Collusion

Collusion

▶ Instead of coordinating prices (or output) by merging, can firms increase profits by coordinating their choices explicitly? We call such coordination "collusion."

▶ In the static game, such coordination was impossible since the best response of a firm in a collusive agreement is to decrease price (or increase output). See problem set 3.

Q1 Can repeated interaction enable firms to collude?

Q2 What are the ingredients which enable collusion?

Q3 In what types of industries are firms more likely to collude?

Motivation

Motivating Case 1:
Federal Baseball Club vs. National League (1922)

▶ Major League baseball is organized as a collection of teams which choose to play each other. This is like a bunch of firms which choose to compete with each other but no one else.

▶ In contrast, the National Football League, the National Basketball Association, and the National Hockey League are organizations (i.e., firms) unto themselves.

   - Note that we've seen rival leagues enter in these sports (e.g., XFL, ABA, WHL).

▶ After the "Federal League," a competitor to the American and National baseball leagues, folded in 1915, some Federal League owners were compensated by the surviving leagues teams.

▶ Those who were not (e.g., the owner of the Baltimore Terrapins), sued the National League, the American League and other defendants, including several Federal League officials for conspiring to monopolize baseball by destroying the Federal League.

▶ In a unanimous decision written by Justice Jon Heithold, the Supreme Court argued that owners in the American and National Leagues operate in the business of "giving exhibitions of base ball, which are purely state affairs" so their business was not interstate commerce and therefore could not have violated the Sherman Act.

▶ By this precedent, Major League Baseball is exempt from anti-trust regulations.

Motivating Case 2:
Eichenseer vs Madison-Dane County Tavern League, Inc., et al (2008)

▶ In 2002 Government officials in Madison, WI threatened local bars with increased regulations if they did not do something to curb college drinking.

▶ In response, local bars voluntarily banned drink specials on weekend nights.

▶ The Plaintiffs, Univ of Wisconsin students, filed class action suit for damages against twenty-four campus-area taverns and the Madison-Dane County Tavern League, Inc. They alleged that the defendants had engaged in an illegal conspiracy in restraint of trade by voluntarily agreeing to limit "drink specials" on Friday and Saturday nights after 8:00 p.m.

▶ The Wisconsin Supreme Court ruled that Madison city officials pressured the bars to remove the drink specials. Consequently, their "price collusion" was the result of the city's interest in maintaining public health (which it is entitled to do). The bars were, therefore, not in violation of the Sherman Act.

A Final (And Less Fun) Motivating Case: E.I. Du Pont and Ethyl Corp vs. FTC (1984)

The Market: manufacture and sale of lead antiknock gasoline additives.

▶ Additives are used to prevent "knock" - premature detonation in gasoline engine cylinders.

▶ Homogenous good.

Supply:

▶ Four suppliers in 1970s: DuPont (38.4%), Ethyl (35%), PPG (16.2%), Nalco (11.8%).

▶ Ethyl was sole supplier from 1920-48; with rising demand, DuPont entered in 1948, PPG in 1961, Nalco in 1964.

Demand:

▶ Buyers are gasoline refining companies which are large, aggressive, sophisticated.

▶ Demand is inelastic; no close substitutes, and compound accounted for very small percentage of the total cost of the gasoline.

▶ After 1973, demand is declining due to Federal controls on emission standards (i.e., catalytic converters).

The Charge:

The four manufacturers are alleged to have engaged in unfair methods of competition and unfair acts and practices in violation of Section 5 of the FTC Act. The unfair practices include:

▶ Sale by delivered prices

▶ Most-favored-nation clauses

▶ Advance notice of price changes to customers (30 days) and to press.

Question:

1. What factors are necessary for firms to collude?

Theory

A. Finitely Repeated (Simultaneous Move) Games

▶ Consider the Cournot oligopoly game from earlier in the semester.

▶ Two firms, A and B, play the Cournot game twice.

$$P(Y) = 70 - Y \quad \text{(homogeneous goods)}$$
$$C(y_i) = 10y_i, i = A, B$$

▶ The Nash equilibrium to the one-period game:

$y_A^\star = y_B^\star = 20, \ P^\star = 30, \ \pi^\star = 400.$

▶ The monopoly solution:

$Y^M = 30, P^M = 40, \pi^M = 900.$

Firm "Strategies"

A strategy for each firm in the two period game is a contingent plan that specifies:

▶ A level of output in period 1
▶ A level of output in period 2 as a function of the outputs chosen by both firms in period 1.

For Example: "In period 1, I choose 15 units; in period 2, I will choose 20 units if both firms produced 15 units in period 1 and 60 units otherwise."

Call this strategy the "C" strategy for cooperation. If both firms choose this strategy, the outcome will be

▶ $Y_1 = 30, Y_2 = 40; P_1 = 40, P_2 = 30;$
▶ $y_{A,1} = y_{B,1} = 15, y_{A,2} = y_{B,2} = 20;$
▶ $\pi^A = \pi^B = 450 + 400 = 850$

Is (C, C) a Nash Equilibrium?

Need to check whether the best deviation from C increases a
player's pay-offs (profits).

▶ If both firms choose 15 in period 1, neither has an incentive to deviation in
period 2 since (20, 20) is a Nash equilibrium in period 2 stage game.

Optimal deviation strategy for firm A ("D"):

▶ Recall the best response function for this game:

$$y_i = \frac{A - c - By_{-i}}{2B} = \frac{60 - 15}{2}$$

▶ Deviate in period 1 by producing the best reply to 15, which is 22.5.
▶ Given the deviation in period 1, firm A's best reply to $y_{B,2} = 60$ is to produce 0.
▶ Total profits: $506.25 + 0 = 506.25$.

Since profits from "D" are less than profits from "C", we conclude (C, C) is a
Nash equilibrium.

Is (C, C) a SPNE?

But is it subgame perfect? Should firm A be deterred by firm B's threat to flood the market following a deviation?

▶ No, it is not in firm B's interest to carry out the threat once the deviation has occurred.

Subgame perfect Nash equilibrium:

▶ (20, 20) is the unique Nash equilibrium in period 2.

Hence, the requirement that play is Nash in period 2 means that each firm chooses 20 in period 2 *regardless of what happened in period 1*: bygones are bygones.

If play in period 2 does not depend on play in period 1, then the first period game is basically a one-shot game with payoffs given by profits from play in period 1 plus $400.

▶ (20, 20) is the unique Nash equilibrium in period 1.

<u>Conclusion:</u> The unique subgame perfect equilibrium in a finitely repeated Cournot game is to play the Cournot quantity in every period.

The Fix: An Infinitely Repeated Game (T=∞)

To simplify, restrict choice of firm outputs to following set:

$$\{15, 20, 22.5\}$$

Then the payoffs to the stage game are:

	$y_2 = 15$	$y_2 = 20$	$y_2 = 22\frac{1}{2}$
$y_1 = 15$	(450,450)	(375, 500)	$(337\frac{1}{2}, 506\frac{1}{4})$
$y_1 = 20$	(500,375)	(400, 400)	$(350, 393\frac{3}{4})$
$y_1 = 22\frac{1}{2}$	$(506\frac{1}{4}, 337\frac{1}{2})$	$(393\frac{3}{4}, 350$	$(337\frac{1}{2}\ 337\frac{1}{2})$

The Nash equilibrium is, of course, (20,20).

Firm "Strategies"

A strategy in the infinitely repeated game is a plan which specifies for each period t a choice of one of three outputs as a function of the history of outputs chosen in previous periods.

A pair of such strategies generates a pair of outputs for each period $\{(y_{A,t}, y_{B,t})\}_{t=0}^{\infty}$. Firm i's payoffs from this stream of profits is given by the discounted sum

$$\sum_{t=0}^{\infty} \beta^t \pi_i(y_{1,t}, y_{2,t})$$

where $0 < \beta < 1$ is the discount rate.

"T" Strategy

"In every period t, play 15 if both firms have played 15 in every prior period; otherwise play 20."

Is (T, T) a subgame perfect equilibrium?

▶ Since $T = \infty$ there is no final period to work backwards from. Instead, we'll look for an optimal deviation at some arbitrary period.

Profits from (T, T) are

$$\sum_{t=0}^{\infty} \beta^t(450) = 450/[1 - \beta]$$

Suppose Firm i deviates in period $t=0$ and chooses 22.5. Then its payoff from that period forward is

$$506\frac{1}{4} + \sum_{t=1}^{\infty} \beta^t(400) = 506\frac{1}{4} + 400\beta/[1 - \beta]$$

Therefore, Firm $i = \{A, B\}$ has no incentive to deviate if and only if

$$\underbrace{\overbrace{450}^{\pi^M}/(1-\beta)}_{\substack{\text{Pay-off from} \\ \text{playing T}}} > \underbrace{\overbrace{506.25}^{\pi^D} + \overbrace{400}^{\pi^\star}\beta/(1-\beta)}_{\text{Pay-off from deviating}}$$

where π^M, π^D, $\pi^\star$ are profits from collusion (M for monopoly), deviating (D), and the Cournot Nash equilibrium ($\star$), respectively. Solving for β we get

$$\frac{\pi^D - \pi^M}{\pi^D - \pi^\star} < \beta \ .$$

In this case, β must be bigger than 0.529.

Conclusion: If firms are not too impatient and they cannot envision an end to the game, collusion is a potential non-cooperative equilibrium outcome.

Note: This condition must hold for all firms. If the firms have different discount factors (*i.e.*, β_i), you need to check that both are sufficiently patient such that the trigger strategy (*i.e.*, the penalty) is effective.

Factors that Facilitate Collusion

1. Market Power:

▶ Cartel profits are much higher if consumers cannot escape price increases by switching to other, substitute goods.

▶ Cartel does not have to reduce quantities very much to obtain significantly higher profits.

2. High Entry Barriers

▶ Cartel profits attract entry. If entry is easy, cartel has to share its profits with more firms or compete with them. In either case, cartel profits are dissipated.

▶ Inability to sustain cartel profits due to entry reduces the likelihood that the cartel forms.

Factors that Facilitate Collusion (cont'd)

3. Homogenous good
- ▶ Can use market shares or quotas to determine cartel outputs
- ▶ Easy to detect cheating - fall in demand is due to price cuts by a rival rather than demand-specific shocks

4. Low organization costs
- ▶ Coordination is easier with fewer firms.

Cartel Problems

1. Free-rider problem
▶ If some firms collude and reduce output, then firms outside of the cartel benefit - their market share increases.

2. Incentive to cheat
▶ Best reply to everyone agreeing to monopoly output is to produce more.
▶ If firms are capacity constrained, firms cannot cheat even if they would like to do so - collude on capacity.
▶ Cheating is easier to detect if few firms - easier to monitor
▶ Also easier to detect if demand does not fluctuate very much and prices are widely known.

An Aside: "Fiat" Money

▶ Currencies inherently have no value. For example, dollar bills have little nutritional value and provide little heat when burned.

▶ Why is money "valuable" then? We use money as a medium of exchange where we accept a dollar (euro, peso, etc.) in exchange for some service or product we provided because we know (or believe) we can use that dollar to buy something that does provide nutrition, shelter, entertainment, etc. in the future.

▶ How much "something" we can get from that dollar depends on our expectation (belief) of future prices (inflation).

▶ In countries with high inflation (hyperflation, stagflation), markets break down because people believe their money has little value – they believe they can buy very little with it in the future so they're unwilling to accept it now.

▶ This is like our finite game example. Tomorrow won't happen, so I won't cooperate today.

▶ A mandate of the US FRB is to manage inflation. While there is not an explicit target, 2% inflation seems to be the implicit objective.

▶ The number itself is not so important, though. What is important is that consumers today can accurately forecast the value of their tomorrow which enables today to function.

▶ Since the Great Recession, the FRB has also provided "Forward Guidance" to help provide clarity on economic forecasts and potential open market operations in order to avoid bad self-fulfilling equilibria from materializing.

Review of Main Results

▶ Threat of price wars enforces collusion.
▶ But then our theory says price wars do not occur.

Q: How then do we explain price wars we observe?

A series of papers tackled this question by introducing lack of information.

▶ Demand is stochastic (and not observable)
▶ Firm prices (or quantities in Cournot game) are not observable
  (secret price cuts).

Empirical Evidence

Model Outline (Green and Porter, 1984)

Suppose a firm does not sell very much output at the collusive price. Two reasons are possible:

▶ State of demand is low.

▶ State of demand is high. Rival cheated by offering customers a secret price cut.

<u>Results:</u>

1. In this environment, monopoly pricing is no longer an equilibrium outcome.

2. Equilibrium has the following properties:

   • The equilibrium path alternates between periods of high prices (collusive phase) and periods of low prices (price wars).

   • During the collusive phase, firm profits lie between the monopoly and competitive levels.

   • The price war is triggered by a low demand shock.

3. By definition, no one "cheats" as price wars are part of the equilibrium path.

Application: Porter, R. (1983) "A Study of Cartel Stability: The Joint Executive Committee, 1880-1886."

▶ JEC was a cartel that controlled eastbound rail freight shipments, mostly grain, from Chicago to Atlantic seaboard in 1880's.

▶ Formed in 1879 by public agreement. It preceded the passage of Sherman Act.

▶ Approximately homogenous good: although different rail routes, destination of most of the grain was overseas.

▶ Firms have limited capacity and set prices individually.

▶ Total demand was quite variable.

▶ Cartel agreement set market shares; shipments were monitored by cartel weekly.

Economic Mechanism

However, actual market share depended upon prices set by all firms and *unpredictable, idiosyncratic* forces.

So cartel members faced an inference problem:
If market share is high for one member is it because that member offered customers a secret price cut or was it because demand was idiosyncratically high for that member?

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Enforcement mechanism was then a variant of trigger strategy:
If cartel thought that cheating had occurred, it would cut prices for a time, and then return to the collusive price.

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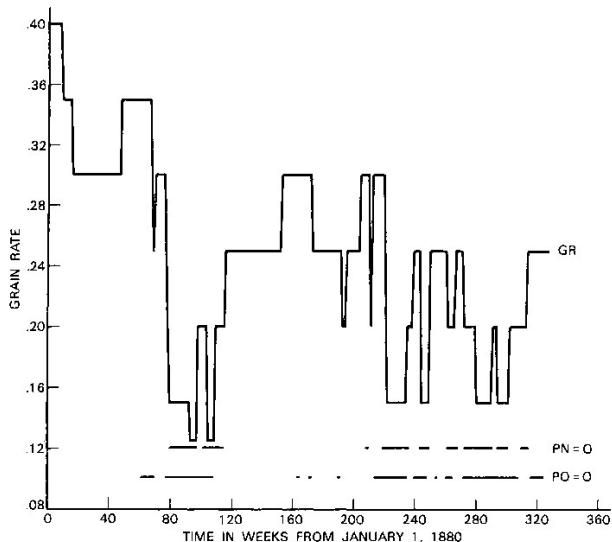**Enforcement mechanism was then a variant of trigger strategy:**
If cartel thought that cheating had occurred, it would cut prices for a time, and then return to the collusive price.

Q: Can we test this hypothesis?

Motivating Data Fact: Price Variation Across Time

IGURE 1

LOT OF GR, PO, PN AS A FUNCTION OF TIME

Econometric Model

Porter estimates an econometric model to identify the markups during collusive periods.

1. Demand:

$$\log Q_t = \alpha_0 + \alpha_1 \log P_t + \alpha_2 L_t + u_{1t}$$

Q_t = shipments of grain in week t, tons
P_t = grain rate, $ per 100 lbs.
L_t = dummy variable; 1 if Great Lakes open.

Note: α_1 is the elasticity of demand.

Econometric Model, cont'd

2. Pricing Equation:

$$(P - MC)/P = \theta_t/\alpha_1$$

where θ_t is the "conduct parameter" we saw in the lecture with homogenous goods (Genesove & Mullin, 1998).

Porter assumes marginal cost takes the following form:

$$MC(Q) = DQ^{\delta-1}$$

After some manipulation (see paper), pricing equation becomes

$$\log P_t = \beta_o + \beta_1 \log Q_t + \beta_2 S_t + \beta_3 I_t + u_{2t}$$

where

S_t = exogenous supply shifters
I_t = dummy variable equal to one if industry colludes in period t.
$\beta_0 = logD$, $\beta_1 = \delta - 1$, $\beta_3 = -log(1 + \theta/\alpha_1)$.

Results

1. Estimates allow Porter to reject the null hypothesis that changes in prices, quantities were due solely to exogenous changes in demand.

2. Put differently, Porter finds evidence that the cartel alternated between periods of collusion and non-cooperative behavior (Cournot).

3. Moreover, these periods of collusion and competition line-up with the behavior reported by the JEC at the time.

The Point: He finds evidence that a SPNE implied by the theory existed in the world. By combining the two, we have learned how to interpret the variation in observed prices.

Back to the DuPont Case: Plaintiff Arguments

The structure of the industry makes it susceptible to collusion.

▶ **Homogenous good:** collusive schemes are much easier to implement since firms simply have to agree on a price and market shares; easy to monitor as well.

▶ **Market Power:** gains from collusion are high. Buyers can't escape to other products when price rises.

▶ **High concentration:** smaller number of firms makes coordination less costly and more beneficial.

▶ **Declining demand + entry costs:** no threat of entry to dissipate collusion rents.

In this context, firms engaged in a number of business practices that facilitated collusion.

Business Practices Which Facilitated Collusion

1. Delivered prices: ensures the customers are quoted the same price from suppliers regardless of their locations. Alternative is mill-based pricing + transport cost.

▶ Easier for suppliers to monitor rival prices and detect price cuts.

▶ Easier to punish because retaliation is localized.

2. Most-favored-nation clause: if seller offers product at lower price to another buyer, other buyers can claim a rebate.

▶ Restricts players' (firms') ability to cheat on collusive agreement by lowering price.

3. Advance and public notice of price changes: informs rival suppliers to facilitate parallel price changes.

Defense Arguments

Each of the three practices pre-date the 1970's
- ▶ Ethyl engaged in these practices prior to 1948
- ▶ Adopted by the other three firms when they entered.

1. Delivered price: demanded by refiners because it would require the manufacturers to be responsible for transporting dangerous compounds to the refineries.

2. MFN: guarantee to buyers against price discrimination; since buyers compete against each other, they wanted to be assured that they would not be at a competitive disadvantage by paying higher prices for compounds.

3. Advance notice of price changes: aids buyers in their financial and purchase planning.
- ▶ Rivals would have quickly learned about any price changes anyway.

The Ruling

Court ruled for the defendants. In so doing it established two criteria for judging whether a business practice is unfair (and therefore illegal):

1. Evidence of anti-competitive intent by the producer charged.

   i.e., **The prosecution needs a "smoking-gun" – a significant hurdle.**

2. Absence of independent legitimate business reason for the practice.

The business activities between defendants failed to meet these criteria.

Broader Implications: Collusion is only illegal when firms explicitly coordinate. The government needs evidence that the accused have met, talked, emailed, etc. to coordinate actions.

Collusion is therefore not illegal when the actions were implicit (*i.e.*, firms colluded by accident). Note that in our theory we could get the collusion SPNE without the firms actually communicating their intentions to restrict output.

This is reminiscent of how monopoly is dealt with in the courts – it is not illegal to be a monopoly; rather it is illegal to restrict output (*i.e.*, it is only illegal to act like a monopoly).

Another Example: The Lysine Price-Fixing Conspiracy

▶ **Companies:** Archer Daniels Midland (ADM), Japanese companies Ajinomoto and Kyowa Hakko Kogyo, and Korean companies Sewon America Inc., and Cheil Jedang Ltd.

▶ **What They Did:** Coordinated to fix prices of the animal feed additive *lysine* during the mid-1990s.

▶ **Evidence:** ADM executive *Mark Whitacre*, then Divisional President of ADM's BioProducts Division, became a FBI informant because his wife threatened to inform the FBI if he failed to. The resulting cooperation resulted in hundreds of hours of video at cartel meetings around the world (e.g., Tokyo, Paris, Mexico City, Hong Kong). ▶ DOJ Videos   ▶ The Informant!

▶ **Penalties:** $105 million in criminal fines, a record antitrust penalty at the time, including a $70 million fine against ADM. ADM was fined an additional $30 million for its participation in a separate conspiracy in the citric acid market. Three ADM executives went to jail, including Whitacre (for a separate fraud scheme).

▶ **Why Important:** Convinced antitrust prosecutors that price-fixing was a far more pervasive problem than they had suspected. Resulted in an increase in the number of price collusion investigations.

Extensions

Collusion in Product Space?

▶ Our focus so far has been on price collusion but there's growing evidence that profits depend more on product characteristics than on prices so the returns to colluding on the former is larger.

▶ An Empirical Example:

"The Ice Cream Split: Empirically Distinguishing Price and Product Space Collusion" (Sullivan, 2018)

▶ Author proposes a methodology to measure product space and price collusion. Two-stage game:
   1. Firms simultaneously choose product characteristics.
   2. Conditional on product characteristics, firms simultaneously choose prices.

▶ Setting: Ben & Jerry's vs Häagen-Dazs in super-premium ice cream segment.
   • Ben & Jerry's ice cream includes chunky ingredients while Häagen-Dazs ice cream does not.
   • In the 1990s, Häagen-Dazs introduced "chunky" ingredients into its super-premium ice cream portfolio.

      "When the smooth get chunky, the chunky get smooth." - **Ben Cohen**

   • This amounts to a different kind of "price war." But is it evidence of collusion?
   • Author says "yes" and finds evidence that Ben & Jerry's and Häagen-Dazs not only colluded in prices, but also substantially colluded in the choice of flavors that were offered.
   • Shows that collusion in product characteristics has a bigger impact on consumer welfare (CV) than collusion in prices.