Cooperatives and Quality-Differentiated Markets: Strengths, Weaknesses, and Modeling Approaches*

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Abstract

This paper analyzes the challenges and opportunities for agricultural marketing cooperatives in value-added, quality-differentiated markets. Product quality in all of its dimensions is critical in modern food markets, but various traditional cooperative business practices are not conducive to success in meeting consumers' demands for quality. We discuss and evaluate these limitations, which have led to pessimism on the part of some commentators regarding the future of cooperatives, but we also demonstrate advantages, relative to investor-owned firms inherent in some traditional co-op practices, such as revenue pooling. We also propose and illustrate appropriate modeling frameworks to study cooperatives' performance in differentiated-product market settings, including comparing the performance of open- and closed-membership cooperatives in competition with an investor-owned firm in a market with horizontal product differentiation.

Keywords: vertical differentiation, horizontal differentiation, quality, open-membership cooperative, closed-membership cooperative

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Economists use the term "quality" to refer to many dimensions of a product. In the context of food, quality may refer to a product's taste, appearance, convenience, brand appeal, and healthfulness, but also to broader dimensions such as characteristics of the production process (e.g., usage of chemicals, sustainability, physical location, or confinement conditions of animals) and implications of production and consumption of the product for the environment. Product quality in all of its dimensions is critical in modern food markets. Consumers in high-income countries such as Europe and the U.S. are willing to pay more for foods that satisfy the quality dimensions that are important to them (Misra, Huang, and Ott 1991; Govindasamy and Italia 1999; Loureiro and Hine 2002, Teisl, Roe, and Hicks 2002; Kiesel and Villas-Boas 2007; Basu and Hicks 2008).[1] Given the great heterogeneity among consumers in what food product attributes matter to them, considerable opportunities exist to differentiate products and exploit market niches.

Of course, most firms in the food system do not sell directly to consumers, but instead sell to market intermediaries who transmit information regarding consumer demands upstream and also introduce additional considerations relating to their own preferences. As spot exchanges have been replaced increasingly with various forms of vertical market coordination and as downstream buyers have become more powerful, transactions in the food sector have become more complex, involving more than the mere transfer of a food product.

Thus, in addition to the quality of the products being marketed, a second dimension of "quality" pertaining to the attributes of the firm producing and/or marketing the product has come to matter in terms of its abilities to satisfy the characteristics in a supplier sought by downstream buyers. For example, grocery retailers seek suppliers who can provide product reliably year around and in volumes necessary to meet their needs, provide ancillary services, such as category management, third-party product-safety certification, and electronic data interchange, and supply products across a category (Salin 1998; Calvin and Cook 2001; Dimitri et al. 2003).

The ability to meet many of the characteristics sought by downstream intermediaries relates at least indirectly to the size or scale of the seller, a fact that helps to explain the steady trend towards increasing firm size and concentration in the food marketing sector (Sexton 2000; Kaufman 2000; Rogers 2001; Dobson, Waterson, and Davies 2003). However, when the desired quality characteristics of the food products themselves are considered, opportunities are created for well-positioned, small firms to exploit market niches. The "localvore" phenomenon

1 For example, Kiesel and Villas-Boas estimated that the U.S. Department of Agriculture's organic seal had an average valuation of $0.23 per gallon for consumers in a major U.S. metropolitan market.

(Ayres and Bosia 2008), in which adherents seek to consume only foods produced within a certain geographic bound of their location, provides a clear example of a product-quality dimension that compels small-scale production. The same conclusion applies to various other product characteristics, such as those relating to specific production practices. First, to the extent that the product attributes are valued highly by relatively few consumers, large-scale agribusiness is unlikely to be involved. Second, the practices themselves are usually labor intensive and not conducive to mechanization or other scale-intensive processes, mitigating or eliminating cost disadvantages for small-scale producers. Thus, although the seller-quality dimensions important to downstream intermediary buyers auger for large-scale sellers and a concentrated food marketing sector, the heterogeneous and evolving preferences of consumers lead to a broadening of the dimensions of product quality and create market niches conducive to the success of small-scale producers and marketers.

The purpose of this paper is to analyze the challenges and opportunities for agricultural marketing cooperatives in this environment and to propose and illustrate appropriate modeling frameworks to study cooperatives' performance in the quality dimension. The increasing importance of quality in the food system has not been lost on farmers and their cooperatives. Concerns over quality have prompted a greater degree of vertical coordination among firms and increasingly coordinated supply chains (Calvin and Cook 2001; Fulton and Sanderson 2002). New cooperatives have appeared to exploit quality-based market niches, often in areas of the market where investor-owned firms do not exist (Fulton and Sanderson 2002), and incumbent cooperatives have attempted to reposition themselves to compete for the business of quality-conscious U.S. consumers (Saperstein 2006; Hirsch 2007).

However, despite cooperatives' efforts to position themselves favorably on the quality spectrum, various traditional cooperative business practices are not conducive to success in meeting consumers' demands for quality. Disadvantages of cooperatives in the quality realm include (i) the horizon problem, which leads cooperatives to pursue short-term goals at the expense of long-term investments that can enhance objective or perceived quality, such as development of differentiated and branded products, (ii) adherence to the traditional principle that cooperatives represent a "home" for member production, which is problematic both with respect to product quality and the ability of niche markets to accept additional product without significant negative impacts on price, (iii) the pooling practices of cooperatives, which often fail to reward adequately producers of the highest quality products, causing an adverse selection problem with attendant reductions in product quality and/or the exit from the cooperative of the producers of high-quality products,[2] (iv) difficulties relative to IOF counterparts in terminating "marginal" members, (v) limitations on procuring product from nonmember sources, and (vi) difficulties in meeting downstream buyers' needs for multiple products and reliable year-around supply.

These factors, when viewed through the prism of an evolving food and agriculture sector, have led to pessimism on the part of various analysts regarding the ability of producer marketing cooperatives to compete and survive in this market climate. An early harbinger of impending difficulties for cooperatives was Helmberger (1966), who suggested that the industrialization of agriculture would lead to the demise of agricultural cooperatives, a view restated by Coffey (1993). Fulton (1995) also argued that the industrialization of agriculture could reduce or eliminate traditional roles that cooperatives have played. For example, vertical integration or contracts often link vertical stages in these settings, replacing the vertical coordination role of traditional cooperatives. He further opined that increasing individualism among producers was inimical to the type of collective action that is essential to success in cooperation. Indeed, the wish to produce differentiated products can be seen as a reflection of such individualism, raising the question of whether cooperation is consistent with such a macro trend. Cook (1995) offers a more nuanced perspective. He shares the view that traditional cooperative structures are generally ill suited to be successful in modern agricultural markets, but believes that they can evolve in a way more conducive to success, with the New Generation structure (Harris, Stefanson, and Fulton 1996) representing a key example.

Despite the importance of these considerations, counterbalancing forces exist on the positive side. Even the mere notion of farmer ownership of cooperative businesses is a plus for some consumers, who would prefer to see their food dollars benefit farmers directly, especially local farmers, rather than agribusiness giants. The vertical-coordination dimension inherent in the farmer-cooperative relationship may give cooperatives an advantage in terms of communicating consumer preferences back to farmers and reducing transactions costs due to opportunistic behavior (Klein, Crawford, and Alchian 1978; Blomqvist 1984; Den Ouden et al. 1996).[3] Traditional pooling practices perform an insurance function that is valued by risk-averse farmers. Further, to the extent that pursuit of quality-differentiated niche markets creates new opportunities for small-scale agriculture,

2 Pooling is one key example of a more general free-rider problem thought to pervade cooperatives (Cook, 1995).

3 However, vertical coordination through contracts between IOF marketers and farmers may generate similar communications advantages, as Fulton (1995) noted.

it revitalizes potentially the traditional economies-of-scale argument for collective downstream marketing (Sexton and Iskow 1988).

As noted, the advent of the New Generation cooperative model demonstrates the ability of the cooperative business form to evolve to changing market conditions, as do the financing innovations introduced through the limited-liability corporation (LLC) framework (Barton 2004), raising the question of whether further adaptations to practices and traditional principles can and should be made to better position cooperatives to compete in the quality dimension. Notably the flexibility in organizational structure that enabled the New-Generation cooperative phenomenon to appear in Canada and the U.S. is not present elsewhere, such as Europe, meaning that policy reforms must precede implementation of any structural innovations for cooperatives in some countries.

In the remainder of this paper, we investigate in more detail problems traditional marketing cooperatives face in positioning themselves favorably in the quality dimension and consider how cooperatives can improve their performance in the dimensions of meeting the quality demands of consumers and intermediary buyers. Rigorous investigation of cooperatives' performance and behavior in quality-differentiated markets is limited by the lack of conceptual foundations because, with a few notable exceptions, nearly all theory on marketing cooperative behavior has assumed that a single, homogeneous product is produced and sold. We address this gap by proposing two prototype models of differentiated product competition, horizontal and vertical differentiation, adapting them to accommodate cooperative marketing firms, and illustrating their application to investigate cooperatives' opportunities and limitations in the quality dimension.

Traditional Cooperative Structure and Principles and Quality

Many commentators and organizations have set forth key principles that define a cooperative. Most, such as the ones offered by the International Co-operative Alliance (ICA 2008), resemble an updated version of the original Rochdale principles. The first and third of the ICA's principles, voluntary and open membership and member economic participation, are central in any listing, and they are the most important for purposes of this paper. Open membership implies that anyone who meets the cooperative's criteria for membership (as set forth in its bylaws) can join. In the marketing cooperative context, the obligation of the cooperative to accept all of a member's deliveries (be a "home" for it) is an accepted corollary of this principle. A second corollary of the open entry postulate is no forced exit for a member who remains in compliance with the cooperative's membership criteria. Thus, whereas an investor-owned marketing firm can acquire or jettison suppliers freely, a traditional cooperative lacks this flexibility.[4]

The ICA's member-economic-participation principle is vague, but in practice subsumes the common practices of marketing cooperatives to (a) refund surpluses in proportion to a member's business volume, (b) pay no dividend on equity capital and refund equity capital only at par value and at the cooperative's discretion, (c) pool returns across members, (d) focus activities on members to the point of excluding favorable opportunities to deal with nonmembers, and (e) when conducting business with nonmembers, avoid paying them on terms that appear more favorable than those given to members.

Although cooperatives are free to specify their criteria for membership in bylaws, such criteria are usually general, encompassing, and outdated, meaning that they don't represent a realistic screen on potential membership. Common membership criteria include a minimum production or acreage level of the commodity and geographic boundaries on eligible production. Quality standards expressed in terms of characteristics of products being produced are generally not mentioned as eligibility criteria for membership.

Given that any realistic production setting is certain to involve heterogeneity in terms of the physical aspects of the products being produced,[5] the open-membership principle is, thus, destined to create the likelihood that a marketing cooperative will be confronted, relative to investor-owned competitors, with handling and marketing a heterogeneous raw-product supply that is not of its choosing and instead delivered exogenously to it. In practice this situation may mean the presence of low-quality products that an IOF would not accept, and less production with particularly desirable (high-quality) attributes, due to limits on the cooperative's ability to procure from nonmembers.[6]

In addition to being relatively unable to control the characteristics of the products it is asked to market, an open-membership cooperative will have less control than its investor-owned counterparts in the magnitude of product it receives. Investor-owned marketers can and often do exert nearly complete control over the raw-product volumes supplied to them. Contracts can specify either the maximum volume eligible to be delivered or set limits on the acreage from which deliveries

4 Open membership is not a legal requirement for cooperatives in the U.S., but it is required in many European Countries (Sexton 1995).

5 Heterogeneity in the characteristics of production, even among farms in a compact geographical area, will occur due to differences in land quality, operator skill, technology, microclimate, levels and types of inputs utilized, and random events.

6 A stark example of this phenomenon is the cooperative that markets fresh produce, but is unable to supply it year round due to limits on procuring products from nonmember sources.

can be made. A common strategy among IOF handlers is to integrate vertically upstream or issue contracts to upstream suppliers to lock in their "high-probability" supply, while relying on the spot market to procure needed supplies in excess of those committed through contracts or vertical integration. An open-membership cooperative, however, has little control over the volume of production that it receives. Members may exit or refuse to deliver to the co-op if better short-run opportunities exist elsewhere. Delivery contracts with members can partially address this problem, but only if they contain significant penalties for breach with the credible threat of enforcement.

This disadvantage matters in terms of utilizing processing capacity at an efficient scale and also in terms of controlling the flow of product to particular market outlets. The former disadvantage matters in any market structure, whereas the latter is inconsequential in a competitive market, with homogeneous products. In this stylized and unrealistic setting, supply flows to a single, integrated market and in conjunction with a single demand function determines price. The identity of the marketing firm through which the product flows is unimportant to determining price. Outcomes, however, may change dramatically once heterogeneous consumer preferences and product differentiation are introduced because individual marketing firms face downward-sloping demands for their products.[7]

Modeling Cooperative Behavior in Quality Differentiated Markets

To examine the impact of traditional cooperative principles in differentiated-product markets, we need to revisit some basic modeling frameworks for differentiated products and incorporate the presence of marketing cooperatives within those models. We focus on two important types of product differentiation: vertical differentiation and horizontal differentiation. With horizontal differentiation, consumers do not agree on a ranking of the available products, while with vertical differentiation, consumers do agree on a ranking but differ as to their intensity of preference for higher ranked products. Differences in objective qualities of agricultural products (e.g., size, color, and extent of blemishes) fit normally in the realm of vertical differentiation. Examples of horizontal differentiation include situations when firms have brands that consumers recognize and value to differing degrees and situations where consumers disagree as to the

7 Although inability to control production is a clear disadvantage in a differentiated product market, Albæk and Schultz (1998) show that it can be an advantage in homogeneous-product duopoly competition between a cooperative and an IOF because it enables the cooperative to commit, much as a Stackelberg leader, to a high output level.

desirability of a product attribute, such as sugar content in cereals and bakery products, fat content of milk, and protein content of wheat. In both vertical and horizontal differentiation models consumers purchase only one product or variety among the available choices, and competition is "localized" in the sense that a particular product or brand competes directly only with products located close to it in the product-characteristic space.[8]

In the remaining sections of this paper we examine prototype models of vertical and horizontal product differentiation and discuss how to incorporate the presence of cooperative marketing firms within these frameworks in order to study their performance in differentiated product markets.

Vertical Product Differentiation

Most formal models of vertical product differentiation adapt the framework set forth by Mussa and Rosen (1978). In the canonical representation, the demand side of the market is characterized by a continuum of consumers who are distributed uniformly with density, *D*, according to their taste for quality, θ, along the interval $\theta \in [a,b]$.

Consumers with higher valuations for quality are willing to pay more for one unit of higher-quality production relative to consumers with less intense preferences for quality. A consumer with taste parameter θ has utility $U(\theta,q_i) = \theta q_i$ and consumer surplus $CS(\theta,q_i,P_i) = \theta q_i - P_i$, from consuming a unit of a good with quality level q_i, where P_i denotes the price of good *i*.

Demands for the vertically differentiated products are found by identifying the locations of the indifferent consumers. Assuming that there are only two quality levels, high (H) and low (L), available on the market, to determine the location, $\overline{\theta}$, of the consumer who is indifferent between H and L production, we equate surplus derived by a consumer from purchasing the H product with the surplus derived by that same consumer from purchasing the L product:

$$\theta q_H - P_H = \theta q_L - P_L \rightarrow \overline{\theta} = \frac{P_H - P_L}{q_H - q_L}.$$

8 These modeling paradigms thus contrast with product differentiation models wherein competition is global and consumers exhibit an "insatiable taste for variety" (Lancaster 1990), purchasing in equilibrium some amount of each available product. Such product differentiation models follow in the tradition of Chamberlin (1933), and are perhaps best exemplified by the work of Dixit and Stiglitz (1977).

Similarly, to find the location, $\underline{\theta}$, of the consumer who is indifferent between consuming L and not purchasing the product at all, we equate consumer surplus derived from consuming the low-quality product with zero:

$$\theta q_L - P_L = 0 \rightarrow \underline{\theta} = \frac{P_L}{q_L}.$$

After establishing the location of the indifferent consumers, the demand for the H and L products can be determined. Assuming that consumers are distributed uniformly on $[a,b]$ with density normalized to D = 1.0, demand for the high- and low-quality products is:

$$D_H(P_H, P_L) = b - \overline{\theta} = b - \frac{P_H - P_L}{q_H - q_L}$$

$$D_L(P_H, P_L) = \overline{\theta} - \underline{\theta} = \frac{P_H - P_L}{q_H - q_L} - \frac{P_L}{q_L}$$

The supply side of the model can be adapted to suit the problem under investigation. It is common to assume that each firm produces a single product with a given level of quality. However, the problem of a monopoly seller of both the H and L products is also of interest in terms of determining its optimal allocation of product across quality categories. In the typical cost specification firm i produces a good of quality q_i at a cost of $c(q_i)$ where $c'(q_i) > 0$ and $c''(q_i) \leq 0$, $i = L, H$. Thus, firms have different costs associated with producing products of different quality levels, and the firm producing the highest quality has the greatest marginal quality cost per unit. Marginal production costs unrelated to quality are commonly assumed to be constant per unit and are normalized to zero. The closer firms are located to one another in the quality space the more intense the price competition among them.[9]

Applications of Vertical Product Differentiation to Cooperatives

Hoffmann (2005) considers a mixed-duopoly market, where a cooperative and investor-owned firm (IOF) compete first in choice of product quality (H or L) and

9 This model can be presented in two stages and solved via backward induction. In the second stage of the model the firms engage in price competition while in the first stage firms choose the level of product quality they wish to produce. As Saitone and Sexton (2009) note, this standard approach in the general economics literature is not descriptive of most agricultural production settings, wherein quality is determined at least in part by exogenous factors, such as weather conditions.

then in price. Consumers have Mussa Rosen (1978) type preferences, and the author considers cases where the cooperative provides the H product, as well as where it provides the L product. Because the cooperative vertically integrates the farm and processing sectors, its objective function differs from the IOF's, leading to different market equilibria than when only IOFs compete. Regardless of whether the firm is an IOF or cooperative, the firms will choose differing levels of quality to lessen the price competition that ensues in the second stage of the model.

Hoffmann (2005) also compares results when the costs associated with producing quality are fixed or variable. If quality costs are fixed or variable exhibiting non-constant returns to scale, ownership structure of the firm determines the level of quality supplied in the market. Due to the vertical integration of the cooperative, the costs associated with producing quality cause the cooperative to undersupply quality relative to an IOF.[10] The model, however, is unable to make predictions as to which organizational form emerges in the preferred role of the high-quality seller. Further the policy implications depend on which firm structure emerges as the high-quality supplier.

While the traditional vertical differentiation model developed by Mussa and Rosen (1978) and adapted to a mixed-market setting by Hoffmann (2005) posits that each firm chooses a single quality level to produce, this is generally not an adequate representation of agricultural production. The quality of the production of any farm is generally heterogeneous and not fully within the control of the producer due to exogenous influences, such as weather conditions. Saitone and Sexton (2009) (SS) and Mérel, Saitone, and Sexton (2009) (MSS) study cooperatives' pooling practices using the vertically differentiated product paradigm in a model that incorporates stochastic production of product quality. Specifically, they show how cooperatives can use revenue pooling to influence the product quality their members produce so as to maximize members' welfare. In SS, product quality can be either high (H) or low (L), and quality is assumed to be exogenous ex ante, determined by an independently and identically distributed farmer-specific shock. However, farmers are able to augment the quality of their production ex post by engaging in costly quality enhancement activities to transform ex ante L production into H.[11]

Because quality of production is stochastic, the market features risk, and SS model farmers as having identical preferences that are represented according to the mean-standard deviation approach by a utility function, $U(\mu_\pi, \sigma_\pi)$, which is

10 Thus when two IOFs or two cooperatives are competing against one another the firms do not have relative cost advantages and thereby the results are symmetric.

11 Examples would include applying pesticides to reduce pest damage, thinning fruit to improve size, or pruning fruit trees prior to harvest to improve color.

increasing in expected profit, μ_π, and decreasing in standard deviation of profit, σ_π, under producer risk aversion. Pooling revenues across heterogeneous quality levels causes an adverse selection problem that can induce farmers who produce a high share of H product to exit the cooperative in favor of other marketing options, or attenuate all farmers' incentives to engage in high-quality enhancement activities, if exit is not an option. SS, however, allow the cooperative to adopt any pooling arrangement ranging from no pooling (independent pools for H and L product) to full pooling (a single pool where H and L revenues are commingled), or any degree of partial pooling. They demonstrate that pooling may confer two advantages: (i) it attenuates the incentive of competitive farmers to produce more H product than the amount that maximizes total member profits, and (ii) it insures producers against risks due to random shocks in their ability to produce products of high quality.

The supply-control dimension of pooling is vulnerable to free riding—those outside the cooperative capture the same advantage as those within the co-op from its efforts to control supply of the H product. An implementability constraint on any pooling arrangement requires that no producer can obtain a higher payoff outside of the cooperative. Analytical and simulation results demonstrate that, depending upon the specific market configuration, implementable partial or full pooling arrangements do exist, thereby demonstrating that cooperative pooling, if conducted strategically, can be a tool for cooperatives to increase member welfare and entice producers to become members when they have outside options. Revenue pooling, long regarded as a problem for traditional cooperatives, thus can represent an advantage for cooperatives relative to other organizational forms if the pooling rate is set strategically.

MSS extend this work by studying cooperative pooling arrangements in the presence of adverse selection. They utilize the same demand-side specification as in SS but model farmers as having identical concave von Neumann-Morgenstern utility functions. There are two types of farmers, high-quality producers and low-quality producers, with stochastic production.[12] The low-quality farmer's crop has a probability, p_L, of being low quality while for the high-quality farmer the probability of production being low quality is p_H, where $p_L > p_H$. MSS focus on the degree of product quality pooling that will result in stable cooperative arrangements in the face of heterogeneous producers and adverse selection. A cooperative is said to be stable if no subset of cooperative members can earn a higher payoff from exiting the cooperative. The authors show that, in some

12 This specification of farmer supply is similar to Zago (1999), who modeled a producer organization with heterogeneous farmers who differed in their ability to producer a high-quality product. Quality is nonstochastic in Zago's formulation.

instances, the risk-reducing dimension of pooling is sufficient to overcome the adverse selection problem to induce the high-quality producers to join a cooperative with the low-quality producers, particularly if pooling is only partial.

The ultimate message of these studies is that cooperatives' pooling practices, which have long been considered to be detrimental in the presence of heterogeneous product quality, can actually be an advantage. However, the pooling rate must be set strategically, and the optimal rate often involves only partial pooling.

Horizontal Product Differentiation

The canonical horizontal product differentiation model, often referred to as the Hotelling (1929) model, characterizes duopoly competition between firms for the patronage of consumers with inelastic demands for the given product.[13] The firms, *A* and *B*, are assumed to be located at the endpoints of a line of length 1.0 with the total number of consumers in the market also set equal to 1.0, both normalizations being utilized without loss of generality.[14] The nature of the space upon which firms are located depends upon the application. It can be geographic space, or a product-characteristic space, such as sugar content of foods, fat content of milk or meats, or protein content of grains. The products are assumed to be homogenous in all aspects besides this defining characteristic. The marginal costs of production are generally assumed to be a constant, *c*, per unit and equal across the two firms.

Consumers purchase one unit of the product that has the lowest total price, defined as the seller's FOB price or mill price, $p_i, i = A, B$, plus "transportation costs" incurred by the consumer.[15] Transportation costs, γ, are linear per unit of distance in the base model, although quadratic transportation costs are also

13 An important generalization of Hotelling's original model is to introduce a consumer reservation price, *R*, to the otherwise inelastic demands. This adaptation changes the nature of competition between the two firms considerably, depending upon the value of γ relative to *R*.

14 As with the vertical differentiation model of Mussa and Rosen (1978), the Hotelling model is often studied in two stages, with the first stage being the firms' location decisions along the line, and the second stage involving price competition, given location. Although specific results are very sensitive to model specification, the intuition that firms choose to locate away from each other in the product space (i.e., engage in product differentiation) carries through to the horizontal differentiation setting as well.

15 These costs can be literally for transportation in the case of geographic differentiation, or they can be costs of foregone utility from "traveling" in product space to consume a product other than the consumer's ideal product.

common in the horizontal differentiation literature. As with the model of vertical differentiation, firm demands are found by identifying the location, v^*, of the indifferent consumer:

$$p_A + \gamma v = p_B + \gamma(1-v) \Rightarrow v^* = (p_B - p_A + \gamma)/2\gamma ,$$

Thus,

$$Q_A = v^* = (p_B - p_A + \gamma)/2\gamma$$
$$Q_B = 1 - v^* = (p_A - p_B + \gamma)/2\gamma.$$

When firms *A* and *B* are IOFs, the Nash equilibrium prices are $\overline{p}_A = \overline{p}_B = c + \gamma$, and the indifferent consumer is located at $v^* = 0.5$. The location differences of the firms, combined with the consumers' costs of transportation, cause the products to be differentiated, thereby allowing the firms to charge prices in excess of marginal cost. Increases in either γ or *c* increase the prices charged by the firms. As $\gamma \to 0$, product differentiation is dissipated, causing prices to converge to marginal cost.

To our knowledge the horizontal differentiation model has not been applied to marketing cooperatives selling branded products to downstream buyers. However, Fulton and Giannakas (2001) and Giannakas and Fulton (2005) have studied farm supply or consumer cooperatives in a model of horizontal differentiation. Both papers feature a mixed market, with a cooperative competing with an IOF for consumer or farmer patronage. In Fulton and Giannakas (2001) consumers are uniformly distributed with respect to their preferences and, hence, willingness to pay for the products supplied by the cooperative and by the IOF. The greater a consumer's value of $\alpha \in [0,1]$, the greater her utility, ceteris paribus, from patronizing the cooperative and the greater her commitment to it. Giannakas and Fulton (2005) focus on an open-membership agricultural input-supply cooperative engaged in competition with an IOF for the patronage of farmers who are differentiated (e.g., in geographic location) with respect to their ability to utilize either firm's input. The firms invest in innovation prior to engaging in price competition.[16]

Mixed Markets and Co-op Membership Policies

Given the paucity of applications to date, we provide an illustrative application of the Hotelling model to study cooperative behavior in a mixed market. We seek to

16 Drivas and Giannakas (2008) adapt the Giannakas and Fulton (2005) model to a marketing cooperative context and mixed oligopsony.

(i) analyze the Nash equilibrium of a mixed market involving one co-op and one IOF, (ii) compare equilibrium behavior in the mixed market when the co-op has open-membership (OM) vs. when it has closed-membership (CM), and (iii) compare equilibria in the mixed market to equilibrium in the standard IOF duopoly market.

Although the model is stylized, it captures some key elements of an increasingly common food market scenario. Branded products exist in the market, one controlled by a cooperative, and the other controlled by an IOF. However, the branded market segment is not large enough to accommodate the entire production of the raw product, meaning whatever amount is not sold in the branded market must be sold into a competitive outside market at constant price. Examples could include value-added branded sales in the domestic market and a competitive export market, branded sales of fresh fruits or vegetables with a competitive processing market for product not sold as fresh, or branded canned or packaged fruits and a competitive generic market such as for the production of sweetener concentrate.[17]

The branded market is depicted by the standard Hotelling model. N = 1 consumers are in the market to purchase the branded product and are arrayed uniformly along a line of unit length with respect to their preference for the differentiating characteristic of the product. Branded processor A located at the left endpoint is a cooperative. Branded processor B located at the right endpoint is an IOF.

Production, *X*, of the raw agricultural commodity is exogenous, and we assume $X > 1$, so that not all production can be sold in the branded market. Each end-use product requires 1 unit of agricultural product, and either branded processor can also participate in the competitive secondary market if it chooses to do so. The model is intended to depict a situation where the branded market is preferred as a selling venue relative to the unbranded market,[18] in which case, given $X > 1$, the branded market will be covered in equilibrium and, thus, the indifferent consumer is identified in the usual way:

$$p_A + \gamma v^* = p_B + (1 - v^*)\gamma \Rightarrow v^* = \frac{p_B - p_A + \gamma}{2\gamma}$$

$$\Rightarrow Q_A(p_B, p_A, \gamma) = \frac{p_B - p_A + \gamma}{2\gamma}$$

17 Several large processing cooperatives in the U.S. would fit this latter category. For example, Ocean Spray and Welch's have well-known juice brands, but also process raw product into concentrate, which represents essentially a competitive generic sweetener market.

18 We subsequently impose conditions on the exogenous variables that insure that this condition is met.

where prices charged in the final product market are p_A and p_B, $Q_A(p_B, p_A, \gamma)$ is the demand for the co-op's brand, and $Q_B(p_B, p_A, \gamma) = 1 - Q_A$ is demand for the IOF's brand.

All nonmaterial (i.e., "processing") costs are identical for A and B and are constant at c per unit. Each seller in the branded market incurs a fixed cost of $F > 0$. The fixed cost can be interpreted, for instance, as advertising expenditures or costs related to product certification, as in Lence et al. (2007). The competitive secondary market is denoted by Y. The constant value of the product in the secondary market net of any costs is α.

IOF duopoly market: Equilibrium in the IOF duopoly market is straightforward to derive, and it provides a basis for comparison to the mixed-market solutions. When both A and B are IOFs, the equilibrium is as follows:

$$p_A^{IOF} = p_B^{IOF} = c + \alpha + \gamma$$

$$Q_A^{IOF} = Q_B^{IOF} = 0.5, Q_Y = X - 1$$

$$w_A^{IOF} = w_B^{IOF} = \alpha$$

Equilibrium price for the farm product follows simply from the fact that $X > 1$, so that either IOF branded producer can purchase its farm-product needs without bidding the price above its value in the Y market.

OM cooperative mixed market: By definition, whoever wishes to sell to the OM cooperative at the cooperative price is accepted as a member. Any farm product delivered to the co-op that is not sold in the branded market must be sold in the Y market for net price α. The OM cooperative is assumed to set price, w_A, for the farm commodity so as to pay the maximum price possible subject to covering its costs, given the volume delivered to it (e.g., Helmberger 1964). To find w_A, we first define the co-op's net revenue, exclusive of farm-product costs:

Net revenue product: $NRP_A = (p_A - c)\left(\dfrac{p_B - p_A + \gamma}{2\gamma}\right) + \alpha Q_Y - F$,

where Q_Y is total sales into the Y market by the OM cooperative. Net average revenue product is $NARP_A = NRP_A / Q_T$, where

(1) $Q_T = Q_A + Q_Y = X - Q_B = X - (1 - Q_A) = X - 1 + \dfrac{p_B - p_A + \gamma}{2\gamma}$.[19]

The cooperative chooses price p_A for its branded product to maximize $NARP_A$, taking p_B as given.

(2) $\max\{p_A\} \quad NARP_A = \{(p_A - c)\left(\dfrac{p_B - p_A + \gamma}{2\gamma}\right) + \alpha Q_Y - F\} \div Q_T$.

We use equation (1) to substitute for Q_Y and Q_T in (2). From the first-order condition to (2), we obtain the OM cooperative's reaction function:

(3) $P_A = P_B - \gamma + 2\gamma X - \sqrt{2\gamma}[F + (X-1)(P_B - \gamma + 2\gamma X - \alpha - c)]^{1/2}$.

Firm B chooses p_B to maximize profits, taking p_A and w_A as given. Because co-op firm A has open membership, firm B can procure no farm product if it pays less than firm A. Thus we impose $w_A = w_B$.[20] Firm B's optimization problem then is as follows:

(4) $\max\{p_B\} \quad \pi_B = (p_B - w_A - c)\left(1 - \dfrac{p_B - p_A + \gamma}{2\gamma}\right) - F$.

From the first-order condition to (4), we obtain firm B's reaction function as follows:

(5) $p_B = (p_A + \gamma + c + w_A) / 2.$

Equilibrium in the mixed market with an OM co-op is defined by conditions (3) and (5) and also by

(6) $Q_A = \dfrac{p_B - p_A + \gamma}{2\gamma}$ (demand for A),

19 Equation (1) relies upon the argument that all product sold into the Y market is sold through the cooperative in this model. Given the core assumption that the branded market is more profitable than the generic market, $p_A - c > \alpha$, and the OM cooperative will pay a price to farmers that is greater than α . Thus, no firm can make a profit by selling solely into the Y market. Similarly Firm B will not purchase farm product to sell into the Y market given that it must match the cooperative's price in order to acquire product, in which case $w_B > \alpha$ in equilibrium.

20 The IOF will never pay more than the OM cooperative because for any $w_B > w_A$, the IOF can reduce price and increase profits without changing its volume of purchases since X is exogenous.

(7) $Q_B = 1 - Q_A$ (demand for B),

(8) $w_A = w_B = w = NARP_A$. (co-op pricing rule).

The endogenous variables are p_A, p_B, Q_A, Q_B, and *w*. We solve the system of five equations for the equilibrium values of the endogenous variables by first solving (3), (5), and (8) simultaneously for $p_A, p_{B,}$ and *w*, and then substituting the equilibrium prices into (6), (7), and (1) to get branded and generic product sales:

$$p_A^{OM} = p_B^{IOF} = \alpha + c - \frac{F}{(X-1)} + \gamma \frac{2X-1}{2(X-1)},$$

$$w^{OM-IOF} = \alpha + \frac{\gamma}{2(X-1)} - \frac{F}{(X-1)},$$

$$Q_A^{OM} = Q_B^{IOF} = 0.5, \; Q_Y = X - 1.$$

The aforementioned condition that branded-market sales yield more per-unit profit than unbranded sales requires that $p_i - c - 2F > \alpha \Rightarrow 2F < \gamma$. This same condition guarantees that $w^{OM-IOF} > \alpha$.[21] The mixed OM co-op and IOF model thus yields two key results: The OM cooperative acts as a “yardstick of competition” by causing the market price of the farm commodity to be $w^{OM-IOF} > \alpha$. However, the profits from the cooperative’s participation in the branded product market are dissipated by its open-membership requirement, which cause it to also participate in the less profitable generic market.

CM cooperative: Consistent with the prior literature (e.g., Sexton 1983), we assume that the CM cooperative accepts membership and production so as to set output at the maximum value of NARP. By setting p_A and, thus, Q_A to maximize NARP, the cooperative is able to pay the highest possible price for the raw product, thereby maximizing profits for the farmers who are able to join it, given the assumption of inelastic farm supply. Given the assumptions of the model, the CM cooperative will not operate in the Y market. The objective function of the CM cooperative is thus

21 This result follows because the OM cooperative’s price to farmers is a weighted average of its net revenues in the branded market and the Y market. The Y market yields α revenue per unit and the branded market yields $p_A^{OM} - c - 2F > \alpha$.

(9)

$$\max\{p_A\} \quad NARP_A = \frac{(p_A - c)Q_A}{Q_A} - \frac{F}{Q_A} = p_A - c - \frac{F}{Q_A} = p_A - c - \frac{2\gamma F}{p_B - p_A + \gamma}.$$

From the first-order condition to (9), we derive the reaction function:

(10) $P_A = \gamma + P_B - \sqrt{2\gamma F}$.

Firm B's problem is changed from the mixed market with the OM cooperative because B does not have to match the price paid by the CM cooperative for the farm product; it need only pay the value, α, of the competitive Y market:[22]

(11) $\max\{p_B\} \quad \pi_B = (p_B - \alpha - c)\left(1 - \frac{p_B - p_A + \gamma}{2\gamma}\right) - F$.

From the first-order condition to (11), we derive B's reaction function:

(12) $p_B = (p_A + \gamma + c + \alpha)/2.$

Equilibrium in the mixed market with a CM co-op is defined by equations (10) and (12), the branded market demand functions (6) and (7), and by the CM co-op's pricing rule, which is

(5') $\mathrm{w_A} = \mathrm{NARP_A} = \mathrm{p_A} - \mathrm{c} - \frac{2\gamma \mathrm{F}}{\mathrm{p_B} - \mathrm{p_A} + \gamma}$.

The equilibrium is found by solving (10) and (12) for the equilibrium branded prices, and then substituting those values into (6), (7), and (5') to obtain equilibrium values for Q_A, Q_B, and w_A.

$$p_A^{CM} = \alpha + c + 3\gamma - 2\sqrt{2\gamma F},$$
$$p_B^{IOF} = \alpha + c + 2\gamma - \sqrt{2\gamma F},$$
$$w^{CM} = \alpha + 3\left(\gamma - \sqrt{2\gamma F}\right),$$
$$w^{IOF} = \alpha,$$

22 Since the competitive Y market yields zero profit to marketing firms, the B firm is indifferent about participating in it, so we assume for simplicity that it sells only in the differentiated-product market.

$$Q_A^{CM} = \frac{\sqrt{2\gamma F}}{2\gamma},$$

$$Q_B^{IOF} = \frac{2\gamma - \sqrt{2\gamma F}}{2\gamma},$$

The mixed branded-product market yields asymmetric results in the case of the CM cooperative. The cooperative charges a higher price than the IOF, i.e., $p_A^* - p_B^* = \gamma - \sqrt{2\gamma F}$, which is positive whenever $\gamma > 2F$, a condition which holds by assumption. Accordingly, the CM cooperative also holds a lower market share in the branded-product market than if it operated with open membership.

The presence of either an OM or a CM cooperative increases total farmer welfare, measured as the total revenue received for marketing the fixed crop, *X*, whenever the condition $\gamma > 2F$ holds. However, the OM cooperative is generally better for overall farmer welfare than the CM cooperative, due to the yardstick-of-competition effect. Whenever $X \leq 3$, i.e., the branded products have a combined market share of at least one-third, total farmer revenue is always greater under the OM than the CM cooperative. However, the payoff to membership in the cooperative is generally dissipated by the OM requirement, i.e., $w^{CM} > w^{OM}$ whenever $X - 1 > 1/3$, i.e., whenever the Y market is at least 1/3 the size of the branded market.[23] The policy tradeoff regarding whether cooperatives should be compelled to maintain open membership is that the open-membership requirement is needed to obtain the competitive yardstick effect, but the incentive of farmers to make upfront investments in time and effort to create the branded-product cooperative is muted because returns to the activity are dissipated by the open-membership requirement in most market environments.

23 When $X - 1 \leq 1/3$, it is, surprisingly, possible that the OM cooperative pays a higher price to farmers than the CM cooperative. The reason is that the interactions in the branded market are different (as manifest by differences in the reaction functions) when the IOF competes with an OM cooperative versus a CM cooperative. In particular, because the IOF must match the farm price of the OM cooperative, this raises the IOF's costs and, hence, shifts up its reaction function relative to the case of competition with a CM cooperative—compare equations (5) and (12). This fact enables the OM cooperative to charge a higher price in the branded market, ceteris paribus. It is beyond the scope of this paper to explore this effect in any detail.

Conclusion

Product quality in all of its dimensions is paramount to success in modern food markets, as is a second dimension of quality pertaining to the attributes of the marketing firms themselves, in terms of their abilities to satisfy the characteristics in a supplier sought by downstream buyers. The ability of cooperatives to play an effective role in improving farmer welfare will hinge increasingly on their ability to perform successfully in quality-differentiated and branded-product markets. This analysis has examined cooperatives' principles and practices from the perspective of their impacts upon cooperatives' performance in the quality dimension. Despite cooperatives' efforts to position themselves favorably on the quality spectrum, various traditional cooperative business practices are not conducive to success in meeting the market's demands for quality.

Quality differentiation and product differentiation are synonymous, so to analyze cooperatives' behavior and performance in modern, quality-differentiated agricultural markets, economists must embed them within models of product differentiation. Given the limited work that has been performed in this dimension to date, we reviewed and extended to the realm of cooperatives two prototype models of product differentiation, the Mussa-Rosen (1978) model of vertical product differentiation and the Hotelling (1929) model of horizontal differentiation.

Recent applications of these frameworks to analysis of marketing cooperatives demonstrate their potential to yield insights into cooperatives' performance in quality-differentiated markets. Saitone and Sexton (2009) demonstrate that cooperatives' pooling practices, well known to cause an adverse selection problem, also provide offsetting benefits in terms of opportunity to improve profit by regulating the distribution of high- and low-quality product, and ability to spread risks among farmers when production of quality is stochastic. Mérel, Saitone, and Sexton (2009) demonstrate that these advantages may be sufficient to overcome the adverse-selection disadvantage of pooling, in the sense of enabling stable cooperatives conducting partial or full pooling to emerge in the presence of outside marketing options. In this paper, we applied the Hotelling model in a mixed duopoly market setting to compare the performances of open- and closed-membership cooperatives in terms of ability to increase farmer income. Open membership conveys a yardstick-of-competition effect that causes all farmers to receive a higher price whether they are co-op members or not, but open membership also tends to dissipate the benefits from value-added or branded production, meaning that such investments are less likely to be made in an open-membership environment.

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