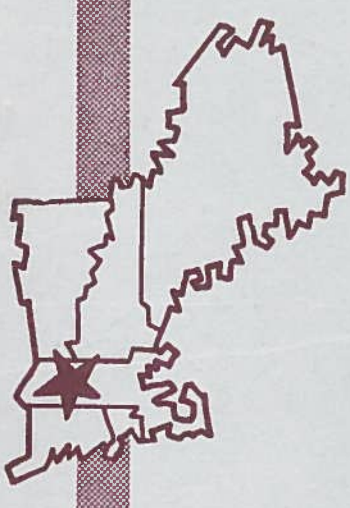
1964 PROCEEDINGS

New England Agricultural Economic Council



JUNE 15, 16, 17

UNIVERSITY OF MASSACHUSETTS

PROCEEDINGS

NEW ENGLAND AGRICULTURAL ECONOMIC COUNCIL

ANNUAL CONFERENCE

University of Massachusetts
Amherst, Massachusetts

June 15, 16, 17, 1964

A REPORT ON THE INTRASEASONAL ALLOCATION OF MC INTOSH APPLES

John P.H. Brand
Department of Agricultural Economics
University of Connecticut

Producers of any storable commodity, such as McIntosh apples, are faced with the problem of deciding when to sell. To achieve maximum profits, a producer would be expected to follow a course of action which would equate marginal revenue to marginal cost. In the case of a storable commodity sold over time, the producer would have to be cognizant of his marginal revenue and marginal costs at all times.

I shall report on an investigation of the intraseasonal allocation of McIntosh apples which was completed recently at the University of Connecticut by Mr. Lester Myers, candidate for the Master of Science degree. The investigation analyzed the marketing performance of the New England-New York McIntosh apple industry over a fifteen-year period, 1947 to 1961. Actual market performance was compared with that performance which would have maximized net returns to the industry. Demand functions at the wholesale level for fresh McIntosh apples in the New England-New York area were estimated for nine marketing months, September to May. These functions were then used in a price discrimination model to obtain optimum intraseasonal allocations for each of the fifteen years. Optimum allocations were then compared to actual allocations. Quadratic programming techniques were the mathematical means employed to secure the solutions to the monthly allocation problems.

For analytical purposes, the fifteen-year period may be divided into three five-year periods (1947-51, 1952-56, 1957-62). Average monthly prices for the 1952-56 period showed a steady rise from October to May except for the months of January and February when they remained constant. This steady increase in price as the marketing season progressed is consistent with the accrual of storage costs as the season advances.

The other two five-year periods, however, were characterized by fluctuations throughout the marketing months. The 1957-62 period was marked by low prices at the start of the season and extremely high prices at the end. This may have been due to large marketings at the start of the season with a resulting shortage and high prices at the close of the season. However, some of the price increase at the end of the season may have been caused by the increased utilization of controlled atmosphere storage during that period. Prices decreased from December to February during the 1947-51 period. This may have been due to an underestimation of total production early in the season.

Profit maximization to growers from the sale of McIntosh is dependent upon the timing of their sales throughout the nine to ten-month marketing season. A knowledge of intraseasonal shifts in demand is imperative if the timing of sales is to be consistent with a goal of maximizing profits. An indication of producers' knowledge of demand is reflected in how closely they approach the maximization of net returns under given cost conditions.

With these basic, facts and assumptions in mind, the objectives of the study were as follows:

1. To analyze and evaluate the marketing performance of the New England-New York McIntosh industry with respect to the maximization of profits on a yearly basis since 1947; and
2. To define optimal seasonal allocations of the yearly crops produced during September through May of the 1947-62 period.

This was to be accomplished by comparing actual monthly marketings with derived optimal monthly marketings in order to evaluate the industry's fresh marketing performance in each of the production years studied.

In estimating each of the nine monthly demand functions, the wholesale sale of fresh McIntosh was considered the dependent variable. Independent variables included price of McIntosh sold on the fresh wholesale market; wholesale prices of Delicious and other eating apples; per capita personal income; and time. Yearly observations over sixteen years were divided into nine monthly sub-periods: September through May of 1947 to 1962. Each month was considered to be a separate market and a separate demand function was derived for it.

The independent variables explained from 58 percent in May to 95 percent in December of the fluctuations in the wholesale quantities of fresh McIntosh sold over the sixteen-year period. Price elasticities of demand at mean prices and quantities ranged from -.62 in March to -1.27 in December.

The McIntosh price coefficient was negative in all months and significant in every month except May. The Delicious price coefficient was negative in all months except September and May, but was not significant in these two months. The price of other eating apples had a positive effect in all months and was significant in December and January. Income had a negative effect during the harvest season, September to December, and a positive effect the rest of the season, January to May. The income coefficient was significant in three months: January, February, and April. Time had a negative effect from January to April and a positive effect in the other five months. The time coefficient was significant in four months: December, January, February, and April.

The estimated coefficients did not wholely measure up to a priori expectations. The most serious digression was the negative effect of Delicious prices on the consumption of McIntosh. However, due to limitations of available data, the derived demand functions were accepted as reasonable facsimiles of actual monthly demand functions for McIntosh apples.

Market performance evaluation must be based on some criterion of the "best" performance. The producer may consider the "best" intraseasonal allocation as one that maximizes his total net returns for the season. In this study the McIntosh industry was treated as a single firm in imperfect competition with other apple varieties on the fresh market. Marketing performance was evaluated on the basis of maximization of net returns to the industry.

A variation of the familiar monopolist's price discrimination model utilized the derived monthly demand functions to determine monthly marketings which would have maximized net returns to the industry each year.

The solution to the allocation problem, using the theory of the traditional price discrimination model, is reached when a product is selectively allocated between the different markets until the marginal revenues in each market are equal to each other, and to the marginal cost. This solution implies that marginal costs are equal in every market. It has been suggested that it would be more realistic to assume that selling costs would differ from market to market, giving each market a different marginal cost.

The traditional solution also indicates that total production is determined where the horizontal sum of the marginal revenue curves intersects the marginal cost curve. In the case of fresh apples, the total supply is predetermined and must be allocated after it is produced.

The solution under conditions of different marginal costs for each market and a given total supply is to equalize the marginal net returns in all markets. Marginal net revenue is here defined as marginal revenue minus marginal cost.

Since the total supply of McIntosh is produced in a given time period and must be distributed in succeeding time periods, the cost of production was assumed to be fixed. Therefore, the marginal costs were entirely the marginal costs of selling in each market and each market was defined as a month.

Under the traditional price discrimination model net marginal revenue in all markets is then zero. The sum of optimum quantities sold in each market represents, then, the optimum total output of the firm. Optimum allocation between markets when total production is given, is achieved when net marginal revenues are equal in all markets. Specifically, when the markets are separated in time, the discounted net marginal revenues must be equal in all markets.

The estimated monthly demand functions were adjusted and algebraically transformed to allow price of McIntosh apples to be a function of quantity sold. Monthly costs of storage were subtracted from each monthly demand function. All functions were put on a comparable basis by discounting each monthly function at a one-half percent per month rate. The demand functions for each month were then incorporated into a quadratic programming framework and the yearly McIntosh crops were allocated throughout the nine-month marketing season so that discounted net marginal revenues were equal in all months of a particular marketing season.

The optimum production level would have resulted in zero net marginal revenue levels in all months when total production was properly allocated. However, since the supply in any given year was assumed fixed, net marginal revenues could be either positive or negative, or even, by chance, zero.

Quantities which should have been marketed each month of the fifteen seasons to maximize net revenues were determined and represent the division of annual production in each year so that discounted net marginal revenues in each month of the season were equal.

Monthly marketings, both actual and optimal, were also determined as percentages of the total crop available. The percentage ranges relevant to the optimal allocation were quite narrow, fluctuating from a range of 4.0 percentage points in October to a range of 1.2 points in February. The number of months that actual marketings fell within the optimal percentage ranges in a particular marketing season was considered to be an indication of how well the industry allocated its crop during that respective season. According to this criterion, the 1953 and 1954 marketing seasons performed "best". These two seasons also had low absolute net marginal revenue values. This, however, was a coincidence and does not mean that the two methods of market evaluation measure the same thing.

Absolute net marginal revenue values were an attempt to evaluate production levels while monthly ranges were an attempt to measure allocation performances.

Total net revenues were computed for both optimal and actual marketings for each of the fifteen seasons. Total marketing costs were subtracted from total revenues to obtain net revenues. Both the actual and optimal total net revenues were based on the derived monthly demand functions. The difference between optimal total net revenue and actual total net revenue was used as a criterion for evaluating yearly marketing performance. Based on this criterion, the industry performed "best" during the 1960-61 marketing season with a difference of only $343,000 or 1.1 percent of actual total net revenue. This was also the year when net marginal revenue associated with the optimal allocation was nearest to zero (0.15 cents). Therefore, it appeared that the 1960-61 season approached being a model year with respect both to size of crop when storage costs are the only costs considered, and to the allocation of the crop. The weakest performance was given during 1947-48 when close to $2.4 million, or 11.5 percent of actual total net revenue was lost to the industry through misallocation of the crop.

Although the "best" and the "worst" monthly allocations fell at opposite ends of the time period studied, there was no trend showing improvements over time with respect to allocations. Over $2 million were forfeited in each of three seasons, with these three seasons scattered throughout the period (1947, 1954, 1959). On the other hand, three seasons came within $500,000 of optimum net revenue (1952, 1956, 1960).

In the 1961 season, 14.6 million bushels were sold on the fresh market for a net income of approximately $28 million. During the 1960 season only 10.2 million bushels were sold for a net income of approximately $31.5 million or a decrease of 4.4 million bushels contributed to an increase in net revenues of $3.5 million. It appears that in some of the years studied, the crop offered for sale was too large to attain maximum net returns.

When total production was properly allocated in each season, six years had positive net marginal revenues and nine years negative. None of the years had marginal revenues of zero, although the 1960-61 season approached it with a net marginal revenue of .15 cents. The computed net marginal revenues for each year represent the addition or subtraction to total net revenue associated with the sale of one more pound of McIntosh per capita in that year. When the discounted net marginal revenue is positive, marginal revenue exceeds marginal cost of storage. When it is negative, marginal revenue is less than the marginal cost of storage. If the marginal cost of storage exceeds marginal revenue, marginal cost, which includes all costs, must also exceed marginal revenue. Therefore, any season which had negative net marginal revenues, had greater than optimum production. Seasons with positive net marginal revenue may or may not have had less than optimum production, depending on the magnitude of marginal costs of production.

Three years, 1953, 1954, and 1960 had small absolute values for net marginal revenues when only marginal cost of storage was considered. Total production per capita available for sale in these years was 18.8, 16.9, and 17.7 pounds respectively, indicating that the optimum production for the time period was in the vicinity of 17 pounds per person.

In summary, the study was an attempt to analyze the feasibility of separating markets in time. Derived demand functions for monthly markets indicate that the demand for McIntosh is inelastic in some months and elastic in others. The monthly allocation of yearly production according to different monthly demands could have resulted in increases of over $2 million in net revenue to growers in certain years.

The feasibility of putting such a monthly allocation program into practical use would require growers to be bound together under one controlling marketing organization which would have to have complete knowledge of all stocks and sales. Some control measures would be required to insure that the proper aggregate amount was placed on the market each month.

The total benefit in additional net revenues from price discrimination and optimal allocation over the fifteen years would have been slightly over $18.5 million. Yearly operating costs of a controlling organization would only have to be slightly over $1 million annually for costs to be equal to additional revenue.

In some years a reduction of the total crop would have resulted in sizable increases in net revenues. When supply control is advocated, the effect on seller's incomes is due to price increases following reductions in supply. Net incomes will only be increased if the yearly price elasticity for McIntosh is less than one. Generally, fresh apples are considered to have a demand of less than one, and McIntosh are assumed to have a similar schedule. However, the substitution effect between McIntosh and other varieties is not clear with present data, and positive income results from a supply reduction program for only McIntosh is, therefore, in doubt.