Dynamic Games

Lesson 3: Credibility & Strategic Commitment

Universidad Carlos III de Madrid

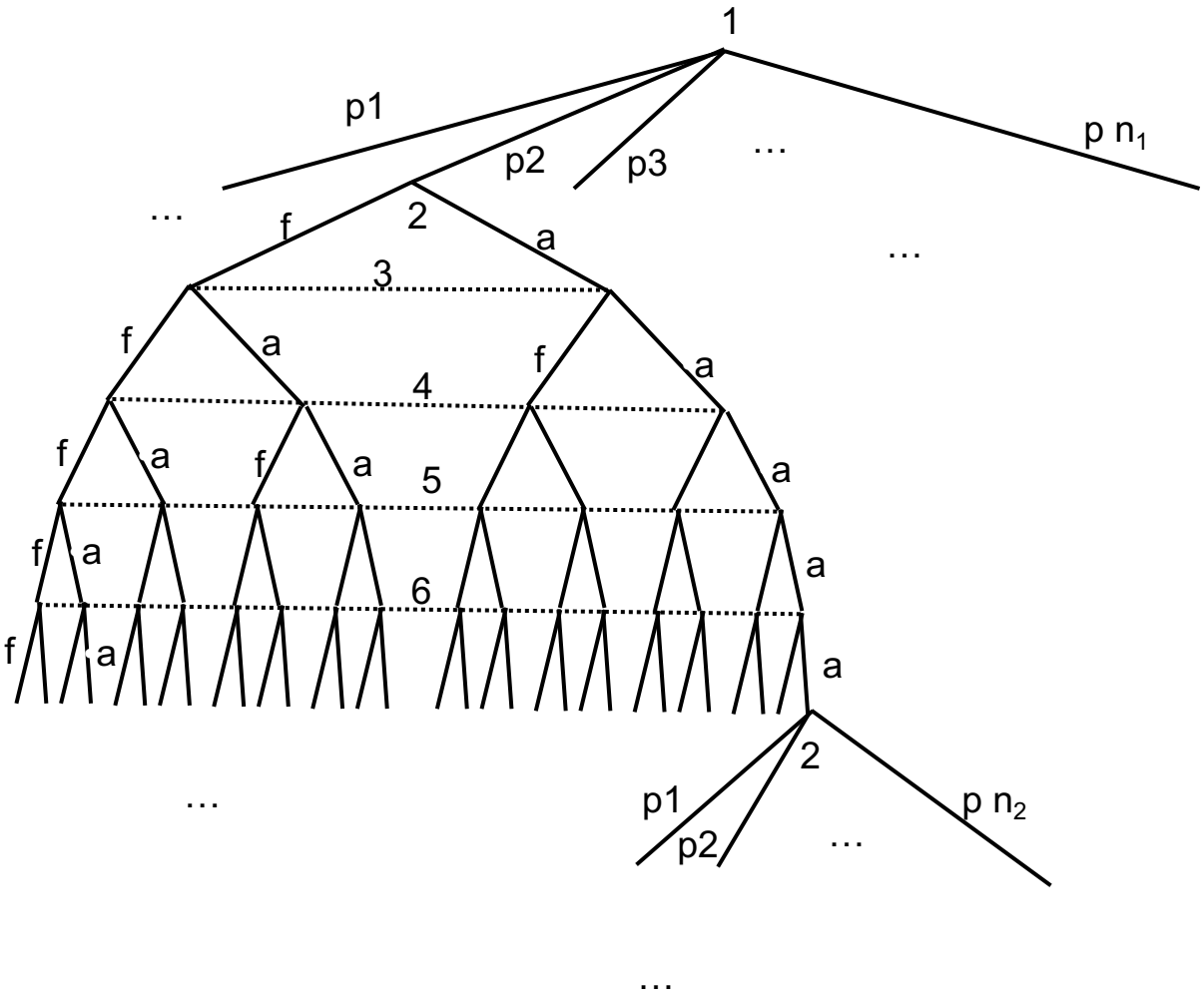
Key concepts on credibility and commitment

- Recall:
  - Backward Induction: Look forward, reason backwards.
  - SPNE: shares the same logic, but extended to games of imperfect information.
  - NE≠SPNE, NE may include non credible threats and promises.
- In today's class we'll see how to be credible: Strategic commitment.

Dividing up the treasure

- There are 6 pirates and a treasure of 60 gold coins.
- Piracy laws impose this rule to divide the bounty:
  - The oldest pirate proposes a division.
  - If half or more vote in favor, it is implemented. It is understood that the pirate proposing votes in favor.
  - Otherwise he is thrown overboard and the next oldest proposes a new division.
  - The process continues until a proposal is accepted.
  - In case a pirate is indifferent, he or she votes against.
- How will they split the treasure?

Dividing up the treasure. Extensive form



Dividing up the treasure.

Backward induction

	1	2	3	4	5	6
Proposal pirate 1	58	0	1	0	1	0
Proposal pirate 2		58	0	1	0	1
Proposal pirate 3			59	0	1	0
Proposal pirate 4				59	0	1
Proposal pirate 5					60	0
Proposal pirate 6						60

Each pirate accepts the proposal by pirate *n* as long as he or she gets the same or more of what is shown on the table and rejects any other proposal.

Each pirate makes the proposal shown in the table.

Credibility. NE versus SPNE

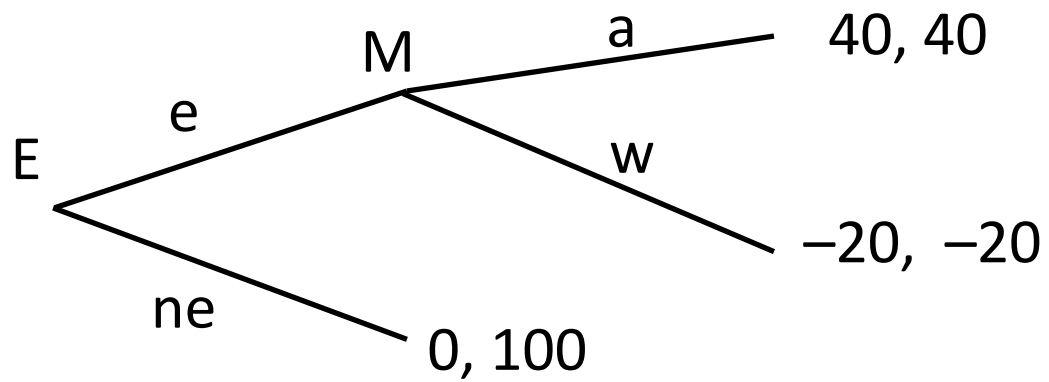
- SPNE eliminates NE based on non credible threats or promises.
- A threat or promise is not credible if, at the time of carrying it out, it goes against the interests of the player who made it.
- There is a credibility problem for any strategy containing a non credible promise or a threat.

Example of a non credible threat: the entry game

- A monopolist enjoys 100 % of the possible profits in a given market.
- A potential entrant is considering whether to enter to compete in this market.
- If the entrant enters, the former monopolist can either accommodate to the new situation or star a price war.
- If it accommodates, they will compete a la Cournot and they will win 40 each.
- In case of a price war, they will both lose 20.

Example of a non credible threat: the entry game

Extensive form



Normal form

	w	a
e	-20, -20	40, 40
ne	0, 100	0, 100

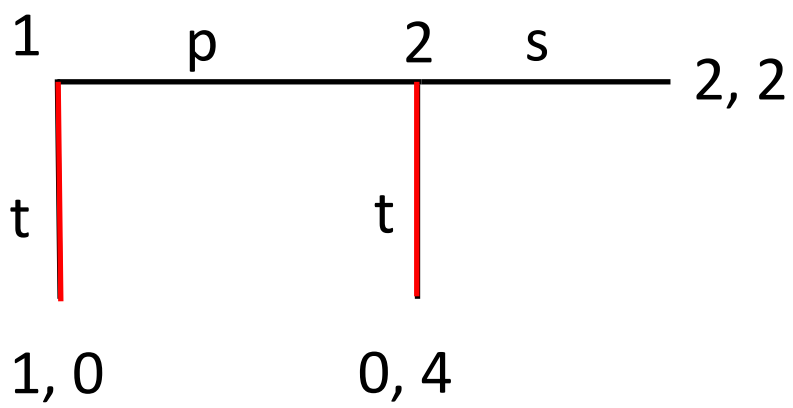
EN pure = {(ne, w), (e, a)}

Example of a non credible threat: the entry game

- The Nash equilibrium (ne, w) contains a non credible threat: "if you enter, I will start a price war where you will lose 20".
- This is not credible because the monopolist will also lose. Once the entrant enters, the monopolist will be better off if it accommodates.
- (ne, w) is neither a SPNE nor an equilibrium by backward induction.

Example of a non credible promise: the centipede game

- There is €1 on the table.
- Player 1 can take it (t) and then the game ends.
- She also can pass and wait (p). In this case the money is multiplied by 4 and and the turn pass to Player 2.
- Player 2 can take all the money (t) or split it with Player 1 (s).



Strategy (p, s) contains a non credible promise:

"If you pass, I'll share the money."

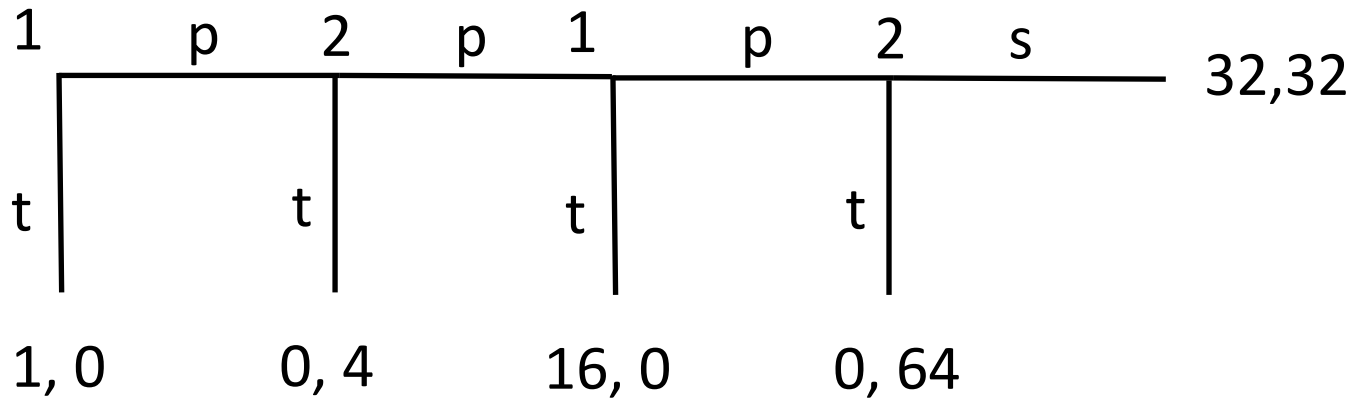
(p, s) is not a NE.

The only NE, SPNE or BI is (t, t).

Also: "be my equity partner and lend me €1, for I know how to invest it and promise to share the earnings".

Example of a non credible promise: the centipede game

- Why is it called the centipede game?
- Add two more turns: every time a player waits, the money is multiplied by 4.



The extensive form resembles a centipede (use some imagination).

The only SPNE is ((t, t), (t, t)).

Three ways to be credible

- Acquire a costly commitment:
  - Overinvest in capacity. This way a firm announces that it can produce great quantities and deter aggressive production plans by competitors.
  - Excessive advertisement. This way the commitment to remain in the market is credible.
- Eliminate accommodative strategies in the future, or cancel some alternatives to have a stronger bargaining position:
  - Scuttling your ships.
  - Odysseus tied to the mast.
- Give up control, let a third person make the decision for you (my hands are tied).
  - Separation of powers.
  - Independence of the Central Bank.
  - Doomsday machine.

Being credible: 1. Costly commitment

- Two firms must decide whether to enter in a new market:
  - The present value of future profits in the market are 10.
  - Entry cost is 7.

	E	NE
E	-2 , -2	3 , 0
NE	0 , 3	0 , 0

  - If a firm believes the other one will enter, it will choose No Enter.
  - If it believes the other one will not enter, it will choose Enter.
  - Chicken game.

Being credible: 1. Costly commitment

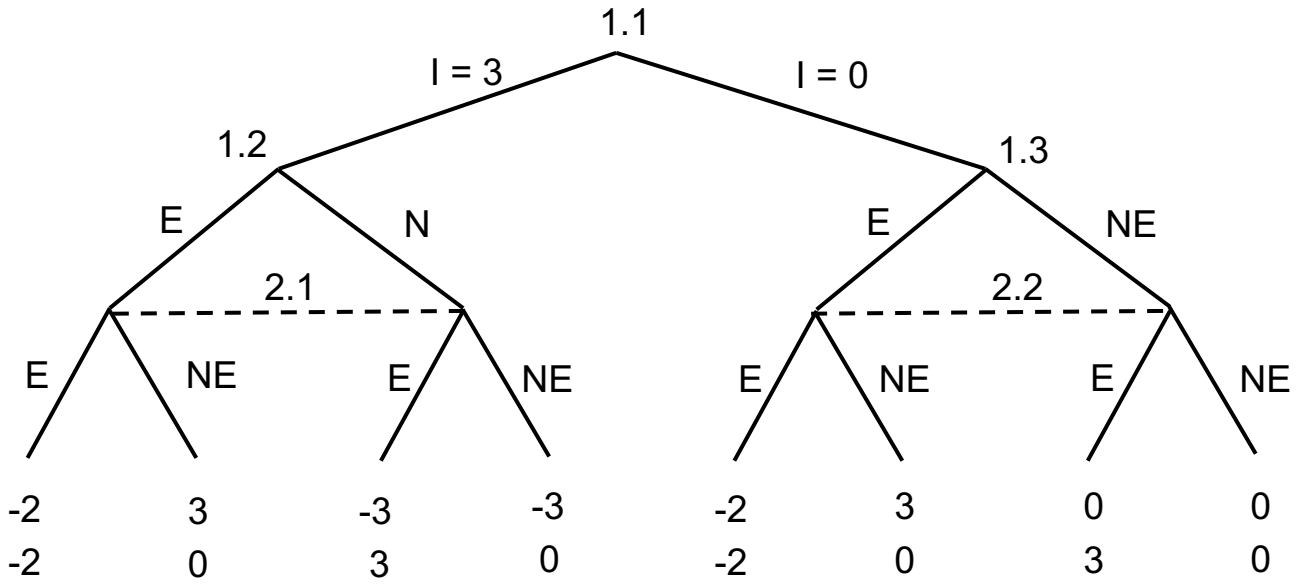
- Firm 1 makes an initial investment of 3 million. If it does not enter, the investment is lost :

	E	NE
E	-2 , -2	3 , 0
NE	-3 , 3	-3 , 0

- Now Enter is a dominant strategy.

Being credible: 1. Costly commitment

Extensive form



- In subgame after 1.3 there are two NE in pure strategies : {(E, NE), (NE, E)}, with payoffs 3 and 0 for Firm 1, respectively.
- In subgame after 1.2 there is one NE: (E, NE) with payoff 3 for Firm 1.
- SPNE={(I=3, (E, NE), (E, (NE)), (I=0, (E, NE), (E, (NE)), (I=3, (E, NE), (NE, (E))}. (Ordered by subgame.)

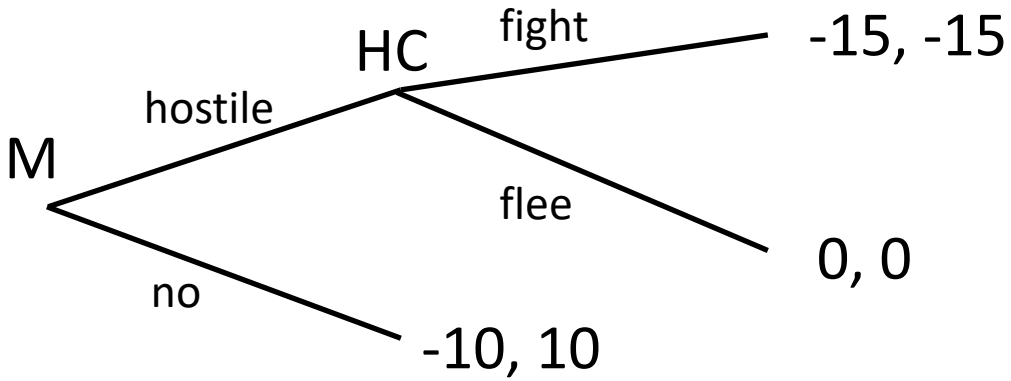
Being credible: 2. Eliminate strategies

- In the spring of 1519, Hernán Cortés left Cuba for the Mexican coast with 508 men, 16 horses and a couple of pieces of artillery. They disembarked and founded the city of Veracruz.

- There, Cortés found out about the existence of Moctezuma, Aztec emperor in a splendid city in the interior who commanded a grand army. He also knew that many cities under Aztec rule disliked the Aztecs and that they might serve as allies.

- Cortés decided to try and conquer the Aztecs :
  - If Moctezuma responded with hostility, the Spaniards had the option of fighting or fleeing.
    - In the first case, the losses would be large for both sides (-15, -15).
    - In the second case, they would neither win nor lose anything (0,0).
  - If Moctezuma did not respond with hostility, Hernán Cortés and his men would gain 10, while Moctezuma would lose 10.

Being credible: 2. Eliminate strategies

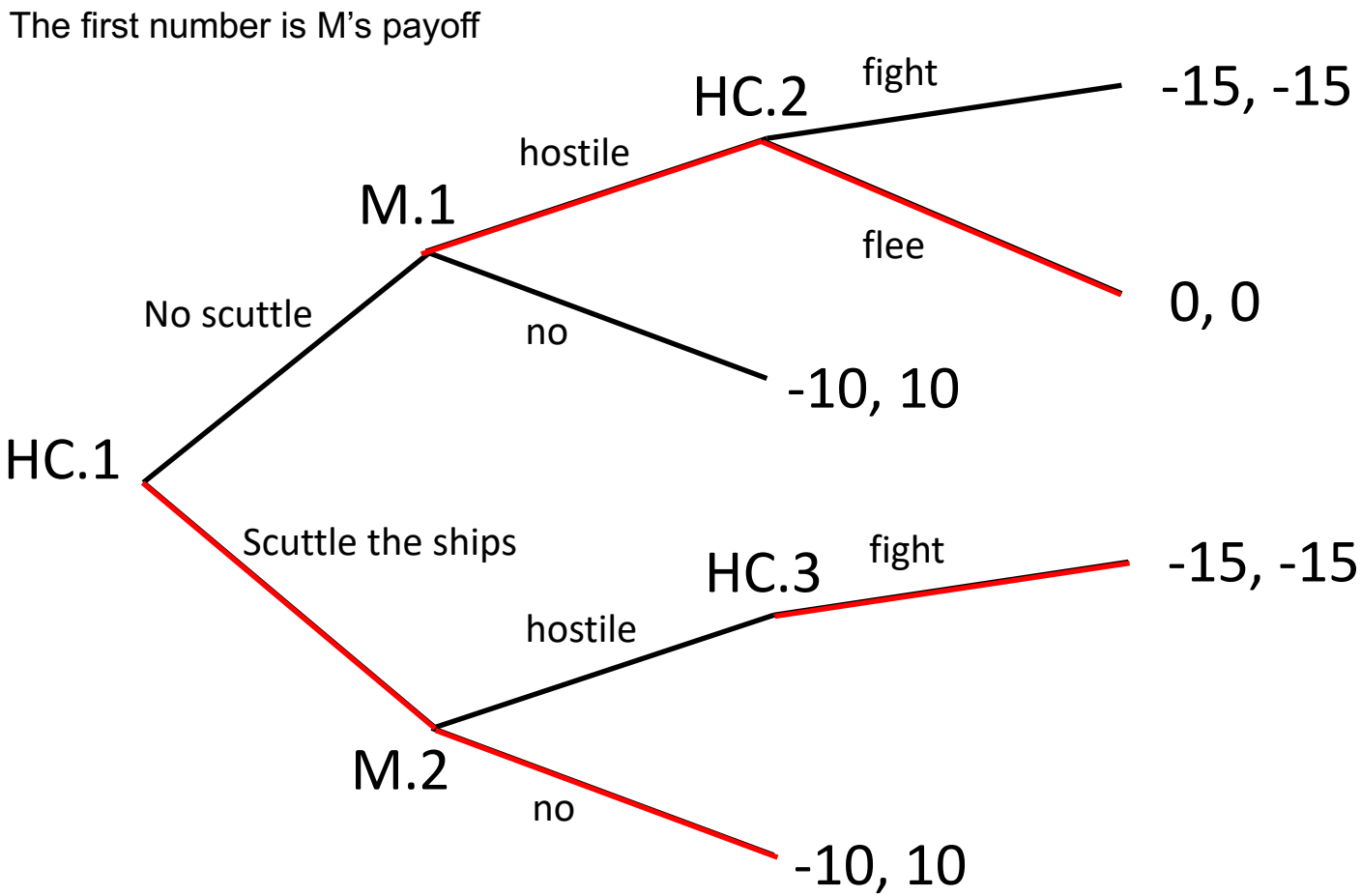


SPNE: (hostile, flee)

Being credible: 2. Eliminate strategies

- Hernán Cortés plans to change the game by taking an initial action: sunk all his boats in Veracruz.
- If he does this, there is no longer the possibility of fleeing.
- Moctezuma will hear the news about Cortés' action.
- The game is like this:
  - Hernán Cortés must decide whether to scuttle or not the ships.
  - Moctezuma must decide whether to meet Cortés with hostility or not after observing Cortés' move.
  - Hernán Cortés must decide whether to fight of to flee in case he did not sink the ships, or just fight if he sunk them.

Being credible: 2. Eliminate strategies



SPNE = ((Scuttle the ships, flee, fight), (hostile, no))

Being credible: 3. Give up control

- Two neighboring countries, both possessing nuclear weapons, face a potentially dangerous situation.
- Country 1 could ignore its neighbor's provocations, which would yield zero profit for both of them, or respond to the provocations.
- If it responds, Country 2 can withdraw (with payoff 1, -1) or can further aggravate the conflict.
- The two countries know that if the conflict gets worse they will end up playing the game of mutually assured destruction (MAD):

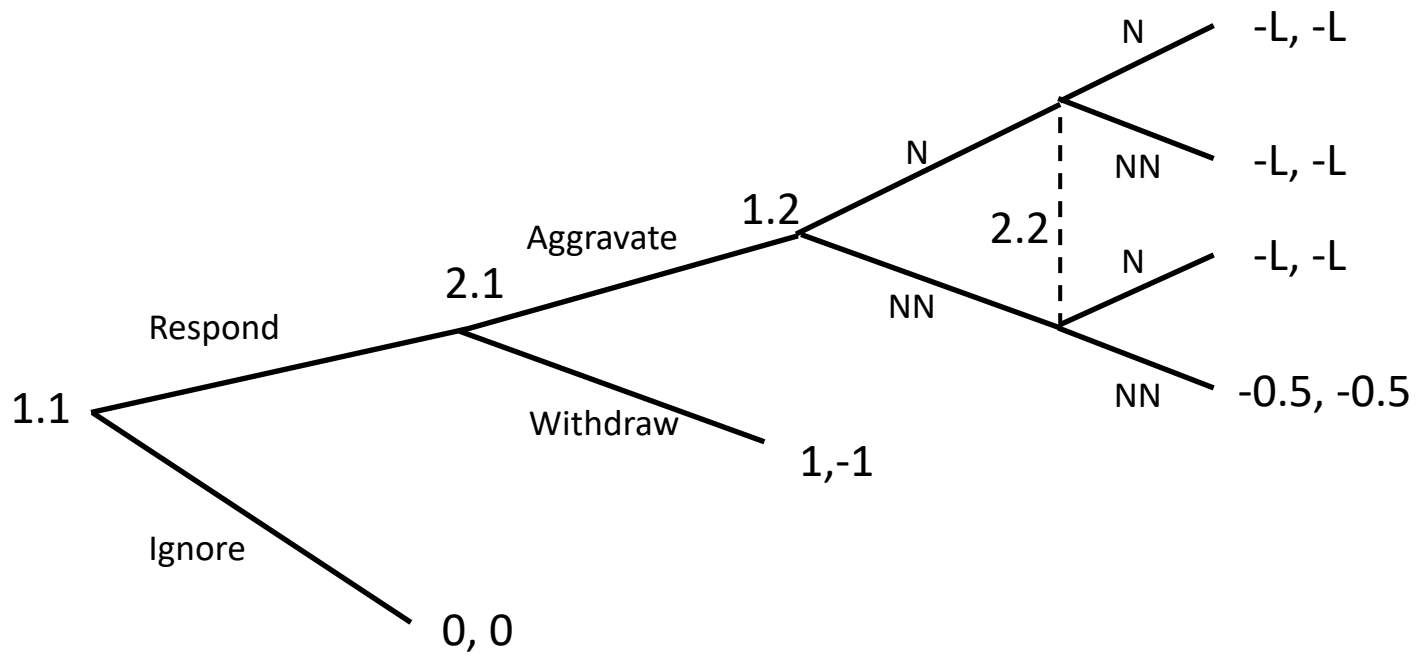
	N	NN
N	-L, -L	-L, -L
NN	-L, -L	-0,5, -0,5

N: use nuclear weapons, NN: not to use nuclear weapons.

L is a very large number.

Being credible: 3. Give up control

Extensive form:

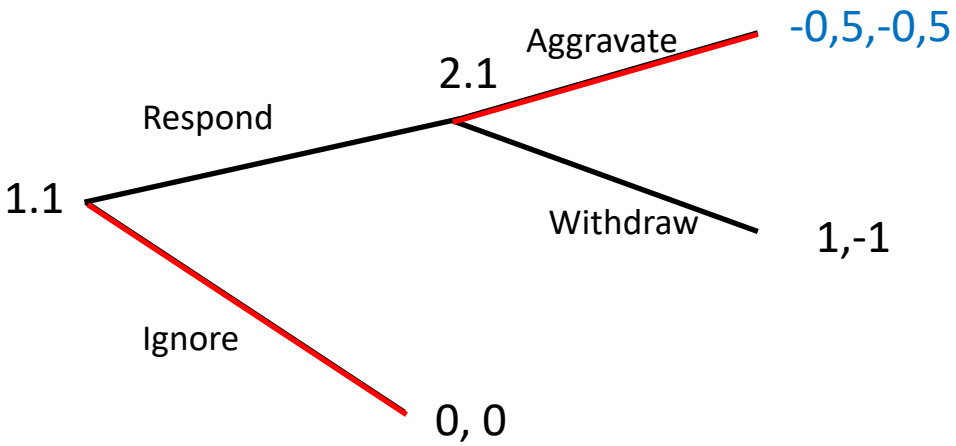


Being credible: 3. Give up control

	N	NN
N	-L, -L	-L, -L
NN	-L, -L	-0,5, -0,5

The subgame starting at 1.2 has two NE: {(N,N), (NN, NN)}.

Consider first NE (NN, NN):



SPNE: ((Ignore, NN), (Aggravate, NN)).

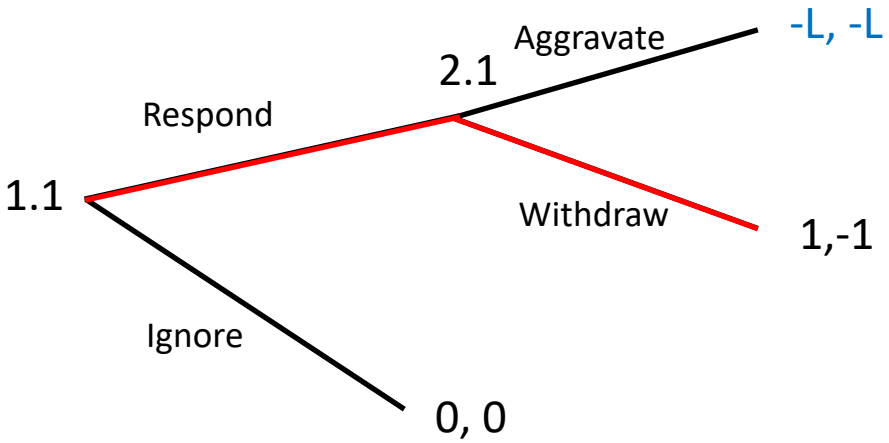
(Ordered by players).

Being credible: 3. Give up control

	N	NN
N	-L, -L	-L, -L
NN	-L, -L	-0,5, -0,5

The subgame starting at 1.2 has two NE: {(N,N), (NN, NN)}.

Consider now NE (N, N):



SPNE: ((Respond, N), (Withdraw, N)).

(Ordered by players).

In both SPNE destruction is avoided.