Chapter 18

Game Theory and Strategic Choices

1. How to Think Strategically
2. The Prisoner's Dilemma and the Challenge of Cooperation
3. Multiple Equilibria and the Problem of Coordination
4. Advanced Strategy: First and Second Mover Advantages
5. Advanced Strategy: Repeated Games and Punishments

Chapter 18 (1 of 6)

Apply the four steps for making good strategic decisions:

- Introduce Game Theory
- Four-Step Recipe

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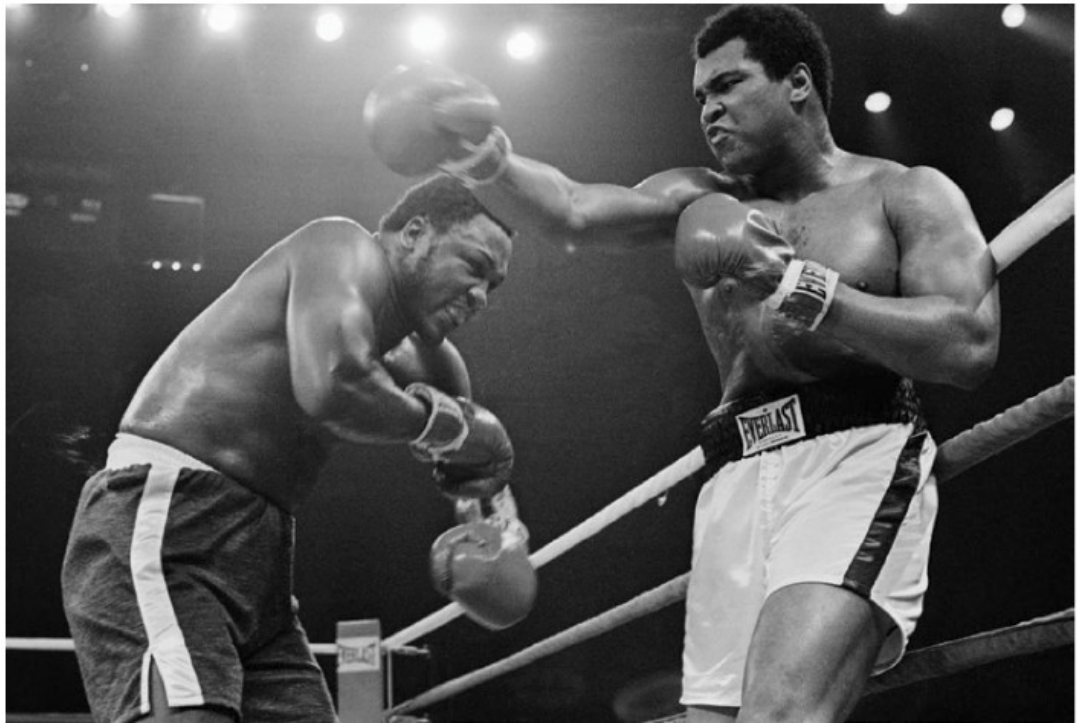
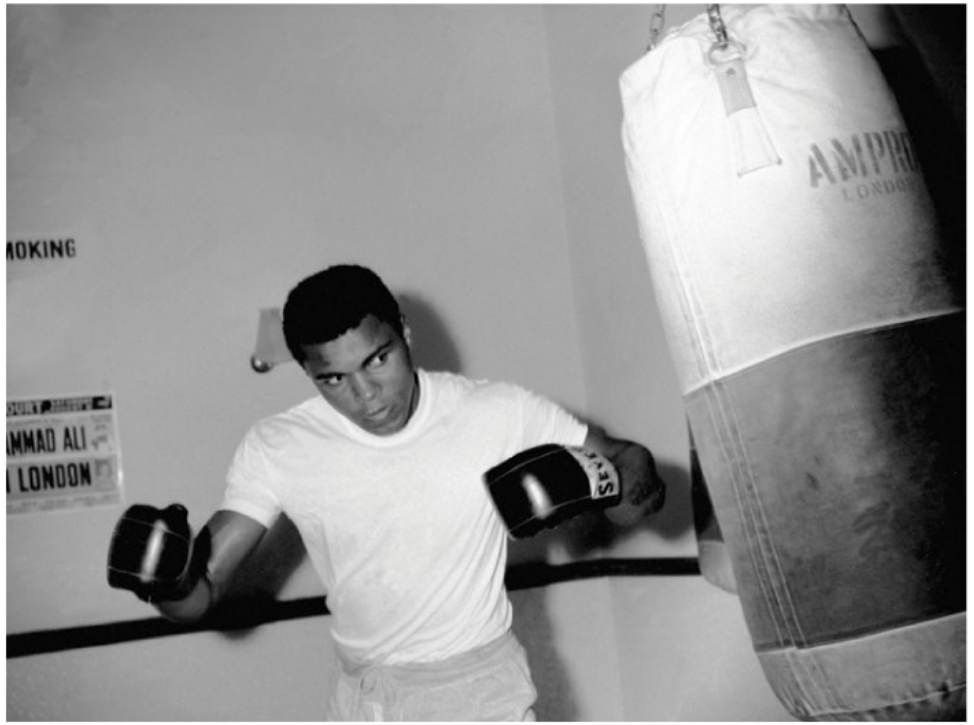
One image involves game theory. The other does not.





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Introducing Game Theory

Game theory is the science of making good decisions in **situations involving strategic interaction.**

- **Strategic interaction:** When your best choice may depend on what **others** choose, and their best choice may depend on what **you** choose.

Underlying idea comes from the *interdependence principle.*

- Your **decisions are intertwined** with those of others.

Strategic interactions are in relation to both **competition** and **collaboration.**

Strategic interactions are all around you (1 of 2)

Games:

- Boxing, football, basketball, baseball, soccer
- Chess, checkers, tic-tac-toe, rock-paper-scissors

Business:

- Your decision to cut your price depends on how your rivals will respond.
- How you position your product depends on how competitors position their products.
- Your decision to enter a new market depends on whether incumbent firms will respond with a price war.
- The profitability of your investment in a project may depend on how much your partners invest in that project.

Strategic interactions are all around you (2 of 2)

Politics and international affairs:

- The payoff from voting on a bill depends on whether others vote for it too.
- My decision to vote for something depends on how I think my constituents (or opponents) will respond.
- A leader's decision to amass troops near the border depends on how they think other countries will respond.

Friends and family:

- You will go to the party only if your friends also go to the party.
- What state you live in (or part of the state) you chose to live and work in depends on where your friends and family live.

Four steps for making good strategic decisions

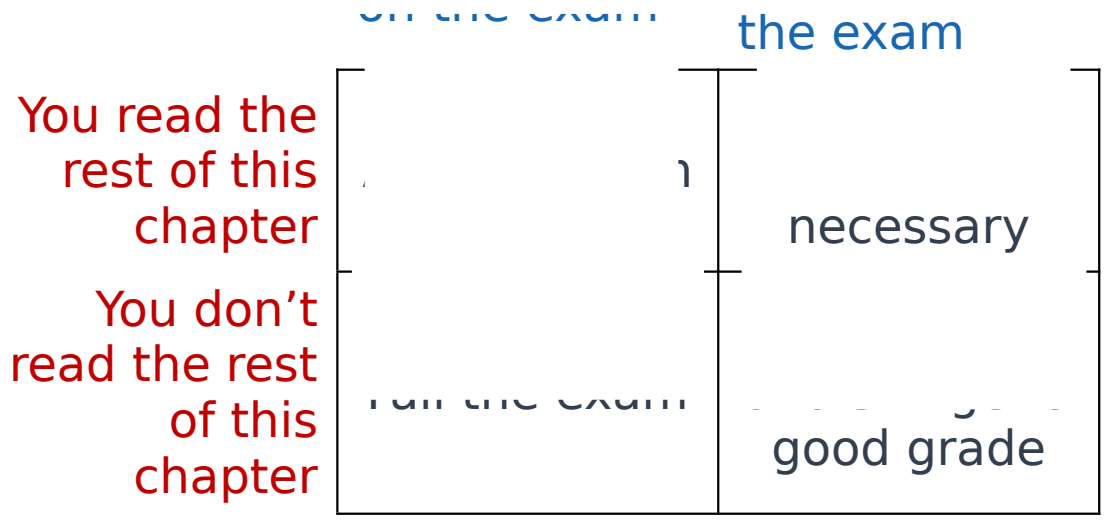
1. Consider **all** the possible outcomes.
2. Think about the “what ifs” separately.
3. Evaluate your best response.
4. Put yourself in someone else’s shoes.

Step 1: Consider all the possible outcomes (2 of 2)

Every combination of choices that both you and other players might make.

Payoff table: A table that lists…

- **your choices** in each row.
- the **other player's choices** in each column.
- and thus shows all possible outcomes, listing the payoffs in each cell.



Step 2: Think about the "what ifs" separately

Side-step the potential for going down the rabbit hole of

- "I think that they think that I think that they think…"

Break the problem into **simpler components**, which are the various choices the other person could make.

- What if they do? What if they don't?

	Professor puts game theory on the exam	Professor omits game theory from the exam
You read the rest of this chapter	Ace the exam	You study more than necessary
You don't read the rest of this chapter	Fail the exam	Save time and still get a good grade

Step 3: Evaluate your best response (2 of 2)

HELPFUL HINT: When evaluating each "what if" scenario, place a **checkmark** next to your best response.

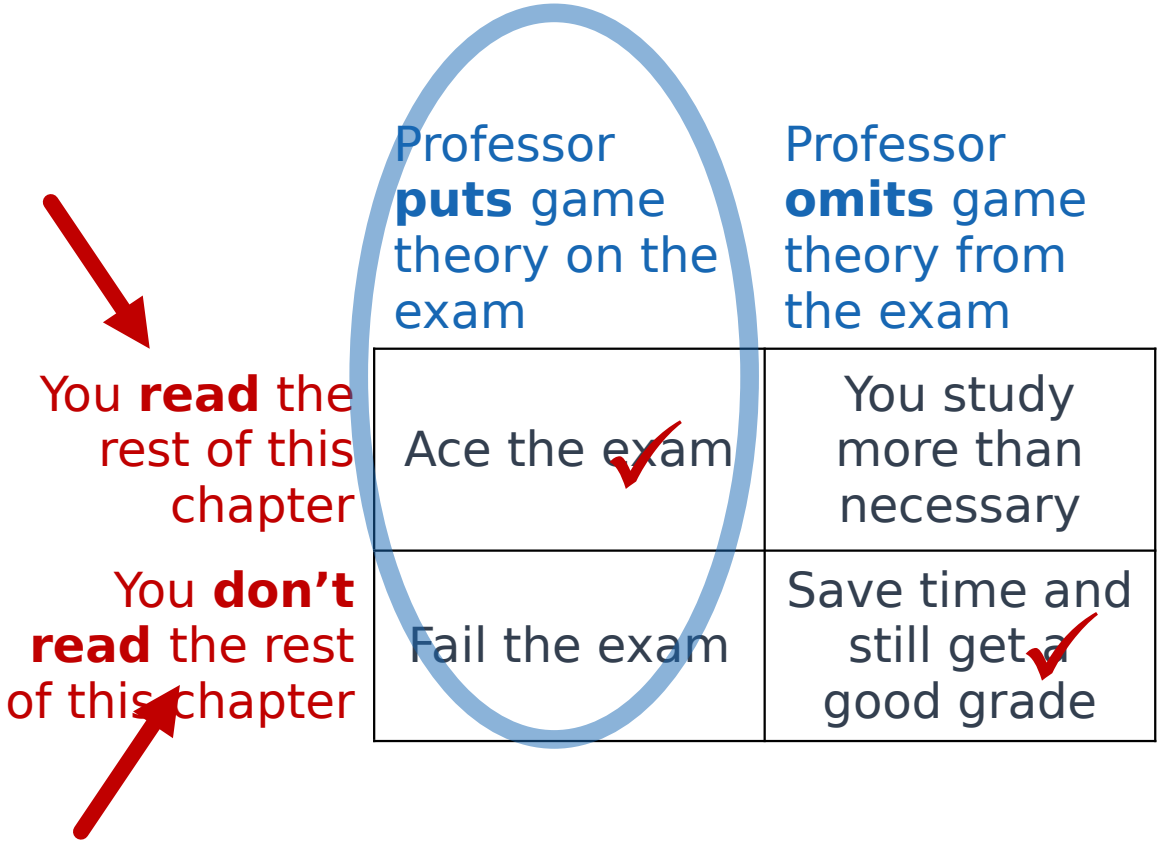
For each "what if?" you want to evaluate your best response.

- **Best response:** The choice that yields the **highest payoff** given the other player's choice.

"What if" the professor puts game theory on the exam?

- Your two "responses" are **read** or **don't read**.
- Given the possible outcomes, your **best response** is **"read"** for this particular "what if" scenario.

You Try! Repeat this thought experiment for the other "what if" scenario: "**omits**"



Step 4: Put yourself in someone else's shoes (2 of 2)

Work your way through someone else's thought process to better predict *their* choices.

- Repeat Steps 1–3 but from the perspective of the OTHER player (**the professor**).

"What if" the student reads the chapter?

- Professor's two "responses" are **put** or **omit**.
- Given that professors want to reward effort, the professor's **best response** is **"put"** for this particular "what if" scenario.

You Try! Repeat this thought experiment for the other "what if" scenario: "**don't read**"

	Professor **puts** game theory on the exam	Professor **omits** game theory from the exam
You **read** the rest of this chapter	Ace the exam ✓✓	You study more than necessary
You **don't read** the rest of this chapter	Fail the exam ✓	Save time and still get a good grade ✓

Concept Check: Reading the Payoff Table

You are the row player, Amtrak. You are thinking about how to best respond to the various "what if" scenarios.

When choosing your best response to **Greyhound bus**, should you compare your payoffs **across a given row** or compare payoffs **up and down a given column**?

	Greyhound runs **1** route per day	**Greyhound** runs **2** routes per day	**Greyhound** runs **3** routes per day
Amtrak runs **1** route	You earn $6 m They earn $6 m	You earn $3 m They earn $8 m	You earn $2 m They earn $7 m
Amtrak runs **2** routes	You earn $7 m They earn $3 m	You earn $4 m They earn $4 m	You earn $1 m They earn $2 m

As the row player, **Amtrak**, you find your best response by comparing the payoffs

up and down

_____ **mn .**

Key take-aways: How to think strategically

Strategic interaction

- When your best choice depends on what others choose (and vice versa).
- Your decisions and payoffs are intertwined with those of others.

Four steps for making strategic decisions

1. Consider all possible outcomes.
2. Think about the “what ifs” separately.
3. Play your best response.
4. Put yourself in the OTHER player’s shoes.

Chapter 18 (2 of 6)

Understand how the Prisoner's Dilemma highlights the problems of getting people to cooperate:

- Nash Equilibrium
- Failure of Cooperation

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What's your advice for the CEO of Coca-Cola?

CEO of Coke asks you for strategic advice:

- **CEO's new idea:** "Why don't we just **abolish** our **advertising budget** altogether?"
- **CEO's logic:** "**If Pepsi does the same** thing, then **both** firms will **earn higher profits**, because both will sell roughly the same amount of cola, with neither of us wasting billions of dollars on useless advertising."

Cola market background facts:

- Advertising increases a company's market share.
- BUT the **impact** of Coke's and Pepsi's advertising ultimately **offset** each other.
- Advertising does not convince people to drink more soda overall.

Step 1: Consider all the possible outcomes

Payoff table: A table that lists…

- **Coke's choices** in each row.
- **Pepsi's choices** in each column.

Payoffs for possible outcomes:

- Currently, both earn **$1 billion** in profits (after spending $1 billion in advertising).
- The deal: Save $1 billion in advertising, thus increasing profits to **$2 billion.**
- If one company defects from the deal, they can steal market share from the other company (**an extra $1 billion**).

	Pepsi cooperates (no advertising)	**Pepsi defects** (it advertises)
Coke cooperates (no advertising)	Coke earns $2b Pepsi earns $2b	Coke earns $0 Pepsi earns $3b
Coke defects (it advertises)	Coke earns $3b Pepsi earns $0	Coke earns $1b Pepsi earns $1b

Steps 2 and 3: For each "what if," play your best response (2 of 2)

You are "Coke" :

- What if **Pepsi cooperates**? ☾ what's your best move?
- What if **Pepsi defects**? ☾ what's your best move?

You Try! Work through the "What if **Pepsi defects**?" scenario on your own.

What if **Pepsi cooperates**?

- Your two options are "**cooperate**" or "**defect.**"
  - **Cooperation** earns you **$2b.**
  - **Defect** earns you **$3b.**
- Thus, if Pepsi **cooperates**, then your best response is to **defect**.

	Pepsi cooperates (no advertising)	**Pepsi defects** (it advertises)
Coke cooperates (no advertising)	Coke earns $2b Pepsi earns $2b	Coke earns $0 Pepsi earns $3b
Coke defects (it advertises)	Coke earns $3b ✔ Pepsi earns $0	Coke earns $1b ✔ Pepsi earns $1b

Step 4: Put yourself in the OTHER player's shoes (2 of 2)

You are now "Pepsi":

- What if **Coke cooperates**? ☾ what's your best move?
- What if **Coke defects**? ☾ what's your best move?

You Try! Work through the "What if **Coke defects**?" scenario on your own.

What if **Coke cooperates**?

- Your two options are **"cooperate"** or **"defect."**
  - **Cooperation** earns you **$2b.**
  - **Defect** earns you **$3b.**
- Thus, if Coke **cooperates**, then your best response is to **defect**.

	Pepsi cooperates (no advertising)	**Pepsi defects** (it advertises)
Coke cooperates (no advertising)	Coke earns $2b Pepsi earns $2b	Coke earns $0 Pepsi earns $3b ✔
Coke defects (it advertises)	Coke earns $3b ✔ Pepsi earns $0	Coke earns $1b ✔ Pepsi earns $1b ✔

The **equilibrium** outcome versus the **best** outcome

Nash equilibrium: An equilibrium in which the choice that each player makes is a best response to the choices other players are making.

- Wherever **TWO checkmarks** appear in one cell

It's an equilibrium because no one can do better by changing their choice alone.

- They are making their best choice given the choices that others are making.

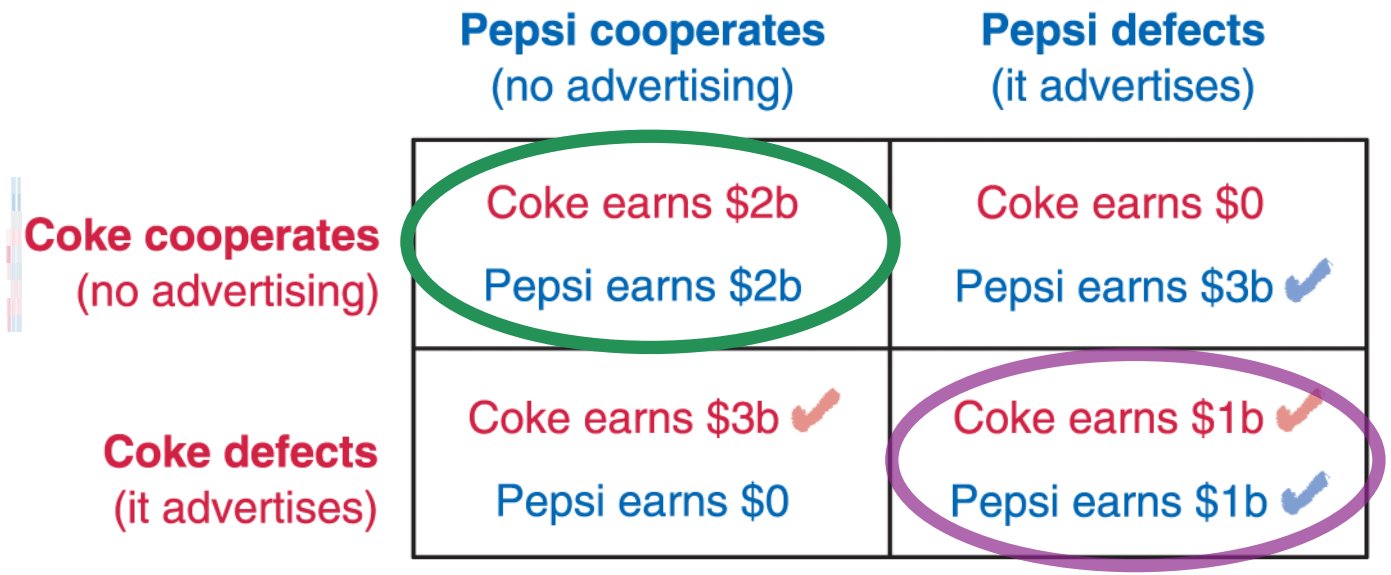
Equilibrium prediction:

- Both *defect* and earn **$1b each.**

Socially optimal outcome:

- Both *cooperate* and earn **$2b each.**
- Maximizes joint economic surplus.

Equilibrium ≠ Socially optimal!!!



Understanding why Coke and Pepsi fail to cooperate

They are jointly better off if they cooperate!

- **Why does Coke defect?**

  Coke understands that Pepsi has a financial **incentive to defect** from the deal.

  If Pepsi defects, this leaves Coke as the only "cooperator" and Coke is left with $0.

- **Why does Pepsi defect?**

  Pepsi understands that Coke has the **same temptation to defect.**

Why can't they just agree to cooperate?

Best response is to defect! ☾ temptation to defect undermines their cooperation.

- Any agreement to cooperate is **NOT credible.**

Prisoner's Dilemma: How Markets Can Deliver Bad Outcomes

Key take-away: People often **fail to cooperate** even when there's a project that could make them *all better off.*

- The temptation to "take advantage" undermines cooperation.

RECALL Chapter 7: Competitive markets generally yield efficient outcomes.

- **True:** Markets maximize economic surplus in *perfectly competitive* settings.
- **False** for market setting in which there is *strategic interaction.*
  - In a world full of strategic interactions, there's no reason to assume that free markets will yield good outcomes.

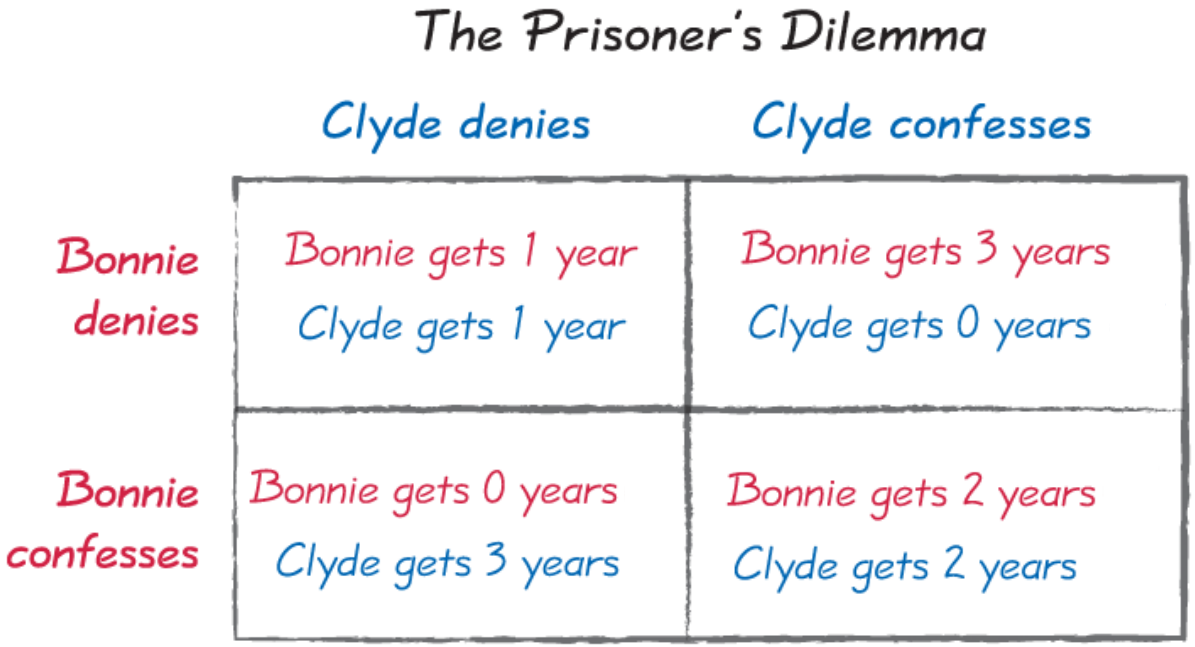
The Prisoner's Dilemma (1 of 2)

Police catch two criminals speeding away from the scene of a bank robbery.

If the police can't extract a confession, then Bonnie and Clyde are only charged with speeding away, which is **one year in jail.**

The police offer each the following deal:

- If you help us by confessing, then **you go free and your friend takes the fall.**
- If your friend helps us but you don't, then you go to jail for **three years.**
- If you both confess, then you both go to jail for **two years.**



Step 1: Payoff table

- **Bonnie's choices** in each row
- **Clyde's choices** in each column
- Shows all possible outcomes, listing the payoffs in each cell

The Prisoner's Dilemma (2 of 2)

Steps 2 and 3: For each "what if," play your best response, and then **Step 4:** Play as the OTHER player.

You are **Bonnie:**

- What if **Clyde denies**?

  Bonnie's best response: **Confess, 0 years**

- What if **Clyde confesses**?

  Bonnie's best response: **Confess, 2 years**

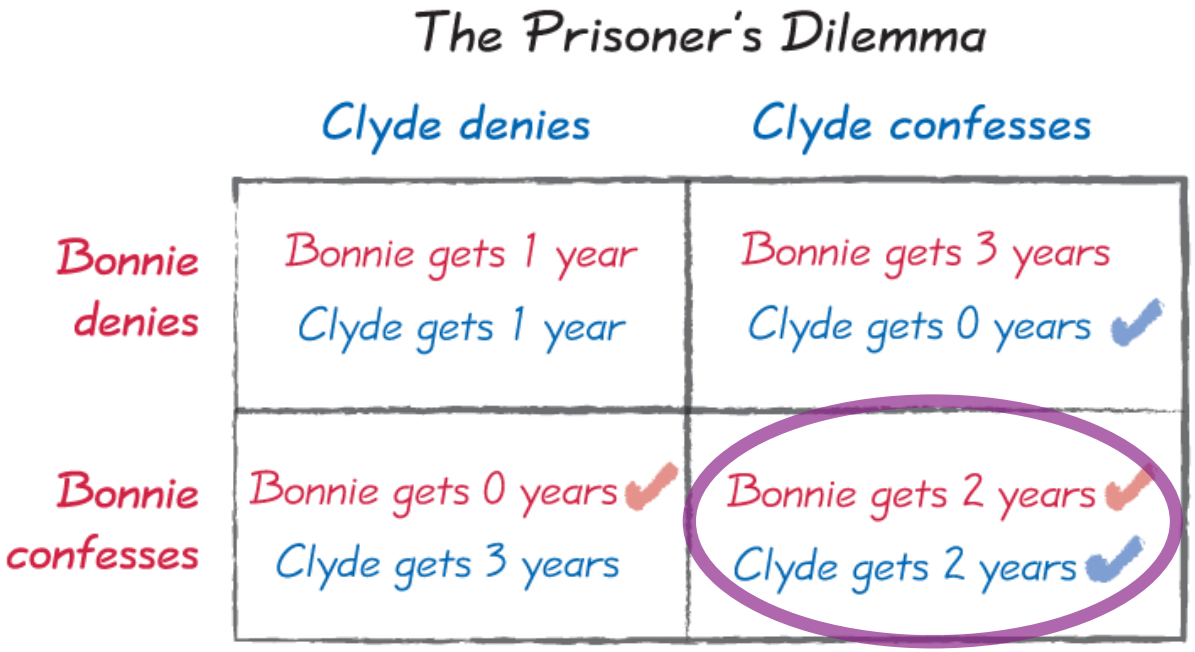
You are **Clyde:**

- What if **Bonnie denies**?

  Clyde's best response: **Confess, 0 years**

- What if **Bonnie confesses**?

  Clyde's best response: **Confess, 2 years**



HELPFUL HINT: When comparing payoffs in a given "What if" scenario…

The **row player** (Bonnie) compares payoffs up and down a given column.

The **column player** (Clyde) compares payoffs across a given row.

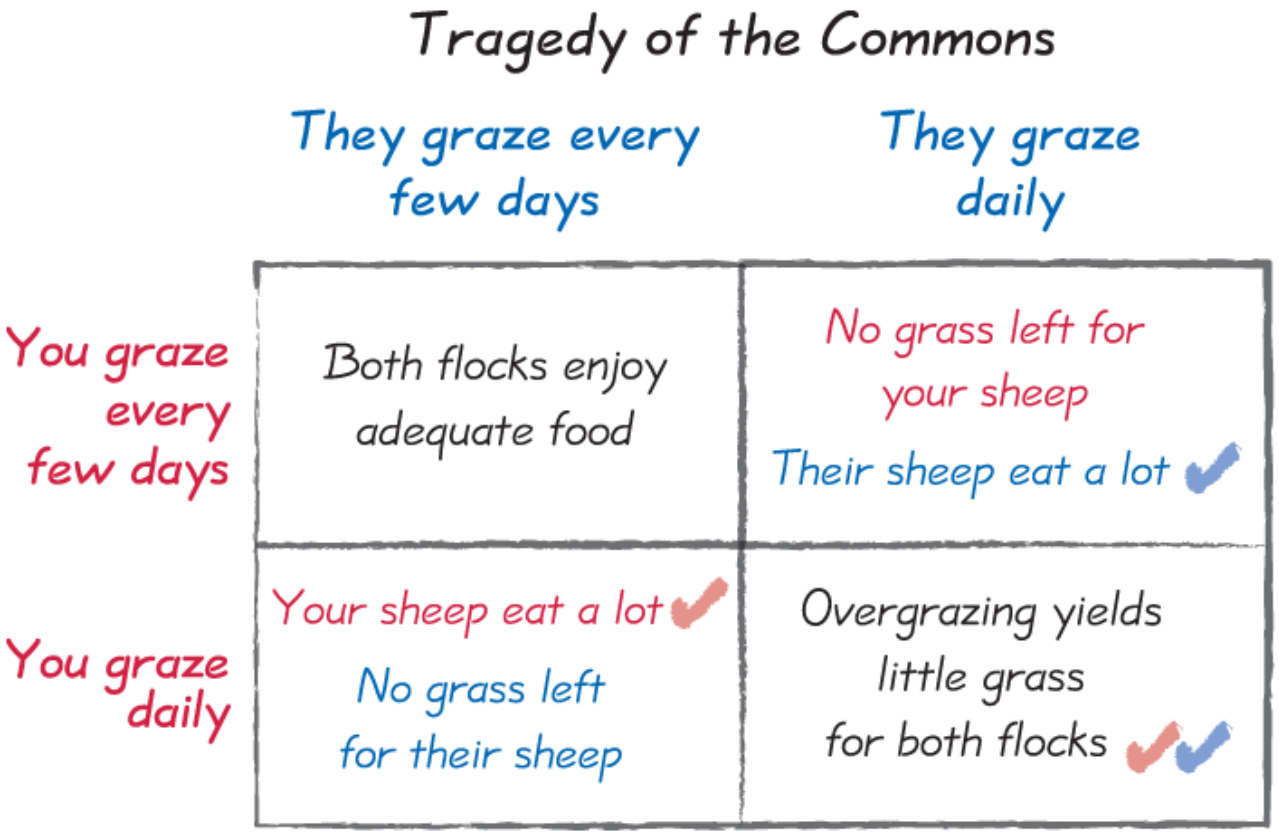
You Try! More examples of the Prisoner's Dilemma (2 of 2)

The **tragedy of the commons** leads shared resources to be overused.

- Everyone is worse off compared to if they cooperated.

<u>More shared resources examples:</u>

- Overfishing
- Pollution emission
- Public roads and traffic jams
- Politicians who overspend for special interest groups
- Friends who overorder when you agree to split the bill



Concept Check: Nash Equilibrium

Collusion: Competitors get together and **agree to charge the same high price.** The payoff table shows the profits you and the other player earn under each scenario.

A. What is the **Nash equilibrium** of this game?

B. Does the Nash **correspond** to the "best" outcome (i.e., the socially optimal outcome)?

	They **undercut** the high price	They charge the **high** price, as agreed
You **undercut** the high price	You earn $2 m They earn $2 m	You earn $4 m They earn $0
You charge the **high** price, as agreed	You earn $0 m They earn $4 m	You earn $3 m They earn $3 m

A. The Nash equilibrium is **both undercut**, and you each earn $2 million in profit.

B. No, the best outcome is for both to charge high prices, earning $3 million each.

Nash equilibrium ≠ Best outcome

Key take-aways: The Prisoner's Dilemma and the challenge of cooperation

Nash Equilibrium

- An equilibrium in which the choice that each player makes is a best response to the choices that other players are making.
- Visually, wherever there are **TWO best response checkmarks** in a single cell.

Prisoner's Dilemma

- Yields a failure to cooperate.
- Temptation to take advantage undermines cooperation.
- Nash equilibrium outcome ≠ Best outcome (cooperation).

Chapter 18 (3 of 6)

Figure out how best to coordinate with your allies to make complementary choices:

- Coordination Games
- Anti-coordination Games

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Understanding the Difficulty of *Coordination*

Coordination games: When all players have a common interest in coordinating their choices.

- You want to make a choice that is **complementary** to mine.

Smartphone example:

You want to buy the **same** smartphone brand as your family to maximize the compatibility of the two phones' operating systems.

Your best response is to **coordinate** so that you're making the **same choice** as your family (or friends).

	They buy an **iPhone**	They buy a **Samsung**
You buy an **iPhone**	Text messages come through cleanly. ✓✓	Clunky cross-platform messaging.
You buy a **Samsung**	Clunky cross-platform messaging.	Text messages come through cleanly. ✓✓

Difficult to coordinate because there are **multiple equilibria** ☾ **more than one equilibrium.**

- May fail to coordinate, yielding an out-of-equilibrium outcome

Another coordination game: Business hours

Setting your hours of operation:

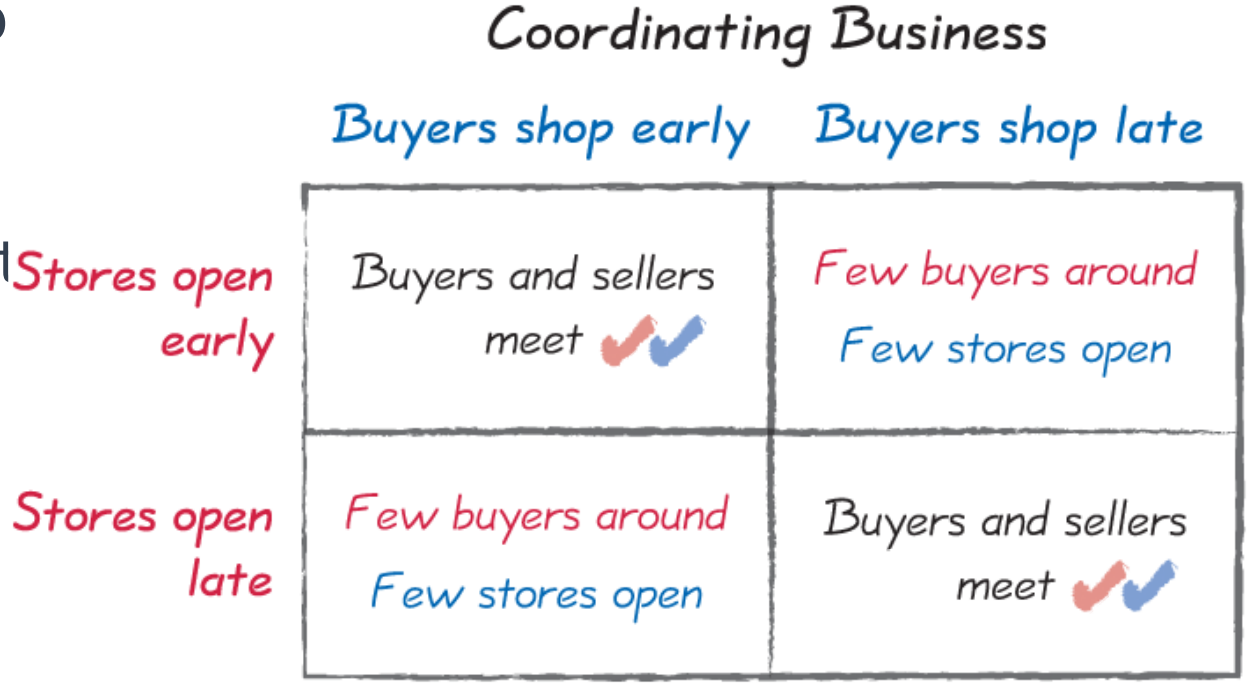
- Your customers want to shop when your store is open.
- You want to open your store when your customers are out shopping.

Problem: Multiple equilibria

- "Early" equilibrium
- "Late" equilibrium

What will your customers do?

Will you successfully coordinate with them?



You have a crush on your friend. What should you do?

If they are "**friendly**"

- your best response is to be **friendly** because you don't want to ruin what you have as friends.

If they are "**romantic**"

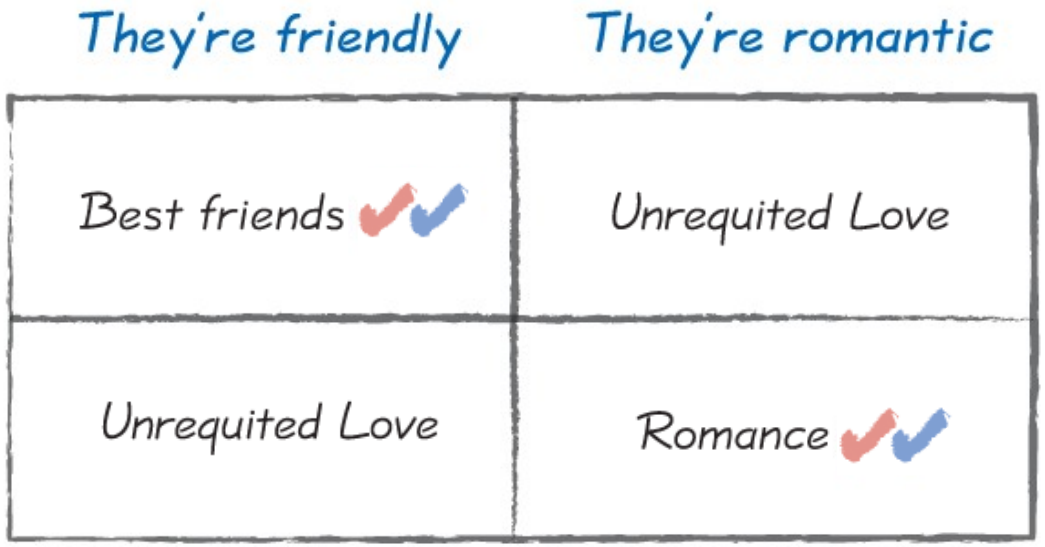
- your best response is to be **romantic**!

Problem: Multiple equilibria

- "Friends" equilibrium
- "Romance" equilibrium

When you don't know what the other person is going to do, **you might end up making the wrong choice** for *both* of you.

Another coordination game: Friendship or romance?



A different type of coordination games: Anti-coordination games

Coordination games ☾ your best response is the **same** choices as the other player.

Anti-coordination games ☾ your best response is to take a **different** action than the other player.

Common elements:

- Your best response is **complementary** to the other player's action.
- There is **more than one** equilibrium.
- Multiple equilibria make it **difficult** for players **to coordinate** their actions.

Playing phone tag after a dropped call

	They call back	**They wait**
You call back	Busy signal (or goes to voicemail)	Call connects ✓✓
You wait	Call connects ✓✓	You both sit around waiting.

Another anti-coordination game: Traffic Jams

To avoid traffic, you want to choose the route that other drivers don't pick:

- If they take the **highway**, you want to take the **backroads**.
- If they take the **backroads**, then you want to take the **highway**.

Problem: Multiple equilibria

- They take highways, and I don't.
- They take backroads, and I don't.

But **how do we coordinate** our decisions so that everyone can avoid a traffic jam?

Traffic Game

	Others take highway	Others take back roads
You take highway	Traffic jam on highway	Smooth trip ✔✔
You take back roads	Smooth trip ✔✔	Traffic jam on back roads

Good and Bad Equilibria

So far…

We saw situations in which any of the possible equilibria would be a good outcome.

- Just solve the coordination problem to get to one.

Now…

Situations in which there's a **good and a bad** equilibrium.

- Need to solve the coordination problem.
- AND prevent the bad equilibrium from occurring.

Coordination Games: Good and Bad Equilibria

Bank Runs: If too many people want to withdraw their money from the bank at the same time, the bank won't have enough money to hand over (the bank lends most of their money out).

- A bank run can occur when everyone believes a bank run will occur.

Bad equilibrium: If you believe everyone else will **withdraw**, then you should race to the bank to **withdraw** your savings before the bank vault is empty.

	Others withdraw	**Others keep money in the bank**
You withdraw your money	Bank run: We race to get our money out first. ✓✓	You don't earn interest. Others definitely lose their savings.
You keep your money in the bank	You definitely lose your savings. Others don't earn interest.	Stability: We both earn interest. ✓✓

Good equilibrium: All savers are happy keeping their money in the bank earning interest.

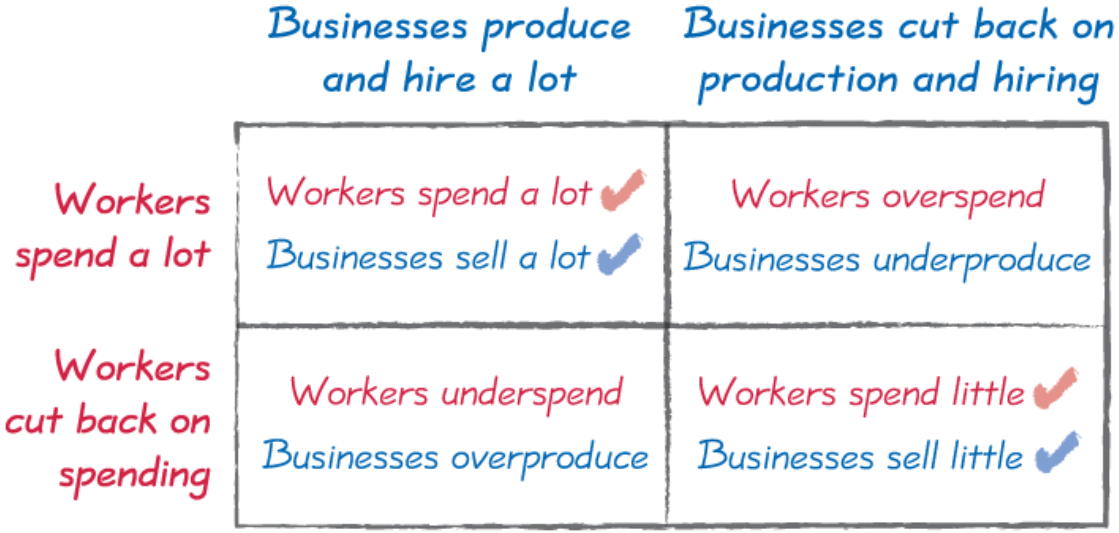
Good and Bad Equilibria: Booms and Busts

Boom economy: Good equilibrium

- If firms **hire a lot**, workers can afford to **spend a lot**.
- If workers are **spending a lot**, then firms can afford to **hire a lot**.

Bust economy: Bad equilibrium

- Firms **aren't hiring**, so workers **don't spend**.
- Workers **aren't spending**, so firms **can't afford to hire.**



How do we coordinate on the GOOD equilibrium?

- Want to avoid all other outcomes.
- **Solution:** Governments can stimulate the economy to try and raise worker and business

Solving Coordination Problems

Solution 1: Communication

- Works when all players want the same thing (no opposing incentives)

Solution 2: Focal points, culture, and norms

- Focal point: A cue from outside a game that helps you coordinate on a specific equilibrium.
- **Example:** When should we meet for lunch? ☾ Noon is a common lunch time in the United States.
- **Example:** Should we bow or shake hands as a greeting?

Solution 3: Laws and regulations

- Can enforce coordination
- **Example:** Which side of the road should we drive on: left or right?

Can you and your classmate coordinate successfully?

If you and your classmate can **pick the same number** without first discussing your choice with your partner, **then you win** the game!

1	2
3	4

1	7
30	13

Key take-aways:
Multiple equilibria and the problem of coordination

In coordination and anti-coordination you want to make the choice that **complements** the choice of the other player.

- Coordination is difficult because there is **more than one equilibrium.**

Solving the coordination problem

1. Communication
2. Focal points, culture, and norms
3. Laws and regulations

Chapter 18 (4 of 6)

Make your move when it's most advantageous:

- Games That Play Out Over Time
- Game Tree
- First- and Second-Mover Advantage

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Introducing advanced strategy

Our focus so far…

Simultaneous games: You make your choice without knowing what the other player has chosen.

- As if you are choosing at the same time (like “rock-paper-scissors”).

Now we focus on…

Sequential games: You can see your rival’s action before choosing yours (or vice versa).

- Games that play out over time (like chess or “tic-tac-toe”).
- Order of the moves matters.
- May yield a first-mover advantage, or a second-mover advantage.

Airline scheduling as a simultaneous game (2 of 2)

American and United are trying to decide how many Chicago to D.C. flights to schedule per day.

	United runs one flight per day	United runs two flights per day	United runs three flights per day
American runs one flight per day	American earns $40m United earns $40m	American earns $25m United earns $50m ✔	American earns $15m ✔ United earns $45m
American runs two flights per day	American earns $50m ✔ United earns $25m	American earns $30m ✔ United earns $30m ✔	American earns $12m United earns $18m
American runs three flights per day	American earns $45m United earns $15m ✔	American earns $18m United earns $12m	American earns $0m United earns $0m

Airline scheduling as a sequential game

What happens if American can **move first**, and it chooses to run **three flights** per day?

What is **United's** best response?

	United runs one flight per day	United runs two flights per day	United runs three flights per day
American runs one flight per day	American earns $40m United earns $40m	American earns $25m United earns $50m	American earns $15m United earns $45m
American runs two flights per day	American earns $50m United earns $25m	American earns $30m United earns $30m	American earns $12m United earns $18m
American runs three flights per day	American earns $45m United earns $15m ✔	American earns $18m United earns $12m	American earns $0m United earns $0m

By moving first, American shifts the equilibrium outcome, so American earns **$45m** instead of $30m.

- First-mover advantage!

First-Mover Advantage

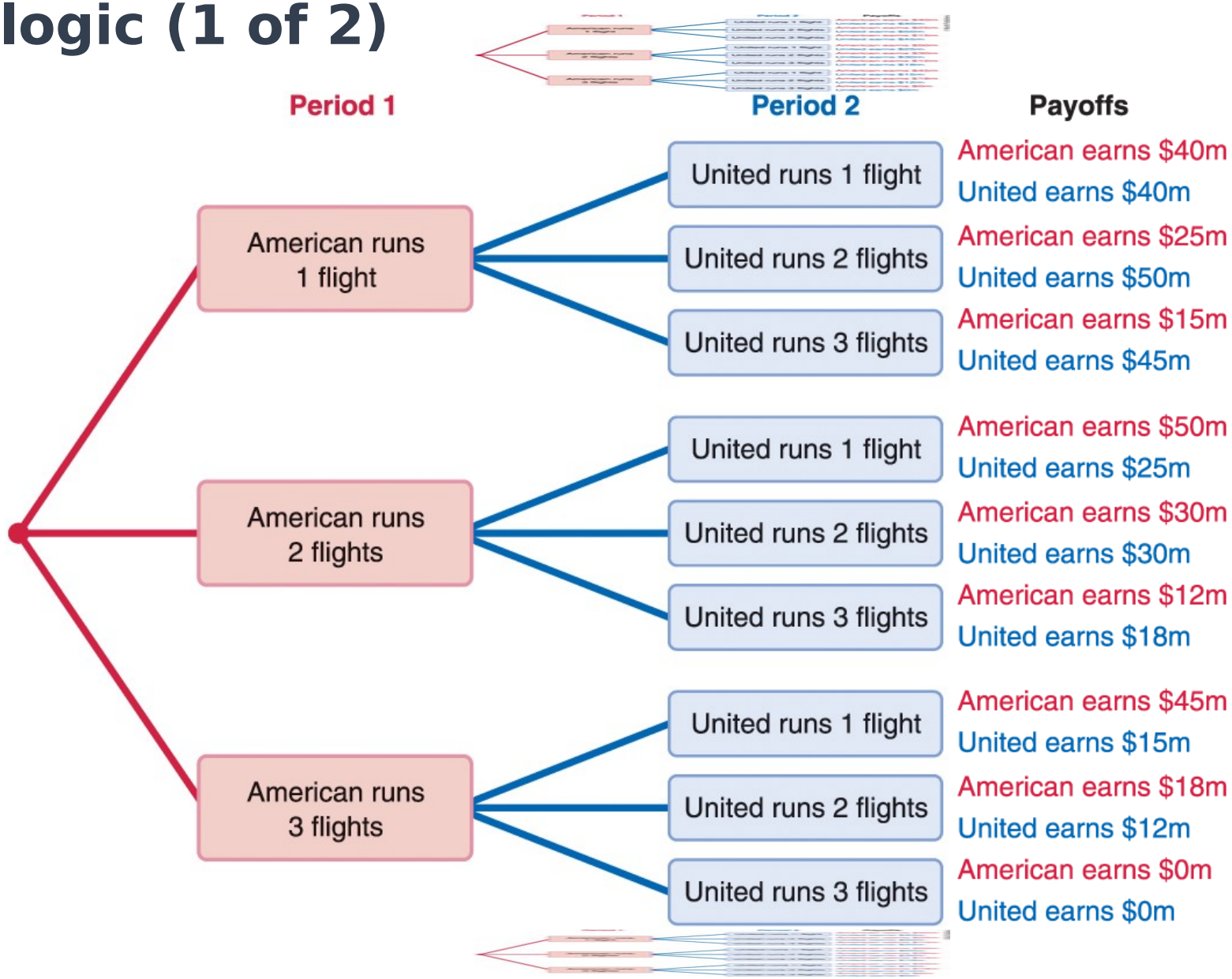
First-mover advantage: The **strategic gain** from an anticipatory action that can force a rival to respond less aggressively.

Airline scheduling example:

- American's aggressive choice forced United to adapt and respond less aggressively.
- American needs to **credibly commit** to running three flights per day (not just announce its choice).
  - Take concrete actions that will make any other choice costly.
  - Invest in new jets, rent extra gates ☾ anything to show commitment to running three flights per day.

Using game tree logic (1 of 2)

Game tree: Shows how a game **plays out over time**, with the first move forming the **trunk**, and then each subsequent choice **branching** out, so the final **leaves** show all possible outcomes.



Game Tree: Look Forward and Reason Backward

Look forward:

In games that play out over time, you should look forward to **anticipate the likely consequences of your choices.**

Reason backward:

Start by analyzing the **last period** of the game.

- Use this to figure out what will happen in the second-to-last period, and **keep reasoning backward** until you can see all the consequences that follow from today's decision.
  - **In short:** Start from the end and reason backward.

Using game tree logic (2 of 2)

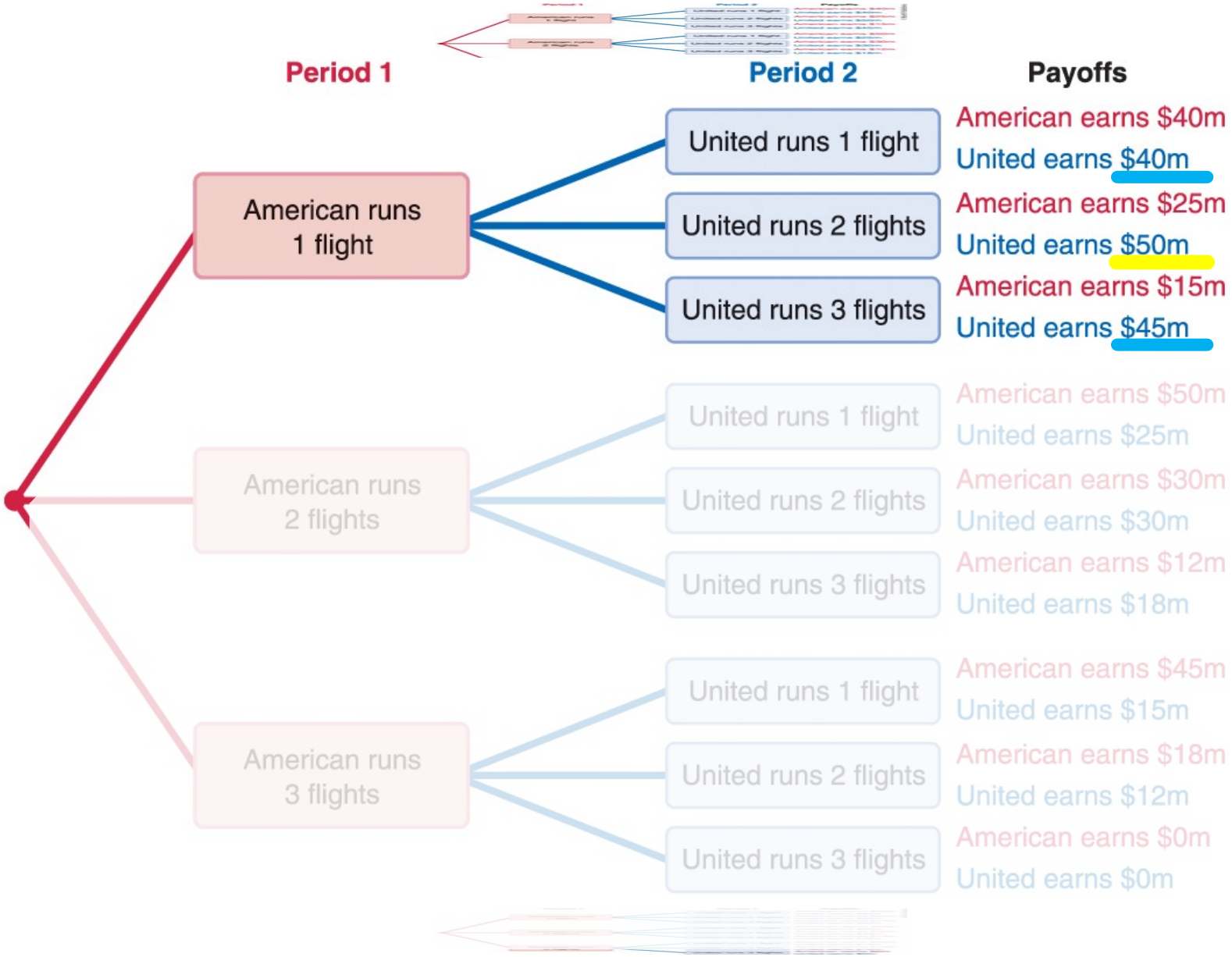
For each "what if" branch, look forward:

What if **American runs one flight**?

- Look forward to the last period.
- **United's** best response is to **run two flights** per day and earn **$50m** (and **American** earns **$25m**).

Pruning the tree: If an action is not a best response, then cross it out (it's irrelevant).

- If **American runs one flight**, we can prune the **top** and **bottom** branches.



You Try! Keep pruning the tree (2 of 2)

What if **American runs two flights**? What if **American runs three flights**?

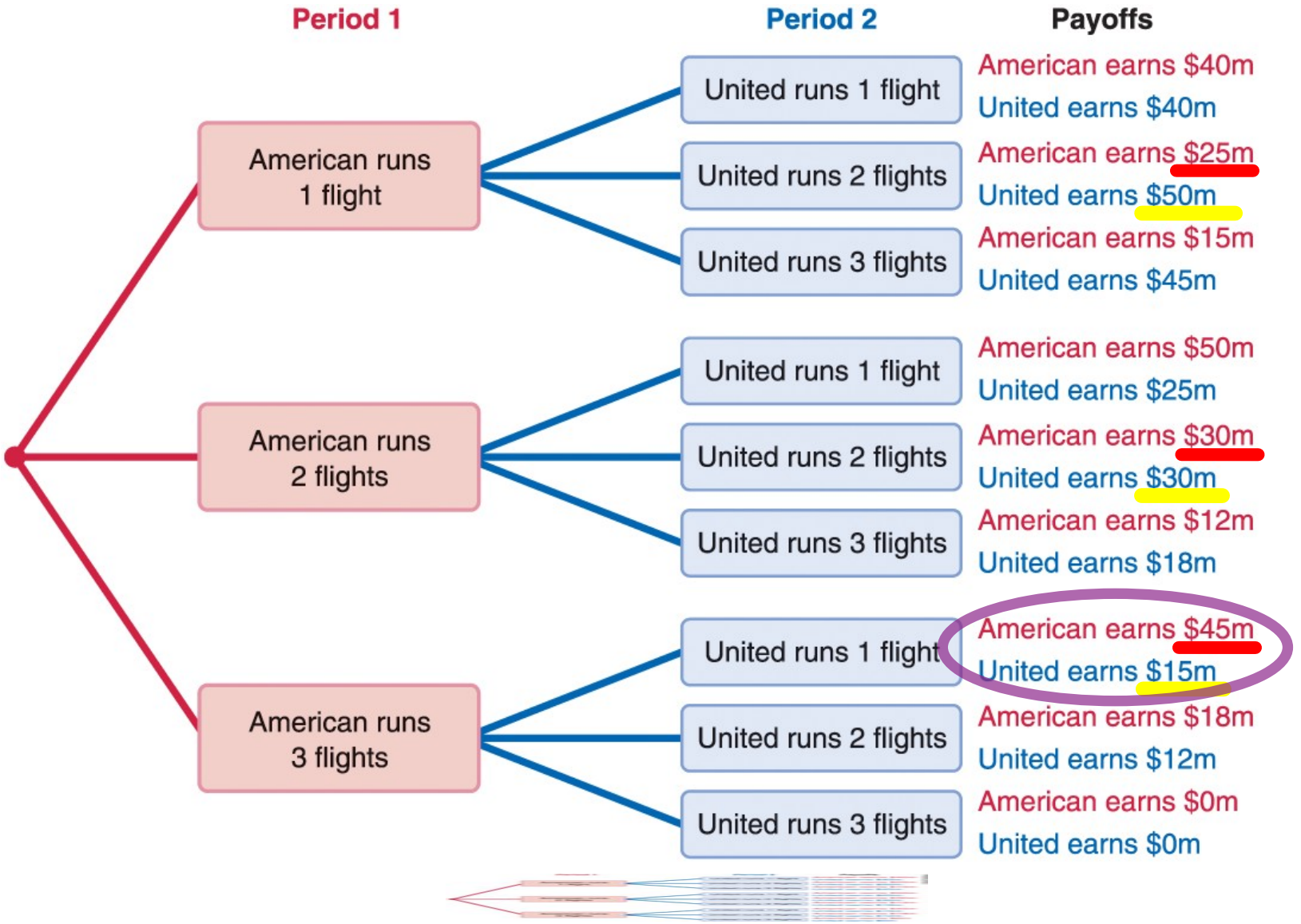
- What's **United's** best response? Which branches can be pruned?

Reason back one step closer to the base of tree:

- Given the remaining branches and leaves, what choice will **American** make?
  - Run **three flights** and earn **$45m.**

Outcome: Follow the highlighted path.

- **American** runs **three flights**, and **United** runs **one flight** ($45m, $15m).



First-Mover versus Second-Mover Advantage

Moving **early or late** depends on the value of **commitment versus flexibility.**

Second-mover advantage: The strategic advantage that can follow from taking an action that **adapts to your rival's choice.**

- **Flexibility** to adapt your strategy in light of the choices made by the first mover.

Examples:

- **Pricing:** As the second mover, you watch what your competitor does, and then you sell the same products at slightly lower prices.
- **Product-positioning:** The second mover waits to see which part of the market remains underserved, and then positions to gain the largest customer base.
- **Cake cutting game:** They cut, you pick.

Key take-aways: First- and second-mover advantages

A **game tree** shows how all possible outcomes can play out **over time.**

- **Think forward** and **reason backward.**
  - Start by analyzing the last period, and reason back from there to assess the ripples of your decision today.

First-mover advantage

- Credible **commitment** to aggressive action

Second-mover advantage

- **Flexibility** to adapt to other player's choices

Chapter 18 (5 of 6)

Elicit cooperation by threatening punishment in repeated interactions:

- Collusion in Prisoner's Dilemma
- Finitely Repeated Games
- Indefinitely Repeated Games

1. How to Think Strategically
2. The Prisoner's Dilemma and the Challenge of Cooperation
3. Multiple Equilibria and the Problem of Coordination
4. Advanced Strategy: First and Second Mover Advantages
5. Advanced Strategy: Repeated Games and Punishments

Repeated Games

Our focus so far…

One-shot games: A strategic interaction that occurs **only once.**

- Never going to see or interact with the other player again.
- Do not need to consider how today's decision impacts how others will treat you in the future.

Now we focus on…

Repeated games: When you face the same strategic interaction with the same rivals and the same payoffs in **successive periods**.

- You interact with them **repeatedly**, so the decision you make today will affect your future interactions.
- Finitely repeated games: When you face the same strategic interaction a **fixed** number of times.
- Indefinitely repeated games: When you face the same strategic interaction an **unknown** number of times.

Collusion and the Prisoner's Dilemma

In 2009, executives at several major publishers met over a series of private lunches, discussing how to stay profitable in the emerging e-book marketplace.

The deal: All charge the same high price for the bestselling e-books, **$12.99** (instead of $9.99).

One-shot game outcome:

- Both **defect** from the deal, thus failing to collude.

But in reality, all major publishers ended up colluding successfully!

- *Let's explore!*

Collusion: An agreement by rivals to not compete with each other, but to all charge high prices instead.

	HarperCollins cooperates (Charges $12.99)	**HarperCollins defects** (Charges $9.99)
Penguin cooperates (Charges $12.99)	Penguin earns medium profit HarperCollins earns medium profit	Penguin makes a loss HarperCollins earns large profit ✔
Penguin defects (Charges $9.99)	Penguin earns large profit ✔ HarperCollins makes a loss	Penguin earns zero profit ✔ HarperCollins earns zero profit ✔

Finitely Repeated Game

Suppose Penguin and HarperCollins thought they would interact exactly **three times.**

Look forward and *reason backward:*

- **Final period:** Both players know they'll never interact again.
  - Effectively face a one-shot Prisoner's Dilemma ☾ both choose to **defect.**
- **Second-to-last period:** Both players know their rival will defect in the next period.
  - Effectively face a one-shot Prisoner's Dilemma ☾ both choose to **defect.**

This **incentive to defect continues** as you roll back your analysis to earlier periods.

The outcome: When there's a **known** final period, neither publisher will cooperate in any period.

Collusion and the Prisoner's Dilemma:
Indefinitely repeated games (1 of 3)

If you don't know when your interactions will end, then there's **no last period** in which you know your rival will definitely be tempted to defect.

- Can sustain cooperation!

Strategic plan: A list of instructions that describes exactly how to respond in any possible situation.

- Might include a credible threat of punishment if your rival defects
  - A sufficient threat could elicit cooperation in an indefinitely repeated Prisoner's Dilemma.

Grim Trigger strategy:

1. If other players have cooperated in all previous rounds, then **you will cooperate.**
2. If any player has defected in any previous round, then **you'll defect forever**.

Collusion and the Prisoner's Dilemma:
Indefinitely repeated games (2 of 3)

	HarperCollins follows Grim Trigger strategy (Continue to cooperate)	**HarperCollins deviates from strategy** (Defect today)
Penguin follows Grim Trigger strategy (Continue to cooperate)	Penguin earns: - Medium profit today, and - Chance to cooperate in the future, earning medium profit ✔ HarperCollins earns: - Medium profit today, and - Chance to cooperate in the future, earning medium profit ✔	Penguin earns: - A loss today, and - Zero profit in the future HarperCollins earns: - A large profit today, and - Zero profit in the future
Penguin deviates from strategy (Defect today)	Penguin earns: - A large profit today, and - Zero profit in the future HarperCollins earns: - A loss today, and - Zero profit in the future	Penguin earns: - Zero profit today, and - Zero profit in the future ✔ HarperCollins earns: - Zero profit today, and - Zero profit in the future ✔

Collusion and the Prisoner's Dilemma:
Indefinitely repeated games (3 of 3)

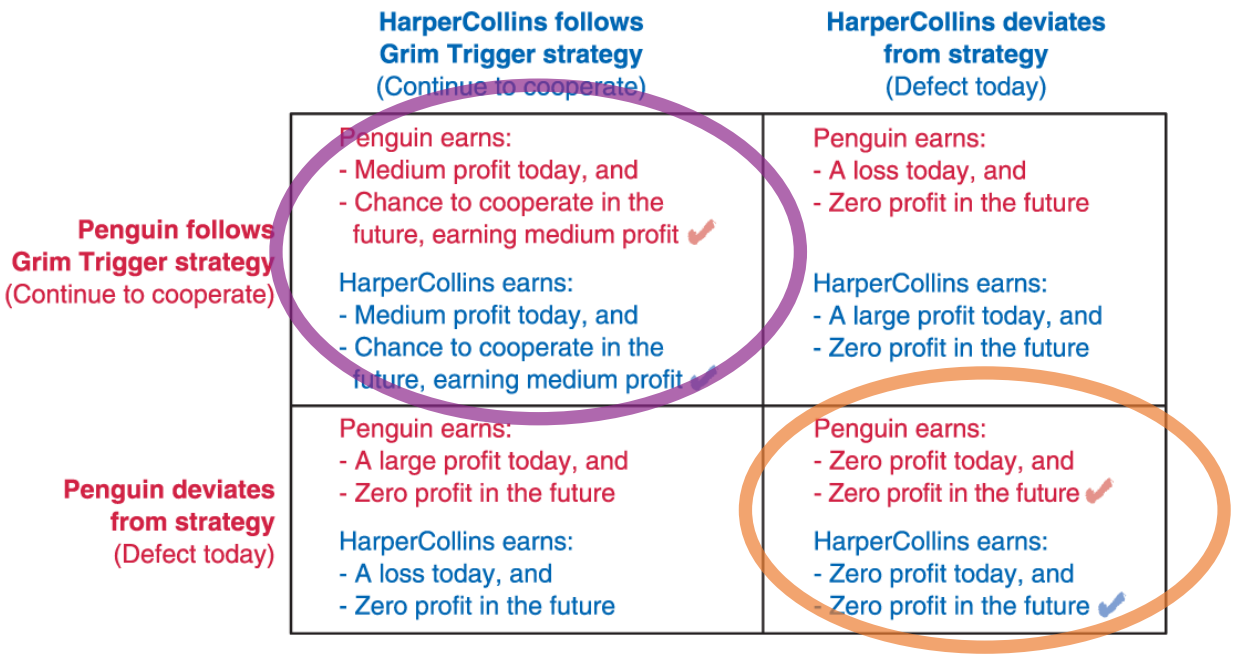
Indefinitely repeated game outcomes:

Cooperate Outcome: As long as you and your rival value future profits enough, you're better off cooperating.

- Threat of punishment drives cooperation.
- The loss of these future profits makes cooperating the better choice.

Defect Outcome: After either player defects, your rival continues to defect forever, so your best response is also to defect (and vice versa).

- Reminder that **cooperation is not guaranteed.**



Key take-away: Cooperation is possible as long as people continue to interact for an **unknown** period of time.

Concept Check: Indefinitely Repeated Games

If CVS and Walgreens play this game for an indeterminate number of periods, and each uses a Grim Trigger strategy, then what is the Nash equilibrium (or equilibria)?

	Walgreens charges a high price (cooperate)	**Walgreens charges a low price** (deviates)
CVS charges a high price (cooperate)	CVS earns $16 billion in profit today and in every future period. Walgreens earns $12 billion in profit today and in every future period.	CVS loses $8 billion in profit today, and $0 profit in every future period. Walgreens earns $18 billion today and earns $0 every future period.
CVS charges a low price (deviates)	CVS earns $20 billion in profit today, and $0 profit in every future period. Walgreens loses $5 billion today and earns $0 every	CVS earns $0 billion ir profit today, and in every future period. Walgreens earns $0 billion in profit today, and in every

Key take-aways: Repeated games and punishments

Repeated games

- When you repeatedly interact with your rivals
- Account for how today's decision will impact future interactions

Indefinitely repeated games

- When you face the same strategic interaction an unknown number of times

Grim Trigger strategy

- Punishes your rivals for not cooperating
- Punishment drives cooperation
  - Indefinitely repeated play helps solve the Prisoner's Dilemma.

Chapter 18 (6 of 6)

1. Four steps for making strategic decisions
2. Temptation to take advantage undermines cooperation
3. Want to make a choice that complements the choice of others, but multiple equilibria makes coordination difficult
4. Game tree: look forward and reason backward
5. Credible threat of punishment can elicit cooperation

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