3.5 — Using Game Theory in Research

ECON 316 • Game Theory • Fall 2021
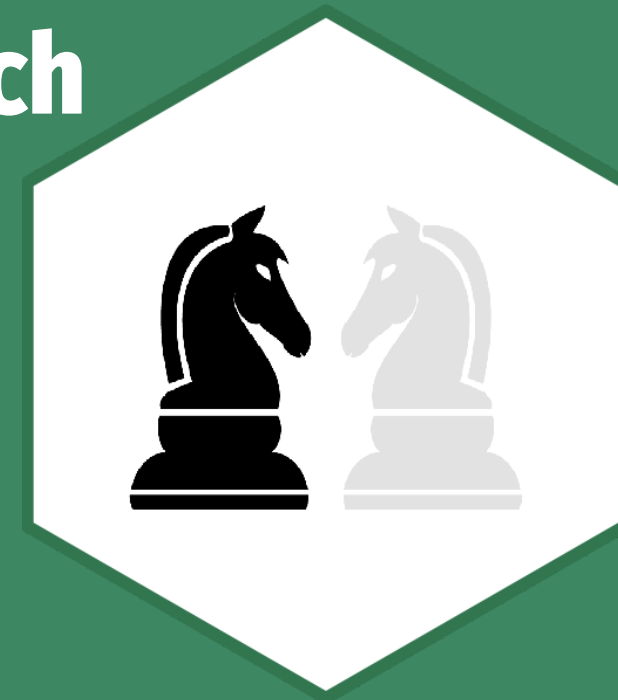
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Game Theory

- Game theory appears somewhat tautological

  - Result of game is baked into the rules of a game specified
  - Game theorists often know the result even before the players play

- More useful as a **theoretical framework** for understanding strategic interactions

  - If players were rational and had perfect information — what would they do?
  - Compare the (theory) prediction with reality
    - Do players act differently in reality?

When Results are Not as Predicted

- Behavioral economists:

    - Did players make a mistake? Act less than "rational"?
    - Cognitive biases, behavioral economics explanations
    - Did players not understand the rules?

- Game theorists:

    - Did you specify the game correctly?
    - Are the rules correctly modeled?
    - Are the payoffs correctly specified?

Research with Game Theory

- Most fruitful part of research (in my biased opinion) is using game theory to understand the role of *institutions* (norms, culture, shared histories, government policies, etc.)

  - Coordination devices
  - Focal points
  - Sorting between multiple Nash equilibria
  - Path dependent outcomes
  - Making threats/promises credible
  - Making exchanges self-enforcing
  - Resolving asymmetric information problems

- We'll see this starting this week, and in the papers we'll read

The Two Major Models of Economics as a "Science"

Optimization

- Agents have **objectives** they value

- Agents face **constraints**

- Make **tradeoffs** to maximize objectives within constraints

Equilibrium

- Agents **compete** with others over **scarce** resources

- Agents **adjust** behaviors based on prices

- **Stable outcomes** when adjustments stop

Game Theory vs. Decision Theory Models I

- Traditional economic models are often called **"Decision theory"**:

- **Equilibrium models** assume that there are **so many agents** that **no agent's decision can affect the outcome**

  - Firms are price-takers or the *only* buyer or seller
  - **Ignores all other agents' decisions**!

- **Outcome**: **equilibrium**: where *nobody* has any better alternative

Game Theory vs. Decision Theory Models III

- **Game theory models** directly confront **strategic interactions** between players

  - How each player would optimally respond to a strategy chosen by other player(s)
  - Lead to a stable outcome where everyone has considered and chosen mutual best responses

- **Outcome**: **Nash equilibrium**: where *nobody* has a better strategy **given the strategies everyone else is playing**

Equilibrium in Games

- **Nash Equilibrium**:
  - no player wants to change their strategy **given all other players' strategies**
  - each player is playing a **best response** against other players' strategies

A Suggested Framework

I. Identify the strategic interaction

- Who are the players
- What choices can they make?
- How does the *interaction* of their choices determine outcomes for each player?

A Suggested Framework

II. Model the game: rules, payoffs, etc (*often the hard part!*)

- Ordering of choices -- sequential, simultaneous?
  - Information -- what does each player know and not know
  - One-shot or repeated?
  - If repeated: a finite number of times? an infinite number of times? ending with certain probability?
- Define the payoffs (*again, the hard part!*)
  - use *economic theory* to determine how various interactions should affect various outcomes for each player
  - numerical payoffs make things easy, but constrain you to fewer possibilities

A Suggested Framework

III. Predict the outcome(s)

- Solve for Nash equilibria
  - If applicable, consider: pure vs. mixed strategies, one-shot vs. repeated games
- If using variables in payoffs, what values of variables will give us various equilibria?
- If multiple equilibria -- any reasons we should expect one over others?

A Suggested Framework

IV. Compare reality with predictions

- Are there behavioral reasons players do not reach predicted outcome?
- Are there institutions, policies, norms, ethics, etc. that lead players towards/away from certain outcomes?

V. Consider changes in the game

- What would have to change (payoffs, rules, etc) to get different outcomes?
- Are there policies or institutions that might affect or cause this?
- Consider welfare of players: how do the players do? How could this be improved?

Example I: Patronage, Copyright, and Crowdfunding as Alternative Institutions

Patronage Today

Patronage Today

KICK**STARTER**

Discover   Start a project   About us   🔍   Search Projects

Jenni Noyes' Debut Album - In Darkness & Light
by Jenni

▶ PLAY

58
backers

£1,304
pledged of £3,200 goal

22
days to go

Back This Project   ★ Remind me

This project will only be funded if at least £3,200 is pledged by Thu, May 12 2016 4:15 AM EDT.

📍 Leeds, UK   🏷 Music   ♥ Project We Love

Jenni
🕐 First created | 3 backed
🌐 jenninoyes.uk

Help a new solo artist release her first album capturing 9 life changing moments from a repertoire of 20 years of songwriting.

See full bio   Contact me

Share: 🐦 Tweet   f Share   </> Embed   📌 Pin   t Post
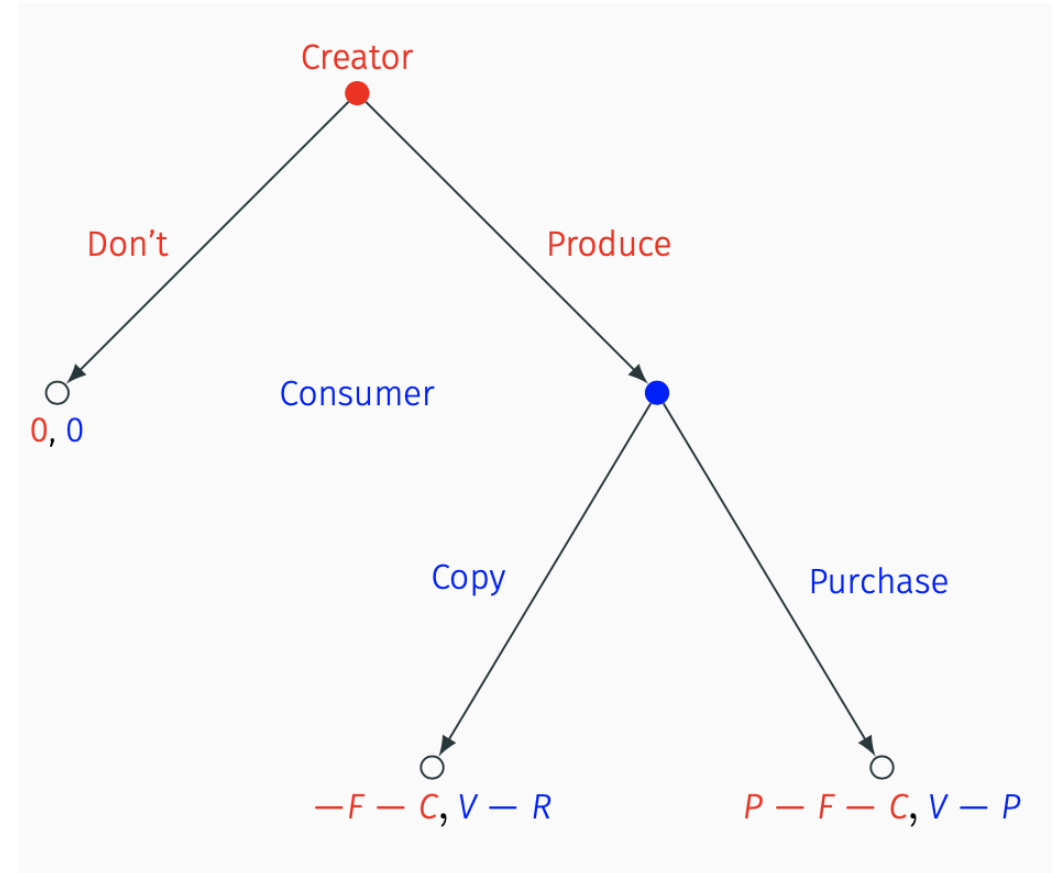
Basic Game

- **Creator** can produce a (single) expressive work

  - Fixed cost F
  - Marginal cost C
  - If produced, incur cost $-(F + C)$, and sell at price P

- **Consumer** can consume or copy expressive work

  - Values it at V
  - Purchases at price P
    - $V - P$: consumer surplus
 - Copies with replication cost, R

Safner, Ryan, 2021, "Kickstart My Art: Are Crowdfunding and Intellectual Property

Complements or Substitutes?"

Basic Game

- Solve this game by backwards induction:

- Consumer will Purchase when:

  - $R > P$: costlier to copy than to purchase
  - $V > P$: price to buy is lower than value (i.e. consumer surplus, $V - P \geq 0$)

- Producer will Produce when:

  - Consumer Purchases
  - $P > F - C$: revenue exceeds cost
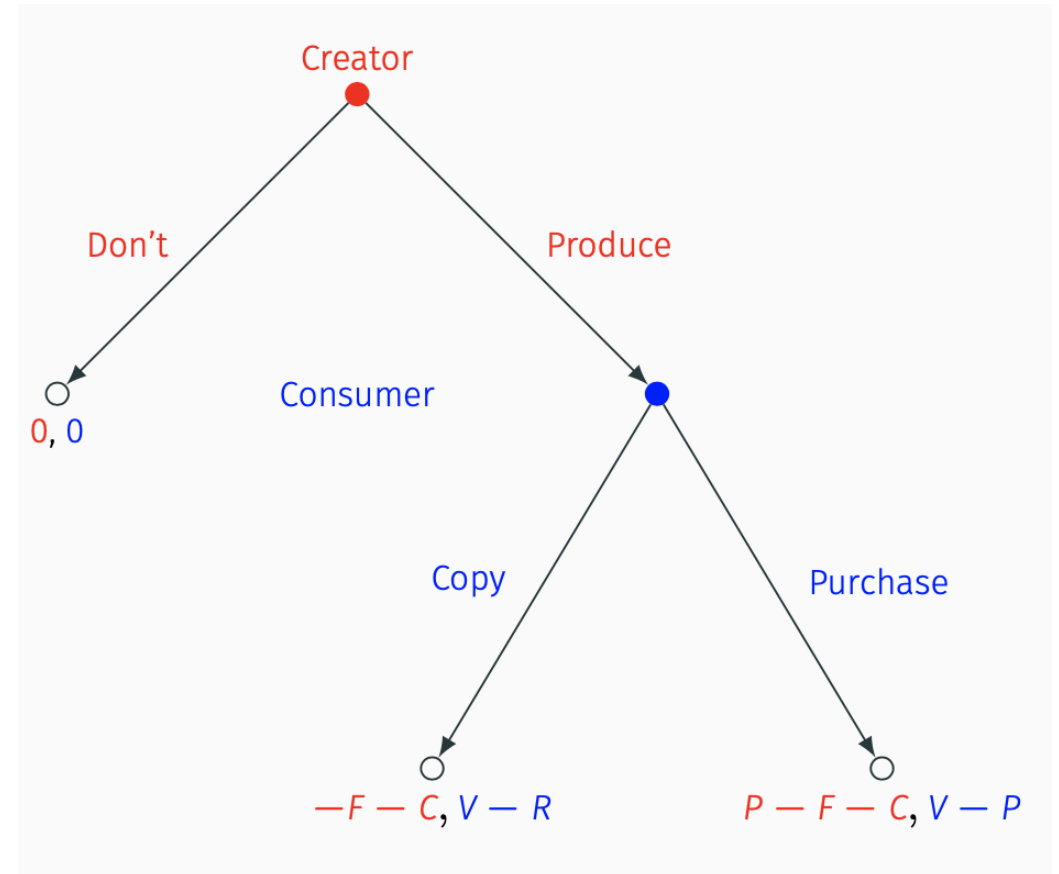
Mechanisms to Enhance Cooperation

- An agent ("patron") bears the fixed costs (F) in exchange for some of the following:
  - Distribution rights (copyrights); personal prestige; portion of profits; rewards
- Deterrence of pirating & shirking (raise R relative to P)
  - Technology affects replication costs; Customization, product differentiation, price discrimination; Legal threats; Reputation
- Compare three systems:
  1. Patronage of the arts
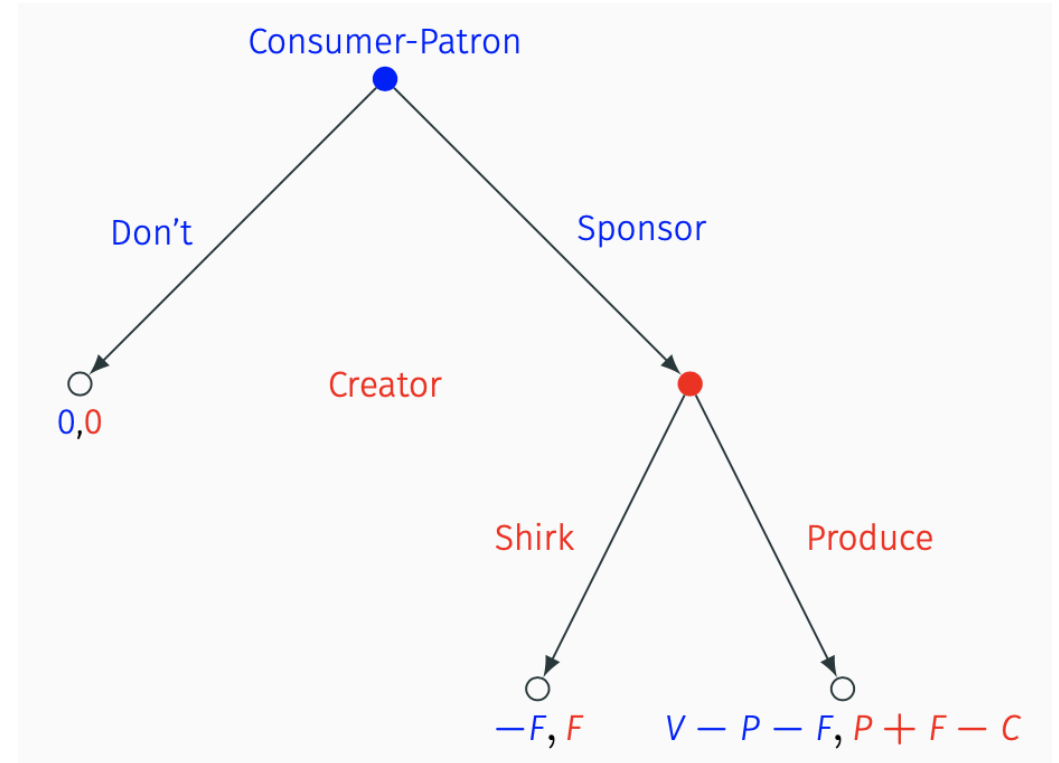 2. Copyright
  3. Crowdfunding

Patronage of the Arts (& Sciences)

Patronage Version of the Game

- **Patronage of the arts**: institution that changes the rules of the game

  - Consumer-Patron decides to sponsor a Creator by bearing their fixed costs F
  - Creator now in a principal-agent problem: produce or shirk (abscond with F)

- Rules of the game that affect key parameters:

  - Removes opportunity of copying (custom works)
  - F: fixed costs now borne by patron

Safner, Ryan, 2021, "Kickstart My Art: Are Crowdfunding and Intellectual Property Complements or Substitutes?"
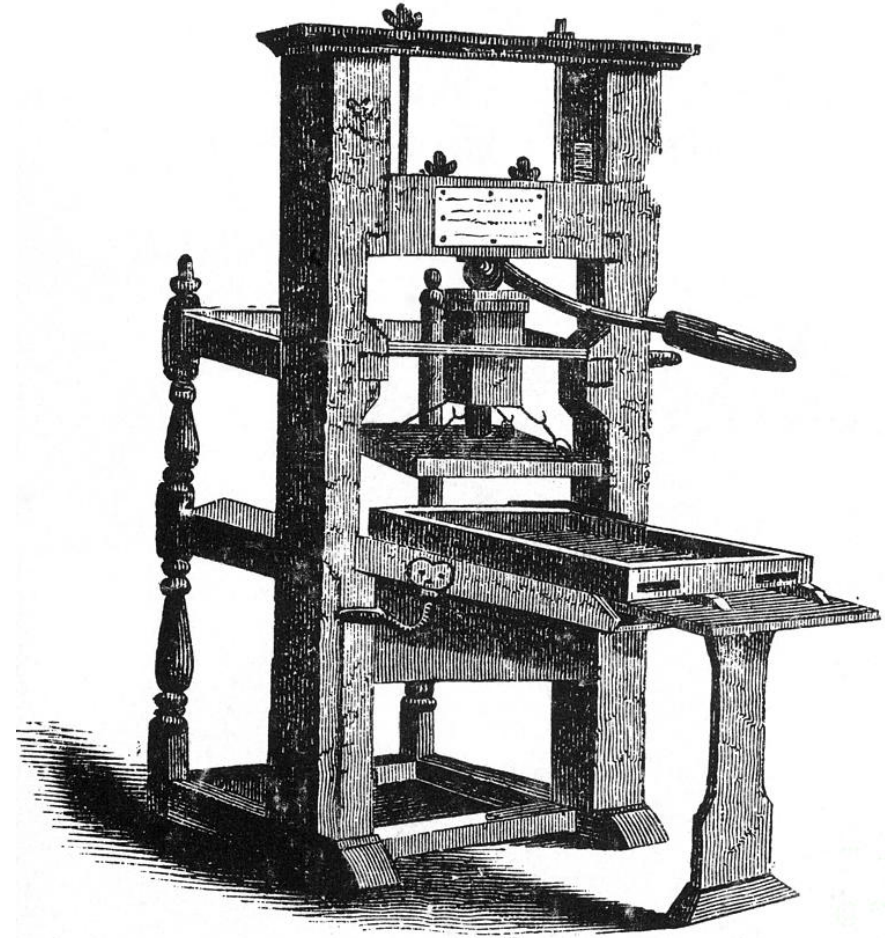
Copyright

- Cost of replication has plummeted via new technology (both for creators & for copyists)

- Copyright: Individual creator can control distribution rights and seek legal sanctions against copyists

Safner, Ryan, 2021, "Kickstart My Art: Are Crowdfunding and Intellectual Property
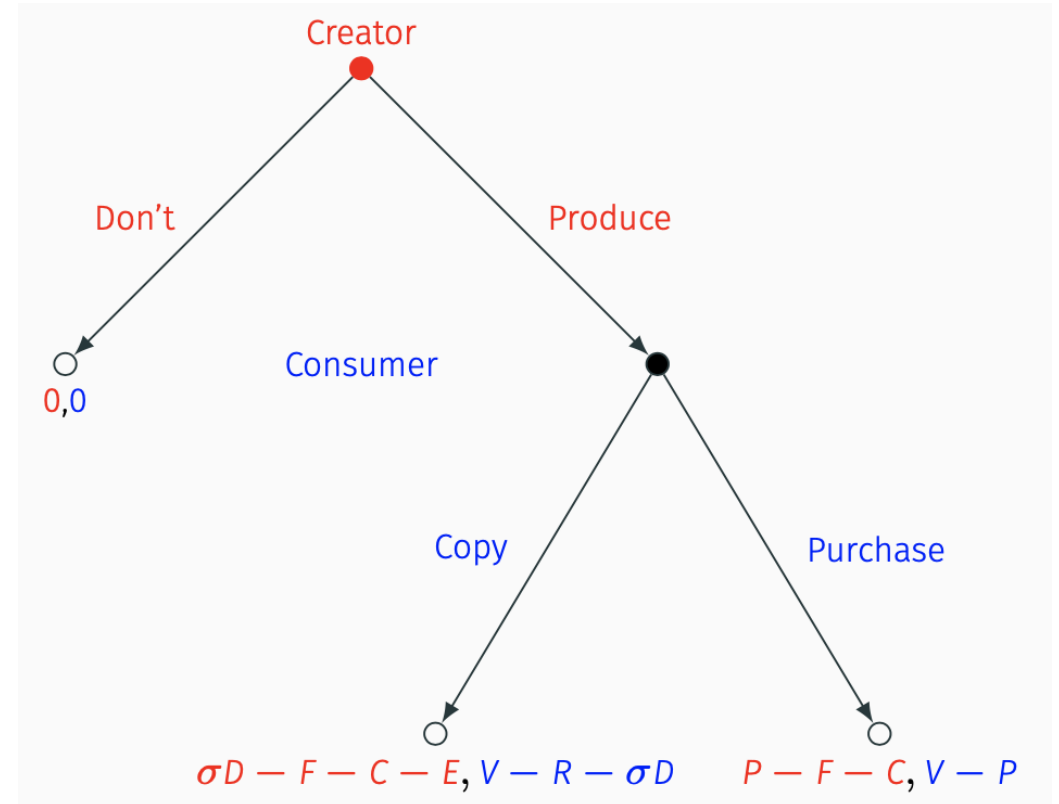
Complements or Substitutes?"

Copyright Version of the Game

- **Copyright**: another institution that changes the *payoffs* of the original game
  - If Consumer chooses to Copy, now faces additional:
  - D: damages from copyright lawsuit
  - σ: probability of getting caught/sued
  - Creator gains σD (from lawsuit against Consumer), but must pay E for enforcement costs (legal fees)

Safner, Ryan, 2021, "Kickstart My Art: Are Crowdfunding and Intellectual Property
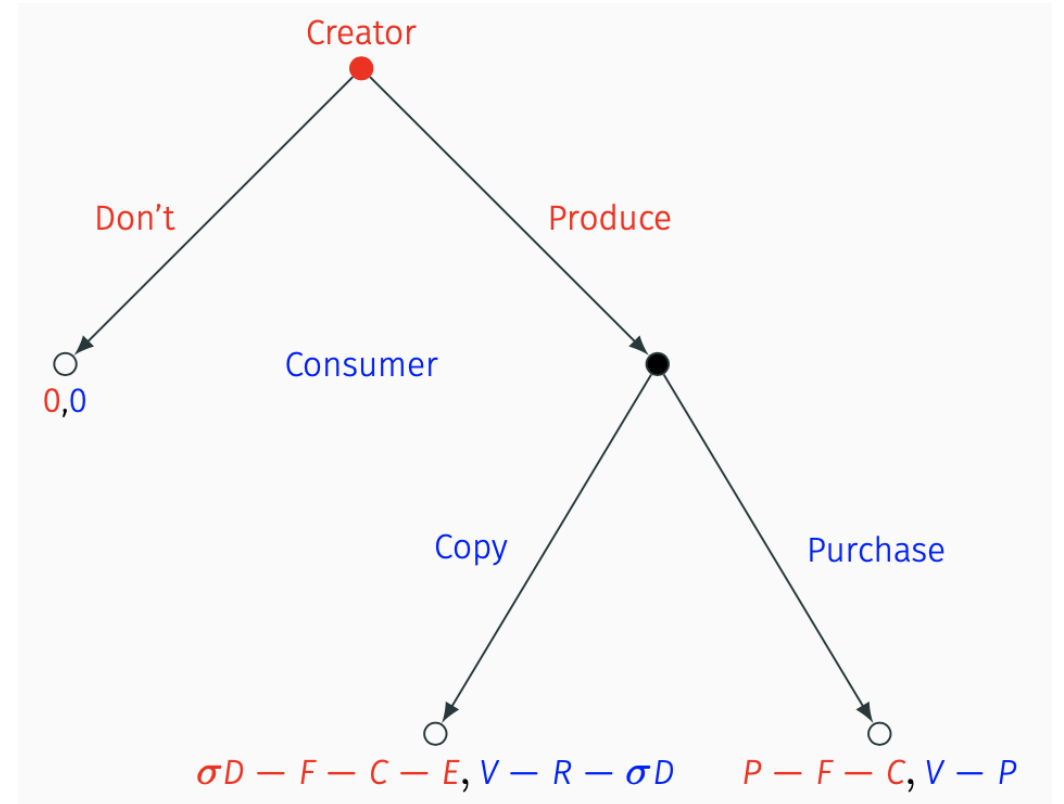
Complements or Substitutes?"

Copyright Version of the Game

- Consumer purchases when:
  - $P < R - \sigma D$
  - More likely than first version of game

Safner, Ryan, 2021, "Kickstart My Art: Are Crowdfunding and Intellectual Property

Complements or Substitutes?"

Creator

Don't   Produce

Consumer

0,0

Copy   Purchase

$\sigma D - F - C - E, V - R - \sigma D$ $P - F - C, V - P$

Patronage with Copyright/Crowdfunding Version

- **Patronage with Copyright**: *three* players
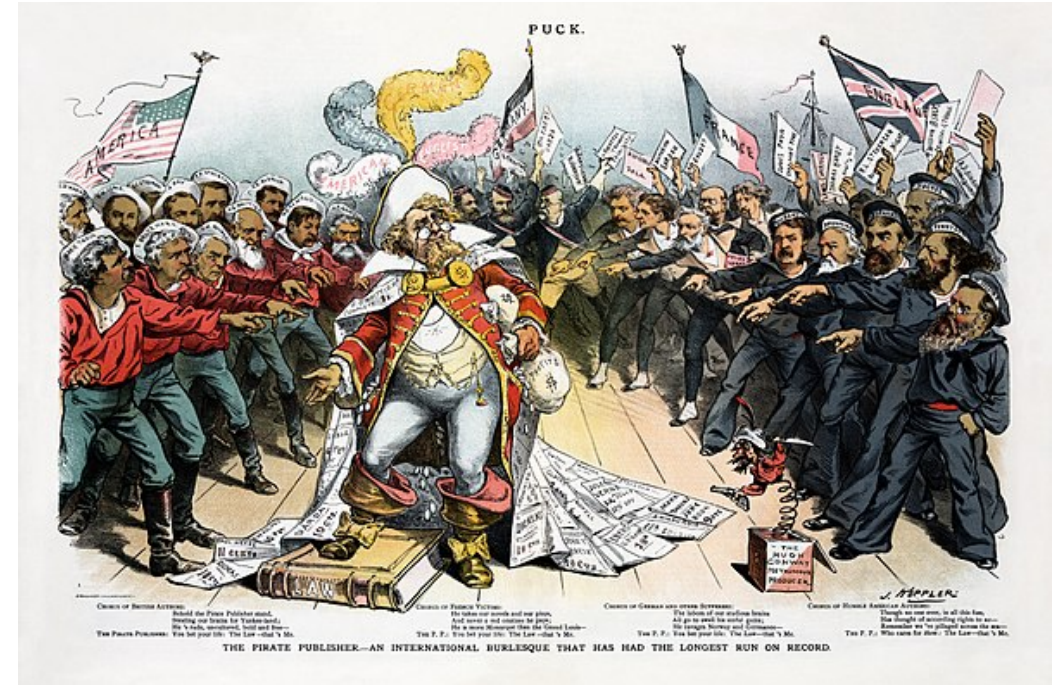
  - patron and consumer are different
  - patron can sponsor creator by bearing F
  - patron contracts for copyright and some share α of the profits

- **Crowdfunding**: patrons $\neq$ wealthy elites, but a collection of many people contributing towards F

Safner, Ryan, 2021, "Kickstart My Art: Are Crowdfunding and Intellectual Property

Complements or Substitutes?"
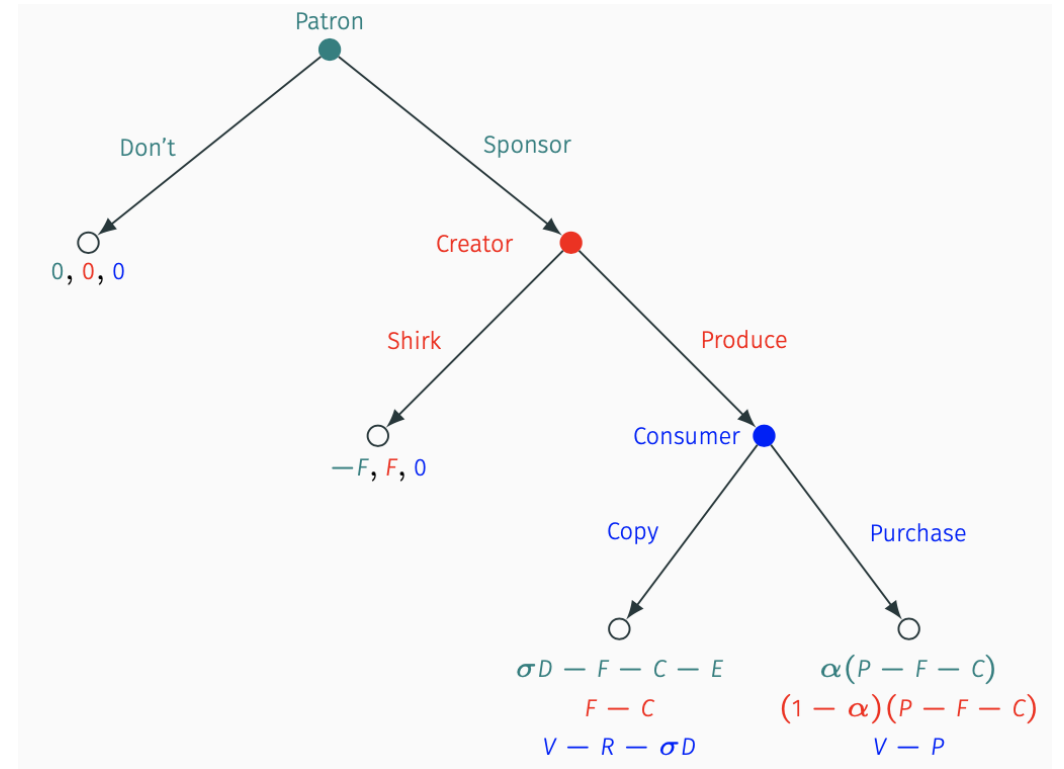
Example II: 19th Century American Literary Piracy

- From 18th—mid 20th century the United States *refused* to respect copyright of *foreign* authors

- American publishing industry expressly built on piracy of foreign works (mostly British novels)

- The U.S. is now the world's copyright policeman, enforcing its copyrights internationally

Safner, Ryan, 2021, "Pirate Thy Neighbor: The Protectionist Roots of International Copyright Recognition in the United States"

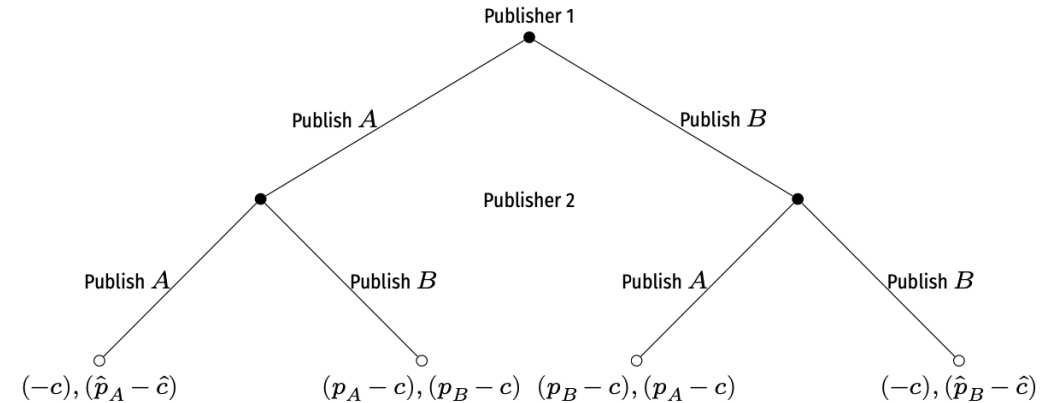# Example II: 19th Century American Literary Piracy

- U.S. publishers' piracy of foreign authors in the 19th century faced a tragedy of the commons:

  - No exclusive claims over printing foreign works (no copyright $\implies$ no right to exclude)

- Solved this problem by creating a publishing cartel that created "property rights" in piracy of foreign authors

- Enabled protectionist resistance to calls for respecting international copyrights

  - System broke down by end of 19th century
  - Rising U.S. cultural output in 20th century: publishers now advocate for international
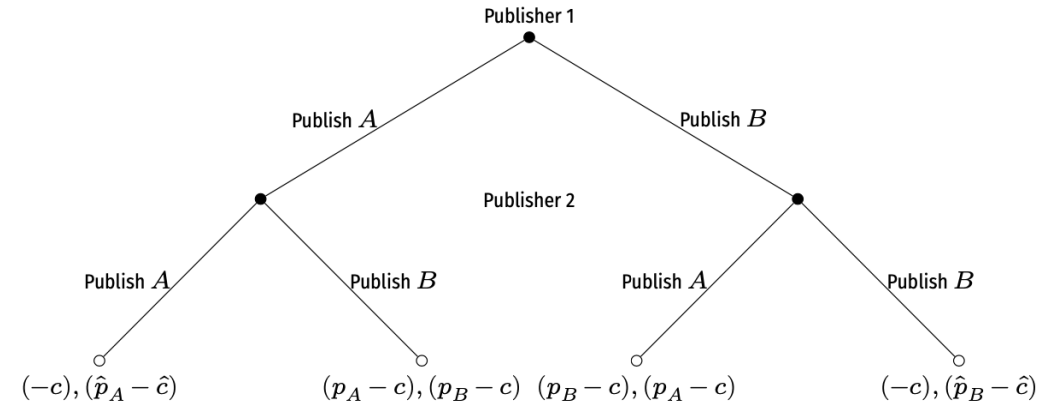
Game Setup

- Two representative American publishers, 1 and 2; two authors A, and B

- Publisher 1 moves first and decides to publish A or B at profit-maximizing price p with cost c

- Publisher 2 moves second and can decide to publish:

  - the *same* author as 1 ("pirate") at lower cost $\hat{p} < p$; $\hat{c} < c$ or
  - the *other* author at cost c

Publisher 1

Publish A Publish B

Publisher 2

Publish A Publish B Publish A Publish B

$(-c), (\hat{p}_A - \hat{c})$ $(p_A - c), (p_B - c)$ $(p_B - c), (p_A - c)$ $(-c), (\hat{p}_B - \hat{c})$

Game Setup

- Consumers will buy only from lower-priced publisher
  - If publisher 2 pirates, can sell at lower price than publisher 1
  - If both publish different authors, each earns $p_i - c$, where $i = \{A, B\}$
- Authors A and B may fetch different prices p_A and p_B depending on market demand

Safner, Ryan, 2021, "Pirate Thy Neighbor: The Protectionist Roots of International Copyright Recognition in the United States"

Publisher 1

Publish A Publish B

Publisher 2

Publish A Publish B Publish A Publish B

$(-c), (\hat{p}_A - \hat{c})$ $(p_A - c), (p_B - c)$ $(p_B - c), (p_A - c)$ $(-c), (\hat{p}_B - \hat{c})$

Game Setup

- Piracy/original publishing depends on:
  - relative value of author A vs B
  - profits of original sales $(p_i - c)$ vs. profits of pirate sales $(\hat{p}_i - \hat{c})$
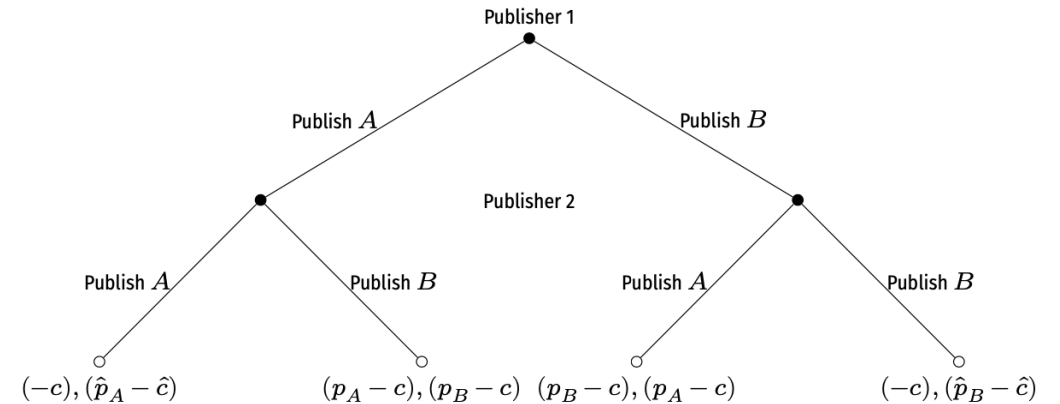 - both demand for pirated works $(\hat{p}_i)$ and reproduction technology $(\hat{c})$
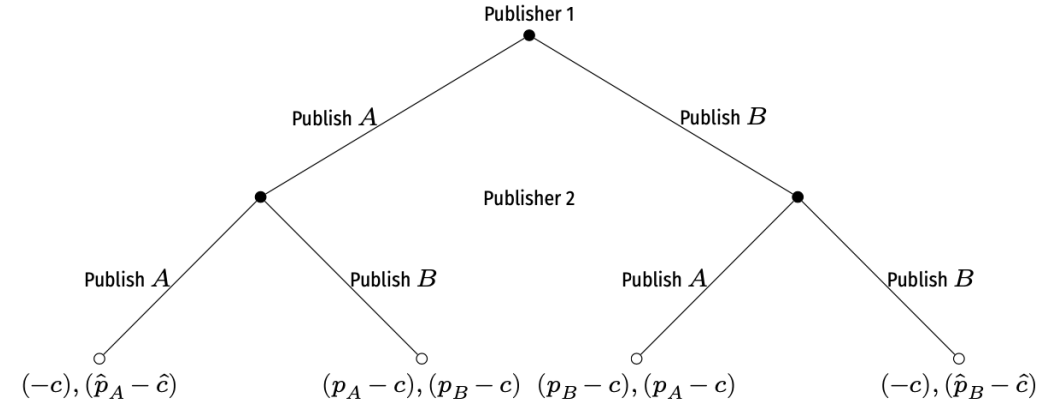
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Game Outcome – Role of Institutions

- Parameters $p_A, p_B, c,$ and $\hat{c}$ are determined by market conditions and institutions:

- Historically, several methods to secure property rights and deter piracy from other publishers

  - Arts patronage
  - Monopoly/guild (Stationers' Company of London)
  - Internal trade organizations
  - Copyright law

Publisher 1

Publish A Publish B

Publisher 2

Publish A Publish B Publish A Publish B

$(-c), (\hat{p}_A - \hat{c})$ $(p_A - c), (p_B - c)$ $(p_B - c), (p_A - c)$ $(-c), (\hat{p}_B - \hat{c})$

The Cartel Solution: "Courtesy of the Trade"

- 1790—1891 U.S. did not recognize copyrights to foreign authors

- U.S. publishing industry largely pirated famous British authors

  - Set up "courtesy of the trade" system of voluntary norms to avoid tragedy of commons
  - Created pseudo-property rights in foreign authors works
  - Ended up paying authors despite no obligation to, nor any legal protection earned

The Cartel Solution: "Courtesy of the Trade"

- 1790—1891 U.S. did not recognize copyrights to foreign authors

- Resolved the tragedy of the commons problem via a cartel

- A publisher would announce which foreign author they would publish and stake their "claim"
  - Other publishers would refrain from republishing that author, in hopes that when they stake a claim on a different author, others would respect it
  - If didn't respect claims, retaliation: nobody would respect their future claims

More General Solutions

- 1891 International Copyright Act "respects" foreign copyrights in U.S.

  - "Manufacturing clause" required foreign works to be printed in U.S.
  - Rationale for "trade courtesy" cartel disappears

- U.S. publishers begin publishing U.S. authors

  - Now in their interest to push for other countries to respect U.S. copyright