPENDIX 1

Australian Demand for Beef

The appendix reports on further exploration of the retail beef demand function reported in Main, Reynolds and White [7]. In particular, consideration is given to tests of parameter constancy and to the algebraic form of the function. Because of recent large changes in the price and quantity consumed of beef and veal and because of the absence of a potential important explanatory variable, chicken price, it is reasonable to hypothesize that the function may have altered in recent years. When determining a discriminating monopolist's optimal decision the functional form of the function becomes an important consideration; see, for example, Theil [17, p. 540-2].

Three functional forms were estimated, a linear, a log and a quadratic. The quadratic terms did not significantly add to the explanatory power of the estimated function so only the linear and log functions are reported. Applying ordinary least squares with quarterly observations for the period 1962 (I) through 1975 (IV) the estimated log and linear functions obtained were:

(A.1) $q = 16 \cdot 15 + 1 \cdot 5117 D_1 + 2 \cdot 3767 D_2 + 1 \cdot 2566 D_3$
$(2 \cdot 27)\ (0 \cdot 5986)\quad (0 \cdot 5826)\quad (0 \cdot 5801)$
$-\ 20 \cdot 2329 p_b + 5 \cdot 8838 p_s + 2 \cdot 6360 y$
$(2 \cdot 2482)\quad (2 \cdot 0020)\quad (0 \cdot 5381)$
$R^2 = 0 \cdot 68,\ s = 1 \cdot 4595,\ d = 2 \cdot 47,\ d_4 = 2 \cdot 32$

(A.2) $lnq = 1 \cdot 7379 + 0 \cdot 1227 D_1 + 0 \cdot 2032 D_2 + 0 \cdot 1083 D_3$
$(0 \cdot 1759)\ (0 \cdot 0475)\quad (0 \cdot 0462)\quad (0 \cdot 0461)$
$-\ 1 \cdot 3864 lnp_b + 0 \cdot 4355 lnp_s + 0 \cdot 5068 lny$
$(0 \cdot 1612)\quad (0 \cdot 1591)\quad (0 \cdot 1364)$
$R^2 = 0.66,\ s = 0 \cdot 1160,\ d = 2 \cdot 46,\ d_4 = 2 \cdot 24$

where q = per capita quarterly beef consumption,
            D_i = 1 if quarter i, 0 otherwise,
            p_b = index of real retail beef prices (1967 = 100),
            p_s = weighted average index of real retail prices of lamb & mutton (1967 = 100),
            y = real per capita consumption expenditure.

In choosing between the linear and the log function an approach suggested by Theil [17] has been adopted. Taking the antilogs of the estimated values of the log regression (A.2), computing the sums of squares of their deviations from the observed values of per capita beef consumption gives 120 which is greater than the residual sums of squares of the linear regression (A.1) of 104. Again, taking the logs of the estimated values of the linear function (A.1), computing the sum of squares of their deviations from the log of the dependent variable gives 0·6210 which is less than the residual sums of squares of the log function (A.2) of 0·6593. The linear function wins on both counts and thus is the preferred function.

Several tests were conducted to evaluate changes, if any, of the parameters of the linear function (A.1) over the sample period. They included tests of the hypothesis that the demand for beef is more (or less) responsive to price changes at low price levels (a number of arbitrary levels were considered), the hypothesis of non-symmetry of response to rises and falls in price, and the homogeneity test described in Brown, Durbin and Evans [3], which was used to test for piece-wise stability of the function (four sub-samples of 14 observations each were considered). None of the tests rejected the hypothesis of constant parameters (at the 0·05 level).

In Table A.1 are reported estimates of the own price elasticity of demand for beef at the retail, wholesale and auction (or farm) levels for a period of high beef prices, 1973, and a period of low beef prices, 1975. The differences between the estimates follows from the linear functional form and from the assumption of fixed cost retail and wholesale margins (as suggested by Griffith [5]).

TABLE A.1

Estimated Retail, Wholesale and Auction Level Elasticities of Australian Demand for Beef for High (average 1973) and Low (average 1975) Prices.

YEAR	Own price elasticity of demand at		
	Retail	Wholesale	Auction
1973	—1·85	—1·31	—1·19
1975	—0·90	—0·39	—0·27

Notes: Elasticities calculated as (dq/dp_b) p_i/q with dq/dp_b from equation (A.1), p_i denotes index of real beef price (with i = retail, wholesale and auction), and q denotes per capita beef consumption. The retail, wholesale and auction prices are related by fixed cost margins based on Griffith [5].

APPENDIX 2

Other Countries' Demand for Australian Beef

This appendix considers the demand by countries other than U.S.A., Canada, E.E.C. and Japan for Australian beef and veal. They include the U.S.S.R., South East Asian, Middle-East and non-E.E.C. European countries. Little is known about the price elasticity of these countries' demand for Australian beef.

Table A.2 presents a statistical picture of the quantity and average value of Australian exports of beef and veal to other countries for the past six years. Clearly the aggregate figures hide a diversity of qualities of beef and of price variations in shipments to different markets. Given these reservations, the estimates for percentage changes in quantity exported and in average price suggest a negative relationship between price changes and exports (except for 1972-3). In addition to price factors the demand for Australian beef in other countries is influenced by income, by tastes, by promotion of Australian beef, and by prices of competing sources of animal protein. Casual observation and discussion with members of the meat trade suggest that these demand curve shift factors have been important.

TABLE A.2

Quantity and Average Unit Value of Australian Beef and Veal Exports to Other Countries 1970-1 to 1975-6

Year	Quantity exported 000 tons	Change in quantity exported per cent	Average unit value of exports cents/kg	Change in average unit value per cent
1970-1	43.4		73.3	
1971-2	31.8	—31	88.5	19
1972-3	40.7	9	117.4	29
1973-4	30.4	—10	138.2	16
1974-5	67.9	38	78.4	—55
1975-6	129.9	62	74.8	— 5

Notes: 1. Exports to all countries less U.S.A., Canada, Japan, Germany, France, Italy, UK.
2. Quantity given in product weight.
3. Unit value obtained as value of exports (valued at the f.o.b. Australian port of shipment equivalent of the actual price paid the exporter) divided by product weight.
4. Source: Australian Bureau of Statistics, *Overseas Trade Statistics,* 1974-5 and *Exports of Major Commodities by Country,* June 1976.

To obtain some information on the order of magnitude of the price elasticity of demand of other countries for Australian beef and veal a single equation regression model for quantity on time (a proxy for income, tastes and market development) and price was run

$$ln \, Q = \quad 3 \cdot 0693 + 0 \cdot 2098T - 1 \cdot 2685 \, ln \, P; R^2 = 0 \cdot 8901$$
$$(0 \cdot 2216) \quad (0 \cdot 0565) \quad (0 \cdot 4012)$$

where Q = exports to other countries (Table A.2)
$T = 1$ for 1970-1, 2 for 1971-2, etc.
p = average export price (Table A.2)

Clearly the estimated parameters are of a very tentative nature—because of the simplified form of the explanatory function, the small sample and the level of aggregation of the data. Even so, the estimates suggest that while the demand is price responsive, it appears to be not as elastic as is widely believed.

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