

# **OLIGOPOLY DYNAMICS: COLLUSION AND PRICE WARS**

# Overview

- Context: Firms interact over time — possibly using history-dependent strategies
- Concepts: repeated games, grim strategies, collusion, price wars
- Economic principle: repetition helps enforcing otherwise unenforceable agreements; greater punishment, greater rewards (topsy-turvy)

# Competition externality

- Competition implies an externality: each firm maximizes own profit, not joint profit
- Incentive to internalize externality — collusion:
  - Organized, public cartel agreements
  - Secret agreements
  - Tacit agreements — focal points
- Types of agreement
  - Increase price
  - Reduce supply
  - Set levels of service quality, advertising, etc
  - Territory restrictions



# Stability of collusive agreements

- Homogeneous-product duopoly; firms simultaneously set prices; constant marginal cost (i.e., no capacity constraints)
- If game is played once, Bertrand equilibrium
- What if game is played repeatedly at  $t = 1, 2, \dots$  (indefinitely)
- Claim: there may exist *grim strategy* equilibria whereby  $p > MC$ 
  - set  $p = p^M$  if  $p = p^M$  in the past
  - set  $p = MC$  otherwise

# Stability of collusive agreements

- Equilibrium profit NPV

$$V = \frac{1}{2} \pi^M + \delta \frac{1}{2} \pi^M + \delta^2 \frac{1}{2} \pi^M + \dots = \frac{1}{2} \pi^M \frac{1}{1 - \delta}$$

- Expected NPV from undercutting rival

$$V' = \pi^M + \frac{0}{1 - \delta}$$

- Condition for Nash equilibrium

$$V \geq V' \quad \text{or simply} \quad \delta \geq \frac{1}{2}$$

## Digression: relational contracts

- Many (most) economic relations are based on informal contracts
- Ditto for most international agreements (e.g. WTO, Kyoto, etc)
- Agreements are self-enforcing if they form a Nash equilibrium like to one considered above



## Stability of collusive agreements

- Collusion is possible if discount factor is sufficiently high, that is, if future is important enough
- Discount factor: how is one dollar next year worth now?

$$\delta = \frac{1}{1+r}$$

- Equilibrium condition  $\delta \geq 1/2$  is equivalent to  $r \leq 100\%$
- Equilibrium condition rather weak; why isn't there more collusion?

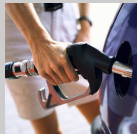
# Why is collusion not more frequent?

- Determinants of discount factor

$$\delta = \frac{(1 + g)(1 - h)}{1 + r/f}$$

where

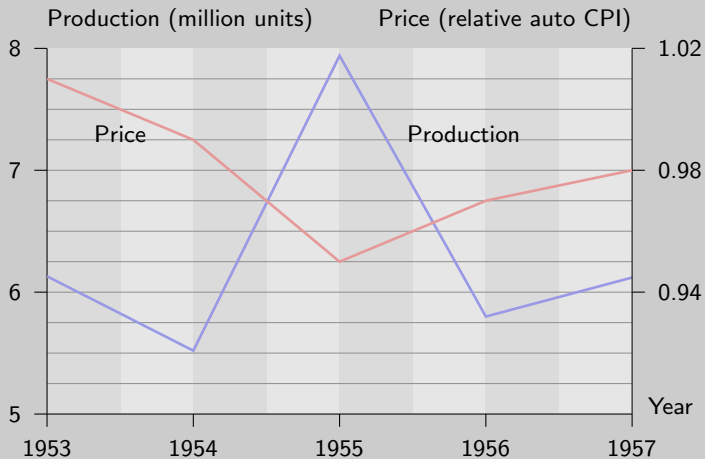
- $r$ : annual interest rate
  - $f$ : frequency of interaction (rounds per year)
  - $g$ : industry growth rate
  - $h$ : hazard rate (probability of industry or firm end)
- Antitrust policy
  - Credibility of infinite price war (topsy-turvy principle)\*
  - Observability of prices



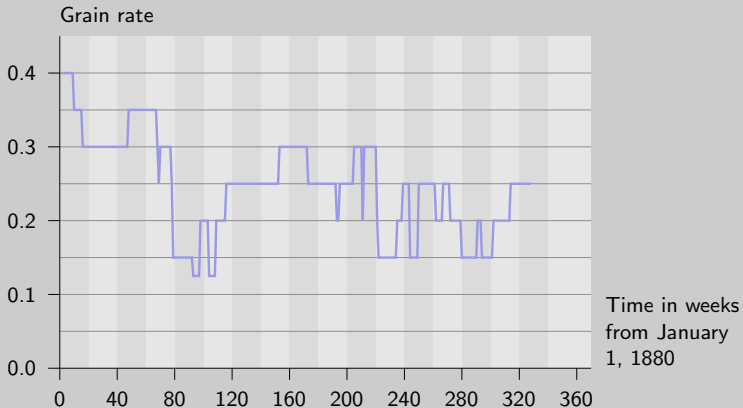
\* The harsher the punishment, the greater the payoff that can be sustained in equilibrium.



# US cars in the 1950s



# Price wars



# Price wars

- Industry where demand fluctuates
- Each firm observes price, own demand, not market demand
- Low firm demand implies guessing problem:  
is it low market demand or price cutting by rival?
- If firms assume it's market fluctuation and keep setting high price, then incentive is to cut price
- In order for collusion to be an equilibrium, firm must set low prices when firm demand is low — even though, in equilibrium, low demand always results from market fluctuations
- If price cuts are difficult to observe, then occasional price wars may be necessary to discipline collusive agreements

# Demand fluctuations

- Observable demand fluctuations (e.g., seasonality)
- Incentive to undercut greater during periods of high demand (more to be gained)
- Collusive equilibrium may require that prices be lower during periods of high demand

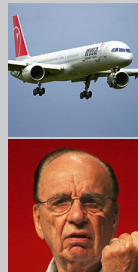
# Demand fluctuations and price wars

- Unobservable demand shocks  $\Rightarrow$  price  $\downarrow$  demand  $\downarrow$
- Observable demand shocks  $\Rightarrow$  price  $\downarrow$  demand  $\uparrow$
- Which model is right? It depends!
  - Freight shipments 19th century: cyclical price wars
  - Cement, retail: counter-cyclical price wars



# Price wars in asymmetric industries

- In the preceding models, price wars are a coordinated effort by all firms as part of a collusive equilibrium
- Price wars initiated by weak firms
  - Fares are dictated not by the strongest, but by the financially troubled. —CEO of Alaska Airlines
- Price wars initiated by strong firms
  - Murdoch's 1993 acquisition of the London *Times*



# Market structure and collusion

- Collusion is more likely in concentrated industries than in fragmented ones:
  - Easier to *establish* a collusive agreement
  - Easier to *maintain* a collusive agreement
  - Example: repeated Bertrand with  $n$  firms
- Easier to maintain collusion among similar firms
  - Example: duopoly where one firm has a cost advantage over the other one; efficient equilibrium not stable; and symmetric equilibrium also likely to be unstable
  - Example: diamond industry
  - Example: bromide cartels
- Bottom line: collusion easier to maintain among few and similar firms

## Bromide cartel

- Six price wars between 1885 and 1914, two of which right after publicly announced cartel agreement violations
- Price wars result from disagreement among cartel members regarding profit distribution; not equilibrium price wars in the sense explained earlier
- If all firms were symmetric, such disagreements would be less likely



## Multimarket contact

- Irrelevance result: if all markets are identical, multi market contact makes no difference
- Relevance result: firm  $i$  has an advantage in market  $i$  (cost  $\underline{c}$  versus rival's  $\bar{c} = \underline{c} + t$ )
  - Efficient equilibrium: firm  $i$  takes over market  $i$
  - Taken in isolation, these equilibria are not stable
  - Taken together, they may be stable
- Bottom line: Collusion is normally easier to maintain when firms compete in more than one market

## Multimarket contact: US airlines

- Market: flight connection between two different cities
- Average contact in market  $i$ : average number of other markets where competing airlines face each other
- Positively correlated with airfares
- Possible explanation: airlines use competition in other routes as a means to collude in a given route

# Multimarket contact: Dog Food Industry

- In 1980s, US dog food sales greater than \$3bn/year
- Market segments: dry, moist, snack, canned, and soft-dry
- In 1986, Quaker Oats (dominant in moist) acquired Anderson Clayton, increasing share in dry market
- Ralston Purina (dominant in dry) responded by acquiring Benco Pet Food's Inc., Quaker's main rival in the moist market,  
to say 'Hey, we can come at you in your strong area if you come after us in our strong area'
- The war continued: Quaker launched *Moist 'n Beefy*, a clear attack on Ralston's *Moist & Meaty* brand. Ralston Purina introduced *Grrravy*, a clear attack on Quaker's *Gravy Train* brand.

# Information sharing

- Perfect information, one of the conditions for perfect competition
- Natural presumption: the more transparent a market is, the more competitive it is
- Not necessarily so: information sharing and transparency may enhance collusion

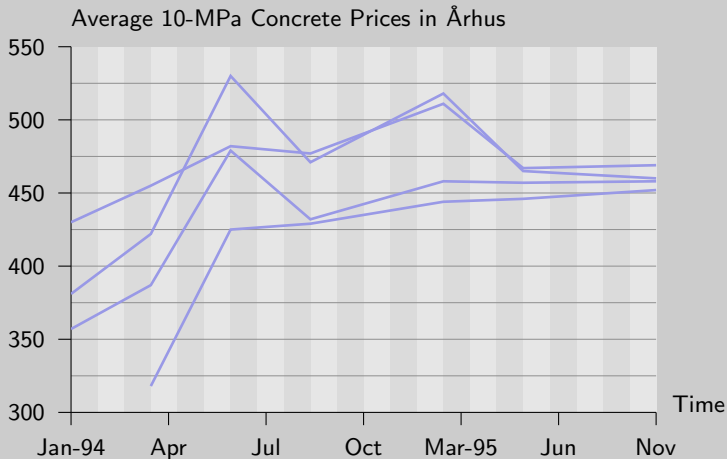
# GE and Westinghouse

- Market: large turbine generators
- Produced to order, mostly to electrical utilities. Sellers (GE, Westinghouse) submit bids or negotiate with buyers
- 1950s: secret bid ring results in jail sentences
- May 1963: GE announces new pricing policy:
  - *price book* made public
  - *most-favored customer* clause created
  - accounting firm to audit
- Within less than a year, Westinghouse copies GE's policy
- Prices remained stable and identical until 1975, when US Department of Justice forced a consent decree

## Danish ready-mixed concrete market

- Concrete market: regional submarkets, typically oligopolies with 3 or 4 competitors
- Until 1993: list prices subject to individual, confidential discounts
- October 1993: Danish Competition Council decided gathers and publishes actual transaction prices (weekly basis)
- Result: higher prices

# Danish ready-mixed concrete market

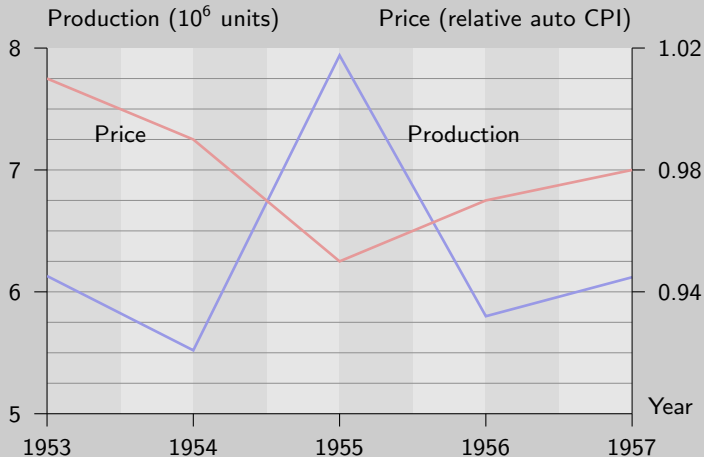


# Empirical analysis of cartels and collusion

- Information sources: legal cartels, dismantled cartels, indirect evidence
- Sugar cartel
  - Increase transparency (code of ethics)
- Lysine and citric acid cartels
  - sales quotas and buy-backs (individualized punishments)
- Collusion in the US auto industry
  - Use data to distinguish collusion from alternative story



# US auto industry



# Identifying the oligopoly solution

Price and cost by model and year

