STRATEGY AND GAMES

Context and concepts

- Context: You're in an industry with a small number of competitors. You're concerned that if you cut your price, your competitors will, too. How do you act?
- Ditto pretty much any strategic decision: capacity, entry and exit, product positioning.
- Example: E.T. Whether Mars should buy a product placement for M&Ms.

The field of strategy

- Strategy includes:
  - Organizational structure and processes needed to implement the firm's plan
  - Boundaries of the firm: scale, scope, extent of outsourcing
  - Formal analysis of strategic behaviour: game theory

Game theory

- Formal analysis of strategic behaviour: relations between inter-dependent agents.
- Informally, game theory reminds us to:
  - Understand our competitors. Our results depend not only on our own decisions but on our competitors' decisions as well.
  - Look into the future. Decisions taken today may have an impact in future decisions, both by ourselves and by our competitors.
  - Pay attention to information. Who knows what can make a difference.
  - Look for win-win opportunities. Some situations are competitive, but others offer benefits to all.

What they say

I think it is instructive to use game theory analysis... Game theory forces you to see a business situation over many periods from two perspectives: yours and your competitor's.
— Judy Lewent, CFO, Merck

At their worst, game theorists represent a throw back to the days of such whiz kids as Robert McNamara... who thought that rigorous analytical skills were the key to success. Managers have much to learn from game theory—provided they use it to clarify their thinking, not as a substitute for business experience.
— The Economist

Overview

- Our goal is to create an awareness of strategic considerations in many circumstances of business life (and, in fact, of everyday life).
- Our focus is on how to play some common games: pricing, capacity, entry and exit, product positioning, and ways to encourage cooperation.
- In practice, many of the benefits come from choosing the right games and avoiding the wrong ones. For example: avoid price games.
### Historical notes

- John von Neumann, also co-inventor of the computer/operating system.
- John Nash, 1994 Nobel laureate, the first game theorist to receive the prize.
- Game theory is now commonly used by various consulting companies such as McKinsey.
- The 1995 U.S. spectrum auction was partly designed by game theorist Paul Milgrom.

### The E.T. “chocolate wars”

In the movie “E.T.,” a trail of Reese's Pieces, one of Hershey's chocolate brands, is used to lure the little alien into the house. As a result of the publicity created by this scene, sales of Reese's Pieces tripled, allowing Hershey to catch up with rival Mars.

### Chocolate wars...

- Universal Studio's original plan was to use a trail of Mars's M&Ms and charge Mars $1mm for the product placement.
- However, Mars turned down the offer, presumably because it thought $1mm was high.
- The producers of “E.T.” then turned to Hershey, who accepted the deal, which turned out to be very favorable to them (and unfavorable to Mars).

### Chocolate wars...

- Formal analysis of the E.T. game.
- Suppose:
  - Publicity from the product placement increases Mars's profits by $800,000.
  - Hershey's increase in market share costs Mars $500,000.
  - Benefit to Hershey from having its brand featured is given by $b$.
  - Hershey knows the value of $b$. Mars knows only that $b=1,200,000$ or $b=700,000$ with equal probability.

### Mars 1: decision approach

```
M  [-200, 0]  H
   /
  |[-200]
  /
  /   [0]
not buy  buy
```

### Mars 2: naïve game theory

```
M  [-200, 0]  H
   /  
  |[-500, -50]
  /
  /   [0, 0]
not buy  buy
```
Mars 3: real game theory

Quick summary

- Think about your competitor: Mars should think about Hershey, and vice versa.
- Timing matters: Hershey had the last move.
- Information matters: Hershey has more information than Mars, and in this example it made a difference.
- Key business insight: part of the benefit to Mars was to keep the opportunity from Hershey. Similar situation: Boeing, Airbus, and the super-jumbo.

Game theory: concepts

- What are the elements of a game?
  - Players (in previous example: Mars and Hershey)
  - Rules (sequentially respond to Universal’s offer)
  - Strategies (Yes or No)
  - Payoffs (sales minus payment to Universal)
- What can I do with it?
  - Determine how good each of my strategies is
  - Figure out what my rival is probably going to do

Normal-form game

Outcomes of games

- Sometimes a game can be “solved” just by looking at dominant and dominated strategies (e.g., example above).
- However, there are many games for which this isn’t enough to produce an outcome.
  - Nash equilibrium: Combination of moves in which no player would want to change her strategy unilaterally. Each chooses its best strategy given what the others are doing.
**Prisoner's dilemma**

Example: output setting (million barrels a day) by OPEC members

<table>
<thead>
<tr>
<th>Iran's Output</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>42</td>
<td>44</td>
</tr>
<tr>
<td>4</td>
<td>22</td>
<td>24</td>
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</tbody>
</table>

- Dominant strategies: high output.
- Equilibrium payoffs are (32, 24), much worse than would be attained by low output, (46, 42).
- Conflict between individual incentives and joint incentives.
- Typical of many business situations.
- Are cartels inherently unstable?

**Takeaways**

- Game theory is a formal approach to strategy.
- Highlights impact of strategic interactions among firms or other "players."
- Forces you to consider your competitors' choices.
- More coming...

**Practice problem 2.7**

Questions:
- Dominant strategy?
- Dominated strategy?
- Best responses?
- Nash equilibrium?

**Practice problem 2.8**

Time/Newsweek cover story game

Version (ii): Time more popular

Questions:
- Dominant strategy?
- Dominated strategy?
- Best responses?
- Nash equilibrium?

Comment: This is a product positioning game. The question is whether to fight head-to-head or differentiate.

Answer: It depends!
Ericsson v Nokia

- Ericsson and Nokia compete on 4G handsets. Two possible price levels: $100 and $90. Production cost is $40.

<table>
<thead>
<tr>
<th></th>
<th>Nokia's price</th>
</tr>
</thead>
</table>
|        | 100           | 90
| Ericsson's price |
| 100    | 800           | 1,100
|        | 900           | 400
| 90     | 700           | 900
|        | 900           | 800

Estimated market demand (000 per quarter):

- Suppose firms choose prices simultaneously. Describe the game and solve it.

<table>
<thead>
<tr>
<th></th>
<th>Estimated profit ($m per quarter):</th>
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<tbody>
<tr>
<td></td>
<td>Nokia's price</td>
</tr>
</tbody>
</table>
|        | 100           | 90
|        | 60            | 55
| Ericsson's price |
| 100    | 80            | 84
|        | 42            | 45
| 90     | 45            | 40

* 30m = (100-40) 500k

Neither Ericsson nor Nokia have a dominant strategy. The Nash equilibrium of this game is therefore (90,90), leading to profits of (40,45) for Ericsson and Nokia, respectively.

Ericsson v Nokia...

- Both Ericsson and Nokia have a dominant strategy: price at $90. The Nash equilibrium of this game is therefore (90,90), leading to profits of (40,45) for Ericsson and Nokia, respectively.
- Notice that both Ericsson and Nokia are worse off than they would be by pricing at $100. This game has the structure of a prisoner's dilemma.

Ericsson v Nokia 2

- Suppose that Nokia has a limited capacity of 900k units per quarter. How would the analysis change? (Changes in yellow.)

<table>
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<th></th>
<th>Estimated profit ($mm per quarter):</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Nokia's price</td>
</tr>
</tbody>
</table>
|        | 100           | 90
|        | 48            | 45
| Ericsson's price |
| 100    | 64            | 45
|        | 42            | 36
| 90     | 45            | 40

Ericsson v Nokia 2...

- It is now a dominant strategy for Nokia to price at $100. It is still a dominant strategy for Ericsson to price at $90.
- Suppose you work for Ericsson. Your market research team tells you that practically 100% of all unfulfilled demand for Nokia will be transferred to Ericsson.
- Your CIO is unsure whether Nokia is capacity constrained or not. How much would you value this piece of info? How would your strategy depend on it?

Coke v Pepsi

- You work for Pepsi. The company has just signed a major star endorsement. You must decide how much to spend on your Summer ad campaign. Net profits (in $m) depend on how much you (Coke spend - amount) and on whether or not Coke has signed a major star.
Coke v Pepsi...

- Coke’s decision of whether to sign a major star has already been taken. You don’t know what the decision was. Your CIO tells you that there is a 70% chance they did.
- You also know that Coke will have a chance to react to your decision of how much to spend.
- Should you go for a $1m or a $2m campaign?

Coke v Pepsi intuition

- This is a sequential game with incomplete information. Let us solve it backwards and include “Nature” as a player.
- If Coke did sign a star, then it will choose $2m if and only if Pepsi chooses $2m. If Coke did not sign a star, then it will choose $1m regardless of what Pepsi chooses.
- Moving backwards:
  - If Pepsi chooses $1m, then Coke will choose $1m. Pepsi’s expected payoff is 70% 2 + 30% 3 = 2.3m.
  - If Pepsi chooses $2m, then Coke will choose $2m with probability 70%, $1m with probability 30%. Pepsi’s expected payoff is 70% 0 + 30% 6 = 1.8m.
  - Pepsi should choose $1m. (What considerations are we leaving out of the analysis?)

Coke v Pepsi game tree