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**Essay in Microeconomics.**

**Topic:**

**Is Collusion Possible?**

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***Contents:***

1. **Introduction.**
2. **Two types of behaviour (Collusive and non-collusive).**
3. **Game theory.**
4. *Concept.*
5. *The problem of collusion.*
6. *Predatory pricing.*
7. **Repeated games approach.**
8. *Concept.*
9. *Finite game case.*
10. *Infinite game case.*
11. *“Trigger” strategy*
12. *Tit-for-Tat.*

 *d.) Finite game case, Kreps approach.*

1. **The motives for retaliation.**
2. **Conclusion.**
3. **Bibliography.**
4. **Introduction.**

 In this essay I would discuss the price and output determination under the one essential type of imperfect competition markets- oligopoly. Inter-firm interactions in imperfect markets take many forms. Oligopoly theory, those name refers to “competition among the few”, lack unambiguous results of these interactions unlike monopoly and perfect competition. There is a variety of results derived from many different behavioural assumptions, with each specific model potentially relevant to certain real-world situations, but not to others.

 Here we are interested in the strategic nature of competition between firms. “Strategic” means the dependence of each person’s proper choice of action on what he expects the other to do. A strategic move of a person influences the other person’s choice, the other person’s expectation of how would this particular person behave, in order to produce the favourable outcome for him.

1. Two types of behaviour (Collusive and non-collusive).

##  Models of enterprise decision making in oligopoly derive their special features from the fact that firms in an oligopolistic industry are interdependent and this is realised by these firms. When there are only a few producers, the reaction of rivals should be taken into account. There are two broad approaches to this problem.

 First, oligopolists may be thought of as agreeing to co-operate in setting price and quantity. This would be the Collusive model. According to this model, firms agree to act together in their price and quantity decisions and this would to exactly the same outcome as would have been under monopoly. Thus the explicit or co-operative collusion or Cartel would take place.

 Second approach of the oligopoly analysis is based on the assumption that firms do not co-operate, but make their decisions on the basis of guesses, expectations, about the variables to which their competitors are reaching and about the form and the nature of the reactions in question. The Non-collusive behaviour deals with this model. Here, though in equilibrium the expectations of each firm about the reactions of rivals are realised, the parties never actually communicate directly with each other about their likely reactions. The extreme case of this can even imply competitive behaviour. Such a situation is much less profitable for firms than the one in which they share the monopolistic profit. The purpose of this paper is to analyse the case of the possibility of collusion between firms in order to reach the monopolistic profits for the industry, assuming that they do not co-operate with each other. This would be the most interesting and ambiguous case to look at.

1. **Game theory.**

*a.) Concept.*

 The notion of game theory would a good starting point in the study of strategic competition and would be very helpful in realising the model and the problems facing oligopolistic firms associated with it.

 Game theory provides a framework for analysing situations on which there is interdependence between agents in the sense that the decisions of one agent affect the other agents. This theory was developed by von Neumann and Morgenstern and describes the situation, which is rather like that found in the children’s game “Scissors&Stones”. Each firm is trying to second-guess the others, i.e. the behaviour of one firm depends on what it expects the others to do, and the in turn are making their decisions based upon their expectations of what the rivals (including the first firm) will do. In our case, the players of the game are the firms in the industry and each of them wants to maximise its pay-off. The pay-off that a player receives measures how well he achieves his objective. Let’s assume in our model the pay-off to be a profit. Their profits depend upon the decisions they make (the strategies chosen by the various players including themselves). A strategy in this model is a plan of action, or a complete contingency plan, which specifies what the player will do in any of the circumstances in which he might find himself. The game also depends on the move order and the information conditions.

 Games can be categorised according to the degree of harmony or disharmony between the players’ interests. The pure coordination game is the one extreme, in which players have the same objectives. The other extreme is the pure conflict of the opposite interests of players. And usually there is a mixture of coordination and conflict of interests- mixed motive games.

 Although the importance of the other players’ choices takes place, sometimes a player has a strategy that is the best irrespective of what others do. This strategy is called dominant, and the other inferior ones are called dominated. A situation in which each player is choosing the best strategy available to him, given the strategies chosen by others, is called a Nash equilibrium. This equilibrium corresponds to the idea of self-fulfilled expectations, tacit, self-supporting agreement. If the players have somehow reached Nash equilibrium, then none would have an incentive to depart from this agreement. Any agreement that is not a Nash equilibrium would require some enforcement.

*b.) The problem of collusion.*

 Now I would like to use an example of a game in which the Cournot output deciding duopoly is involved. This game is illustrated by the table below:

|  |  |  |
| --- | --- | --- |
|  |  | Firm B’s output level |
| HIGH | LOW |
| Firm A’s output level | HIGH | (1;1) | (3;0) |
| LOW | (0;3) | (2;2) |

 Here a firm chooses between two alternatives: high and low output strategies. The corresponding pay-offs (profits) are given in the boxes. In this game, the best thing that can happen for a firm is to produce a high level of output while its rival produces low. Low output of the rival provides that price is not driven down too much, thus a firm could earn a good profit margin. The worst thing for a firm is to change places with its rival assuming the same situation takes place. If both firms produce high levels of output, then the price would be low, allowing each of them to earn still positive but very small profits. Nevertheless, (HIGH;HIGH) would be the dominant strategy of this game (we would observe a Nash equilibrium in strictly dominant strategies here). It is the best response of firm A whenever B produces a high or low output and this is also true for firm B. The non-co-operative outcome for each firm would be to get the pay-off of 1. But as we can see, it would be better for both to lower their output and thereby to raise price, as their profits would increase to 2 for each firm instead of 1 in NE. Strategy (LOW;LOW) would be the collusive outcome. The problem of collusion is for the firms to achieve this superior outcome notwithstanding the seemingly compelling argument that high output levels will be chosen.

 This was an example of a “one-shot” game and we saw that the collusive outcome was not available for that case. But in reality these games are being played over and over (on a long-term basis) and we will see later in this essay how the collusion can be sustained by threats of retaliation against non-co-operative behaviour.

*c.) Predatory pricing.*

 Here we need to introduce the explicit order of moves in the model. There are again two players-firms on the market- an incumbent firm and a potential entrant in the market. The game is illustrated below:

 The potential entrant chooses between entering and staying out of the industry. In the case of his entering, the incumbent firm can either fight this entry (which as we see would be costly to both), or acquiesce and arrive at some peaceful co-existence (which is obviously more profitable). The best thing for incumbent is for entry not to take place at all. There are in fact two Nash equilibria: (IN;ACQUIESCE) and (OUT;FIGHT). But the last mentioned (OUT;FIGHT) is implausible, as if the incumbent were faced with the fact of entry, it would more profitable for him to acquiesce rather than to fight the entry. Due to this fact the potential entrant would choose to enter the industry and the only equilibrium would be (IN;ACQUIESCE). Thus we can conclude, that in this case the incumbent’s threat to fight was empty threat that wouldn’t be believed, i.e. that threat was not a credible one. The concept of perfect equilibrium, developed by Selten (1965;1975), requires that the “strategies chosen by the players be a Nash equilibrium, not only in the game as a whole, but also in every subgame of the game”. (In our model on the picture, the subgame starts with the word “incumbent”). We have got the perfect equilibrium to rule out the undesirable one.

1. **Repeated games approach.**
2. *Concept.*

 As I have already mentioned, in practice firms are likely to interact repeatedly. Such factors as technological know-how, durable investments and entry barriers promote long-run interactions among a relatively stable set of firms, and this is especially true for the industries with only a few firms. With repeated interaction every firm must take into account not only the possible increase in current profits, but also the possibility of a price war and long-run losses when deciding whether to undercut a given price directly or by increasing its output level. Once the instability of collusion has been formulated in the “one-shot” prisoners dilemma game, it raises the question of whether there is any way to play the game in order to ensure a different, and perhaps more realistic, outcome. Firms do in practice sometimes solve the co-ordination problem either via formal or informal agreements. I would focus on the more interesting and complicated case of how collusive outcomes can be sustained by non-co-operative behaviour (informal), i.e. in the absence of explicit, enforceable agreements between firms. We have seen that collusion is not possible in the “one-shot” version of the game and we will now stress upon a question of whether it is possible in a repeated version. The answer depends on at least four factors:

1. Whether the game is repeated infinitely or there is some finite number of times;
2. Whether there is a full information available to each firm about the objectives of, and opportunities available to, other firms;
3. How much weight the firms attach to the future in their calculations;
4. Whether the “cheating” can/can not be detected due to the knowledge/lack of knowledge about the prior moves of the firm’s rivals.

 The fact of repetition broadens the strategies available to the players,

because they can make their strategy in any currant round contingent on the others’ play in previous rounds. This introduction of time dimension permits strategies, which are damaging to be punished in future rounds of the game. This also permits players to choose particular strategies with the explicit purpose of establishing a reputation, e.g. by continuing to co- operate with the other player even when short-term self-interest indicates that an agreement to do so should be breached.

*b.) Finite game case.*

 But repetition itself does not necessarily resolve the prisoner’s dilemma. Suppose that the game is repeated a finite number of times, and that there is complete and perfect information. Again, we assume firms to maximise the (possibly discounted) sum of their profits in the game as a whole. The collusive low output for the firms again, unfortunately for the firms, could not be sustained. Suppose, they play a game for a total of five times. The repetition for a predetermined finite number of plays does nothing to help them in achieving a collusive outcome. This happens because, though each player actually plays forward in sequence from the first to the last round of the game, that player needs to consider the implications of each round up to and including the last, before making its first move. While choosing its strategy it’s sensible for every firm to start by taking the final round into consideration and then work backwards. As we realise the backward induction, it becomes evident that the fifth and the final round of the game would be absolutely identical to a “one-shot” game and, thus, would lead to exactly the same outcome. Both firms would cheat on the agreement at the final round. But at the start of the fourth round, each firm would find it profitable to cheat in this round as well. It would gain nothing from establishing a reputation for not cheating if it knew that both it and its rival were bound to cheat next time. And this crucial fact of inevitable cheating in the final round undermines any alternative strategy, e.g. building a reputation for not cheating as the basis for establishing the collusion. Thus cheating remains the dominant strategy.

*\* NOTE:* the *is* however one assumption about slightly incomplete information, which allows collusive outcome to *occur* in the finitely repeated game, but I will left it for the discussion some paragraphs later.

*c.)\_ Infinite game case.*

 Now lets consider the infinitely repeated version of the game. In this kind of game there is always a next time in which a rival’s behaviour can be influenced by what happens this time. In such a game, solutions to the problems represented by the prisoners dilemma are feasible.

*i.) “Trigger” strategy*

 Suppose that firms discount the future at some rate “w”, where “w” is a number between O and 1. That is, players attach weight “w” to what happens next period. Provided that “w” is not too small, it is now possible for non-co-operative collusion to occur. Suppose that firm B plays “trigger” strategy, which is to choose low output in period 1 and in any subsequent period provided that firm A has never produced high output, but to produce high output forever more once firm A ever produces high output. That is B co-operates with A unless A “defects”, in which case B is triggered into perpetual non-co-operation. If A were also to adopt the “trigger” strategy, then there would always be collusion and each firm would produce low output. Thus the discounted value of this profit flow is:

2+2w+2w^2+2w^3+…=2/(1-w)

 If fact A gets this pay-off with any strategy in which he is not the first to defect. If A chooses a strategy in which he defects at any stage, then he gets a pay-off of 3 in the first period of defection (as B still produces low output), and a pay-off of no more than 1 in every subsequent period, due to B being triggered into perpetual non-co-operation. Thus, A’s pay-off is at most

3+w+w^2+w^3+…=3+w/(1-w)

 If we will compare these two results, we will get that it is better not to defect so long as

W > (or =) ½

 We can conclude that is the firms give enough weight to the future, then non-co-operative collusion can be sustained, for example, by “trigger” strategies. The “trigger” strategies constitute a Nash equilibrium = self-sufficient agreement. However it is not enough for a firm to announce a punishment strategy in order to influence the behaviour of rivals. The strategy that is announced must also be credible in the sense that it must be understood to be in the firm’s self-interest to carry out its threat at the time when it becomes necessary. It must also be severe in a sense that the gain from defection should be less than the losses from punishment. But because it is possible that mistakes will be made in detecting cheating (if, for example, the effects of unexpected shifts in output demand are misinterpreted as the result of cheating), the severity of punishment should be kept to the minimum required to deter the act of cheating.

*ii.) Tit-for-Tat.*

 Trigger strategies are not the only way to reach the non-co-operative collusion. Another famous strategy is Tit-for-Tat, according to which a player chooses in the current period what the other player chose in the previous period. Cheating by either firm in the previous round is therefore immediately punished by cheating, by the other, in this round. Cheating is never allowed to go unpunished. Tit-for-Tat satisfies a number of criteria for successful punishment strategies. It carries a clear threat to both parties, because it is one of the simplest conceivable punishment strategies and is therefore easy to understand. It also has the characteristics that the mode of punishment it implies does not itself threaten to undermine the cartel agreement. This is because firms only cheat in reaction to cheating be others; they never initiate a cycle of cheating themselves. Although it is a tough strategy, it also offers speedy forgiveness for cheating, because once punishment has been administered the punishing firm is willing once again to restore co-operation. Its weakness is in the fact that information is imperfect in reality, so it is hard to detect whether a particular outcome is the consequence of unexpected external events such as a lower demand than forecast, or cheating, Tit-for-Tat has a capacity to set up a chain reaction in a response to an initial mistake.

*d.) Finite game case, Kreps approach.*

 Lets now return to the question of how collusion might occur non-co-operatively even in the finitely repeated game case. Intuition said that collusion could happen- at least at the earlier rounds- but the game theory apparently said that it could not. Kreps et al. (1982) offered the elegant solution to this paradox. They relax the assumption of complete information and instead suppose that one player has a small amount of doubt in his mind as to the motivation of the other player. Suppose A attaches some tiny probability p to B referring- or being committed- to playing the “trigger” strategy. In fact it turns out that even if p is very small, the players will effectively collude until some point towards the end of the game. This occurs because its not worth A detecting in view of the risk that the no-collusive outcome will obtain for the rest of the game, and because B wishes to maintain his reputation for possibly preferring, or being committed to, the “trigger” strategy. Thus even the small degree of doubt about the motivation of one of the players can yield much effective collusion.

1. **The motives for retaliation.**

 The motives for retaliation differ in three approaches. In the first approach, the price war is a purely self-fulfilling phenomenon. A firm charges a lower price because of its expectations about the similar action from the other one. The signal that triggers such a non-co-operative phase is previous undercutting by one of the firms. The second approach presumes short-run price rigidities; the reaction by one firm to a price cut by another one is motivated by its desire to regain a market share. The third approach (reputation) focuses on intertemporal links that arise from the firm’s learning about each other. A firm reacts to a price cut by charging a low price itself because the previous price cut has conveyed the information that its opponent either has a low cost or cannot be trusted to sustain collusion and is therefore likely to charge relatively low prices in the future.

**6. Conclusion.**

 So far I have discussed the collusion using some simple example with a choice of output levels made by the two firms. But there may be several firms in the industry, and in fact firms have a much broader choice. It may be that their decision variable is price, investment, R&D and advertising. Nevertheless the more or less the same analysis could be applied in each of the case.

 I have examined different assumptions and predictions, which allow or do not allow the possibility of collusion. In reality such thing as collusion definitely takes place, if it had not, there would not have been any strong an ambiguous discussion of this topic. But I think it would be appropriate to end this essay with an explicit reminder that once we leave the world of perfect competition, we lose the identity of interests between consumers and producers. So, the discussion of benefits to firms in oligopoly that arise from finding strategies to enforce collusive behaviour might well have been the discussion of the expenses of consumers.

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