Game Theory
for
Strategic Advantage

15.025

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Part III: "Big" Applications

Repeated Interaction	Asymmetric Information	Communication
↓	↓	↓
Long-Run Relationships	**Designing Auctions & Markets**	**Credibility & Reputation**

Classes 11-14   **Classes 15-18**   **Classes 19-21**

Games Played over Time

Today:

- Price wars

- Dynamic Pricing

- Loyalty Programs

Beginning next class:

- Repeated games

- Theory and cases

NYC Tabloids

- July 1994: *NY Post* "tested" a price of 25 cents
- *Daily News* price = 40 cents. (Yes, it matters!)

- Why? *NY Post* previously went from 40 to 50.
- *Daily News* "did not cooperate" (= follow).

- *NY Post* cut price →$ 0.25 <u>in Staten Island only</u>.
- Shortly afterwards, *Daily News* priced at 50 cents!

Airline Pricing

- History of anticompetitive "devices"
- Reservations system

- Frequent-flier programs (AA, 1981)
- Miles? Points?? Dollars???

- Hub-and-spoke model
- Direct flights vs. connecting flights prices

Dynamic Pricing Game

Long game, tricky logic: think through every branch

1. Separate role for signals and loyalty programs

2. Keeping the game manageable (➔ your projects!)

3. Backward Induction refresher

Read ➔ Play online ➔ Solve ➔ Discuss ➔ Extend

Dynamic Pricing: Rules

- Two firms. 100 customers. Zero marginal costs.

- **Stage 1:** Invest in creating "Loyal" customers?

  - Loyal customers buy from you no matter the price

  - Two choices: 0 Loyal (no cost) or 30 Loyal (cost $250)

- **Stage 2:** Firms alternate price announcements.

  - May only announce "cuts" or "confirm previous price"

  - Choices are $50, $40, $30, $20, $10

Dynamic Pricing: Rules

- Sales are made only after prices "settle"
- Potentially *very* long game
- Can be played with several goals in mind

- Simplified Format
- Game ends when a player confirms previous price
- Play to maximize monetary payoffs

Dynamic Pricing: Payoffs

- Payoffs = Revenue – Loyalty Cost

- If prices settle at $50 for both firms, the "disloyal" customers are split evenly.

- Otherwise, firms do not split the disloyals equally:

  - "Larger firm" is one that (a) has lower price, or (b) was first to announce final price (if equal)

  - Larger firm sells 100 or 70 at its own price (depending on loyalty of other firm's customers)

  - Smaller firm sells 0 or 30 at its own price

Preparation Questions

- You have invested in Loyal customers, but the other firm has not. They win the coin flip and choose price $40.
  - **How would you respond? Why?**

- Neither you nor your opponent has invested in Loyal customers. You win the coin flip.
  - **Do you begin at $50 or go lower? How much lower?**

- **Will you invest in Loyal customers or not?**

Game-Theoretic Analysis

- Construct solution taking the game "as-is"

- Reason through various scenarios

- Conclusions for investment in Loyalty

- Modify the game / discuss alternative strategies
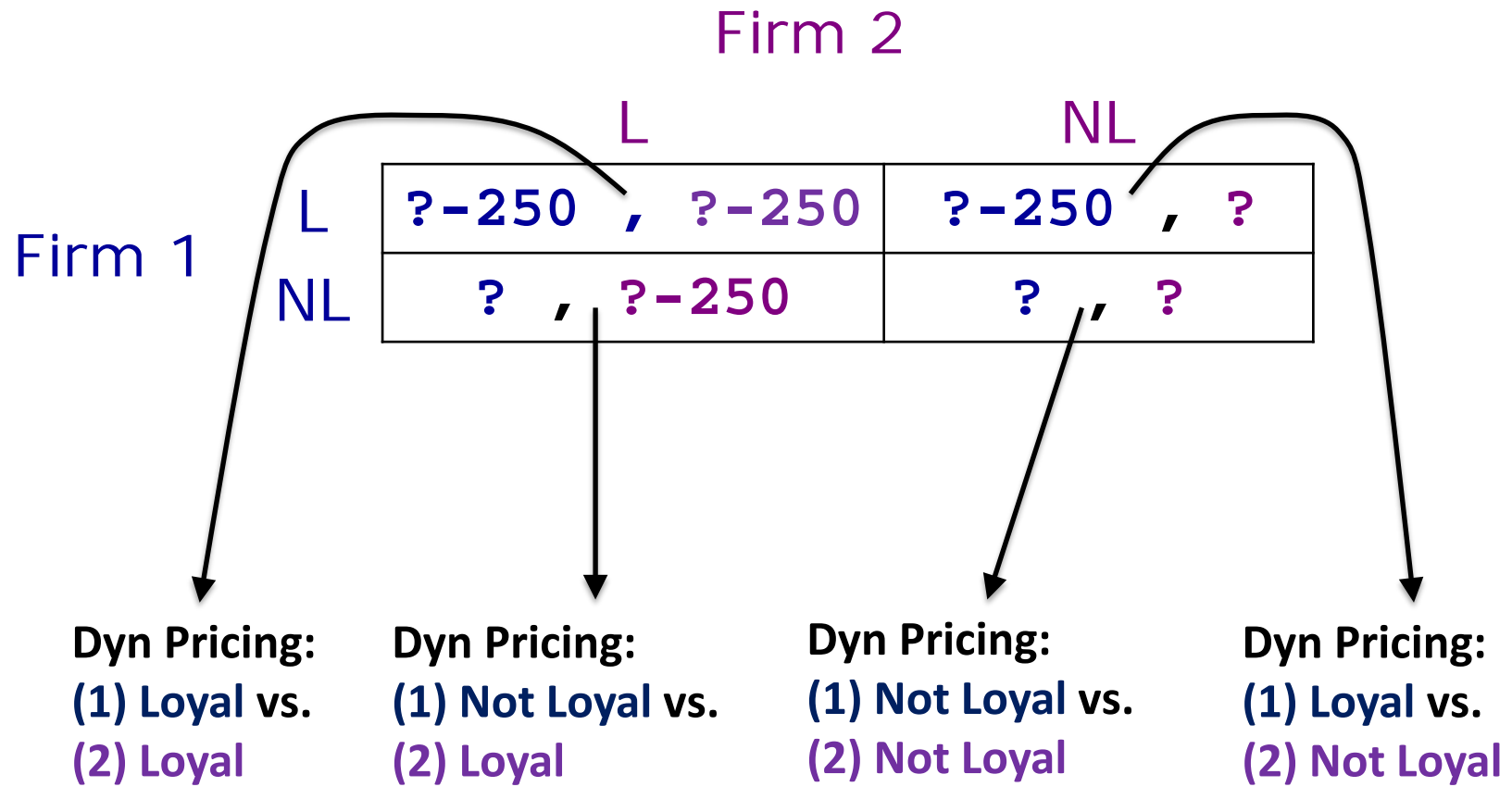
➔ **Look Forward, Think Back** ⬅

- Two-stage games: what happens in the 2nd stage?

- Evaluate ALL possible scenarios, ROLL BACK

- Build a "Game Outlook" from stage 1

- Key principle: *backwards induction*

Backwards Induction

- Loyalty strategies are public after Stage 1

- In Stage 2, a different game for any combination of "Loyal" and "Not Loyal" ... (L,NL), (L,L), (NL,NL), (NL,L)

- Compute revenues in all scenarios

- Game Tree?

Multi-Stage Game

Firm 2

	L	NL
L	**?-250 , ?-250**	**?-250 , ?**
NL	**? , ?-250**	**? , ?**

Firm 1

Dyn Pricing:
(1) Loyal vs.
(2) Loyal

Dyn Pricing:
(1) Not Loyal vs.
(2) Loyal

Dyn Pricing:
(1) Not Loyal vs.
(2) Not Loyal

Dyn Pricing:
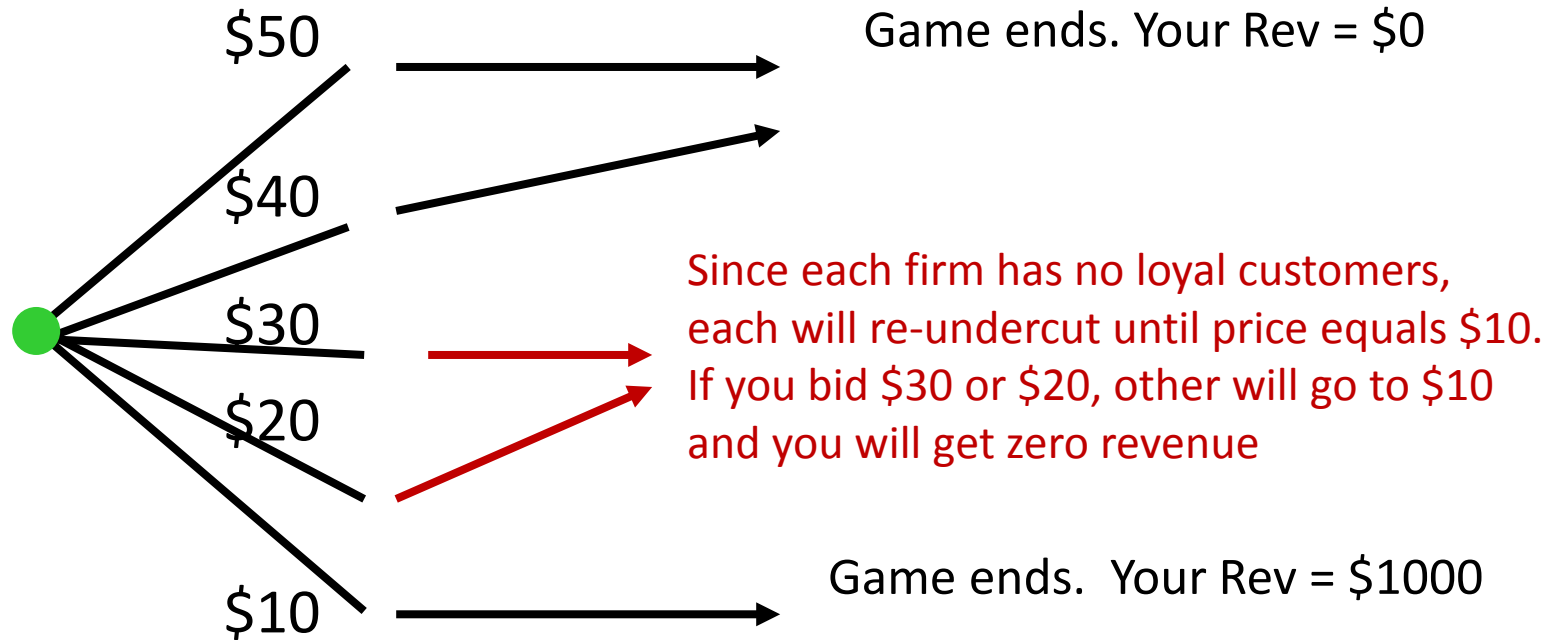**(1) Loyal vs.**
(2) Not Loyal

Compute all Stage 2 Revenues and roll back!!!

Upside of Loyalty

- If other firm undercuts you, your final payoff will be higher if you secured some loyal customers

- Suppose the other firm has no loyal customers and begins at $40...

- What would you do if you do NOT have loyalty?

- And what if you DO?

Disloyal vs. Disloyal → $40

$50   Game ends. Your Rev = $0

$40

$30   Since each firm has no loyal customers, each will re-undercut until price equals $10.

$20   If you bid $30 or $20, other will go to $10 and you will get zero revenue

             Game ends. Your Rev = $1000

$10

Any disloyal must be first to the lowest price
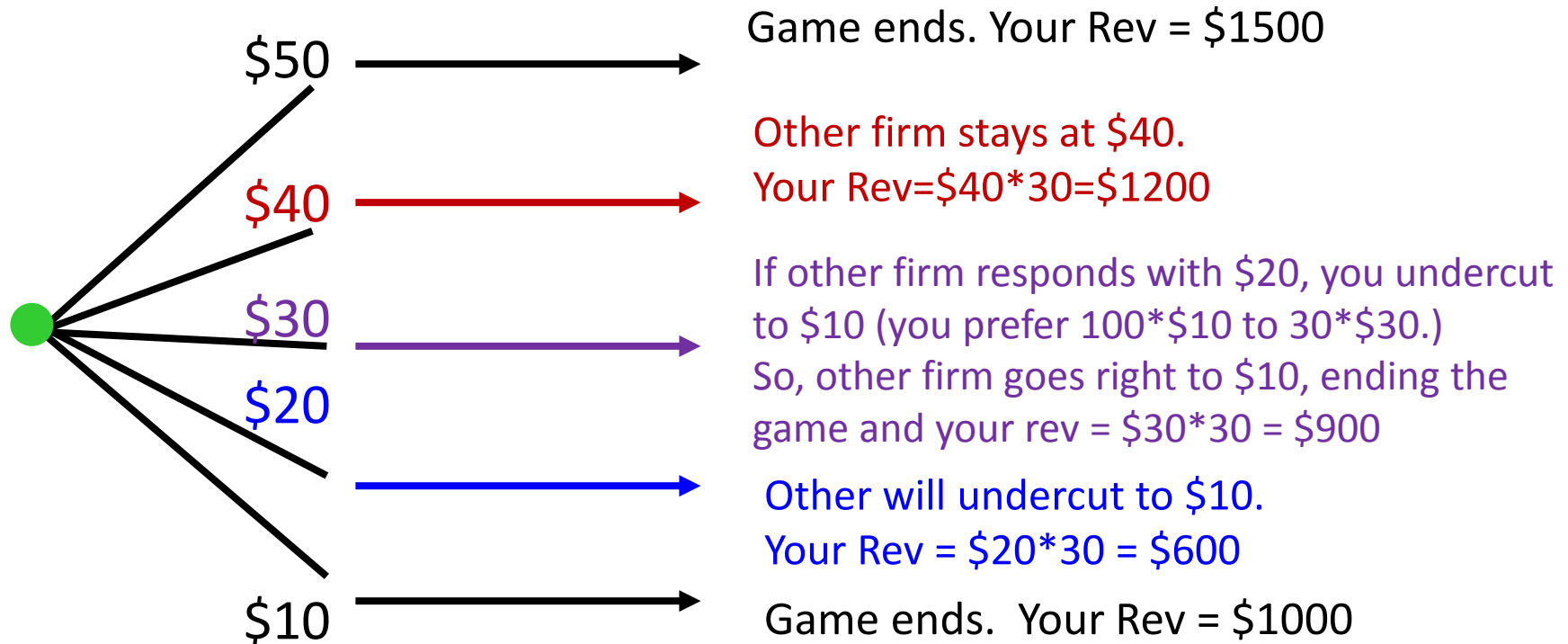
Respond with $10 and get $1000

Not as good as $1500 if you had Loyal

Lesson 0

Look all the way ahead in the game (Don't respond to $40 with $30!)

"Loyal" vs. "Disloyal" → $40

Pricing stage (you are "Loyal") → the $250 is sunk

$50 ——————————→ Game ends. Your Rev = $1500

$40 ——————————→ Other firm stays at $40.
Your Rev=$40*30=$1200

$30 ——————————→ If other firm responds with $20, you undercut to $10 (you prefer 100*$10 to 30*$30.)
So, other firm goes right to $10, ending the game and your rev = $30*30 = $900

$20 ——————————→ Other will undercut to $10.
Your Rev = $20*30 = $600
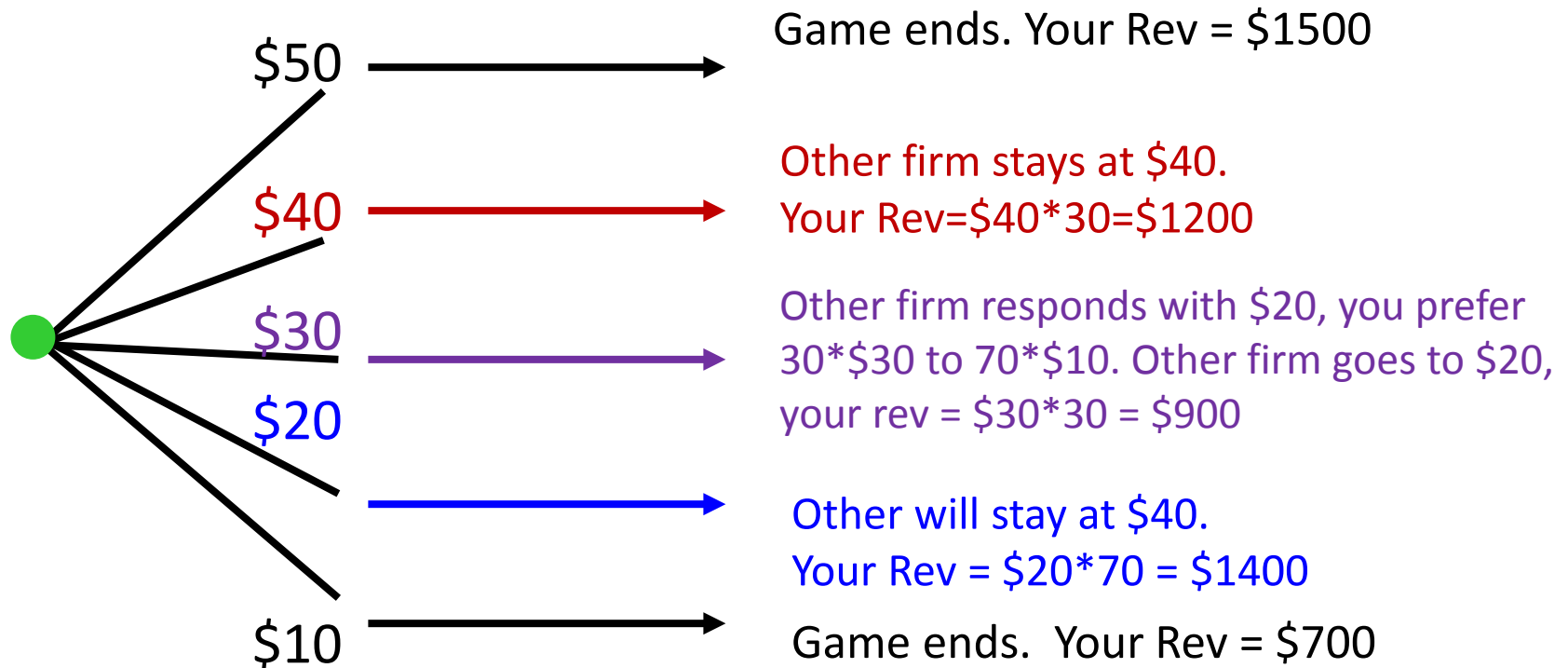
$10 ——————————→ Game ends. Your Rev = $1000

- Disloyal must be the low-price firm (or 1st to a tie)!
- Look at each step and conclude that $50 is best!

Downside of Loyalty

- A "disloyal" opponent can undercut you without triggering a price war!

- Unwillingness to re-undercut makes you an easy target

  – Disloyal opponent (whether first or second) will undercut you with $40, leaving you with only $1500

- A "Loyal" opponent (if they go first) also undercuts you with $40… why?

"Loyal" Undercut by "Loyal"→$40

$50 ——————→ Game ends. Your Rev = $1500

$40 ——————→ Other firm stays at $40.
Your Rev=$40*30=$1200

$30 ——————→ Other firm responds with $20, you prefer 30*$30 to 70*$10. Other firm goes to $20, your rev = $30*30 = $900

$20 ——————→ Other will stay at $40.
Your Rev = $20*70 = $1400

$10 ——————→ Game ends. Your Rev = $700

- Look at Each Step and conclude that $50 is best!
- But then 1st-moving Loyal gets Rev = $40*70 = 2800!

Upside of Disloyalty

- You are so "Lean & Hungry" that no Loyal opponent messes with you

- Against Loyal opponent, you go to $40
  (no matter who goes first), get Rev = 70*$40 = $2800

- What about against Disloyal?

Disloyal vs. Disloyal

- Any undercutting leads to ultimate price of $10
- Revenues are no greater than $1000
- Better to stick with $50
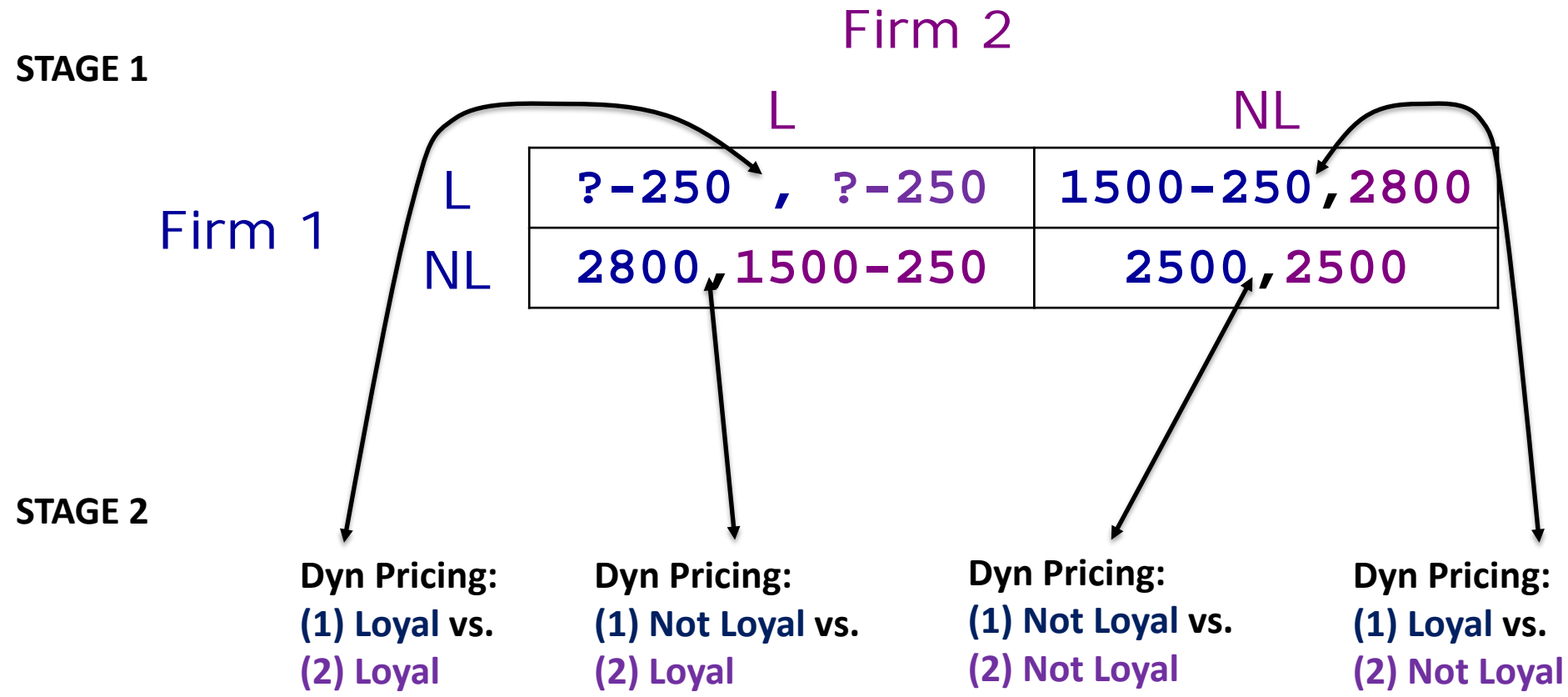- No price war in equilibrium!

VERY FRAGILE !!
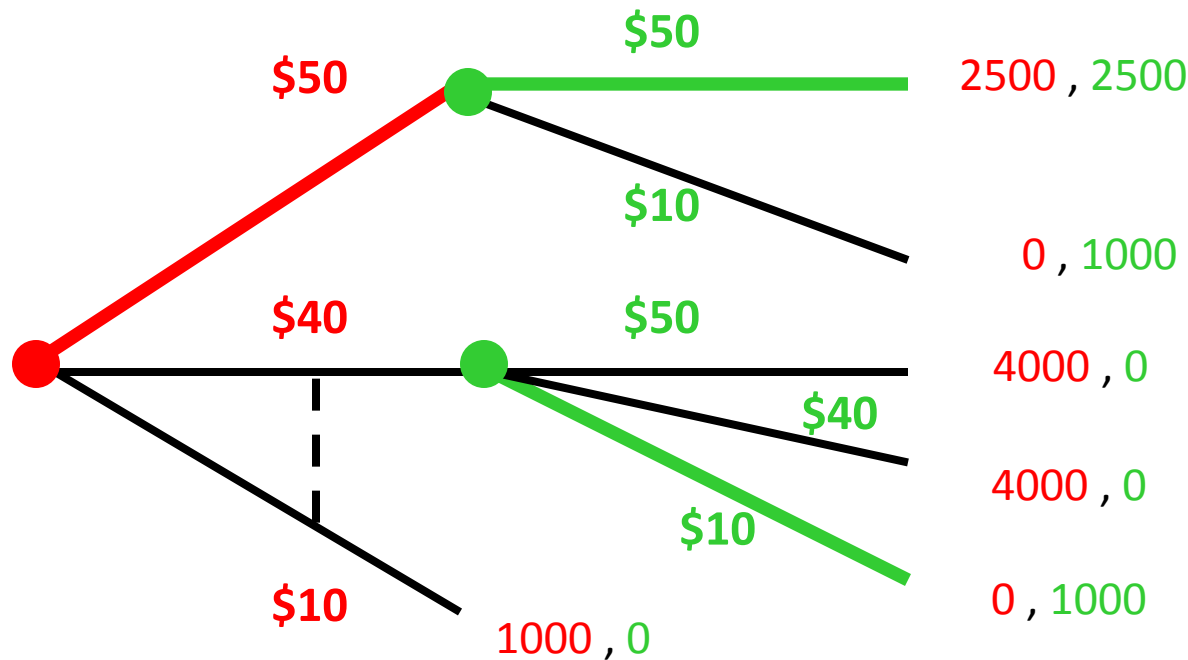
Lean and Hungry works well!

Creating Loyalty: Two Effects

- Direct effect of Loyalty: secure part of the demand

  – Direct effect stronger if program is more attractive

  – Stronger if you can price discriminate?

- Strategic effect of Loyalty: weaker bargaining position

  – Doesn't matter in a price war

  – Matters more if undercutting is "on the margin"

- Which one is stronger?

Multi-Stage Game

Firm 2

	L	NL
L	?-250 , ?-250	1500-250,2800
NL	2800,1500-250	2500,2500

Firm 1

Dyn Pricing:
(1) Loyal vs.
(2) Loyal

Dyn Pricing:
(1) Not Loyal vs.
(2) Loyal

Dyn Pricing:
(1) Not Loyal vs.
(2) Not Loyal

Dyn Pricing:
(1) Loyal vs.
(2) Not Loyal

Loyal vs. Loyal: first mover cuts to $40
Expected revenue = 0.5*2800+0.5*1500 = 2150

Reduced-Form Game

STAGE 1

Firm 2

	L	NL
L	1900 , 1900	1250 , 2800
NL	2800 , 1250	2500 , 2500

Firm 1

Not Loyal is a Dominant Strategy!

Lesson 1

Keep track of the Direct and Strategic Effects!

Retail Competition

- Nordstrom competing in the cutthroat world of online retail

- Nordstrom price-match guarantee:
  "We are unable to match prices from auction and outlet stores or their websites, or other retailers' discount promotions, shipping offers and gift card offers."

- Focused on retailers perceived as direct competitors.

- Commitment to aggressive behavior (the opposite of Loyalty!)

Creating Loyalty: a Bad Idea?

- Loyalty is a <u>dominated strategy</u> in stage 1!

- Why would you go ahead anyway?

    - Fear of price-wars (fragile equilibrium)

    - Fraction of "captive" customers

    - Price discrimination

    - Collusion on prices

Fear of Price War

- If you fear *p = $10* in Not Loyal vs. Not Loyal "subgame" …
- … coin flip determines who makes all the sales
- Expected payoffs in stage 1 look like this

<div align="center">

Firm 2

		L	NL
Firm 1	L	1900 , 1900	1250 , 2800
	NL	2800 , 1250	500 , 500

</div>

- Two Nash Equilibria – as in the cities game
- "Free-riding on insurance against price war"
- Stable population split = 45% Loyal

Lesson 2

Keep in mind your opponents' goals (and / or doubt their rationality)

Ryanair

- Launched Dublin-London route in 1986

- Enter a market with similar choices as incumbents?
  - Aer Lingus "to bring benefits to the Irish community"
  - British Airways has (obviously) deep pockets.
- Lowest BA fare was GBP 99
- Ryanair enters at GBP 98, "first-rate customer service and on-board service comparable to BA."

- What happened? How did the game change?

Captive Consumers

- If 50 customers can be "captured" then strong **direct effect**
- Loyal vs. Disloyal still ends $50:$40, but different market shares
- Expected payoffs in stage 1 look like this

Firm 2

		L	NL
Firm 1	L	2250,2250	2250,2000
	NL	2000,2250	2500,2500

- Two Nash Equilibria – as in the "Stag Hunt"
- If I think you're building loyalty, I must protect my market
- UnStable population split = 50% Loyal

Lesson 3

Relative strength of direct vs. strategic effects shapes the game
(and potentially the industry)

Price Discrimination

- Back to 30 captive customers
- If you **could** charge different prices to frequent and occasional travelers… Expected payoffs in stage 1 **would** look like this

Firm 2

		L	NL
Firm 1	L	2250,2250	3000,1750
	NL	1750,3000	2500,2500

- Price wars could occur in every subgame
- All prices = $50!! Pure business-stealing! Prisoners' Dilemma!!!!!!
- What actually happened?
- [Same outcome if prices were "fixed" – collusion]

Lesson 4

Think the whole game through

the (credible) threat of (price) war keeps all prices high…

… absent price discrimination or promotions, loyalty programs may undermine the ability to threaten…

Airline Loyalty Programs
Co-opetition, Ch.5 (posted)

- *American* starts AAdvantage

- *United* copies MileagePlus

- Most others follow

- Low-cost carriers typically more hesitant

- Price discrimination? Like GM and Ford credit cards…

- Tacit(?) coordination / reservation systems / price fix

Takeaways

- Look forward, think back

- Subgame-perfect equilibrium key tool for dynamic games

- Rationality of opponent (undercutting machine?)

- *Direct* vs. *strategic* effect:

  – Protect demand

  – Weaker bargainer

- Relative strength of the 2 effects (# of captives)

- Credible threats (could cut 1 price only, but..)

Next Time

- Kick off from today's game ➜

  ➜ Repeated interaction

- Read: "The Dynamics of Price Competition"

  (it's about tit-for-tat, etc...)

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