Collusion.

Industry profit in an oligopoly (sum of all firms’ profits) $< \text{monopoly profit}$.

Price lower and industry output higher than in a monopoly.

Firms lose because of non-cooperative behavior: Each firm ignores the effect its action has on rivals’ profits (externality).
Agreements to increase market power (cooperative behavior): collusion.

Examples:

Cartel agreements (OPEC)

Cartels illegal (Sherman Act, USA; Treaty of Rome, Europe).
Two other channels of collusion:

1. Secret agreements (enforced by extra-legal means)

2. Tacit agreements: self-enforcing (sustained through implicit threats of punishment for deviants - possibly through future non-cooperation).

Economists emphasize (2): repeated interaction makes collusion self-enforcing.
Repeated Bertrand Game

2 firms: 1 and 2

Constant identical marginal cost: $c$

Market meets every period: $t = 1, 2, ... \infty$

Identical market demand curve every period.

Firms set prices every period.

Lower price firm gets market (equal prices split market equally).
Each firm’s payoff: discounted sum of profits over time

Discount factor: $\delta = \frac{1}{1+r}, r =$ interest rate, $0 \leq \delta < 1$.

Present value of $1$ next period = $\$\delta$ today.

Present value of $1$ after $t$ periods = $\$\delta^t$ today.
Strategy of each firm: specifies the price in each period for each possible history observed.

Look at subgame perfect equilibrium: NE in every subgame.

The game from any time $t$ onwards (after each realized history) is a subgame.
One equilibrium:

History independent strategies.

Each firm expects its rival to choose price $= c$ every period regardless of past history.

In best response, each firm chooses price $= c$ every period regardless of past history.

This is a subgame perfect equilibrium: it replicates the one shot Bertrand outcome.
But there are other equilibria that lead to more collusive outcomes.

They involve history dependent strategies.
Consider the following "Trigger Strategies":

Each firm charges monopoly price $p^m$ in period 1.

In any period $t > 1$, firm charges monopoly price $p^m$, if the past history is one where both firms charged monopoly price in period 1, ..., $t - 1$, and if that is not the case, it charges price $= c$. 
Result: In any subgame, if a firm expects its rival to follow trigger strategy (of the above kind), it is a best response for the firm to also follow the same trigger strategy, provided $\delta \geq \frac{1}{2}$. 
To see this, consider any subgame beginning in period $t \geq 1$.

There are two possible types of realized history:

i) The firms have set monopoly price $p^m$ every period in the past

ii) Some firm has set price $\neq p^m$ in the past.

In case (ii), since firm 1 expects firm 2 to follow trigger strategy, it expects firm 2 to set current price $= c$, and so its best response is to set its own current price $= c$ i.e., to follow the same trigger strategy. Vice-versa.

Therefore in any subgame of type (ii), trigger strategies constitute a NE.
In case (i), since firm 1 expects firm 2 to follow trigger strategy, it expects firm 2 to set current price \( = p^m \).

Now, firm 1 has two options:

(a) Stick to trigger strategy and set its own current price \( = p^m \)

(b) Deviate and undercut rival.
If firm exercises option (a) & sticks to its trigger strategy, its
- current profit is $\frac{1}{2}\Pi^m$ where $\Pi^m = \text{monopoly profit}$.

and next period, as it expects the rival to follow trigger strategy, rival will choose price $= p^m$ again and, by sticking to its trigger strategy, the firm can make $\frac{1}{2}\Pi^m$ next period and so on every period thereafter so that its total payoff from sticking to trigger strategy is:

$$\frac{1}{2}\Pi^m + \delta(\frac{1}{2}\Pi^m) + \delta^2(\frac{1}{2}\Pi^m) + \delta^3(\frac{1}{2}\Pi^m) + \ldots.$$  

$$= \frac{1}{2}\Pi^m(1 + \delta + \delta^2 + \delta^3 + \ldots)$$  

$$= \frac{1}{2}\Pi^m(\frac{1}{1 - \delta})$$
If firm exercises option (b) i.e., deviates from trigger strategy and undercuts rival, it can get almost the entire monopoly profit $\Pi_m$ today, but since it expects its rival to follow trigger strategy it knows that rival’s price $= c$ in all subsequent periods and so it can make at most zero profit in the future. So maximum total payoff from deviation is

$$\Pi_m + \delta(0) + \delta^2(0) + \ldots = \Pi_m$$

So option (a) is a best response if:

$$\frac{1}{2} \Pi_m \left( \frac{1}{1 - \delta} \right) \geq \Pi_m$$

which is equivalent to

$$\frac{1}{2} \left( \frac{1}{1 - \delta} \right) \geq 1$$

that can be simplified to

$$\delta \geq \frac{1}{2}$$
Thus, if $\delta \geq \frac{1}{2}$ then following the trigger strategies is a NE in every subgame and hence a subgame perfect equilibrium for the repeated game.

When firms play these trigger strategies, they will actually charge $p^m$ every period - no deviation will be observed in actual play of the equilibrium.

Market outcome: identical to a monopoly outcome.

Perfect collusion.

More generally, the less firms discount the future (i.e., the more patient they are), the greater the possibility of sustaining collusion through tacit self-enforcing agreements.
Factors affecting possibility of sustaining collusion in the market.

1. Patience - how forward looking firms are (high value of $\delta$).

2. How frequently the market meets (i.e., length of time interval between successive price setting opportunities): Smaller the interval between time periods, higher the value of $\delta$ (deviation from collusion is punished sooner).
3. Probability that the firms will be around in the industry next period - the smaller that probability, the lower the effective value of $\delta$, lower the possibility of collusion, 

$\Rightarrow$ Industries with high rates of entry and exit (volatility) are less likely to be collusive than stable industries.
4. Growth in industry demand or profitability - reduces incentive to deviate (because future collusion payoffs are higher).

Declining industries - less likely to be collusive.
Other factors:

5. Fear of antitrust proceedings even though there is no explicit cartel.
6. Coordination problems - many equilibria, firms may not coordinate on the most collusive one.
7. Imperfect observability of prices and deviations from collusive path by rivals.
9. Market structure: more concentration, easier to sustain collusion.

Concentration refers to how concentrated the distribution of market shares is.

If firms are identical, then its simply the inverse of the number of firms.

Higher the number of firms, smaller the share of monopoly profit received by each firm by colluding and hence greater the incentive to deviate from collusion.
10. Similarity between firms. If firms are dissimilar, it becomes harder to get perfect collusion.

For example, if $c_1 < c_2 < \text{monopoly price for firm 1}$, then perfect collusion requires that firm 1 sell to the entire market and share its monopoly profit with the other firm (firm 2 has higher cost and so any production by firm 2 is simply a waste of potential profit).

But this kind of a scheme requires complex direct negotiations & contracting that is likely to attract attention of antitrust authorities.
11. Multimarket contact - helps collusion.

For example, in one market firm 1 has a cost advantage and in another market firm 2 has a cost advantage. Each firm can charge monopoly price in its market of advantage and let the other take the other market (by charging a very high price).

Many examples of this among multinational firms.
12. Institutions that facilitate collusion by making deviations easier to detect or less attractive:

* most favored customer clauses (reduces incentive to cut prices)

* laws that require public disclosure of price contracts between buyers and sellers.
Real industries: often oscillate between high collusive prices and price wars. How do we explain that?
1. In markets with large buyers where prices are negotiated: Secret price cuts.

Uncertainty about demand - fluctuation not observed directly.

Difficult to detect price cut by rival from the fall in quantity sold.

Low sales could be because of rival undercutting or because of low market demand.

Cannot observe deviation by rival - difficult to initiate punishment (price-war).

How does collusion work in such markets?
Suppose every firm follows the strategy of not initiating punishment whenever it records fall in quantity sold.

Then, firms will always undercut rivals secretly.
On the contrary, suppose firms follow the strategy of entering punishment phase whenever they observe fall in quantity sold.

Then, sooner or later, industry must enter punishment phase because even if no one cheats, demand will be low at some point of time.

But then, collusion must break down forever after a point.
Way out?

Firms punish (enter price war or Bertrand pricing) whenever they observe fall in quantity sold but only for a limited number of periods after which they revert to collusive pricing (charging monopoly price).

When all firms follow this strategy, no firm wants to undercut secretly, because that will attract punishment for sure.

But they all know that sooner or later demand will fall and they will enter a limited punishment phase of price war.

The latter phase is necessary because if it was not there, would be deliberate undercutting.
Prediction: low prices/price wars in low demand phases (recessions), collusive (high) prices in high demand phases (booms).

Collusion follows the business cycle.
2. In markets with fluctuating demand where demand fluctuation is observed and so are prices set by firms.

No secret price cuts.

Suppose demand shocks are independent over time - and demand is either "high" or "low".
Comparing pros and cons of deviation.

If you stick to high collusive price you get a certain (A) "expected" path of profit based on average future profit from collusion.

If you deviate: you lose (A) but gain in terms of (B) higher current profit.

Whether we can sustain collusion depends on comparison of (A) and (B).

However current profit from deviating and taking over the entire market i.e., (B) depends on whether current demand is high or low.

If demand is high, (B) is high.

If demand is low, (B) is low.
So, it is quite possible that (A) > (B) in periods of low demand and (B) > (A) in periods of high demand.

In that case one cannot sustain collusion in all periods.

Firms charge collusive prices in periods of low demand (with the threat of punishment if anyone deviates in those periods).

But in periods of high demand, they give up trying to collude and their strategy does not prescribe any collusive price for such periods.
Prediction: Price wars in booms, collusive prices in recessions.

Collusion moves counter to the business cycle.