Part III: “Big” Applications

Repeated Interaction
- Long-Run Relationships

Asymmetric Information
- Designing Auctions & Markets

Communication
- 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 $\rightarrow$ $0.25$ in *Staten Island* only.
• 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

### STAGE 1

<table>
<thead>
<tr>
<th>Firm 1</th>
<th>L</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>?-250, ?-250</td>
<td>?-250, ?</td>
</tr>
<tr>
<td>NL</td>
<td>? , ?-250</td>
<td>? , ?</td>
</tr>
</tbody>
</table>

### STAGE 2

- **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

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” \( \rightarrow \) $40

Pricing stage (you are “Loyal”) \( \rightarrow \) the $250 is sunk

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

\[\begin{array}{c|c|c}
\text{Price} & \text{Your Revenue} & \text{Other Firm's Action} \\
\hline
50 & \text{Game ends. Your Rev = $1500} & \\
40 & \text{Other firm stays at $40. Your Rev = $1200} & \\
30 & \text{If other firm responds with $20, you undercut to $10 (you prefer} & \\
   & \text{100*$10 to 30*$30.) So, other firm goes right to $10, ending} & \\
   & \text{the game and your rev = $30*30 = $900} & \\
20 & \text{Other will undercut to $10. Your Rev = $600} & \\
10 & \text{Game ends. Your Rev = $1000} & \\
\end{array}\]
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

- 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!

Lean and Hungry works well!

Very Fragile!!
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

STAGE 1

Firm 1

L |
NL |

STAGE 2

Firm 2

L |
NL |

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**

<table>
<thead>
<tr>
<th></th>
<th>Firm 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Firm 1</td>
<td>1900, 1900</td>
</tr>
<tr>
<td></td>
<td>2800, 1250</td>
</tr>
</tbody>
</table>

*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 dominated strategy 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

\[
\begin{array}{c|cc}
\text{Firm 1} & \text{L} & \text{NL} \\
\hline
\text{L} & 1900, 1900 & 1250, 2800 \\
\text{NL} & 2800, 1250 & 500, 500 \\
\end{array}
\]

- 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

<table>
<thead>
<tr>
<th>Firm 2</th>
<th>L</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1 L</td>
<td>2250,2250</td>
<td>2250,2000</td>
</tr>
<tr>
<td>Firm 1 NL</td>
<td>2000,2250</td>
<td>2500,2500</td>
</tr>
</tbody>
</table>

• 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

<table>
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<th>L</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>2250, 2250</td>
<td>1750, 3000</td>
</tr>
<tr>
<td>NL</td>
<td>3000, 1750</td>
<td>2500, 2500</td>
</tr>
</tbody>
</table>

- 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...)