An Economic Model of Vertical Integration and Multiple Pricing Based on the Maple Sirup Industry[1]

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THE ECONOMIC MODEL presented in this paper is based on empirical data collected on the maple sirup industry. It illustrates the competitive position of agricultural producers who sell consumer products at different levels of the production, processing, and marketing chain. The data were obtained by a mail questionnaire sent to all known maple sirup producers in the United States. Seventy percent of the producers responded to the questionnaire.

The maple sirup industry has five claims to distinction: (1) it is one of the oldest American agricultural industries, having been practiced by the early Indians; (2) world production is confined almost entirely to the North American continent; (3) it has a very high degree of vertical integration; (4) it is the only agricultural industry wherein palatable products are produced from the sap of a tree; and (5) it is one of the few agricultural commodities produced in the United States of which imports normally exceed domestic production.

Production of maple sirup is confined to natural growth areas of hard maple trees. This restricts production in the United States primarily to the Great Lakes area and the Northeast, and in Canada to the Eastern Provinces of Nova Scotia, New Brunswick, Quebec, and Ontario. Of the normal world annual production of 3 million gallons of sirup, Canada usually produces two-thirds and the United States one-third. Consumption is reversed, with the United States consuming approximately two-thirds and Canada one-third.

[1] This article represents part of a research project that was cosponsored by the Pennsylvania State University and the Marketing Economics Division, ERS. The entire study is described in a Ph.D. dissertation by Reed D. Taylor entitled "Characteristics of the United States Producer Maple Syrup Markets."

In the United States hard maple groves are scattered, usually being found in hilly regions at least 400 feet above sea level. Since sap is converted to sirup within a short distance of where the sap is collected, production facilities also are widely scattered.

About 87 percent of the U.S. producers are either full-time or part-time farmers, with sirup production making up an average of 23 percent of their total farm gross receipts. Traditionally, individual producers have boiled the approximately 40 gallons of sap required to produce 1 gallon of sirup. The product is "consumer finished," with the exception of packaging. Most producers also package the sirup for consumers.

Maple Sirup Sales

Multiple pricing is practiced by maple sirup producers in the United States. Products of equal quality are sold in alternative markets at price differentials that exceed differences in market costs.

Sirup is graded in four categories: Fancy, A, B, and C. Fancy and A are considered table grade, while B and C usually are sold for manufacturing purposes. About 77 percent of U.S. production is table grade, and 23 percent is manufacturing grade (table 1). Since table grade is the only sirup which has alternative markets, it alone is included in the analysis of producer marketing behavior.

Table grade sirup is sold by producers directly to consumers, retailers, and manufactures. Difference in packaging is the only modification required in processing for these alternative markets. Sirup sold to manufacturers is packaged in drums; the rest is in consumer packages.

Table 1.--Distribution of maple sirup produced by grade, 1,493 producers in 14 States, 1963

Grade	Percent of production
Fancy	45
A	32
B	16
C	7
Total	100

Source: (4, table 55).

Eighty-eight percent of producers sold table grade sirup directly to consumers, disposing of 60 percent of their output at a weighted average price of $6.22 per gallon equivalent, (table 2). A high percentage of these sales were to tourists. Twenty-one percent sold to retailers, disposing of 16 percent at an average price of $5.91 per gallon. Thirty-three percent sold to manufacturers, moving 24 percent of the product at an average price of $3.55 per gallon. Sirup sold directly to consumers grossed almost twice as much per gallon as that sold to manufacturers.

Producers differentiate and sell simultaneously in the different markets by the use of multiple pricing. In addition, the individual producer grows his own trees, collects sap from them, manufactures sirup, and packages it in consumer packages. The maple sirup industry probably represents the highest degree of producer vertical integration in agriculture.

Plant Budgets

Budgeting of maple sirup operations suggested that producers acted rationally in their marketing decisions. Budgets, including all processing and marketing costs, revealed significant differences in operator returns (profit, labor, and management) among the three markets. In the smallest plant budgeted, with annual capacity of 7,292 gallons of sirup, operator returns were $1.32 per gallon when all table grade sirup was sold to consumers, $0.97 when all was sold to retailers, and $0.34 when sold to manufacturers (4, tables 81-92).[2]

Effects of Size on Producer Behavior

Size of operation is an important factor in influencing market behavior. Maple sirup producers were divided into five categories based on total gallons produced. Categories selected were 0-199, 200-399, 400-599, 600-799, and 800 gallons and over. Since trends were the same in all five cases, size categories 200-399

[2] Underscored numbers in parentheses refer to items in the References, p. 106.

Table 2.--Distribution of table grade maple syrup and prices received by market, 1,493 producers in 14 States, 1963

Market	Percent of producers[a]	Percent of production	Price per gallon equivalent
Direct sales to consumers	88	60	$6.22
Sales to retail outlets	21	16	5.91
Sales to manufacturers	33	24	3.55
Total or average	--	100	$5.53

[a] Since some producers sold products in more than one market, the percentages add to more than 100.

Source: (4, tables 17, 18, 41, 42, 62).

and 600-799 were omitted to simplify presentation. In this paper the smallest category refers to producers of 0-199 gallons, and the largest refers to those producing 800 gallons and over.

Size of operation proved to be a significant factor in explaining market distribution by individual producers (table 3). Seventy percent of the smallest producers sold to consumers exclusively. Most of the largest producers sold in more than one market; large producers found the direct consumer market profitable but limited. In sales to retailers, however, small size was a limiting factor since retailers need substantial sirup supplies on a reliable basis. Only 13 percent of the smallest producers sold to retailers (1 percent sold to retailers exclusively), while almost half of the largest producers sold to retailers. Sales to manufacturers were made by more than half of the largest producers but only 19 percent of the smallest.

Nearly all producers sold to the more profitable markets--consumers and retailers. Sales to manufacturers were made primarily to dispose of "surplus" table grade sirup.

The larger the producer, the more difficult it is for him to market his entire supply directly to consumers, although 14 firms did it. Most sales directly to consumers take place on the farm. This limits the potential number of customers for most producers. A producer's optimal strategy is to sell to different markets at prices determined by supply and demand.

Most individual maple sirup producers meet the three conditions necessary for successful multiple pricing. First, they have three separate markets. They can package and retail sirup on the farm at a lower cost per unit than can be

Table 3.--Percentage of producers selling table grade maple sirup by outlet and size of operation, 1,493 producers in 14 States, 1963

Sales outlet	Average for all sizes	Size of operation in total gallons per producer[a]		
		0-199	400-599	800 and over
Individual outlets:	Percent	Percent	Percent	Percent
Consumers	[b](88)	(92)	(83)	(89)
Consumers exclusively	52	70	30	19
Retailers	(21)	(13)	(31)	(47)
Retailers exclusively	2	1	2	0
Manufacturers	(33)	(19)	(50)	(55)
Manufacturers exclusively	9	6	15	10
Multiple outlets:				
Consumers and retailers	13	10	18	26
Consumers and manufacturers	18	11	24	24
Retailers and manufacturers	1	1	0	1
Consumers, retailers, and manufacturers	5	1	11	20
Total	100	100	100	100
Number of producers in size category	1,472	704	169	74

[a] For simplification, size categories 200-399 and 600-799 were omitted. Data for these categories showed the same trends as for the ones included. The complete table is in (4, table 62).

[b] Percentages in parentheses represent producers who sold in more than one market, and therefore they add to more than 100.

done through usual marketing channels. Second, elasticities of demand at each price level differ between markets. Third, producers have market power in selling to consumers and retailers. In consumer sales, the market structure on the producer's side varies between monopolistic competition and monopoly but approaches pure competition for the consumer. In sales to retailers, the producer's side can best be described as ranging between pure and differentiated oligopoly, while the retailer's would vary between pure and differentiated oligopsony. In selling to manufacturers, structure is best described as pure competition for the producer and pure oligopsony for the manufacturer (4, chapters III, V, and VI).

Because the smaller producers find it difficult to sell to retailers, they are in a somewhat weaker position than that of pure of differentiated oligopoly ascribed to larger maple sirup producers selling to retailers.

Model of Market Behavior

The following describes the competitive situation facing individual agricultural producers who sell consumer products at different levels of the production, processing, and marketing chain. Although based on the maple sirup industry, we believe the description applies to other agricultural industries. Where vertical integration is practiced and consumer products are produced, the opportunity for multiple pricing is present even if not exercised.

Each of the three markets in the maple sirup industry presents a different demand curve to the individual producer (fig. 1).

The direct consumer market (packaged) has the most inelastic demand curve. The packaged wholesale market is more elastic than the direct market to consumers but more inelastic than the wholesale drum market to manufacturers. The latter market has an almost perfectly elastic demand curve and approaches perfect competition. Demand curves for sirup are considered net of marketing costs. To maximize returns with any given quantity, a producer should distribute his sales in such a way that marginal revenue in each market is equal to marginal revenue in other markets. Vertical integration allows the producer to sell in different markets. Structural characteristics of these markets permit him to optimize his profit stream by multiple pricing.

Assume that a producer sells in the three markets, as in figure 2. The demand curve for retailing direct to consumers is D_1D_1, for selling packaged sirup to wholesalers D_2D_2, and for selling drum (unpackaged) sirup to manufacturers D_3D_3. The respective marginal revenue curves are MR_1MR_1, MR_2MR_2, and MR_3MR_3. The sum of the marginal revenue curves is shown by the curve ABCD. To maximize total returns with any given output the producer should sell his entire output (quantity) directly to consumers if it is equal to or less than point B; divide his sales between consumers and retailers when output is more than B but equal to or less than C; and use all three markets if output is greater than C. If output is greater than C, there will be a unique distribution of product in the three markets. For example, if the output were C or more, the quantity OQ_1 always would be sold to consumers at a price P_1;

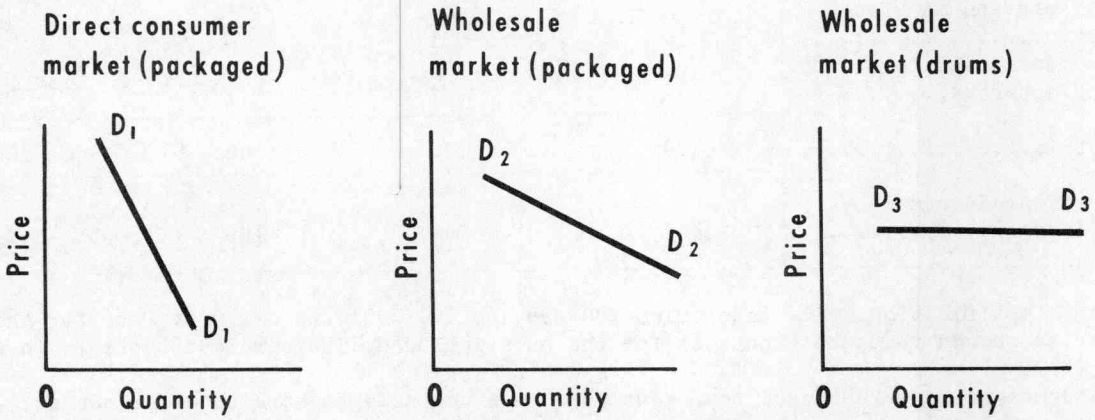

Figure 1.--Relative configurations of demand curves facing individual maple sirup producers.

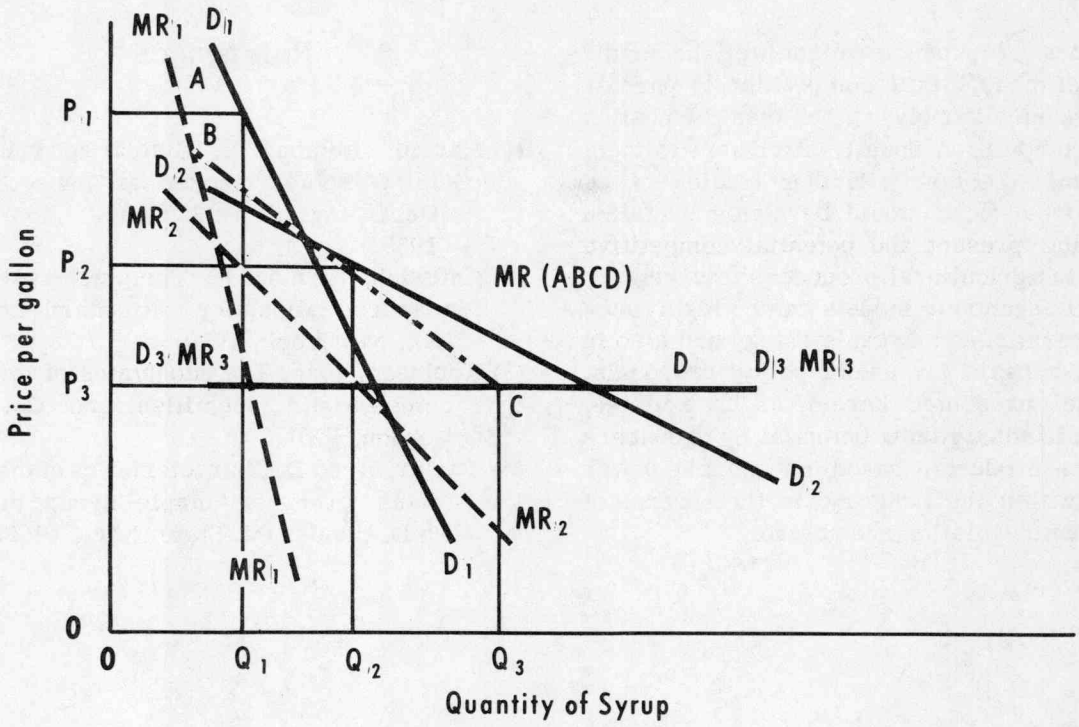

Figure 2.--Aggregate configurations of demand curves facing individual maple sirup producers.

the quantity OQ_2 would be sold to retailers at a price P_2; and any remainder would be sold to manufacturers at a price P_3.

One difference exists between the type of behavior explained in the model presented herein and the theoretical model of multiple pricing presented in the literature (2,3). The usual model of multiple pricing describes income maximizing behavior of a monopolist selling an identical product in two or more separate markets at one horizontal level of the production, processing, and marketing chain. Our model for individual maple sirup producers and other similar industries resembles the one proposed by researchers for the milk market where multiple pricing occurs as a result of selling the same quality product at different prices at different vertical levels of the production, processing, and marketing chain (1). Although multiple pricing in the milk market results primarily from extensive State and Federal market controls and other insitututional regulations, it occurs in the maple sirup industry at the individual producer level of marketing because of vertical integration and inherent structural characteristics of the market.

Implications

Examples of producers whose competitive situation is similar to that of maple sirup producers are: (1) Large egg producers who have retail and wholesale routes but who sell the bulk of their eggs to large wholesale buyers, either whole, or processed into dried or frozen form; (2) milk producers who have "call-at-the farm" jug sales, retail routes, and wholesale outlets; (3) greenhouse operators who retail direct to consumers, sell wholesale to retail outlets, and offer their product to wholesalers; (4) fruit, vegetable, and nut growers who sell from roadside stands or the farm, who sell to retail outlets, and who wholesale to processors or through brokers; (5) and the many integrated operations (broilers, layers, turkeys, swine, beef) in which the integrator has access to several vertical markets and thereby the opportunity to use multiple pricing.

Maple sirup producers and other agricultural producers fitting the suggested model would have market power in some markets. The closer the producers sell to the consumer, the greater their power. Agricultural producers selling

some types of products might well be in the position of monopolistic competition or pure or differentiated oligopoly, rather than the postion of pure competition usually attributed to them by economic theorists. Further studies of the type reported here would be highly useful in determining present and potential competitive behavior in agricultural producers' markets.

Realistic economic models can be highly useful in determining market strategy and also in providing a basis for useful policy proposals. The model presented herein, as an example, shows profit maximizing potential by producers of certain products, based on market power inherent within the industry, in the absence of Government regulation and control.

References

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