Industrial Organization 03
Collusion

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Outline

1. Definition
2. Why cartels are forming?
3. Why do we not observe only cartels?
   - Sanctions against cartels in Europe and in the US
   - Instability of cartels due to the strategic interactions
4. A model of collusion
5. Factors favoring collusion: examples.


**Introduction**

Adam Smith (The Wealth of Nations, Book I, 1776)

*People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or some contrivance to raise prices.*
Definition of collusion

We talk about **collusion** (or **cartels**) when firms on a market agree to realize profits superior to the "normal" profits they should get in a situation of competition.

→ "Normal" profits are those of the non-cooperative Nash equilibrium (Bertrand, Cournot...).

Collusion can be:

- **Explicit**: the firms agree explicitly on prices, but also on quantities, production capacities, investments in R&D, etc.
- **Tacit**: behavior that allows firms to realise profits superior to the "normal" profits, without an explicit agreement.
Why Cartels are Forming?

Firms in a market are tempted to collude to raise their market power (their profits)...

We suppose that in the case of competition, firms "maximize their profit". Why then forming a cartel makes it possible for firms to raise their profits?

Because a situation of competition is comparable to the prisoner dilemma:
- A firm decides of its strategy (by setting prices, quantities, investments...) to maximize its profits...
- ... but it doesn’t take into account the effect of its decision on the other firms.
- In a cartel, the firms take into account how the decisions of each of one them impacts the profits of the others.
Different Types of Cartels

- Price fixing
- Quantity fixing (rare)
- Geographic markets repartition
- etc. (other ideas?)

But...

- We can have *parallel behaviors* without collusion
- Some concerted practices are authorized under some conditions (ex: Research Joint Ventures)
Why all firms are not colluding?

→ Because collusion is forbidden (competition policy). But this is not sufficient to discourage cartel formation!

→ Because firms in a cartel have incentives to "cheat", to "deviate" from the cooperative equilibrium.

- Break unilaterally the collusion agreement to set, for example, a lower price... to capture a larger share of demand.
- If each firm expects that the others will cheat, collusion is not possible.
- **Punishment mechanisms** are required to dissuade the "cheaters ".

Marc Bourreau (TPT)
Cartels and Public Policy

Cartels are **socially inefficient**:  
- Loss of social welfare when the price is higher than marginal cost: "dead-weight loss" (welfare criterion).  
- Transfer from consumers to producers (consumers surplus criterion).

Yet, in the 19th century, cartels were common and legal in the US (steal, sugar, petroleum...).

In France, since 1810, the article 419 of the Code Pénal forbids price-fixing agreements "*prices above and below of what would have been set by the free and natural competition*"...

... but in practice, the Courts punish few cases ("good" cartels).
Cartels and Public Policy

At the end of the 19th century, beginning of the 20th, the American Congress voted two laws to fight against the high prices set by the "trusts":

- The Sherman Antitrust Act in 1890
- The Federal Trade Commission Act in 1914

These laws forbid explicit agreements which aim at reducing competition intensity.

Sherman Act (1890):

Section 1. Every contract, combination in the form of trust or otherwise, in restraint of trade or commerce... is declared to be illegal. Section 2. Every person who shall monopolize, or attempt to monopolize, or combine or conspire with any person or persons, to monopolize any part of the trade or commerce... shall be deemed guilty of a felony...
Cartels and Public Policy

In Europe, Article 85 of the Rome Treaty (1958):

The following shall be prohibited...: (a) directly or indirectly fix purchase or
selling prices... (b) limit or control production... (c) share markets or
sources of supply...

Now Article 101 of the Treaty on the Functioning of the European Union.

The laws which prohibit the cartels are entitled:

- **Antitrust Law** in the US
- **Competition Policy** in Europe.
Why Do We Not Observe Only Cartels?

The Sanctions against Cartels

Cartels and Public Policy

Examples of financial sanctions for collusion (source: OCDE 2000):

<table>
<thead>
<tr>
<th>Case</th>
<th>Sanction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worldwide cartel of graphite electrodes</td>
<td>300 millions $ and sentences in the US ; 218 millions euros in Europe</td>
</tr>
<tr>
<td>Anti-competitive agreement related to the TGV</td>
<td>378 millions French francs</td>
</tr>
<tr>
<td>Worldwide cartel of vitamins</td>
<td>1 billion $ and sentences in the US ; 855 millions euros in Europe</td>
</tr>
<tr>
<td>Worldwide cartel of lysine et citric acid</td>
<td>200 millions $ and sentences in the US</td>
</tr>
</tbody>
</table>
Legislations implementation:

- The interdiction is applied more or less strictly according to the countries (US more strictly) and according to the time (stricter nowadays).
- The interpretation of what constitutes an anti-competitive agreement may also vary from one country to another (ambiguities).
  - R&D agreements
  - Professional association, information exchanges...

- Leniency programs:
  - A company which participated in a cartel which would inform on the cartel, may benefit from a partial or complete sanction reduction.
The Stability of Cartels

Should the collusion be tacit or explicit, it requires repeated interactions and a punishment mechanism:

- Setting prices superior to the competitive prices (for example) is held by an agreement (tacit or explicit) that in the case of deviation from the collusive equilibrium, the cheater would face a "punishment".
- **The "punishment"**: a temporary price war, or any other actions aiming at reducing the deviant firm’s profits.
- The "punishment" should be sufficiently costly compared to the deviation profits.
- It is even more efficient if it is not costly for the firms implementing it.
- Any "deviation" should be detected.
An Example of Cartel

The **diamants cartel**:  
- DeBeers Group, founded in 1870, dominates the worldwide diamant market.  
- Mostly controls trade rather than production: Central Selling Organization (CSO).  
- More than 80% of the worldwide production transit through the CSO.

Benefits for producers to go through CSO:  
- Evaluation, publicity, price stability.  
- Fear of reprisal in case of "deviation".

A **deviation**:  
- Zaire (Mobutu) tried to deviate (in 1981).  
- Two months later, a huge quantity of unidentified diamants flooded the market: price fall by almost 40%. 


A Model of Collusion

- Two firms sell identical goods (perfect substitutes)
- Same marginal cost of production, $c$

→ Same assumptions as in the Bertrand competition model

- But we consider a repeated game with infinite horizon ("supergame")
- At each time $t = 0, 1, ..., \infty$, the two firms set prices simultaneously and conditionally to the prices previously set
- $\delta$ denotes the discount factor (value today of one euro, which will be obtained only in the next period)
- $p^m$ denotes the monopole price, $\pi^m$ denotes the monopoly price
The Discount Factor

\( \delta \) is the discount factor (value today of one euro, which will be obtained only in the next period). In general, \( \delta < 1 \).

For example, an investor could invest 1 euro today to get \( 1 + r \) euro at the next period (\( r \): return rate per period). We would get:

\[
\delta = \frac{1}{1 + r}.
\]

When we apply the discount factor to future profits, we talk about discounted value of future profits.

→ For example, to evaluate a project, we usually calculate the "Net Present Value" (NPV) = discounted income - discounted costs
The Collusion Strategy

Let’s consider the following strategy (also called "trigger strategy"):

Collusion period:
A firm sets the price $p = p^m$ (monopoly price) if the other firm has set $p^m$ in the previous periods.

Punishment period:
A firm sets $p = c$ after a deviation (i.e. if the other firm has set a price $p < p^m$ in the previous period) and for all following periods.

How do we determine if the tacit collusion agreement is viable?

Comparison of the discounted value of future profits in the case of collusion with the discounted value of future profit in the case of deviation.
Discounted Profits in Case of Collusion

Every period, both firms set the monopoly price. Therefore, every period, both firms share the monopoly profit.

The discounted value of future profits is:

\[ \Pi = \frac{1}{2} \pi^m + \delta \frac{1}{2} \pi^m + \delta^2 \frac{1}{2} \pi^m + \ldots \]

\[ \Pi = \frac{1}{2} \pi^m \left( 1 + \delta + \delta^2 + \ldots \right), \]

\[ \Pi = \frac{1}{2} \pi^m \left( \frac{1}{1 - \delta} \right). \]
Discounted Profits in Case of Deviation

We look for the incentive to deviate from the anti-competitive agreement (i.e. the net profit in case of deviation).

What would be "the best" deviation strategy (price change)?

Best deviation
At any period, the best deviation consists in setting a price equal to $p^m - \epsilon$.

Therefore, the deviant firm wins (at best)?

$$\tilde{\Pi} = \pi^m + \delta \times 0 + \delta^2 \times 0 + ... = \pi^m$$
Collusion Sustainability

It is "not" in the interest of any firm to deviate if its profit in case of deviation is lower than its profit in case of collusion, that is, if:

\[ \tilde{\Pi} < \Pi, \]

or

\[ \pi^m < \frac{1}{2} \pi^m \left( \frac{1}{1 - \delta} \right), \]

therefore

**Result: stability of collusion**

Collusion is sustainable (an equilibrium) if and only if

\[ \delta > \frac{1}{2} \equiv \bar{\delta}. \]
Collusion Sustainability

The collusion is sustainable if the firms value future profits high enough.

The parameter $\delta$ (limit discount factor) indicates to what extent the collusion is feasible:

- If a factor tend to decrease $\delta$, we say that it *facilitates* collusion.
- If a factor tend to increase $\delta$, we say that it makes collusion *more difficult*.

*Remark:* there are other equilibria to this repeated game (e.g., the Bertrand equilibrium of the one-period game is an equilibrium).
Equilibrium in a price competition game repeated $T < \infty$ times

There is only one (subgame perfect) Nash equilibrium such as $p^* = c$.

Why?

- Backward induction reasoning.
- The last period ($T$th) corresponds to the one-period Bertrand game, so the unique equilibrium of this period is such that $p_T = c$
- At period $T-1$, firms expect that at the last period the Bertrand equilibrium will prevail
- They are in the same situation as in the last period and set $p_{T-1} = c$
- etc.
Market Structure and Collusion

Does a more concentrated market structure (a lower number of firms) facilitate collusion?

- Let’s consider an oligopoly with $n$ identical firms
- The marginal cost is assumed constant and equal to $c$
- Firms compete à la Bertrand
- The discounted value of future profits in case of collusion is

$$\Pi = \frac{1}{n} \pi^M \left( \frac{1}{1 - \delta} \right),$$

- What is the deviation profit? It is always $\tilde{\Pi} = \pi^m$
- The limit discount factor is

$$\delta > \left( 1 - \frac{1}{n} \right) \equiv \bar{\delta}.$$
Market Structure and Collusion

The threshold discount factor,

\[ \bar{\delta} \equiv \left( 1 - \frac{1}{n} \right), \]

increases with \( n \), and therefore we obtain the following result:

Relation between market structure and collusion
Lower is the number of firms, the easier is collusion.

For example, two firms with a discount factor of 0.6 could hold a situation of tacit collusion, but not three firms.
This result has been confirmed in practice.

- In the cartel cases dealt with by the Department of Justice (DOJ) in the US between 1990 and 2003:
  - 77% were related to anti-competitive agreements between 6 firms or less
  - 13% only related to anti-competitive agreements between 50 firms or more

- Out of the 111 cartels detected and sanctioned by the European Commission between 1969 and 2009 (Combe and Monnier, 2012):
  - On average 7.7 participants and median of 5
  - 50% of cartels comprised less than 5 participants and 75% less than 10.

- Cartels often collapse upon entry.
Factors which Promote Collusion

Entry Barriers and Collusion

Do entry barriers facilitate or make collusion more difficult?

Collusion is more difficult if there are weak entry barriers:

- Entry of competitors (e.g., "hit and run" entry) decreases collusion profits.
- The possibility of competitors entry in the future weakens the "threat" of "punishment" in case of deviation.

Let’s assume the following model:

- Every period, there is a probability of entry $\mu$ from a competitor which sets the competitive price $p = c$
- With the probability $1 - \mu$, there is no entry and the two firms may try to collude
- A "hit and run" entry only last one period (the possibility of entry is therefore determined every period).
Entry Barriers and Collusion

In the case of collusion, both firms receive:

$$\Pi = \frac{1}{2} \pi^M + (1 - \mu) \delta \frac{1}{2} \pi^M + (1 - \mu) \delta^2 \frac{1}{2} \pi^M + \ldots,$$

The collusion is therefore sustainable if:

$$\frac{1}{2} \pi^M + (1 - \mu) \frac{1}{2} \pi^M \left(\frac{\delta}{1 - \delta}\right) > \pi^M,$$

with

$$\delta > \frac{1}{2 - \mu} \equiv \bar{\delta}.$$
Entry Barriers and Collusion

The threshold discount factor $\bar{\delta}$ increases with the probability of entry $\mu$.

Therefore, we obtain the following result:

**Relation between entry barriers and collusion**

A higher probability of entry decreases the collusion possibility.

→ A higher probability of entry (weaker entry barriers) decreases future collusion profits and therefore decreases the "cost" of a deviation (punishment).
Frequency of Interactions and Collusion

Do competitive interactions facilitate or make collusion more difficult?

Let’s take the basic model:
- Two firms sell identical goods (perfect substitutes)
- Same marginal cost of production, $c$
- We assume that firms compete every $T$ periods: period 1, $T+1$, $2T+1$, etc.
- The collusion is sustainable if

$$\frac{1}{2} \pi^M \left(1 + \delta^T + \delta^{2T} + \ldots \right) > \pi^M,$$

which is equivalent to

$$\delta > \frac{1}{2^{1/T}} \equiv \bar{\delta}.$$

Relation between interaction frequency and collusion

More frequent interactions facilitate collusion.
Multi-Market Contacts and Collusion

Definition
When firms compete in several different markets.

- Two firms compete in two independent (but identical) markets: market 1 and market 2.
- Firms interact more frequently in market 1 (every period) than in the market 2 (every 2 periods).
- They collude in both markets and in case of a deviation, the "punishment" applies also on both markets.
- **What is the threshold discount factor in both markets?**
- Interaction frequencies: if \(1/2 < \delta < 0,71 = (1/ \sqrt{2})\), collusion is sustainable in market 1, but not in market 2.
Multi-Market Contacts and Collusion

Collusion is sustainable on both markets if the deviation "profits" are superior to the deviation "costs",

\[
\frac{1}{2}\pi^M + \frac{1}{2}\pi^M \leq \frac{\pi^M}{2} (\delta + \delta^2 + ...) + \frac{\pi^M}{2} (\delta^2 + \delta^4 + ...),
\]

or

\[4\delta^2 + \delta - 2 \geq 0,\]

with \(\delta \geq 0, 593.\)

For example, if \(\delta \geq 0, 6\), collusion is not sustainable in market 2, but could be implemented on both markets.

Therefore, multi-market interactions enable collusion in markets where, due to their characteristics, it is a priori not sustainable.
Example of the air sector:
- Air companies compete on numerous air routes, but not all.
- For instance, in 1998, in the US on the 1000 first routes, the 3 main companies had a "contact" on 40% of these routes.

Multi-market contacts and collusion?
- It has been shown that this variable (the average multi-market contact rate) had a positive impact on a route price (after controlling for other price explaining factors).
Secret Price Cuts

- A market with two firms
- Each firm observe its price and its sale, but not the price and the sale of its competitor
- With a probability $\alpha$, demand disappears: it equals 0 ("exogeneous shock")
- If its demand is zero, a firm is unable to know if it is a lack of luck (demand shock) or because its competitor has cheated.

In this context, perfect collusion (monopoly price even after a demand shock) is not possible.
Secret Price Cuts

However, collusion is still feasible following this strategy:

- **Collusion phase**: first set the monopoly price and maintain it as long as the firm maintains its market share.
- **Punishment phase**: when a firm demand is null, it enters a price war for a limited number of periods ($T$), after which it comes back to the monopoly price $p^M$.

Trade off on the choice of $T$:

- The war price should be sufficiently long to dissuade "cheaters"
- But a price war could have been triggered by a bad shock of demand and not by a "deviation"
- Firms have an incentive to limit the time of the price war.
Conclusion of Green and Porter model

If price decreases are difficult to observe, periodic war price could be required to sustain an anti-competitive agreement.

Remark: although there are periods of price wars at the equilibrium, no firm cheats at the equilibrium.
If Demand Fluctuations are Unobserved

What would happen if firms could observe the demand fluctuations?

- Let’s suppose that the demand is cyclical (ups and downs).
- Demand shocks are independent from one period to another.
- In case of collusion, does the profit depend on the demand level?
  - No, due to the independence hypothesis.
- In case of deviation, does the profit depend on the demand level?
  - Yes, deviation more profitable if the demand is high.

**Conclusion:** It could be necessary to decrease the prices when the demand is high. → Prices evolve in a "counter-cyclical" manner.
"If You Find Cheaper Elsewhere..."

Some clauses could also facilitate collusion: for example, clauses such as "if you find cheaper elsewhere, we reimburse the difference..." → allows to detect deviations.

The "most favored customer clause"

- **What is the impact on deviation incentives?**
- If the firms decreases its price to capture the demand in the short-term, it should reimburse the customers who had paid the monopoly price

→ This type of clauses highly reduce incitations to deviate and make cartels more stable.
Other Factors

Other factors:

- Cost asymmetries make collusion more difficult for two reasons:
  - Difficult to agree on a common pricing strategy.
  - It is more difficult to "discipline" the most efficient firms.

- Growing markets: collusion is easier to sustain, as the profit of deviation is weaker compared to the cost (as the market will keep growing).
Take-Aways (1)

- There are two types of anti-competitive agreements: explicit and tacit.
- Cartel formation allows to raise the firms profits, as the firms take into account how the decision of each of them impacts the profits of the others.
- The possibility of collusion is realistic when we take the time dimension into account (repeated interactions between firms).
- Firms cannot always collude as they have the possibility to cheat, which will lead to a punishing price war (cf. arguments from Stigler 1964, sometimes it may be more profitable to be outside a cartel!).
- Collusion possibilities are facilitated by: the low number of firms, the high valuation of discounted future profits, symmetry of costs, absence of demand uncertainty.
## Take-Aways (2)

### Summary table: conditions for cartel formation (stability):

<table>
<thead>
<tr>
<th>Market characteristics</th>
<th>Firms characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Low number of firms</td>
<td>– Homogeneous firms in terms of production costs</td>
</tr>
<tr>
<td>– Weak price elasticity of demand</td>
<td>– Homogeneous firms in terms of products</td>
</tr>
<tr>
<td>– Intermediate products</td>
<td></td>
</tr>
<tr>
<td>– Low demand fluctuations and high fixed costs</td>
<td></td>
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<tr>
<td>– Entry barriers</td>
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</table>