Cartel and asymmetric information

Varian: Intermediate Microeconomics,
chapters 27.10–11, 28.4–6, 37.1–6

In this lecture you will learn

- what cartels do, when they are stable and when not
- what moral hazard and adverse selection are
- how signalization can solve the problem of adverse selection
- what function might have a school not teaching anything useful
- how incentives under complete and asymmetric information work
- what incentives have real-estate agents

Cartel

Cartel – firms are trying to maximize the sum of their profits.
The cartel behaves as a monopoly with more production plants.

Cartel is illegal.

In the US – personal responsibility of managers.

Corporate Penalties

	Fine	Damages	Total
CHRISTIE'S	0	$256,000,000	$256,000,000
Sotheby's	$45,000,000	$256,000,000	$301,000,000

Sotheby's	Sotheby's	Christie's	Christie's
CEO	Chairman	CEO	Chairman
Dede Brooks	Alfred Taubman	Christopher Davidge	Anthony Tenant
			
Pled guilty	Convicted	Received leniency	Indicted
1000 hours of	9 months in	$8,000,000	Not extradicted
service	prison	severance	Fugitive
$350,000 fine	$7,500,000 fine		

Profit maximization of a cartel with two firms

Inverse market demand: $p(y)$, where $y = y_1 + y_2$ (identical product)
Total revenue of cartel: $r(y) = p(y)y$
Cost functions of firms: $c_1(y_1)$ and $c_2(y_2)$

Cartel chooses quantity y_1 and y_2 in order to maximize profit:

$$\max_{y_1, y_2} \pi(y_1, y_2) = r(y) - c_1(y_1) - c_2(y_2)$$

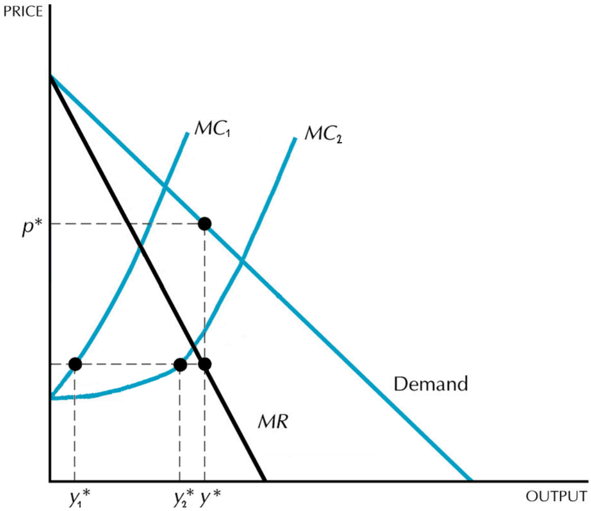
First-order conditions:

$$\frac{\partial \pi(y_1, y_2)}{\partial y_1} = \frac{dr(y)}{dy}\frac{dy}{dy_1} - \frac{dc_1(y_1)}{dy_1} = MR(y) - MC_1(y_1) = 0$$

$$\frac{\partial \pi(y_1, y_2)}{\partial y_2} = \frac{dr(y)}{dy}\frac{dy}{dy_2} - \frac{dc_2(y_2)}{dy_2} = MR(y) - MC_2(y_2) = 0$$

Profit maximization of a cartel with two firms (graph)

First-order conditions: $MR(y^*) = MC_1(y_1^*)$ and $MR(y^*) = MC_2(y_2^*)$



Cartel is unstable in an one-shot game – example

Inverse demand: $p = 11 - y$
Costs: $c_1(y_1) = 3y_1$; $c_2(y_2) = 3y_2$; $MC_1 = MC_2 = 3$

Cartel's quantities, price and profit, if each firm produces half the output?
How does the result change if firm 1 maximizes its own profit?

- Cartel:

$$\max_{y_1, y_2} \pi(y_1, y_2) = (11 - y)y - 3y_1 - 3y_2$$

The same first order conditions for both firms: $11 - 2y = 3$
Result: $y = 4$, $y_1 = y_2 = 2$, $p = 7$, $\pi_1 = \pi_2 = 8$

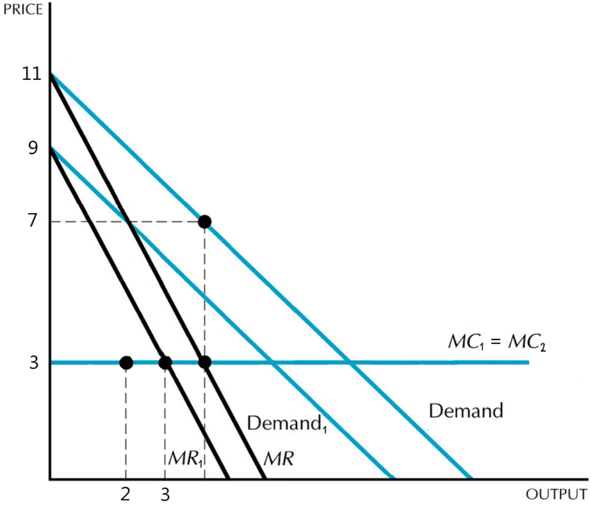
- Firm 1:

$$\max_{y_1} \pi(y_1, 2) = (9 - y_1)y_1 - 3y_1$$

First-order condition: $9 - 2\hat{y}_1 = 3$
Result: $\hat{y}_1 = 3$, $y_2 = 2$, $y = 5$, $p = 6$, $\pi_1 = 9$, $\pi_2 = 6$

Cartel is unstable in an one-shot game (graph)

Result cartel: $y = 4$, $y_1 = y_2 = 2$, $p = 7$, $\pi_1 = \pi_2 = 8$
Result firm 1: $D_1 : p = 9 - y_1$, $MR_1 = 9 - 2y_1$, $\hat{y}_1 = 3$



Prisoner's dilemma

The situation of a cartel corresponds to a game **prisoner's dilemma**
= a simultaneous game in which

- there are 2 players – player A and B,
- each player has 2 actions – confess C and deny D,
- preferences of both payers are $CD \succ DD \succ CC \succ DC$.

		Player B	
		Confess	Deny
Player A	Confess	–3, –3	0, –6
	Deny	–6, 0	–1, –1

Nash equilibrium and equilibrium in dominant strategies is CC.

Is this equilibrium Pareto efficient? No. Both players are better off in DD.

Prisoner's dilemma – a cartel with two firms

Simultaneous game:

- two firms 1 and 2
- each firm has two actions:
  - cartel quantity q_i^m
  - competitive (Cournot) quantity q_i^c
- preferences given by profits of firms:
  π_i^d (**d**efault) $> \pi_i^m$ (**m**onopoly) $> \pi_i^c$ (**c**ompetition) $> \pi_i^s$ (**s**ucker)

Payoff matrix of the game – the same structure as prisoner's dilemma:

		firm 2 q_2^c	**firm 2** q_2^m
firm 1	q_1^c	$\pi_1^c; \pi_2^c$	$\pi_1^d; \pi_2^s$
firm 1	q_1^m	$\pi_1^s; \pi_2^d$	$\pi_1^m; \pi_2^m$

Nash equilibrium and equilibrium in dominant strategies (q_1^c, q_2^c) is not Pareto efficient – both firms better off in (q_1^m, q_2^m).

Repeated prisoner's dilemma

In the repeated prisoner's dilemma, the players may keep (q_1^m, q_2^m), because it is possible to punish the player who chooses q^c in future rounds.

Example of a punishment strategy = **grim trigger** if one of the firm defaults, the other firm chooses q_i^c for the rest of the game
Cartel in a finitely repeated game is not stable.

Why? Let us assume that the cartel game has 10 rounds:

- Both firms choose q_i^c in the 10th round (the dominant strategy).
- Firms' actions in the 9th round cannot be punished.
  $\Longrightarrow$ Both firms choose q_i^c in the 9th round.
- ...
- Firms' actions in the 1st round cannot be punished.
  $\Longrightarrow$ Both firms choose q_i^c in the first round.

In an infinitely repeated game, the punishment strategy can be successful.

Cartel stability in an infinitely repeated game

Under what conditions does *grim trigger* make the cartel stable?

Firm i chooses:

1. stay in cartel – net present value of profits:

$$\pi_i^m + \frac{\pi_i^m}{r}$$

   - π_i^m = cartel profit in this round
   - π_i^m / r = discounted future cartel profit (r = interest rate)

2. default – net present value:

$$\pi_i^d + \frac{\pi_i^c}{r}$$

   - π_i^d = a higher profit from defaulting in this round
   - π_i^c / r = a lower discounted future competitive profit

Cartel stability in an infinitely repeated game (cont'd)

The cartel will be stable if

$$\pi_i^m + \frac{\pi_i^m}{r} > \pi_i^d + \frac{\pi_i^c}{r}$$

$$r < \frac{\pi_i^m - \pi_i^c}{\pi_i^d - \pi_i^m}$$

Because $\pi_i^d > \pi_i^m$ and $\pi_i^m > \pi_i^c$,

$$\frac{\pi_i^m - \pi_i^c}{\pi_i^d - \pi_i^m} > 0.$$

Conclusion:

The cartel is stable if the firms are sufficiently patient (r is low).

If r is low, the loss of future profits $\pi_i^m/r - \pi_i^c/r$ outweights the increase of current profits $\pi_i^d - \pi_i^m$.

Example – cartel stability in an infinitely repeated game

The same instructions as in the previous example:

Cartel profit $\pi_i^m = 8$
Cournot profit $\pi_i^{c(C)} = 64/9 = 7{,}\bar{1}$
Profit from default: $\pi_i^d = 9$

What is the threshold interest rate that makes the cartel stable?

Cournot:

$$r < \frac{\pi_i^m - \pi_i^c}{\pi_i^d - \pi_i^m} = \frac{8 - 7{,}\bar{1}}{1} = 0{,}\bar{8}$$

Cartel is stable if the interest rate is below 89%.

CASE: Indianapolis concrete cartel

2006 and 2007: the DOJ busted up a long-lived cartel with concrete.

How did the cartel work?

- regular meetings at local hotels – agreement on prices
- monitoring – directors anonymously gathered price quotes
- threats or an emergency meeting when the agreement was violated

Cartel had a lot of problems, but occasionally increased prices by 17%.

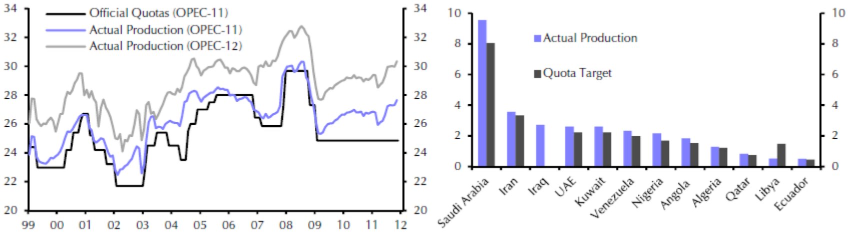
Why did the cartel fall apart?

1. problem: a noncooperative manager from a firm outside of the cartel
2. repeated attempts to persuade the manager to join the scheme
3. complaints about his performance to his corporate boss
4. manager went to the FBI and informed them of the cartel's operations

EXAMPLE: OPEC

- legal cartel
- 12 members
- is not a monopoly – half of production from non-OPEC countries

Problems with overproduction – example (2011):



OPEC-11 = OPEC without Iraq that did not have a quota (transition phase)
Libya – not reaching its quota for technical reasons (Arab spring)
Source: http://seekingalpha.com/article/314086-who-is-cheating-on-their-opec-production-quota

Asymmetric information

Up to now we assumed **complete information** = consumers and firms know quality of goods sold and purchased.

Market with asymmetric information = one side of the market has better information than the other side of the market.

Examples:

- health sector – the MD is better informed than the patient
- insurance – the client has better information than the insurer
- used cars – the seller has better information than the buyer

Asymmetric information $\implies$ quantity traded can be inefficiently low.

There are private solutions of the problem of asymmetric information.

Asymmetric information (cont'd)

We will deal with 2 types of asymmetric information...

- **adverse selection** – a situation, in which one side of the market does not observe the type/quality of the good on the other side
- **moral hazard** – a situation, in which one side of the market does not observe the behavior of the other side of the market

a 2 possible solutions of asymmetric-information problems.

- **signalization** – agents might want to invest in signals that will differentiate them from other agents
- **incentives** – using contract conditions to solve moral hazard in labor markets

Example of adverse selection – the market for "lemons"

Market for used cars: good cars G and bad cars B

Suppy:

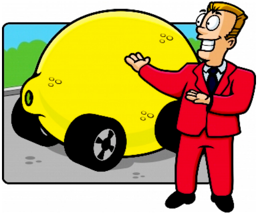
- 100 sellers offering 50 G and 50 B
- willingness to sell G for \$2,000 and B for \$1,000

Demand:

- a large quantity of risk-neutral buyers
- each knows that 50 cars are G and 50 cars are B
- willingness to purchase G for \$2,400 and B for \$1,200

If the buyers *can tell* G from B,
all good cars G sell for \$2,400
and all bad cars B sell for \$1,200.

The market for used cars is efficient.



Example of adverse selection – the market for "lemons"

What cars sell and for what price if the buyers can't tell G from B?

If buyers can't tell G from B, their willingness to pay is

$$1/2 \times 1{,}200 + 1/2 \times 2{,}400 = \$1{,}800.$$

Who is willing to sell at the price? Only the owners B.
The buyer is willing to pay only

$$1 \times 1{,}200 = \$1{,}200.$$

Result: Only B will be traded in equilibrium for \$1,200.

Conclusion: The quantity sold in the market is inefficiently low.

Reason: The presence of B reduces the willingness to pay for G
(externality due to adverse selection)

Example of signalization – the market for “lemons”

Sellers of G can signal that they have good cars.

E.g. they can spend \$100 for a certificate of quality.

If sellers of B can’t get the certificate, customers can use the certificate to tell G from B – the certificate signals quality.

Certificates solve the adverse-selection problem:

- The market is efficient. Cars B and G are sold.
- The welfare in the market increases by $50 \times (2{,}400 - 2{,}000 - 100) = \$15{,}000$.

Model of signalization – labor market in a town

Labor supply:

10,000 able workers A:

- value of product: $a_A = 16$M
- year of study costs: $c_A = 0.2$M

10,000 unable workers U:

- value of product: $a_U = 14$M
- year of study costs: $c_U = 1$M

All workers are willing to work for a minimum wage $w^{min} = 5$

Demand for labor:

Perfect competition: many risk-neutral firms
Each firm has a production function: $a_A L_A + a_U L_U$

Endogenous variables:

- the number of workers: L_A and L_U
- lifetime wage of workers: w_A and w_U
- the number of years at the university: e_A and e_U

Model of signalization – labor market in a town (cont'd)

The town has no universities – no one has education ($e_U = e_A = 0$)

Who works and for what wages? Is the labor market efficient?

The result depends on whether firms can tell A from U.

- Complete information – firms can tell A from U:
  Demand for labor as in perfect competition – $w =$ value MP_L:
  - $w_A = a_A = 16$
  - $w_U = a_U = 14$

  Wages higher than $w^{min} \implies$ everyone works $\implies$ efficient market
- Asymmetric information – firms cannot tell A from U:
  Firms willing to pay an average value of MP_L:

$$w_A = w_U = a_A/2 + a_U/2 = 15$$

  Wages higher than $w^{min} \implies$ everyone works $\implies$ efficient market

Model of signalization – labor market in a town (cont'd)

Asymmetric information – firms cannot tell A from U.
Workers can study, but education does not increase their productivity.

Sequential game with two steps:

1. Workers have 2 choices:
   - study program lasting e^* years
   - study program lasting 0 years
2. Firms choose the wages of workers w_A and w_U

Two different sequential equilibria:

- **pooling equilibrium** – all workers make the same choice
  $\implies$ not possible to tell A from U
- **separating equilibrium** – A and U make a different choices

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When does the separating equilibrium arise?
Do education opportunities increase efficiency of markets and welfare?

Model of signalization – labor market in a town (cont'd)

Looking for separating equilibrium, in which A study and U don't.

In this separating equilibrium, firms believe that

- workers with education are $A \implies$ they pay them $w_A = a_A = 16$
- workers without education are $U \implies$ they pay them $w_U = a_U = 14$

If the duration of education e^* is in a range

$$\frac{a_A - a_U}{c_U} < e^* < \frac{a_A - a_U}{c_A}$$

$$2 < e^* < 10,$$

the profile $(e_A, e_U, w_A, w_U) = (e^*, 0, 16, 14)$ is separating equilibrium.

It is an equilibrium – no incentive to change actions:

- firms maximize profit (workers A get a_A and U get a_U)
- U does not choose $e_U = e^*$ because the education cost $1 \times e^* > 2$
- A does not choose $e_A = 0$ because wage increase $2 > 0.2e^*$

Model of signalization – labor market in a town (cont'd)

Do study possibilities increase welfare and efficiency of the market?

No:

- Market efficiency stays the same – efficient even without education.
- Welfare is lower because workers A spent $0.2e^*$ for education (assuming that education does not create any value *per se*).

<u>BONUS QUESTION:</u>

Does the result change if A can also freelance for $w_A^f = a_A^f = 15.2$?

Yes:

If the education $e^* < 4$, A are willing to study.

- Efficiency increases because A are more productive in firms: $a_A > a_S^Z$
- Welfare is higher because the cost of studying $0.2e^* < a_A - a_S^Z = 0.8$. Education signals the quality of the worker.

APPLICATION: The sheepskin effect

Difficult to measure the effect of diploma on wages – selection bias.

Clark and Martorell (JPE, 2014) – use regression discontinuity design.
No evidence of a sheepskip effect of a Texan high school diploma.

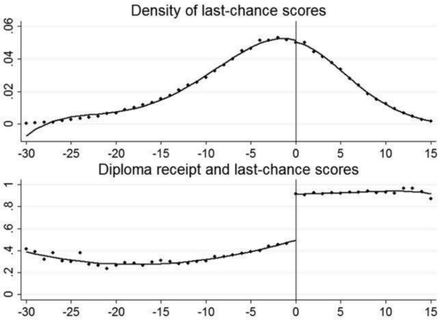

Fig. 1.—Last-chance exam scores and diploma receipt. The graphs are based on the last-chance sample. See table 1 and the text. Dots are test score cell means. The scores on the *x*-axis are the minimum of the section scores (recentered to be zero at the passing cutoff) that are taken in the last-chance exam. Lines are fourth-order polynomials fitted separately on either side of the passing threshold.

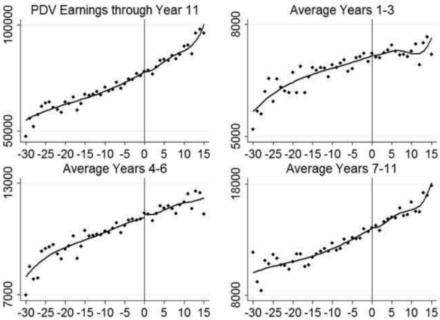

Fig. 2.—Earnings by last-chance exam scores. The graphs are based on the last-chance samples. See table 1 and the text. Dots are test score cell means. The scores on the *x*-axis are the minimum of the section scores (recentered to be zero at the passing cutoff) that are taken in the last-chance exam. Lines are fourth-order polynomials fitted separately on either side of the passing threshold.

CASE: Reputations in collectibles sales

List (JPE, 2006) studied the market for sports memorabilia.

Asymmetric information – sellers know the value of the items.

Natural experiment:

1. Seller: „I would like to buy a card, which has a value of $\$x$."
2. The buyers can offer a card of
    - a corresponding value
    - a lower value – but he may damage his reputation
3. the card is evaluated by an independent expert

Findings:

- local sellers cheat less (they are more often in the market)
- everyone cheats with items that cannot be evaluated by a third party

Example of moral hazard – bicycle insurance

Theft probability depends on behavior (e.g. the number of locks).

If the insurance

- observes clients' behavior, it can adjust insurance accordingly
- does not observe the behavior, the insured bikers do not have incentives to take care of their bicycles = **moral hazard**

The insurance is not willing to provide full insurance ("deductible").

The amount of insurance is inefficienty low due to moral hazard.

CASE: Vehicle insurance

Probability of accident depends on many factors such as speed. $\Longrightarrow$ moral hazard occurs in this situation.

The insurance premium is usually based on driver's history.
It is an imperfect solution of moral hazard.

Solution: usage-based insurance (UBI) or pay as you drive (PAYD)

Payment for km may be based on data collected from the vehicle:

- type of driving (speed, braking)
- time-of-day information
- historic riskiness of the road
- distance or time traveled
- time/distance driven without a break

What should you know?

- The prisoner's dilemma is a particular game in which the Pareto efficient outcome is strategically dominated by an inefficient outcome.
- A cartel is a group of firms that maximize profit of the industry.
- If firms play a one-shot or a finitely repeated game, the cartel is unstable.
- If they play an infinitely repeated game, punishment ensures cartel's stability if firms are sufficienty patient (r is low).

What should you know? (cont'd)

- Adverse selection is a situation, in which one side of the market does not observe the type/quality of the good on the other side
- Moral hazard a situation, in which one side of the market does not observe the behavior of the other side of the market.
- Signalization may solve the problem of asymmetric information, but may also be publically wasteful.