3. Strategic Moves

3.1 Game Trees and Subgame Perfection

What if one player moves first?

Use a **game tree**, in which the players, their actions, and the timing of their actions are explicit.

Allow three choices for each of the two players, Alpha and Beta: Do Not Expand (DNE), Small, and Large expansions.

The payoff matrix for simultaneous moves is:

The Capacity Game

		Beta		
		DNE	Small	Large
Alpha	DNE	\$18, \$18	\$15, \$20	\$9, \$18
	Small	\$20, \$15	\$16, \$16	\$8, \$12
	Large	\$18, \$9	\$12, \$8	\$0, \$0

TABLE 1. The payoff matrix (Alpha, Beta)

If Alpha preempts Beta, by making its capacity decision before Beta does, then use the **game tree**:

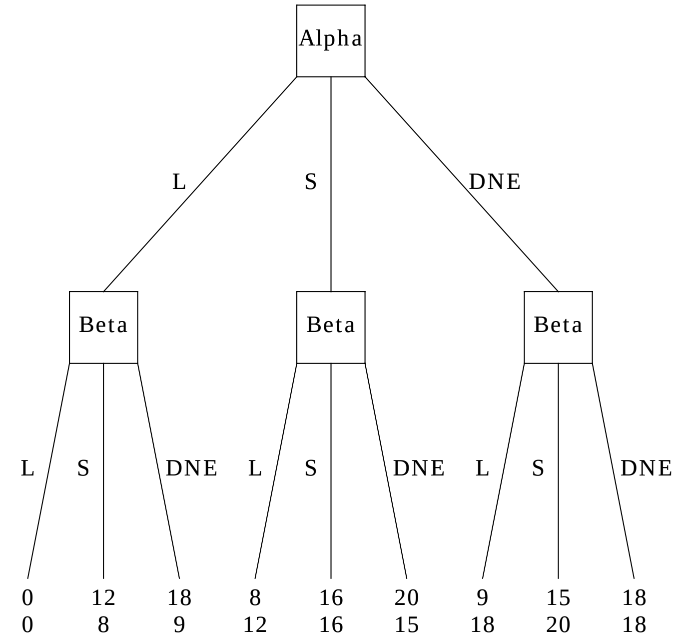


Figure 1. Game Tree, Payoffs: Alpha's, Beta's

Use *subgame perfect Nash equilibrium*, in which each player chooses the best action for itself at each node it might reach, and assumes similar behaviour on the part of the other.

3.1.1 Backward Induction

(See Bierman & Fernandez, Ch. 5)

With complete information (all know what each has done), solve this by *backward induction*:

1. From the end (final payoffs), go up the tree to the first parent decision nodes.
2. Identify the best (i.e. the highest payoff) decision for the deciding player at each node. The choice at each node is part of the player's optimal strategy.
3. "Prune" all branches from the decision node in 2. Put payoffs at new end = best decision's payoffs
4. Do higher decision nodes remain? If "no", then finish.
5. If "yes", then go to step 1.
6. For each player, the collection of best decisions at each decision node of that player → best strategies of that player.

The simultaneous game (payoff matrix) equilibrium is Alpha: Small; Beta: Small.

The sequential game (game tree) equilibrium is Alpha: Large; Beta: Do Not Expand.

In the sequential game, Alpha's capacity choice has **commitment value**: gives Alpha (in this case) **first-mover advantage**.

3.2 Threats and Credible Threats, or Why Commitment Is Important

Two firms, Able and Baker, are competing in an oligopolistic industry (an industry with few sellers who are engaged in a strategic "dance").

Able, the dominant firm, is contemplating its capacity strategy, with two options:

- "Aggressive," a large and rapid increase in capacity aimed at increasing its market share, and
- "Soft," no change in the firm's capacity.

Baker, a smaller competitor, faces a similar choice.

The table shows the NPV (net present value) associated with each combination of strategies:

		Baker	
		Aggressive	Soft
Able	Aggressive	12.5, 4.5	16.5, 5
	Soft	15, 6.5	18, 6

TABLE 2. Simultaneous Payoffs (Able, Baker)

There is a unique Nash equilibrium: Able chooses Soft and Baker chooses Aggressive, to give a payoff to Able of 15.

But from Able's point of view, this combination is not as good as if both Able and Baker chose Soft → Able's payoff of 18.

But without Baker's cooperation, this outcome will not be reached.

What if Able committed to choose Aggressive whatever Baker chose? If this were **credible**, then Baker would choose Soft (for a higher payoff of 5, over 4.5), which in turn would give Able a payoff of 16.5.

How to commit to Aggressive on Able's part?

It's not enough to announce it or even to promise[1] it: not a *credible* move, since Baker knows that Soft is a *dominant strategy* for Able: no matter what Baker does, Able's payoff is higher if it's Soft.

One way is for Able to make a preemptive move, by accelerating its decision process and aggressively expanding its capacity before Baker decides what to do: turns a *simultaneous* interaction into a *sequential* game:

1. Talk is cheap ... because supply exceeds demand.

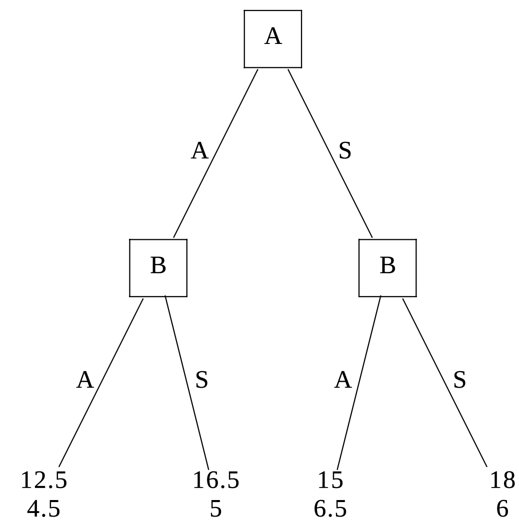


Figure 2. Sequential Payoffs (Able, Baker)

{Able: Aggressive, Baker: Soft} is a subgame perfect Nash equilibrium of the sequential game.

Able may be able to credibly commit by demonstrating that it was rewarding its managers on market share rather than the NPV profit of the payoffs: more profitable for the managers to go for capacity aggressively, even if the company's payoff appears lower.

Paradoxically, Able's position is strengthened if it can reduce its options and tie itself to Aggressive.

Inflexibility can have value: strategic commitments that limit choices can actual improve one's position.

How?

By altering one's rivals' expectations of about how one will compete, and so altering their decisions.

By committing to what seems an inferior decision (Aggression), Able alters Baker's expectations and its action, to Able's advantage.

Commitments must be credible and communicated and understandable to be of value.

- By their nature, strategic commitments (threats or promises) are intended to change others' expectations and behaviour; others must wonder whether the committed player mightn't fall back on the uncommitted best action: it's nothing but a bluff.
- The movie *Dr Strangelove* describes a Russian commitment — The Doomsday Machine — to respond to any incursion into Soviet airspace with an attack of nuclear missiles on the U.S. Unfortunately, the Russian have overlooked telling the Americans about it ...
- The rivals' managers must understand the implications for their own firms' payoffs of Able's ability to price low with its excess capacity.

To be truly credible, the commitment must be *irreversible*: very costly to stop or reverse.

Non-credible threats are ignored.

3.2.1 Subgame Perfect Equilibria

Nash Equilibria from non-credible threats are poor predictors of behaviour.

A subgame: is a smaller game within a larger game with two special properties:

1. once players begin playing the subgame, they do so for the rest of the game;
2. the players all know when they are playing the subgame.

The subgame's *subroot* node: the initial node: the subgame consists of the subroot and all its successors — property 1.

If every information set that contains a decision node of the subgame *does not* contain decision nodes that are not part of the subgame — property 2.

The subgame preserves the original game's:

- set of players,
- order of play,
- set of possible actions, and
- information sets.

Rational behaviour in the full game should be rational in the subgame.

Defn: A strategy profile is a **subgame-perfect equilibrium**[2] (SGPE) of a game *G* if this strategy profile is also a N.E. for *every* subgame of *G*.

With perfect information (singleton information sets), the SGPE = those from backwards induction (B.I.).

B.I. eliminates non-credible threats, so a N.E. ⇔ a SGPE, with perfect information.

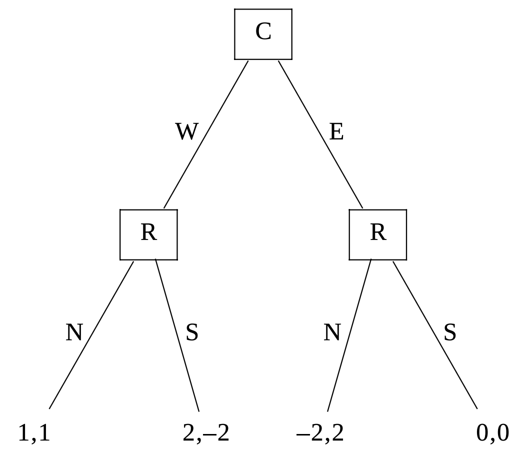
The real power of SGPE occurs when there is *not* perfect information — when players are not always aware of what their opponent did (modelled by multi-node information sets).

So long as there is perfect information, backwards induction results in Nash equilibria that are S.G.P.

2. Reinhart Selten received the 1994 Nobel Prize in Economics for his development of this concept.

3.2.2 An example: side payments

A sequential game, in which there may be "side payments" from one player to another:



Side Payments 1 (R,C)

The second mover, R, has the following option:

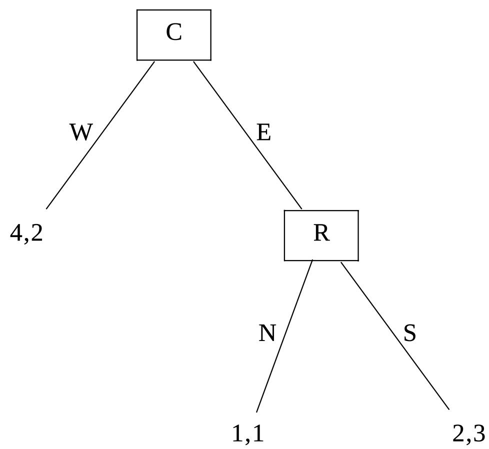
- Before his move, he can promise or threaten to reduce his payoff to any positive number or zero by adding the same amount to C's payoff.
- This can only happen at one final outcome (only one of NE, NW, SE, or SW).
- This is a promise (or threat) of a *side payment*

What would happen without the promise of a side payment?

What would happen with such a promise?

3.2.3 Another example: side payments

A second game tree with side payments possible:



Side Payments 2 (R,C)

We distinguish:

- compellent promises (threats) from
- deterrent promises (threats).

Two separate possibilities:

- R: "If W, then payoffs 2½, 3½"
  a compellent promise
- R: "If SE, then payoffs of ½, 4½"
  a deterrent promise

Which is *credible* or *a self-enforcing contract*?

3.3 A Menu of Strategic Moves

3.3.1 Threats and Promises

- An *unconditional move* may give a strategic advantage to a player able to seize the initiative and move first.
- Possible for a second mover to gain similar strategic advantage by commitment to a *response rule*: "If you do/don't act like this, then I'll do/not act like that." The rule must be in place and *clearly communicated beforehand*.
- Two sorts of response rules: *threats* and *promises*.
- A *threat* is a response rule that punishes others who fail to cooperate with you.
  — *Compellent threats* to induce action (hijacker).
  — *Deterrent threats* to deter action (NATO).
  — Both sorts: both sides will suffer if the threat has to be carried out.
- A *promise* is a rule that rewards others who cooperate with you.
  — Again, both *compellent* ("Clean up your room") and *deterrent* ("Don't be nasty to your sister").
  — Both share a common feature: once the action is taken (or not taken), there is an *incentive to renege.*

- What about:
  Mugger: If you "lend" me $20, then I promise I won't hurt you. Implicit threat overshadows the explicit promise. What is the status quo ante?

3.3.2 Warnings and Assurances

- Warnings and assurance are non-strategic: there is *no temptation to renege*, since they are Nash equilibrium actions.
- Threats and promises: the response rule commits you to actions you wouldn't take in its absence, i.e. strategic.
- If the rule says merely that you will do what is best at the time, then there is no change in others' expectations, and hence no influence.
- But there may still be a informational role for stating what will happen without a response rule: *warnings* and *assurances*.
- A *warning*: it's in your interests to carry out a "threat". A warning is used to inform others of the effects of their actions.
- When it's in your interest to carry out a "promise": an *assurance*.

- Threats and promises are truly strategic moves, but warnings and assurances are more informational;

— they don't change your response rule in order to influence another player,

— instead you are merely informing them of your response to their actions.
or altering the other player's information set

— You aren't manipulating them by altering your response rule from what will be best at the time.

— There is no issue of credibility with warnings and assurances, since there is no incentive problem for you.

— Hence warnings and assurances don't require commitment.

3.3.3 Summary of Strategic Moves

- An *unconditional* move is a (response) rule in which you move first and your action is fixed.
- *threats* and *promises* occur when you move second: they are conditional because the response dictated by the rule depends on what the other side does.
- A strategic move is a preemptive action, and the response rule must be in place before the other side moves.
- Hence the game should be analysed as a sequential move game, which may dramatically alter the outcomes, even though the payoffs remain unchanged, due to the different rules of play.

3.4 Strategic Moves

(See Dixit & Nalebuff in the Folder.)

- For the scorched earth policy strategy to be effective, you must destroy what the invader (raider) wants, which may not coincide with what you want.
- An example of a *strategic move*: designed to alter the beliefs and actions of others in a direction favourable to yourself.
- distinguishing feature is that the move purposefully limits your freedom of action, unconditionally or conditionally.
- Leaving your options open is not always preferable in strategic interactions: your lack of freedom has strategic value, by changing other players' expectations about your future responses.

  They know that when you have the freedom to act, you also have the freedom to give up.

  So by reducing your freedom to give up, you strengthen your position.

3.5 Unconditional Moves

Consider rivalry between the US and Japan to develop High Definition TV (HDTV):

- The US has the technological edge (for now), but has more limited resources because of accumulated budget deficits.
- The Japanese can win, but so can the US with a strategic move.
- The payoff matrix:
  — Hi,Hi is the worst for both: the US is more likely to win, but at a higher cost.
  — Lo,Hi (Hi,Lo) is next worse for the US (Japan) because Japan (the US) is likely to win.
  — The Japanese prefer Lo,Hi: their chances of winning are high and they care less about the resource cost.
  — The US prefers Lo,Lo: they are likely to win at low cost.

The HDTV Race

		Japan's effort	
		Lo	Hi
US effort	Lo	4, 3	2, 4
	Hi	3, 2	1, 1

TABLE 3. The payoff matrix (US, Japan)

A non-cooperative, positive-sum game.
(One Nash equilibrium.)

Lo,Lo $\rightarrow$ US wins
Lo,Hi $\rightarrow$ J wins
Hi,Lo $\rightarrow$ US wins
Hi,Hi $\rightarrow$ standoff or US wins

- US has a dominant strategy, Lo, but the Japanese can anticipate this.
- Japanese best response is Hi.
- (Lo,Hi) is an equilibrium, but it's the US's second worst payoff. This calls for a strategic move by the US.
- If the US moves first by announcing its unconditional effort level before the Japanese reach their decision, the game becomes sequential-move, with the following tree:

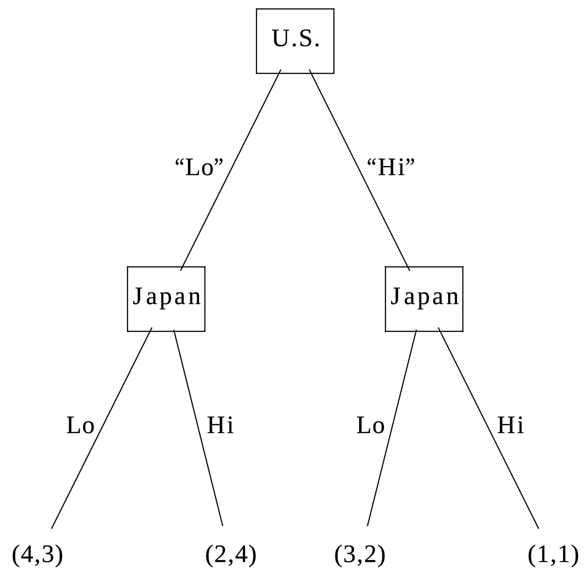


Figure 3. Tree and Payoffs in Sequential-Move Game (U.S., Japan)

Solve by looking forward and reasoning back:

— If U.S. Lo, then Japanese Hi, and U.S. gets 2.

— If U.S. Hi, then Japanese Lo, and U.S. gets 3.

— So U.S. should announce Hi, and expect the Japanese to respond Lo.

— Equilibrium of sequential-move game, and results in a payoff of 3 for the U.S., higher than the 2 it got in the simultaneous game.

- The U.S. strategic move is its unilateral and unconditional declaration of its choice, *not* the choice it would have made in a simultaneous-play game:
- U.S. has nothing to gain by declaring Lo, which is what the Japanese expect anyway.
- Strategic moves: commit to *not* follow the equilibrium move of the simultaneous-play game.

  — The strategic move alters the Japanese beliefs and so their move. (If the U.S. could then change its move from Hi to Lo, it should do so.) But ...

Questions:

Why should the Japanese believe the U.S. declaration?

Wouldn't they expect a change of mind?

If they do, wouldn't they choose Hi?

- The *credibility* of the U.S. declaration is suspect. Without credibility, the U.S. move has no effect.
- Most strategic moves must face the issue of credibility. (Consider the possible preemptive moves in Chicken!)
- To make a strategic move credible, you have to take some other supporting action that makes reversing the move too costly or even impossible: *commitment*.
- Strategic moves contain two elements:
  1. the planned course of action and
  2. the commitment that makes this action credible.
- Visibility?

3.6 More Strategic Moves

- More complicated options than above. Instead of establishing a response rule directly, you could allow someone else to take advantage of one of these options:

  — Allow someone else to make an unconditional move before you respond, *or*

  — Wait for a threat before taking any action, *or*

  — Wait for a promise before taking any action
- Cases in which someone who could move first does even better by allowing the other side to make an unconditional move first: sometimes it is better to follow than to lead.
- But sometimes your goal: to prevent your opponent from making an unconditional commitment:

  — "When you surround an enemy, leave an outlet free." Deny the enemy the credible commitment of fighting to the death.
- It's never advantageous to allow others to threaten you:

  — you could always do what they wanted you to do without the threat;

  — the fact that they can make you worse off if you do not cooperate is bad, because it only limits your available options.
- *But* if the other side can make *both threats and promises*, then you can both be better off.

3.7 The Appropriate Threat

- Why do trade disagreements (Australia v. the USA, or the USA v. the EC, or the USA v. Japan) seldom lead to (threats of) armed conflict or seizure of other's goods or citizens?
- Excessive threats have problems:
  1. Lack of credibility.
  2. If it worked, it might result in a further questioning of the relationship.

  3(a) If it didn't work (because of lack of credibility, say), and the threat was carried out, then the punisher may be seen as uncivilised.

  3(b) If it didn't work, and the threat wasn't carried out, then the threatener's reputation may be damaged — future credibility.

  4. An excessive threat muddies the water.

So we note:

- Threats may be costly.
- Excessive threats may be counterproductive.
- A successful threat need never be carried out, so long as there are no mistakes. e.g.. *Dr. Strangelove, or How I Stopped Worrying and Loved the Bomb*
- Too large a threat may lose credibility.

e.g.. Boeing v. Airbus.

Getting the threat right ...

The Piranha Brothers

— *Monty Python's Flying Circus ...*

The Operation: ✗

1. Select a victim.
2. Threaten to beat him up if he paid the "protection" money.

The Other Operation: ✘

1. Select a victim.
2. Threaten not to beat him up if he didn't pay the "protection" money.

The Other Other Operation ✓

1. Select a victim.
2. Threaten to beat him up if he didn't pay the "protection" money.