An Evaluation of Cooperatives' Comparative Strengths and Weaknesses in a Vertically Differentiated Agricultural Product Market

Discussion Paper for the University of Wisconsin Center for Cooperatives

Tina L. Saitone and Richard J. Sexton*

* Tina L. Saitone is a Post-Doctoral Scholar and Richard J. Sexton is a Professor, Department of Agricultural and Resource Economics, University of California, Davis. The authors are grateful to Pierre Mérel for helpful comments on this work.

An Evaluation of Cooperatives' Comparative Strengths and Weaknesses in a Vertically Differentiated Agricultural Product Market

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. want to consume and are willing to pay more to consume 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 for product differentiation and exploiting 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 become replaced increasingly with various forms of vertical market coordination and as downstream buyers have become increasingly 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

[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.

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 the 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 size or scale of the seller, a fact which 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 (Ayres and Bosia 2008), in which adherents seek to consume only food products produced within a certain geographic bound of their location, provides the clearest example of a product-quality dimension that compels small-scale production. However, 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 a 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 are leading to a broadening of the dimensions of product quality and creating market niches conducive to the success of small-scale producers and marketers. The purpose of this discussion paper is to analyze the challenges and opportunities for agricultural marketing cooperatives in this environment and to propose appropriate modeling frameworks to analyze 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 the market's 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)

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

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 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, 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 (NGC) model (Harris, Stefanson, and Fulton 1996) demonstrates the ability of the cooperative business form to evolve to changing market conditions, as do the financing innovations introduced through the 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 NGC 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.

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. Among the exceptions is a treatment by Zago (1999), who models a producer organization, such as a cooperative, where heterogeneous farmers produce a product which differs in quality based upon their ability. Depending upon which producer type (e.g., high or low ability) constitutes the majority, different remuneration schemes will be chosen by producers and higher or lower than the first-best level of quality will be provided.

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

Hoffman (2005) considers a mixed-duopoly market, where a cooperative and investor-owned firm (IOF) compete first in choice of product quality and then in price in a vertically differentiated market. 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. The model, however, is able to make no predictions as to which organizational form emerges in the preferred role of the high-quality seller.

Fulton and Giannakas (2001) also study a two-period, mixed duopoly model, but adopt a somewhat different approach. Period 1 features price competition between a co-op and IOF, and in period 2 consumers decide which product to purchase. The authors show that member commitment depends on the cooperative's reputation, while assuming nonetheless that product quality is homogenous across the cooperative and IOF.

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. We propose and illustrate a prototype model of vertical product differentiation 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,[5] 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.[6] 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 not mentioned as eligibility criteria for membership.

[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] To be eligible for the single-tax treatment specified by subchapter T of the IRS code, U.S. cooperatives must conduct at least 50% of their business with members.
[6] For example Blue Diamond Growers bylaws specify one acre or 70 trees for the production of almonds.

Given that any realistic production setting is certain to involve heterogeneity in terms of the physical aspects of the products being produced,[7] 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.[8]

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 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, meanwhile, has at best only short-run control over the volume of production that it receives if it requires members to sign marketing contracts.

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

[7] 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.

[8] 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.

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.[9]

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. Product differentiation is classified broadly into two types: horizontal and vertical 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 desirability of a product attribute, such as sugar content in cereals and bakery products, fat content of milk, and protein content of wheat.

In the remaining sections of this paper we investigate how traditional cooperative principles affect a cooperative's performance in a vertically differentiated product market. We adapt the standard Mussa-Rosen (1978) model of vertical differentiation to a prototype

---

[9] 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.

agricultural market setting. We place particular emphasis on an advantage flowing from traditional cooperative principles in this setting, namely a cooperative's ability to insure risk-averse farmers against quality risk.

A Prototype Model of Vertical Differentiation for an Agricultural Market

We consider a market where farmers produce a vertically differentiated commodity which can either be high-quality (H) or low-quality (L), where consumers always prefer H over L. Differences in objective qualities of products (e.g., size, color, and extent of blemishes) fit normally in the realm of vertical differentiation. Because these product characteristics can ordinarily be discerned by marketing firms and consumers (Bockstael 1984; Chambers and Pick 1994), we assume perfect-information throughout the market chain. The ex ante quality levels of the products are exogenous (Bockstael 1984; Chambers and Pick 1994; and Hollander, Monier-Dilhan, and Ossard 1999), e.g., they are determined by weather conditions. However, through quality enhancement farmers can affect the ex post proportions of H and L product they produce, but they cannot choose the magnitude of the H or L product. H product quality, q_H, is normalized to 1.0, and the quality of the L product is $q_L = \alpha$, where $\alpha < 1$.[10]

Farmers each produce one unit. They are arrayed uniformly on the continuum [0, *X*] with density 1/*X*. Total output is *X*. Costs of producing output are sunk and do not enter into the analysis. Farmers are assumed initially to be homogeneous in their ability to produce H product; relaxation of this assumption is discussed later.

[10] This formulation contrasts with the approach taken by Hoffman (2005), who assumed that duopoly firms set their quality levels in stage 1 of a two-stage model, and then competitive farmers produce the quality level their marketing firm had chosen. Although Hoffman's formulation abstracts from the fundamental role that exogenous factors invariably play in influencing quality of farm products, it may represent a valuable alternative to our approach when the focus is on vertically coordinated agriculture, wherein downstream marketers exert influence over the production choices of upstream farmers.

An important feature of most agricultural production settings is stochastic product quality due, for example, to variability in weather conditions, pest infestations, etc. We model this uncertainty by specifying the exogenous ex ante share of output that is L for any farmer i as $\gamma_i = \gamma^* + \varepsilon_i$, where $0 < \gamma^* < 1$, and ε_i is an independently and identically distributed random disturbance defined on the support $[-\gamma^*, 1-\gamma^*]$, with mean zero and variance σ_ε^2. Define market share of L production as γ, where

$$\gamma = \frac{1}{X}\left(\int_0^X \gamma_\tau d\tau\right) = \frac{1}{X}\left(\int_0^X \gamma^* d\tau + \int_0^X \varepsilon_\tau d\tau\right) = \gamma^* + \frac{1}{X}\int_0^X \varepsilon_\tau d\tau .$$

Thus, $E[\gamma] = \gamma^*$, and

$$\mathrm{var}[\gamma] = E\left\{\left(\frac{1}{X}\int_0^X \varepsilon_\tau d\tau\right)^2\right\} = \frac{1}{X^2}\mathrm{var}\left[\int_0^X \varepsilon_\tau d\tau\right] = \frac{1}{X^2}\int_0^X \mathrm{var}\left[\varepsilon_\tau\right] d\tau = \frac{1}{X^2}\int_0^X \sigma_\varepsilon^2 d\tau = \frac{\sigma_\varepsilon^2}{X},$$

given independence among the ε_τ. In addition, note that $E[\varepsilon_i \cdot (1/X)\int_0^X \varepsilon_\tau d\tau] = (1/X)\sigma_\varepsilon^2$.

We assume that farmers have identical preferences that can be represented according to the mean-standard deviation approach (Markowitz 1978) by a utility function, $U(\mu_\pi, \sigma_\pi)$, which is increasing in expected profit, μ_π ,and decreasing in standard deviation of profit, σ_π, under producer risk aversion.[11]

Although total output is exogenous, farmers are able to undertake activities to increase the proportion of H product by "transforming" ex ante L product to H. A farmer can transform product that would be L in the absence of quality-enhancing activities into H product through a convex cost function,

[11] The obvious alternative to the mean-standard deviation approach is the von Neumann-Morgenstern expected utility framework. The two approaches have been shown to yield equivalent preference rankings under quite general conditions (Meyer 1987; Bar-Shira and Finkelshtain 1999).

(1) $$C_i(T_i) = 0.5\beta XT_i^2,$$

where $T_i \in [0, \gamma_i]$ is the amount of L product transformed to H by producer *i*, and β, $0 < \beta < \infty$, is a parameter that calibrates the marginal cost of quality enhancement. Examples of transformation include the application of pesticides to reduce pest damage, thinning of fruit to increase size, and delaying harvest to increase ripeness.

*N p*otential consumers are in the market. Following Mussa and Rosen (1978), they are indexed by a taste parameter for quality, θ, and distributed uniformly distributed on the interval $\theta \in [0, 1]$. Each consumer derives utility from only the first unit of the commodity that she purchases. A consumer with taste parameter θ has utility $V(\theta, q) = \theta q$ and surplus $CS_H(\theta, P) = \theta - P$ from consuming a unit of the H product or $CS_L(\theta, \alpha, p) = \theta\alpha - p$ from consuming a unit of the L product, where *P* (*p*) represents the price of the H (L) product.

The consumer who is indifferent between consuming the H product and the L product is represented by taste parameter $\tilde{\theta} = P - p/(1-\alpha)$, i.e., $CS_H(\tilde{\theta}, P) = CS_L(\tilde{\theta}, p) > 0$, while the consumer who is indifferent between consuming the L product and not consuming the product at all, and accordingly obtaining $CS_L = 0$, is represented by $\bar{\theta} = p/\alpha$. In general the location of $\tilde{\theta}$ is determined by a self-selection condition that this consumer is indifferent between consuming H and L product and obtains positive surplus from either choice: $CS_H(\tilde{\theta}, P) = CS_L(\tilde{\theta}, p) > 0$, whereas the location of $\bar{\theta}$ is determined by an individual rationality condition because the consumer with taste parameter $\bar{\theta}$ obtains $CS_L(\bar{\theta}, p) = 0$.

The respective aggregate demands for the H and L products that account for the presence of both products on the market and consumers' ability to choose are:

(2) $$Q_H = N(1-\tilde{\theta}) = N\left(1 - \frac{P-p}{1-\alpha}\right),$$

(3) $$Q_L = N(\tilde{\theta} - \bar{\theta}) = N\left(\frac{P-p}{1-\alpha} - \frac{p}{\alpha}\right).$$

Inverting the system comprised by (2) and (3) results in the indirect demand functions:

(4) $$P = 1 - (1/N)(Q_H - \alpha Q_L),$$

(5) $$p = \alpha[1 - (1/N)(Q_H - Q_L)].$$

We assume throughout that the potential demand for the commodity exceeds the sum of the exogenous output, so $X/N < 1$ represents the product's market penetration rate.

Competitive Equilibrium

To establish a baseline to compare alternative market equilibria, we first solve for the competitive equilibrium. Taking account of the possibility of quality enhancement of L product to H, the equations linking consumption to the available production are $Q_H = (1-\gamma)X + T$, and $Q_L = \gamma X - T$, where $T = \int_0^X T_\tau d\tau$. Substituting these relationships into the indirect demand functions, (4) and (5), obtains:

(4') $$P(T|\alpha,\gamma,X) = 1 - (X/N)[1-\gamma(1-\alpha)] - (T/N)(1-\alpha),$$

(5') $$p(\alpha, X) = [1 - X/N]\alpha.$$

Quality-enhancement decisions are made ex post—after the realization of the ε_i, and, accordingly, are unaffected by the uncertainty inherent in the problem, meaning such decisions are based purely upon a profit criterion. To derive the supply function for quality enhancement, differentiate a farmer's transformation cost function (1) to obtain marginal cost, $MC(T_i) = \beta X T_i$. Quality enhancement also involves an opportunity cost because each unit of L that is transformed to H cannot be sold as L at price $p(\alpha, X)$. Thus, the full marginal cost of transformation is $\beta XT_i + p(\alpha, X)$, and the optimal volume of transformation, T_i^*, is determined by the condition

(6) $$P(T|\alpha,\gamma,X) = \beta XT_i^* + p(\alpha,X) \rightarrow T_i^* = (P-p)/\beta X .$$

Aggregating across farmers obtains the industry supply function for transformation or quality enhancement:

(7) $$T_A^* = \int_0^X T_\tau^* d\tau = (P-p)/\beta \leq \gamma X.$$

The inequality in (7) reflects that transformation of L product to H is limited by its ex ante availability, γX. Given our interest in examining how institutions affect incentives to produce high-quality product, we limit our discussion to those market settings wherein both H and L product are produced in the competitive equilibrium, meaning that (7) is satisfied at strict inequality.

Substituting (4') for P and (5') for p into (7) and solving yields the reduced-form expression for T_A^*, the L product transformed to H in the competitive equilibrium:

(7') $$T_A^* = \frac{(1-\alpha)(N - X + \gamma X)}{N\beta - \alpha + 1} < \gamma X .$$

Industry Profit Maximum

It is useful to compare the competitive equilibrium amount of quality enhancement to the amount, T_M^*, that maximizes industry profits. To find T_M^* we solve the following maximization problem for T:

(8) $$\underset{\{T\geq 0\}}{Max} \quad \pi = P(X - \gamma X + T) + p(\gamma X - T) - 0.5\beta T^2 \text{, s.t. } T \leq \gamma X .$$

The unconstrained, interior solution to (8) is found where the industry marginal revenue from transformation, $MR(T|(1-\gamma)X)$, given ex ante H production, equals the industry marginal cost of transformation, $MC(T)=\beta T$, plus the foregone opportunity to sell a unit of L at price p.

Since $MR(T)$ declines monotonically in T and $MC(T)$ rises monotonically in T, at most one such intersection will exist. The corner solution, $T_M^*=0$, arises whenever the net marginal revenue, $MR(T)-p$, from transformation is nonpositive, given γ. This outcome occurs whenever the market demand for transformation, $P(T|(1-\gamma)X)-p$, evaluated at the ex ante level of H production, $(1-\gamma)X$, is inelastic, Substituting from (4') and (5') for P and p, respectively, $MR(T)-p\leq 0$ whenever $(1-\gamma)X\geq N/2$. For $(1-\gamma)X<N/2$, demand for transformation is elastic, $MR(T)-p$ is positive, and

(9) $$T_M^*=\frac{(1-\alpha)[N-2X+2\gamma X]}{N\beta-2\alpha+2}>0.$$

For all cases of interest competitive farmers supply an excessive amount of H product relative to the amount that maximizes industry profits:

(10) $$T_A^*-T_M^*=\frac{N(1-\alpha)[1-\alpha+X\beta(1-\gamma)]}{(N\beta-\alpha+1)(2-2\alpha+N\beta)}>0.$$

Cooperative Marketing and Vertical Product Differentiation

We now consider the presence of a marketing cooperative in the vertically differentiated market. The impacts of many traditional cooperative principles and practices can be analyzed within this setting. Specific market equilibria, of course, hinge importantly on the nature of competition in the market, such as whether the cooperative is a monopoly seller as in Zago (1999), or whether it competes with IOF marketing firms in a mixed-oligopoly environment as in Hoffman (2005). An illustrative list of examples would include

- Volume control. The monopoly, open-membership cooperative will market the entire volume, *X*, produced by the farmers and will make no attempt to influence its allocation through transformation between H and L product, whereas typical IOF contracts limit deliverable total production or specify steep discounts on product delivered above a quota amount, and utilize premiums and discounts to control the allocation between H and L products.
- Regulation of product quality. In the context of this model, quality regulation could take the form of (i) imposition of a minimum quality standard (MQS) proscribing sale of the L product, or (ii) jettisoning members who consistently produce high shares of low-quality product. Saitone (2008) shows that, under certain market conditions, imposition of MQS can increase industry profit. However, such controls on farmer production are inconsistent with the traditional cooperative principle of acting as a home for member production and having no forced exit of members. Jettisoning members that produce the highest shares of low-quality products matters to the vitality of the cooperative if (i) the cooperative pools revenues across members such that the incidence of low-quality products affects the overall pooled return paid by the cooperative, or (ii) if, in its marketing activities, the cooperative is unable to segregate products by quality for downstream buyers, so the incidence of low-quality products affects the cooperative's average selling price.
- Investments in upgrading product quality. Such an analysis would involve making the H and L quality levels endogenous and introducing a second, quality-choice stage to the

model (Hoffman 2005), but would enable cooperatives' horizon-problem issues to be studied.[12]

- <u>Vertical coordination.</u> In Hoffman (2005), once downstream marketing firms set their quality levels, upstream farmers automatically produce products of the desired quality. Thereby the model abstracts from fundamental issues of vertical coordination that are paramount in modern marketing chains.

Cooperatives' Pooling Practices

To illustrate the model in some detail, we study the impact of cooperative pooling in this market. We allow the cooperative to pool revenues between the H and L products, and, specifically, allow any form of pooling ranging from no pooling (i.e., independent pools for H and L product) to the traditional principle of complete pooling (i.e., a single pool for H and L product). Pooling in this setting has two beneficial impacts: it attenuates the risks to individual farmers from stochastic production of H and L products, and it limits producers' incentives to transform L product to H, which is beneficial from (10). Offsetting these benefits are two limitations associated with cooperation and pooling: the supply-control aspect of pooling is vulnerable to free riding—any farmers outside the cooperative capture the benefits of the supply control but incur none of the costs, and pooling may cause an adverse selection problem when producers are heterogeneous in terms of their ability to produce H product.

We model cooperative pooling by defining a parameter $\delta \in [0,1]$ and letting $1-\delta$ denote the portion of each farmer's production, whether H or L, that is assigned to a common pool. Thus,

[12] Analytical manifestations of the horizon problem would involve a cooperative either facing a higher cost of capital than a competitor IOF or having a capital constraint. Either situation is likely to cause the cooperative to be the low-quality producer in a two-stage game with quality choice in stage 1, as in Hoffman (2005). Notably, Hoffman's model does not involve either of these features—the cooperative and IOF have identical costs. Thus, his model can make no prediction as to which firm emerges as the high-quality seller.

farmers receive a "pooled price" on the portion of their production that is allocated to the common pool and quality-specific prices for the remainder of their production.[13] The pooled price, $\tilde{P}$, is a quantity-weighted average of the high-quality and low-quality prices derived in the market equilibrium:

(11) $$\tilde{P} = [1-\gamma+(T/X)]P + [\gamma-(T/X)]p .$$

Competitive farmers' incentive to undertake quality enhancement, in (6), is determined by the price difference for H and L product relative to the marginal costs of transforming quality. In the presence of pooling, the value to a producer from quality enhancement is no longer determined by the market prices, *P* and *p*, but, rather, by the following prices, which reflect the specific pooling arrangement:

(12) $$P_H(T) = \delta P(T) + (1-\delta)\tilde{P}(T),$$

(13) $$p_L(T) = \delta p + (1-\delta)\tilde{P}(T) .$$

Substituting these expressions into (6) in place of *P* and *p*, using (4') and (5'), respectively, to replace *P* and *p* in (12) and (13), and aggregating yields the equilibrium amount of quality enhancement, T_C^*, in a pooling co-op:

(14) $$T_C^*(\delta \,|\, \alpha,\gamma,\beta,X) = \delta(P(T)-p)/\beta = \frac{\delta(\alpha-1)[N-X+\gamma X]}{(\alpha-1)\delta - N\beta} \le T_A^*,$$

with $\partial T_C^*(\delta \,|\, \cdot)/\partial\delta > 0$, i.e., as the cooperative increases the share of farmers' production paid through a pooled price (smaller δ), farmers transform less product from L to H.

---

[13] This analytical approach can represent a wide range of pooling arrangements. A literal example is the so-called 50-50 pooling arrangement (i.e., $\delta = 0.5$) utilized for many years by Tri Valley Growers, a diversified fruit and tomato processing cooperative in California (Hariyoga 2004).

Optimal Cooperative Pooling

The cooperative, through the mechanism described in (11) – (13), can implement any pooling arrangement, ranging from no pooling ($\delta = 1$) to complete pooling ($\delta = 0$), with $\delta = 0$ providing full insurance to farmers from stochastic shocks to their own ex ante production of H and L products but providing no incentive to enhance quality, i.e., $T_C^* = 0$. Setting $\delta = 1$, provides no insurance and results in the competitive equilibrium amount of quality enhancement, $T_C^* = T_A^*$, which is not optimal from an industry profit-maximization perspective because $T_M^* < T_A^*$. Thus, when farmers are risk averse we reach the immediate conclusion that some degree of pooling is optimal to attenuate the incentives of competitive farmers to produce excessive amounts of the H product and to insure against adverse realizations of ε_i. A key question, however, is whether such pooling arrangements can survive free riding by farmers and adverse-selection problems.

To study optimal pooling practices, we consider two alternative market configurations. First, we study a monopoly cooperative such that all farmers must sell through the cooperative. This enables us to study optimal pooling arrangements without the constraints imposed by possible farmer exit. Second, we consider a mixed market where farmers can sell their production through the cooperative firm or an outside option, such as a competitive marketing firm or downstream vertical integration. Free riding can emerge in this setting, as can adverse selection when heterogeneous farmers are introduced.

The game unfolds sequentially as follows: (i) the cooperative credibly announces its pooling rate, δ, (ii) when there is an outside option, farmers decide whether to market through the cooperative or through a competitive marketing firm, given the cooperative's pooling rule, (iii) ε_i are realized, farmers make quality enhancement decisions competitively, market prices are determined, and consumption occurs.

Monopoly Cooperative

The cooperative seeks to maximize welfare of its members through its choice of pooling parameter, δ, given the farmers' quality-enhancement behavior, $T_C^*(\delta|\cdot)$, expressed in (14). Given farmer homogeneity, this is equivalent to maximizing utility for a representative farmer. The formal optimization problem can be stated as follows:

$$(15) \qquad \underset{\{0\le\delta\le1\}}{Max} \quad U(\mu_\pi,\sigma_\pi), \text{ s.t.}$$

$$\pi_i = P_H - [P_H - p_L](\gamma_i - T_i) - 0.5X\beta T_i^2 = P - (1-\delta)(P-p)(\gamma - T_i) - \delta(P-p)(\gamma_i - T_i) - 0.5X\beta T_i^2$$
$$\mu_{\pi_i} = \mu_P\left(1-\gamma^* + T_i\right) + p\left(\gamma^* - T_i\right) - (\sigma_\varepsilon^2/N)(1-\alpha) - 0.5X\beta T_i^2$$
$$\mu_P = 1 - (1/N)[X(1-\gamma^* + T)(1-\alpha)]$$
$$\sigma_{\pi_i}^2 = (1-\alpha)^2 X\frac{\sigma_\varepsilon^2}{N^2}\left(1-\gamma^*+T_i\right)^2 - 2(1-\alpha)\frac{\sigma_\varepsilon^2}{N}\left(1-\gamma^*+T_i\right)(\mu_P - p) + \frac{\sigma_\varepsilon^2}{X}(\mu_P - p)^2(1-\delta^2) + \sigma_\varepsilon^2(\mu_P - p)^2\delta^2$$
$$T = T_C^*(\delta|\cdot)$$
$$T_i = T/X,$$

where P_H and p_L are defined in (12) and (13), respectively, and μ and σ denote expected values and standard deviations, respectively. Expected profit is the product of μ_P and expected H quantity plus the product of p (nonstochastic) and expected L quantity, less transformation costs (which are determined ex post) and a term due to the joint variability of P and ε_i. Third and higher moments of the distribution for ε_i were set to zero in computing $\sigma_{\pi_i}^2$. Variance of profit is a rather complicated expression, reflecting that profits are stochastic due to variability in the H price, variability in the i^{th} farmer's realization of H output, and variability in other members' realizations of H output, which affects $\sigma_{\pi_i}^2$ through the pooling rule. Notably, the first three terms for $\sigma_{\pi_i}^2$ vanish in the limit as N and X become very large. The key term is the final one, which reflects variability in profits due solely to the stochasticity of γ_i, given μ_P and δ. As $\delta \to 0$ due to pooling, this source of variability is eliminated.

The first-order conditions (FOC) to (15) are

$$\text{(16)} \qquad \frac{\partial U(\cdot)}{\partial \mu_\pi}\frac{\partial \mu_\pi}{\partial \delta} + \frac{\partial U(\cdot)}{\partial \sigma_\pi}\frac{\partial \sigma_\pi}{\partial \delta} \le 0, \left(\frac{\partial U(\cdot)}{\partial \mu_\pi}\frac{\partial \mu_\pi}{\partial \delta} + \frac{\partial U(\cdot)}{\partial \sigma_\pi}\frac{\partial \sigma_\pi}{\partial \delta} \right)\delta = 0, \delta \ge 0.$$

Let $\delta^*(X, N, \gamma^*, \beta, \alpha, \sigma_\varepsilon)$ denote the solution to (16). Recall that $MR(T) - p \le 0$ when $(1-\gamma)X \ge N/2$, given realized H production. Because the cooperative sets its pooling parameter ex ante, the relevant condition is

$$\text{(17)} \qquad E[MR(T)] - p \le 0 \to (1-\gamma^*)X \ge N/2.$$

Thus, in the presence of risk-averse or risk-neutral farmers, $\delta^* = 0$ (complete pooling) is optimal whenever (17) holds. Given that $p > 0$, this condition holds whenever the demand for the H product is inelastic, given ex ante H production, and for some range of elastic H demand as well. Even if (17) does not hold, the corner solution, $\delta^* = 0$, may still be optimal if farmers are sufficiently risk averse.

When the interior solution, $0 < \delta < 1$, applies, the FOC can be written as

$$\frac{\partial \mu_\pi}{\partial \delta} = \lambda = \left(\frac{-\partial U(\cdot)}{\partial \sigma_\pi} / \frac{\partial U(\cdot)}{\partial \mu_\pi} \right) \frac{\partial \sigma_\pi}{\partial \delta},$$

where $s(\sigma_\pi, \mu_\pi) = \left(\frac{-\partial U(\cdot)}{\partial \sigma_\pi} / \frac{\partial U(\cdot)}{\partial \mu_\pi} \right)$ is the slope of an indifference curve in the (μ_π, σ_π) space, and $s(\sigma_\pi, \mu_\pi) > 0$ under farmer risk aversion (Meyer 1987). In addition, $\partial \sigma_\pi^2 / \partial \delta = 2\sigma_\varepsilon^2 \delta (\mu_P - p)^2 [1 - (1/X)] > 0$. Thus $\lambda > 0$ under producer risk aversion, and the cooperative sets a higher pooling rate than the rate which maximizes expected profits.

Figure 1 summarizes the optimal pooling rule under alternative market configurations. Indifference curves in the (μ_π, σ_π) space are depicted for a risk-averse farmer. To consider the (μ_π, σ_π) combinations attainable by the cooperative through choice of δ, we write $\mu_\pi = f(\delta), \sigma_\pi = g(\delta) \rightarrow \delta = g^{-1}(\sigma_\pi)$, so that $\mu_\pi = f(g^{-1}(\sigma_\pi)) = h(\sigma_\pi)$. The marginal rate of substitution of σ_π for μ_π is

(18) $$MRS = \frac{d\mu_\pi}{d\sigma_\pi} = \frac{\partial \mu_\pi / \partial \delta}{\partial \sigma_\pi / \partial \delta} = \frac{(\partial \mu_\pi / \partial T)(\partial T / \partial \delta)}{\partial \sigma_\pi / \partial \delta}.$$

The denominator of (18) is always positive, and $\partial T / \partial \delta > 0$ in the numerator. When $\left.\frac{\partial \mu_\pi}{\partial T}\right|_{T=0} < 0$, $MRS(\delta) < 0$, and μ_π declines monotonically in σ_π as depicted by the curve $h_1(\sigma_\pi)$. The corner solution, $\delta^* = 0$, is optimal in these settings. When $\left.\frac{\partial \mu_\pi}{\partial T}\right|_{T=0} > 0$, $h(\sigma_\pi)$ first rises and then declines, as depicted by the curve $h_2(\sigma_\pi)$. Partial pooling is optimal in this case, but $\delta^* < \delta^M$, where $\delta^M =$ argmax$\{\delta\}$ μ_π.

Mixed Market with Free Exit

Now consider optimal cooperative pooling in a market where farmers can exit the cooperative in favor of a competitive marketing arrangement. All marketing firms operate with zero marginal cost. Due to competition among them, a competitive marketing firm pays for H and L product according to the market prices in (4') and (5').

A pooling arrangement, $\tilde{\delta}$, is implementable if no farmer prefers to market outside of the cooperative, given $\tilde{\delta}$. Utility of a farmer in the monopoly cooperative is $U(\mu_\pi^C(\tilde{\delta}), \sigma_\pi^C(\tilde{\delta}))$, where μ_π^C and σ_π^C are defined in problem (15), and *i* subscripts are omitted. A farmer who defects from the monopoly cooperative receives full market price for any L product transformed to H. The expression for expected profit, μ_π^D, for the defecting farmer is identical to μ_π, in (15), but the defecting farmer anticipates making transformation decisions according to the rule $T_i^D = (\mu_P(\tilde{\delta}|\cdot) - p)/\beta X$, instead of the cooperative rule $T_i^C = \tilde{\delta}(\mu_P(\tilde{\delta}|\cdot) - p)/\beta X$. Thus, $\Delta T_i = T_i^D - T_i^C = (1-\tilde{\delta})(\mu_P - p)/\beta X \geq 0$, and, accounting for both the expected revenue and cost from additional transformation, we have

$$\Delta\mu_\pi = \mu_\pi^D - \mu_\pi^C = \Delta T_i(\mu_P - p) - 0.5\Delta T(\mu_P - p)(1-\tilde{\delta}) = \Delta T\,(\mu_P - p)[1 - 0.5(1-\tilde{\delta})],$$

and $\Delta\mu_\pi > 0$ whenever $\tilde{\delta} < 1$. The offsetting factor is that the defecting farmer is exposed fully to his production risk, manifest through the distribution of ε. From (15), a defector's standard deviation of profit, σ_π^D, is $\sqrt{\sigma_\pi^2}$, substituting $\delta = 1$ and $T_i = T_i^D$.

Implementability imposes the following additional constraint on the optimization problem in (15):

(15a) $$U(\mu_\pi^C(\delta), \sigma_\pi^C(\delta)) \geq U(\mu_\pi^D(\delta), \sigma_\pi^D),$$

i.e., any successful pooling arrangement must be immune to producer defections. Three possibilities emerge in the revised optimization problem: (i) constraint (15a) does not bind and, therefore, the unconstrained optimum, δ^*, is implementable, (ii) no pooling arrangement satisfies (15a), and only $\tilde{\delta} = 1$ (no pooling) is implementable, and (iii) there exists a set, $\Psi \supset [0,1]$, of partial pooling arrangements which satisfy constraint (15a) and, thus, are implementable, but $\delta^* \notin \Psi$, i.e., the unconstrained optimum is not implementable. These possible outcomes are illustrated in the subsequent simulation analysis.

Heterogeneous Producers with Free Exit

To this point we have assumed that farmers are identical ex ante, but may differ ex post due to realizations of the ε_i. Such ex post heterogeneity does not create an adverse selection problem, as long as producers making binding marketing commitments prior to the realization of the ε_i.[14] Ex ante heterogeneity among farmers in terms of ability to produce H product is problematic for pooling due to adverse selection because, for any $\delta < 1$, farmers with high expected shares of H product (low γ^*) anticipate transferring revenues to farmers with low ex ante H production. A pooling scheme, $\tilde{\delta} < 1$, may not survive competition for such farmers from competitive marketing firms.

To consider implementability of a pooling arrangement with ex ante farmer heterogeneity, assume that *X* growers are distributed uniformly in their ability to produce high-quality products according to the distribution $\gamma^* \in [\underline{\gamma}, \omega\underline{\gamma}]$, where $\omega > 1$ represents a convenient measure of heterogeneity. Each grower *i* produces one unit with the share of L product $\gamma_i = \gamma_i^* + \varepsilon_i$, where ε_i is now defined on the support $[-\underline{\gamma}, 1 - \omega\underline{\gamma}]$, with mean zero, variance σ_ε^2.

Ex ante the farmers most harmed by cooperative pooling at the most productive ones—those with $\gamma^* = \underline{\gamma}$. These farmers will benefit from the insurance aspect of a cooperative pooling arrangement, but will face the highest ex ante penalty from pooling in terms of foregone compensation. These farmers have the highest propensity to defect from any pooling arrangement, so satisfying (15a) for them is sufficient for implementability of a pooling arrangement, $\tilde{\delta}$. Conversely, if the highest-quality producer wishes to exit the cooperative due to adverse selection, his exit will reduce the average quality in the cooperative, reducing the payout

[14] However, if a cooperative lacked enforceable agreements, it would be vulnerable to ex post opportunistic behavior by farmers with negative realizations of ε.

under any pooling arrangement, and increasing the likelihood that others will exit, causing a pooling arrangement to unravel.

A Parameterized Model and Simulation Analysis

We adopt a specific utility function: $U(\mu_\pi, \sigma_\pi) = \mu_\pi / (\kappa + \sigma_\pi)^2$, where $S(\mu_\pi, \sigma_\pi)$ = $2\mu_\pi / (\kappa + \sigma_\pi)$. Higher values of κ make the indifference curves flatter, implying less risk aversion. A reasonable restriction is $\kappa > 0$, which rules out increasing absolute risk aversion (Battermann, Broll, and Wahl 2002).

In order to deal with the added complexities of the heterogeneous-producers case, we impose additional simplifying assumptions. We set $\beta = \infty$, meaning that no ex post transformation of product from L to H occurs. This assumption thus eliminates one of the cooperative advantages from pooling because inefficient quality enhancement by competitive producers is no longer a consideration, placing the focus squarely on the tradeoff between the risk-spreading advantages of cooperative pooling versus the adverse selection problem it causes.[15] Further, we focus on the case where both *N* and *X* are "large", enabling us to achieve marked simplification of the expression for σ_π^2, as discussed previously in relation to equation (15).

For the heterogeneous producer case, utility for the producers with ex ante quality, $\underline{\gamma}$, in the open market is

[15] In the presence of an outside option, the ability of a cooperative to calibrate production through pooling is no longer an advantage relative to the outside options because such a scheme is subject to free riding, i.e., the increase in *P(T)* caused by a pooling-induced reduction in transformation is captured by all producers, whether members of the cooperative or not. Thus, we lose nothing in abstracting from this feature when considering outside options. In contrast, insurance features of pooling are not subject to free riding.

(18) $$U(\mu_\pi^D, \sigma_\pi^D \big| \underline{\gamma}) = \frac{P - (P-p)\underline{\gamma}}{(\kappa + (P-p)\sigma_\varepsilon)^2},$$

In the cooperative the same producers have utility:

(19) $$U(\mu_\pi^C(\delta), \sigma_\pi^C(\delta) \big| \underline{\gamma})) = \frac{P_H - \delta(P-p)\underline{\gamma}}{(\kappa + \delta(P-p)\sigma_\varepsilon)^2},$$

where $P_H = \delta P + (1-\delta)\tilde{P}$ from (13) and $\tilde{P} = [P - 0.5\underline{\gamma}(1+\omega)(P-p)]$, where $0.5\underline{\gamma}(1+\omega)$ is the average L quality share in the co-op when all farmers are members. Making these substitutions into (19) yields:

(19') $$U(\underline{\gamma}, \delta, \omega \big| \cdot) = \frac{P - (P-p)\underline{\gamma}[1 + (1-\delta)(1+\omega)]}{(\kappa + \delta(P-p)\sigma_\varepsilon)^2}$$

A sufficient condition for a pooling arrangement to be implementable is, thus, that

(20) $$\frac{P - (P-p)\underline{\gamma}[1 + (1-\delta)(1+\omega)]}{(\kappa + \delta(P-p)\sigma_\varepsilon)^2} \geq \frac{P - (P-p)\underline{\gamma}}{(\kappa + (P-p)\sigma_\varepsilon)^2}.$$ [16]

Although specific results depend on the degree of heterogeneity, ω, the importance of risk in the problem as measured by σ_ε^2, and farmers' risk preferences embodied in $U(\mu_\pi, \sigma_\pi)$, implementable partial-pooling arrangements exist in this setting.

In the homogeneous-producers model, simulating a market implies choosing values for seven parameters: $N, X, \alpha, \beta, \gamma^*, \sigma_\varepsilon^2$, and κ. Figure 2 depicts δ^* as a function of σ_ε^2 for alternative choices of ex ante L quality, γ^*. All δ^* in figure 2 satisfy the implementability constraint (15a) at strict inequality. $\delta^*(\sigma_\varepsilon^2 \big| \cdot)$ declines monotonically, reflecting the basic principle that a higher rate of pooling is more advantageous for riskier market settings. Holding σ_ε^2 constant, higher

[16] The condition in (20) is not a necessary condition because, even if (20) fails to hold so that the highest-quality producers exit the cooperative, a subset of the farmers may be better off remaining in the cooperative under the given pooling arrangement. Two offsetting factors are at work. Defection of the highest-quality producers reduces expected payoff to everyone under the pooling arrangement increasing the likelihood of additional exit, but those with higher values of γ^* have poorer options in the outside market, making them less likely to defect ceteris paribus.

values of γ^* imply a larger $P-p$ gap, increasing the profitability of undertaking transformation, thereby reducing the optimal pooling rate, δ^*.

Figures 3 and 4 provide more insight into the implementability constraint for the homogeneous-producers model. They depict cooperator and defector utilities as a function of δ, in alternative market settings. Defector utility declines monotonically in δ because $\partial\mu_\pi^D / \partial\delta < 0$, and when $\delta = 1$ $U(\mu_\pi^C(\delta), \sigma_\pi^C(\delta)) = U(\mu_\pi^D(\delta), \sigma_\pi^D)$. Figure 3 depicts a market where demand for transformation is elastic given ex ante H production, and $U(\mu_\pi^C(\delta), \sigma_\pi^C(\delta))$ increases over a range of δ, i.e., limiting the extent of pooling gives farmers incentive to enhance quality, and, over a considerable range of δ values the effect of higher mean profit on utility dominates the effect of higher $\sigma_\pi^C(\delta)$. Many pooling arrangements are not implementable in this market because $U(\mu_\pi^C(\delta), \sigma_\pi^C(\delta)) < U(\mu_\pi^D(\delta), \sigma_\pi^D)$, but the unconstrained optimum, $\delta^* \approx 0.856$, is implementable. Figure 4 depicts a market where demand for transformation is inelastic at $(1-\gamma)X$, so $U(\mu_\pi^C(\delta), \sigma_\pi^C(\delta))$ decreases monotonically in δ. The unconstrained optimum, $\delta^* = 0$, is not implementable, but various partial pooling schemes are implementable. The constrained optimum is $\tilde{\delta} \approx 0.231$, where the two utility curves first intersect.

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 firm itself, in terms of its abilities to satisfy the characteristics in a supplier sought by downstream buyers. 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.

This analysis has examined traditional cooperative principles and practices from the perspective of their impacts upon cooperatives' performance in the quality dimension. We adapted the Mussa-Rosen (1978) model of vertical product differentiation to a prototype agricultural market setting and outlined how the model could be used to study various cooperative principles and practices. To illustrate the full workings of the model, we conducted a detailed analysis of traditional revenue pooling by a cooperative. Although cooperatives' pooling practices are generally considered inimical to the production of high-quality products due to adverse selection, we showed that pooling can confer two strategic advantages to cooperative members in a quality differentiated market—pooling attenuates the incentive of competitive farmers to over produce high-quality product and insures risk-averse farmers against adverse realizations of quality. When farmers have outside options, a pooling arrangement must be robust to farmer defections. We demonstrated that, depending upon the market configuration, pooling arrangements that maximize member utility may or may not meet this implementability constraint.

On balance the results demonstrate the potential for revenue pooling to present a strategic advantage for cooperatives relative to other organizational forms if the pooling rate is set strategically. We believe that the basic modeling framework utilized here can be adapted and extended to usefully analyze comparative advantages and disadvantages of other core cooperative principles and practices.

References

Albæk,S. and C. Schultz. "On the Relative Advantage of Cooperatives." *Economic Letters* 59(1998): 397-401.

Ayres, J. and M. Bosia. "Bridging Global Markets Summits and Local Markets: Food Sovereignty as Micro-Resistance to Globalization." Paper presented at the annual meeting of the International Studies Association, San Francisco, CA, March 27, 2008.

Bar-Shira, Z., Finkelshtain, I., "Two-Moments Decision Models and Utility-Representable Preferences." *Journal of Economic Behavior & Organization* 38(1999): 237-244.

Barton, D. "A Comparison of Traditional and Newly Emerging Forms of Cooperative Capitalization." Paper presented at NCR-194 Research on Cooperatives Annual Meeting, Kansas City, MO, November 2004.

Basu, A.K. and R.L. Hicks. "Label Performance and the Willingness to Pay for Fair Trade Coffee: A Cross-National Perspective." October 2008. Available at: http://ssrn.com/abstract=1287567.

Blomqvist, K. "Cooperatives and Consumer Research." *Journal of Consumer Policy* 7(1984): 323-341

Bockstael, N.E. "The Welfare Implications of Minimum Quality Standards." *American Journal of Agricultural Economics* 66(1984): 466-471.

Calvin, L. and R. Cook. "U.S. Fresh Fruit and Vegetable Marketing: Emerging Practices, Trends and Issues." United States Department of Agriculture, Economics Research Service, Agricultural Economic Report No. 795 (2001).

Chambers, R.G. and D.H. Pick. "Marketing Orders as Nontariff Trade Barriers." *American Journal of Agricultural Economics* 76(1994): 47-54.

Coffey, J.D., "Implications of Farm Supply Cooperatives of the Industrialization of Agriculture." *American Journal of Agricultural Economics* 75(1993): 1132-1137.

Cook, M. "The Future of U.S. Agricultural Cooperatives: A Neo-Institutional Approach." *American Journal of Agricultural Economics* 77(1995): 1144-1152.

Dimitri, C., A. Tegene, and P.R. Kaufman. "U.S. Fresh Produce Markets: Marketing Channels, Trade Practices, and Retail Pricing Behavior." U.S. Department of Agriculture, Economic Research Service, Agricultural Economics Report No. 825, September 2003.

Den Ouden, M., Dijkhuizen, A.A., Huirne, R.B. and P.J. Zuurbier. "Vertical Coordination in Agricultural Production-Marketing Chains, with Special Reference to Product Differentiation in Pork." *Agribusiness* 12(1996): 277-290.

Dobson, P. M. Waterson, and S. Davies (2003) "The Patterns and Implications of Increasing Concentration in European Food Retailing," *Journal of Agricultural Economics* 54(1): 111-125.

Fulton, M. "The Future of Canadian Agricultural Cooperatives: A Property Rights Approach." *American Journal of Agricultural Economics* 77(1995): 1144-1152.

Fulton, M. and K. Giannakas. "Organizational Commitment in a Mixed Oligopoly: Agricultural Cooperatives and Investor-Owned Firms." *American Journal of Agricultural Economics* 83(2001): 1258-1265.

Fulton, M. and K. Sanderson. "Cooperatives and Farmers in the New Agriculture." *Report Prepared for the Co-operatives Secretariat Agriculture and Agri-Food Canada* (2002).

Govindasamy, R. and J. Italia. "Predicting Willingness-to-Pay a Premium for Organically Grown Fresh Produce." *Journal of Food Distribution Research* 30(1999): 44-53.

Hariyoga, H. "An Economic Analysis of Factors Affecting the Failure of an Agricultural Marketing Cooperative: The Bankruptcy of Tri Valley Growers," Ph.D. Dissertation, University of California, Davis, 2004.

Harris, A., B. Stefanson, and M. Fulton. "New Generation Cooperatives and Cooperative Theory." *Journal of Cooperatives* 11(1996) : 15-28.

Helmberger, P.G. "Future Roles for Agricultural Cooperatives." *American Journal of Agricultural Economics* 48(1966): 1427-1435.

Hirsch, J. "Dairy Co-op to Drop Hormone; The Major Milk Supplier is Phasing Out a Synthetic Compound that Boosts Production." *Los Angles Times,* March 8, 2007.

Hoffman, R. "Ownership Structure and Endogenous Quality Choice: Cooperatives versus Investor-Owned Firms." *Journal of Agricultural and Food Industrial Organization* 3(2005): Article 8.

Hollander, A., S. Monier-Dilhan, and H. Ossard. "Pleasures of Cockaigne: Quality Gaps, Market Structure, and the Amount of Grading." *American Journal of Agricultural Economics* 81(1999): 501-511.

International Co-operative Alliance. "Statement on the Cooperative Identity." http://www.ica.coop/coop/principles.html, page accessed August 2, 2008.

Kaufman, P. (2000) "Consolidation in Food Retailing: Prospects for Consumers & Grocery Suppliers," U.S. Department of Agriculture, Economic Research Service, *Agricultural Outlook* August 2000.

Kiesel, K. and S.B. Villas-Boas. "Got Organic Milk? Consumer Valuations of Milk Labels after the Implementation of the USDA Organic Seal." *Journal of Agricultural & Food Industrial Organization* 5(2007): http://www.bepress.com/jafio/.

Klein, B., R.G. Crawford, and A.A. Alchian. "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process." *Journal of Law and Economics* 21(1978): 298-326.

Loureiro, M.L. and S. Hine. "Discovering Niche Markets: A Comparison of Consumer Willingness to Pay for Local (Colorado Grown), Organic, and GMO-Free Products." *Journal of Agricultural and Applied Economics* 34(2002): 477-487.

Markowitz, H.M. *Mean-Variance Analysis in Portfolio Choice and Capital Markets*. Oxford: Basil Blackwell, Inc., 1987.

Misra, S.K., C.L. Huang, and S.L. Ott. "Consumer Willingness to Pay for Pesticide-Free Fresh Produce." *Western Journal of Agricultural Economics* 16(1991): 218-227.

Mussa, M. and S. Rosen. "Monopoly and Product Quality." *Journal of Economic Theory* 18(1978): 301–17.

Rogers, R.T. "Structural Change in U.S. Food Manufacturing, 1958-1997." *Agribusiness* 17(2001): 3-32.

Saitone, T.L. "The Economics of Minimum Quality Standards Imposed by Agricultural Producer Organizations," Ph.D. Dissertation, University of California, Davis, 2008.

Salin, V. "Information Technology in Agri-Food Supply Chains." *International Food and Agribusiness Management Review* 1(1998): 329-334.

Saperstein, G. "How to Support Your Local Farmer." *New York Times,* June 11, 2006.

Sexton, R.J. AAnalysis and Evaluation of Competition Policies Affecting Agricultural Cooperatives,@ *Jordbruk och Konkurrens*, Swedish Ministry of Agriculture, 1995, 389-427.

Sexton, R.J. "Industrialization and Consolidation in the U.S. Food Sector: Implications for Competition and Welfare." *American Journal of Agricultural Economics* 82(2000): 1087-1104.

Sexton, R.J. and J. Iskow. AFactors Critical to the Success or Failure of Emerging Agricultural Cooperatives,@ Giannini Foundation Information Series No. 88-3. Division of Agriculture and Natural Resources, University of California, June 1988, 52p.

Teisl, M., B. Roe, and R. Hicks. "Can Eco-Labels Tune a Market?" *Journal of Environmental Economics and Management* 43(2002): 339-359.

Zago A.M. "Quality and Self-Regulation in Agricultural Markets: How Do Producer Organisations Make the Rules?" *European Review of Agricultural Economics* 26(1999): 199-218.

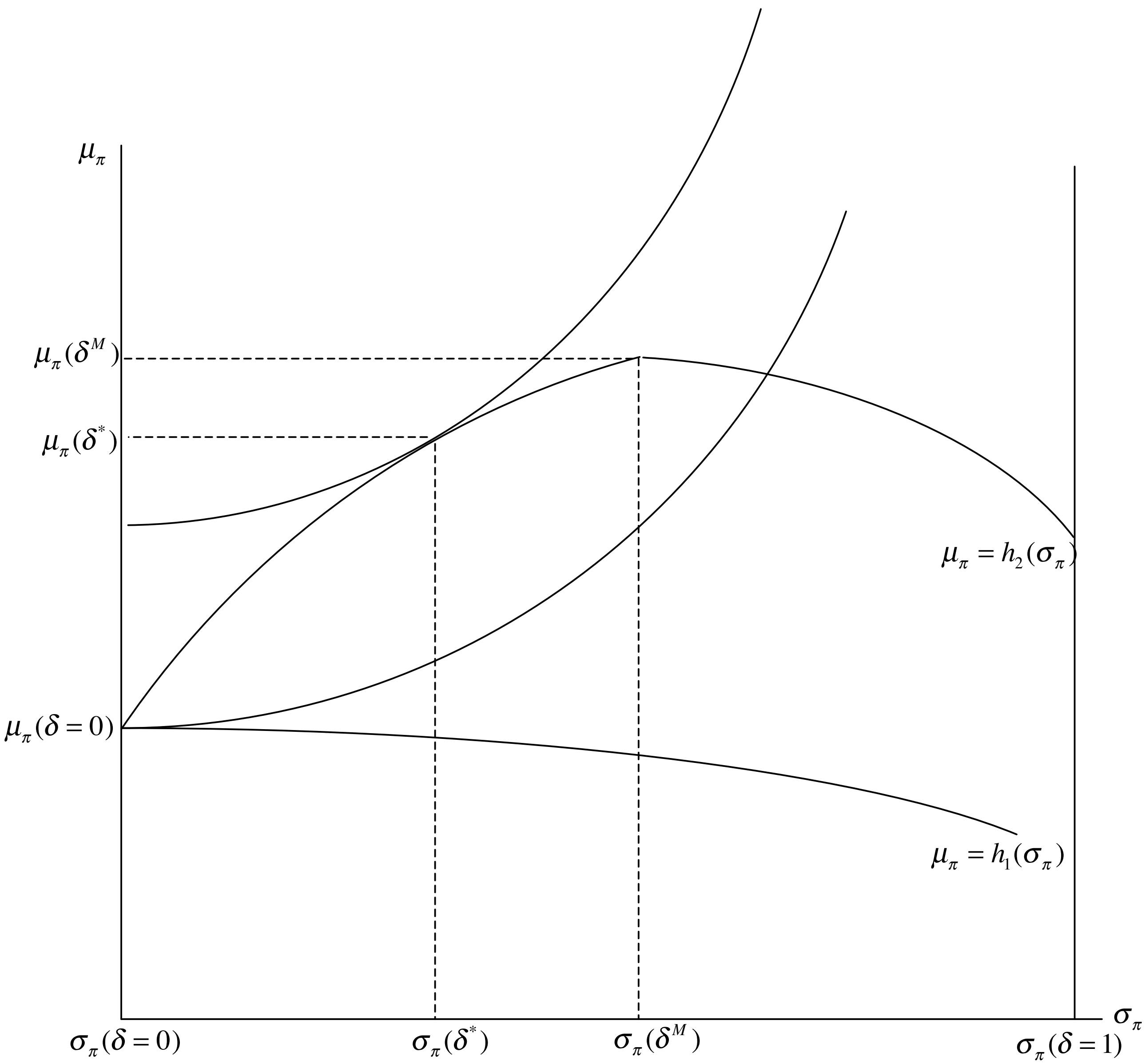
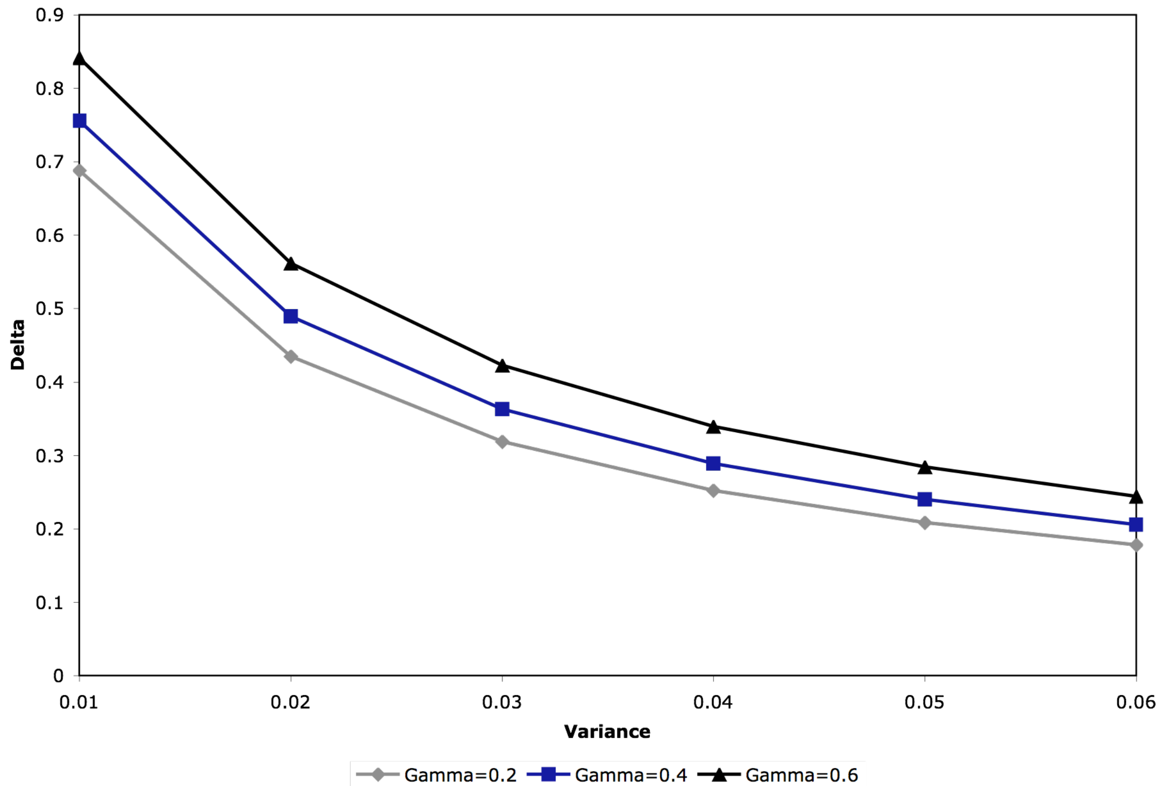
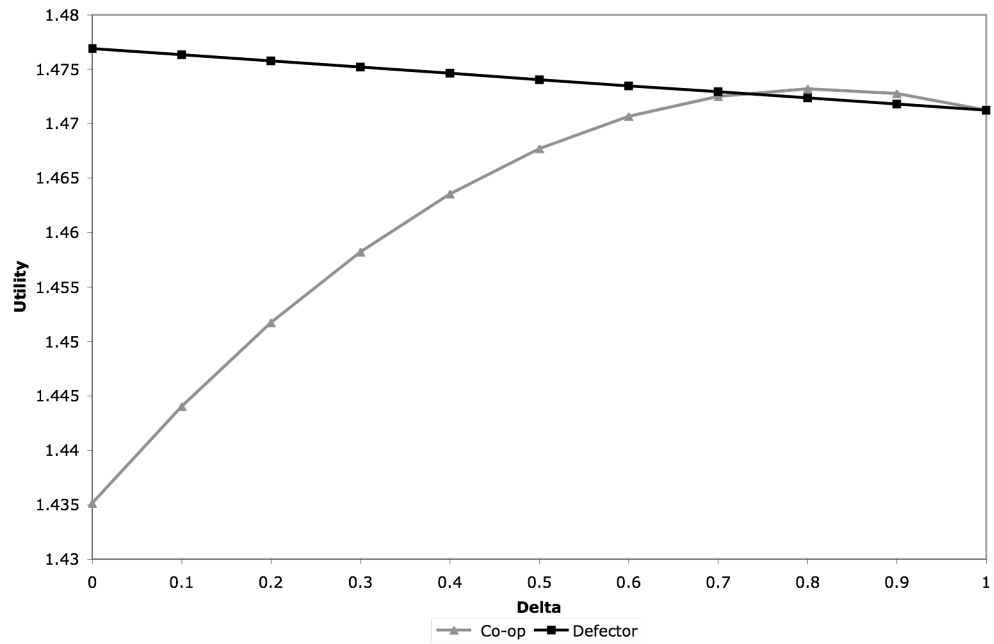


Figure 1. Optimal revenue pooling for a monopoly cooperative



Note: $N = 40$, $X = 10$, $\alpha = 0.5$, $\beta = 0.8$, $\kappa = 0.5$

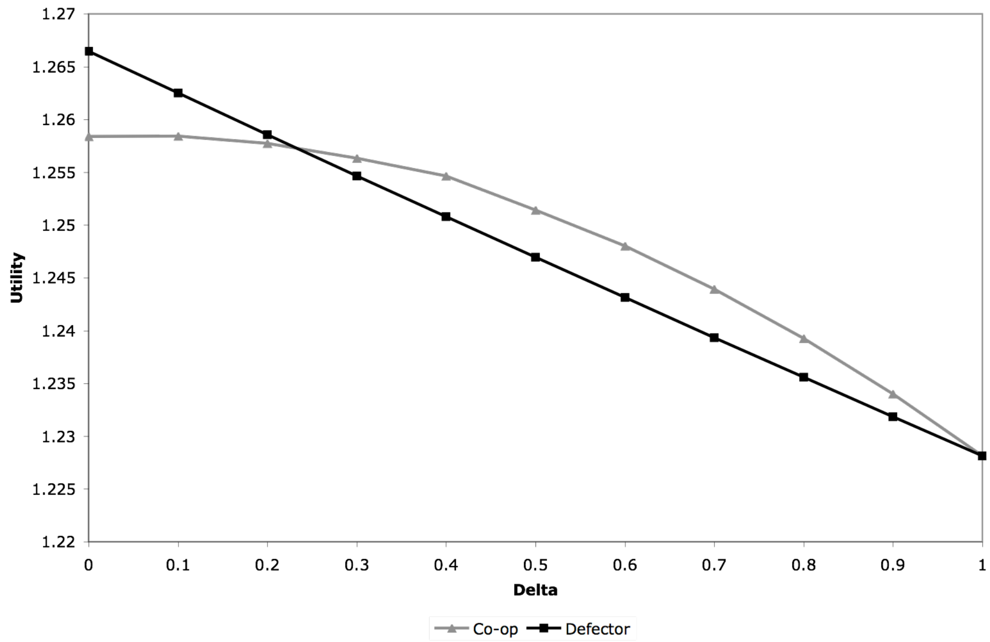
Figure 2. Implementable pooling rules for alternative market structures



Note: $\sigma_{\varepsilon}^{2} = 0.04$, $X = 10$, $\gamma = 0.6$, $\alpha = 0.5$, $\kappa = 0.7$, $\beta = 0.75$, $N = 40$,

$\delta^{*} = 0.856$

Figure 3. Implementable pooling rule.



Note: $\sigma_\varepsilon^2 = 0.02$, $X = 32$, $\gamma = 0.375$, $\alpha = 0.2$, $\kappa = 0.5$, $\beta = 0.5$, $N = 40$, $\tilde{\delta} = 0.231$, $\delta^* = 0$

Figure 4. Nonimplementable pooling rules