Industrial Organization
Collusion

You should have noticed by now that the aggregate profits in all types of market structure other than a monopoly is always lower than that in the monopoly. The reason for this is due to competition and the fact that in firms choosing to maximize their profits, they fail to realize the externality of their choices. This means that it is possible for each firm in truth to obtain greater profits if they were to behave as a single firm. This suggests that if firms are able to either tacitly or explicitly arrive at an agreement, they could benefit at the expense of the consumer, and we call this kind of behavior **Collusion**. Some examples are as follows,

1. **Cartel**: This is an institutional form of collusion, where agreement is formally obtained between members, example being the OPEC.
2. **Secret Agreement**: Where agreement is sought without the knowledge of the public.
3. **Tacit Agreement**: This often occurs through elaborate signals, which may or may not have been previously acknowledged, and would require some historical reason, or for a particular firm to be a focal point in the market.

1 Repeated Interaction & Stability of Collusive Agreement

Consider the following model which for all intent and purposes is a Bertrand model setup, with the sole exception that the game is repeated and infinite number of times.

1. Homogenous Product
2. Duopoly, $i \in \{1, 2\}$
3. Firms set prices simultaneously

4. Constant marginal cost of c.

5. Firms engage in **Repeated Game** where they set prices in each period t, where $t \in \{1, 2, ..., \}$.

Such a model would be a more realistic depiction of the economy at large. The question then is what possible equilibrium would arise. We know from our previous discussion that the Bertrand-Nash Equilibrium for a one short game described by points 1 to 4 is where the firms price at their marginal cost. This would mean that one possible strategy by both firms is to price at marginal cost all the time, so that both firms earn zero profits in perpetuity. Since we know that in each period, such a strategy is yield a Nash Equilibrium, there is no possibility that either firm would deviate. However, just as we did when we examine Game Theoretic Concepts, we may want to consider the possibility that firms might want and be able to arrive at a Nash Equilibrium that would allow both firms to achieve higher profits.

Another possible strategy would be for the firms play a **Grim Trigger Strategy**. Each firm would price at the monopoly price in each period, p_m, so that the market as a whole earns a monopoly profit, π_m, which they agree to share equally, $\frac{\pi_m}{2}$. This strategy would continue as long as the other firm abide by the agreement, whether tacitly, or explicitly arrived at. However, if in the previous period the other firm were to choose not to price at p_m in one period, the firm would punish the other by pricing at c in perpetuity so that the aggregate profit for both firms is zero in perpetuity. We now need to understand under what conditions would this collusive agreement stand. We can do so by examining whether the payoff from playing the strategy survives at least **one deviation** from the strategy.

Let the discount factor of the firm be δ, and determines the value of each dollar in the following period in the current period. If both firms play the strategy, the payoff to each in perpetuity is,

$$\frac{\pi_m}{2} + \delta\frac{\pi_m}{2} + \delta^2\frac{\pi_m}{2} + ...$$
$$= \frac{\pi_m}{2}\left(1 + \delta + \delta^2 + ...\right) = \frac{\pi_m}{2}\frac{1}{1-\delta}$$

Alternatively, consider what the payoff to each player would be should they deviate while the other stays the course. Since both firms are the same, we only need to

consider the case of one firm. Should one firm deviate, it would realize that just by pricing $p_m - \epsilon$ would allow it to capture the entire market in that period, but it would in turn earn nothing in all subsequent periods in perpetuity, which would give it a lifetime payoff of π_m. Now we can bring the two payoff together. The strategy to achieve Collusion can be a Nash Equilibrium if and only if,

$$\frac{\pi_m}{2}\frac{1}{1-\delta} \geq \pi_m$$
$$\Rightarrow \pi_m \geq 2\pi_m - 2\delta\pi_m$$
$$\Rightarrow \delta \geq \frac{1}{2}$$

This means that as long as the **discount factor** is sufficiently large, the collusion equilibrium is sustainable. Typically, we think of the **discount factor**, $\delta \in [0, 1]$. The reason is as follows; the value of a dollar saved in a period yield $1 + r$ in the following period, where r is the **interest rate** for the saving. So that in turn, the value of a dollar tomorrow is the inverse of that, i.e. $\frac{1}{1+r} = \delta$. However, there may be other factors that can determine the discount rate which we will discuss shortly. But the crux of the matter is that in deciding whether to enter into a collusive agreement, the firms weight the long run gains versus the short run losses, or the argument is reversed when you think in terms of deviation.

Interest rates are typically thought of as a annual rate, however, **price changes can be more than once a year**, and the preceding discussion has left the duration of a period deliberately ambiguous, so that if the number of price changes per period is more than once a year, we have to adjust the true interest rate. Suppose the price changes f times a year, then the effective rate per period is $\frac{r}{f}$. This then mean that $\frac{1}{1+\frac{r}{f}} = \delta$.

Another possible factor is that of stochastic termination in each period, that is the market can seize to exist in any future period. Suppose the probability that the market can become obsolete is b. That is with probability b that the firm will get $\frac{1}{1+\frac{r}{f}}$ and probability $1-b$ the firm would get zero. This means that the dollar tomorrow is worth $\frac{1}{1+\frac{r}{f}}b$.

The opposite of the market seizing to exist is that the market grows, such as the software industry. Suppose the market grows at a rate of g, then each dollar of profit

is worth $1 + g$ in the following period.

Taking all this factors into considerations, the definition of δ can be expressed as,

$$\frac{1+g}{1+\frac{r}{f}}b$$

We can then say the following about the likelihood of a successful collusion;

Collusive Pricing is more likely if,

1. Frequency of price changes are high, that is a high f since in means increased interactions between the firms.
2. There is a high probability that the market will continue to survive, that is a high b.
3. The growth rate of the industry is high, that is g is high.

Since all the factors ensure a higher discount factor.

Based on the above analysis, it seem highly likely that under repeated contact, firms can and should collude. It which case, why don't they?

1. **Antitrust Policy** prevents explicit collusion by firms.
2. The fluidity of entry and exit in most industries, that is high turnover, ensures that if a firm believes the likelihood of its demise is high, it would make collusion, tacit of otherwise difficult.
3. As you might have noticed, it may be an extremely harsh type of punishment since in punishing the other firm, the firm is in truth punishing itself with a declaration of a price war in perpetuity! **Of course we could examine how stringent the requirement would need to be if the trigger strategy is only for one period**. In truth, the typical evolution of prices in most markets finds its parallel in a oscillatory pattern, alternating between high and low prices, which the aforementioned model does not generate, suggesting that it may be a mere theoretical curiosity. What may give rise to such a phenomenon, and can we model such a possibility?

- Some markets may be characterized as a **customer markets** where consumers are relatively large compared to the firms, such as Mega-Supermarkets. These markets could be characterized as one where the consumers can negotiate for favorable prices on a case by case basis, which makes the determination of true demand fluctuations difficult to observe. A possible strategy would be to punish the other firm for a fixed period regardless of whether the fall in demand is a result of real fall in market demand, or whether it was a result of the competition undercutting her in price. However, the punishment cannot be in perpetuity, since the firm could always do better by being less stringent. And yet if the punishment is not punitive, there is no bite to the strategy, and the firm would end up being persistently the victim to a cheating partner. In this case, price wars are a periodic necessity to keep everyone in check, and we would get a market with constantly fluctuating prices. Note that although price wars occur, in equilibrium no firm ever cheats! Note further that price changes are **pro-cyclical**.
- For other industries, it may be true instead the demand conditions are actually observable. In which case, how could oscillating prices be created? The key to note here is the incentive to cheat are greatest when demand is high due to the greater short run gains, but low during economic downturns. This means that a possible strategy would for firms to lower prices collectively (price war like outcome) to reduce the gains to cheating when demand is high, but higher relative prices to when demand is low since the incentive to cheat is low. In which case, the prices are **counter cyclical**.
- Not all shocks are market wide, some shocks or disturbances to a firm's demand might be idiosyncratic. This asymmetry means that the probability of a firm facing a greater probability of cessation of operation would then lower its discount factor, thereby raising the incentive to cheat, and causing a price war in hopes of resurrecting the firm. When shocks are asymmetric, collusion is difficult.

4. The model implicitly assumes that prices are perfectly observable, which need not be true, that is **prices need not be perfectly observable**. Consider a rival supplier to a automobile manufacturer, in a bid to increase its contract,

secretly undercuts its competition by negotiating privately with the automobile manufacturer. This then makes coordination and agreement difficult to enforce.

5. **Collusion is easier when firms are similar, and the industry is concentrated**, that is the number of firms is small. The former argues that similarity facilitates agreement on pricing thereby reducing incentive to cheat. The latter is because agreement is more easily obtained when there are less firms to coordinate between.

6. **Collusion is easier when firms compete in more than one market, and when each has a respective advantage in some of their markets**. The crux of the matter is that as long as you have symmetry in all the markets, the condition that is required of the discount factor remains unchanged. However, if any one firm has an advantage in a least a significant market, the threat of an immediate retaliation in that market would reduce the deviation payoff thereby making it easier for collusion to take place. Put another way, when there is an advantage in a "home market", the values of the discount factor can be is larger, thereby making collusion easier.

7. Some **Institional Factors** such as laws, and practice such as **Most-Favored-Customer Clauses** which prevents firms from offering discounts to only some clients, would actually increase the incentive for firms to maintain collusion prices. While other laws that require pricing transparency in effect reducing the cost to competitors of monitoring deviating firms thus enhancing collusion formation.