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AN EVALUATION OF A NEW ZEALAND MARKETING BOARD'S SUPPLY DIVERSION STRATEGIES

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It appears that the agricultural economics literature lacks much evidence upon which we can judge the performance of statutory boards as marketing institutions. This paper reports the achievements of the New Zealand Apple and Pear Marketing Board in two areas of supply diversion—the allocation of fruit between fresh and process markets, and the allocation of fresh fruit sales over time. Results indicate that the Board has achieved considerable gains for producers in the first of these areas, while in the second its behaviour has favoured consumers.

Introduction

During the past thirty years, agricultural economists (especially those in the United Kingdom and Australia) have reported their views on the performance of statutory agricultural marketing boards [1, 5, 6, 7, 9, 10, 11, 17, 18, 19]. This literature suggests two broad areas in which marketing boards have been seen to attempt to seek higher or more stable prices and incomes for their farmer suppliers. These are (i) the raising of returns from given on-farm demands and (ii) the raising of the level of on-farm demand through market development and the reduction of marketing costs. The general consensus, at least amongst economists, is that statutory marketing boards have often been successful in increasing (but not necessarily maximizing) returns from given demands, but have been less successful in the second area related to increased efficiency of marketing. On the other hand, those who have been more actively involved with marketing boards argue more strongly in their favour [7, 9]. An important point that emerges from this literature is that very little evidence exists upon which we can judge the performance of statutory boards as marketing institutions. Bateman is especially critical in this regard when he says 'the lack of clear . . .

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answers as to how marketing boards affect . . . performance has not prevented commentators making rather clear-cut policy recommendations, [3, p. 211] and 'we have no more empirical evidence for or against any of these organizations than we had 30 years ago' [3, p. 212]. While a search through the above literature indicates that the latter statement exaggerates the true situation, it does stress the serious lack of empirical research into the performance of marketing boards.

Therefore the main purpose of this paper is to report research involving one of New Zealand's marketing boards, namely that responsible for the marketing of apples and pears. Concentration is on the past ability of this board to increase prices from given demands, since this is an area in which the traditional tools of economic analysis can be readily applied. Such statistical evidence can then be weighed up by policy makers against the necessarily more subjective and hypothetical evidence [4, p. 129; 11, p. 282] relating to a board's ability to improve marketing efficiency, to assist in the evaluation of alternative marketing policies.

On a commodity basis, the results are also considered to be of interest in the light of recent studies into the prospects for quantity-control in the U.S. apple market. Fuchs *et al.* [8] measured the revenue effect of reductions in on-tree supplies, Baritelle *et al.* [2] simulated the effect of various market allocation policies in the Washington apple industry, and Piggott [12] made an extensive analysis of various forms of controlled allocation, including that between apple end-uses, in the U.S.A. Hence these American studies attempt to estimate the gains that producers could have achieved through some form of market control—the present study attempts to illustrate the gains that *have been* achieved through such controlled distribution.

The New Zealand Apple and Pear Marketing Board

The New Zealand Apple and Pear Marketing Board was constituted under the *Apple and Pear Marketing Act* 1948 and subsequent amendments. The principal functions of the Board are to acquire and market apples and pears grown in New Zealand or imported into New Zealand, and to determine the prices which the Board is to pay for such apples and pears. These prices are constrained by the guaranteed average price[1] declared each year by an independent Prices Authority, and are administered by the Board with the aid of a buffer fund. Such a price setting procedure has resulted in substantial stabilization of the average annual price and aggregate industry income, as described elsewhere [13].

The Board has chosen to be the sole supplier of apples and pears to the domestic retail market, although it faces competition from growers who are permitted, subject to certain regulations, to sell fruit direct to consumers either at the 'farm gate' or by mail order. The Board is also the sole exporter of apples and pears from New Zealand. Finally, the Board is grower dominated, consisting of four members nominated by the New Zealand Fruitgrowers' Federation and two other members appointed by government.

[1] More specifically, the government guarantee refers to the provision of loan finance when the buffer fund moves into deficit.

The Board's Activities to Increase Income from Given Demands

Each harvest season, producers allocate their fruit between only two possible markets—the Board, or the direct-sales market. At that time, the guaranteed average price for the season would be known, and the allocation would be made on the basis of relative price expectations, contractual obligations and penalties, and total crop size. The Board, given the predetermined total quantity of fruit supplied by producers, formulates its marketing plan based on initial fruit allocations between export, domestic and process markets. Important determinants of this allocation would be fruit quantity and quality, variety mix, and relative profit expectations. Depending upon the results realized in each end use, however, the Board can (and does) modify its initial crop allocation during the season. On the domestic fresh apple market, the Board sets wholesale prices each week, these prices being altered in accordance with the Board's strategy in this market. The services of selected wholesaler agents are employed to facilitate the sale of fruit from the Board to retailers.

Hence the Board has the opportunity to use its monopoly power in the domestic retail market to increase in two distinct ways its net revenue earned from this market.[2] These are: (i) the diversion of supplies from the domestic retail market to other markets; and (ii) the distribution of retail sales over the year through storage.

In the next section we take as given the Board's total fresh sales on the domestic market in recent years, and examine the consequences of the Board's allocation decisions over time periods within each year. In the subsequent section attention is focused on the Board's total annual domestic sales, and an attempt is made to indicate the consequences of the Board's allocation decisions regarding product end uses. We will be concerned only with apples, since this fruit is of much greater importance than pears (the other fruit handled by the Board) in terms of the volumes of fruit sold fresh or processed. For example, apples accounted for over 75 per cent of fresh domestic sales of apples and pears, and over 95 per cent of the total volume of these fruits processed by the Board in recent years (see Appendix 1).

Supply diversion between time periods

Two of the consequences for the marketing of apples since the establishment of the Board have been its ability to set wholesale prices week by week throughout the year, and therefore have some influence over the quantities of apples that are sold each week, and its ability to obtain adequate finance for the construction of cool-store facilities. As a result, weekly marketings and prices set by the Board have remained fairly constant within any year, apart from short periods of temporary scarcity and higher prices at the beginning and end of each year.

It is our observation that the Board puts forth the view that its week-by-week pricing and storage policy is performed primarily for the

[2] To put the importance of this market into perspective, domestic fresh sales account for about 20 per cent of the Board's sales revenue, and export of fresh fruit for about 75 per cent of total revenue. Remaining revenue is provided by sales of processed products.

benefit of consumers, and that the Board's pricing and storage strategy is, by choice, not a profit-maximizing one. For example, the Chairman of the Board, in the 1975 Annual Report, stated: 'On the local market the obligation on the Board to supply apples and pears throughout New Zealand over a period of ten months adds significantly to . . . costs' (p. 5).

Therefore we attempt to evaluate the Board's pricing and storage policy in terms of the following two hypotheses:

H1—the Board has consistently sought a weekly pricing and storage policy that would not maximize net revenue from given supplies and demands; and

H2—by consistently following a policy of week-to-week price stability, the Board has increased consumers' welfare above the level that would have resulted from the profit-maximizing pricing policy.

To test these hypotheses, annual total net revenue and consumers' surplus were estimated for both the actual pricing policy of the Board and the profit-maximizing policy. To help indicate the gains that the Board had actually achieved from its past policies in this regard, we also estimate the levels of total net revenue and consumers' surplus that would have resulted under perfectly competitive conditions, i.e. if the Board did not have monopoly powers in the domestic retail market.

Methodology. The problem of a monopolist supplier allocating product supplies between time periods so as to maximize revenue net of time-variable storage costs, subject to a restraint on the total available supply of the product, is well known. Total revenue net of storage costs is maximized when the quantity allocations are such that, for any pair of time periods, the marginal revenue to be earned from delaying a sale by storing the product from the earlier to the later of the time periods is equal to the marginal storage costs that would be incurred.

Given the demand functions for each time period

$$Q_t = a_t - b_t P_t + u_t; \quad t = 1, \ldots, T \tag{1}$$

and ignoring the possibility that future revenues and costs should perhaps be discounted, an expression for total revenue (TR) can be derived:

$$TR = \sum_{t=1}^{T} P_t \hat{Q}_t \tag{2}$$

where P_t are prices set by the Board, and $\hat{Q}_t$ are weekly sales quantities estimated from the demand functions (1).

Total variable costs of storage (VSC) are estimated from the following linear cost function:

$$VSC = \sum_{t=1}^{T} c(t-1)\hat{Q}_t \tag{3}$$

where c is the marginal cost of storing one unit of the product for one further time period (i.e. the cost of leaving the cooling system turned on for an extra time period).

Now total revenue net of variable storage costs (R) will be given by:

$$R = TR - VSC. \tag{4}$$

To obtain the revenue-maximizing price policy that could be followed by the monopolist firm, the value of R is maximized subject to a restraint (5) on total sales:

$$K = \sum_{t=1}^{T} \hat{Q}_t \tag{5}$$

where K is the total quantity of fruit to be allocated over time.[3]

To estimate the total net revenue that resulted from the Board's actual pricing policies, such prices were substituted into the demand functions (1), and the resultant estimates of Q_t were substituted into equations (2) and (3).

Under perfectly competitive conditions, market prices would also be the marginal revenues of individual sellers, and a competitive equilibrium would be reached when these marginal revenues (i.e. the market prices) differed from period to period only by the marginal costs of storage from one period to the other. However, since the Board influences the total quantity of fresh fruit available for retail distribution during the year (K), strictly speaking there is no perfectly competitive determination of weekly sales. Hence we will refer to this market structure as 'quasi-competitive', and the resultant prices were obtained in an iterative manner by varying weekly prices until condition (5) held true. Total net revenue was then estimated by substituting these prices into the demand functions (1) to obtain estimates of weekly sales, which in turn were substituted into equations (2) and (3).

The measurement of total consumer welfare poses many conceptual problems. Our approach involves the estimation of consumer surplus in each time period, and then the summation of all such consumer surpluses over all time periods. Thus we assume that consumer surplus is a suitable measure of aggregate consumer welfare, that such utility measures are additive and that the utilities of all different time periods

[3] This is achieved by forming the following Lagrangian expression (L):

$$L = \sum_{t=1}^{T} P_t (a_t - b_t P_t) - \sum_{t=1}^{T} c (t - 1) (a_t - b_t P_t)$$

$$+ \lambda (K - \sum_{t=1}^{T} (a_t - b_t P_t)).$$

Differentiating with respect to prices (P_t) and the Lagrangian multiplier (λ) we obtain:

$$\partial L/\partial P_t = a_t - 2b_t P_t + c(t - 1)b_t + \lambda b_t$$

$$\partial L/\partial \lambda = K - \sum_{t=1}^{T} (a_t - b_t P_t)).$$

To maximize L, we set the partial derivatives equal to zero, which yields the following equations:

$$P_t = a_t/2b_t + [c(t - 1) + \lambda]/2$$

$$K = \sum_{t=1}^{T} (a_t - b_t P_t).$$

These equations were solved in an iterative manner by searching for that value of λ for which the latter two equations held true. Fortunately, the solutions obtained obeyed the non-negativity requirements for all prices and quantities.

are given equal weight. These assumptions are no doubt questionable, but nevertheless we adopt this approach in the absence of a better utility model. Similar approaches have also been mentioned elsewhere in relation to price stabilization [16, ch. 12].

From the demand functions (1), total consumer surplus in period t, CS_t, at a particular level of price p_t^* is conventionally measured as the area below the demand curve but above p_t^* (and remembering that quantity, not price, is the dependent variable):

$$(6) \qquad \begin{aligned} CS_t &= \tfrac{1}{2}((a_t/b_t) - p_t^*)\hat{Q}_t \\ &= \tfrac{1}{2}[((a_t/b_t) - p_t^*)a_t - b_t p_t^*]. \end{aligned}$$

Equation (6) was used to estimate consumer surplus in each time period t, for any sequence of prices, and these estimates were summed over time periods to give our aggregate index of consumer welfare (C):

$$(7) \qquad C = \sum_{t=1}^{T} CS_t.$$

The demand relationships. We hypothesized that the quantity of fresh apples demanded by wholesalers in any single week would depend upon the apple price set by the Board in that week, the prices of substitute fruits in that week, and other variables (including incomes) whose influence on demand may be measured as a time trend. Pears were the only substitute fruit for which weekly price data were available. The demand relationships were therefore specified[4] in the form:

$$(8) \qquad q_t = f(P_{at}, P_{pt}, T_t)$$

where q_t = quantity of apples (lb per caput) sold by the Board in week t,
P_{at} = deflated apple wholesale price (cents per lb) set by the Board in week t,
P_{pt} = deflated pear wholesale price (cents per lb) set by the Board in week t; and
T_t = a time trend with units equal to one year.

The weekly data covered the period 1968 to 1975. Of the 42 weeks that comprise the Board's main selling season (from February until November) estimates of the demand functions (8) that were judged satisfactory were obtained for 32 weeks.[5] All these equations showed the expected inverse relationship between weekly sales and prices. The level of demand appeared to have declined over time during the majority of weeks, although this decline did not appear to be any more rapid in the early part of the year (when most direct sales take place) than

[4] A distributed-lag model was also formulated by including a lagged quantity variable, but gave improved estimates in only a few instances, judged insufficient to lead to the acceptance of the hypothesis of lagged price effects. Another approach to model estimation would have been to pool all data and make use of additive and multiplicative weekly dummy variables. With the data covering a period of 42 weeks, the number of independent variables so created was computationally impractical.

[5] The demand functions for the remaining 10 weeks included a constant term only. Also, the statistical validity of some of the functions was improved by grouping adjacent weeks.

later. In only seven of the demand equations did the pear price appear to exert any significant influence on apple sales. The estimated demand functions are presented in Appendix 2.

Figure 1 includes some of these demand curves, sufficient to indicate clearly that the demand for apples has varied in a systematic fashion through the year. These curves[6] measure the weekly demand equations with all variables other than apple price and quantity set at their average 1968/1975 values. All weeks have been subjectively grouped into three periods, and the three sections of the figure combine to display the gradual movement of the demand curve through the seasons. During February and March the demand curve appears to become slightly steeper and to shift out to the right. The demand curve then falls and becomes much flatter in April and continues to move to the right until July. From August the demand curve reverses its movement and shifts to the left, with the slope of the curve becoming much steeper around November.[7]

Evaluation of the Board's storage strategy. If the first of our hypotheses is to be rejected, then we must find that

$$R_B = R_M \tag{9}$$

where R_B is the total net revenue from the Board's actual pricing policy, and R_M is the total net revenue of the optimum monopolistic pricing policy.

TABLE 1

Pricing Policies and Net Revenue Estimates

Year	Total net revenue[a] under Quasi-competitive pricing (R_P)	Board's actual pricing (R_B)	Monopolistic pricing (R_M)	($R_B - R_P$) as percentage of R_P	($R_M - R_B$) as percentage of R_B
1968	2·94	3·01	3·29	2·4	9·3**[b]
1969	2·94	3·03	3·25	3·1	7·3*
1970	2·80	2·82	3·12	0·7	10·6***
1971	2·76	2·84	3·08	2·9*	8·5***
1972	2·72	2·69	2·95	—1·1	9·7***
1973	2·72	2·64	2·96	—2·9	12·1**
1974	2·77	2·84	3·03	2·5	6·7*
1975	2·61	2·63	2·91	0·8	10·6***

[a] Measured in millions of dollars at 1965 prices, and net of time-variable storage costs.

[b] *** denotes that the probability of the difference between two revenue estimates being greater than zero is greater than 0.99.
** denotes the above probability is greater than 0·95.
* denotes the above probability is greater than 0.90.

[6] The weekly demand curves have been drawn using the mean values of prices and sales, plus and minus one standard deviation of the sales variable to give some idea of the variation in the data over the eight years.

[7] It is difficult to specify the causes of these seasonal demand changes, but it is not really important to do so for the purposes of this research. Supposedly, variations in apple quality, availability of varieties, and availabilities of other seasonal fruits such as stone fruit, citrus and bananas would have some influence, as would the seasonal preferences and tastes of consumers.

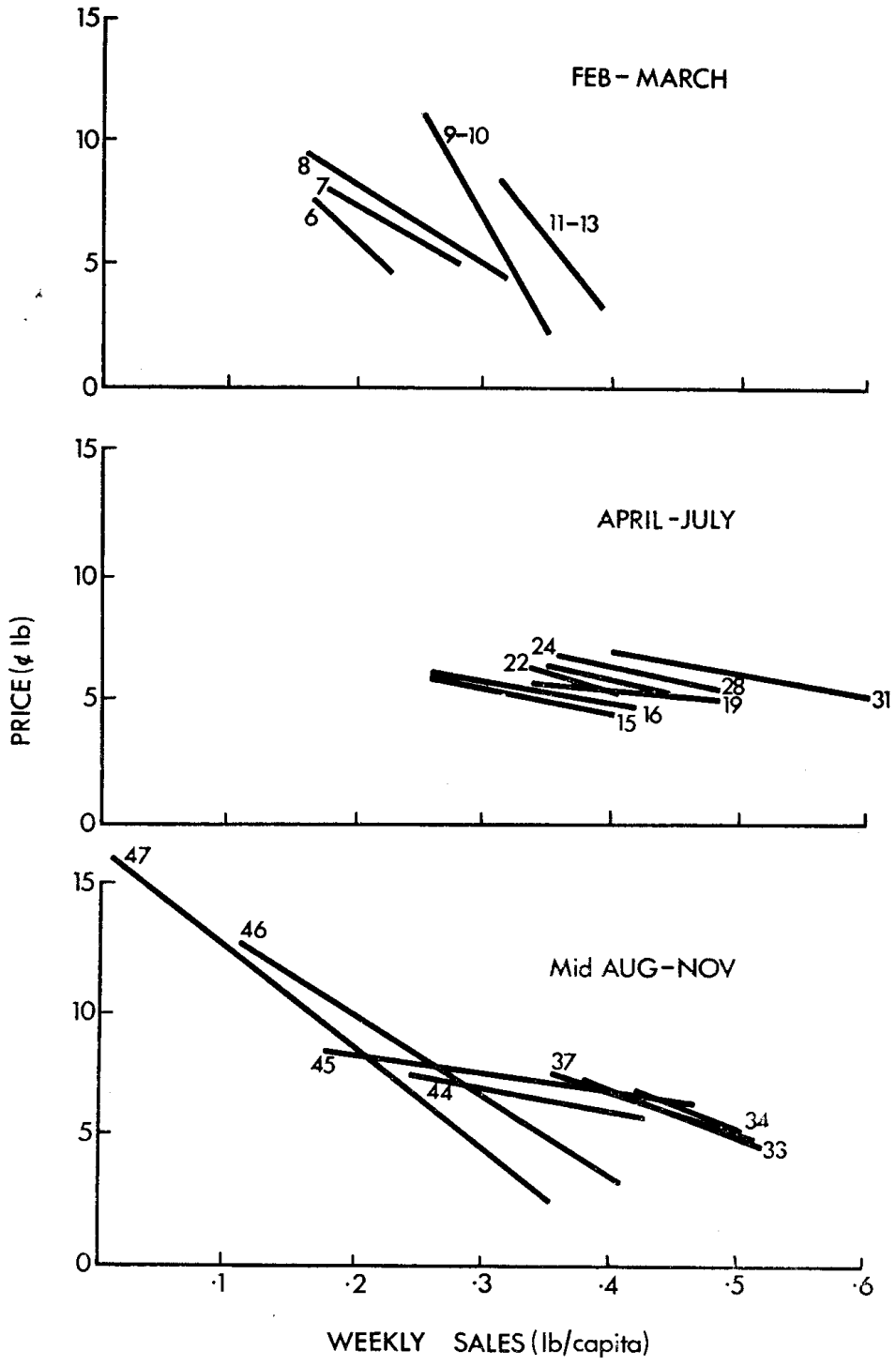

FIGURE 1—Seasonal shifts in demand for apples: 1968/1975.

The relevant data[8] are presented in Table 1. In each of the years 1968/1975, we estimate that the total revenue, net of time-variable storage costs, received by the board as a result of its pricing policy has been less than that which would have resulted from a monopolistic, revenue-maximizing pricing policy[9], and that these differences are highly significant.[10] Thus hypothesis H1 cannot be rejected.

Rejection of the second hypothesis requires that:

$$C_B \leqslant C_M \tag{10}$$

where C_B and C_M are estimates of consumer surplus arising from the Board's actual, and the monopolistic, pricing policy, respectively.

As is evident from Table 2, total consumer surplus derived from the Board's actual pricing policies has, in each of the years 1968/1975, exceeded the consumer surplus estimated to result from the monopolistic

TABLE 2

Pricing Policies and Consumer Surplus Estimates[a]

Year	Consumer surplus per caput under: Quasi-competitive pricing (C_P)	Board's actual pricing (C_B)	Monopolistic pricing (C_M)	($C_P - C_B$) as percentage of C_B	($C_B - C_M$) as percentage of C_M
1968	60·9	61·2	43·1	—0·5	42·0
1969	52·5	50·4	34·9	4·2	44·4
1970	58·7	56·1	44·1	4·6	27·2
1971	52·7	46·5	38·4	13·3	21·1
1972	44·6	48·8	31·2	—8·6	56·4
1973	39·1	37·4	27·2	4·5	37·5
1974	43·9	46·0	29·2	—4·6	57·5
1975	49·1	46·3	35·6	6·0	30·0

[a] The statistical validity of differences in consumer surplus was not estimated.

[8] For all weeks for which estimates of the demand functions were not obtained, the observed prices and the means and variances of the observed quantities were used in estimating total revenue from monopolistic pricing. For the quasi-competitive situation, mean quantities and the appropriate prices were used.

[9] The revenue-maximizing pricing policy would require prices to be set considerably higher than had been the case during February-March, and slightly higher at the end of the year. For the remainder of the year, revenue maximization would require prices to be set at about, or slightly below, levels actually set by the Board in the past.

[10] To assist in hypothesis testing, the variance of total revenue was estimated as

$$\text{var } (TR) = \sum_{t=1}^{T} P_t^2 \text{ var } (\hat{Q}_t)$$

where var $(\hat{Q}_t)$ was estimated with the use of the variance-covariance matrices associated with the regression coefficients of the weekly demand functions (1).

Likewise, the variance of variable storage costs can be measured as:

$$\text{var } (VSC) = \sum_{t=1}^{T} [c(t-1)]^2 \text{ var } (\hat{Q}_t).$$

Finally, the variance of total net revenue was estimated as:

$$\text{var } (R) = \text{var } (TR) + \text{var } (VSC).$$

pricing policy by from about 20 per cent to about 55 per cent. This suggests that hypothesis H2 also cannot be rejected.[11]

In summary, the evidence supports the view that the Board has not discriminated over time in its pricing policy to the point of maximizing profits, and by so doing has increased consumer welfare above the level that would have resulted from a profit-maximizing policy. One further observation can be made concerning the trade-offs that appear to have been made in this matter by the Board. Although we conclude that the Board has not acted so as to maximize profits, and that the difference between its actual revenues and the maximized revenues was highly significant, the mean value of that difference is relatively small and of the order of 10 per cent of the Board's actual revenues. By forgoing this amount of revenue, the Board has achieved an increase in consumer surplus of the order of 40 per cent.

The data of Tables 1 and 2 also suggest the advantages that growers have gained, and consumers have forgone, through the Board's ability to fix weekly prices, rather than had the same annual quantities of fruit been allocated between weekly sales by quasi-competitive market forces. Our assessment of the data is that such producer gains and consumer losses have not been great. The extent to which the Board's total net revenue exceeded the estimated net revenue achievable given quasi-competitive pricing (R_p) over the period 1968/1975 was in the range of -3 per cent to $+3$ per cent, and in all but one of these years the differences were not statistically significant at even the 10 per cent level. Likewise, the Board's pricing policy was estimated to have varied consumer surplus from that which would have resulted under quasi-competition (C_p) by between -9 per cent and $+13$ per cent.

Supply diversion between end uses

In this section, we aim to indicate the likely size of gains achieved by the Board through the diversion of supplies of apples to process markets.[12] Mainly as a result of the adoption of superior production technology [14], the quantity of apples supplied to the Board has increased steadily since 1960. The Board opened its first processing factory in 1962, and since then the quantity of apples diverted to the cannery has also increased steadily to reach 1·5 million bushels, over 20 per cent of the Board's total intake of apples, in 1974 and 1975. However, total production of pears and the quantity of pears that are processed by the Board have shown little upward trend, and the quantity processed

[11] The formula for the variance of consumer surplus is complicated, but this statistic could be estimated by simulation. Even so, this would be a time-consuming task which in our opinion was not justified.

[12] We do not consider the planned diversion of supplies from domestic to export markets, since the Board could only equate fresh fruit marginal revenues between these markets should the supply of export grade fruit be at least as great as the quantity required to equate marginal revenues. Thus far, the supply of export-grade fruit has not been as great as this and export marginal revenues exceed those realized on the domestic market, although it should be pointed out that export-grade fruit is not normally marketed domestically. Thus the scope for the Board to realize gains through market separation is probably limited to the domestic fresh market and processed product markets.

amounts to only 3 to 9 per cent of total pear purchases (see Appendix 1).

The theoretical model is indicated in Figure 2. The left-hand section of the diagram contains the marginal net revenue schedule facing the Board for sales of fresh apples on the domestic wholesale market. The situation with respect to processed products is more complex, since various types of products such as juice, slices, sauce and industrial concentrate can be manufactured. For each a separate marginal net revenue schedule would exist, and it is the horizontal summation of these that is presented in the right-hand segment of Figure 2. The horizontal segment of the process marginal net revenue schedule represents the marginal revenue from export sales of concentrate. Being a supplier of only a small percentage of world sales, the New Zealand Board would face an almost infinitely elastic demand for concentrate.

If the Board were to maximize its gain through supply diversion, then for total non-export supplies less than Oq_0, it should sell the entire crop fresh. If its total supply in any year equalled $Oq_1 + Oq_2$, then Oq_1 should be sold on the fresh market, and Oq_2 processed (in this case, into two different products, the quantities of each being those which equated marginal net revenues). For all annual supplies in excess of $Oq_3 + Oq_4$, the Board would maximize gains by restricting fresh sales to Oq_3 and allocating all other supplies to process production.

A lack of suitable data meant that estimation of the processed products demand schedule was impossible. Therefore we cannot test the hypothesis that the Board has allocated supplies according to the theoretical monopolistic model. Thus the analysis will be restricted to indicating the extent to which total revenue (net of allocation costs) from the sale of fresh fruit has been increased due to the planned diversion of apples to the processed products market.

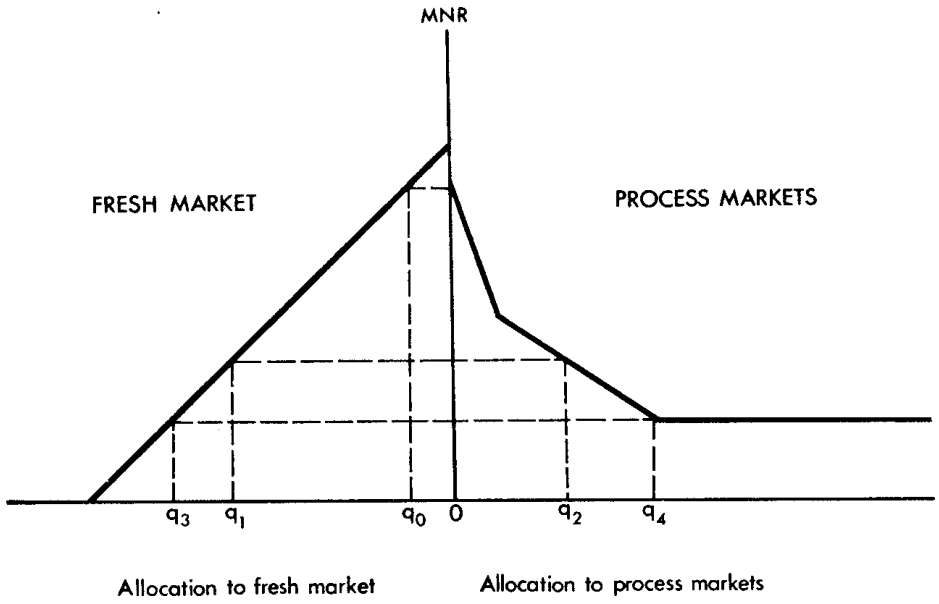

FIGURE 2—Supply diversion between fresh and process markets.

The fresh market apple demand relationships. We hypothesize that the average annual price realized in the direct-sales market will depend *inter alia* upon the producers' initial supply allocation decision—that is, upon the total quantity of apples allocated by producers for sale on the direct-sales market. Quantities of substitute fruits purchased on both this market and the wholesale market—which would include the quantity of apples sold by the Board—and personal disposable incomes could be other explanatory variables.

On the domestic wholesale market, we hypothesize that the level of annual sales of apples achieved by the Board will be jointly determined by the average of all weekly prices set by the Board, the average apple price in the direct-sales market, prices of substitute fruits and personal incomes.

After data considerations had led to the specification of only one substitute fruit (pears) and to the choice of a time trend variable to represent the aggregate influence of personal incomes and other explanatory variables closely correlated with time, we formulated the following pair of simultaneous equations:

Wholesale market:

$$(11) \qquad Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 P_t' + \alpha_3 S_t + \alpha_4 T_t + e_t$$

Direct-sales market:

$$(12) \qquad P_t' = \beta_0 + \beta_1 Q_t' + \beta_2 Q_t + u_t$$

where Q_t = annual purchases of apples (lb per caput) in the domestic wholesale market;
Q_t' = annual purchases of apples (lb per caput) in the direct-sales market;
P_t = deflated annual average apple price (cents per lb) set by the Board;
S_t = deflated annual average pear price (cents per lb) set by the Board;
P_t' = deflated annual average apple price on the direct-sales market; and
T_t = a time trend variable, with 1956 = 1, 1957 = 2, . . ., 1975 = 20.

On substitution of (12) into (11) we obtained the following reduced form equation:

$$(13) \quad Q_t = ((\alpha_0 + \alpha_2 \beta_0)/A) + (\alpha_1/A)\ P_t + (\alpha_2\beta_1/A)\ Q_t' + (\alpha_3/A)\ S_t + (\alpha_4/A)\ T_t + (\alpha_2/A)u_t + (1/A)\ e_t$$
$$\text{where } A = 1 - \alpha_2\ \beta_2.$$

The reduced form equation was solved by OLS. Because of high correlation between T_t and Q_t', little appeared to be lost through the deletion of the time trend variable from the estimated equation. Inclusion of the Q_t' variable in its squared form improved the explanatory power of the model. Exclusion of the S_t variable resulted in a marked reduction in the absolute value of the estimated coefficient of the P_t variable, while the substitution of the square of Q_t' for Q_t' had the opposite effect, which could have a significant influence upon subsequent calculations of supply diversion gains. A double logarithmic formulation

of the model was also estimated, but was judged inferior to the linear and quadratic models.

Because of the sensitivity of the P_t coefficient to the model specification, four alternative estimates of the demand equation are given in Appendix 3. In the following section we carry out a sensitivity analysis on the estimated gains from supply diversion, depending upon the choice of demand equation.

A partial evaluation of the Board's supply diversion strategy. We now estimate the extent to which the Board's total net revenue from the domestic fresh apple market would have been reduced in 1974 and 1975, had smaller quantities of apples been diverted to processing. In both of these years, the quantity of fruit that the Board allocated to processing was well above former levels (see Appendix 1) because of particularly heavy apple crops in these years.

Table 3 indicates the average price set by the Board in 1974 and 1975, and the estimated level of sales and net revenue at those prices. These revenue estimates are net of the fresh market allocation costs due to grading, packing, containers, distribution and promotion. Two further prices were then calculated, being those required to increase estimated fresh sales by 25 per cent, and 50 per cent, of the Board's process allocation.[13] Then, the extent to which total net revenue would have changed due to the higher annual fresh sales volume and lower price was estimated. Using the fresh demand equation (2) (Appendix 3), we estimated that had the Board planned to sell 25 per cent of its process allocation on the fresh market during 1974 and 1975, total net revenue from that market would have been reduced by $0·75 million at 1965 prices. This revenue reduction would have been $2 million had 50 per cent of the process allocation been released onto the fresh market.

The above figures underestimate the total revenue reduction since they do not recognize the net revenue that would be forgone from the reduced level of processed product sales. The underestimation is not thought to be serious, however, since had the above quantities of fruit been withdrawn from processing, a decreased output of the marginally-profitable apple concentrate would have been planned. This could have the result of adding $0·2 million and $0·4 million, respectively, to the above revenue-reduction estimates.

Results of a sensitivity analysis for 1975 are given in Table 4. It can be seen that demand equation (2) gives the most conservative estimate of the gains achieved by the Board due to its supply diversion strategy. Other equations, in which sales are less responsive to price changes, indicated that fresh market net revenue could have been reduced by $1 million and up to $3 million depending upon the extent of the increase in fresh sales.

It is also relevant to compare those gains that the Board has achieved

[13] Therefore we do not attempt to estimate the reduction in revenue that would have resulted had the Board done *no* processing at all, since this would have involved considerable extrapolation beyond our observed data values. Even if we did, it would not follow that such gains would have been forgone in the absence of the Board, since several of the Board's processed lines are commercially viable products which could have been produced by private enterprise were the Board not in existence.

TABLE 3

Estimated Reductions in the Board's Fresh Market Net Revenue resulting from Increased Fresh Market Allocations—Equation 2[a]

Year	At actual price				At price necessary to increase fresh sales by:					
					25% of process allocation			50% of process allocation		
	Annual sales	Price	Variable costs	*TNR*	Annual sales	Price	Change in *TNR*	Annual sales	Price	Change in *TNR*
1974	19·0	6.08	2·22	2·25	23·9	4·29	—0·74	28·8	2·47	—2·03
	(0·5)			(0·06)	(1·2)		(0·10)	(2·2)		(0·06)
1975	18·2	5·34	2·02	1·89	22·9	3·63	—0·75	27·6	1·89	—2·00
	(0·5)			(0·05)	(1·4)		(0·09)	(2·3)		(0·06)

[a] All money amounts measured at 1965 prices. Sales are expressed in lb/caput, prices and costs in cents/lb, and total net revenue (*TNR*) in millions of dollars.
The standard deviations of estimates are given in parentheses.

TABLE 4

Sensitivity of Estimated Revenue Reductions to Choice of Demand Equation—1975

Fresh sales increased by	Estimated reduction in fresh market net revenue[a] Eq. 1	Eq. 2	Eq. 3	Eq. 4
25% of process allocation	—1·23	—0·75	—1·00	—1·00
50% of process allocation	—3·08	—2·00	—2·66	—2·68

[a] In millions of dollars at 1965 prices, net of fresh market allocation costs.

from the diversion of fruit to processing with the Board's overall level of profitability. The Board's trading operations (measured in 1965 prices) yielded a profit of $0·48 million in 1975, and a loss of $2.37 million in 1974. Therefore the gains that are indicated above are of considerable magnitude when viewed in the light of the Board's overall trading profits.

We should also note that marginal net revenue was still negative[14] given the level of fresh sales in 1974 and 1975. Hence the Board had not maximized its gains from supply diversion (provided that the minimum value of processed product marginal revenues was non-negative), and had perhaps shown some concern for consumer interests by not seeking maximum gains through further reducing fresh market supplies and therefore further increasing retail prices.

Discussion and Conclusions

As far as the Board's diversion of supplies over time is concerned, our analysis concludes that the Board has not used its monopoly power to the full extent possible, but has chosen a policy which has resulted in considerable gains to consumers at relatively low cost to growers. However, our analysis also indicates that if the Board were to lose its monopoly of supply to the domestic retail market and if steps were taken to ensure that near-perfect competition was to prevail in this market, then any consequent change in growers' revenues and increase in consumers' welfare, due to changes in the weekly price and supply pattern, would probably be small. Therefore, in any discussion of the merits of 'free' versus Board-controlled domestic retail marketing, this particular aspect of the Board's behaviour would not appear to be of great significance provided that 'free' markets were synonymous with perfectly competitive markets and that diversion of fruit to processing continued at about the levels of recent years.

Turning to the Board's strategy of fresh-to-process supply diversion, the study suggested that this had resulted in the realization of substantial short-term gains. However, some private and social costs of perhaps a longer-run nature have also been incurred.

[14] Marginal revenues from the sale of fresh apples on the domestic retail market have been negative in each of the years 1956-75. However, marginal revenues have shown some increase since 1962, the year in which the Board commenced processing apples.

First, the strategy has contributed to a reduction in the Board's share of the local fresh apple market, and therefore to a reduction in the Board's share of the consumer-to-producer income transfer that results from the strategy. The discriminatory strategy not only raises prices charged by the Board at the wholesale (and therefore retail) level, it also allows prices charged in the direct-sales market to be higher than they otherwise would since the policy leads to demand expansion in the latter market. Thus producers who supply the direct-sales market, as well as those who supply the Board, are encouraged to expand production. The Board, however, withdraws fruit for processing only from the (increased) supplies of its own producers since it has no control over supply in the direct-sales market. We believe this was a major contributory cause in the reduction of the Board's share of the New Zealand fresh apple market from 75 per cent in 1962 to 45 per cent in 1975. In as much as the Board's diversion policy raises the price of *all* fresh apples sold in New Zealand, the fact that the Board's share of that market has declined significantly means that the Board's share of the total amount of income transfer is also decreasing.

Second, not only has the non-Board producer increasingly gained from the Board's policy, he has done so without being called upon to contribute to the cost of the scheme, i.e. the costs involved in operating the Board's processing factories. These costs are presently met entirely by the Board, and therefore by its suppliers. Thus inequities exist.

Third, the decision as to an appropriate level of the transfer payment from consumers to producers is made by a producer-dominated body. Only two members of the policy-setting Board of six are required by legislation to 'in addition to their other functions as members of the Board, represent the interests of consumers of apples and pears'. While the Board may not have maximized its gains from supply diversion, it has nevertheless acquired substantial income increments for pip-fruit producers. Since, as noted by Campbell [5], the role of consumer groups in national policy formulation could be undergoing change, we would expect that this point will increasingly become an important policy issue.

Fourth, the scheme leads to the familiar result of resource misallocation, due to the pooling of receipts and the payment of an equalized price for process and domestic-grade fruit. This pricing policy has been adopted for equity purposes since the decision as to whose fruit is earmarked for processing is taken somewhat arbitrarily by the Board.

Thus we have accumulated some evidence as to the consequences of a particular marketing board's strategies with respect to supply diversion. These consequences included income gains to producers, inequities amongst producers, welfare losses to consumers, changes in the Board's market share, and national losses due to resource misallocation. Such objective evidence should be of value, when combined with evidence perhaps of a more subjective nature on the ability of marketing boards to reduce costs or expand demand, to assist the process of policy formulation and evaluation in agriculture. This was the approach taken in a recent study into the marketing of the New Zealand apple and pear crop [15].

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APPENDIX 1

Fresh and Process Allocations of Apples and Pears ('000 bushels)

Year	Apples			Pears		
	Total non-export fruit	Allocated to fresh sales	Allocated to process sales	Total non-export fruit	Allocated to fresh sales	Allocated to process sales
1960	1461	1461	—	357	357	—
1961	1680	1680	—	478	478	—
1962	1960	1636	324	444	444	—
1963	1798	1533	265	368	357	11
1964	2264	1787	477	412	403	9
1965	1897	1535	362	441	404	37
1966	2030	1469	561	449	418	31
1967	1955	1373	582	413	382	31
1968	2179	1502	677	468	429	39
1969	2027	1416	611	421	402	19
1970	2502	1548	954	441	409	32
1971	2085	1414	671	494	454	40
1972	2550	1668	882	460	434	26
1973	2224	1259	965	474	414	60
1974	2971	1470	1501	390	372	18
1975	2918	1460	1458	375	353	22

Source: NZ Apple and Pear Marketing Board Annual Reports and supplementary statistics.

APPENDIX 2

Estimated Weekly Derived Demand Equations for Apples

Week no.	Estimated coefficients[a]				R^2
	Constant	Apple price	Pear price	Trend	
6[b]	0·41	—0·024		—0·012	0·53
	(0·09)	(0·012)		(0·005)	
7	0·57	—0·035		—0·023	0·71
	(0·11)	(0·013)		(0·007)	
8	0·58	—0·031		—0·030	0·72
	(0·11)	(0·013)		(0·009)	
9-10	0·06	—0·011	0·080	—0·009	0·31
	(0·16)	(0·009)	(0·041)	(0·005)	
11-13	0·27	—0·017	0·044	—0·004	0·41
	(0·10)	(0·010)	(0·016)	(0·003)	
14	0·29				
	(0·04)				
15	0·29	—0·140	0·149		0·56
	(0·31)	(0·055)	(0·086)		
16	1·25	—0·151		—0·022	0·50
	(0·41)	(0·086)		(0·014)	
17-18	0·80	—0·062		—0·020	0·20
	(0·32)	(0·052)		(0·011)	
19	0·96	—0·153	0·049		0·77
	(0·26)	(0·038)	(0·041)		
					0·26
20	0·81	—0·078			
	(0·30)	(0·054)			
21	0·32				
	(0·03)				
22	0·83	—0·071		—0·013	0·75
	(0·14)	(0·022)		(0·004)	
23	0·39				
	(0·06)				
24	0·94	—0·085		—0·012	0·47
	(0·26)	(0·041)		(0·008)	
25	1·02	—0·091		—0·021	0·39
	(0·43)	(0·068)		(0·012)	
26	0·58	—0·239	0·208		0·68
	(0·44)	(0·074)	(0·086)		
27	1·11	—0·096		—0·020	0·60
	(0·29)	(0·046)		(0·008)	
28	1·23	—0·112		—0·030	0·79
	(0·25)	(0·038)		(0·007)	
29-30	0·42				
	(0·04)				
31	1·32	—0·115		—0·027	0·40
	(0·55)	(0·085)		(0·016)	
32	1·03	—0·075		—0·024	0·39
	(0·51)	(0·081)		(0·013)	
33	0·87	—0·053		—0·021	0·66
	(0·26)	(0·041)		(0·007)	
34	0·92	—0·066		—0·012	0·65
	(0·18)	(0·028)		(0·004)	
35-36	0·44				
	(0·04)				
37	0·94	—0·062		—0·025	0·48
	(0·41)	(0·059)		(0·012)	
38-40	0·48				
	(0·03)				

APPENDIX 2 (continued)

Week no.	Estimated coefficients[a]				
	Constant	Apple price	Pear price	Trend	R^2
41-43	0·62	—0·052	0·028		0·21
	(0·21)	(0·024)	(0·024)		
44	0·60	—0·129	0·094	—0·011	0·79
	(0·45)	(0·040)	(0·054)	(0·009)	
45	0·97	—0·074		—0·024	0·74
	(0·19)	(0·025)		(0·014)	
46	0·63	—0·033		—0·023	0·59
	(0·15)	(0·018)		(0·019)	
47[c]	0·41	—0·024			0·31
	(0·15)	(0·015)			

[a] The coefficients in parentheses are the standard errors of the estimates.
[b] The first week of February.
[c] The third week of November.

APPENDIX 3

Estimated Annual Wholesale Apple Demand Equations

Equation	Estimated coefficients and standard errors						R^2	$\bar{R}^2$	F	*SEE*
	Const.	P_t	Q'_t	$Q_t'^2$	S_t	T_t				
1	36·95 (4·63)	—2·10 (0·67)	—0·50 (0·19)		1·08 (0·99)	—0·06 (0·19)	0·90	0·88	34·6	1·22
2	36·77 (3·92)	—2·69 (0·55)		—0·02 (0·002)	1·21 (0·69)		0·91	0·90	55·9	1·12
3	41·22 (3·16)	—2·16 (0·48)		—0·02 (0·002)			0·90	0·88	73·3	1·18
4	36·38 (4·16)	—2·20 (0·58)	—0·56 (0·05)		1·29 (0·73)		0·90	0·88	48·9	1·19