Lectures 15, 16: Resolving the PD: Repetition and Reputation

Topics (over two lectures)

1. A Pricing Rivalry Duopoly Game
2. Dynamic Pricing Rivalry
3. How to Achieve Cooperation
4. Detection of Cheating
5. Punishment of Cheaters
6. Repetition: The Folk Theorem
7. Punishment
8. Evidence
9. Real-World Dilemmas

A Real-Life Telephone Conversation

H.P.: *Do you have a suggestion for me?*

R.C.: *Yes, I have a suggestion for you. Raise your goddamn fares 20 percent. I'll raise mine the next morning.*

H.P.: *Robert, we ...*

R.C.: *You'll make money, and I will too.*

H.P.: *We can't talk about pricing.*

R.C.: *Oh, bullshit, Howard. We can talk about any goddamn thing we want to talk about.*

In 1982 Robert Crandall (MBA, Wharton, '60) was the CEO of American Airlines, Howard Putnam the chairman of Braniff International Airways. (U.S. District Court, CA383-0325D)

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

(See the New York episode in Lecture 1 above: the *NY Post* didn't know Rupert's history of strategic gaming.)

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- 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

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- There is a prize for the seller with the highest total profit in the room at the end.

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- Total profits will be calculated at the conclusion of the game.
- Your aim is to maximise your *profits*.
- You don't know how many rounds there will be.

Game Debrief

Questions:

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

A POM for the Duopoly Game

	2	3	4	5	6
2	0, 0	0, 0	0, 0	0, 0	0, 0
3	0, 0	3, 3	6, 0	6, 0	6, 0
4	0, 0	0, 6	5, 5	10, 0	10, 0
5	0, 0	0, 6	0, 10	6, 6	12, 0
6	0, 0	0, 6	0, 10	0, 12	6, 6

What is the N.E.?

So why I do call this lecture "solving the repeated P.D."?

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- Why is it important to consider the dynamics?
  - Because most interactions in most markets are *repeated*.

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➢ What if Fairfax had understood Rupert Murdoch's News' intentions better in the example above, p.3, (or the New York interaction several years later)?

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This interaction is very similar to a *repeated or iterated PD.*

(See Rao et al. on avoiding a price war, Reading 32.)

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Q: What prospect of *punishment* will deter cheating?

Iran v. Iraq in 1990. (Cournot)

Consider Iran and Iraq supplying oil:

- "Lo" = 2 million bbl/day, "Hi" = 4 million bbl/day.
- A Cooperative solution of {Lo,Lo} = total production of 4 m bbl/day, @ $25/bbl.
- A Competitive solution of {Hi,Hi} = total production of 8 m bbl/day, @ $10/bbl.
- An 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
Iran's output	Lo	46,42	26,44
	Hi	52,22	32,24

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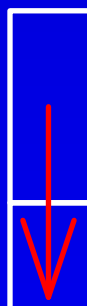

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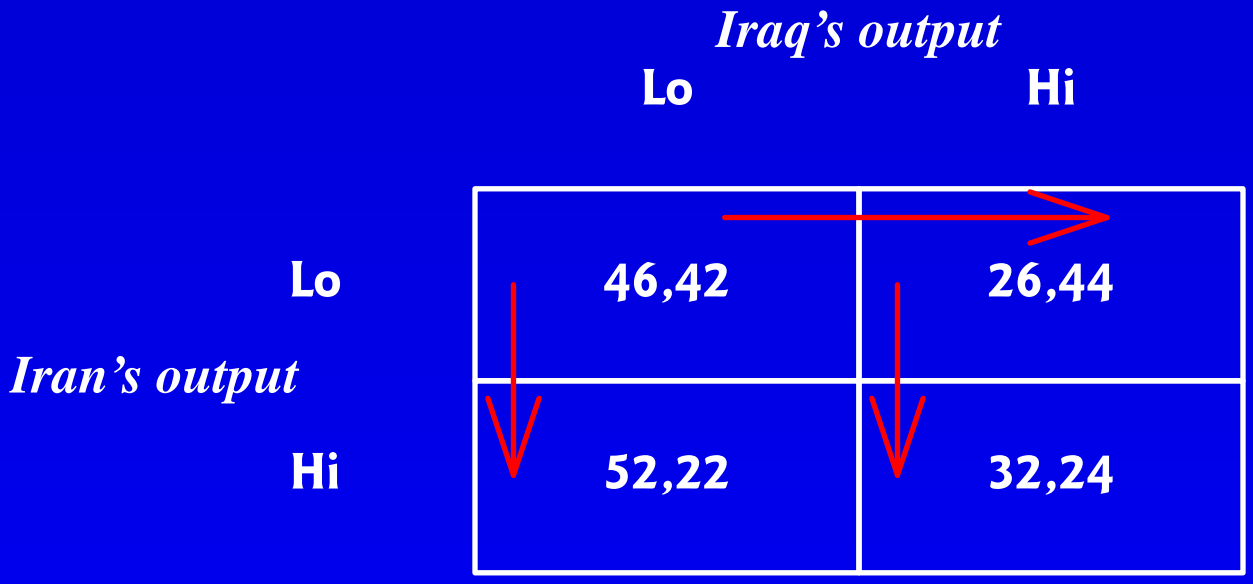

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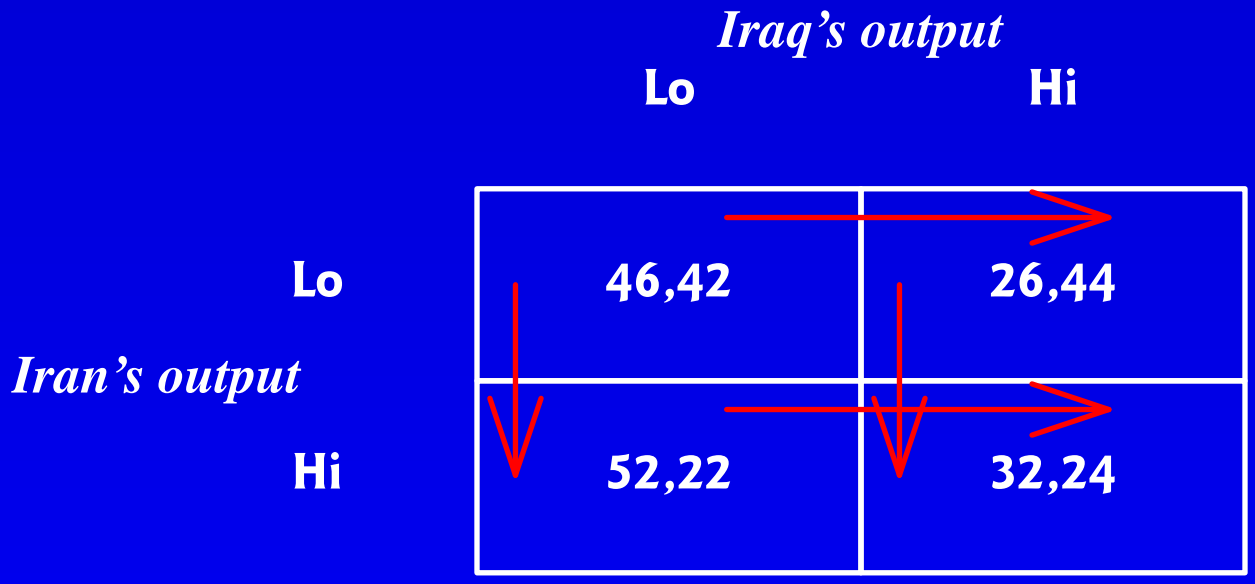

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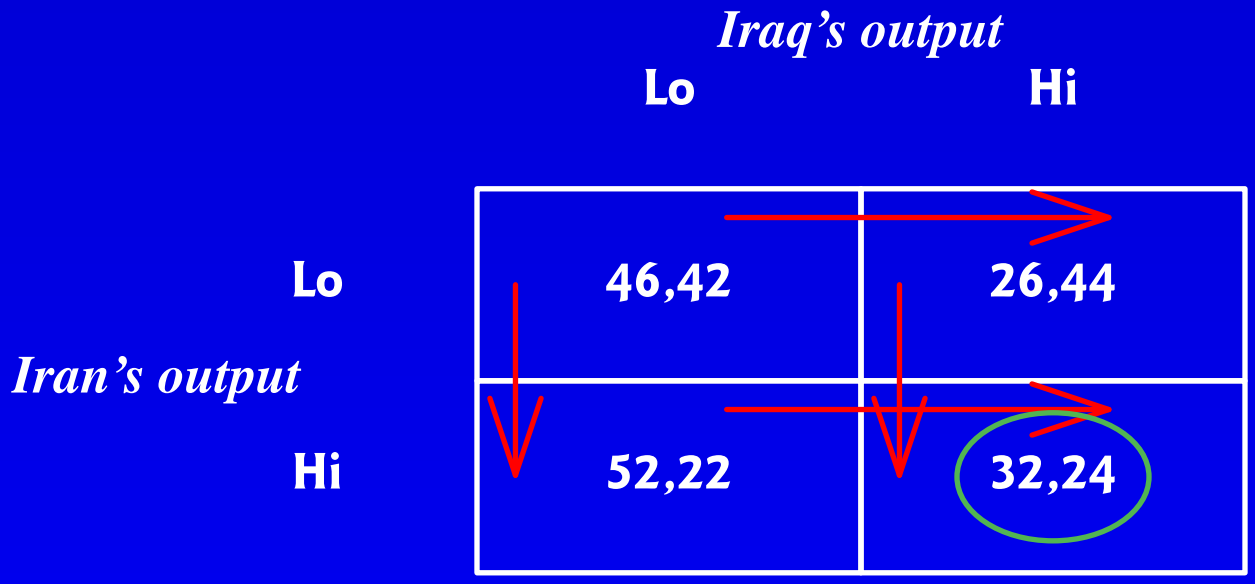
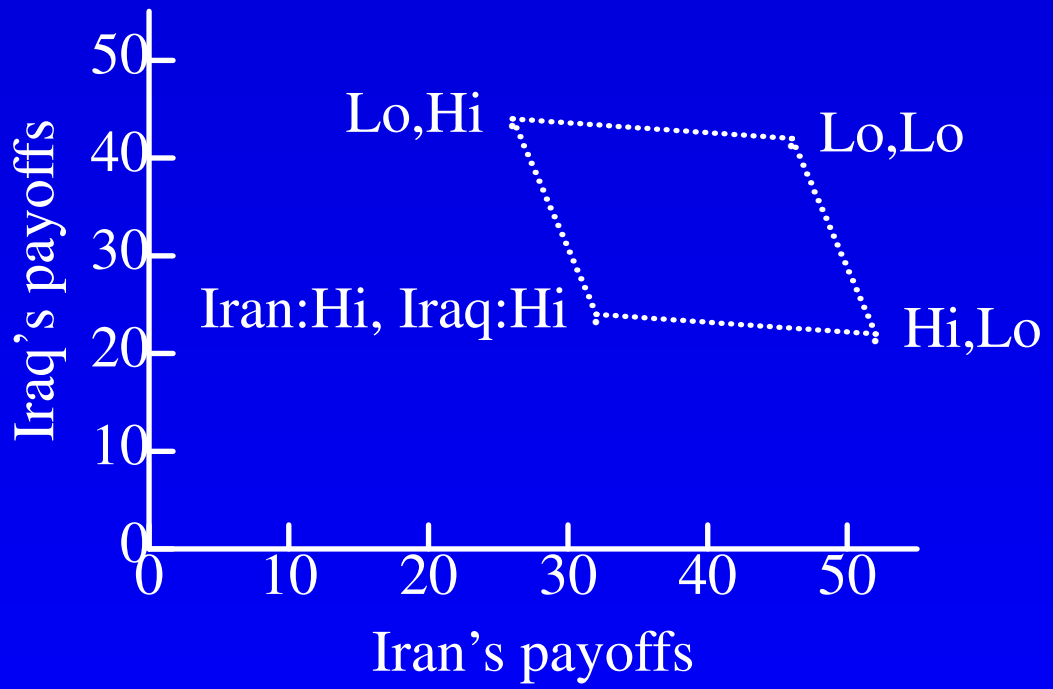


The payoff matrix (Iran, Iraq) in 1990. A non-cooperative, positive-sum game, with ? dominant strategy/ies.

The Payoffs Plotted



Iran: output; Iraq: output.
Higher outputs → lower payoffs

Individually rational payoffs: no worse than {Hi,Hi}.

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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 (Cournot)

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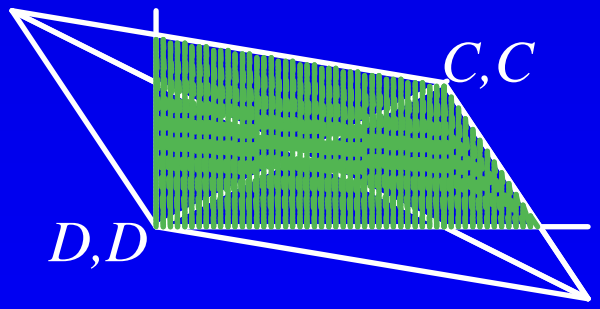
Without side-payments or contracts, there is no way to ensure cooperation in the one-shot game. Only in *a repeated game* does there exist the ability to punish. Collapse of the agreed {Lo,Lo} → the high cost of lower future profits.

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 (C,C=Lo,Lo $\rightarrow$ 46,42) and the break-even or competitive price (D,D=Hi,Hi $\rightarrow$ 32, 24) can be sustained as an equilibrium in the infinitely repeated PD. (See payoffs in the graph.)



A low discount rate is equivalent to low impatience.

Folk Theorem: For the two-person PD, any *individually rational outcome* (shaded area) can be supported for sufficiently low discount rates.

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Need to consider more than just one period's profits

— ***Look forward and reason backwards***

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Depends on:

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

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

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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 could attain this — but collusion is illegal.

Focal points.

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

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$\therefore$ Not easily exploited!

An Ideal Strategy in a Repeated Game?

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- *Tit For Tat* manages to encourage cooperation wherever possible, but avoids exploitation.
- But are there flaws in Tit for Tat?
  - Misperceptions can be costly: mistakes "echo" back and forth
  - No way of saying "enough is enough"
  - And what if there is more than one other player?
  - Not sub-game perfect.
    (Because it's supported by non-credible threats.)

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- *Tat for Two Tits*: need two successive cooperates by the other player to stop defecting.
- *Always Defect*: you bastard!

An alternative strategy?

How about:

1. begin cooperating
2. continue cooperating even if the other side defects
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

A Matching Price Pledge

Without price matching:

		Kmart Low	*Kmart* High
Big W	Low	2000, 2000	4000, 0
	High	0, 4000	3000, 3000

With price matching:

	Low	High	Match
Low	2000, 2000	4000, 0	2000, 2000
Big W High	0, 4000	3000, 3000	3000, 3000
Match	2000, 2000	3000, 3000	3000, 3000

Kmart

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Big W \ *Kmart*	Low	High	Match
Low	2000, 2000	4000, 0	2000, 2000
High	0, 4000	3000, 3000	3000, 3000
Match	2000, 2000	3000, 3000	3000, 3000

High is weakly dominated by Match, and
Low is weakly dominated by Match,
∴ Match emerges from the PD.

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' price war (Reading 31).

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4. **Multi-market contact between firms.**
   Facilitates cooperation. Why?

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, e.g. OPEC) is cutting price, or increasing production
4. difficulties in separating falls in sales due to rivals' stealing from those due to unanticipated contractions in market demand.

All of these uncertainties slow the firm's reaction time, and so the effectiveness of any retaliatory price cuts (or production increases) against defecting firms.

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5. **Volatility of demand and cost conditions.**
   Higher volatility $\rightarrow$ less cheating.

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: near the known end, no long-term gains from not cheating.

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But cooperation is observed anyway, perhaps because:

a. no fixed end, or

b. "nice" players initially, waiting to defect, or

c. low discounting of the future, so cheating is deterred by the prospect of cut-throat competition.

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

Case: The 1992 U.S. Airlines Fare War

Did Northwest Airlines (NWA) mean to start a fare war in May 1992 that was matched and later escalated by its rivals? The fare war deepened the losses in the industry.

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

(Besanko et al., Reading 31.)

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, it should do so when demand is 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 et al., Reading 31)

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).

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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).

(See Besanko et al., Reading 31.)

Collapse of discipline.

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

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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.

(See Besanko et al., Reading 31.)

Sustaining Cooperative Pricing — Summary

Condition	*Y or N?*
High market concentration	Y
Firm asymmetries	N
High buyer concentration	N
Lumpy orders	N
Secret price terms	N
Demand volatility	N
Price-sensitive buyers	N

Y = sustains cooperative pricing
N = doesn't sustain such pricing

6.4 Firms' practices to facilitate pricing cooperation

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- Uniform delivered prices
- Strategic use of inventories and order backlogs

(See Besanko et al., Reading 31)

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.

A Choice of Punishment

Want:

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

Other Repeated PD Solutions

Changing the Penalties (for Defectors) and Rewards (for Cooperators) of the Repeated PD game.

One player takes Leadership:

such as the swing producer in OPEC, Saudi Arabia.

Experimental Evidence

In lab experiments, Cooperation does occur, right up until the end, or just before.

See the results of our Duopoly Game in class.

When should you defect (even when you know how many more rounds to go)?

Axelrod: "Don't be envious, Don't be the first to defect. Echo both cooperation and defection. Don't be too clever."

Real-World Dilemmas

- State governments compete to attract business.
  Offer excessive inducements.

- Unions v. employers.
  Employ lawyers

- Biology: The ♂ bowerbird's dilemma:
  build his own bower, or destroy others'

- Price matching (DJ's pledge).