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Cooperatives in Oligopolistic Industries: The Western Canadian Fertilizer Industry

by

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Articles

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A major conclusion of cooperative economic theory is that cooperatives are able to improve the efficiency of the markets in which their members are directly participating. Enke and Taylor, for instance, show that if a single consumer cooperative, acting so as to maximize the welfare of its members, were to replace a profit-maximizing monopolist, the result would be an improvement in the well-being of the members and an increase in the level of society welfare. Helmberger, in discussing marketing cooperatives for farmers, concludes that in many circumstances the existence of a cooperative will push a market toward the competitive outcome.

More recently, cooperative theory has moved away from analyzing the cooperative as the only firm in the industry and has begun to examine questions regarding the impact of cooperatives on industries that are oligopolistic in nature. Rhodes examines the role of the large agricultural cooperative as a competitor alongside investor-owned firms, while Cotterill analyzes the impact of cooperatives on industrywide performance under various market structures. Sexton and Sexton examine entry of a cooperative into an industry and the behavior likely to be taken by the incumbent firms to forestall such entry.

The purpose of this paper is to investigate empirically the impact of a cooperative on a market that is oligopolistic in nature. As a focus to the analysis, the western Canadian fertilizer market will be examined. Until recently, four cooperatives owned and operated plants in this industry.

The paper will begin with a review of the structure of the western Canadian fertilizer industry. A summary of the relevant literature on the pricing and output behavior of the cooperative enterprise will then be undertaken. With this framework in place, the impact of a cooperative entering the industry will be analyzed from a theoretical point of view and a comparison made to the actual behavior of the industry. A summary and suggestions for further study will conclude the paper.

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Table 1.—Consumption of Commercial Fertilizers, by Province and Nutrient, 1981–86

Year	Province			
	Manitoba	Saskatchewan	Alberta	Total Prairies
		thousand tonnes		
		Nitrogen (N)		
1981	154.4	167.7	302.2	624.3
1982	167.1	192.0	299.4	658.5
1983	171.5	222.5	303.8	697.8
1984	205.1	289.3	335.9	830.3
1985	236.1	296.4	353.5	886.0
1986	236.0	317.8	308.9	862.7
		Phosphate (P_2O_5)		
1981	91.9	140.1	154.6	386.6
1982	85.5	143.2	148.4	377.1
1983	85.0	160.6	162.3	407.9
1984	103.3	186.3	166.8	456.4
1985	105.9	185.0	174.1	465.0
1986	105.4	185.5	154.6	445.5

Source: Agriculture Canada, *Handbook of Selected Agricultural Statistics*, 1986.

The Western Canadian Fertilizer Industry

The fertilizer industry in western Canada is dominated by five firms: Cominco, Sherritt Gordon, Simplot, Imperial Oil, and Western Co-operative Fertilizers Ltd. (WCFL). Although there has been a substantial increase in the amount of fertilizer (particularly nitrogen) used in recent years (table 1), no major new firms have entered the industry since WCFL, Simplot, and Imperial Oil began production in 1964, 1967, and 1969, respectively (Bayri, Rosaasen, and Furtan). WCFL, which is owned by Alberta Wheat Pool, Saskatchewan Wheat Pool, Manitoba Pool Elevators, and Federated Cooperatives Limited, mothballed their Calgary plant and permanently closed their Medicine Hat operation in the summer of 1987, thereby leaving WCFL with no production capability of its own (Saskatchewan Wheat Pool).

The lack of entry into the industry, along with the small number of firms, suggests that the existing firms in the industry may be restricting entry, and likely possess market power. In 1976 the five firms in the industry, along with Northwest Nitro-Chemicals Ltd. (a fertilizer distributor), were charged with the fixing of nitrogen prices to western Canadian farmers. This case was closed in 1980 with a "not guilty" verdict. It has also been suggested that the industry has followed a limit pricing strategy whereby they earn above normal profits but also deter entry by new firms (Bayri, Rosaasen, and Furtan).

The western Canadian market for fertilizer is quite different from that in the western and midwestern United States. During the 1980s, fertilizer consumption patterns in these regions followed very different paths. For

Table 2.—Revenues and Operating Profits for Selected Western Canadian Fertilizer Companies, 1978–87

	Sherritt Gordon					Cominco				
	Revenue	Operating Profit	Total Costs*	Profit/ Revenue	Profit/ Costs	Revenue	Operating Profit	Total Costs*	Profit/ Revenue	Profit/ Costs
	------- *($ million Cdn)* -------					------- *($ million Cdn)* -------				
1978	47	16	31	0.35	0.53	271	35	236	0.13	0.15
1979	54	18	36	0.33	0.49	317	54	263	0.17	0.21
1980	65	21	44	0.32	0.46	393	97	296	0.25	0.33
1981	85	22	63	0.25	0.34	467	98	369	0.21	0.27
1982	80	18	62	0.23	0.29	386	38	348	0.10	0.11
1983	111	23	88	0.21	0.26	422	36	386	0.09	0.09
1984	157	35	123	0.22	0.28	461	67	394	0.15	0.17
1985	167	44	123	0.26	0.36	444	26	418	0.06	0.06
1986	139	23	116	0.17	0.20	359	-19	378	−0.05	−0.05
1987	120	−1	120	0.00	0.00	78	7	71	0.09	0.10
Average				0.23	0.32				0.12	0.14

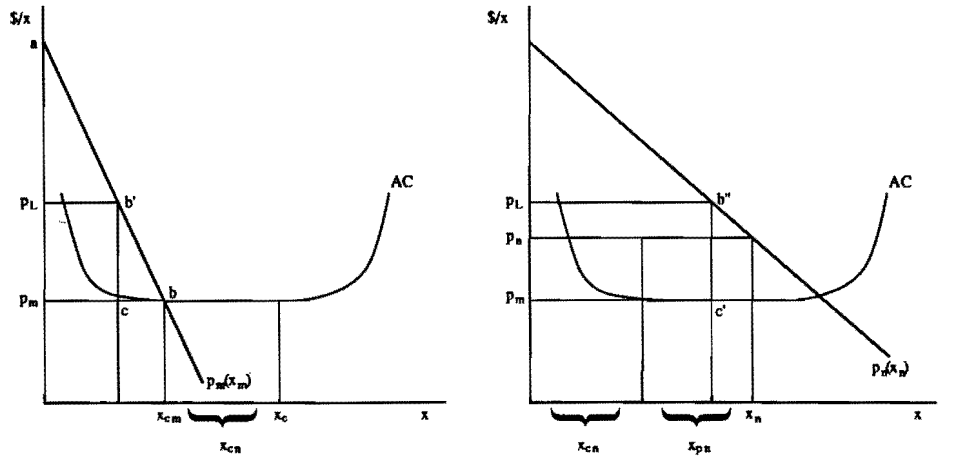
*Calculated by subtracting Operating Profit from Revenue.
Source: Sherritt Gordon and Cominco, *Annual Reports*, selected years.

instance, Cominco reported in its 1983 *Annual Report* that nitrogen fertilizer consumption for that year increased 5.7 percent in Canada, while it declined 16.3 percent in the United States. Phosphate demand behaved in a similar manner, increasing 5.3 percent in Canada and declining 13.5 percent in the United States. In addition, there is evidence that the western Canadian market is viewed as the more profitable by the fertilizer companies. Sherritt Gordon remarked in its 1987 *Annual Report* that "Total volume of Sherritt fertilizer sales increased 9 percent in 1987 but more profitable domestic sales declined in line with reduced overall demand in western Canada."

The revenue and operating profit data for two of the firms operating in the western Canadian fertilizer market, Cominco and Sherritt Gordon, are presented in table 2. Both Sherritt and Cominco produce nitrogen and phosphate fertilizers, and Cominco also produces potash. Sherritt Gordon sells approximately 75 percent of its production into the western Canadian market (Sherritt Gordon 1984), and Cominco divides its sales roughly 50:50 between Canada and the United States (Cominco 1987). Sherritt's higher operating profit to revenue ratios, when combined with their greater dependence on the Canadian market, is again suggestive of a western Canadian market that is more profitable than that in the United States.

The numbers in table 2 can be interpreted with some knowledge regarding the structure of costs. It is argued that in the fertilizer industry average costs fall rapidly over some initial range of production. As illustrated in figure 1, average costs then level off and remain relatively constant over a fairly wide range (Bayri, Rosaasen, and Furtan). This type of cost structure is quite common to industrial firms (Baumol, Panzar, and Willig). Over the range of output where average cost is constant, marginal cost will be constant and equal to average cost. Thus, assuming that firms achieve a level

Figure 1.—Pricing and Output for Cooperative Members and Nonmembers



of production that takes them into the constant average cost range, marginal cost will be the same as average cost (and vice versa).

In an oligopolistic industry, the price set by firms is a markup over marginal cost, with the markup determined by the market share, the elasticity of demand, and the conjectural variations held by each firm (Jacquemin). A measure of this markup can be obtained by taking the ratio of operating profits to total costs. Using the difference between revenues and operating profits as an indication of total costs, table 2 presents markup ratios for Cominco and Sherritt Gordon. Since the cost and profit data include both nitrogen and phosphate production (and, for Cominco, potash production), the ratios in table 2 should be interpreted as an average of the markup ratios for the different fertilizers produced.

The apparent greater profitability and higher markups in the western Canadian fertilizer market raise questions regarding why other firms have not entered this industry in response to this profitability. In particular, the question raised in this paper is why cooperatives have not taken a more active role in this market in an effort to reduce some of the oligopolistic power that appears to be exerted. The following sections examine these questions from the point of view of oligopolistic industries and barriers to entry. The next section presents a short review of the cooperative pricing and output literature, and the sections following examine barriers to entry and the behavior of a cooperative in an oligopolistic industry.

Cooperative Pricing and Output Behavior

The theoretical literature on cooperatives suggests a cooperative may be able to exert a beneficial influence on an industry, making it more compet-

itive and efficient. This section reviews this literature, concentrating on two of the behavioral rules that are often ascribed to cooperatives: marginal cost pricing and average cost pricing.[1]

The cooperative is usually distinguished from the profit-maximizing firm on the basis of three criteria: democratic control by the members on the basis of one-member/one-vote, limited payment on capital, and distribution of the earnings of the organization based on patronage.[2] The cooperative does not use the amount of capital that a person has invested in the organization as the basis for determining voting power or allocating surplus. Instead, the basis for such decisions is either the member per se or the amount of business the member does with the cooperative (LeVay).

The fact that a member does business with the cooperative suggests a further distinction—cooperative members both own and do business with the organization. Therefore, cooperative members will not only be interested in how much profit the organization makes, they will also be concerned with the effect the price that is charged has on their welfare. Formally, this translates into a concern for the profits earned by the cooperative and the producer surplus earned by the members on their own farming operations.

To maximize the sum of profits and producer surplus, the appropriate behavior is to set marginal cost equal to price; this is equivalent to producing the level of output that equates the demand curve for the product with the marginal cost of producing the good. Although marginal cost pricing is the behavior rule that maximizes members' welfare, it may not be the rule that is actually adopted by the cooperative. Instead, the cooperative may find it is forced to set price equal to average cost. This situation arises when the cooperative members are unable to distinguish between the price they pay for the good they receive and the patronage dividends that are paid to them by the cooperative (Gislason; Trifon; Ireland and Law). In instances such as this, cooperative members view the patronage payments as a discount on the price they pay and correspondingly demand more of the product than the cooperative should optimally supply. In such cases, the members will find themselves worse off than had marginal cost pricing been supported.

Average cost pricing behavior is likely to result whenever marginal cost and average cost differ substantially at the output level that maximizes member welfare.[3] For those industries in which average cost is constant over a wide range of production (e.g., the fertilizer industry), average cost and marginal cost will be equal over this output interval. This implies that average cost pricing and marginal cost pricing will be identical. Members' welfare will be maximized no matter which rule is chosen, and the price and quantity levels that result will be equal to competitive levels.

Oligopolistic Industries and Entry by New Firms

In modeling an oligopolistic industry, whether it be composed of cooperatives and/or profit-maximizing firms, the main problem is one of the interrelationships between the firms in the industry. In contrast to models where there are a large number of firms or there is only a single firm,

oligopoly models provide no unique answer to the problem of market output and price determination. In an oligopolistic industry, each firm realizes that it has market power and that its actions may influence those of other firms in the industry. The assumptions that are made with regard to how firms see their rivals reacting to their actions (i.e., conjectural variations) is what distinguishes the virtually infinite number of oligopoly theories from each other.

A common model used in the analysis of oligopolistic industries is the Cournot-Nash model. In this model, the assumption is made that each firm in the industry believes that if it should change its level of output, the other firms will not respond with a change in their level of output (i.e., the conjectural variation is zero). Although other assumptions regarding the reactions of firms are possible, the Cournot-Nash model is an useful comparison because it reflects noncooperative behavior by all the firms in the industry (Friedman, Jacquemin).

An important result of the industrial organization literature is that a firm will base its decision to enter an industry on the level of profits it can expect to earn after it has entered. According to the standard Cournot-Nash model, when a firm enters an industry, the optimal response by the incumbent firms is to reduce their output, thereby accommodating the entrant. The implication of this is that incumbent firms cannot use the pre-entry price (e.g., a limit price) to prevent entry of a profit-maximizing firm.Pre-entry price strategies are typically based on the assumption that incumbents will maintain their production levels when a new firm enters. However, once entry occurs, it is usually not optimal for the incumbent firm to behave in this manner, with the result that pre-entry price strategies are generally not credible (Jacquemin).

Since the incumbents know that this is the problem they face in attempting to keep firms out of the industry, they can influence the answer. One possibility is to invest in a level of capital that changes their post-entry Cournot-Nash behavior in a manner that is profit-reducing and, hence, entry-deterring for the new firm. A similar type of strategy is possible when the incumbent firms find it costly to change price or output in the short run. The incumbent firms in this position may reduce price or increase output in the pre-entry period with the knowledge that when the new firm enters, they can only accommodate the entrant (i.e., raise price or lower output) slowly over time.During the adjustment period the entrant may incur a loss, thereby deterring it from entry. Another strategy, and one that is examined below in more detail, is for the incumbent firms to incur a fixed and nonrecoverable cost (e.g, advertising, a particular type of technology) that entrants are also required to incur. If this fixed cost is larger than the profits that an entrant could make upon entry, then entry will be deterred (Friedman, Jacquemin).

Cooperative Pricing and Output Behavior: The Oligopolistic Case

For a profit-maximizing firm, entry into an industry will prove profitable if the post-entry level of profit that the entrant expects to earn is greater

than the pre-entry level of profit, namely zero. In analyzing a cooperative as a potential entrant, a similar comparison must be made. However, there are some important differences. First, the comparison should be between the pre-entry and post-entry level of member welfare (i.e., profits plus producer surplus), since this is the concern of the members of the cooperative entrant. In particular, if the level of welfare earned by the cooperative members is greater after entry than before entry, there is an incentive for the cooperative to enter.

Second, although the incumbent firms cannot influence the pre-entry profits of the profit-maximizing firm, they can influence the pre-entry level of welfare of the cooperative entrant. By lowering price, for example, the incumbents can influence the level of producer surplus the cooperative members earn prior to entry, thereby influencing the benefits of entry. As will be seen, this means that cooperatives may be deterred from entering an industry by the use of a price strategy. Although this gives the incumbents more tools with which to restrict entry, it also reduces their ability to exert market power (Sexton and Sexton).

To determine whether a cooperative will enter an industry, it is thus necessary to examine the pricing and output strategy of the incumbents before entry and the pricing and output strategies of both the incumbents and the cooperative entrant after entry. It will be useful if the post-entry behavior of the profit-maximizing incumbents and the cooperative are analyzed first. With knowledge of their behavior in this period, the pre-entry strategy of the incumbents can be determined more easily.

Assume that after entry, there are two firms in the industry, a cooperative and a profit-maximizing firm. Each produces a homogeneous good and has costs of production $c_i(x_i)$ (i = c [cooperative], p [profit-maximizing]). The inverse demand curves for fertilizer by cooperative members and nonmembers are denoted $p_m(x_m)$ and $p_n(x_n)$, respectively. The aggregate inverse demand curve is $p(x)$, where $x = x_m + x_n$. Assume that all the cooperative members patronize the cooperative, while the nonmembers may purchase from either firm. The quantity purchased by nonmembers from the cooperative is denoted x_{cn}, while the quantity purchased from the profit-maximizing firm is x_{pn} ($=x_p$); $x_n = x_{cn} + x_{pn}$. The total amount purchased from the cooperative is $x_c = x_m + x_{cn}$.

The assumption of a homogeneous good means that the cooperative and the profit-maximizing firm must charge the same price, p_n, to nonmembers if both wish to capture a share of this market. The price charged to cooperative members is p_m and need not equal p_n. Assume also that both the cooperative and the profit-maximizing firm follow Cournot-Nash behavior; that is, in making their decisions, both firms assume that the other firm will leave its output unchanged when each changes its own level of output.

The problem facing the cooperative can be written as:

$$\max_{x_m x_{cn}} W = \int_0^{x_m} p_m(z)dz + p_n x_{cn} - c_c(x_m + x_{cn}) \qquad (1)$$

while the problem for the profit-maximizing firm is:

$$\max_{x_{pn}} \Pi = p_n x_{pn} - c_p(x_{pn}). \tag{2}$$

Assuming Cournot-Nash behavior on the part of the two firms, the first-order conditions for the cooperative are:

$$\frac{\partial W}{\partial x_m} = p_m(x_m) - c_c'(x_c) = 0 \tag{3}$$

$$\frac{\partial W}{\partial x_{cn}} = p_n + p_n' x_{cn} - c_c'(x_c) = 0 \tag{4}$$

while for the profit-maximizing firm the first-order condition is:

$$\frac{\partial \Pi}{\partial x_{pn}} = p_n + p_n' x_{pn} - c_p'(x_{pn}) = 0 \tag{5}$$

Equation (3) implies that the cooperative should set the price to its members equal to marginal cost (figure 1). Given that cooperative member and nonmember demand is sufficient to exploit the scale economies (i.e., that x_c is in the range of constant average cost), the cooperative should charge members a price p_m that is equal to the competitive price.

The farmers who are not members of the cooperative will be charged a price (p_n) that exceeds marginal cost (figure 1). This follows from the fact that p'_n is less than zero, which in turn implies that p_n must exceed the marginal cost of both the profit-maximizing firm and the cooperative. This also implies that p_n will exceed p_m.[4]

Assuming constant and identical marginal costs for both the cooperative and the profit-maximizing firm, the nonmember market will be divided evenly between the two firms. With constant marginal costs in the relevant range of output, the level of sales the cooperative chooses to make to members and nonmembers will not influence its overall marginal cost of production. Thus, no matter what the total level of output, $c_c'(x_c)$ will equal $c_p'(x_p)$. This means that equations (4) and (5) are identical, except for the designation of cooperative versus profit-maximizing, thereby implying that $x_{cn} = x_{pn}$.[5]

If cooperative membership is open, the nonmember price of fertilizer is unlikely to remain above the member price in the long run. In an attempt to maximize the profits on their farms, nonmembers will join the cooperative to be able to purchase fertilizer at the lower price. This will either drive the profit-maximizing firm out of business or will force it to lower its price to equal the cooperative member price. Either way, the result is one price for fertilizer. This price will equal marginal cost because the cooperative will always supply its members with fertilizer at marginal cost.

The existence of the cooperative in the industry causes the profits of the profit-maximizing firm to fall to zero.Thus, while it is in the best interests of the cooperative members to have a cooperative enter the industry, clearly it is not in the interests of the incumbent profit-maximizing firm. This raises the question of whether the profit-maximizing firm can restrict entry of the cooperative, and, if this is possible, what the costs would be of doing so.

Suppose that in order for the cooperative to enter the industry, it must incur a cost K.[6] If the total welfare earned by the members prior to the cooperative's entry is greater than the welfare earned by the members after entry (less the entry cost K), then it will not pay the cooperative to enter. This suggests the profit-maximizing firm may be able to deter entry by the cooperative.

After entry by the cooperative, the welfare of the cooperative members is given by the area under the members' demand curve for fertilizer and above the price charged to members, i.e., area abp_m (figure 1). What about member welfare before the cooperative enters the industry? Suppose that prior to entry, the incumbent firm sets a price equal to p_L. This reduces the pre-entry welfare of members to the area $ab'p_L$. Thus, compared with the pre-entry level of welfare, the members experience a gain in welfare equal to $p_Lb'bp_m$ if they form a cooperative and enter the industry.

If the cooperative is looking at a T-period horizon, it will clearly be in the best interests of members to enter the industry if the cost, K, is less than the discounted sum over T periods of the welfare change, $p_Lb'bp_m$, i.e., entry will take place if:

$$K < \sum_{t=1}^{T} \alpha^{t-1} p_L b' b p_m$$

where $\alpha < 1$ is the discount parameter.

The above expression indicates the conditions under which the cooperative will enter the industry; it also, however, gives the circumstances under which entry can be deterred. If the profit-maximizing firm sets the cooperative limit price, p_L, low enough so that the inequality in equation (6) above is reversed, it can deter entry while at the same time allowing itself to earn a positive level of profits, $p_Lb'cp_m$ plus $p_Lb''c'p_m$, in each time period. In an effort to maximize profits and still deter entry, it can be expected that the incumbent will charge a price, p_L, that makes the inequality in equation (6) an equality. The implication of this is that the cooperative members will be indifferent between entering or not entering the industry—in short, the threat of entry alone ensures cooperative members a maximum level of welfare.

The idea that threat of entry can lead to a competitive or near competitive price is suggestive of sustainable prices and contestable markets (Baumol, Panzar, and Willig). Indeed, both cooperative limit prices and sustainable prices are the response by incumbents to the possibility of entry by new firms. However, there are a number of important differences. In a perfectly contestable market, it is assumed that firms can enter and exit the industry without cost and without any immediate response by the incumbent firms. The first assumption is explicitly rejected in this paper by the requirement that entrants must incur a cost K to enter the industry. The effect of an entry cost is that the market price can be kept above the competitive level because, even if the entrant can earn the same level of profits as the incumbent did before entry occurred, it will have to incur the fixed cost K.[7] However, if the potential entrant is a cooperative, then the cooperative limit price will be lower than the price that will deter a profit-maximizing firm. This follows because, for any given price, the level of member welfare is

always greater than the level of profits. As a result, the price that will equate discounted member welfare with the entry cost K (i.e., the cooperative limit price) will always be less than the price that equates discounted profits with K.

The assumption that the incumbent firms will not respond to entry is also rejected in this paper. In fact, it is assumed in the model above that the cooperative and the profit-maximizing firm engage in a Cournot-Nash game after entry occurs, a game that assumes the incumbent is able to alter its price and output when the new firm enters. As pointed out in the previous section, entry by a profit-maximizing firm in models of this type will not cause the price to fall to the competitive level. Instead, it will be optimal for both the incumbent and the entrant to set output in such a fashion that price will be above marginal cost. With the cooperative as the entrant, however, this result is altered. Prices fall to marginal cost (at least for members) because of the cooperative's interest in member welfare as opposed to profits.

To summarize, the similarity between cooperative limit prices and sustainable prices is a result of the objective function given to the cooperative, rather than the assumptions of perfectly contestable markets. More specifically, the concern the cooperative has for member welfare, rather than assumptions of no-cost entry and exit and no adjustment by incumbent firms, results in a situation where price may approach marginal cost. In this way the model of this paper follows very much in the spirit of the cooperative monopoly models discussed earlier.

There are a number of other factors that should be considered in determining the limit price. First, since all farmers are potential members of the cooperative and all gain from its entry into the industry, it may be argued that all farmers are effectively members of the cooperative. This implies that member welfare should be given by the area under the total demand curve and above the price p_m. Under this view of the cooperative, the profit-maximizing firm finds that entry can be deterred, but only by setting a much lower limit price. This, of course, increases the level of welfare earned by members even in the absence of the cooperative actually entering. However, consideration of all farmers as members of the cooperative implies that an effective method for their participation exists. The logic of collective action suggests that such a method may be difficult to find (Olson).

Second, the time horizon of the cooperative may play a critical role. As Staatz (1984) points out, cooperative memberships cannot be traded. The horizon of a cooperative member may therefore be limited to his or her lifetime, resulting in an inability of cooperative members to see any advantage today of savings that are incurred well into the future. The effect of a shorter time horizon is to increase the level at which the profit-maximizing firm can set the limit price (see equation [6]).

Third, the cooperative limit price is also a function of the level of the fixed cost K. As Jacquemin points out, it would be realistic to suppose that this cost is determined at least in part by the actions of the incumbent firms and thus cannot be taken as an exogenously determined parameter. As part of their strategic behavior, the incumbent firms recognize that while a higher level of K would reduce their profits, it would also increase the

price that they would be able to charge without fear of entry. If the extra profit earned as a result of raising the level of K is greater than the cost incurred, then the incumbents could be expected to raise the level of K. This can be done through such things as advertising or the adoption of technology that is highly specific to the fertilizer industry.

In summary, a profit-maximizing firm can deter the entry of a cooperative into an industry with the use of a limit price. This result is in contrast to the situation where the new entrant is a profit-maximizing firm. As was pointed out earlier, a profit-maximizing firm is unlikely to be deterred by a limit price, since what determines whether a profit-maximizing firm enters or not is the post-entry level of profits, not the pre-entry level. The cooperative, however, can be deterred from entering by an appropriately chosen limit price. The presence of a cooperative entry threat can therefore be expected to keep industry prices close to the competitive level plus the cost of entry.

An Application to the Western Canadian Fertilizer Industry

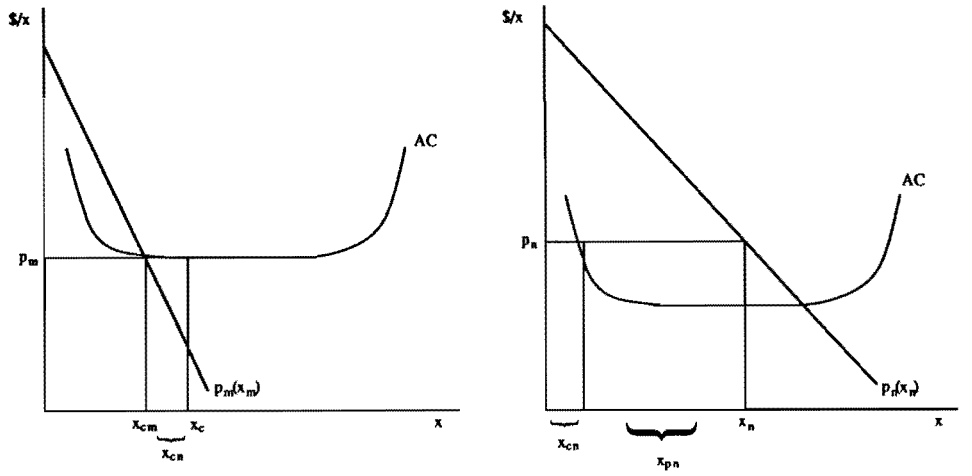
The theoretical model developed above suggests that the presence of a cooperative in the industry should result in a long-run price that is at the competitive level. It was shown earlier in the paper, however, that fertilizer does not appear to be priced at marginal cost, a result that is in agreement with the findings of Bayri, Rosaasen, and Furtan. In other words, even prior to the closing of the WCFL plant, the fertilizer industry was not operating competitively.

This finding may not be unexpected, however, since it is known that WCFL has operating costs that are substantially above those of the other firms in the industry (Blue, Johnson and Associates). Equations (3)–(5) imply that if the cooperative has higher marginal costs $[(c_c'(x_c) > c_p'(x_p)]$, then it could price at or near marginal cost to members (equation [3]) and still sell a small amount of material to the nonmember market at a price higher than its marginal cost (equation [4]).[8] One possible solution is presented in figure 2. Members purchase fertilizer at price p_m, while nonmembers pay a price of p_n. If the difference in costs between the cooperative and the profit-maximizing firms are large enough, then the member and nonmember prices would be very close to each other.

It should be noted that the type of price discrimination assumed in the above model does not appear to occur in practice, however. Evidence from the Saskatchewan Farm Input Survey suggests that prices charged by the Saskatchewan Wheat Pool are similar to those charged by other fertilizer retailers. In addition, there is no procedure for cooperative members to pay a lower price than other customers if they do patronize the cooperative.[9]

One reason for the lack of price discrimination might be that the profit-maximizing firms have reduced price to p_m (figure 2) to remain competitive with the cooperative. Since their average cost is less than p_m, the profit-maximizing firms can charge a price equal to that of the cooperative and still make a profit. Another possibility is that the cooperatives may have decided not to practice price discrimination, but instead to charge their

Figure 2.—Pricing and Output When Marginal Costs are Different



members the same price as nonmembers. This could result in the cooperative realizing a profit if the market price was above p_m. If the cooperatives did pursue such behavior, it might indicate they did not feel the cost of price discrimination warranted the extra member welfare it gave rise to, or it might indicate that they were more interested in the level of profits than the level of member welfare.

Although the relatively more costly production of the cooperative is one explanation for why price has been historically above the competitive level, the question remains as to why the cooperatives have not invested in new facilities in order to lower their costs, which in turn could result in lower prices. To examine this question, it is necessary to examine the impact that such investment would have on the welfare of cooperative members.

Calculations of the welfare loss experienced by cooperative members as a result of noncompetitive pricing in the western Canadian nitrogen fertilizer industry are presented in table 3. The numbers in table 3 represent the net present value of the change in producer surplus that results when price is lowered from the oligopolistic level to the competitive level, i.e., an estimate of the value of the expression on the right-hand side of equation (6).

In calculating the change in producer surplus for members, it was assumed that a reduction in the fertilizer producer price from the oligopolistic level to the competitive level would reduce the retail price (which includes a retail and transportation margin) by a similar amount.[10] The oligopolistic price is calculated by increasing the competitive price by 30 percent, the average markup calculated for Sherritt Gordon (see table 2). An estimate of the competitive price was obtained from Bayri, Rosaasen, and Furtan. The calculations were done for different demand elasticities, different time hori-

Table 3.—Estimates of Cooperative Members' Welfare Loss From Noncompetitive Pricing in the Nitrogen Fertilizer Industry, 1986.

Elasticity	−0.2			−0.4			−0.6		
Time	% Farmers as Co-op Members			% Farmers as Co-op Members			% Farmers as Co-op Members		
Horizon	100	60	40	100	60	40	100	60	40
Years	*$ millions Cdn*								
	30 percent markup								
1	68	41	27	69	42	28	70	42	28
2	127	76	51	129	77	52	131	78	52
15	709	425	283	719	431	288	729	437	292
20	851	510	340	863	518	345	875	525	350
25	962	577	385	976	586	390	990	594	396
30	1,050	630	420	1,065	639	426	1,080	648	432
	20 percent markup								
1	45	27	18	46	27	18	46	28	18
2	84	51	34	85	51	34	86	52	34
15	470	282	188	475	285	190	479	288	192
20	564	339	226	570	342	228	575	345	230
25	638	383	255	645	387	258	651	390	260
30	696	418	279	703	422	281	710	426	284

[a]The numbers in this table represent the net present value of the change in consumers' surplus that results when the retail price of nitrogen fertilizer is reduced by the difference between the oligopolistic price and the competitive price. The competitive price was assumed to be $260 per tonne N. This represents a 10 percent increase in the competitive price of $237 per tonne in 1984 calculated by Bayri, Rosaasen, and Furtan. The oligopolistic price is calculated by inflating the competitive price by the markup. See table 1 for examples of historical markups in the western Canadian fertilizer industry. A linear demand curve was assumed in order to make the consumers' surplus calculations.

[b]The retail price was assumed to be $535 per tonne N. In the fall of 1986, anhydrous ammonia (82-0-0) was retailing in Saskatchewan at approximately $440 per tonne. The $535 per tonne figure represents the nitrogen equivalent price. Source: Saskatchewan Farm Input Survey.

[c]All estimates are based on a fertilizer quantity of 862,000 tonnes N. This number represents 1986 total consumption of nitrogen in Manitoba, Saskatchewan, and Alberta. Source: Agriculture Canada, Handbook of Selected Agricultural Statistics, 1986.

[d] A discount rate of 5 percent was assumed.

zons, and different assumptions regarding the percentage of members who are cooperative members. The sensitivity of changing the markup to 20 percent is also examined. The prices and quantities used in the calculations are based on industry data for 1986.

The estimates in table 3 indicate, for instance, that if 40 percent of farmers were cooperative members, the elasticity of demand was −0.2, and the time horizon was 20 years, then these cooperative members would be willing to spend up to $340 million Cdn in 1986 to have a cooperative enter the industry and supply fertilizer at average (equals marginal) cost. If the cost of entering the industry was less than this amount, then it would pay a group representing 40 percent of farmers to enter the industry and establish a plant to produce nitrogen at the competitive price.

To put the figure of $340 million into perspective, the cost of building a nitrogen fertilizer plant in 1986 was approximately $425 million Cdn.[11]

However, it would be incorrect to compare the $340 million Cdn with the capital cost of $425 million Cdn and conclude that western farmers should not be investing in a fertilizer plant. According to economic theory, average cost should include a normal return to investment; thus, at least part of the $425 should be included in the competitive price. In a breakdown of the difference between revenue and operating profit, Sherritt Gordon included a charge for depreciation and amortization, thus giving support to the notion that the markups calculated in table 2 include at least some return to investment.

These numbers suggest there is room for cooperative members to influence the price of fertilizer. However, despite the fact that a large percentage of western Canadian farmers are members of a cooperative,[12] and that the market price for fertilizer appears to have been above the cooperative limit price, entry by cooperatives has not occurred. In fact, as mentioned above, the cooperative-owned fertilizer plant was among the most costly and inefficient and was recently shut down and mothballed.

One of the reasons that entry and/or expansion by a cooperative may not have occurred is that there exist other barriers to entry. For instance, if the cooperative found that in addition to the cost of the fertilizer plant, it was also forced to incur other entry or expansion costs, then it might find that entry was not worthwhile. It is expected that costs of this nature may well be present in the fertilizer industry, since they are one way that incumbent firms have of deterring entry. Further research is required to determine what these costs might be in the context of the western Canadian fertilizer industry and the degree to which they have deterred entry by both cooperatives and profit-maximizing firms.

A Modification of Cooperative Theory

There may be other reasons why cooperatives have not been entering the fertilizer industry. One of the more important factors may be that the cooperative is not making its decisions on the basis of the criteria that were assumed in the theoretical analysis. More precisely, it was argued above that while a profit-maximizing firm would be interested in maximizing profits, the cooperative should have as its goal the maximization of profits plus producer surplus.

Although this latter goal is a relatively easy objective to give a cooperative in a theoretical setting, it is much more difficult to translate into practice. For instance, cooperative members, directors, and managers can, without too much effort, forecast what their profits will be from a new or upgraded fertilizer plant. However, it is much more difficult to conceptualize and measure the impact of a new plant on the individual profits of each of the cooperative members. Without extensive economic modeling and education as to what producer surplus is, members may find it difficult to appreciate the additional part of the cooperative goal, let alone develop estimates or projections of it.

Cooperatives may also find it difficult to operate in the best interest of their members for another reason—the goals and objectives of the managers may not be the same as those of the members. The result is a principal-

agent problem.[13] Although problems of bureaucracy and improper incentive structures are important in profit-maximizing firms, it may be that in cooperatives the impact is more severe.

In profit-maximizing firms, the owners would like to see the corporation achieve maximum profits. However, because raises and promotions for managers are almost always based on the decisions actually taken, rather than on an examination of opportunities foregone, managers may be much more likely to undertake conservative strategies that ensure that the company is reasonably healthy and not open to major risks. Such behavior is expected to lead to less than maximum profits or growth. As well, managers and directors can be expected to withhold information to the management levels above them if the transmission of such information would prove injurious to their employment or chances of promotion (Monson and Downs).

Similar developments are also likely to occur in cooperatives. Although the boards of directors of cooperatives may be presumed to have similar goals to that of the members who elected them (although even this has to be questioned), such a supposition cannot be made in the case of managers. As in profit-maximizing companies, the typical cooperative manager will be interested more in his or her own personal goals than in the objectives of the members who own the cooperative. Thus, there is unlikely to be as much incentive to maximize profits plus producer surplus as the members would prefer.

In fact, if the promotion decisions regarding managers are made with a view to the way the cooperative has operated financially, the managers are not likely to be interested in making decisions that would indirectly benefit members, since such actions are almost invariably less profitable for the cooperative. Managers might be expected to withhold information to the members and the board of directors if such information suggested that the cooperative become involved in an undertaking that would appear to be poor "business." The result is the power of the board of directors to suggest and carry out its preferred policies may be eroded. This, in turn, suggests that it might be surprising indeed if cooperatives behaved in the manner suggested by theory.

Summary and Conclusions

The purpose of this paper was to examine the impact of cooperatives on oligopolistic industries. Interestingly, although farm leaders have often extolled the virtues of cooperatives in making the markets in which farmers participate more competitive, only recently has theoretical and empirical work been undertaken on the efficacy of cooperatives in industries where there exist a small number of profit-maximizing firms.

The theoretical analysis carried out in this paper suggests that the entrance of a cooperative into an oligopolistic industry can be expected to improve the efficiency of the industry. In particular, if the industry has a cost structure similar to that found in the fertilizer industry, the existence of a cooperative interested in maximizing member welfare will drive the price down to the competitive level. This result extends the conclusions drawn from an examination of the impact of a cooperative on a monopolistic

market. As well, the paper concludes that the threat of entry by a cooperative is enough to drive the market price to a level that is relatively close to the competitive level, and that merely by threatening to enter, cooperative members can obtain the welfare benefits of actually entering.

Although the theoretical results suggest that cooperatives should be quite active in entering or threatening to enter markets, the situation in the western Canadian fertilizer industry is much different. In this market, the cooperative-owned fertilizer plant, WFCL, was extremely hesitant in expanding its production and does not appear to have been acting in the manner of a new entrant.

There are a number of reasons to suggest why cooperatives may not behave as expected. First, the incumbent firms in the industry may have erected entrance barriers in the form of fixed costs that make it uneconomical (in the sense of increasing member welfare) for cooperatives to enter. Second, the information required to maximize member welfare is onerous to obtain and conceptualize. Third, the conclusions of the principal-agent literature suggest that even if members are aware of the proper actions for cooperatives, the managers may not have the proper incentives to carry out their wishes. In fact, since the managers' personal goals are much more closely linked to the profitability of the cooperative than to the members' welfare, it is to be expected that the cooperative would be reluctant to pursue projects that make the cooperative less financially sound.

Notes

1. See, for instance: Domar; Helmberger and Hoos; Enke; Anderson, Porter, and Maurice; Ireland and Law; Sexton; Taylor.

2. Other distinguishing characteristics include open and voluntary membership, cooperative education, and cooperation among cooperatives. These six features of cooperatives have been adopted by the International Cooperative Alliance in 1966 as the basic operating guidelines for cooperatives (Report of ICA).

3. For an empirical test of average versus marginal cost pricing, see Sexton, Wilson, and Wann.

4. The existence of profits from nonmember sales should not influence the purchasing decisions of members. Earnings from nonmembers are usually retained by the cooperative and are not redeemed to members; thus, members are not encouraged to purchase more of the good as a result of a patronage payment.

5. See note 8 for further proof and explanation.

6. The discussion in the remaining portion of this section is based on Sexton and Sexton.

7. Since it is assumed that the entrant can enter the industry before the incumbent can react, the entrant will be able to set price just slightly below that of the incumbent and capture the entire market, thereby earning virtually the same level of profits as the incumbent had previously earned. If this level of profit (or more precisely, the discounted value of this level of profit) is less than the entry cost, K, then entry will be deterred.

8. The sales of the cooperative and the profit-maximizing firm to the nonmember market are dependent upon their relative marginal costs. Assuming a linear demand curve (p'_n is constant) and constant marginal costs [$c'(x_c)$ and $c'(x_p)$ are constant], the difference between the sales of the cooperative and those of the profit-maximizing firm can be determined by subtracting equation (5) from equation (4):

$$x_{cn} - x_{pn} = \frac{c'(x_n) - c'(x_p).}{p'_n}$$

9. One possibility is for the cooperatives to pay a patronage dividend on the level of fertilizer purchased. This practice is not followed in any of the cooperatives, however. Instead, patronage is allocated on the basis of the total business (including deliveries of grain) the member does with the cooperative.

10. This assumes that the retail and transportation margin is a constant. If this margin increases and decreases with increases and decreases in the fertilizer producers' price, then the numbers in table 3 will understate the gain in welfare that would arise from making production more competitive.

11. Sherritt Gordon began production with a new world-scale ammonia urea fertilizer plant in May 1983. The plant had an expected 20-year life, annual capacity of 500,000 tonnes, and cost $370 million Cdn (Sherritt Gordon 1983). With 5 percent inflation, the cost in 1986 would be approximately $425 million Cdn.

12. The Saskatchewan Wheat Pool currently handles approximately 60 percent of the grain in Saskatchewan. The comparable numbers for Alberta Wheat Pool and Manitoba Pool Elevators are 66 percent and 58 percent, respectively.Together, the three prairie pools and United Grain Growers have approximately 264,000 members; this may include double counting as some farmers may be members of both UGG and one of the three prairie pools (Fulton 1988). The total number of farms in the three prairie provinces in 1981 was 154,816 (Agriculture Canada). Although many farms will have two or more individuals that are or could be members of a cooperative, the numbers indicate a fairly large percentage of farmers are members of at least one cooperative.

13. The literature on principal-agent problems, as well as the closely related question of property rights, is large. See Ross; Furubotn and Pejovich; Fama; Jensen and Meckling and the references therein for a discussion of these two topics. Staatz (1987) discusses the application of agency theory to cooperatives.

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