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The Theory of Agricultural Cooperatives: A Neoclassical Primer

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The Theory of Agricultural Cooperatives:
A Neoclassical Primer
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Preface

This monograph is intended to serve as a primer on the neoclassical theory of agricultural cooperatives. Individuals with an understanding of fundamental economic principles should be able to comprehend the material in this primer, which is presented verbally and graphically. Mathematical models of both farm supply and marketing cooperatives are included in an appendix. The material in the appendix should be appropriate for graduate students, advanced undergraduate students, and others with elementary skills in calculus.

This work was originally developed as a chapter for a planned revision of the textbook, Cooperatives in Agriculture (Englewood Cliffs, N.J.: Prentice Hall, 1989), edited by David W. Cobia. Consequently, some of the material presented here reflects ideas contained in two chapters of that book written by the late Brian H. Schmiesing, formerly of South Dakota State University and Southwest Minnesota State University. The author appreciates helpful comments by Joan Fulton, Claudia Parliament, and Richard Sexton in their reviews of an early draft.

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The Theory of Agricultural Cooperatives:  
A Neoclassical Primer

Introduction

This monograph provides an introduction to the neoclassical theory of cooperatives. Theory is a tool economists use to study the behavior of economic agents such as consumers and firms. An economic theory begins with assertions about behavior, such as consumers maximize utility or firms maximize profits. Then a model, which is a simplified representation of reality, is constructed by specifying a set of assumptions about how the elements of the theory relate to the real world. By using models, economists reduce the complexities of the real world so they can focus on understanding essential economic relationships. Utilizing logical arguments of deduction or mathematical techniques, economists derive conclusions or predictions about economic behavior from a model.

The neoclassical approach to theory is the one economists use most often. In neoclassical economics, the value of products and the allocation of resources are determined by the costs of production and the tastes and preferences of consumers. Neoclassical theory relies on marginal analysis, in which the quantity of a product that is purchased or sold is based on the additional utility, revenue, or cost associated with the last unit.

The neoclassical theory of the firm found in most economic textbooks is inadequate for understanding the economic behavior of cooperatives because assertions about cooperative behavior are generally quite different than those for investor-owned firms (IOFs). For example, the standard theory of the firm begins with the assertion that firms maximize profits. This assertion is usually rejected by cooperative theorists, who have ascribed other objectives to cooperatives, including maximization of member returns, maximization of patronage refunds, and minimization of costs. Each of these objectives requires a separate analysis, and conclusions about IOF behavior, based on profit maximization, do not necessarily apply to cooperatives.

The theory presented here uses the neoclassical approach, including marginal analysis, to derive conclusions about the economic behavior of cooperatives. The neoclassical theory of cooperatives is useful because it generates valuable insights into the expected behavior of cooperatives in various market structures and the differences between the behavior of cooperatives and IOFs. Because the theoretical analysis of cooperatives can be based on several different assertions about cooperative objectives, it also sheds light on the economic implications of a cooperative’s choice of objectives and aids in the development of business strategies for cooperatives that are consistent with their objectives. In addition, cooperative theory yields some important implications for public policy based on the expected
effects of cooperatives on economic welfare, including their effects on the performance of other firms in imperfect markets.

Although most of the neoclassical theory of cooperatives has been developed in the context of marketing cooperatives, we will first focus our attention on the theory of farm supply cooperatives. That theory is less complex than the theory of marketing cooperatives, and the concepts used in the theory of farm supply cooperatives will be more familiar to individuals with knowledge of the standard theory of the firm. Later, we will build on the theory of farm supply cooperatives in developing the theory of marketing cooperatives. Following that model, there is a discussion of the effects of cooperatives on economic welfare and the performance of imperfect markets.

Not all theoretical analyses of cooperatives have been conducted using the neoclassical approach. Game theory, which is used to study strategic decision making, and a variety of other theoretical methods—such as transaction cost economics, agency theory, and property rights economics—that may be conveniently labeled “new institutional economics” have been used to provide additional insights into cooperative behavior and address shortcomings in the neoclassical theory. Both game theory and new institutional economics are beyond the purpose and scope of this monograph.

Theory of Farm Supply Cooperatives

Farm supply cooperatives are cooperatives that supply members with inputs they use in farm production. Farm supply cooperatives may manufacture these inputs or purchase them from other firms. For simplicity, we assume the cooperative in our model supplies a single input to farmers. We also assume the cooperative produces the input it sells to its members. The model can be extended to a cooperative that purchases the input from another firm by considering the production costs as consisting of the costs of acquiring, transporting, and merchandizing the input.

Roles of the Manager, Board of Directors, and Members

Although most economic analyses of the firm are based on the assertion that firms maximize profits, there is no clear consensus about the objective of cooperatives. Indeed, while the standard theory of the firm is based on the existence of an entrepreneur who makes decisions about the allocation of capital, labor, and other factors of production in the creation of profits, there has been disagreement about who the decision maker is in a cooperative. Some early analyses of cooperatives, such as those by Emelianoff (1942) and Phillips (1953), did not acknowledge that entrepreneurial decisions were made by cooperatives. Instead, Phillips assigned the decision-making role to the cooperative’s members, who in-
dividually allocated their resources between their farming operations and the cooperative.

In 1962, Helmberger and Hoos presented a model of a marketing cooperative in which the cooperative was given a decision-making role and the objective of maximizing the price it paid its members for the raw product. Helmberger and Hoos did not specify whether it was management or the board of directors that played this decision-making role. Instead, they assumed the existence of a “peak coordinator,” consisting of an individual or group of individuals who wielded effective control over the organization. The peak coordinator was not necessarily associated with the manager or the board of directors, but rather with the individual or group that specified the cooperative’s objective and engaged in strategies to attain it.

Since Helmberger and Hoos, neoclassical models of cooperatives generally have assigned the decision-making role to the cooperative, although not addressing the issue of whether management or the board of directors was in control. Some of those models have been based in part on the Helmberger and Hoos model, and they have assumed the objective of maximizing the raw product price paid members. However, several other cooperative objectives also have been used or discussed.

More recently, in some theoretical work on cooperatives, there has been a renewed focus on the role of individual members as decision makers. In those models, cooperatives are treated as coalitions of members with different and frequently conflicting interests. Within that framework, game theory has been used to analyze the internal decision-making processes of cooperatives by examining the strategies members and managers use to achieve their goals.¹

Possible Cooperative Objectives

Because cooperatives are complex business organizations that serve a wide variety of purposes and perform a wide variety of functions, there is no single objective, like maximizing profits, that is generally accepted by all managers, boards of directors, and members. Furthermore, because an individual cooperative may represent different and conflicting interests of its membership and management, there may be substantial disagreement within a cooperative about which objectives it should pursue.

A cooperative may pursue several objectives at the same time. For example, a cooperative may attempt to earn a certain level of net income, maximize operating efficiency, maintain and expand its facilities, and increase its sales volume. How-

¹ Cooperative theory has evolved over several decades, and a thorough review of its development is beyond the scope of this monograph. See Staatz (1987 or 1989) for excellent surveys of this topic.
ever, these objectives can all be interpreted as strategies a cooperative might follow in pursuing a single, broader long-term objective such as maximizing member returns.

Because the analytical techniques used in neoclassical economic theory usually work best when a single objective is specified, we will follow that approach here. However, we will examine several alternative objectives that seem plausible given the principles of cooperation, the objectives of cooperative members, and the competitive environment in which cooperatives operate. As we will see, the output and pricing decisions of a cooperative will often differ depending on which objective is pursued.

One possible objective for a cooperative is to maximize its net earnings in the same manner an IOF maximizes profits. Several reasons have been offered for why cooperatives might seek to maximize net earnings or profits. By pursuing this objective, a cooperative will maximize funds available for paying patronage refunds or internally financing growth, and it can avoid hostility and retaliatory pricing by rival firms (Enke 1945, pp. 149–50). Maximization of net earnings also may result in higher measures of financial performance. To the extent that cooperative managers, boards of directors, and members use financial standards based on profit maximization, the pursuit of other objectives may result in poorer comparisons. It is also possible that profit maximization may become part of a cooperative’s corporate culture through hiring managers from IOFs or because it is the objective cooperative directors pursue in their individual farming operations.

Other possible objectives may stem from recognition of the concept that the purpose of a cooperative is to operate, not for its own economic gain, but for the benefit of its members. Two objectives that members might consider appealing and consistent with this concept are maximization of the per-unit patronage refund and minimization of the net price paid by members. The first of these might at first appear to be an obvious goal for a cooperative. However, minimization of the net price paid by members may be a more attractive objective because it takes into consideration the value of both the patronage refund and the cash price. This objective may be particularly appealing to members whose decisions to purchase farm inputs from the cooperative are based on comparison of the prices charged by the cooperative and competing firms.

Another objective consistent with the purpose of a cooperative is maximization of member returns, which consist of the total profits of the individual members, including the net earnings of the cooperative, which are distributed to mem-

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2 Many possible objectives have been suggested for cooperatives. This section considers only five objectives, those analyzed by LeVay (1983a). For a more thorough discussion of cooperative objectives, see Bateman, Edwards, and LeVay (1979).
bers as patronage refunds. Support for this objective has been offered by Ladd (1982), LeVay (1983a), and Sexton (1984). The objective is consistent with the profit-maximizing behavior ascribed to producers in most neoclassical models, and it would seem to be a more effective means of enhancing the benefits members receive from the cooperative than focusing on a single indicator, such as the price of the farm input. A disadvantage of the objective is it does not provide managers an easily measurable target, such as cooperative net earnings, the per-unit patronage refund, or the net price.

Finally, there are reasons why a cooperative might seek to maximize the quantity of the farm input it produces. Managers, boards of directors, and members may be inclined to judge the cooperative’s success in terms of its size and growth. In fact, in some cases management salaries may be linked to sales or turnover. A cooperative also may want to maximize output to achieve economies of scale, reduce excess capacity, or increase its market share.

**Profit-Maximizing (IOF) Farm Supply Firm**

To compare the behavior of a farm supply cooperative to that of an IOF, we must first briefly review the standard theory of the firm. Assume the IOF is a profit-maximizing firm that sells a single farm input to farmers in a perfectly competitive market. In other words, the firm competes with a large number of other firms. Therefore, its market share is so small it cannot affect the price it receives for the input no matter how many units it sells.

The IOF’s demand curve and cost curves are shown in figure 1. Under perfect competition, the firm faces a horizontal demand curve, reflecting that the price the firm receives ($P_1$) is constant regardless of the quantity it sells. The cost curves represent the costs of manufacturing or procuring the farm input and selling it to farmers. Average total cost ($ATC$) is simply the total cost of producing the input divided by the number of units produced. Marginal cost ($MC$) is the change in total cost due to producing one additional unit of the input. The average total cost curve shown in figure 1 is U-shaped, representing conventional ideas about costs. Average cost at first decreases over a range before increasing. Marginal cost is assumed to be generally increasing, at least over the relevant range. It intersects the minimum of the average cost curve from below. As long as the marginal cost of producing the farm input is less than average cost, average cost is declining. However, once marginal cost is greater than average cost, the average cost curve is positively sloped.

A profit-maximizing farm supply firm in a perfectly competitive market will produce the quantity of farm input $Q_1$ for which marginal cost equals the market price. As long as the marginal cost—the cost of producing an additional unit—is
Figure 1. Profit maximization by a farm supply firm (IOF) given perfect competition

less than the market price, as for quantities less than $Q_1$, the firm can increase its profits by producing more of the input. By producing $Q_1$, the firm earns profits equal to the shaded area. That area represents the difference between the firm’s total revenue (which is the market price $P_1$ times the quantity $Q_1$) and its total cost (which is the average total cost $C_1$ times $Q_1$).

Monopoly and Monopolistic Competition

Many markets for farm inputs are not perfectly competitive. Farm supply firms often face downward-sloping demand curves. Instead of selling whatever quantity they produce at a constant price set by the market, these firms must lower the price they charge to increase sales. The flexibility a firm facing a downward-sloping demand curve has in setting its price provides it market power, i.e., the ability to raise its price to a level greater than its marginal cost.

A firm may face a downward-sloping demand curve if it is a monopoly, i.e., it is the only supplier of the farm input in the market. It also may face a downward-sloping demand curve if the market is characterized by monopolistic competition. Under monopolistic competition, there is competition from other sellers, but each
firm faces a downward-sloping individual demand curve and has some market power.

In markets for farm inputs, downward-sloping demand curves frequently result from the spatial distribution of competing firms. If a farm supply firm sets a high price, it may sell only to farmers located nearby. At lower prices, the firm may attract additional sales from farmers who are farther away and relatively closer to competing suppliers. Downward-sloping demand curves also may be due in part to customer loyalty or product differentiation. Farm supply firms use various means to differentiate their products from those of competitors, including advertising, brand creation, and the provision of credit or delivery and application services.\(^3\)

A profit-maximizing farm supply firm facing a downward-sloping demand curve is illustrated in figure 2. Because the demand curve \((D)\) represents the quantity that would be demanded at each price, it also represents the firm’s average revenue \((AR)\). The marginal revenue curve \((MR)\) extends beneath the demand curve. Marginal revenue is the added revenue the firm receives from each additional unit of sales. When the demand curve facing a firm is downward sloping, the marginal revenue curve lies beneath the demand curve because the price of all units must be lowered to sell an additional unit.

The slope of the demand curve depends on the availability of close substitutes for the product. If the input supplier is a monopoly, the demand curve will be steeper than under monopolistic competition. The introduction of similar products by firms competing in the same market would flatten a firm’s demand curve. At the extreme, if there were many firms offering perfect substitutes, the market would be characterized by perfect competition. Then the firm’s demand curve would be horizontal, as in figure 1, and it would represent both the firm’s average revenue and its marginal revenue.

A profit-maximizing farm supply firm facing a downward-sloping demand curve will produce the quantity of farm input for which marginal cost equals marginal revenue, represented by \(Q_2\) in figure 2. As long as marginal cost is less than marginal revenue, as for quantities less than \(Q_2\), the firm can increase its profits by producing additional units. At \(Q_2\), the firm’s profits equal the shaded area, which represents the difference between the firm’s total revenue \(P_2 \times Q_2\) and its total cost \(C_2 \times Q_2\).

\(^3\) When there is an oligopoly, i.e., several firms selling the same product, each firm will face a downward-sloping individual demand curve. If one firm lowers its price or increases its output, the other firms in the market can be expected to react by adjusting their prices or output. The various models used to explain and predict the behavior of an oligopolistic market are beyond this monograph’s purpose and scope.
Price and Output Solutions for Cooperative Objectives

The price and output solutions for four cooperative objectives commonly considered by cooperative theorists are illustrated in figure 3 for cases in which the cooperative faces a downward-sloping demand curve. For convenience, these solutions are summarized in table 1. In these examples, we assume the cooperative sells the farm input only to its members so the demand curve facing the cooperative represents the demand of its members for the input. However, we also assume members are free to purchase the input from other farm supply firms.

If the cooperative maximizes its net earnings, it will produce at level $Q_1$, which is determined by the intersection of its marginal revenue and marginal cost curves ($MR = MC$). The price, which is read from the demand curve, is $P_1$, and the average total cost is $C_1$. The net earnings of the cooperative are $(P_1 - C_1) \times Q_1$. Assuming the cooperative returns all net earnings to members as patronage refunds, the per-unit patronage refund is $P_1 - C_1$ and the net price paid by members is $C_1$. 

Figure 2. Profit maximization by a farm supply firm (IOF) given a downward-sloping demand curve
Minimization of the net price occurs at quantity $Q_2$, which corresponds to the minimum of the average total cost curve—the point at which average total cost is intersected by marginal cost ($MC = ATC$). The cash price $P_2$ is relatively high compared to the other solutions. However, after deducting the per-unit patronage refund $P_2 - C_2$, the net price is $C_2$, which represents the lowest possible cost at which the input can be produced.

Maximization of member returns occurs at $Q_3$, determined by the intersection of the demand and marginal cost curves ($AR = MC$). The cooperative’s net earnings $(P_3 - C_3) \times Q_3$ are less than when the cooperative’s objective is maximization of net earnings. This is because member returns consist of two components—the cooperative’s net earnings, which are distributed to members as patronage refunds, and the consumer surplus members receive as consumers of the farm input.

*Consumer surplus* is the difference between what consumers individually would be willing to pay for a product, as indicated along the demand curve, and what they actually pay when a single market price is charged for all units. In effect, consumer surplus consists of what consumers save because there is a single
Table 1. Price and output solutions for a farm supply cooperative under various objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Criterion</th>
<th>Quantity</th>
<th>Price</th>
<th>Patronage refund</th>
<th>Net price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximization of cooperative net earnings</td>
<td>$MR = MC$</td>
<td>$Q_1$</td>
<td>$P_1$</td>
<td>$P_1 - C_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>Minimization of net price</td>
<td>$MC = ATC$</td>
<td>$Q_2$</td>
<td>$P_2$</td>
<td>$P_2 - C_2$</td>
<td>$C_2$</td>
</tr>
<tr>
<td>Maximization of member returns (including patronage refunds)</td>
<td>$AR = MC$</td>
<td>$Q_3$</td>
<td>$P_3$</td>
<td>$P_3 - C_3$</td>
<td>$C_3$</td>
</tr>
<tr>
<td>Maximization of quantity</td>
<td>$AR = ATC$</td>
<td>$Q_4$</td>
<td>$P_4$</td>
<td>0</td>
<td>$P_4$</td>
</tr>
</tbody>
</table>

Market price. Graphically, it is equal to the area below the demand curve and above the market price. In the current context, consumer surplus is represented by the triangular area below the demand curve $D$ and above the price $P_3$. That area, plus the cooperative’s net earnings $(P_3 - C_3) \times Q_3$, constitutes the member returns attributable to the cooperative’s sales of the farm input. Maximum member returns are represented by the shaded area.

Maximization of the quantity of the farm input produced by the cooperative occurs at $Q_4$, determined by the intersection of the demand and average total cost curves ($AR = ATC$). Both the price and average cost are $P_4$. Thus both the cooperative’s net earnings and the per-unit patronage refund are zero. Accordingly, this solution is often called the “breakeven” solution. Production of quantities greater than $Q_4$, although technically possible, would result in losses for the cooperative.

If the cooperative sells the farm input in a perfectly competitive market, the solutions for maximization of net earnings and maximization of member returns are identical, as shown in figure 4. Under perfect competition, the cooperative is a price taker, and the price it receives for the input is constant regardless of the quantity it sells. The price dictated by the demand curve represents both the cooperative’s average revenue and marginal revenue. Consequently, the criterion for maximization of net earnings ($MR = MC$) is the same as for maximization of member returns ($AR = MC$). In other words, the cooperative can ensure member returns are maximized simply by setting the quantity it produces to maximize its own net earnings, in the same manner as an IOF would maximize profits. In figure 4, that quantity is $Q_1$, and the average cost of producing the farm input is $C_1$. 
Figure 4. Price and output solutions for a farm supply cooperative under various objectives given perfect competition

The cooperative’s net earnings are \((P - C_1) \times Q_1\), and the per-unit patronage refund is \(P - C_1\).

Minimization of the net price occurs at the quantity corresponding to the minimum of the average total cost curve regardless of the slope of the demand curve. Thus under perfect competition, the net price is once again minimized at \(Q_2\), which corresponds to the intersection of the marginal cost and average total cost curves \((MC = ATC)\). At \(Q_2\), average cost is \(C_2\). The cooperative’s net earnings are \((P - C_2) \times Q_2\), and the per-unit patronage refund is \(P - C_2\).

If the cooperative maximizes the quantity of the farm input it produces, output is again determined by the intersection of the demand and average total cost curves \((AR = ATC)\). Quantity is \(Q_4\), and both the price and average cost are \(P\). Consequently, both the cooperative’s net earnings and the per-unit patronage refund are zero.

*Stability of Cooperative Price and Output Solutions*

An important issue concerns the stability of the cooperative price and output solutions. In all solutions, except for the one corresponding to the maximization
of quantity, members receive a patronage refund. If they recognize the refund when making their purchasing decisions, they will have an incentive to expand their use of the farm input beyond the level associated with the cooperative’s objective. Thus the output solutions associated with objectives other than maximization of quantity may not represent equilibrium solutions because they are unstable. Purchases of the input will continue to expand until they reach $Q_4$ in figure 3. At that level, which corresponds to the intersection of the demand and average total cost curves, the price of the farm input equals the average cost of producing it. The patronage refund is zero, so members no longer have an incentive to increase their purchases. Thus this solution represents an equilibrium, unlike the others.

The instability of the other solutions has important implications for cooperatives that pursue those objectives. Because the receipt of patronage refunds provides members an incentive to expand their use of the input beyond the optimal level, a cooperative may not be able to achieve another objective unless it imposes some sort of restriction on the purchase of the farm input. However, restrictions, such as quotas on purchases from the cooperative, could create member relations problems and contribute to erosion in customer loyalty over time.

The significance of this problem will depend on the extent to which members take patronage refunds into consideration when making purchasing decisions. It has been argued that members may not expect to receive patronage refunds when purchasing farm supplies or may consider the effective after-tax present value of cash and noncash patronage refund distributions to be zero. If so, the price and output solutions associated with other objectives may be stable. In addition, some research (Royer and Smith 2007) suggests that cooperatives may be able to use pricing strategies to achieve and maintain output levels consistent with other objectives.

**Strategies for Reducing Costs**

Cooperatives must develop business strategies consistent with their objectives to successfully adapt to changing market conditions. For example, a cooperative that seeks to minimize the net price its members must pay for the farm input may find it can reduce the average cost of producing the input by shifting the demand curve or its cost curves. Consider the cooperative represented by the cost curves $ATC_1$ and $MC_1$ in figure 5. So we can focus on costs, assume the cooperative charges a price for the farm input just sufficient to cover its costs. Thus if the cooperative faces the demand curve $D_1$, it will produce $Q_1$ units of the input and charge a price equal to the average total cost $C_1$. As the figure shows, $C_1$ represents a relatively high average cost compared to other points on $ATC_1$. Therefore,
Figure 5. Strategies for reducing average total cost

the cooperative might consider moving to another point on the curve to reduce its average cost.

One strategy might be for the cooperative to lower the demand it faces for the input. Assume the cooperative currently serves both member and nonmember patrons. For example, the cooperative might sell fertilizer for use both on farms and on residential lawns and gardens. The cooperative could discontinue sales to nonmembers, shifting the demand curve it faces from $D_1$ to $D_2$. The new demand curve intersects the cooperative’s average total cost curve at the minimum. By reducing the quantity it produces from $Q_1$ to $Q_2$, the cooperative can lower its average cost from $C_1$ to $C_2$. Thus as a result of discontinuing service to nonmembers, the cooperative is able to lower the cost of providing the input to members.

In this example, the cooperative shifts its demand curve so it can operate at a different point on its short-run average total cost curve.\(^4\) In the short run, at least one of the cooperative’s factors of production is fixed. In other words, we assume the plant the cooperative uses to produce the farm input is of a fixed capacity. In the long run, all factors of production can be varied. Consequently, an alternative

\(^4\) All curves depicted in the figures are for the short run unless otherwise indicated.
long-run strategy might be for the cooperative to move along its long-run average cost curve by constructing a larger manufacturing plant or expanding the capacity of its existing plant.

Assume the cooperative continues to sell the farm input to nonmembers, so its demand curve remains \( D_1 \). By building a new plant, represented by the cost curves \( ATC_2 \) and \( MC_2 \), the cooperative can operate on the long-run average total cost curve (LRAC) where it is intersected by the demand curve. The cooperative will produce \( Q_3 \) units of the farm input at an average cost of \( C_3 \), which is lower than either \( C_1 \) or \( C_2 \).

In other situations, the problem may be that the cooperative is underutilizing its existing plant capacity. Assume the cooperative’s manufacturing plant is once again represented by the cost curves \( ATC_1 \) and \( MC_1 \) but the demand curve is \( D_3 \). The cooperative produces \( Q_4 \) units of the input at an average cost of \( C_4 \). Increasing production to \( Q_2 \) would lower the average cost from \( C_4 \) to \( C_2 \) at the minimum of \( ATC_1 \). The difference between \( Q_2 \) and \( Q_4 \) is referred to as excess capacity—the cooperative’s existing plant is too large relative to its use. Because the cooperative is using only a small proportion of its existing plant’s capacity, those units of the farm input that are produced must cover a disproportionately large share of the plant’s fixed costs. The cooperative would be able to lower its average cost by either decreasing its plant size or increasing the demand for its production.

Neighboring cooperatives might consider merger as a means of reducing excess capacity and achieving economies of scale. Consider two cooperatives, each of which operates a propane delivery truck at 40 percent capacity. By merging their propane operations, the cooperatives might be able to eliminate one of the trucks, as well as some excess propane storage capacity, and reduce labor expenses. Cooperatives also might consider increasing the demand for their products by promoting sales to nonmembers.

**Long-Run Equilibria for Various Objectives**

In the long run, a firm can vary its capacity by expanding or reducing the size of its manufacturing plant or by building a new plant. Similarly, new firms can enter the industry or existing firms can exit. In addition, the demand curve for the cooperative’s production can shift, and its costs can change over time.

If the industry is perfectly competitive, there are no barriers to entry and the existence of excess profits—profits in excess of the normal return on capital included in average total cost—will attract new firms into the industry. The entry of those firms will shift the market supply curve for the farm input to the right, and the market price will fall. This process will continue until price equals minimum long-run average cost. At that point, profits are zero and the firms in the
industry will receive only a normal return equal to the opportunity costs of the factors of production they employ.

Figure 6 represents the long-run equilibrium for a profit-maximizing IOF. The equilibrium market price is \( P \), and the demand curve facing the firm is tangent to the firm’s long-run average cost curve (LRAC) at quantity \( Q_1 \). For the minimum of the long-run average cost curve to occur at \( Q_1 \), so must the minimum of the short-run average cost curve (ATC). Thus \( LRAC, ATC, LRMC \) (long-run marginal cost), and \( MC \) (short-run marginal cost) all are equal to the market price \( P \) at \( Q_1 \). Moreover, \( P \) is equivalent to \( AR \) (average revenue) and \( MR \) (marginal revenue) given the horizontal demand curve. The market is in equilibrium because the condition for profit maximization (\( P = MC \)) is satisfied and there is no incentive for the entry or exit of firms when profits are zero (\( P = ATC \)).

Price \( P \) and quantity \( Q_1 \) would also represent the long-run equilibrium for a cooperative, regardless of its objective. All cooperatives would operate at \( Q_1 \) because the criteria for maximization of net earnings (\( MR = MC \)), minimization of net price (\( MC = ATC \)), maximization of member returns (\( AR = MC \)), and maximization of quantity (\( AR = ATC \)) all are satisfied at that level. Thus under perfect
competition, the long-run equilibria for cooperatives are identical to that for a profit-maximizing IOF.

A cooperative that is in a monopoly market will continue to face a downward-sloping demand curve in the long run if there are barriers to the entry of new firms into the industry. For convenience, assume figure 3 now reflects the long-run demand and costs facing the cooperative. Then the figure can be used to represent the long-run price and output solutions for the objectives listed in table 1. Given these conditions, the long-run price and output solutions for a cooperative will be identical to the short-run solutions already discussed.

Under monopolistic competition, there are no barriers to entry, and in the long run the existence of excess profits provides an incentive for the entry of new firms into the industry. According to standard theory, a firm will maximize its profits by producing at the level where its marginal revenue curve intersects its long-run marginal cost curve. With additional entry, the demand curve facing the firm will shift to the left until it is tangent to the firm’s long-run average cost curve and its profits are driven to zero.

This is illustrated in figure 7. Assume the industry consists of profit-maximizing IOFs with identical costs and market demand is distributed equally among all firms. At long-run equilibrium, the demand curve facing each individual firm, which is labeled $D$, is tangent to the long-run average cost curve $LRAC$ at $Q_1$. At that quantity, each firm’s marginal revenue curve $MR$ intersects its long-run marginal cost curve $LRMC$. The market price is $P$, and profits are zero because price is equal to average total cost. Output is at equilibrium because there are no profits or losses in the industry. Consequently, there is no incentive for entry or exit.

Notice that because the demand curve facing the firm is downward sloping, the tangency between the demand curve and the long-run average cost curve must occur to the left of the cost curve’s minimum. As a result, monopolistic competition among profit-maximizing firms is characterized by excess capacity. In this example, the excess capacity is $Q_2 - Q_1$.

We typically would not expect to observe farm input markets consisting of cooperatives engaged in monopolistic competition with one another. More often we would expect a market in which there is a mix of IOFs and cooperatives. To construct a model of such a market, we must make additional assumptions about the structure of the market and the behavior of the firms. The results of the model will depend on the assumptions we make.

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5 Long-run demand and cost curves generally are not as steep as their short-run counterparts because decisions made in the long run are more responsive to price changes given consumers and producers have additional choices and more time to adjust.
Figure 7. Long-run equilibria for IOFs and cooperatives given monopolistic competition

For example, consider an industry consisting of several IOFs and a single cooperative. Assume the market price is determined by competition among the IOFs and the cooperative is a price taker that can sell whatever quantity it chooses at that price. Market demand, less the quantity sold by the cooperative, is distributed equally among the IOFs. Then entry by new IOFs will continue until the demand curve facing each IOF is tangent to its long-run average cost curve, as at $Q_1$ in figure 7. The output of the cooperative will depend on its objective. Depending on whether the cooperative minimizes net price, maximizes member returns, or maximizes quantity, its output would be $Q_2$, $Q_3$, or $Q_4$ respectively. If its objective is maximization of net earnings, its output would be $Q_3$, the same as for maximization of member returns. Because we have assumed the cooperative is a price taker, its marginal revenue is the market price $P$ instead of $MR$, the marginal revenue for the IOFs. Regardless of its objective, the cooperative will produce a greater quantity of the farm input than an IOF, and in most cases its average cost will be lower.
Theory of Marketing Cooperatives

Marketing cooperatives are cooperatives that market farm commodities produced by member farmers. In some cases, a marketing cooperative simply purchases a commodity from its members and resells it to food manufacturing or processing firms after providing some minimal services such as assembling and grading the commodity. After the cooperative sells the commodity to a manufacturer or processor, it distributes any additional revenues, after deducting transportation or handling costs, to members as patronage refunds. In other cases, the cooperative may process the commodity and sell the processed product to consumers or retailers. In those cases, the patronage refunds include any value added to the commodity by the cooperative.

Here we explore the general case of a processing cooperative that purchases a raw product from its members and uses the raw product to produce a processed product it sells to consumers. For simplicity, we assume that one unit of the raw product is used to produce one unit of the processed product (i.e., the processor is subject to a form of fixed-proportions production technology). The model can be applied to a cooperative that simply markets the raw product for its members by considering the processing costs as representing the costs of transporting or marketing the raw product.

Analyses of the price and output decisions of a processing firm frequently utilize the net average revenue product and net marginal revenue product curves. Use of these curves is advantageous because it allows revenues and costs at the processing level to be combined, thereby facilitating the graphical exposition of the relationship between the processor and the producers of the raw product. Derivation of the net average revenue product and net marginal revenue product curves begins with the net revenue product, which is defined as the total revenue of the processor less the total cost of processing the raw product. The cost of processing the raw product used to compute the net revenue product does not include the cost of the raw product itself.

Net average revenue product (NARP) is defined as net revenue product divided by the quantity of product and is equivalent to the price received by the processor less its average processing cost. It represents the amount per unit that is available for raw product payment and profit. Net marginal revenue product (NMRP) is defined as the change in net revenue product from processing an additional unit of raw product, and it is equivalent to marginal revenue less marginal processing cost.

The relationship of the NARP and NMRP curves to processing costs and the demand for the processed product is illustrated in figure 8. The average and marginal processing costs are represented by APC and MPC in the upper panel. The
Figure 8. Relationship of the \textit{NARP} and \textit{NMRP} curves to processing costs and processed product demand

demand and marginal revenue curves for the processed product are represented by $D$ and $MR$. The \textit{NARP} curve, which is shown in the lower panel, is derived by subtracting the $APC$ curve from the demand curve, which represents the price ($P$) or average revenue ($AR$) for the processed product. Quantities $Q_1$ and $Q_4$ correspond to the intersections of the demand and $APC$ curves. Wherever the demand curve is above the $APC$ curve (i.e., the price is greater than the average processing cost), the \textit{NARP} curve is positive, as it is over the range from $Q_1$ to $Q_4$. The maximum of the \textit{NARP} curve corresponds to $Q_2$, the quantity at which the distance between the demand and $APC$ curves is greatest (i.e., where the slopes of the two curves are the same). The \textit{NARP} curve will have a downward-sloping portion if either the demand curve facing the cooperative is downward sloping or if the average processing cost is increasing, as might be expected in the short run.
Table 2. Price and output solutions for a marketing cooperative under various objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Criterion</th>
<th>Quantity</th>
<th>Price</th>
<th>Patronage refund</th>
<th>Net price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximization of cooperative net earnings</td>
<td>$NMRP = MFC$</td>
<td>$Q_1$</td>
<td>$R_1$</td>
<td>$N_1 - R_1$</td>
<td>$N_1$</td>
</tr>
<tr>
<td>Maximization of net price</td>
<td>$NMRP = NARP$</td>
<td>$Q_2$</td>
<td>$R_2$</td>
<td>$N_2 - R_2$</td>
<td>$N_2$</td>
</tr>
<tr>
<td>Maximization of member returns (including patronage refunds)</td>
<td>$NMRP = S$</td>
<td>$Q_3$</td>
<td>$R_3$</td>
<td>$N_3 - R_3$</td>
<td>$N_3$</td>
</tr>
<tr>
<td>Maximization of quantity</td>
<td>$NARP = S$</td>
<td>$Q_4$</td>
<td>$R_4$</td>
<td>0</td>
<td>$R_4$</td>
</tr>
</tbody>
</table>

The $NMRP$ curve is derived by subtracting the $MPC$ curve from the $MR$ curve. It intersects the $NARP$ curve through the $NARP$ curve’s maximum and is positive as long as the $MR$ curve is above the $MPC$ curve (i.e., marginal revenue is greater than marginal processing cost). The $NMRP$ curve intersects the quantity axis at $Q_3$, which is determined by the intersection of the $MR$ and $MPC$ curves.

Price and Output Solutions for Marketing Cooperatives

Table 2 presents four possible objectives for marketing cooperatives that are analogous to those discussed earlier for farm supply cooperatives. The price and output solutions for these objectives are illustrated in figure 9. In the figure, the $NARP$ and $NMRP$ curves for a processing cooperative are shown with the raw product supply curve facing the cooperative ($S$). The positive slope of the supply curve reflects that the cooperative cannot purchase whatever quantity of the raw product is

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6 Empirical investigations on which objectives cooperatives choose to pursue have yielded mixed results. In a study of California cotton ginning cooperatives, Sexton, Wilson, and Wann (1989) concluded that their data indicated that the cooperatives operated near the maximum of the $NARP$ curve, a result consistent with the Helmberger and Hoos (1962) objective of maximizing the raw product price for whatever quantity members choose to supply. Featherstone and Rahman (1996) conducted a study of Midwestern farm supply and marketing cooperatives in which they concluded that there was strong support for the minimization of average costs and little support for profit maximization as the objective of the cooperatives. More recently, Boyle (2004), in a study of Irish dairy processing cooperatives, concluded that the rule those cooperatives used to price milk was based on the $NMRP$ curve rather than the $NARP$ curve, a finding consistent with an objective of maximizing either processor or producer profits.
Figure 9. Price and output solutions for a marketing cooperative under various objectives

product it chooses at a constant market price. Instead, it must raise the price it pays for the raw product to increase its purchases.

A firm may face an upward-sloping supply curve if it is a monopsony, i.e., it is the only processor in the market. In that case, the supply curve facing the firm may be the result of the increasing marginal costs faced by producers. A firm also may face an upward-sloping supply curve if the market is characterized by monopsonistic competition. Under monopsonistic competition, there is competition from other processors but each firm has some market power. In those cases, the upward-sloping raw product supply curve facing each processor results in part from the spatial distribution of the processors. If a processor sets a low price for the raw product it purchases, it may receive deliveries only from nearby producers. At higher prices, it may attract additional deliveries from producers who are farther away and relatively closer to competing processors.

The marginal factor cost curve represents how much each additional unit of the raw product will cost the processor as it increases the quantity it purchases. If a processor faces an upward-sloping supply curve, as in figure 9, the marginal factor cost curve will lie above the supply curve because to purchase an additional
unit of the raw product, the processor must pay a higher price for the other units it purchases.

Like a farm supply cooperative, a marketing cooperative may choose to maximize its net earnings in a manner similar to an IOF. To do so, it would set the price it pays for the raw product at \( R_1 \) and process \( Q_1 \) units, the quantity that corresponds to the intersection of the \( NMRP \) and \( MFC \) curves. The cooperative’s net earnings would be \((N_1 - R_1) \times Q_1\) where \( N_1 \) represents the value of \( NARP \) at \( Q_1 \). Those earnings would be distributed to members in the form of patronage refunds by setting the per-unit patronage refund to \( N_1 - R_1 \). Adding the per-unit refund to the cash price, the net price paid members would be \( N_1 \).

A cooperative that seeks to maximize the net price it pays members would process quantity \( Q_2 \), which corresponds to the maximum of the \( NARP \) curve—the point at which the \( NARP \) curve is intersected by the \( NMRP \) curve. The cash price would be \( R_2 \), which is relatively low compared to the other solutions. However, after adding the per-unit patronage refund \( N_2 - R_2 \), the net price is \( N_2 \), which represents the maximum price that can be paid.

Maximization of member returns, including the earnings of the cooperative, occurs at \( Q_3 \), determined by the intersection of the \( NMRP \) and supply curves. The cooperative would pay members a cash price of \( R_3 \). The net earnings of the cooperative, which are returned to members as patronage refunds, would be \((N_3 - R_3) \times Q_3\). Although these earnings are less than when the cooperative’s objective is maximization of net earnings, total member returns are greater than for any other solution.

Member returns consist of two components—the cooperative’s net earnings, which are distributed to members as patronage refunds, and the on-farm profits members earn from producing the raw product. The on-farm profits cannot be shown directly in figure 9. However, the figure can be used to illustrate the maximization of member returns if we focus on the producer surplus of members instead of their on-farm profits. As we will see, maximizing the sum of the cooperative’s net earnings and producer surplus is equivalent to maximizing member returns.

Producer surplus is the difference between what producers individually must receive to be willing to produce the product, as indicated along the supply curve, and what they actually receive when a single market price is paid for all units. In effect, producer surplus consists of what producers gain because there is a single market price. Graphically, it is equal to the area above the supply curve and below the market price.

In figure 9, producer surplus is represented by the triangular area above the supply curve \( S \) and below the raw product price \( R_3 \). The area \( R_3 \times Q_3 \) represents the revenues producers receive from sale of the raw product. If we assume the supply curve represents the marginal cost of producing the raw product, the trian-
gular area below the supply curve represents the total variable cost of production.\(^7\) Thus the triangular area above the supply curve represents producers’ on-farm profits and fixed costs.

Because fixed costs are constant with respect to changes in quantity, maximization of the cooperative’s net earnings and producer surplus is equivalent to maximization of member returns—the sum of the cooperative’s net earnings and the on-farm profits of members. Both are maximized at \(Q_3\). Maximum member returns from the cooperative purchasing and processing the raw product are represented by the shaded area in figure 9, which consists of the rectangular area \((N_3 - R_3) \times Q_3\) that represents the cooperative’s net earnings and the triangular area above the supply curve that represents producer surplus.

The quantity of raw product processed by the cooperative is maximized at \(Q_4\), determined by the intersection of the \(NARP\) and supply curves. As in the case of a farm supply cooperative, the maximization of output may represent the only equilibrium solution. In the solutions for the other three objectives listed in table 2, members will have an incentive to increase their deliveries to the cooperative if they take patronage refunds into account in making their marketing decisions. The supply of the raw product will increase until it reaches \(Q_4\). At that level, the price of the processed product equals the sum of the raw product price and the per-unit cost of processing the raw product. The patronage refund is zero, so members no longer have an incentive to increase supply. A cooperative that pursues an objective other than the maximization of quantity may need to resort to a nonprice instrument such as delivery or supply quotas to restrict output.\(^8\)

\textit{Strategies for Raising the Raw Product Price}

Just as farm supply cooperatives may be interested in strategies for reducing the cost of providing a farm input to members, marketing cooperatives may be interested in ways they can raise the price they pay members for the raw product. So we can focus on the raw product price, assume the cooperative sets the price equal to \(NARP\). In other words, it pays a raw product price equal to the difference between the processed product price and the average processing cost so it just covers its costs.

\(^7\) Transportation costs can be included in variable costs when there is a spatial dimension to the raw product market. Because average transportation costs can be expected to rise as the distance between the processor and producers increases, the supply curve will have a steeper slope.

\(^8\) Lopez and Spreen (1985) have also referred to processing rights, penalty schemes, and allocating cooperative earnings to members according a criterion unrelated to patronage. Sexton, Wilson, and Wann (1989) have mentioned multipart pricing schemes.
Figure 10. Strategies for raising the raw product price

Consider the marketing cooperative represented in figure 10. Assume the raw product supply curve facing the cooperative is $S_1$. The cooperative would process $Q_1$ units of the raw product and pay members a net price of $R_1$. A cooperative such as this, which is operating along the upward-sloping portion of its NARP curve, might benefit from shifting the supply curve to the right. For example, if this cooperative could shift the supply curve it faces to $S_2$, where it intersects the NARP curve at the maximum, the cooperative would be able to raise the net price to $R_2$. It might be able to accomplish this by accepting new members or encouraging existing members to expand their production.

A cooperative that is operating along the downward-sloping portion of its NARP curve may be able to raise the raw product price it pays by shifting the supply curve to the left. Assume the supply curve facing the cooperative is $S_3$. If the cooperative could shift the supply curve from $S_3$ to $S_2$, it would be able to raise the net price from $R_3$ to $R_2$. It might be able to accomplish this by implementing delivery quotas or some other nonprice instrument.

Another way a cooperative might be able to increase the price it pays members is to adjust the capacity of its processing plant in the same manner as a farm supply cooperative might adjust the capacity of the plant it uses to manufacture a
farm input. Remember that the \textit{NARP} curve is derived by subtracting average processing cost from the processed product price. Consequently, if the cooperative can lower its processing costs by building a new processing plant or adjusting the size of its existing plant, it can shift its \textit{NARP} curve upward, thereby increasing the price it is able to pay.

\textit{Open- and Restricted-Membership Cooperatives}

To avoid operating along the downward-sloping portion of its \textit{NARP} curve, a cooperative might adopt a \textit{restricted-membership} policy (also called a \textit{closed-membership} policy). Under a restricted-membership policy, a cooperative limits its membership so it can maximize the raw product price it pays current members. Under an \textit{open-membership} policy, a cooperative accepts any producer who applies for membership. As a consequence, it may not be able to limit raw product deliveries.

Assume the raw product supplied by all producers in a cooperative’s trade area is represented by the supply curve $S_3$ in figure 10. A restricted-membership cooperative would fix its membership so the member supply curve is $S_2$. Consequently, it would process $Q_2$ units and pay its members a price of $R_2$. If the cooperative were to follow an open-membership policy, member supply might eventually shift to $S_3$, expanding the raw product processed by the cooperative to $Q_3$. As a result, the raw product price would fall to $R_3$.

Note that if the cooperative were operating along the upward-sloping portion of its \textit{NARP} curve, it might choose to accept new members so it could shift the raw product supply curve to the right. Some marketing cooperatives have alternately adopted open- and restricted-membership policies to balance member supply with changing market conditions over time.

\textit{Long-Run Equilibria for Marketing Cooperatives}

In the long run, a processor may be able to increase its profits or improve its efficiency by adjusting the scale of its processing plant. Meanwhile, the raw product supply curve and the processed product demand curve facing the processor can shift, and its costs can change over time.

Figure 11 shows a processor’s long-run \textit{NARP} and \textit{NMRP} curves as well as the long-run supply ($S_1$) and marginal factor cost ($MFC_1$) curves it faces. At first, assume there are barriers to entry to prevent new processors from entering the market. In other words, the shape and position of the long-run supply curve are unaffected by the entry of other firms.

An IOF that seeks to maximize profits (a monopsony) would set output so \textit{NMRP} = $MFC_1$. It would pay producers a raw product price of $R_M$ and process
Figure 11. Long-run equilibria for IOFs and cooperatives given barriers to entry

$Q_M$ units of output. An open-membership cooperative with the same NARP and NMRP curves would process $Q_O$ units, determined by the intersection of the supply and NARP curves. The cooperative would pay members a price of $R_O$. Consumers would benefit from greater output and a lower processed product price, and producers would benefit from a higher raw product price.

The implications of a restricted-membership policy are much different. A restricted-membership cooperative would act to limit its membership so the supply curve it faces would intersect the NARP curve at the maximum, as $S_2$ does. The cooperative would process $Q_R$ units and pay members a price of $R_R$. Although producers would benefit from a higher raw product price, consumers would be faced with reduced output and a higher processed product price. In this case, the cooperative restricts output to a level even lower than the monopsony, a result first reported by Helmberger (1964).

If there are no barriers to entry, the entry of new processors into the market could shift the supply curve facing an individual firm to the left as more firms compete for delivery of the raw product. Ultimately, the supply curve could shift leftward until it is tangent to the NARP curve and processor profits are zero, an
outcome analogous to the long-run equilibrium for monopolistic competition described earlier. However, the costs of constructing new processing plants may present a barrier to entry, especially in markets that are sparse relative to the size of plant necessary for efficient operation. As a result, many raw product markets may be characterized by monopsony instead of monopsonistic competition. Indeed, there have been numerous instances when agricultural producers have been forced to organize a cooperative to provide a market for their output after the exit of the area’s only processor.

Effects of Cooperatives on Economic Welfare

Public policy concerning cooperatives generally has been supportive. Cooperatives have benefited from favorable treatment with respect to tax status, credit access, technical assistance, and limited immunity from antitrust laws. This support is based largely on the notion that cooperatives are procompetitive forces that improve the performance of imperfect markets and increase general economic welfare.

Economic welfare consists of the sum of the consumer surplus and producer surplus received by market participants. It is maximized when the cost of producing the last unit of a product, as represented by the marginal cost, equals the value of that last unit to buyers, as represented by the market price. A firm or market can be said to allocate resources efficiently if it uses them in such a way that economic welfare is maximized.

The benchmark for market comparisons is perfect competition because perfectly competitive firms are characterized by allocative efficiency in that they produce the quantity at which price equals marginal cost. In analyzing cooperative market performance, we will be interested in determining those cases in which cooperatives can be expected to behave in the same manner as perfectly competitive firms, i.e., the cooperatives are characterized by allocative efficiency. Even when cooperatives are not efficient in an allocative sense, they may be preferred to profit-maximizing firms if they create a greater level of economic welfare.

In figure 12, we compare the short-run price and output solutions for processors maximizing profits, member returns, and quantity to the welfare-maximizing solution. To facilitate the comparison, we assume the raw product supply curve \((S)\) represents the marginal cost to farmers of producing the raw product. We also add a curve labeled \(P – MPC\) to the figure. This curve represents the difference between the market price for the processed product and the marginal processing cost. It is derived by subtracting marginal processing cost from \(D\), the demand curve for the processed product as shown in figure 8.
Economic welfare is maximized when the processed product price equals the sum of the marginal production and processing costs, as at $Q^*$ in figure 12. A profit-maximizing processor would set $NMRP$ equal to $MFC$ at $Q_1$. The firm would restrict output to less than $Q^*$ by acting as a monopoly in the processed product market and a monopsony in the raw product market. More output would be socially desirable because the marginal cost of producing the last unit, which consists of the sum of the marginal cost of producing the raw product represented by $S$ and the marginal processing cost $MPC$, would be less than its value to consumers, as represented by the processed product price $P$. The firm would produce the efficient level of output only if it were a price taker in both markets, i.e., both the processed product demand curve and the raw product supply curve were horizontal.

A cooperative that maximizes member returns would set $NMRP$ equal to the marginal cost of producing the raw product. The cooperative’s output $Q_3$ would be greater than that of a profit-maximizing firm but less than the efficient level of output. Like a profit-maximizing firm, it would act as a monopoly in the processed product market if it faced a downward-sloping demand curve, but it would
behave like a perfectly competitive firm if it faced a horizontal demand curve. Regardless of the slope of the demand curve, the cooperative would act like a perfectly competitive firm in the raw product market because it returns its earnings to members. Because marketing cooperatives are often price takers in the markets in which they sell, cooperatives that seek to maximize member returns can be expected to result in an efficient allocation of resources in those markets.

A cooperative that maximizes quantity would generally overproduce relative to the efficient level. It would produce \( Q_4 \), the quantity at which \( \text{NARP} \) equals the marginal cost of producing the raw product. Production exceeds what is socially desirable because the marginal cost of producing the last unit, i.e., the sum of the marginal cost of producing the raw product and the marginal processing cost, exceeds its value to consumers. There is a misallocation of resources because the resources used in producing the last unit could have been used better in the production of some other good. The cooperative would produce the efficient level of output only if the marginal processing cost is equal to the average processing cost as it is at the minimum of the average processing cost curve or under a cost structure characterized by constant marginal processing costs.

Similar conclusions can be drawn for farm supply firms. For a farm supply firm, welfare maximization requires that the firm produce the quantity of farm input for which price equals marginal cost. A profit-maximizing firm would produce this quantity if it were a price taker. However, if it faces a downward-sloping demand curve, it would act like a monopoly by restricting output so marginal revenue and marginal cost are equal. Regardless of the slope of the demand curve, a cooperative that maximizes member returns will produce the efficient level of output by setting price equal to marginal cost. It will not restrict output, as a monopoly would, when facing its members’ demand. A cooperative that maximizes quantity generally will overproduce by operating where price equals average cost. It will produce at the efficient level only if average cost equals marginal cost.

Effects on Other Firms

An important dimension of the economic performance of cooperatives concerns the effects they can be expected to have on other firms in imperfect markets. According to the competitive yardstick concept, the presence of a cooperative in a market will force profit-maximizing firms to behave more competitively. The logic behind the competitive yardstick is that the cooperative will offer farmers more favorable prices because of its practice of providing members service at cost. Competing firms must match the cooperative’s price to avoid losing customers to it. Consequently, the market will move toward competitive equilibrium. Beneficiaries of the cooperative’s presence in the market include both its mem-
bers, who receive service at cost, and farmers who continue to patronize other firms but receive a better price. Consumers also benefit from greater output and a lower price.

Helmberger (1964) contended that an important factor in determining the existence of the yardstick effect is the cooperative’s membership policy. If faced with a downward-sloping demand curve or increasing average processing costs, only an open-membership cooperative could be expected to exert a positive effect on competition. LeVay (1983b) challenged Helmberger’s conclusion by arguing that an open-membership cooperative will produce beyond the socially desirable level by accepting whatever quantity of raw product members choose to deliver. LeVay conceded that economic welfare still could be enhanced by the stimulating effect an open-membership cooperative would have on competing firms but insisted that this role might also be filled by a cooperative that restricts output to maximize member returns.

Cotterill (1997) has constructed a graphical presentation to describe how the competitive yardstick effect might work in a food processing industry. In his model, farmers produce a raw product that is purchased by processing firms that process the product and sell it to consumers. The processing industry is a duopoly, i.e., it consists of two firms—an IOF and a cooperative in this case. The firms compete in prices, and there are barriers to entry. Both firms maximize profits, but the cooperative distributes its profits to members in proportion to patronage. The cooperative also maintains an open-membership policy, which is essential to the results.

Members respond to the receipt of patronage refunds by increasing their output of the raw product. Thus the cooperative must sell a greater quantity of the processed product, and to do so, it must lower its price. In response to the lower price, consumers switch to the cooperative, and the demand curve facing the IOF shifts to the left. As a result, the IOF must lower its price as well. Through this movement of prices, both firms tend toward equilibrium. At equilibrium, the cooperative’s price is just sufficient to cover its long-run average cost. The IOF sells a smaller quantity at a higher price and still makes a profit. However, its equilibrium price is lower than if the cooperative had been another IOF.⁹

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⁹ Cotterill (1997) has also presented a model of how the competitive yardstick effect might work in a food processing industry characterized by monopolistic competition and consisting of several IOFs and a single cooperative. In that model, both the IOFs and cooperative maximize profits. The firms may engage in either price or nonprice competition, but initially they are involved in nonprice competition through the creation of brands. Again, the cooperative must lower its price to sell the greater output due to its members’ response to the receipt of patronage refunds. Consequently, the IOFs are forced to compete in price, and the inefficiency associated with excessive brand creation is eliminated.
Several other models, including that developed by Tennbakk (1995), have used a mathematical approach to show that in a duopoly consisting of profit-maximizing firms, the replacement of one of the firms by a cooperative that maximizes member returns will result in greater industry output and economic welfare. However, those models are not based on the dynamics of the competitive yardstick model. Instead, the profit-maximizing firm and the cooperative make their output decisions simultaneously.10

Conclusions

The development of the neoclassical theory of cooperatives represents an important step in understanding cooperatives because the standard theory of the firm is inadequate for analyzing these organizations given assertions about their behavior are generally different than those for other firms. Specifically, cooperative theorists usually have ascribed objectives other than profit maximization to cooperatives.

The neoclassical theory of cooperatives has generated valuable insights into the expected behavior of cooperatives in various market structures and the differences between the behavior of cooperatives and IOFs. An analysis of farm supply cooperatives suggests their price and output solutions may differ substantially from those of IOFs both in the short run and the long run, especially if the demand curve is downward sloping. Analysis of the short-run price and output solutions for marketing cooperatives suggests they also may differ substantially from those of IOFs.

The stability of the cooperative price and output solutions is an important issue. In the case of a farm supply cooperative, the receipt of patronage refunds provides members an incentive to expand their use of the farm input beyond the optimal level. Thus the cooperative may not be able to pursue its objective without imposing some sort of restriction on the purchase of the input. The significance of this problem depends on the extent to which members take patronage refunds into consideration when making purchasing decisions.

Cooperatives must adopt business strategies to successfully adapt to changing market conditions. Because they may have objectives other than profit maximization, strategies used by IOFs may not be appropriate for them. Neoclassical cooperative theory has led to the development of strategies for cooperatives that are

10 The Tennbakk model consists of a Cournot duopoly in which both firms simultaneously set quantities while assuming the other firm will not vary its output in response. The model also assumes constant marginal costs and a downward-sloping linear demand curve. The increase in output associated with the replacement of one of the profit-maximizing firms with a cooperative is due to the cooperative’s output rather than an increase in the output of the remaining profit-maximizing firm, which actually decreases.
consistent with their objectives. Both short-run and long-run strategies for reducing the average cost of producing a farm input are described here. Those strategies, which consist of shifting either the demand curve or the cost curves for the input, are consistent with the cooperative objective of minimizing the price it charges members for the input. Strategies for raising the raw product price a marketing cooperative pays members are also described here.

In the long run, the quantity of raw product processed by a marketing cooperative depends on its membership policy. A cooperative with an open-membership policy may process a greater quantity than a profit-maximizing firm. However, a cooperative with a restricted-membership policy may limit output to a level lower than a monopsony to pay members the highest possible raw product price.

Public policy concerning cooperatives generally has been supportive because of the notion that cooperatives are procompetitive forces that improve the performance of markets and increase general economic welfare. In the case of a single processor, a cooperative that maximizes member returns may process a greater level of output than if it were a profit-maximizing IOF. On the other hand, a cooperative that maximizes quantity may process more than a competitive market or what is socially desirable. Similar conclusions can be drawn for farm supply cooperatives.

An important dimension of the economic performance of cooperatives concerns the effects they can be expected to have on other firms in imperfect markets. According to the competitive yardstick concept, the presence of a cooperative in a market will force profit-maximizing firms to behave more competitively by offering farmers more favorable prices to avoid losing customers. It has been argued that the existence of the yardstick effect depends on the cooperative’s membership policy because only an open-membership cooperative can be expected to exert a positive effect on competition. However, economic models have demonstrated that a cooperative that maximizes member returns can result in greater industry output and economic welfare as well.
Mathematical Appendix

Here mathematical models of a farm supply firm and a processing firm are presented to support the descriptive and graphical analyses. Price and output solutions are derived for the IOF objective of maximizing profit and the cooperative objective of maximizing member returns. Solutions also are derived for cooperatives that handle whatever quantity of products members choose to purchase or deliver. Those solutions are then compared to the solutions for the maximization of economic welfare to determine the conditions under which profit-maximizing firms and cooperatives are efficient in an allocative sense.

A Model of a Farm Supply Firm

Assume that agricultural producers employ two inputs in the production of a single product according to the following production function:

\[ q = q(x, y) \]  

where \( q \) is the quantity of the product and \( x \) and \( y \) represent the levels of the two inputs.\(^{11}\) Producer profits can be represented as

\[ \pi = p \cdot q(x, y) - r_x \cdot x - r_y \cdot y \]  

where \( p \) is the price producers receive for the product and \( r_x \) and \( r_y \) are the prices they pay for inputs \( x \) and \( y \).\(^{12}\) Producers maximize profits according to the following first-order conditions:

\[ \frac{\partial \pi}{\partial x} = p \frac{\partial q}{\partial x} - r_x = 0 \]  

and

\[ \frac{\partial \pi}{\partial y} = p \frac{\partial q}{\partial y} - r_y = 0 \]  

\(^{11}\) The purpose of assuming two inputs is to demonstrate that the demand for each input is a function of the price of the other input, as well as its own price and the price of the output. This model could easily be generalized to \( n \) inputs.

\(^{12}\) To keep the notation as simple as possible, we will not employ subscripts for individual agricultural producers.
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where the terms \( p(\partial q/\partial x) \) and \( p(\partial q/\partial y) \) represent the marginal value products of \( x \) and \( y \). To maximize profits, producers will employ each input at the level where its marginal value product is equal to its price.

Solving equations (3) and (4) simultaneously for \( x \) and \( y \) and summing over all producers yields the input demand functions:

\[
x = x(r_x, r_y, p)
\]

and

\[
y = y(r_x, r_y, p).
\]

The demand for each input is a function of the prices of both inputs and the output.\(^{13}\)

Now consider a farm supply firm that specializes in the production of input \( x \). Its profit can be defined as

\[
\Pi = r_x(x) \cdot x - c(x)
\]

\(^{13}\) For example, consider the production function

\[
q = Ax^\alpha y^\beta
\]

where \( \alpha, \beta > 0 \) and \( \alpha + \beta < 1 \). Substituting this function into equation (2) for \( q \), we can derive the following first-order conditions:

\[
\frac{\partial \pi}{\partial x} = p\alpha A x^{\alpha-1} y^\beta - r_x = 0
\]

and

\[
\frac{\partial \pi}{\partial y} = p\beta A x^\alpha y^{\beta-1} - r_x = 0.
\]

Solving these conditions simultaneously for \( x \) and \( y \), the input demand function for \( x \) is

\[
x = \left[ A p \left( \frac{\alpha}{r_x} \right)^{\gamma - \beta} \left( \frac{\beta}{r_y} \right)^{\beta} \right]^{\frac{1}{1-\alpha - \beta}}.
\]

From this, it is clear that the demand for \( x \) is a function of both input prices and the output price.
where \( r_s(x) \) is a convenient form for representing the inverse input demand function \( r_s = r_s(x, r_y, p) \), which is determined by solving equation (5) for \( r_s \) in terms of \( x \). The term \( c(x) \) represents the total cost of producing \( x \).

If the input supplier is a profit-maximizing firm, its first-order condition is

\[
\frac{d\Pi}{dx} = [r_s(x) + x \cdot r'_s(x)] - c'(x) = 0, \tag{8}
\]

which implies that the input supplier will maximize profit by producing \( x \) at the level where its marginal revenue from the sale of \( x \) is equal to the marginal cost of producing \( x \),\(^{14}\) represented by the quantity \( x_1 \) in figure 13.

Next consider a farm supply cooperative that maximizes member returns, including its own earnings, which are returned to members as patronage refunds. Assume all producers are members. Then the cooperative’s objective function can be written

\[
\Pi + \pi = r_s(x) \cdot x - c(x) + p \cdot q(x, y) - r_s(x) \cdot x - r_y \cdot y
\]

\[
= p \cdot q(x, y) - c(x) - r_y \cdot y \tag{9}
\]

\(^{14}\) Here and throughout, it is assumed that the second-order conditions for a maximum are satisfied. In this particular case, the first-order condition for a profit-maximizing input supplier can be rewritten

\[
\frac{d\Pi}{dx} = MR - MC = 0
\]

where \( MR \) and \( MC \) respectively represent the firm’s marginal revenue and marginal cost. Consequently, the second-order condition for profit maximization can be written

\[
\frac{d^2\Pi}{dx^2} = \frac{dMR}{dx} - \frac{dMC}{dx} < 0
\]

or

\[
\frac{dMR}{dx} < \frac{dMC}{dx}.
\]

For a maximum, the slope of the marginal revenue curve must be less than the slope of the marginal cost curve, i.e., marginal cost must be increasing at a faster rate than marginal revenue.
Figure 13. Price and output solutions for farm supply firms given a downward-sloping demand curve

where here \( \pi \) represents the sum of the profits of the individual producers in equation (2). The corresponding first-order condition is

\[
\frac{d}{dx} (\Pi + \pi) = p \frac{\partial q}{\partial x} - c'(x) = 0
\]

where \( p(\partial q/\partial x) \) once again represents the marginal value product of \( x \). Thus the cooperative maximizes member returns by producing at the level where the marginal value product of \( x \) equals the marginal cost of producing \( x \). From equation (3), we know that producers will operate such that the marginal value product of \( x \) is equal to the price paid for \( x \). Thus

\[
r_x(x) = c'(x)
\]
is equivalent to the first-order in equation (10). The cooperative will produce at the level where the marginal cost of producing the farm input is equal to its market price, shown as $x_3$ in figure 13.

In the case of a cooperative that produces whatever quantity of $x$ producers choose to purchase, the receipt of patronage refunds provides producers an incentive to increase their purchases until the cooperative’s average cost of producing $x$ is equal to the price of $x$ and the cooperative breaks even. Producers seek to maximize their profits:

$$\pi = p \cdot q(x, y) - (r_x - s) \cdot x - r_y \cdot y$$  \hspace{1cm} (12)

where $s$ represents the per-unit patronage refund and $r_x - s$ is the net price producers pay for the product. Their first-order conditions are

$$\frac{\partial \pi}{\partial x} = p \cdot \frac{\partial q}{\partial x} - (r_x - s) = 0$$ \hspace{1cm} (13)

and

$$\frac{\partial \pi}{\partial y} = p \cdot \frac{\partial q}{\partial y} - r_y = 0.$$ \hspace{1cm} (14)

Solving equations (13) and (14) simultaneously for $x$ and $y$ and summing over all producers yields the input demand functions:

$$x = x(r_x - s, r_y, p)$$ \hspace{1cm} (15)

and

$$y = y(r_x - s, r_y, p).$$ \hspace{1cm} (16)

Solving equation (15) for $r_x - s$ in terms of $x$, we obtain the input demand function for $x$ in its inverse form:

---

15 This assumption is equivalent to assuming the cooperative maximizes the quantity of $x$ it produces. Similarly, assuming a processing cooperative processes whatever quantity of raw product producers choose to deliver is equivalent to assuming it maximizes the quantity processed.
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\[ r_x - s = R_x(x, r_y, p). \]  \hfill (17)

The per-unit patronage refund \( s \) is equal to the cooperative’s net earnings divided by the quantity of the farm input \( x \) it produces:

\[
s = \frac{r_x(x) \cdot x - c(x)}{x} = \frac{r_x(x) - c(x)}{x}.
\]  \hfill (18)

Substituting equation (18) for \( s \) in equation (17), we obtain the equilibrium condition for the cooperative:

\[ r_x(x) - s = c(x)/x. \]  \hfill (19)

Equilibrium occurs where the net price of the farm input equals the average cost of producing it. For any particular net price, the values of \( r_x \) and \( s \) are not unique. Therefore, it is convenient to assume that the cooperative sets the cash price for the farm input equal to its average cost so that \( r_x(x) = c(x)/x \) and \( s = 0 \). Substituting \( s = 0 \) into equation (19), the equilibrium condition can be expressed in a simpler form without loss of meaning:

\[ r_x(x) = c(x)/x. \]  \hfill (20)

Equilibrium occurs where the price of the input \( x \) equals its average cost, represented by the quantity \( x_4 \) in figure 13.

**A Model of a Processing Firm**

Assume producers produce a single raw product that is sold to a processor. Producers seek to maximize their profits:

\[ \pi = r \cdot q - f(q) \]  \hfill (21)

---

\[ \text{The models of a processing cooperative and the maximization of economic welfare are based on similar models presented in Royer (2001). As before, the processor model can be applied to a cooperative that simply markets the raw product by considering the processing costs as representing the costs of transporting or marketing the product.} \]
where \( r \) is the raw product price paid producers by the processor, \( q \) is the quantity of raw product produced, and \( f(q) \) is the total cost of producing the raw product. Profit maximization occurs where the marginal cost of producing the raw product equals the raw product price:

\[
\frac{d\pi}{dq} = r - f'(q) = 0.
\] (22)

Solving equation (22) for \( r \) and summing over all producers yields the raw product inverse supply function \( r = f'(q) \).

For convenience and without loss of generality, we can assume that a unit of processed product is equal to a unit of raw product. Then the processor’s profit function can be written

\[
\Pi = p(q) \cdot q - k(q) - r(q) \cdot q
\] (23)

where \( p(q) \) is the processed product price and \( k(q) \) represents total processing cost exclusive of the cost of the raw product. Here the raw product price is written as \( r(q) \) to reflect the processor’s monopsony power in the raw product market. Substituting the raw product inverse supply function for \( r(q) \) in equation (23) and differentiating it with respect to quantity, the first-order condition for a profit-maximizing processor is

\[
\frac{d\Pi}{dq} = [p(q) + q \cdot p'(q)] - k'(q) - [f'(q) + q \cdot f''(q)] = 0.
\] (24)

According to equation (24), a processor maximizes its profit by setting its marginal revenue in the processed product market equal to the sum of its marginal processing cost and the marginal factor cost of the raw product (MFC). The first two terms on the right, marginal revenue less the marginal processing cost, are equivalent to the net marginal revenue product (NMRP). Thus the output of the profit-maximizing processor is \( q_i \) in figure 14, determined by the intersection of the NMRP and MFC curves.

Now consider a cooperative processor that maximizes member returns, including its own earnings, which are returned to members as patronage refunds. Assume all producers are members. Then the cooperative’s objective function can be written
Figure 14. Price and output solutions for processing firms

\[ \Pi + \pi = p(q) \cdot q - k(q) - f(q) \]  \hspace{1cm} (25)

where here \( \pi \) represents the sum of the profits of the individual producers in equation (21). The corresponding first-order condition is

\[ \frac{d}{dq} (\Pi + \pi) = [p(q) + q \cdot p'(q)] - k'(q) - f'(q) = 0. \]  \hspace{1cm} (26)

The cooperative maximizes member returns by setting its marginal revenue in the processed product market equal to the sum of its marginal processing cost and the marginal cost of producing the raw product. The first two terms on the right are once again equivalent to \( NMRP \). In addition, the last term is equivalent to the raw product supply curve according to equation (22). Thus the optimal level of output is \( q_3 \) in figure 14, determined by the intersection of the \( NMRP \) curve and the raw product supply curve \( S \).
Jeffrey S. Royer

In the case of a cooperative that processes whatever quantity of raw product producers choose to deliver, the receipt of patronage refunds provides producers an incentive to expand output until the cooperative’s net average revenue product (NARP) is equal to the raw product price and the cooperative breaks even, as in the Helmberger-Hoos model. Producers seek to maximize their profits:

\[ \pi = (r + s) \cdot q - f(q) \]  

(27)

where \( s \) represents the per-unit patronage refund. The first-order condition is

\[ \frac{d\pi}{dq} = r + s - f'(q) = 0. \]  

(28)

The per-unit patronage refund is equal to the cooperative’s net earnings divided by the quantity of raw product processed:

\[ s = \frac{p(q) \cdot q - k(q) - r(q) \cdot q}{q} \]  

\[ = p(q) - k(q)/q - r(q). \]  

(29)

Substituting equation (29) for \( s \) in equation (28), we obtain the equilibrium condition:

\[ p(q) - k(q)/q - f'(q) = 0. \]  

(30)

Equilibrium occurs where the processed product price less the average processing cost equals the marginal cost of producing the raw product. The first two terms are equivalent to NARP. Thus the output of a cooperative that processes whatever quantity members choose to deliver is determined by the intersection of the NARP and raw product supply curves, represented by the quantity \( q_4 \) in figure 14.

Maximization of Economic Welfare

Resources used in the production of a good are allocated efficiently if they are employed in such a manner that the economic welfare associated with its production and consumption is maximized. In the model of a farm supply firm, economic welfare consists of consumer surplus at the farm level:
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\[ CS_j = \int_0^{x^*} r_x(x)dx - r_x^* \cdot x^* \]  \hspace{1cm} (31)

plus producer surplus at the supplier level:

\[ PS_j = r_x^* \cdot x^* - \int_0^{x^*} c'(x)dx \]  \hspace{1cm} (32)

where \( x^* \) and \( r_x^* \) are the quantity and price solutions for \( x \). Summing equations (31) and (32), economic welfare can be written

\[ W = \int_0^{x^*} [r_x(x) - c'(x)]dx. \]  \hspace{1cm} (33)

Setting the first derivative to zero:

\[ \frac{dW}{dx} = r_x(x) - c'(x) = 0. \]  \hspace{1cm} (34)

Economic welfare is maximized at the level where the farm input price equals the marginal cost of producing the input, a well-known result, which is represented by the quantity \( x_3 \) in figure 13.

The first-order and equilibrium conditions for the various farm supply firms are compared to the welfare-maximizing condition in table 3. The first-order condition for a profit-maximizing firm differs from the welfare-maximizing condition in that it contains \( r_x(x) + x \cdot r'_x(x) \), or marginal revenue, in place of \( r_x(x) \), the farm input price. If the firm faces a downward-sloping demand curve, \( x \cdot r'_x(x) < 0 \). As a result, the marginal revenue curve will lie beneath the demand curve, and the firm will restrict its output to less than the welfare-maximizing level. Only if \( r'_x(x) = 0 \), i.e., the firm is a price taker, will the firm’s production meet the criterion for allocative efficiency.

The first-order condition for a farm supply cooperative that maximizes member returns is identical to the welfare-maximizing condition. The cooperative produces the optimal level of the farm input and uses resources efficiently. Examination of equation (20) reveals that this generally is not the case for a coopera-
Table 3. Comparison of the output solutions for farm supply firms to the welfare-maximizing condition

<table>
<thead>
<tr>
<th>Objective</th>
<th>Condition</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximization of economic welfare</td>
<td>( r_s(x) = c'(x) )</td>
<td>(34)</td>
</tr>
<tr>
<td>Maximization of profit</td>
<td>( r_s(x) + x \cdot r'_s(x) = c'(x) )</td>
<td>(8)</td>
</tr>
<tr>
<td>Maximization of member returns (including patronage refunds)</td>
<td>( r_s(x) = c'(x) )</td>
<td>(11)</td>
</tr>
<tr>
<td>Production of quantity demanded by members</td>
<td>( r_s(x) = c(x)/x )</td>
<td>(20)</td>
</tr>
</tbody>
</table>

tive that produces whatever quantity of the farm input members choose to purchase. The equilibrium condition contains \( c(x)/x \), the average cost of producing the input, in place of \( c'(x) \), the marginal cost. If \( c'(x) > c(x)/x \), the cooperative will overproduce \( x \) relative to the welfare-maximizing quantity because the marginal cost of producing \( x \) will exceed its value in producing the farm product \( q \) as reflected by its market price \( r_s(x) \). The efficient level of \( x \) will be produced only if \( c'(x) = c(x)/x \), as at the minimum of the \( ATC \) curve in figure 13 or under a cost structure characterized by constant marginal costs.

In the model of a processing firm, economic welfare consists of consumer surplus in the processed product market:

\[
CS = \int_0^{q^*} p(q) dq - p^* \cdot q^* \tag{35}
\]

plus producer surplus at the processor level:

\[
PS_p = p^* \cdot q^* - \int_0^{q^*} k'(q) dq - r^* \cdot q^* \tag{36}
\]

and producer surplus at the farm level:
Table 4. Comparison of the output solutions for processing firms to the welfare-maximizing condition

<table>
<thead>
<tr>
<th>Objective</th>
<th>Condition</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximization of economic welfare</td>
<td>( p(q) = k'(q) + f'(q) )</td>
<td>(39)</td>
</tr>
<tr>
<td>Maximization of profit</td>
<td>( p(q) + q \cdot p'(q) = k'(q) + f'(q) + q \cdot f^*(q) )</td>
<td>(24)</td>
</tr>
<tr>
<td>Maximization of member returns (including patronage refunds)</td>
<td>( p(q) + q \cdot p'(q) = k'(q) + f'(q) )</td>
<td>(26)</td>
</tr>
<tr>
<td>Production of quantity supplied by members</td>
<td>( p(q) = k(q)/q + f'(q) )</td>
<td>(30)</td>
</tr>
</tbody>
</table>

\[
PS_f = r^* \cdot q^* - \int_0^{q^*} f'(q) dq
\]

(37)

where \( q^* \) is the quantity solution and \( p^* \) and \( r^* \) are respectively the processed and raw product price solutions. Summing equations (35), (36), and (37), economic welfare can be written

\[
W = \int_0^{q^*} [p(q) - k'(q) - f'(q)] dq.
\]

(38)

Setting the derivative to zero:

\[
\frac{dW}{dq} = p(q) - k'(q) - f'(q) = 0.
\]

(39)

Economic welfare is maximized at the level where the processed product price equals the sum of the marginal processing cost and the marginal cost of producing the raw product, represented by the quantity \( q^* \) in figure 14.

The first-order and equilibrium conditions for the various processing firms are compared to the corresponding welfare-maximizing condition in table 4. The
first-order condition for a profit-maximizing firm differs from the welfare-maximizing condition in that it contains \( p(q) + q \cdot p'(q) \), or marginal revenue in the processed product market, in place of \( p(q) \), the processed product price, and it contains \( f'(q) + q \cdot f''(q) \), the marginal factor cost of the raw product, in place of \( f'(q) \), which is equivalent to the raw product price given equation (22). Thus a profit-maximizing firm will restrict output to a level less than the efficient level either if \( p'(q) < 0 \), i.e., the firm faces a downward-sloping processed product demand curve, or if \( f''(q) > 0 \), i.e., the firm faces an upward-sloping raw product supply curve. The firm will produce the efficient level of output only if \( p'(q) = 0 \) and \( f''(q) = 0 \), i.e., the firm is a price taker in both the raw and processed product markets.

The first-order condition for a cooperative that maximizes member returns differs from the welfare-maximizing condition only in that it contains \( p(q) + q \cdot p'(q) \) in place of \( p(q) \). Thus the cooperative will restrict output to less than the efficient level if \( p'(q) < 0 \). If \( p'(q) = 0 \), the two conditions are identical.

The equilibrium condition for a cooperative that processes whatever quantity of raw product members choose to deliver differs from the welfare-maximizing condition in that it contains \( k(q)/q \), the average processing cost, in place of \( k'(q) \), the marginal processing cost. If \( k'(q) > k(q)/q \), the cooperative will overproduce \( q \) relative to the welfare-maximizing quantity because the sum of the marginal costs of producing and processing \( q \) will exceed its value to consumers as reflected by its price in the processed product market. The cooperative will produce the efficient level of output only if \( k'(q) = k(q)/q \), as at the minimum of the average processing cost curve or under a cost structure characterized by constant marginal costs.
References


