Impact of Spatial Price Discrimination within Florida Dairy Cooperatives

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The trend toward deregulation and the relatively high prices in the Florida milk market have increased competition for milk supplies between the Florida dairy cooperatives (FDCs) and other cooperatives like Dairymen Incorporated and Southern Milk Sales. Because of the increased competition in the Florida markets, the FDCs may need to implement a discriminatory spatial pricing policy. The discriminatory pricing policy allows the FDCs to expand their membership by absorbing some of the transportation cost of producers in distant locations that would otherwise be independent producers or members of competing cooperatives. Spatial pricing policies are analyzed to determine the effects of discriminatory pricing on the blend price, average aggregate revenue of cooperative members, and total costs and quantity of milk imports. The results of this study show that a nondiscriminatory pricing policy maximizes the cooperative members' blend price and average aggregate revenue. However, if the FDCs were able to increase the price by $0.50 as a result of using spatial price discrimination to gain market power, spatial price discrimination would maximize average revenue and blend price.

The federal government has been involved in the dairy industry since 1933. Before government intervention, the industry was dominated by milk handlers that behaved as monopsonists (Manchester 1983). The Agricultural Marketing Agreement Act of 1937 provided enabling legislation to farmers for establishing federal milk marketing orders. The government encouraged such orders to establish orderly marketing conditions that approximated a competitive market (AAEA 1986). Masson and Eisenstat (1980) indicate that the movement toward deregulation of the dairy industry arises from concerns that the federal orders and price support program have resulted in a marketing environment that relies little on price discovery mechanisms and too much on classified pricing and the monopoly power of producer cooperatives. As the dairy industry becomes less regulated, a primary concern of producers is the impact on farm-level income of increasing competition for supply contracts in the local markets. The members of the Florida Dairy Farmers Association (FDFA) and the Tampa Independent Dairy Farmers Association (TIDFA) are two groups of producers that are currently facing these issues.

The Florida milk market is a high-valued market dominated by fluid milk sales. In 1992, the weighted average Class I (fluid milk products) utilization rate for the three federal milk marketing orders in Florida was 85.7% (Federal Milk Marketing Order 1992). The weighted average blend price for the three federal milk marketing orders in Florida in 1992 was $15.35 per hundredweight, compared with $13.57 (North Atlantic), $12.68 (East North Central), and $13.13 (all markets) (Federal Milk Marketing Order 1992). The combined sales from four cooperatives—FDFA, TIDFA, Southern Milk Sales, and Dairymen Incorporated—account for virtually all of the milk sold to twenty Florida processing facilities. Of these four cooperatives, FDFA and TIDFA represent approximately 91.5% of the total fluid milk sales to processors in the Florida dairy market; FDFA has 75% of these sales and TIDFA the remaining 25% (FDFA 1992; TIDFA 1992). In addition to the cooperatives' large share of the Florida market, TIDFA and FDFA have also coordinated milk shipments in the recent past. For these reasons, FDFA and TIDFA are considered the Florida dairy cooperatives (FDCs) in this article.

Like other milk markets, the Florida market is a highly seasonal one. From July through November,

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when consumption patterns are steadily increasing (Kilmer et al. 1992), dairy producers are unable to produce an adequate supply of milk because of the adverse effects of environmental conditions. During these months, the Florida dairy cooperatives must obtain supplemental milk from import sources to fulfill supply contracts. For example, in 1992 the FDCs imported 120,183,725 pounds of milk from sources as distant as fifteen hundred miles from the Florida market (FDFA 1992; TIDFA 1992). Within the deficit months, approximately 30% of the total milk imports occur in September. Because of the transportation cost associated with shipping raw milk, FDCs have paid as much as $22.87 per hundredweight for supplemental milk (Kilmer et al. 1992).

The trend toward deregulation, the increasing Florida population (which increases the demand for dairy products), and the relatively high prices in the Florida market have increased competition for milk supplies (i.e., milk producers). Because of the increased competition, the FDCs need to keep prices low to fluid milk processors, keep returns high to dairy farmers, and bring producers into the FDCs in order to satisfy the increasing demand in the Florida milk market. This article focuses on expanding the cooperative membership to meet the increasing demand for dairy products in Florida; however, increasing the FDCs' membership also affects the prices charged processors and the returns to dairy farmers.

To expand the number of producers in the FDCs, the FDCs must go beyond Florida borders, because the FDCs already have approximately 97% of the production in Florida (Cooperative Records). By implementing a discriminatory spatial pricing policy, the FDCs may be able to expand the number of cooperative members by absorbing some of the transportation cost of producers in distant locations that would otherwise be independent producers or members of competing cooperatives. With a discriminatory spatial pricing policy, the FDCs may be able to decrease the quantity and total cost of milk imports by expanding their milk supplies, to increase the total income of producer members, and to be competitive with other producer cooperatives. In this article, spatial pricing policies are analyzed to determine the effects of discriminatory pricing on the blend price, average aggregate revenue of cooperative members, and total costs and quantity of milk imports. This article will determine which spatial pricing policy, discriminatory or nondiscriminatory, provides more benefits in terms of the levels of blend price and average aggregate revenue to the FDCs' members.

Marketing Environment

Federal Market Orders and Price Support Programs

The tools of U.S. dairy policy are the federal marketing orders and the price support program. The marketing orders use a classified pricing system to ensure an adequate supply of fluid milk to the retail market. Meanwhile, the price support program maintains a price floor for Grade B milk, or milk processed into manufacturing products. In 1960, eighty federal marketing orders regulated 43% of all milk marketed. By the end of 1993, approximately 70% of total milk marketings within the United States was regulated by thirty-eight federal orders (Blaney, Miller, and Stillman 1995). Milk sales in a marketing order are composed of Class I, Class II, and Class III sales. Class I sales are represented by the percentage of total production used for beverage purposes. Soft products, such as ice cream and yogurt, represent Class II sales. Class III milk is manufactured into cheese, butter, and nonfat dry milk (III-A). These products are better known as storable milk products. For marketing orders east of the Rocky Mountains, class prices are based on the price paid by unregulated processors for manufacturing grade milk in the Minnesota-Wisconsin (M-W) region. This region represents a marketing area where local production exceeds consumption throughout the year. Subsequently, Minnesota-Wisconsin producers are a supplemental source of raw milk during deficit months in other marketing areas.

In all marketing orders, the class price is related to the M-W price.[1] For example, a federal milk marketing order's Class III price is generally the M-W price. The Class II price is the M-W price plus a price differential that usually totals $0.25 per hundredweight (Schiek 1991). The Class I price is the M-W price plus a Class I differential that is established in the federal orders. The differences in price differentials reflect the additional costs (i.e., transportation and sanitary requirements) associated with marketing Grade A fluid milk. In 1994, the Class I differentials from Eau Claire, Wisconsin (the geographic center of the Minnesota-Wisconsin supply region), to Chicago and Miami were $1.40 and $4.18, respectively (Federal Milk Marketing Order 1994).

[1] As of May 1995, the M-W price is known as the Basic Formula Price (BFP).

Market Power

Since Congress passed the Capper-Volstead Act of 1922, dairy farmers have been collectively bargaining with milk handlers through cooperative organizations. Over the years, the membership in these cooperatives has increased to the point where 82% of all producer milk is marketed through dairy cooperatives (Jacobson and Cropp 1994). The primary role of dairy cooperatives is to perform marketing services for member producers. These marketing services include milk assembly, testing, advertising, record keeping, market analysis, and, most important, obtaining supply contracts with individual processors.

As the supply of milk marketed by local cooperatives increased, milk handlers let dairy cooperatives do their short-term and seasonal balancing of supply with demand (Gaunmitz 1963). Some of the services provided to the milk handlers are disposal of milk in excess of fluid requirements, arranging for an adequate supply of fluid milk on a supplemental or continuing basis, and providing standardized milk by performing quality control functions (Babb 1989). For these services, milk handlers pay cooperatives over-order payments. Some have suggested that these over-order payments are an indication of cooperatives' increasing market power resulting in part from the federal milk marketing orders (Masson and Eisenstat 1980).

Although there are no regulations that directly benefit cooperatives, critiques of the federal milk marketing order system suggest that the regulations indirectly lead to market power by preventing competition in local markets (Kessel 1967). For example, pooling provisions provide larger dairy cooperatives with the opportunity to increase market share in areas that are more competitive. Dominant cooperatives that operate in several markets can use the pooling provisions to increase the blend price and eliminate competition from other dairy cooperatives (Masson and Eisenstat 1980). As competition is reduced, the dominant cooperative becomes the major source of raw milk for regulated handlers in the local market. This situation provides the cooperatives with an opportunity to negotiate over-order payments in excess of what would prevail in a competitive market.

Masson and Eisenstat (1980) argue that once a dairy cooperative is the dominant supplier of milk in a region, monopoly premiums can be obtained from milk handlers because they lack a stable supply of raw milk from other sources. An alternative theory is that the federal milk marketing orders and the price relationships among orders create an environment where the monopoly premiums are independent of the concentration of dairy cooperatives (Babb 1989; Christ 1980; Jesse and Johnson 1985). Babb (1989) estimated over-order payments as a function of cooperative concentration, presence of a major cooperative in a market, price relationships among orders, utilization rates, cost of milk services, product concentration, and processor concentration. Babb used cross-sectional data for each year during the period 1970–87. The results of Babb's article showed that the estimated coefficients for cooperative concentration and the presence of a major cooperative were generally not statistically different from zero. The impacts of both processor and cooperative concentration on the level of over-order payments were found to be relatively small. Variables that did have significant impacts on over-order payments were the price relationships among orders and the cost of raw milk services. The article revealed that over-order payments had a positive relationship with the cost of milk services and the cost of milk from alternative sources. Although these results do not indicate that cooperative concentration does not have an impact on over-order payments, the results do support the theory that variables related to federal regulations impact these payments more than do structural variables.

Spatial Pricing

As competition increases in local markets, cooperatives may secure a larger milk supply by using some form of spatial price discrimination. Under the existing federal milk marketing orders, transportation differentials help assure an adequate supply of fluid grade milk in local markets. These transportation differentials are known as location or zone differentials. Within a milk marketing order, the location differential is a function of how far a producer is removed from the metropolitan area or base point. The differential increases with distance and reduces the blend price that is paid to producers. The original purpose of the location differential was to establish a supply region for a market and to allow processors within the market to purchase milk at the same price, net of transportation costs. The differentials establish a boundary around a marketing area so that there are no price incentives for producers or processors located in other regions to compete in the local market (AAEA 1986). As the markets become more competitive, producer organizations are expanding markets by creating price incentives with spatial pricing policies.

The spatial pricing policies can be nondiscriminatory or discriminatory. The pricing scheme is nondiscriminatory when the farm price is equal to the market price minus transportation cost between the farm and the market. Spatial price discrimination exists when the farm price is not equal to the market price minus transportation cost between the farm and the market.

A nondiscriminatory pricing policy known as free on board (F.O.B.) pricing could be implemented by the cooperatives. An F.O.B. pricing policy allows each producer to receive the same blend price from the cooperative; however, producers pay the full farm-to-market transportation cost. The farm price for all producers is equal to the blend price that is paid by the cooperative less the full farm-to-market transportation cost.

A discriminatory pricing scheme is freight absorption. A cooperative using a freight-absorbing pricing scheme will subsidize the distant producers by absorbing some element of transportation cost. Discrimination from this pricing policy comes from the fact that nearby producers pay more than the full cost of transportation while distant producers receive some type of transportation subsidy. To fund the transportation credits to distant producers, the cooperative can pay nearby producers a lower blend price or use money generated from the members' revenue pool. Because all cooperative members contribute to the pool, the transportation discounts are being partially funded by nearby producers.

Empirical Model of the Florida Dairy Industry

In this section, an empirical model of milk procurement in Florida is developed. Specifically, conceptual relationships dealing with producers' revenue, milk imports, milk exports, and spatial pricing are explored. To determine the average aggregate revenue of Florida dairy producers, a system of equations shows the step-by-step derivations of cooperative members' milk payments. This set of equations is an accurate representation of how the FDCs determine the monthly payments to member producers.

The procedures for deriving the average aggregate revenue of Florida dairy producers for each month start with the dairy cooperatives. The first task is to identify what variables are used to calculate the cooperatives' total revenue. The FDCs operate in a system that pools the revenue generated from its members' total production. The gross pool is the combined revenue from the sale of cooperative members' production before any deductions for the cost of imports and exports. With the three classes of milk in federal milk marketing orders, the FDCs' gross pool is represented as

(1) $\text{Gross Pool} = TR = f\{Q_{mi}, P_{mi}, OOP_{mp}\},$

where TR = total revenue;
Q_{mi} = quantity of Class i sales from the cooperative to milk handlers in month m measured in hundredweights ($m = 1, \ldots, 12$, and $i = 1, \ldots, 3$);
P_{mi} = price of Class i milk in month m;
OOP_{mp} = over-order payment in month m at processing plant p ($p = 1, \ldots, 10$).

Multiplying the quantity and price variables generates the revenue associated with each class of milk. In addition to the revenue generated from class sales, the monthly over-order payment also contributes to the pool. The monthly revenue generated from over-order payments is arrived at by multiplying the Class I and II sales of Florida processors by the amount of the over-order payment. The mathematical equation that determines the revenue in the gross pool is

(2) $$\text{Gross Pool} = \sum_{m=1}^{12}\left[\sum_{i=1}^{3} P_{mi}Q_{mi} + \sum_{p=1}^{10}\sum_{i=1}^{2} OOP_{mp}Q_{mi}\right].$$

Before a blend price can be calculated, the gross pool is adjusted by deducting the cost of fluid milk imports and the transportation cost associated with disposing of surplus milk (exports) produced by the FDCs' members. Because these costs are allocated equally to all cooperative members, the gross pool is reduced accordingly. The generalized functional form of the annual costs associated with imports is

(3) $CMP = f\{Q_{mop}, P_{mo}, D_{op}, HR\},$

where CMP = total cost of imports;
Q_{mop} = quantity of milk imported in month m from origin o to processing plant p in hundredweights ($o = 1, \ldots, 17$);
P_{mo} = price per hundredweight of milk imported in month m from origin o;
D_{op} = distance from origin o to processing plant p;
HR = hauling rate per mile, per hundredweight of milk;

and the annual cost associated with exports is

(4) $CXP = f\{Q_{mah}, D_{ah}, HR\},$

where CXP = total transportation cost of exports;
Q_{mah} = quantity of cooperative member milk exported in month m from production area a to hard manufactur-

ing plant h in hundredweights ($a = 1, \ldots, 40$ and $h = 1, \ldots, 19$);
D_{ah} = distance from production area a to hard manufacturing plant h;
HR = hauling rate per mile, per hundredweight of milk.

To develop the mathematical equations, the generalized forms represented in equations (3) and (4) are expanded such that the annual costs of imports and exports are presented as

$$(5) \quad CMP = \sum_{m=1}^{12} \sum_{o=1}^{17} \sum_{p=1}^{10} (P_{mo} + D_{op}HR)Q_{mop}$$

and

$$(6) \quad CXP = \sum_{m=1}^{12} \sum_{a=1}^{40} \sum_{h=1}^{19} D_{ah}HRQ_{mah}.$$

The annual net pool, or gross pool adjusted for the costs of imports and exports, is calculated by subtracting equations (5) and (6) from equation (2). The new equation is

$$(7) \quad \text{Net pool} = \sum_{m=1}^{12} \left[\sum_{i=1}^{3} P_{mi}Q_{mi} + \sum_{p=1}^{10} \sum_{i=1}^{2} OOP_{mp}Q_{mi} - \sum_{o=1}^{17} \sum_{p=1}^{10} (P_{mo} + D_{op}HR)Q_{mop} - \sum_{a=1}^{40} \sum_{h=1}^{19} D_{ah}HRQ_{mah} - SB_m \right],$$

where SB_m = the transportation cost (subsidy) above \$1.284 per hundredweight of milk not charged to individual milk producers who have a transportation cost from farm to processor in excess of \$1.284. The \$1.284 is a value determined by the cooperatives. If a producer has transportation costs higher than \$1.284 per hundredweight, the producer receives a subsidy for the difference. The value of the subsidy is determined with the model.

When computing a per hundredweight net blend price, the revenue in the net pool is divided by the sum of all cooperative members' monthly production. On an annual basis, the net blend price is

$$(8) \quad \text{Net Blend Price} = \text{Net Pool} / \sum_{m=1}^{12} \sum_{a=1}^{40} Q_{ma},$$

where Q_{ma} = quantity of member milk production available at production area a in month m in hundredweights.

Because the objective of the model in this article is to maximize the average aggregate revenue of the FDCs' members, the next step is to calculate a production area's gross revenue from milk sales. Gross revenue from milk sales is found by multiplying a producer's total production by the net blend price (equation [9]):

$$(9) \quad \text{Gross Revenue}_a = \sum_{m=1}^{12} Q_{ma}NBP_m,$$

where NBP_m = net blend price in month m.

The final step needed to determine the FDCs' monthly payments to members is to adjust a production area's gross revenue for farm-to-market transportation costs. For the model developed in this article, the cooperatives are responsible for all farm-to-market shipments of milk. Because of this assumption, each FDC subtracts from the production area's gross revenue the cost incurred by the cooperative's hauling division from shipping the producer's milk from the production area to the processing plant. The mathematical form of a production area's monthly transportation cost to the processing plants is

$$(10) \quad TP_{ma} = \sum_{p=1}^{10} ZON_{ap}Q_{map} + PU_{ma} + BAS_{ma} - DIS_{ma},$$

where TP_{ma} = production area's monthly farm-to-market transportation cost;
ZON_{ap} = transportation charge per hundredweight of milk from production area a to processor p;
Q_{map} = quantity of cooperative member milk in month m shipped from production area a to processing plant p in hundredweights;
PU_{ma} = total pickup charge at production area a in month m;
BAS_{ma} = total base charge at production area a in month m;
DIS_{ma} = total volume discount at production area a in month m.

A production area's milk check is the total value of monthly production net of transportation cost. The objective of this model is to maximize the aggregate value of cooperative members' milk checks for the 1992 calendar year. By subtracting equation (10) from equation (9), the annual receipts (i.e., milk check) for a production area are obtained (equation [11]).

$$(11)\quad \text{Milk check}_a = \sum_{m=1}^{12}\left[Q_{ma}NBP_m - \left(\sum_{p=1}^{10}ZON_{ap}Q_{map} + PU_{ma} + BAS_{ma} - DIS_{ma}\right)\right].$$

The objective function of the model is developed by replacing the NBP_m in equation (11) with equation (8) and summing equation (11) over the forty production areas. The final adjustment is replacing Q_{mi} in equation (7) with

$$Q_{m1p} = UR_{mp}(Q_{map} + Q_{mop});$$

$$Q_{m2p} = (1 - UR_{mp})(Q_{map} + Q_{mop});$$

$$Q_{m3h} = Q_{mah},$$

where UR_{mp} = Class I utilization rate in month m at processor p.

The objective function and the constraints needed to complete the model are illustrated below in equations (12) through (17).

$$(12)\ \text{Maximize } AAR = \sum_{m=1}^{12}\sum_{a=1}^{40}\left[\sum_{o=1}^{17}\sum_{p=1}^{10}((Q_{map} + Q_{mop})\,(OOP_{mp} + (UR_{mp}P_{m1} + (1 - UR_{mp})\,P_{m2})) - Q_{mop}(P_{mo} + D_{op}HR)) + \sum_{h=1}^{19}Q_{mah}(P_{m3} - D_{ah}HR) - SB_m - \sum_{p=1}^{10}Q_{map}ZON_{ap} - PU_{ma} - BAS_{ma} + DIS_{ma}\right]$$

$$(13)\quad \sum_{a=1}^{40} Q_{map} + \sum_{o=1}^{17} Q_{mop} = D_{mp} \qquad p = 1, \ldots, 10$$

$$(14)\quad \sum_{p=1}^{10} Q_{map} + \sum_{h=1}^{19} Q_{mah} = Q_{ma} \qquad a = 1, \ldots, 40$$

$$(15)\quad \sum_{a=1}^{40} Q_{mah} \le C_{mh} \qquad h = 1, \ldots, 19$$

$$(16)\quad \sum_{p=1}^{10} Q_{mop} \le S_{mo} \qquad o = 1, \ldots, 17$$

$$(17)\quad Q_{map}, Q_{mop}, Q_{mah} \ge 0,$$

where AAR = average aggregate revenue of cooperative members;
D_{mp} = demand in month m of processing plant p in hundredweights;
C_{mh} = capacity of hard manufacturing plant h in month m in hundredweights;
S_{mo} = available supply from origin o in month m in hundredweights.

The decision variables in the model are Q_{map}, Q_{mop}, and Q_{mah}. The model is designed to maximize the average aggregate revenue of producers by minimizing the assembly cost of milk procurement. The procurement of milk involves (1) transporting milk from the farm to the processors, (2) purchasing supplemental milk from the least expensive import source during deficit months, and (3) disposing of milk in the surplus months. The model is equally concerned with activities (e.g., the cost of supplemental milk and the net revenue from export sales) that affect the value of the blend price as well as activities (e.g., intrastate milk flows) that affect individual production areas' revenues. Because all production areas are linked to each processing and manufacturing plant, the model determines simultaneously the optimal interstate and intrastate flows of milk for Florida cooperative members.

Equation (13) maintains that the quantity of milk supplied by Florida cooperative members plus supplemental milk obtained from import sources is equal to the processor's monthly demand for raw milk. The demand for raw milk is an exogenous variable whose value is consistent with monthly shipments of FDCs in 1992 (see below for an explanation of the data and other exogenous variables). Equation (14) ensures that the shipments of milk from a production area to a processor in Florida plus milk supplied to manufacturing plants in other states by FDCs are equal to the total quantity of milk available from a production area. Essentially, this equation requires that uses equal sources at the farm level. The supply of milk from production areas is also an exogenous variable that varies across months and corresponds to 1992 production data.

Equation (15) recognizes that the manufacturing plants have limited capacities; therefore, the total quantity of milk shipped from production areas to a manufacturing plant must be less than or equal to the plant's monthly manufacturing capacity. Equation (16) is a supply constraint. Because milk imports are limited during the deficit months, equation (16) constrains the amount of milk shipped from an import source to a processing plant in Florida. The supply of milk from an import source is an exogenous variable whose value is determined with 1992 data supplied by the FDCs. The final constraint, equation (17), is a nonnegativity constraint for the value of the unknown decision variables.

Alternative Spatial Pricing Scenarios

According to industry representatives of the FDCs, the objective of the organizations is to keep returns high to dairy farmers. To accomplish this objective, the FDCs may need to expand the market boundary by using spatial price discrimination in the form of freight absorption. With this article, the effects of spatial price discrimination on the blend price, the average aggregate revenue of members, and the total costs and quantity of milk imports and exports are analyzed. The model developed in the previous section is used to compare the results of two pricing scenarios: freight absorption and nondiscriminatory spatial pricing in the form of F.O.B. pricing. The differences in the empirical models for the two scenarios are discussed below.

In the freight absorption pricing model (FAPM), the FDCs expand their market boundary by providing a transportation subsidy to distant producers located on the market boundary. The transportation subsidy is implemented through a farm-to-market hauling rate cap. The hauling rate cap places an upper bound on how much the FDCs will charge members for farm-to-market transportation cost. The current hauling rate cap is set by the FDCs at $1.284 per hundredweight. To determine if a production area qualifies for a subsidy, the transportation cost calculated in equation (10) is divided by a production area's total monthly production. If the per hundredweight farm-to-market transportation cost is greater than $1.284, the production area receives a subsidy for the difference. After the eligible production areas are identified, the model determines the total cost of the freight absorption pricing policy by summing the values of each subsidy. The total cost of the freight absorption policy is then subtracted from the FDCs' net pool (equation [7]) before a blend price is calculated.

The FAPM identified seven production areas that received transportation subsidies throughout 1992. With the exception of Clay County, Florida, all production areas receiving a transportation subsidy were located in the Florida panhandle or south Georgia. The authors assume that these seven production areas are members of the FDCs because of the freight absorption pricing policy.

The FDCs' alternative to freight absorption is F.O.B. pricing. In the F.O.B. pricing model (FOBPM), no production area receives a transportation subsidy. Because there is no transportation subsidy, the market boundary of the FDCs is compressed to reflect the assumed market boundary before the policy of spatial price discrimination. Without a transportation subsidy, the authors assume that the seven production areas identified in the FAPM would no longer be members of the FDCs. Hence, the FDCs represent forty production areas in the FAPM and thirty-three production areas in the FOBPM. By removing the hauling rate cap and shrinking the market boundary, the effects of freight absorption can be compared with results from an F.O.B. pricing policy that approximates marketing conditions before spatial price discrimination.

Data Requirements

Most of the data needed to conduct the study were collected from the Florida Dairy Farmers Association, Tampa Independent Dairy Farmers, Southern Milk Sales, and Dairymen Incorporated. The combined sales from these organizations account for virtually all of the milk that is sold to processors within the Florida milk market. The input for the model requires monthly data collected over a one-year time span. Because the 1992 calendar year provided the most recent data, this year was chosen as the time period for the study. The specific data requirements are associated with production, processors, manufacturing plants, import sources, and transportation cost.

Production Areas and Supply

To establish a production area for the model, production data on a per farm basis was collected from the FDCs. The only guideline for establishing a production area is that each area contains three or more producers. Production areas usually correspond with a single county. In situations where several counties are combined to form a single production area, the county with the largest annual production will contain the geographical center of that production area. The combined production of FDFA and TIDFA members results in forty production areas.

Marketing Areas and Demand

Specific locations in Florida are designated as marketing areas, which represent one or more proces-

Table 1. Federal Milk Marketing Order Prices for Florida, 1992 (dollars per hundredweight)

	Class I			Class II	
	Order 6	Order 12	Order 13	Florida Market	M-W
January	16.06	16.36	16.66	12.25	11.71
February	15.68	15.98	16.28	11.95	11.21
March	15.29	15.59	15.89	11.09	10.98
April	14.79	15.09	15.39	11.16	11.46
May	14.56	14.86	15.16	12.12	12.06
June	15.04	15.34	15.64	13.07	12.46
July	15.64	15.94	16.24	12.46	12.59
August	16.04	16.34	16.64	12.67	12.54
September	16.17	16.47	16.77	13.17	12.28
October	16.12	16.42	16.72	12.56	12.05
November	15.86	16.16	16.46	11.87	11.84
December	15.63	15.93	16.23	11.62	11.34

SOURCE: Federal Milk Marketing Order 1992.

sors. The Florida market contains ten marketing areas. The monthly demand for raw milk at each marketing area varies across months, but the total demand for each processor is fixed to correspond with the actual quantity of milk processed during 1992. The demand at all marketing areas is satisfied by milk shipments from cooperative members and imported milk that is marketed through the cooperatives.

The prices that are paid by marketing areas correspond to the class prices of Federal Milk Marketing Orders 6, 12, and 13. Table 1 lists the 1992 prices that were paid in each of these federal milk marketing orders. The Class I price that a marketing area pays is dependent on the location of the marketing area. The Class II prices for producers in the Florida market are the same across marketing orders. Also included in table 1 are the M-W (Class III) prices for 1992.

Marketing areas also pay an over-order payment on all Class I and II milk that is processed at that particular location. The value of the over-order payment is an exogenous variable that differs across marketing areas and months. For each marketing area, the monthly average over-order payment is based on the actual payments made by individual processors in 1992. Because of confidential data, the over-order payment is an average payment per hundredweight of Class I and II milk from processors located in a particular marketing area.

The final exogenous variable associated with processors is the utilization rate. A processor's utilization rate determines the quantity of milk that will be processed into Class I and II products. The actual utilization rates for each processor are used to determine a marketing area's weighted average Class I and II utilization rates. The utilization rates vary by marketing area and month.

Export Alternatives

The total number of export alternatives in the model is nineteen. These nineteen locations represent viable export alternatives for the Florida cooperatives. All plants received at least 100,000 pounds of milk in 1992. Any location that received less than 100,000 pounds is not considered a viable export alternative. Monthly processing capacity for manufacturing plants, which are the types of plants that received most of the FDCs' exported milk, are fixed at levels that coincide with the total amount of exports shipped to that plant by FDCs during 1992.

The prices at export plants are based on the monthly M-W price that is illustrated in table 1. To arrive at the model's monthly Class III price, the M-W is adjusted according to the guidelines in the contract between Florida cooperatives and Dairymen Incorporated.[2] For reasons of confidentiality, the contract specifications are not outlined in the article.

Import Sources

The model includes seventeen import sources located throughout the United States. Each import source represents a location in which supplemental milk was obtained by Florida cooperatives in 1992. The quantity of milk available at each import source is determined by using the same procedures outlined above when assigning processing capacities at export facilities. The price that the cooperatives must pay for the supplemental milk is deter-

[2] The contract price applies to milk that is shipped to plants that are owned by Dairyman Inc. or shipments to plants in which Dairyman Inc. acts as the broker for Florida cooperatives.

mined by using the actual prices reported by the FDCs.

Transportation Cost

The final data requirement provides information on transportation cost. The two types of transportation cost in the model are farm-to-market transportation cost and transportation cost associated with imports and exports. To calculate any transportation cost, the following distance variables are needed: (1) production area to marketing area, (2) production area to export alternatives, and (3) import source to processing plant. The origin and destination points of these distance variables are determined by using the geographical center of the production areas and the exact location of the processors, manufacturers, and import sources. AUTOMAP is used to determine the exact distance for all production areas, marketing areas, export alternatives, and import sources.

Along with the mileage, the additional information needed to calculate the transportation cost on imports and exports is a hauling rate. The hauling rate on imports and exports is $2.00 per loaded mile with a load of milk equal to 475 hundredweights (FDFA 1992; TIDFA 1992). Dividing the $2.00 per loaded mile by 475 gives a figure of .0042105, which represents the per mile, per hundredweight hauling charge for imports and exports. This value remains constant across months.

The hauling rate schedule used to calculate farm-to-market transportation cost is a modified version of FDFA's hauling rate schedule. Many aspects of FDFA's hauling schedule are used to calculate the production-area-to-market transportation cost. The levels of the base, zone, and pick-up charges are obtained directly from the hauling rate schedule provided by FDFA. The production-area-to-market transportation cost for a production area is calculated by adding together the total base, zone, and pick-up charges and subtracting the total volume discount. With the FDFA's current pricing policy, a production area's per-hundredweight transportation cost cannot exceed the cooperatives' predetermined hauling rate cap of $1.284. If the farm-to-market transportation cost is greater than $1.284 per hundredweight, the production area receives a subsidy to pay the additional transportation costs above the cap of $1.284 per hundredweight. This subsidy is given to compensate the cooperative members living in north Florida and south Georgia when their milk is hauled to buyers north and west of Florida because FDFA has a surplus of milk. TIDFA does not have a transportation cap.

Results

The results of the FAPM and FOBPM are presented in table 2. In this table, the annual results for 1992 are compared for each pricing policy. Differences in the average aggregate revenue, blend price, production, cost of imports and exports, and quantity of imports and exports are used to explain the results of the nondiscriminatory and discriminatory pricing scenarios.

The first variable in table 2 is the average aggregate revenue, or mailbox price. The objective function of the model (equation [12]) maximizes the average aggregate revenue of all the members in the FDCs. The aggregate revenue in the model is equivalent to the sum of FDCs' payments to producers in 1992. Dividing the aggregate revenue by the total milk supply yields the average aggregate revenue, or mailbox price, for members of the FDCs. The FAPM and the FOBPM result in mailbox prices of $15.50 and $15.76, respectively. The nondiscriminatory pricing model has an annual mailbox price that is $0.26 higher than the average mailbox price paid to producers after expanding the market boundary.

The ranking of the net blend price from each

Table 2. Annual Results of FAPM and FOBPM

	Spatial Models		
	FAPM	FOBPM	Difference
Variables			
Mailbox price (AAR per cwt.)	15.50	15.76	(0.26)
Net blend price ($ per cwt.)	16.23	16.48	(0.25)
Total quantity imported (cwt.)	196,581.17	895,336.36	(698,755.19)
Total cost of imports ($)	3,952,000	18,506,500	(14,554,500)
Total quantity exported (cwt.)	1,253,195.23	223,960.06	1,029,235.10
Total cost of exports ($)	2,262,306.48	308,133.64	1,954,172.80
Total production (cwt.)	27,715,521	25,439,223	2,276,298

scenario is also consistent with the results of the mailbox price. The FOBPM has an annual net blend price of $16.48 per hundredweight. This price is $0.25 higher than the net blend price of $16.23 in the FAPM. If the average mailbox price and the annual net blend price are considered, F.O.B. pricing is the optimum spatial pricing policy if the primary objective of the cooperative is to maximize the average aggregate revenue of members by increasing the net blend price.

The FAPM reduces the cost and quantity of milk imports into Florida. On an annual basis, the FAPM results in total imports of 196,581.17 hundredweights at a cost of $3,952,000 ($20.10 per hundredweight). The FOBPM imports 895,336.36 hundredweights of milk at a total cost of $18,506,500 ($20.67 per hundredweight). These results are consistent with the differences in the two models. In the FAPM, the FDCs represent a larger milk supply. Because of the larger supply of local production, the cooperatives import less milk during the deficit months. In contrast, the market boundary is compressed in the FOBPM, and the FDCs represent only thirty-three production areas. The decrease in local production results in a larger quantity of milk imports.

As expected, the FAPM reduces the cost and quantity of imports at the expense of exported milk. The FOBPM exports 223,960.06 hundredweights of milk at a total cost of $308,133.64. The average transportation cost of exports in the FOBPM is $1.38 per hundredweight. Because of the larger supply of local production, the FAPM increases the total cost and quantity of exported milk. The FAPM exports 1,253,195.23 hundredweights of milk at a cost of $2,262,306.48, which results in an average transportation cost of exports of $1.81 per hundredweight. Notice that the optimum pricing strategy, F.O.B. pricing, results in the lower cost of exports and the higher cost of imports. In contrast, a policy of spatial price discrimination results in the higher cost of exports and the lower cost of imports. Based on these results, the outcome of the study appears to be dependent on which pricing strategy results in the lower cost of exported milk. These results are consistent with what Nubern and Kilmer (1995) found in a study of alternative procurement systems for Florida dairy farmers.

Given the apparent relationship between the optimum pricing strategy and the transportation cost of exports, table 3 illustrates the changes in average aggregate revenue and net blend price for surplus and deficit months. Traditionally, the surplus months in the Florida market are December through June and the deficit months are July through November. These import and export patterns are consistent with the results of the FOBPM. The average aggregate revenue, net blend price, and total production are compiled for the surplus and deficit months and reported in table 3 for both the FAPM and the FOBPM.

Table 3. Results of Surplus and Deficit Months for FAPM and FOBPM

Variables	FAPM Surplus Months	FAPM Deficit Months
Mailbox price (AAR per cwt.)	15.20	16.00
Net blend price ($ per cwt.)	15.88	16.80
Total production (cwt.)	17,605,924	10,109,597

Variables	FOBPM Surplus Months	FOBPM Deficit Months
Mailbox price (AAR per cwt.)	15.74	15.81
Net blend price ($ per cwt.)	16.42	16.57
Total production (cwt.)	16,138,652	9,300,571

With table 3, the results of the FAPM and the FOBPM can be compared on the basis of surplus and deficit months. In the surplus months, the FAPM results in a mailbox price of $15.20 and a net blend price of $15.88 per hundredweight. Results from the same months in the FOBPM show that both the mailbox price and the net blend price are higher, $15.74 and $ 16.42, respectively. In the surplus months, the nondiscriminatory spatial pricing policy increases both the mailbox price and the net blend price by $0.54 per hundredweight. As expected, the results are opposite in the deficit months. By increasing the local supply of milk, which reduces milk imports in the deficit months, the FAPM increases both the mailbox price ($16.00) and the net blend price ($16.80). The FOBPM results in a mailbox price of $15.81 and a net blend price of $16.57. These prices are $0.19 and $0.23, respectively, less than the corresponding prices in the FAPM. The results of the deficit months indicate that a policy of spatial price discrimination maximizes the average aggregate revenue of members if the FDCs are importing milk.

The study indicates that the optimum pricing strategy is F.O.B. pricing. F.O.B. pricing maximizes the average aggregate revenue and results in the lower cost of exports. The FDCs export milk seven months out of twelve. Because of the loss in revenue associated with disposing of surplus milk, a freight absorption pricing strategy that expands the market boundary is not the optimum pricing policy for the FDCs. Currently, the benefits associated with freight absorption are not enough to offset the additional cost of exporting milk. If the marketing environment changes and the FDCs increase the total quantity of milk shipped into Florida, the results indicate that a policy of freight absorption would be effective in this situation.

Sensitivity Analysis

In both spatial pricing models, the prices paid by milk handlers are fixed. If prices remain unchanged as the FDCs expand the market boundary, the study shows that the FOBPM maximizes the average aggregate revenue per hundredweight. The problem with this solution is that the current FAPM does not account for changes in price that may result from an increase in bargaining power. In the FAPM, the FDCs may increase their market power by expanding the market boundary. By controlling a larger supply of local milk production, the FDCs may bargain for higher prices if they are successful in protecting the Florida market from alternative milk supplies.

Assume that in the FAPM the FDCs have sufficient market power so that they can bargain for higher prices. Since the FAPM already maximizes the average aggregate revenue in the deficit months, an assumption is made that the FDCs would bargain for higher prices only in the surplus months (December through June). Through sensitivity analysis, scenarios that have price increases in the surplus months are created. Price increases are incorporated into the model through the over-order payment.

To determine at what point the FAPM becomes the optimal solution, the over-order payment is reduced parametrically from an initial value of $1.00. Through gradual reductions in price, the model showed that a $0.50 increase in the over-order payment is necessary for the FAPM to become the optimal solution. With a $0.50 increase in an over-order premium, the FAPM has mailbox and net blend prices of $15.77 and $16.49, respectively. These results are $0.01 higher than those of the FOBPM (table 2). The results of the sensitivity analysis show that the FAPM is the optimum scenario only if the FDCs are able to bargain for a price increase of approximately $0.50 in the surplus months.

Conclusions

In the model of spatial price discrimination, the annual average blend price and the annual average aggregate revenue per cooperative member are less than what would occur if all production areas were paying the full farm-to-market transportation cost (i.e., F.O.B. pricing model); however, a policy of spatial price discrimination is optimum in the deficit months. By expanding the market boundary and representing a larger supply of local production, the FDCs are able to reduce the cost and quantity of imported milk. The disadvantage to this pricing policy is that the cost and quantity of exports are increased. For these reasons, the FAPM is the optimum policy in the deficit months and the FOBPM is the optimum policy in the surplus months. Because the FOBPM maximizes the annual average aggregate revenue per member, the results appear to be dependent on which pricing policy reduces the costs of exported milk. If the market environment changes so that the FDCs are importing milk most of the year, a policy of spatial price discrimination could maximize the members' mailbox price.

A nondiscriminatory pricing policy maximizes the cooperative members' annual blend price and annual average aggregate revenue. However, if the FDCs were able to increase the processor price by at least $0.50 using spatial price discrimination to gain market power, spatial price discrimination would maximize average aggregate revenue and blend price. There may be other economic variables (i.e., interregional price relationships, competition between the two Florida cooperatives, alternative supplies from other cooperatives) that would determine whether the FDCs could bargain for a higher processor price. Further research could employ game theory to determine the impact on the results from the competition between the two Florida cooperatives. This article assumes that the current competitive environment would continue. Furthermore, contestable market theory could be employed to determine the impact on the results from the cooperatives outside Florida that would like to supply milk to Florida. An analysis of how these issues affect the cooperatives' spatial pricing strategy is beyond the scope of this article.

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