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The Case of Cooperative Mixed Duopoly

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Abstract:

The paper focuses on markets in which firms with different ownership structures compete with each other in a one-period Nash-Cournot setting. In particular the market outcome of a duopoly of one marketing cooperative and one private wholesaler (cooperative mixed duopoly) is compared to the outcomes of a public firm mixed duopoly and a pure private duopoly. None of these market arrangements are found to produce the first-best efficient outcome. However, both mixed markets improve efficiency compared to the private solution, and the overall welfare effects of the public firm mixed duopoly are superior to the cooperative mixed market. Finally, the distribution of surplus between the different producer groups and the different wholesaler firms is discussed.

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1. Introduction.

The purpose of this exercise is to analyse relative welfare and distributional effects of a market arrangement which I have labeled cooperative mixed oligopoly. A cooperative mixed market is a market in which a cooperative competes with private firms. Many markets have structures like this, especially markets for agricultural products. Here, the focus will be on the competition on the wholesale level in the marketing process of some raw product supplied by independent farmers. For whatever reason, such wholesale markets are often characterized by a small number of firms and thus the potential for imperfect competition is present. Indeed, the formation of cooperatives by the farmers is often a means of protecting them from exploitation by large oligopsonistic or monopsonistic private wholesalers or processing companies; the *raison d'être* for the cooperative being to secure its members a higher and more stable price for their raw product.

In Norway (and possibly in other countries as well), various means of supporting large agricultural marketing cooperatives is an important part of the regulation of agricultural markets. They are to a substantial extent protected against competition from imports, some receive special subsidies, and some are given the exclusive right to purchase or process the raw product in question (e.g. the national dairy marketing cooperative). LeVay (1983a) observes that governments seldom specify the reasons why they are being sympathetic to the formation of agricultural cooperatives, and goes on to ask: "Can it be that agricultural co-operation is considered to be so self-evidently a good thing that its benefits do not have to be demonstrated? After all, it sounds good in that it is said to be a democratic form of organisation, not too blatantly profit orientated and therefore non-exploitative, a mechanism for self-help, a means of maintaining the family-farm whilst at the same time attaining economies of scale, a gentling influence on the rapaciousness of capitalism." The belief seems to be that the presence of cooperatives in the market has positive welfare effects. They are thought to ensure the producers better terms and greater security, while at the same time improving overall market performance. A substantial body

of literature by agricultural economists also advocates this view.¹

At the same time, the Norwegian mixed economy has a certain tradition for utilizing limited nationalization of imperfectly competitive industries, i.e. the establishment of a public firm competing with private firms in order to enhance efficiency in such markets. It seems therefore that supporting the formation of cooperatives or public firms, and thereby obtaining a mixed market structure, can be viewed as alternative ways to regulate oligopolistic markets. While there are several theoretical contributions to be found on both cooperatives in oligopoly and public firms in oligopoly, the comparison of the two means of regulation has to my knowledge not yet been done.

In the agricultural economic theory on oligopsony/oligopoly, heavy emphasis has been put on the impact on farmers' surplus from different market arrangements. Little explicit attention is paid to consumers' surplus, and thus the market structures discussed are often that of oligopoly for requisite societies (where farmers are consumers) and that of oligopsony for marketing cooperatives (where farmers are suppliers). According to Sexton (1990) the role of cooperatives in oligopsony has received little formal attention, and he claims to be "the first to document in a rigorous oligopsony model the membership, market structure, and the technological conditions that determine the existence and magnitude of (a competitive yard-stick) effect (for cooperatives)". Sexton analyses the issue in a spatial oligopsony model, and he finds that the presence of an open-membership cooperative makes the farmers better off compared to a market with only private wholesalers. In Sexton's model, however, the final product is sold in a perfectly competitive market (i.e. the oligopsonists are price takers in the final market). This means that the presence of a cooperative does not affect the magnitude of the consumer surplus, which if it did, should be a concern for policy makers in choosing the best regulatory design. In the model considered in this paper the wholesalers or processors are oligopolists in the final market.

¹ According to Staatz (1987) much recent work suggests there are valid justifications for public policy support of farmer cooperatives, particularly because of their effects on competition and their potential to improve economic coordination. These works seem to reinforce earlier industrial organization analyses, e.g., Helmberger. Helmberger also observes that restricted membership cooperatives can give rise to market results that are undesirable from the viewpoint of all but the members of the cooperative.

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In other works the market structure under consideration has been monopoly/monopsony by a private firm or by a cooperative (see Enke, 1945; Taylor, 1971). Fulton (1989) investigates empirically the impact of a requisite cooperative in a market that is oligopolistic in nature, based on recent theoretical contributions by Rhodes (1983), Cotterill (1987), and Sexton and Sexton (1987).² In all these works, the performance of a cooperative mixed oligopoly is compared to the first-best and/or the pure private oligopoly solutions.

The discussion in this paper will follow the lines of DeFraja and Delbono (1989). Their paper discusses the role of a public welfare maximizing firm competing with private profit maximizing firms in an oligopolistic industry. This market constellation is called a mixed market in the literature, and despite its commonness in many western economies, it has not been theoretically analysed until recently.³ I am interested in the interaction between a marketing cooperative and private firms in a similar setting.⁴ As DeFraja and Delbono I will assume Cournot competition, i.e., the firms set quantities as a best response to the quantity marketed by the rivaling firm. To simplify the analysis the market interaction is modeled as a static duopoly game. The model is developed in section 3 and the outcomes of different market equilibria are compared in section 4. Section 2 discusses alternative ways of formulating the cooperative's objective. In section 5 I outline in a preliminary way how the model could be expanded into a two-stage model where the firms first compete for supply of the raw input. Finally, some concluding remarks are given in section 6.

² Rhodes' and Cotterill's contributions are published in J. S. Royer (ed.) "Cooperative Theory: New Approaches." Washington, D.C.: USDA ACS Serv. Rep. 18, July 1987. I have been unable to get a hold of this report.

³ An excellent survey of this literature is DeFraja and Delbono (1990).

⁴ "A mixed oligopoly is a market where a homogeneous or differentiated good is supplied by a "small" number of firms and the objective function of at least one of them differs from that of the other firm." (DeFraja and Delbono, 1990). The 'mixed' label refers to ownership, and therefore is also applicable to a market in which a cooperative owned by its suppliers competes with a private firm owned by capitalists or stockholders. To distinguish the two types of mixed markets, we will talk about public firm mixed markets and cooperative mixed markets.

2. Objectives of marketing cooperatives.

The marketing cooperative constitutes a special type of firm, since the owners do not only contribute capital but also do business with the organization. Similar to a regular investor-owned firm it is usually run by elected representatives, the board, and professional managers. Although this is not very different from a regular investor-owned firm, it is not as easy for the owners of the cooperative to take their business elsewhere as it would be for stockholders. According to Rhodes (1983) "(i)t is assumed that those directing the cooperative may define its mission in ways that are limiting in terms of commodities handled and trade territory served. (...) the very fact of its user orientation does limit the legitimate activities of a cooperative." It seems that the most important difference between a cooperative and an investor-owned firm is that the residual claimant is not capital but the persons who constitute the cooperative (its members). In most cases the cooperative has an egalitarian decision rule, each member has one vote.

Although it is largely accepted in agricultural economics that the presence of cooperatives in the market has the potential of enhancing efficiency, there is no deep consensus regarding what the cooperative enterprise actually maximizes.⁵ Several different objectives for a marketing cooperative are discussed by Bateman, Edwards and LeVay (1979a). The most important ones can be summarized as follows:

1. Maximization of the cooperative firm's profit.
2. Joint profit maximization, in which the cooperative sets its output so as to maximize its members joint profit from the raw input production and the cooperative plant production.
3. Maximization of throughput or production.
4. Maximization of membership.
5. Maximization of patronage refunds per unit, or of net returns per unit (taking no account of costs or producer surplus).

⁵ Bateman et.al. (1979b) examine the meaning of the word "cooperative" in theory and practice, but find that due to the wide variety of cooperative organizations it is hard to establish a universal definition.

Objective no. 1 implies that the cooperative seeks to act similar to a private profit maximizing firm buying its raw input from outside sources. Objective no. 2 implies that the cooperative acts as if its members production is internal production, and then maximizes total net returns. Maximization of throughput or total production assuming decreasing returns to scale, will lead to an output greater than the efficient one. Total quantity will be set where average costs rather than marginal costs equal the market price (per unit return from the market). Maximization of membership can have similar implications, while maximization of patronage refunds per unit will tend to restrict output (the equilibrium condition being to set quantity where the slope of the average cost curve equals the slope of the average revenue curve).⁶

A crucial factor in the cooperative's ability to choose their quantity is whether it employs an open membership policy or not. If the cooperative is unable to restrict membership or unable to restrict each member's supply, attaining goals 1, 2 and 5 may not be feasible, and the equilibrium resulting from 3 and 4 may be the only likely outcome. It is, however, shown by Zusman (1982) that there exist cost distribution rules that are attainable through majority voting, and that lead to the desired supply by individual members.

In addition to the problem of determining what the cooperative actually wishes to maximize, there are all sorts of openings for internal incentive problems that can influence what goals are feasible for the cooperative. There are problems of reaching efficient goals through majority voting, how to restrict individual members' production, how to monitor each member's performance and how to make efficient investment decisions. Of course, large cooperatives who are run by professional managers will be vulnerable to the same kind of incentive problems as investor-owned private firms (conflicts of interest between owners and managers).

For the purposes of this paper I model the cooperative as maximizing the joint profits of members' production and cooperative production. I assume that the cooperative in question has a fixed number of members and is able to dictate its members output.

⁶ See Bateman et.al. (1979a) for a more extensive discussion of the implications of the different objectives.

Under these assumptions the cooperative is treated like a cartel, and the short-run behavior is studied. According to Fay (1908), the difference between a cooperative and a cartel is that while the cartel "is an association of the strong to become yet stronger, bold, unyielding and exclusive, the co-operative society is an association of the weak, who gather together and try to lift themselves and others out of weakness into strength." But he also observes that "there is often more of the co-operative aroma in the early days of weakness than in the latter days of strength." Utilizing any other of the suggested objectives in this setting, would make the members altogether worse off.⁷

3. The Model.

Assume that the producers of the raw input are equally divided into two groups.⁸ Half of the producers are organized in an exclusive cooperative (i.e. a restricted membership cooperative), and the other half sells their output to a private firm. We further assume that the number of raw input producers is large, so that they can not display market power on their own. For simplicity, all producers are identical with regard to costs, and they produce a homogenous product, q . Furthermore, the duopolists can not discriminate between their suppliers, and hence we assume that for any magnitude of total production all members of the cooperative supply the same amount to the cooperative. By the same reasoning all suppliers to the private firm produce the same amount.⁹ In other words, an increase or decrease in demand for each group is equally distributed between its members. Let q_m^c denote the purchase and supply of the final product by the cooperative,

⁷ This formulation of the maximand is accredited to Enke (1945), and is also used in, e.g., Fulton (1989) and Royer (1982).

⁸ The point of this paper being to illustrate how the differences in objectives result in differences in strategic behavior in the final market, the explanation of how the market division is determined is not an issue at this point. For convenience it is assumed that this stage of the game is solved, with the outcome that the raw producers are divided into two identical groups.

⁹ We assume that all non-member suppliers will respond identically to a change in demand from the private firm since their cost functions are assumed to be identical, and we assume that the cooperative has to treat all members equally. The formulation of the cost function could also reflect an idealization implying that there is only one cooperative supplier and one private supplier, none of them able to display market power. The results would not be altered by such a simplification.

q_n^c the equivalent for the private firm, and Q^c the total production of the cooperative mixed duopoly.

The identical aggregated cost functions of the two producer groups are represented by¹⁰

$$c(q_i) = \frac{1}{2}kq_i^2, \quad i = m, n \quad (1)$$

where k is a positive constant. Marginal cost is thus increasing and equal to kq_i . The duopolists each bear a fixed cost, F , and have constant marginal costs in inputs other than the raw product, for simplicity normalized to 0.¹¹

Market demand for the final product is linear, and the inverse demand function can be written

$$p(Q) = a - Q \quad (2)$$

In the cooperative mixed duopoly total production $Q^c = q_m^c + q_n^c$ and $p(Q^c)$ is the price that clears the market for the total supply Q^c .

3.1 Cooperative mixed duopoly.

Following our assumption about the objective of the marketing cooperative, the cooperative maximizes

¹⁰ Both the cost function and the demand function is taken from DeFraja and Delbono's paper. For the purposes of this paper, however, I have decomposed the costs so that the variable costs constitute the aggregated cost function of each raw product supplier group, while the fixed costs are invested in the wholesaler firms (alternatively the processing plant or the distribution capital).

¹¹ Which means that the industry is in fact a natural monopoly. Assuming that there are increasing marginal costs in the wholesale production and that F is sufficiently small would take care of the assumption of natural duopoly, but since this is a one-shot game and we assume that the fixed costs are sunk, we don't have to worry about this. In fact it does not really matter who bears the fixed cost in our setting.

$$\Pi_c^c = p(Q^c)q_m^c - c(q_m^c) - F = (a - q_m^c - q_n^c)q_m^c - \frac{1}{2}k(q_m^c)^2 - F \quad (3)$$

The cooperative acts as if the production of its suppliers is internal production. And since we have assumed Cournot competition the cooperative acts like a monopolist towards its residual demand curve, i.e. set output such that marginal revenues equal marginal costs.

$$\frac{\partial p}{\partial q_m^c}q_m^c + p = \frac{\partial c}{\partial q_m^c} \quad (4)$$

The private firm, however, is in a monopsonistic position in its raw product market segment, assuming that the non-member producers are not allowed to supply any of its output to the cooperative. It is faced by an upward sloping supply curve, the aggregated marginal cost curve of its suppliers. The private firm thus maximizes

$$\Pi_p^c = p(Q^c)q_n^c - c'(q_n^c)q_n^c - F = (a - q_m^c - q_n^c)q_n^c - k(q_n^c)^2 - F \quad (5)$$

Since the private firm takes into account that an additional unit purchased (and marketed) raises the price of all units purchased, the general first order condition is

$$\frac{\partial p}{\partial q_n^c}q_n^c + p = \frac{\partial c}{\partial q_n^c} + \frac{\partial^2 c}{\partial (q_n^c)^2}q_n^c \quad (6)$$

Solving the two optimization problems for our specific cost and demand functions and rearranging the first order conditions, we obtain the following reaction functions

$$r_c = q_m^c(q_n^c) = \frac{a - q_n^c}{k + 2} \quad (7)$$

$$r_p = q_n^c(q_m^c) = \frac{a - q_m^c}{2(k + 1)} \quad (8)$$

In equilibrium both reaction functions must be satisfied simultaneously, thus

$$q_m^{c*} = \frac{a(1+2k)}{b} \quad \text{and} \quad q_n^{c*} = \frac{a(1+k)}{b} \quad (9)$$

where $b = 2k^2 + 6k + 3$. We observe immediately that $q_m^{c*} > q_n^{c*}$ since $(1 + 2k) > (1 + k)$. In equilibrium the cooperative puts a larger quantity on the market than the private firm. Indeed the private firm supplies a smaller quantity than a cooperative as a response to any output marketed by its rival (as long as the quantity is strictly positive). Moreover, the slope of the private firm's reaction function is steeper than the slope of the cooperative's reaction function (see graphic representation in Appendix I). Thus the private firm increases production less than a cooperative in response to a decrease in production from its rival, and decreases production less than a cooperative when faced by a larger output by a competing firm.

3.2 Public firm mixed duopoly.¹²

Like for marketing cooperatives, several alternative assumptions of public firms' objective function can be made. It is, however, common to assume that a public firm maximizes some measure of social welfare. The most 'complete' assumption would be that of a public firm jointly maximizing raw producers', wholesalers' and consumers' surplus:¹³

$$\begin{aligned} W^o(q_m^o, q_n^o) &= \int_0^{q^o} (a - t) dt - c(q_m^o) - c(q_n^o) - 2F \\ &= \frac{1}{2}[a^2 - (a - q_m^o - q_n^o)^2 - k(q_m^o)^2 - k(q_n^o)^2] - 2F \end{aligned} \quad (10)$$

The general first order condition for a public firm maximizing (10) is

$$p_o = \frac{\partial c}{\partial q_m^o} \quad (11)$$

which is identical to the first-best solution associated with the residual demand curve facing

¹² I do not consider the case of a public firm competing with a cooperative because I regard the two forms of mixed oligopoly as alternative ways of regulating an imperfect market.

¹³ Alternatively the public firm could maximize the (weighted) sum of consumers' and wholesalers' surplus or the sum of consumers' surplus and joint own profit.

the public firm. Note however that the overall market outcome is not first-best because of the best response condition for the competing private firm.

Rearranging the first order condition for welfare maximum with our specific functions yields the following reaction function for the public firm:

$$r_o = q_m^o(q_n^o) = \frac{a - q_n^o}{k + 1} \quad (12)$$

Utilizing the private firm's reaction function (8) and solving for the Nash-Cournot equilibrium yield

$$q_m^{o*} = \frac{a(2k + 1)}{d} \quad \text{and} \quad q_n^{o*} = \frac{ak}{d} \quad (13)$$

where $d = 2k^2 + 4k + 1$.

3. Welfare implications.

Before the two different types of mixed markets are compared a proper framework for evaluation must be established. In this case the bench-mark solutions are given by the first-best efficient solution and the unregulated market outcome which is the private Cournot duopoly.

The first-best solution for the duopoly (fixed costs are sunk), is to share the market and produce to the level where marginal cost equals the marginal willingness to pay for the product. This is the solution that would be obtained by a public firm controlling both plants and maximizing social welfare. The first order condition for both plants in the first-best solution is the same as for the public firm in mixed duopoly:

$$p = \frac{\partial c}{\partial q_i^f} \quad i = n, m \quad (14)$$

The quantity produced in each plant in our example is thus:

$$q_i^f = \frac{a}{k+2}, \quad i = n, m. \quad (15)$$

The other extreme regarding the ownership structure in this market would be that of a private duopoly. We assume here that both private firms act as monopsonists towards 'their' producers.¹⁴ From (8) we have the reaction functions of both profit maximizing firms. Solving both simultaneously yield the equilibrium quantity of each firm

$$q_i^{p*} = \frac{a}{2k+3}, \quad i = n, m \quad (16)$$

Utilizing equations (1) through (16), we can calculate the magnitude of production, profits and welfare in the different market settings. The equilibrium values of the different variables are summarized in table 1, and the equilibrium is graphically illustrated in figure 1 (Appendix I).

Utilizing the total quantity equilibrium solutions we find that

$$Q^f > Q^o > Q^c > Q^p \quad (17)$$

Not surprisingly we find the results of the extreme market forms at each end of the 'Q-line', with the private duopoly producing the smallest total quantity and the first-best providing the largest quantity. Total production in a duopoly with an exclusive cooperative competing with a private profit maximizing firm is greater than the total production of a private duopoly, and less than that of a public firm mixed duopoly and the first-best quantity. And since total welfare is maximized in the first-best solution, welfare is less than first-best in both mixed markets. This result also means that consumers' surplus is greater in the public firm mixed duopoly than in the cooperative mixed duopoly, and both mixed markets yield greater consumers' surplus than the private duopoly solution.

¹⁴ Stahl (1988) shows that a two-stage model with winner-takes-all competition between marketing merchants obtaining stock from suppliers and reselling to consumers, yields Walrasian (first-best) prices. But this is with price competition both in the input and output markets. In our setting, the wholesalers do not compete for inputs (so far) and compete through quantities in the final market.

To determine the overall social welfare effects, we have to take costs into consideration. Because of the identical and increasing cost functions of the producer groups, symmetric distribution of production between the duopolists is *cet.par.* more efficient than asymmetric distribution. The higher costs of asymmetric production will partly offset the gain in consumers' surplus from a larger total supply.¹⁵ In both mixed markets the distribution of production between the rivaling firms is asymmetric. From (9) and (13) we find that $q_m^{o*} > q_m^{c*}$, so that production is more asymmetric in the public firm mixed market than in the cooperative mixed market.¹⁶ Observe also that the private duopoly produces a symmetric solution.

Moreover, the public firm produces more than the first-best solution and the cooperative less:

$$q_m^{o*} > q_m^{f*} > q_m^{c*} \quad (18)$$

Using the social welfare function (10) and the equilibrium quantities of the different market structures, we can calculate and compare the total welfare effects of different market structures. Through lengthy calculations we obtain:

Proposition:

Given increasing marginal costs in production of a raw product supplied by independent producers and assuming Cournot (duopoly) competition in the final market, the relative welfare implications of different market structures are

$$W^f > W^o > W^c > W^p \quad (19)$$

where W^f is the first-best welfare, W^p is the welfare of a public firm mixed duopoly, W^c is the welfare of a cooperative mixed duopoly, and W^o is the welfare of a private duopoly.

¹⁵ DeFraja and Delbóno (1988) find that in some cases, when the market is competitive enough (the number of private firms is large), the social surplus is greater in a private oligopoly than in a public firm mixed oligopoly.

¹⁶ It follows from the private firm's reaction function that $q_n^{c*} > q_n^{o*}$ when $q_m^{c*} < q_m^{o*}$.

Proof:

Total welfare in the duopoly market is given by

$$\begin{aligned}
 W^i(q_m^i, q_n^i) &= \int_0^{q^i} (a - t) dt - c(q_m^i) - c(q_n^i) - 2F \\
 &= \frac{1}{2}[a^2 - (a - q_m^i - q_n^i)^2 - k(q_m^i)^2 - k(q_n^i)^2] - 2F
 \end{aligned} \tag{20}$$

Substituting the equilibrium values of prices and quantities we obtain the total welfare values listed in Table 1 (see Appendix II).

Checking relative values:

$W^f > W^o$ if $k^4 + 3k^3 + 3k^2 + k > 0$ which is always the case because $k > 0$.

$W^o > W^c$ if $8k^5 + 30k^4 + 36k^3 + 22k^2 + 35k + 1 > 0$ which is always the case because $k > 0$.

$W^c > W^p$ if $4k^5 + 24k^4 + 43k^3 + 29k^2 + 6k > 0$ which is always the case because $k > 0$.

Hence the ranking of the different market outcomes according to total welfare effects is as given by (19) for all positive values of k . Q.E.D.

The efficiency loss from asymmetric production does not offset the welfare gains from a lower market price, i.e., the increase in consumer surplus from a lower market price is greater than the loss in producers' surplus and the extra costs incurred because of asymmetric production in the two identical plant.

Raw producers' surplus: Since the greatest total quantity is produced in first-best and the smallest total quantity is produced in private duopoly, consumers are best off in first-best and worst off in private duopoly. This is true for raw producers as well. Consumers are however better off in public mixed duopoly than in cooperative mixed duopoly. For raw producers in the 'member' group the opposite result would be expected.

The 'member' group: For the cooperative it is assumed that all surplus is distributed to its members, hence the producer surplus for this group is equal to the total

revenue of the cooperative. Incentive problems that may arise from the fact that the marginal revenue received by each supplier does not equal her marginal cost of production, are not considered here. (The amount supplied by each member is dictated by the cooperative, and there are no information or incentive problems.) Thus raw producers' surplus is equal to the cooperatives' gross surplus minus farm costs and the fixed costs of the cooperative:

$$\Pi_m^c = p(Q^c)q_m^c - c(q_m^c) - F = (a - q_m^c - q_n^c)q_m^c - \frac{1}{2}k(q_m^c)^2 - F \quad (21)$$

The public firm sets its quantity demanded so that in equilibrium the price paid to the farmers is equal to the price in the final market. This implies that all surplus is distributed to the raw producers and that the public firm in fact incurs a loss equal to F . It is assumed that a government subsidy covers this loss. Assuming that the cooperative members must cover the fixed costs of the cooperative plant, it depends on the magnitude of fixed costs whether the producers are best off in cooperative mixed duopoly or in public firm mixed duopoly. However, since the problem in this paper is stated as a choice on behalf of the government as to what kind of market structure to support, it is assumed that the government would also subsidize the cooperative by the same amount, i.e., F . Note that this does not make any difference with respect to the equilibrium conditions for the cooperative, whereas it does affect the public firms' reaction function if it is forced to cover the fixed costs through revenues.¹⁷

Assuming that the fixed costs of the cooperative and the public firm are covered by the government, thus

$$\Pi_m^c > \Pi_m^o > \Pi_m^f > \Pi_m^p \quad (22)$$

The member group is unambiguously best off in the cooperative situation. The public firm solution makes the member group produce more than in first-best, and since they are

¹⁷ With the chosen cost structure the public firms' reaction function would then be identical to the 0-profit constraint, according to Cremer, Marchand and Thisse (1989).

assumed to be paid according to their marginal cost in both scenarios, they are better off in public firm mixed duopoly than in first-best. Their worst scenario is the private duopoly.

The 'non-member' group: In all market regimes the 'non-member' group receives the minimum required price to induce the supply of the equilibrium quantity to the private firm. This price is given by the aggregated supply-function, i.e. the aggregated marginal cost curve. Non-members surplus is thus

$$\Pi_n^i = q_n^i c'(q_n^i) - c(q_n^i) = \frac{1}{2}k(q_n^i)^2 \quad (23)$$

and they are worst off in public firm mixed duopoly and best off in first-best. Moreover the non-member group is better off in private duopoly than in the cooperative mixed duopoly. To sum up:

$$\Pi_n^f > \Pi_n^p > \Pi_n^c > \Pi_n^o \quad (24)$$

This result may point to a major problem with the public firm mixed solution. It is highly unrealistic to assume that a distribution like this would be desirable or acceptable in practice.

The wholesalers: In all scenarios other than first-best, the private duopolists earn a profit of

$$\Pi_p^i = p(Q^i)q_n^i - c'(q_n^i)q_n^i - F = (a - q_n^i - q_m^i)q_n^i - k(q_n^i)^2 - F \quad (25)$$

The private firm must make money in all scenarios where they can exercise a degree of market power. Since the residual demand facing the private firm is greatest in private duopoly and least in public firm duopoly, we have that:

$$\Pi_p^p > \Pi_p^c > \Pi_p^o > \Pi_p^f \quad (26)$$

In first-best, the private firm will loose money because the fixed costs will not be covered.

As noted earlier, the public firm does not make any money (rather it loses money) and the cooperative surplus from the wholesale plant is part of the raw producers surplus

(or else they would be better off with the public firm).

The distribution of surplus is interesting because one of the rationales behind government support of cooperatives is to increase the share of surplus paid to farmers. The interpretation of this could be to put more weight on raw producers' surplus than on consumers' or duopolists' surplus. Thus choosing the regulation form that maximizes efficiency (i.e. second-best), is not necessarily the right choice. In the setting depicted in my model, the cooperative members are indeed better off in the cooperative mixed duopoly, but compared to the first-best this is at the expense of consumers and non-member producers. Regulating the market through establishing a public firm is better than the cooperative solution measured by total welfare, but makes non-member producers even worse off. This could alternatively be compensated for through other (non-market) means of income redistribution. However, it is not likely that a division of the market yielding such a large discrepancy between the revenues to different raw producer groups is sustainable in the long run. The non-member group would either wish to become members of the cooperative if the private processor/marketing firm does not fight for its suppliers by offering a higher price, or they would wish to form their own cooperative. The more long-term or dynamic aspects of such competition are discussed in the next section.

5. Possible two-stage expansions of the model.

A major problem with the model presented above, is that it does not explain how the market for the raw product is divided between the processors. If the game was played in a second period, all farmers would wish to become members of the cooperative since members get a higher revenue from production than non-members. Alternatively, it would be tempting for the non-member group to form their own cooperative. It may also be difficult for the cooperative to sustain in the long run the behavior assumed in my model. On one hand, it must be able to restrict existing members' production such that it does not take into account the patronage refunds accruing from the revenues of the cooperative operation. On the other hand it must be able to restrict membership, which is contradictory to the basic ideals of most cooperative associations and not in accordance

with the Rochdale principles.¹⁸ According to Zusman (1982) and Rhodes (1983) there, however, is no reason to assume that an open membership cooperative will be unable to restrict members' supply in the short run.

In Kreps' and Scheinkman's now classic 1983 article, they show that when competitors choose capacities in the first stage and compete in prices in the second stage, the Nash equilibrium outcome is the Cournot solution. In their model the processors' production functions are independent in the sense that one firm's capacity level does not affect the cost of the other firm's capacity. In other words, the factors of production are assumed to be supplied by a competitive market where the prices are given. When competing for the raw product input the behavior of one firm will affect the price the other firm must pay. Stahl (1988) analyses a situation in which wholesalers compete in prices for the raw product in the first stage and also compete in prices in the final market. In this model he finds that the middlemen's equilibrium strategies will result in Walrasian prices without involving the theoretical construction of some auctioneer setting the market price.

Assuming that the agents compete in prices for the raw product constitutes a knife-edge problem. There are only two possible outcomes: Either the prices stated by the wholesalers are different and the one who offers the best price buys the entire stock offered by farmers, or they state equal prices and split the market. Another possibility is that the wholesalers offers a combination of price and quantity, or several combinations of prices and quantities (a demand curve).

It does not seem to be clear that private oligopolists would be able to exploit market power in such a market (price competition for inputs) - in which case the cooperative is not needed to enhance welfare or efficiency. But of course an alternative reason to establish a cooperative would be for farmers to extract greater surpluses which in this situation would be socially inefficient. And what is the core question here is whether the government should support or encourage the formation and viability of cooperatives.

¹⁸ "Membership of a cooperative society should be voluntary and available without artificial restriction or any social, political, racial or religious discrimination, to all persons who can make use of its services and are willing to accept the responsibilities of membership." International Cooperative Alliance, Rule 1, 1976. (LeVay, 1983b.)

Helmberger and Hoos (according to Staaz, 1987) adopted a vertical integration view of cooperatives. They argued that farmers act as price takers and thus have well-defined supply functions. Moreover, the cooperative management strives to maximize the average per-unit (cooperative) surplus to farmers. In the short run the cooperative takes its members' production as fixed, but in the long run the equilibrium output and price depend on the cooperative's membership policy. The open membership cooperative then tends to produce too much output (set $p = NARP$), and the closed membership cooperative restricts output to the level where $NMRP = NARP$.¹⁹ As Staatz observes, however, "... the model is counterfactual because most cooperatives earn net margins and issue patronage refunds. Indeed the 'zero surplus' strategy of this model is inconsistent with the Rochdale principle of selling at regular retail prices and later rebating net margins to members instead of discounting prices at retail."²⁰

Staatz is also referring to a more recent contribution by Cotterill.²¹ According to Staatz "Cotterill's findings reinforce those of Helmberger, namely that in monopoly and oligopoly situations, open membership cooperatives play an important competitive yardstick role in moving output and price levels closer to those of perfect competition." Closed membership cooperatives or cooperatives that retain their earnings as unallocated reserves will not disturb the equilibrium in oligopsony markets. The latter remains true if the cooperative members do not expand production (by buying out members who supply the private firms), the retained earnings are used only in ways competitors view as nonthreatening, and in the case of processing cooperatives, output is sold in perfectly competitive markets. "If the cooperative has a nonnegligible share of the output market and members are free to expand output in response to higher prices, an oligopolistic

¹⁹ NARP is the net average revenue product and NMRP is the net marginal revenue product, or in common 'economish', average revenue and marginal revenue.

²⁰ "Simply by adopting the open membership principle, the co-operative has a salutary effect on its competitors, since, although it tends to produce too much and to pay its members too high a supply price, the other firms tend to produce too little and to pay too low a price for the raw product." (LeVay, 1983b.)

²¹ I have not been able to get hold of Cotterill's report. See footnote 2.

cooperative may 'break the market' for the processed product, causing its IOF's competitors to withdraw."

It seems that the oligopoly/oligopsony models discussed in the literature tend to create corner solutions. The open membership cooperative will either produce too much, or drive the whole market to the competitive solution. The closed membership cooperative is good for its members, but does not have a favorable impact on overall market performance in most cases. When modeling markets with marketing cooperatives it is quite common to assume that the final product is sold in a perfectly competitive market, thus avoiding any questions about what happens to consumer surplus in these markets. This is also the case with Sexton's model, which I will briefly outline below. His model does however suggest an interesting explanation for the division of the market, and why in equilibrium there might be cooperatives competing with private firms.

Sexton (1990) analyses a cooperative mixed oligopsony where it is assumed that the processors are faced by a spatial market for raw input supply from farmers, and are price takers in the final market.²² Plant locations and the number of firms are fixed and competition takes place in n directions. The spatial element allows the purchaser to earn some profit, the competition taking place over the marginal supplier or the border-line supplier. Equilibrium behavior requires that net prices of rivals (net of transportation costs) are equal at their common borders. Sexton assumes that the farmers have to cover the transportation costs to the processing plant, thus the suppliers will weigh the extra revenue paid by the cooperative against the extra transportation costs they must bear. The effect of offering a higher price to farmers is greater supply from current suppliers plus larger market radius (i.e. supply from more farmers).

Sexton compares the effect on farm-processor price spreads when a private firm competes with open or closed membership cooperatives with the outcome when competition takes place between private firms only. The outcomes resulting from different conjectures about the rivals' behavior are compared. The different behavioral conjectures being

²² Transportation costs are likely to be important with regard to the raw product, but not to the same extent with regard to the processed product. The raw product is often more perishable than the final product.

Loschian competition (LO) where each competitor behaves as if his market area is fixed; Hotelling-Smithies competition (H-S), where each competitor believes his actions will not affect his rivals' prices; and Cournot-Nash competition (C-N) where the firm believes that its quantity changes will go unheeded by rivals. Competitive behavior is more desirable when the processor believes (rationally) that he can encroach upon the cooperative's market area. In a non-spatial world, the open membership cooperative drives its rivals to the competitive solution. The closed membership cooperative is modelled such that it maximizes per unit refund ($NARP = NMRP$), whereas the open membership cooperative operates on a zero-profit basis ($p = NMRP$).

Sexton's results are summarized in the following quotation: "..., when NARP is increasing over the range of grower supply, open membership is the optimal policy, and proposition 1 indicates that a cooperative elicits more competitive behavior (a lower price spread) from its rivals than would a comparable for-profit processor conjectured to behave in a Loschian, Cournot-Nash, or Hotelling-Smithies fashion. Conversely, a cooperative that fixes membership to maximize NARP provides a range of prices indicated by proposition 3 whereby a rival for-profit processor can rationally entertain Loschian conjectures and act like a monopsonist within its market area. A cooperative that maintains an open membership policy in spite of a diminishing NARP is predicted to have a more salutary effect on spatial competition than its closed-membership counterpart. From proposition 1, the NARP-pricing cooperative elicits a lower price spread from rivals than a comparable for-profit processor conjectured to pursue Cournot-Nash behavior." And regarding policy implications that can be drawn from his results, they "help justify favorable policies toward open membership cooperatives as procompetitive forces whose presence mitigates for-profit firms' opportunities to exercise monopoly or monopsony power."

When discussing his results, Sexton is exclusively interested in what happens to the farm-processor price spread, i.e., the welfare implications for farmers is the focus. Indeed, the presence of cooperatives induces the private firms to pay higher prices to their raw product suppliers. However, the price in the final market is given (the firms are price takers), and thus the competition for raw inputs does not affect consumers' surplus.

According to Sexton the model is easily extended to handle imperfect competition in the selling markets (footnote 7), but he does not comment on the welfare implications of such an extension. If the model is accommodated to a situation where the processors have market power in the final market, would this lessen the competitive yard-stick effect of the cooperative? The answer to this probably depends on the form of competition (strategic interaction) and to what extent the agents can commit to certain strategies. As Sexton notes, the competitive yard-stick effect is likely to be greater the more the private firms think they can capture market shares from the cooperative.

It is also common to discuss the magnitude of total transportation costs in spatial models. It is not clear to me whether the firms have identical market radiuses in equilibrium, but assuming that the cooperative and the private firm do not have equal market shares, transportation costs will be higher than first-best.

I think one must be careful when evaluating cooperatives' welfare effects only by looking at the revenues paid to farmers. More specifically, the cooperative's (as well as the rest of the market agents') behavior in the final market must be taken into account, and be compared with other possible market or regulatory arrangements. Sexton assumes a large market for the final product, i.e. infinite elasticity of demand. If this is not the case, the evaluation of cooperatives' market performance should take into consideration to what degree it brings us closer to first best. The direction of the effect on overall market performance, i.e., whether the cooperative yield more efficient solutions than the worst scenario, is not the only interesting aspect here. If we are still far from the first-best solution, the possibility exists that other means of regulation or market arrangements would do better, and is worth investigating. The positive effects of cooperatives acting in markets where market power can be exercised has been demonstrated by numerous contributions. But the demonstration of how well the cooperative does concerning overall welfare effects remains to be determined. It seems reasonable, though, that this should be investigated for specific markets and alternative institutional settings.

6. Concluding remarks.

The above model is highly simplistic, and can by no means be used to make

authoritative policy suggestions. The model should be viewed as an attempt to clarify the basic structures of mixed markets and to establish the relevance of comparing the different models of mixed markets as alternative indirect regulation structures. The analysis shows that the overall performance of the cooperative mixed duopoly is inferior to that of a public firm mixed duopoly. Compared to the private duopoly solution the cooperative improves welfare for its members and also for consumers. This happens at the expense of the non-members and the private processor. The result of the public firm mixed duopoly is to expand total output even further, although not all the way to first-best. The member group is better off than in first-best when supplying to the public firm, but this is the worst scenario for the non-member group.

It is my intention to go on to analyse the welfare effects in a model where the competition for inputs is taken into account. Such an analysis will have to discuss implications of different assumptions about the cooperative's membership policies, way of distributing revenues from the cooperative operation and ability to price discriminate between different consumer groups. The challenge is to combine a model a la Sexton and a model with incomplete competition in the final market.

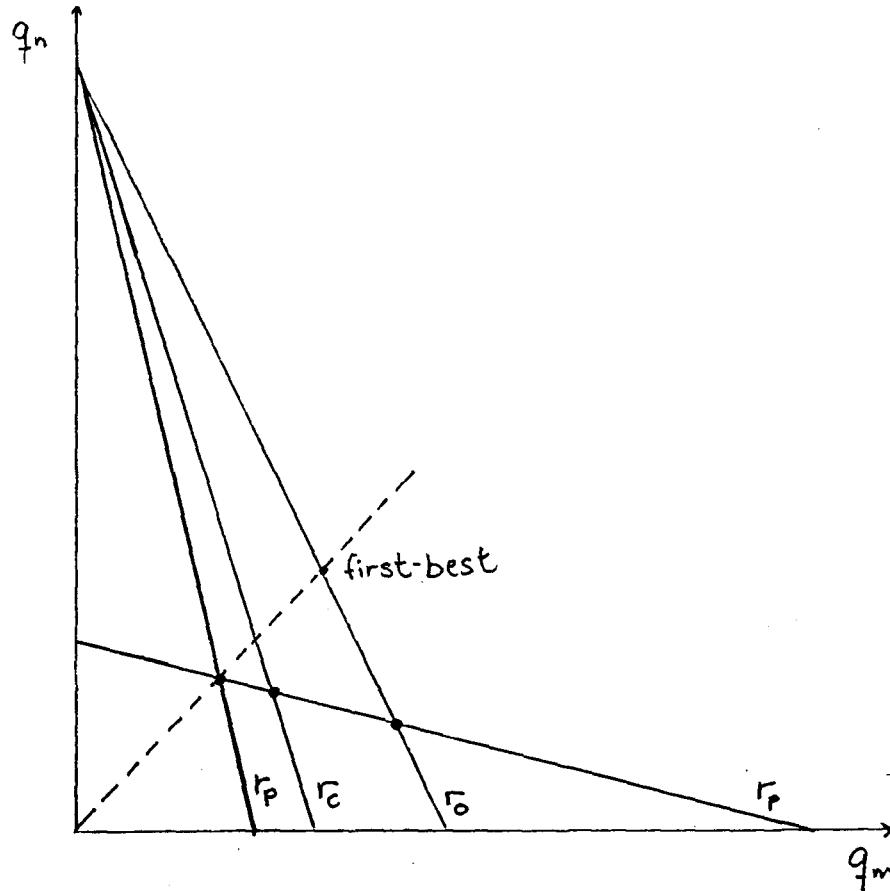
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APPENDIX I:

Figure 1: Reaction functions of different Cournot duopoly agents.



APPENDIX II:

I have used the following notation: subscripts n and m refers to the two raw producer groups, non-member and member respectively, and superscript or subscript i refers to the market arrangement. Thus Π_j^i denotes the surplus of farmers (raw producers), $j = n, m$, and $i = c, o, p, f$ refers to the market structure. Π_r^i is the surplus of the "regulated" duopolists, where $r = c, o$, and Π_p^i is the surplus of the private duopolists.

Table 1: Equilibrium values

	Cooperative mixed duopoly	Public firm mixed duopoly	First-best	Private duopoly
q_m^{i*}	$\frac{a(2k+1)}{b}$	$\frac{a(2k+1)}{d}$	$\frac{a}{k+2}$	$\frac{a}{2k+3}$
q_n^{i*}	$\frac{a(k+1)}{b}$	$\frac{ak}{d}$	$\frac{a}{k+2}$	$\frac{a}{2k+3}$
Q^i	$\frac{a(3k+2)}{b}$	$\frac{a(3k+1)}{d}$	$\frac{2a}{k+2}$	$\frac{2a}{2k+3}$
p_i	$\frac{a(2k^2+3k+1)}{b}$	$\frac{ak(2k+1)}{d}$	$\frac{ak}{k+2}$	$\frac{a(2k+1)}{2k+3}$
Π_m^i	$\frac{a^2}{2b^2}(4k^3+20k^2+9k+2)-F$	$\frac{a^2}{2d^2}(4k^3+4k^2+k)$	$\frac{a^2k}{2(k+2)^2}$	$\frac{ak}{2(2k+3)}$
Π_n^i	$\frac{a^2}{2b^2}(k^3+2k^2+k)$	$\frac{ak^2}{2d}$	$\frac{a^2k}{2(k+2)^2}$	$\frac{ak}{2(2k+3)}$
Π_r^i	$(-F)$	$(-F)$	-	-
Π_p^i	$\frac{a^2}{2b^2}(k^3+3k^2+3k+1)-F$	$\frac{a^2k^2}{d^2}(k+1)-F$	-	$\frac{a^2(k+1)}{(2k+3)^2}-F$
W^i	$\frac{a^2}{2b^2}(7k^3+29k^2+28k+8)-2F$	$\frac{a^2}{2d^2}(7k^3+15k+7k+1)-2F$	$\frac{a^2}{k+2}-2F$	$\frac{a^2(3k+4)}{(2k+3)^2}-2F$
w_n^i	$\frac{a}{b}k(k+1)$	$\frac{ak^2}{d}$	$\frac{ak}{k+2}$	$\frac{ak}{2k+3}$

$$b = 2k^2 + 6k + 3 \quad d = 2k^2 + 4k + 1$$