Theme C: Repetition and Reputation: Resolving the Prisoner's Dilemma

(See Besanko in the Folder.)

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But for 3½ years News kept the *Mirror*'s price below; its share rose from 50% to 53%, and it increased its advertising rates, which increased its annual profit by nearly $1.6m, while the *Sun*'s fell by $1.3 m.

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Then Fairfax surrendered and henceforth the *Mirror* has been price leader.

(See the New York episode in Theme A above.)

1. A Pricing Rivalry Duopoly Game

- You (and your team) are sellers of a homogeneous, unbranded commodity.
- There is one other seller of this product in the market.
- Since the product is a commodity, buyers will automatically buy from the seller with the lower price.
- If both sellers charge the same price, then the two sellers split the market.
- If one seller charges a lower price, then that seller gets all the sales.

Demand For The Product

The industry demand for the product is as follows:

Industry Demand	
Price	***Quantity***
$9	0
$8	1
$7	2
$6	3
$5	4
$4	5
$3	6
$2	7
$1	8
$0	9

Profits and Costs

- If you price at $4 and the other team at $5, then you make all the sales, selling 5 units for a sales revenue of $20. The other team has zero revenue.
- There is an average cost of $2 per unit, so your profit π would be

$$\pi = \$20 - (5 \times \$2) = \$10$$

The other team has zero costs and so zero profits, when you undercut them.

- Your aim is to maximise your team's *profit.*

The Game

- We will play the pricing game for several rounds.
- Each round, you and your opposing team will simultaneously (and secretly!) choose a price.
- You will have a minute to decide your price.
- Write your price on the slips of paper provided.
- As soon as prices are submitted, I'll collect the prices and show you your profits and the other team's profits.
- Total profits will be calculated at the conclusion of the game.
- Your aim is to maximise your team's *profit.*

Game Debrief

Questions:

- How did your game evolve?
- What signals did you send? How? Were they effective? Consequences?
- What did the other side do? Why — what did they mean? Your response?
- What patterns of play can you see across the score sheet?

2. Dynamic Pricing Rivalry

- What should pricing rivalry mean in practice?
  - Should you compete by cutting price, trying to capture market share
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- Why is it important to consider the dynamics?
  - Because most interactions in most markets are repeated.

More Questions.

- What conditions influence the intensity of price competition in a market?
- Why do firms in some markets seem able to coordinate their pricing behaviour and to avoid price wars, while in other markets intense price competition is the norm?
- What is the value, if any, of policies under which the firm commits to matching the prices charged by its rivals?
- When should a firm match the price of a rival, and when should it do its own thing?

  Price competition is a dynamic, strategic process: a firm's decisions will affect how rivals and the firm itself behave in the future.
- What if Fairfax had understood News' intentions better in the example above (or the New York interaction several years later)?

Dynamic Pricing Rivalry

Firms compete again and again: it's not just once off.

Actions that might have short-run benefits may become harmful in a repeated situation in which rivals can react tomorrow to an action made today.

A price cut today to steal market share from rivals may result in matching price cuts tomorrow by the rivals, leading eventually to no changes in market shares, but lower profits all round: *a price war.*

This interaction is very similar to a *repeated Prisoner's Dilemma.*

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- Who gains from competition?
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- How can such cheating be *detected*?
- What prospect of *punishment* will deter cheating?

Iran v. Iraq in 1990.

Consider Iran and Iraq supplying oil:

- "Lo" = 2 million bbl/day, "Hi" = 4 million bbl/day.
- Cooperative solution of (Lo,Lo) = total production of 4 m bbl/day, @ $25/bbl.
- Competitive solution of (Hi,Hi) = total production of 8 m bbl/day, @ $10/bbl.
- Off-diagonal solution of (Hi, Lo) or (Lo,Hi) = 6 m bbl/day, @ $15/bbl.

If Iran's extraction costs are $2/bbl, and Iraq's are $4/bbl, then the following payoff matrix is their net returns (in $million/day).

The Prisoner's Dilemma (Oil cartel)

Iraq's output	Lo	Hi
Lo	46,42	26,44
Hi	52,22	32,24

Iraq's output

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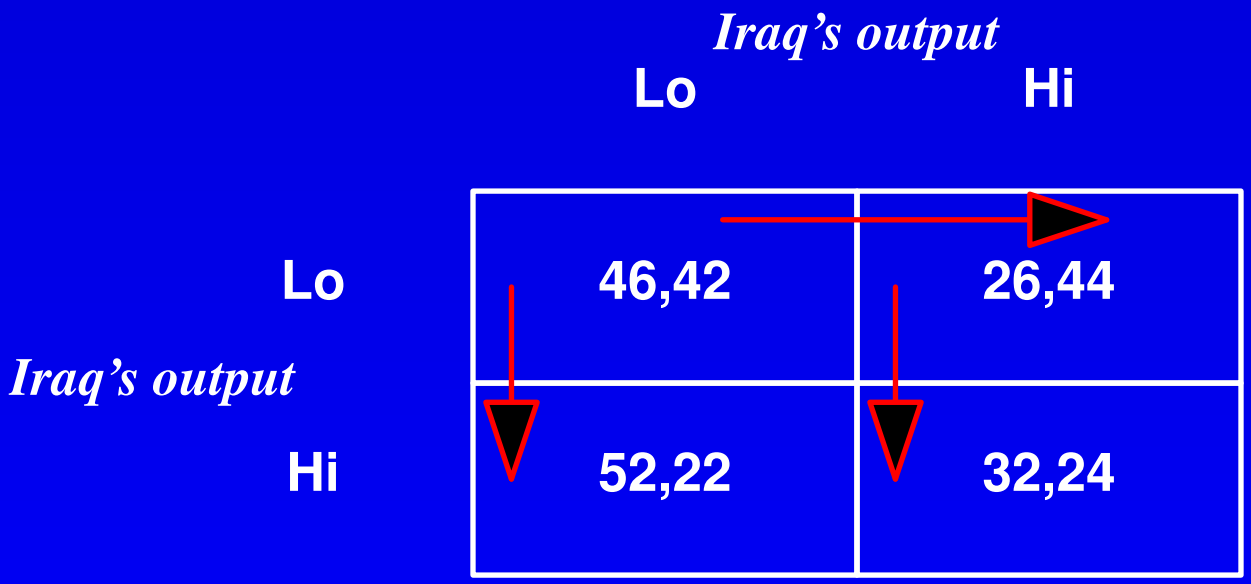

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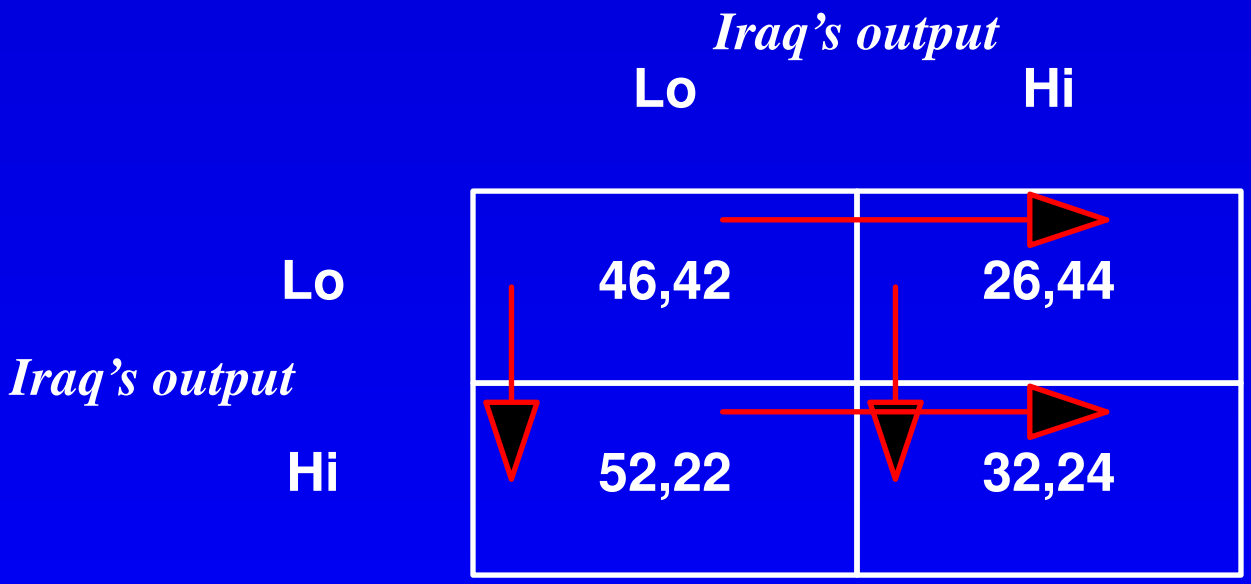

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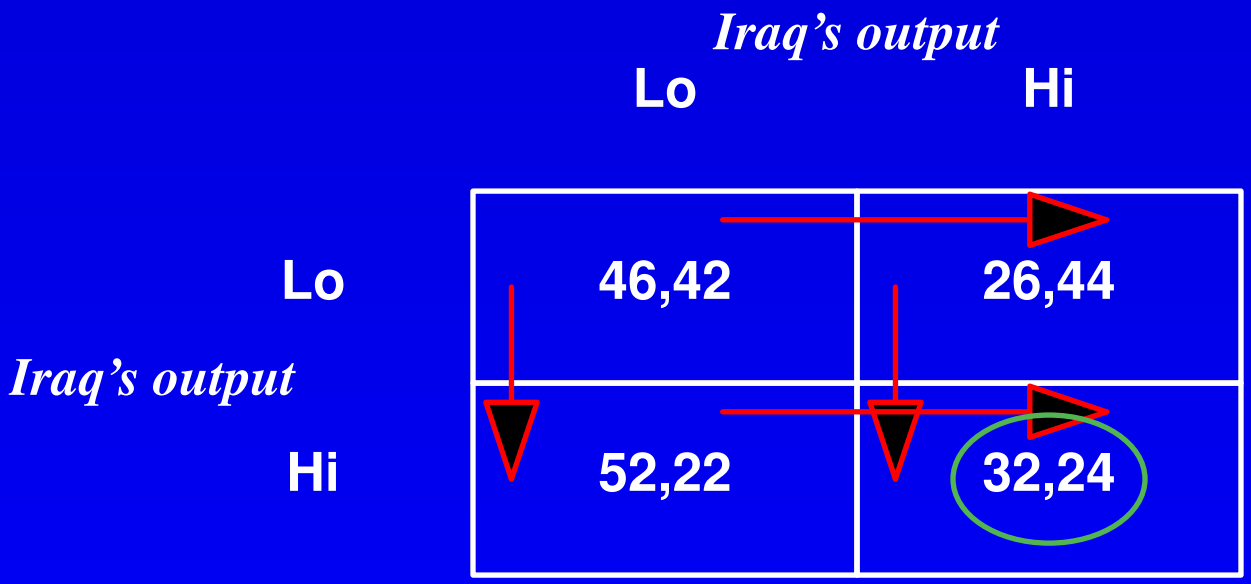

The payoff matrix (Iran, Iraq) in 1990.
A non-cooperative, positive-sum game,
with ? dominant strategy/ies.

4. Detection Of Cheating

If the price falls below $25/bbl, then there must be cheating. If it's not you, then it must be the other guy.

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But what if there are *more than two players*, or what if it's due to a *shift in demand* down? Not so easy.

What if it's not simple price competition?
e.g., quality, not so easily monitored (although even prices actually paid may not be easy to monitor).

Collusion may focus on the more transparent dimensions of choice (such as price).

Competition may move to the less observable dimensions of choice (such as quality)
— D&N's Law of Increasing Opaqueness.

Cheating may be passive (e.g. not moving to increase taxes).

***n*-person games: Who's the cheat?**

5. Punishment of Cheaters

- A prisoner who turns informer may fear for life and limb. (What of Gotti's jury members? What is cooperation in their case.)
- Police may scare drug dealers into confessing with the threat of (what?)

Threatened loss of *reputation* may be used.
Or threatened loss of income:

Iran v. Iraq

Consider Iran & Iraq's oil production game.

- **Iran's temptation to cheat is \$52–46=\$6; Iraq's is \$44–42=\$2.**
- **But (Hi,Hi) $\rightarrow$ (32,24), a \$14 loss for Iran, and an \$18 loss for Iraq.**
- **In *a repeated game* these two amounts, as the threatened loss *every round of play*, may be sufficient to deter cheating, especially for Iraq.**

Without side-payments or contracts, no way to ensure cooperation in the one-shot game. Only in *a repeated game* does there exist the ability to punish. Collapse of (Lo,Lo) $\rightarrow$ a high cost of lower future profits.

6. Repetition: The Folk Theorem

The Folk Theorem of game theory says that for sufficiently low discount rates, *any* price between the monopoly (or joint-profit-maximising) price and the break-even or competitive price can be sustained as an equilibrium in the infinitely repeated Prisoner's Dilemma.

A low discount rate is equivalent to low impatience.

For the two-person Prisoner's Dilemma, any individually rational outcome can be supported for sufficiently low discount rates.

To D(efect) or not to D(efect)

Need to consider more than just one period's profits

- ***Look forward and reason backwards***

Depends on:

- **each firm's pricing *strategy* (what to do, how to respond)**
- **each firm's *expectations* of its rivals' strategies**
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Some general concerns:

- **How quickly can my rivals respond?**
- **What is the difference between my defection profits and shared monopoly profits?**

6.1 Coordinating on an equilibrium

The Folk Theorem doesn't guarantee an equilibrium, and achieving a desired equilibrium, one amongst many, is a coordination problem, such as faced Shirl and Hal this morning.

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To price cooperatively, firms must coordinate on a strategy, such as *Tit for Tat*:

- a variation of the "eye-for-an-eye" rule of behaviour
- cooperation in the first period (nice),
  then mimic your rival's action from the previous period

A collusive agreement would attain this — but collusion is illegal.

Focal points.

Without an agreement or overt communication, the firms must find a *focal point* — a strategy so compelling that it would be natural for all firms to expect others to adopt it.

Focal points are highly context- or situation-specific.

Especially difficult to coordinate in competitive markets that are turbulent and changing rapidly.

Sometimes facilitated by traditions and conventions that make rivals' moves easier to follow or their intentions easier to interpret.

Four Attributes for an Effective Strategy:

- **Clarity: it's easy to recognise and follow.**
- **Niceness: it starts out cooperating.**
- **Provocability: one defection and you're on.**
- **Forgiving: if your rival cooperates, then you relent.**

An Ideal Strategy?

- Tit-For-Tat manages to encourage cooperation wherever possible, but avoids exploitation.
-

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- Tit-For-Tat manages to encourage cooperation wherever possible, but avoids exploitation.
- But flaws?
  - Misperceptions costly: mistakes "echo" back and forth
  - No way of saying "enough is enough"
  - And what if there is more than one other player?

➢ Other possibilities?

- **The Grim Strategy: cooperate until the other defects, then defect for all eternity.**
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➢ Other possibilities?

- The Grim Strategy: cooperate until the other defects, then defect for all eternity.
- Tit for Two Tats: cooperate until the other player has defected twice in a row, then defect until the other cooperates.
- Tat for Two Tits: need two successive cooperates by the other player to stop defecting.
- Always Defect: you bastard!

An alternative?

How about:

1. **begin cooperating**
2. **continue cooperating**
3. **keep count of how many times the other side appears to have defected while you have cooperated**
4. **when this count becomes "too high", then TfT (as punishment, that is)**

The question remains of defining "too high".

Case: Price wars.

Case: David Jones

Case: How misunderstanding can lead to price wars

It may be that many real-life price wars are not started by deliberate attempts by one firm to steal business from its competitors, but instead flow from misreads and misunderstanding of rivals' behaviour.

Such as Besanko's tyre manufacturers (in the Folder).

6.2 How market structure affects the sustainability of cooperative pricing

Under certain market structures firms will find it difficult to coordinate on a focal strategy, and their behaviour may be influenced by market structure.

Four conditions of market structure that may affect the attainment of cooperative pricing and competitive stability:

1. Market concentration (the number and distribution of firms),
2. Structural conditions that affect reaction speeds and detection lags,
3. Asymmetries among firms,
4. Multi-market contact between firms.

Conditions for collusion.

Four reasons why a firm's response to its rivals' actions might be delayed:

1. infrequent interactions,
2. lags in confirming rivals' prices
3. ambiguities in identifying exactly who (among a group) is cutting price
4. difficulties in separating falls in sales due to rivals' stealing from those due to unanticipated contractions in market demand.

All of these slow the firm's reaction time, and so the effectiveness of retaliatory price cuts against defecting firms.

Moderating Influences

Several structural conditions affect the importance of these factors:

- **Market concentration**
- **Lumpiness of Orders**
- **Information about sales transactions**
- **The number and size of buyers**
- **Volatility of demand and cost conditions**

6.3 End-game behaviour

Beware *end-game behaviour*:

If players know when the game will end (how many rounds to go), then there may be unravelling of any cooperation/collusion.

But cooperation is observed anyway, perhaps because:

a. **no fixed number, or**
b. **"nice" players initially, waiting to defect, or**
c. **low discounting of the future, so cheating deterred.**

One good turn deserves another. You scratch my back and I'll scratch yours.

Case: The 1992 U.S. Airlines Fare War

Why did Northwest Airlines (NWA) start a fare war in northern spring 1992 that was matched and later escalated by its rivals? The fare war deepened the losses in the industry.

Given the immediate computerised information about fares, the others would know and respond: how to increase profits this way?

But asymmetries: NWA had a poor route system, an inferior FF programme, and a bad reputation. With high prices, NWA would get less business than would American and United, with better route structures and better FF programmes, and NWA would fly almost empty planes.

Cutting prices has an effect not emphasised above: if the industry prices fall, total demand will rise.

Why the price war started.

So two benefits to NWA:

1. with price-sensitive vacationers, NWA's competitive disadvantages minimised,
2. a disproportionate share of additional traffic with NWA.

So if NWA could fill its planes only by stimulating market demand, should do so when demand most elastic, during the summer.

Low-quality or low-share firms may gain more from defection (i.e. pricing low), even if the higher-quality rivals immediately match.

(See Besanko in the Folder.)

Case: Price discipline in the U.S. tobacco industry

Until the 1990s the U.S. cigarette industry had a high degree of concentration and pricing cooperation.

Dominant firms (PM and RJR) would announce the list price rises twice a year, and the others would follow: much above the inflation rate, and highly profitable (40% margins).

But L&M's share had fallen from 21% in 1947 to 2% in the late 1970s — shut-down? Least to lose from undercutting, by selling discount cigs at 30% below branded. By 1984 its share had tripled, selling 65% of its output as discounts.

An insignificant niche? But B&W lost $50 m in revenues in 1983, and in 1984 undercut L&M's discounts, as did other rivals: L&M's share of discounts fell from 90% to 15% by 1989.

L&M then introduced "deep discounts" 30% below discounts, and their rivals followed: in 1992 three segments — a premium ($69/1000), a discount ($49/1000), and a d-d ($31/1000).

Collapse of discipline.

Coordination of pricing in three tiers more difficult than a single tier, and growth in the cheaper tiers have come from the premium tier (when the total market was shrinking), with considerable substitution.

On "Marlboro Friday," 3/4/93, PM cut its flagship's price by 20%: Marlboro's share had fallen from 30% to 21% over five years. Reluctance of rivals to raise their d-d prices: highly elastic demand and retailer reluctance.

Since then return of market discipline? Price increases in all segments in 1993, 1994, 1995: premium prices down 26%, discount up 8%, d-d up 48%, and Marlboro's share up to 30% by mid-1995.

6.4 Firms' practices to facilitate pricing cooperation

Firms themselves can facilitate cooperative pricing by:

- **Advance announcement of price changes**
  e.g. Continental Airlines
- **Price leadership**
- **Most-Favoured-Customer (MFC) Clauses (See Theme F later.)**
  compare leasing; against oneself.
- **Uniform delivered prices**
- **Strategic use of inventories and order backlogs**

(See Besanko in the Folder.)

7. Punishment is Guaranteed

Examples of enforcing price collusion through a punishment guarantee — all in the name of "competition."

Crazy Eddie (since convicted of fraud in New York) and Newmark & Lewis and their implicit cartel:

N&L will refund 100% of the difference, plus another 25%, or more in kind (asymmetric, detection of cheating, punishment of cheaters)

A *most-favoured-customer* (MFC) guarantee.

Du Pont and its "most-favoured-customer" clause: the seller will offer to those most favoured customers the best price he offers to anyone, which made expanding market share more costly.

8. A Choice of Punishment

Want:

- **simplicity & clarity**
- **certainty: defection punished & cooperation rewarded**

Question: **how severe? to fit the crime? higher? (is it a punishment or a deterrent?) what if there are mistakes in detection?**