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Why Not A Wheat Cartel?

In the last decade there has been a series of startling events in the international grain arena which has evoked an increasing amount of attention on the part of agricultural economists. An important topic of discussion in the resulting flurry of theoretical and empirical literature has been the competitive structure of the international wheat market. McCalla appears to have been the first entrant into the fray with his pathbreaking duopoly model of the world wheat market. Subsequent ventures have included a triopoly model of the world wheat market (Alaouze, Watson and Sturgess) and another important contribution by McCalla outlining an array of strategies that market participants might attempt to follow and the resulting market situations that would arise from such marketing strategies.

Although these descriptive studies are important it appears that relatively little attention has been given to the formation of optimal strategies for the major participants on the supply sides of the international grain trade--the large grain companies such as Cargill, Continental, Bunge etc., and the Canadian and Australian Wheat Boards. At first glance the solution to the problem is rather trivial, i.e., these large sellers should exploit any monopoly-monopsony power they might possess. This, however, does not take account of the fact that the bulk of the operations of these firms are located in the United States and other major exporting regions. Hence, one must recognize that the exporting regions, while attempting to maximize their social welfare, will probably not allow these firms a free hand. Specifically, suppose it is assumed that the exporters are not allowed to systematically extract economic surplus from the domestic

market, i.e., they are forced to act in a relatively competitive manner in buying and marketing the grain domestically. This, however, would not preclude these large sellers from joining together to form a cartel in the international market.

The purpose of this paper, then, is to outline the behavior one might expect from such a cartel in the world market. The resulting model and theoretical results appear to be a generalization of the Schmitz-Just model of semi-price discrimination.

In addition to determining the decision rule for profit maximization on the part of the cartel and demonstrating the Schmitz-Just result on the independence of the domestic and international price formation, we also discuss the major problems that are usually seen to face effective cartelization. We are able to demonstrate that all interior solutions to our joint profit maximization problem possess what Osborne (1976) has termed the "ray property" and hence provide what appear to be effective and feasible solutions to each of the commonly recognized major obstacles to effective cartelization.

Section 1 discusses the basic rationale for setting up an international wheat cartel. Section 2 contains a brief but important discussion of the actual mechanics of the world wheat trade and why they argue for cartelization on the part of producers. We discuss our reasons for rejecting the joint marketing board approach in Section 3, although it should be noted that our results would carry through to such a 3 member cartel acting to maximize joint profits. In Section 4 we outline one model and discuss the major decision rules. Section 5 is devoted to examining and, hopefully, solving some of the more important problems associated with cartelization.

1. Marketing a Monopolizable Product

Viewed in a large sense North America and Australia (NAAUS) have an effective monopoly position in the world wheat market. Although there are other large scale producers of wheat, their position in the world market is effectively dwarfed by the NAAUS position. For instance, in the period 1971-73 NAAUS accounted for approximately 97% of the net exports of wheat in the world market. Therefore, NAAUS is the dominant factor on the supply side in the world wheat market, and there appears to be potential for NAAUS to cartelize its exports. However, one must remember that it does not appear to be to the advantage of the exporting nations to allow such a cartel to exercise monopoly (monopsony) power in their domestic markets.

Given that the optimal policy is to exploit the monopoly power in the export market, the remaining question of importance is how to go about it. This is particularly important in view of the structure of the North American wheat market. One major portion of the market (Canada) operates under a producer-oriented marketing board, while the other (United States) operates on a basically private trading system with some government involvement. One suggestion that has been bruited about is combining the overall supply side of the market into one large producer-oriented marketing board. We hope to demonstrate below that this may not be a feasible goal. As an alternative we suggest the formation of a cartel between the major U.S. grain exporting companies, the Canadian Wheat Board and the Australian Wheat Board.

2. Mechanics of World Wheat Trade

McCalla effectively describes the structure of the international wheat trade. However, his description gives little insight into the actual

mechanics of the international wheat trade. We feel closer examination of these mechanisms buttresses the argument for the organization of a wheat cartel. To see this more clearly let us consider the two major types of marketing instruments--the public tender and the privately negotiated contract. The public tender is an offer by an importing nation to purchase wheat with all terms of the contract specified but price. Interested exporting nations and international middlemen may submit bids to fill all or a portion of the tender at one or a series of prices. In contrast, all terms of the privately negotiated contract are open to negotiation. Negotiations are generally limited to invited traders--state trading monopsonies (monopolies) and international middlemen on the buying (selling) side. Both the public tender and privately negotiated contract could be effectively exploited by an international cartel. The cartel participants would submit a joint bid for public tenders while using their improved bargaining power to sway the final outcome of privately negotiated contracts.

3. Why Not a Joint Marketing Board?

One of the key obstructions to the formation of a joint marketing board between the United States, Canada and Australia is the structure of the U.S. wheat market. Perhaps the major reason the Canadian board is so viable today is that it has gradually evolved over the last fifty years. This wide experience and the relatively compact size of the market enhance the possibility for such cooperation. The U.S. market, however, has long operated under quite different principles and organization. To convert the U.S. market to a marketing board would involve tremendous transitional problems and difficulties that might entirely negate potential benefits to be derived from acting as a monopolist in the world

market. Establishing a worldwide information and sales network in order to make the marketing board effective would require large amounts of capital and time while only duplicating the private network already in existence. Perhaps of even greater importance would be the political issue of the division of power. It is doubtful that either producers or consumers could come to a quick agreement on this issue. Therefore, it seems much more attractive to take advantage of the superstructure that has evolved with the emergence of the country elevator, large grain company marketing system in the United States rather than trying to revamp the market structure of the United States.

4. The Model

Consider an industry with, say, n firms which buy grain in the domestic market and then market it internationally. For the purposes of our argument we shall consider the Canadian and the Australian Wheat Boards as two of these firms. Assume that the firms act together so as to maximize the overall profits of the export cartel. Further, it is assumed that each member of the cartel is forced to act as a strict competitor in buying grain.

To proceed, let p denote the competitively determined acquisition price of wheat in the domestic market. Hence, each firm incurs at minimum a base cost of p times the amount of grain purchased--both for domestic and foreign sale. Let the function $g_i(Q_i^d)$ represent costs over and above the purchase cost of grain required to market the internally, where Q^d_i is the amount of grain marketed internally by the i^{th} firm. Assume $\frac{\partial g_i}{\partial Q^d_i} > 0$ $\frac{\partial^2 g_i}{\partial Q^{d\ 2}_i} < 0$. Now recognizing that the export of

grain incurs significantly different costs specify $f_i(Q^f_i)$ as the i^{th} firm's cost of marketing Q^f_i of grain in foreign markets. In addition to covering the cost of insurance, conditioning and storing grain for export, the function f_i is also taken to include costs incurred in removing grain from domestic trade channels and placing it in the hold of a vessel berthed in an export facility (i.e., fobbing costs), and if necessary, the cost of cargo insurance and ocean freight rates. Total cost to the i^{th} firm of marketing the amount $(Q^f_i + Q^d_i)$ of grain is then $p\,(Q^f_i + Q^d_i) + f_i(Q^f_i) + g_i(Q^d_i)$. We assume $\frac{\partial f_i}{\partial Q^f_i} > 0$, $\frac{\partial^2 f_i}{\partial Q^{f\,2}_i} > 0$.

Since the firms are joining together to exploit their monopoly position in the world wheat market write the international price of wheat as $p^f(\sum_{1=1}^{n} Q^f_i)$, i.e., price in international markets is a function of the total exports of the cartel. Internally, assume that the grain companies can charge a certain overage $h_i(Q^d_i,\alpha)$ above the acquisition price to insure coverage of domestic merchandising costs. Hence, we can write the revenue each firm can generate as $p^f(\sum_{i=1}^{n} Q^f_i) + pQ^d_i + h_i(Q^d_i,\alpha)$ where α represents a governmental control parameter that prevents monopolization of the domestic market. We assume $\frac{\partial h_i}{\partial Q^d_i} > 0$, $\frac{\partial h_i}{\partial \alpha_i}$, $\frac{\partial^2 h_i}{\partial Q^{d\,2}_i}$, $\frac{\partial p^f}{\partial Q^f_i} < 0$.

Therefore, the total profits of the cartel can be represented as

$$\Pi = p\sum_{i=1}^{n} Q^d_i + p^f\left(\sum_{i=1}^{n} Q^f_i\right)\cdot \sum_{i=1}^{n} Q^f_i + \sum_{i=1}^{n} h_i(Q^d_i,\alpha) - p\sum_{i=1}^{n}(Q^f_i + Q^d_i) - \sum_{i=1}^{n} f_i(Q^f_i) - \sum_{i=1}^{n} g_i(Q^d_i) \qquad (1)$$

First order conditions for profit maximization are

$$\frac{\partial \Pi}{\partial Q^d_i} = p + \frac{\partial h_i}{\partial Q^d_i} - p - \frac{\partial g_i}{\partial Q^d_i} = 0 \qquad i = 1,2...n \qquad (2)$$

$$\frac{\partial \Pi}{\partial Q^f_i} = \frac{\partial p^f}{\partial Q^f} \sum_{i=1}^{n} Q^f_i + p^f - p - \frac{\partial f_i}{\partial Q^f_i} = 0 \qquad i = 1,2...n \qquad (3)$$

where $Q^f = \sum_{i-1}^{n} Q^f_i$. Therefore, profit maximization requires that the amount each member of the cartel markets domestically equates the marginal overage to marginal merchandising costs, while firms marketing the grain internationally equate the marginal revenue of the cartel as a whole to its marginal cost of marketing the grain. Interestingly, this implies that each firm will export less under a cartel arrangement than it would if it simply equated its marginal revenue to marginal costs as it would if it acted to maximize only its own profits. Graphically, these decisions can be depicted as in Figures 1 and 2. More will be said about the implications of this result in the next section.

5. Problems to Cartelization

One of the most important problems facing any cartel is the problem of cartel stability. The major barriers to stability are external competition, sharing the cartel revenues, locating the contract surface, and detecting and deterring cheating by members. Because of the overwhelmingly predominant position the cartel we propose would have in the world wheat market, we feel it is safe to exclude the first problem from consideration. Unfortunately, this is not the case for the other four problems mentioned. In the following we shall attempt to show that the cartel described in the previous sections

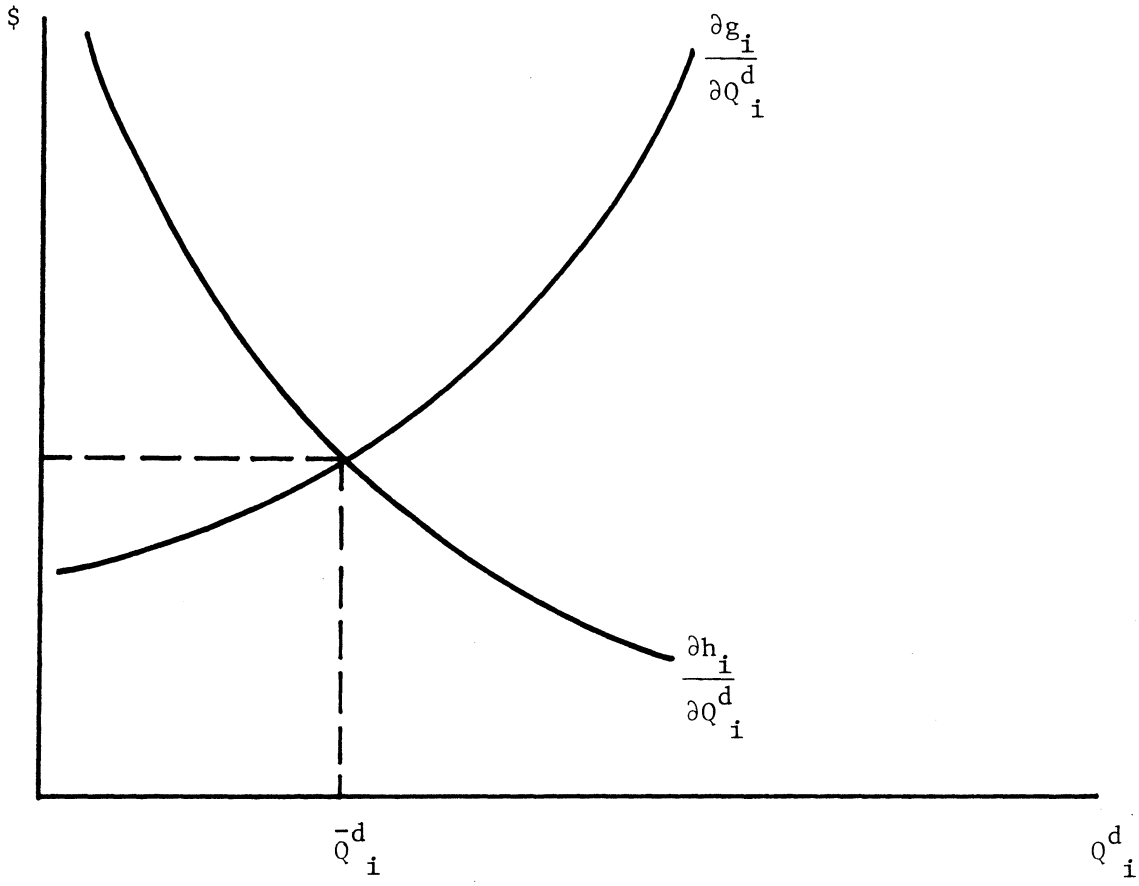
$
$\frac{\partial g_i}{\partial Q^d_i}$
$\frac{\partial h_i}{\partial Q^d_i}$
$\bar{Q}^d_i$
Q^d_i

Figure 1

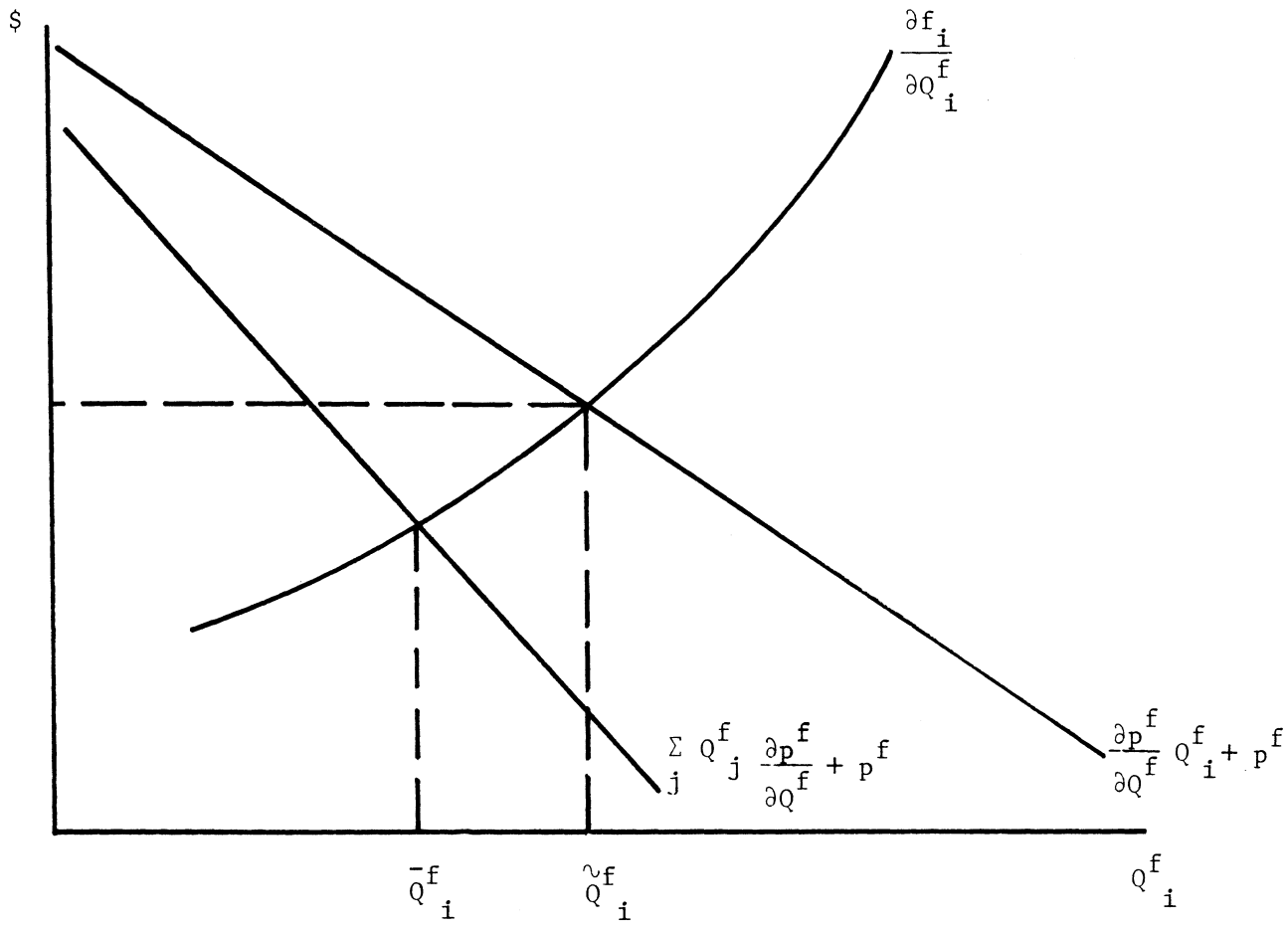
$
$\frac{\partial f_i}{\partial Q^f_i}$
$\sum_j Q^f_j \frac{\partial p^f}{\partial Q^f} + p^f$
$\frac{\partial p^f}{\partial Q^f} Q^f_i + p^f$
$\bar{Q}^f_i$
$\tilde{Q}^f_i$
Q^f_i

Figure 2

can in most cases effectively deal with the latter four problems. Our line of argument will closely follow that suggested by Osborne (1976) in his important paper on cartel problems.

To proceed we need to first introduce the notion of the i^{th} firm's profit function. Each firm's profit function will consist of two distinct parts--profits associated with domestic operations and profits associated with foreign operations which can be written respectively as

$$\Pi^d{}_i(p,\alpha,Q^d{}_i) = pQ^d{}_i + h_i(Q^d{}_i,\alpha) - pQ^d{}_i - g_i(Q^d{}_i) \tag{4}$$

and

$$\Pi^f{}_i(\Sigma_j Q^f{}_j,p) = Q^f{}_i p^f(\Sigma_j Q^f{}_y) - pQ^f{}_i - f_i(Q^f{}_i) \tag{5}$$

The total profit function for the i^{th} firm then is $\Pi^d{}_i + \Pi^f{}_i = \Pi_i$.

Using this definition of the profit function we are able to generate isoprofit contours. Differentiating Π_i at a given level of profit and using the implicit function theorem obtains

$$\frac{dQ^f{}_k}{dQ^f{}_j} = \frac{-\partial\Pi_i/\partial Q^f{}_j}{\partial\Pi_i/\partial Q^f{}_k} \tag{6}$$

$$= \begin{cases} -1 & i\neq j, j\neq k \\ -\dfrac{Q^f{}_i \dfrac{\partial p^f}{\partial Q^f} + p^f - p - \dfrac{\partial f_i}{\partial Q^f{}_i}}{Q^f{}_i \dfrac{\partial p^f}{\partial Q^f}} & \end{cases}$$

and

$$\frac{dQ^f{}_k}{dQ^d{}_i} = -\frac{\partial\Pi_i/\partial Q^d{}_i}{\partial\Pi_i/\partial Q^f{}_k} \tag{7}$$

$$= \begin{cases} -\dfrac{\dfrac{\partial h_i}{\partial Q^d_i} - \dfrac{\partial g_i}{\partial Q^d_i}}{Q^f_i \dfrac{\partial p^f}{\partial Q^f}} & k \neq i \\ -\dfrac{\dfrac{\partial h_i}{\partial Q^d_i} - \dfrac{\partial g_i}{\partial Q^d_i}}{Q^f_i \dfrac{\partial p^f}{\partial Q^f} + p^f - p - \dfrac{\partial f}{\partial Q^f_i}} & k = i \end{cases}$$

The important thing to notice about these relationships is that by (2) the the numerator of (7) will always be zero. Hence, what happens in the international market does not affect the profit maximizing decision for the domestic market and, therefore, domestic pricing decisions will be taken independently of what occurs in the international arena. As mentioned earlier this is a generalization of the Schmitz and Just semi-price discrimination result.[1]

Turning to cartel behaviour, we see that the contract curve of possible cartel solutions will be the locus of tangencies between the isoprofit curves of the n firms, i.e., points which are Pareto optimal in the sense that movement away from it signals a decline in profits for at least one member of the cartel. By (7) we can ignore the domestic situation in the determination of the cartel point and we can, therefore, represent the contract curve in the two firm case as in Figure 3 where superscripts represent decreasing levels of profit.

Once the cartel locates the contract curve and chooses a cartel point, say B, the cartel faces the additional problem that each individual firm has an incentive to cheat on the cartel by increasing his exports beyond the cartel point to the detriment of the other members of the cartel. This behavior

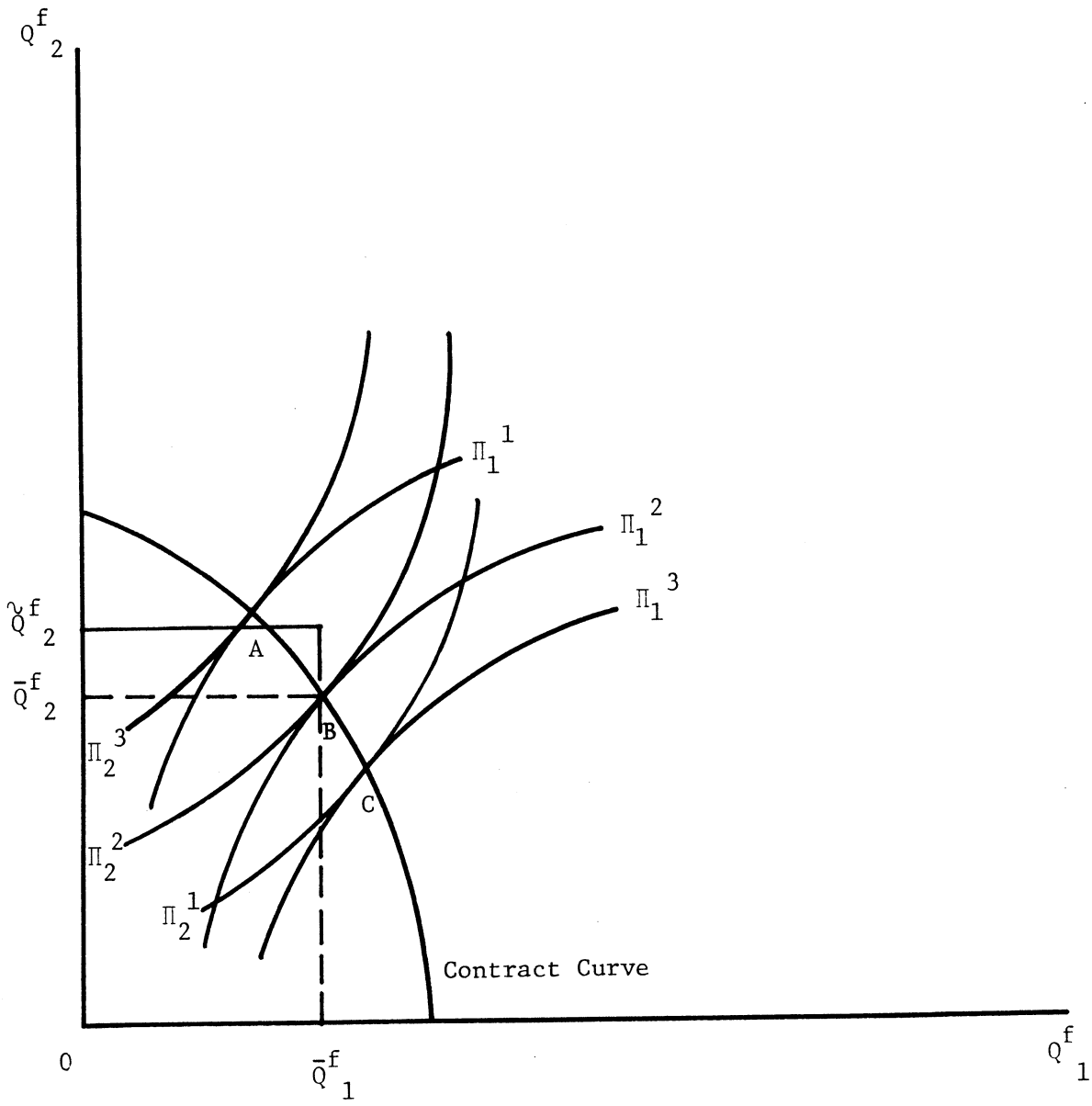
Q^f_2
Π_1^1
Π_1^2
Π_1^3
$\tilde{Q}^f_2$
A
$\bar{Q}^f_2$
B
C
Π_2^3
Π_2^2
Π_2^1
Contract Curve
0
$\bar{Q}^f_1$
Q^f_1

Figure 3

is a direct consequence of (3) where it is seen that each firm equates its marginal costs of marketing the grain internationally to the marginal revenue of the entire cartel. Now because of our assumption on $\frac{\partial p^f}{\partial Q^f}$ it is clear that the marginal revenue of the cartel as a whole associated with an incremental change in Q^f_i is less than the i^{th} firm's marginal revenue. Hence, each firm perceives additional revenue to be captured by increasing its exports past the cartel point. Once this is done, however, cartel profits must fall by (3) and, therefore, any increase in the i^{th} firm's profits as a result of expanding past the cartel point comes at the expense of the other members of the cartel. For instance, suppose the second member of the cartel decides to cheat by increasing his exports of wheat from the cartel amount $\bar{Q}^f_2$ to say $\tilde{Q}^f_2$ in Figure 3. While this increases his profits above profit level Π^2_2 the profits of the other cartel member fall below Π^2_1 which in turn is an incentive for the loyal member to diverge from the cartel solution. In game theoretic terms the cartel faces a prisoner's dilemma, where as a whole the cartel is better off if no one cheats but each individual has an incentive to cheat.

Osborne (1976) has recently demonstrated that a quota rule which allows each loyal member of the cartel to react to cheating by retaliation in the form of maintaining a constant share of the market can in many cases effectively deter cheating. For this rule to be at all effective, however, one must be able to demonstrate that the hyperplanes tangent to each member's isoprofit surface at the cartel point intersect in a line $L(Q^f)$ which is a ray from the origin. If the solution to the profit maximization problem satisfies this condition then it is said to have the "ray property". We shall now demonstrate that the profit maximization conditions given in (3) have this property.

To proceed, we shall follow Holahan and note that at the joint profit maximizing point $\bar{Q}^f = (\bar{Q}^f_1 \ldots . \bar{Q}^f_n)$ described by (3) each isoprofit curve is tangent to a hyperplane that can be expressed as

$$\sum_{i=1}^{n} \xi_{ij}(Q^f_i - \bar{Q}^f_i) = 0 \tag{8}$$

for the j^{ih} hyperplane, where ξ_{ij} are constants. Using Q^f_k to normalize (8) then obtains

$$Q^f_k - \sum_{i=k} \beta^j_{ik} Q^f_i = \tau_{kj} \tag{9}$$

where τ_{kj} is the intercept of the j^{ih} hyperplane along the Q^f_k axis and β^j_{ik} are the slopes of the hyperplance in the Q^f_i, Q^f_k plane and are to be associated directly with (6) since the hyperplane is tangent to the isoprofit surface. Now substituting the n-1 expressions defined in (6) into (9) in turn implies

$$Q^f_k + \sum_{\substack{i\neq k \\ i\neq j}} Q^f_i + \frac{Q^f_j \frac{\partial p^f}{\partial Q^f} + p^f - p - \frac{\partial f_j}{\partial Q^f_j}}{\frac{\partial p^f}{\partial Q^f}} = \tau_{kj} \tag{10}$$

Now multiplying through by one in the form $\frac{\partial p^f}{\partial Q^f} / \frac{\partial p^f}{\partial Q^f}$ and simplifying obtains

$$\frac{\frac{\partial p^f}{\partial Q^f} \sum_{k=1}^{n} Q^f_k + p^f - p - \frac{\partial f_j}{\partial Q^f_j}}{\frac{\partial p^f}{\partial Q^f}} = \tau_{kj} \tag{11}$$

By (3), however, the numerator of (11) is zero which means that the j^{th} hyperplane intersects each axis at the origin for all j. Therefore, each hyperplane must have the origin and the point $\bar{Q}^f$ in common which in turn

implies the "ray property" for any internal solution to the joint profit maximization problem.

Now that we have demonstrated that any solution to the profit maximization problem has the "ray property" we shall introduce and briefly discuss Osborne's quota rule. A much more detailed discussion and several alternative quota rules are contained in Osborne (1976). To proceed, define

$$s_i = \frac{\bar{Q}^f_i}{\sum_{i=1}^{n} \bar{Q}^f_i}$$

as the i^{th} member's market share at the cartel point. The quota production rule for the j^{th} member then is to produce

$$\max \left(\bar{Q}_j^k, \bar{Q}_j^f + \frac{\sum_{k \in K} \Delta Q^f_k}{\sum_{k \in K} s_k} \right)$$

where ΔQ^f_k is the amount by which the k^{th} member of the cartel cheats. In the case of a two member cartel this decision rule is demonstrated in Figures 4. Suppose that the cartel point is given by point A and further that the second member decides to cheat in the form of exporting $\tilde{Q}^f_2$. If the first firm detects the cheating and implements the quota rule described above he will then export the amount $\tilde{Q}^f_i$ necessary to maintain his market share, which moves the total level of exports back to a point on the ray from the origin. If 2 expects 1 to react in this fashion he will not cheat because at B his profit is lower than it is at A. In most cases 1 will have the incentive to move to B since he loses less profit than he would if allowed the cheater to cheat without retaliation.[2]

Now that we have demonstrated that there appears to be a feasible deterrence program that the cartel could enact so as to limit cheating we turn to the

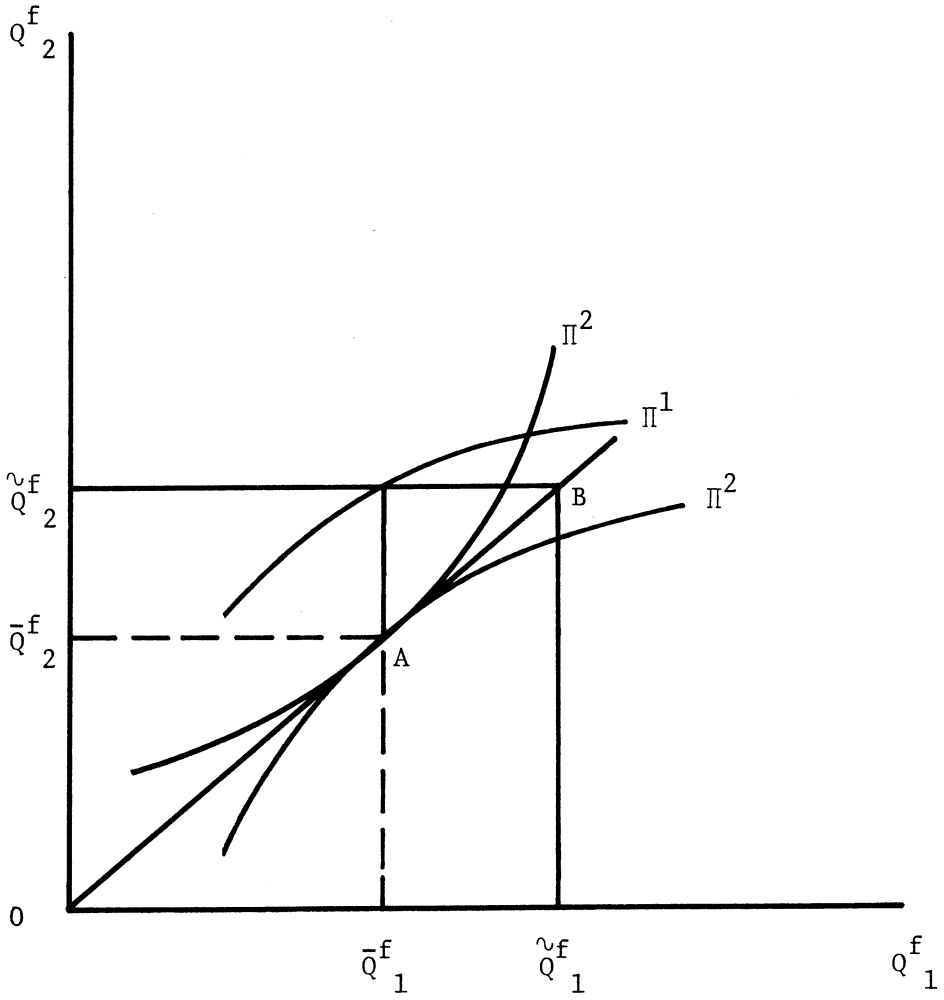

Figure 4

problem of discovering cheating. Deterrence can only be effective if cheating is discovered. For the case of the international wheat market we would argue that there would be a short time lag between cheating and discovery. All of the major grain companies maintain highly sophisticated information networks as do the major governments involved with their various inspection programs, etc. Hence, although there may be a very short time lag involved in the discovery process we feel that this could be compensated for by following Osborne's suggestion and adjusting the quota rule so as to keep the expected vector of outputs on the ray from the origin. In concluding this section on problems to cartelization we simply note that Osborne (1976) has demonstrated that any solution to the cartel problem which has the "ray property" effectively eliminates the sharing problem (pp 840-1).

6. Concluding Remarks

Rather than recapitulate and summarize the results of the foregoing analysis let us first detail what our arguments do not imply. First and most importantly we do not mean to imply nor do we suscribe to the notion of using a wheat cartel to bring the OPEC oil cartel to heel. The basis of our argument is that the world wheat market is so structured as to offer advantages to the exporters of wheat as a result of cartelization. One of them is not the exercise of some type of predatory power over the OPEC nations. These nations simply are not large enough importers to make the wheat cartel an effective weapon. Any attempt to tighten the screws on their food supply would almost surely fail.

Secondly, we do not mean to imply that the world is characterized by the model we have presented. We feel that the domestic sector is fairly

accurately modeled but our model of the international sector is more in the way of a proposal, better yet, a plan of action. That is, we feel that it is a start in the direction of developing behavioral objectives for just such a cartel as well as a means for coping with the very real cooperative problems cartelization will bring about.

In closing, we would like to reiterate our feeling that cartelization may provide an effective means of taking advantage of our international trading position. Given the array of trade barriers the exporting nations face in world markets there appears to be little sense in clinging to the neoclassical paradigm of trade relations based on world welfare maximization when almost all our trading partners institute protectionary and/or monopolistic (monopsonistic) practices. So, why not a wheat cartel?

Footnotes

1/ This can also be demonstrated by noting that the n first order conditions given by (2) are independent of the n first order conditions given by (3).

2/ Holahan has pointed out that in the case of extremely anti-symmetrical cost structures, it may not pay 1 to move to a point on the ray from the origin. However, we agree with Osborne's (1978) reply that this seems to be fairly unimportant in practice.

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