

Hunger Chain - A Competitive Supply Chain Simulation

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Learning Objectives

- Decisions under uncertainty: The **Newsvendor Model**
- Shortage gaming (**panic orders, hoarding**) and the value of information
- **Supply chain competition**: how your competitors' actions may affect your payoff? The **Prisoners' Dilemma**: Why is order inflation inevitable?
- **Inventory rationing** for efficiency and fairness

Courses and Audience

- Few existing games are **interactive** and **competitive** in the sense that one team's action affects others' payoff.
- Newsvendor model, shortage gaming and Prisoners' Dilemma are **hard to teach** but **easy to play** out.
- Courses and audience
 - Courses: Operations management, supply chain management, procurement / sourcing, distribution and logistics.
 - Target audience: undergraduate, graduate (MS, MBA) and executive / continuing education students.

Student / Instructor Feedback

- “The Hunger Game was very **interactive** and brought critical thinking to the activity. I really enjoyed it as we got to work in groups while being inclusive enough to work together as a class. **The competition aspect of the activity pushes each group to become more proactive with critical thinking** which broadens everyone's perspective and **reflection of real world competition.**”
- “The game worked really well. My teaching evaluation in this semester finally reached **4.38 [out of 5]** – I am SO happy!”

Screen Play (3 Hours)

1. The Newsvendor Game (30 mins)

- Students experience random demand, and must make decision under uncertainty
- After the game, students discuss their game experience and how to order

2. Newsvendor model lecture (1 hour)

- Calculate the optimal order quantity for the game
- Comment on winning / losing teams' performance
- Play the newsvendor game again to verify the learning

3. The Shortage Game (1 hour 30 mins)

- Panic orders, hoarding, Prisoners' Dilemma, supply chain melt down
- Link game to real life events
- Supply rationing: the fair sharing rule

Watch YouTube Videos for Teaching Notes

Agenda

1. Introduction
2. How to play the game?
3. Games
 - Newsvendor game
 - Shortage game
4. Discussion and extension



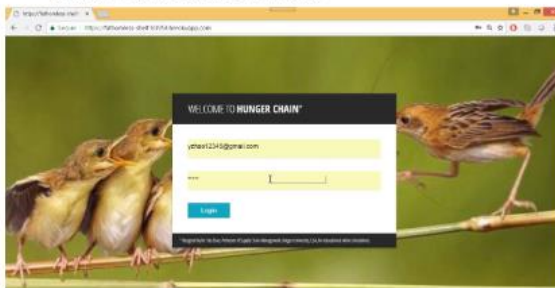
Hunger Chain Simulation - Introduction

youtu.be

<https://youtu.be/tHCXs51Ba-E>

An introduction to Hunger Chain - A Competitive Supply Chain Simulation

Students Receive Results



Hunger Chain Simulation - How to play

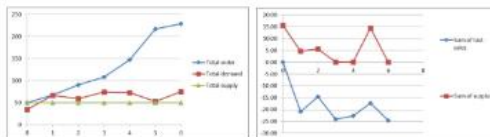
youtu.be

https://youtu.be/Blo1th_6duk

Use an example to show how to play the Hunger Chain Simulation

Game Trajectory

This is just an example, please plot **your** game data (competitive information table) in Excel.



Facing stable demand, why did total order increase significantly over time?

Why do we have both lost-sales and surplus inventory in the same time?

Hunger Chain Simulation - Gaming and Discussion

youtu.be

<https://youtu.be/WPqK5JwXEy8>

Teaching note for the Hunger Chain Simulation

Agenda

1. Introduction
2. How to play the game?
3. Games
 - Newsvendor game
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4. Discussion and extension



Introduction

Supply Shortage



Mummy bird only has one worm, whom to give it to?

Hot Vehicle Models



Dealers often are begging for hot models*

* "GM warns allocation scammers" Automotive News, January 23, 2012.

COVID-19: Shortage Gaming of The Toilet Paper



Short of Protection Gowns, so ...



Other Examples

- Flu outbreak & vaccine
- high-tech industries: Solectron
- The great famine

Flu vaccination priority list

Due to shortages in the supply of flu vaccines this year, health officials are strongly recommending not everyone get vaccinated. The elderly and chronically ill are among those who should be vaccinated.

HIGH RISK	2002-03 population in millions	Percent vaccinated
>64 years old	35.6	66.2%
Chronic illness		
50 – 64 years old	13.5	43.6%
19 – 49	18.8	23.9%
2 – 18	6.8	10%
Pregnant	4.0	12.4%
All children*	5.9	30%
Other**	102.9	20%

* Ages 6 to 23 months ** Health care personnel, household contacts, healthy people 50 to 64 years old

SOURCE: Centers for Disease Control and Prevention

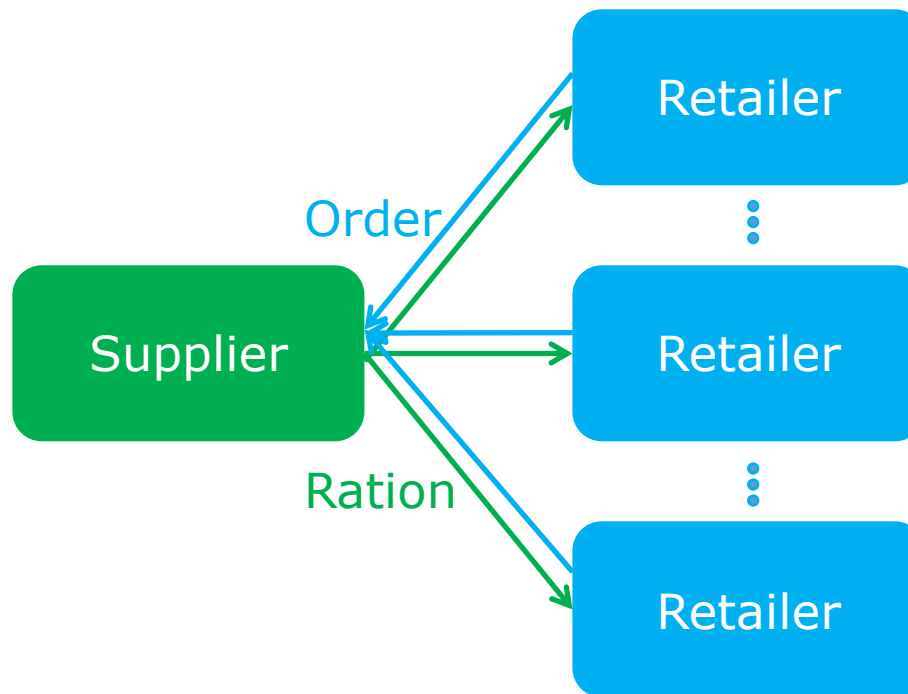
AP

Supply Chain Problems under Shortage

- Panic orders
- Hoarding
- Unfair allocation
- Supply chain melt-down
- How to ensure efficiency and fairness?



The Supply Chain



Supply is limited, how to allocate efficiently and fairly?

- Instructor plays the supplier, students play the retailers.
- The retailers place orders; the supplier decides on supply allocation.

Proportional Allocation Rule

- If total order \leq total supply, **Ration** = order;
- Otherwise, if a retailer's order is x% of total orders, he receives x% of available supply

$$\mathbf{Ration} = \frac{\mathbf{The\ retailer's\ order}}{\mathbf{Sum\ of\ all\ retailers' orders}} \times \mathbf{Supply}$$

- Conceptually simple and easy to implement → commonly used in practice
- The most intuitive rule for allocating the supply because retailers can voice their needs as they know themselves the best
- Fair and equitable opportunity for everyone

Hunger Chain Simulation

- One supplier and multiple identical retailers
 - Instructor plays the supplier, student teams play the retailers for 6 periods.
- Retailers are newsvendors
 - Retail price = \$10, cost = \$2, salvage = \$0
 - Lost-sales (underage) cost > surplus (overage) cost
- Demands are random but statistically the same for all retailers

A Competitive Environment

Multiple Retailers



Compete for a limited supply

The Competing Retailers

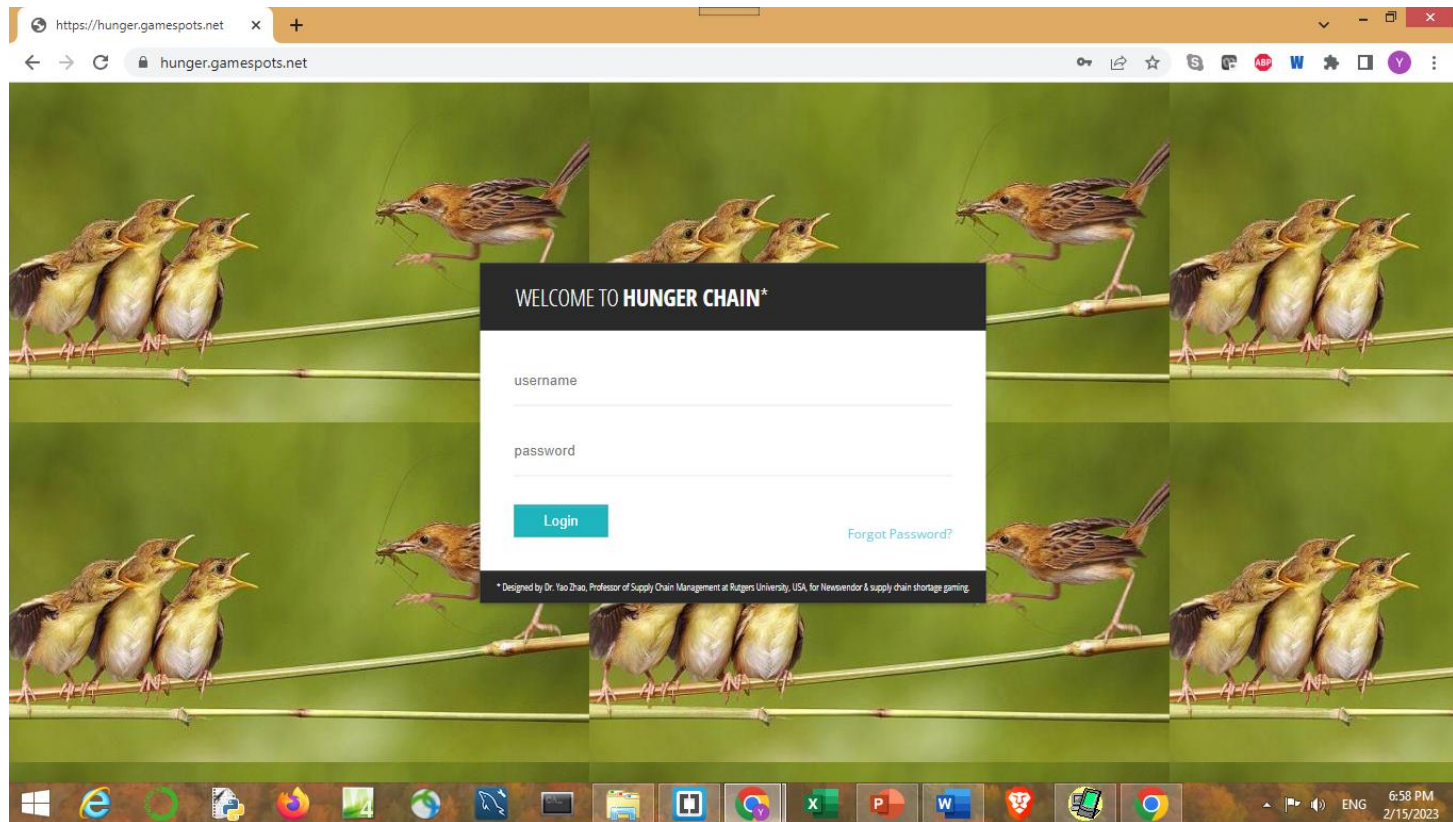
- At the beginning, each retailer has
 - Identical financial status
 - Same share of the supply
 - Same chance to win



How to Play the Game?

Instructor: Account & Login

Email yaozhao@business.rutgers.edu for an instructor account



Website: <https://hunger.gamespots.net/>

Instructor Creates Login for Student Teams

Game Page for yaozhao@business.rutgers.edu

Game Setup

Number of Groups (Integer):

Number of Rounds (Integer):

Player E-mails (To send login credentials to students. **seperated by ;**. Example: andy@yahoo.com;bill@gmail.com. Check spam or trash if not received):

Demand Distribution:

Demand Synchronization:

Supply per Player (default = 12.5, mean demand = 15):

Sale Price (default = \$10):

Cost (default = \$2):

Maximum Order:

Game Controls

Windows taskbar: 6:40 PM 10/12/2022

Callout 1: Enter number of student teams, at least 2 teams.

Callout 2: Enter number of rounds (periods), typically 6.

Callout 3: Enter one email for each team (separated by ;)
Teams will receive a password via this email once instructor starts a game.

Instructor Sets Demand

Game Page for yaozhao@business.rutgers.edu

Game Setup

Number of Groups (Integer):

Number of Rounds (Integer):

Player E-mails (To send login credentials to students. **seperated by ';'**. Example: andy@yahoo.com)

Demand Distribution:

Demand Synchronization:

Supply per Player (default = 12.5, mean demand = 15):

Sale Price (default = \$10):

Cost (default = \$2):

Maximum Order:

Game Controls

Select demand distribution.

Select either Asynchronized or synchronized demand for retailers.

Windows taskbar: 6:40 PM 10/12/2022

Instructor Sets Cost Parameters

The screenshot shows a web browser window with the URL `hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu`. The page title is "Game Page for yaozhao@business.rutgers.edu". The "Game Setup" section contains the following fields:

- Number of Groups (Integer):
- Number of Rounds (Integer):
- Player E-mails (To send login credentials to students. **seperated by '*'**. Example: andy@yahoo.co):
- Demand Distribution:
- Demand Synchronization:
- Supply per Player (default = 12.5, mean demand = 15):
- Sale Price (default = \$10):
- Cost (default = \$2):
- Maximum Order:

Callout boxes provide the following instructions:

- Enter Supply per Player
- The total supply = Supply per Player * Number of Groups
- Mean demand = 15; if Supply per Player << 15, shortage game; if >>, independent newsvendor game.
- Enter retailers' Sales Price.
- Enter retailers' cost per unit of product.
- Salvage value is set to zero.
- Select maximum retailers' order.

Instructor Starts A Game

Game Page for yaozhao@busine: x

hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu

Game Controls

Start Game Restart Game Reset Game Save Game End Game Log Out

Current Game

Show Complete Game Info

Show Competitive Info

Financial Performance (Refresh the Page If Necessary)

Period	Player	Ordered?	Profit	Cumulative Profit
0	yaozhao@andromeda.rutgers.edu	true	60.90	60.90
0	yzhao12345@gmail.com	true	60.90	60.90

Next Round Calculate

Previous Games

Show Game List

6:55 PM 10/12/2022

Students Receive Results



yaozhao@andromeda.rutgers.edu Game Page

Logout

A student team login by its email and the received password.

Current Game (Refresh the Page If Necessary)

Period	Demand	Order	Ration	Sales	Lost Sales	Surplus Inventory	Profit	Cumulative Profit
0	8.59	<input type="text" value="12.5"/>	12.5	8.59	0.00	3.91	60.90	60.90

Submit Order

The team only sees its own results but not the results of the competing teams.

Previous Games

Show Game List



Instructor Clicks Next Round

The screenshot shows a web browser window with the URL `hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu`. The page is titled "Game Page for yaozhao@busine: x".

Game Controls

Start Game Restart Game Reset Game Save Game End Game Log Out

Current Game

Show Complete Game Info

Show Competitive Info

Financial Performance (Refresh the Page If Necessary)

Period	Player	Ordered?	Profit	Cumulative Profit
0	yaozhao@andromeda.rutgers.edu	true	60.90	60.90
0	yzhao12345@gmail.com	true	60.90	60.90
1	yaozhao@andromeda.rutgers.edu	false		
1	yzhao12345@gmail.com	false		

Next Round Calculate

The "Next Round" button is highlighted with a red box. A blue callout box points to the "Ordered?" column in the table, containing the following text:

- The summary of financial performance is shown to all teams
- 'false': the team has yet ordered
- 'true': the team has ordered

The Windows taskbar at the bottom shows the time as 7:00 PM on 10/12/2022.

Students Submit Order



yaozhao@andromeda.rutgers.edu Game Page

Logout

Current Game (Refresh the Page If Necessary)

Period	Demand	Order	Ration	Sales	Lost Sales	Surplus Inventory	Profit	Cumulative Profit
0	8.59	12.5	12.5	8.59	0.00	3.91	60.90	60.90
1		0<=Order<infinity						

Submit Order

Previous Games

Show Game List

Student team types in order, which must be non-negative and less than the maximum order, then clicks Submit Order



Instructor Generates Results

Game Page for yaozhao@busine: x

hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu

Start Game Restart Game Reset Game Save Game End Game Log Out

Current Game

Show Complete Game Info

Show Competitive Info

Financial Performance (Refresh the Page If Necessary)

Period	Player	Ordered?	Profit	Cumulative Profit
0	yaozhao@andromeda.rutgers.edu	true	60.90	60.90
0	yzhao12345@gmail.com	true	60.90	60.90
1	yaozhao@andromeda.rutgers.edu	true	74.68	74.68
1	yzhao12345@gmail.com	true	111.12	111.12

Next Round Calculate

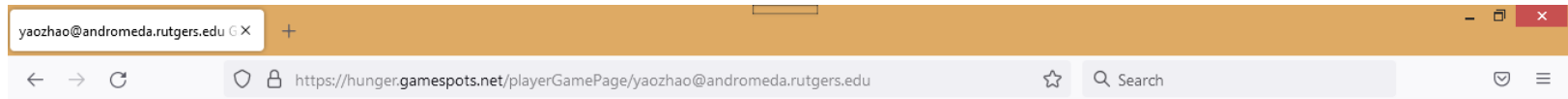
Previous Games

Show Game List

After receiving orders from all teams, instructor clicks Calculate to generate results

Windows taskbar: 7:07 PM 10/12/2022

Students Receive Results Again



yaozhao@andromeda.rutgers.edu Game Page

Logout

Current Game (Refresh the Page If Necessary)

Period	Demand	Order	Ration	Sales	Lost Sales	Surplus Inventory	Profit	Cumulative Profit
0	8.59	12.5	12.5	8.59	0.00	3.91	60.90	60.90
1	9.69	12	11.11	9.69	0.00	1.42	74.68	74.68

Submit Order

Previous Games

Show Game List

Instructor clicks Next Round again, ..., until reaching the number of rounds (periods).



Reminders

- **Save** the game frequently to avoid losing game data.
- Compatible browsers: Chrome, Firefox, Safari, Brave, ...
- Frequently reload / refresh the page to update game status.
- Instructors:
 - Please **save** and **end** the game before logout. You can **reload** an unfinished game later.
 - You may back up the game data in Excel files (copy and paste) as the database may be maintained and cleaned every year.

Instructor Only

Show Competitive Info.

The screenshot shows a web browser window with the URL `hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu`. The page title is "Game Page for yaozhao@busine...". Under the heading "Current Game", there are two buttons: "Show Complete Game Information" (highlighted in teal) and "Hide Competitive Information". Below these buttons is a table with the following data:

Period	Total Demand	Total Order	Total Supply	Total Lost Sales	Total Surplus Inventory
0	17.18	25.00	25.00	0.00	7.82
1	32.25	35.00	25.00	15.47	8.22

Below the table is a line graph titled "Game Trajectory I" with the y-axis labeled "Total Orders" ranging from 10 to 40. The graph shows three lines: "Total Demand" (red line with circles), "Total Supply" (blue line with circles), and "Total Order" (teal line with circles). The "Total Demand" line starts at approximately 17.18 at period 0 and rises to 32.25 at period 1. The "Total Supply" line is a horizontal line at 25.00. The "Total Order" line starts at 25.00 at period 0 and rises to 35.00 at period 1. A blue callout box points to the "Total Lost Sales" value of 15.47 in the table, containing the text: "Show competitive info. such as total demand and total order, ... I typically hide it initially and show it after the game runs half-way to demonstrate the impact of information."

Game Controls

The screenshot shows a web browser window with the URL `hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu`. The page contains several input fields for game parameters: "Supply per Player" (value: 12.5), "Sale Price (default)", "Cost (default = \$2)", and "Maximum Order" (dropdown menu). Below these fields is a "Game Controls" section with buttons for "Start Game", "Restart Game", "Reset Game", "Save Game", "End Game", and "Log Out". Underneath is a "Current Game" section with buttons for "Show Complete Game Information" and "Show Competitive Information". At the bottom, there is a "Financial Performance (Refresh the Page if Necessary)" section. The Windows taskbar at the bottom shows the time as 7:36 PM on 10/12/2022.

Restart the game with the same game setup.

Change the game setup.

Save the game.

End game and decide whether to save it.

Logout; please end the game before logout.

Manage Previous Games

Game Page for yaozhao@busine: x

hunger.gamespots.net/instructorGamePage/yaozhao@business.rutgers.edu

1	yaozhao@andromeda.rutgers.edu	true	49.24	49.24
1	yzhao12345@gmail.com	true	68.56	68.56
2	yaozhao@andromeda.rutgers.edu	false		
2	yzhao12345@gmail.com	false		

Next Round Calculate

Previous Games

Hide Game List

Number	Time	Number Player	Number Round	Action
1	9/18/2017, 7:32:04 PM	4	6	Select ▼
2	9/18/2017, 7:56:39 PM	4	6	Select ▼
3	11/14/2017, 7:15:07 PM	7	6	Select ▼ View Delete Reload Select ▼
4	11/14/2017, 8:10:39 PM	7	6	Select ▼
5	5/22/2018, 11:08:09 AM	2	6	Select ▼
6	11/3/2018, 12:01:07 AM	61	6	Select ▼
7	11/7/2018, 3:06:24 PM	5	2	Select ▼

View a previous game

Delete a previous game

Reload and continue a previous game

7:39 PM 10/12/2022

The Newsvendor Game

- Instructor sets Supply per Player \gg mean demand (15). The suggested value = 25, so there is no supply shortage and competition among the retailers.
- Instructor can inform all students of its total capacity.
- Play the game for 6 periods to see how each team orders.
- Compare their orders to the newsvendor solution, let them explain why they order too much or too little.
- If necessary, ask students to play the game again to try out the newsvendor solution!

The Shortage Game

- Instructor sets Supply per Player \ll mean demand (15). The suggested value is 12.5 or 10 depending on how intensive you want the competition to be.
- Choose the game parameters as you wish, but be sure to make sales price $>$ cost.
- Inform all students of the game parameters, especially the total supply capacity, to create a competitive mindset.

Let's Play

Periods 1-3

Without revealing the competitive information

Intermezzo

- Any observations and comments?
- Truth telling or order inflation?
- Game theory basics



Game Theory Basics

- Every retailer is maximizing its own profit – you should not be an exception
- Competition: your profit depends on others' actions. How?
- Must consider others' actions (if you know) before taking your own
- Information (what do you know?)
 - How much others know about you?
 - How they may react to your actions?
 - Do others know that you know about them? ...



Let's Play

Periods 4-5

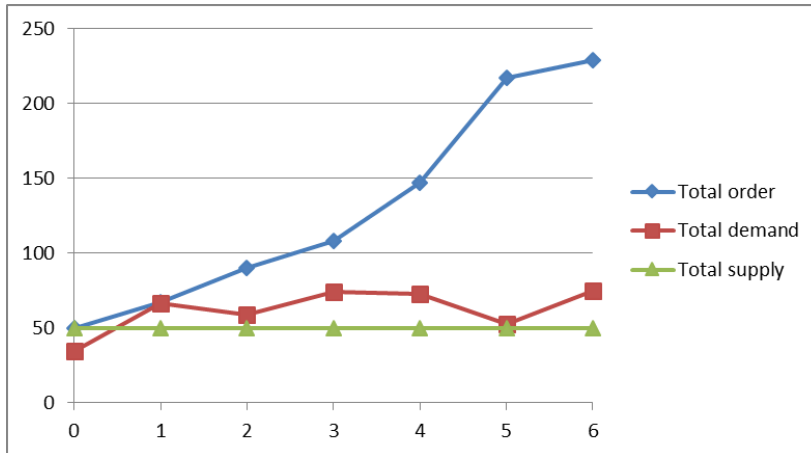
And revealing the competitive information

Game Trajectory

- Illustrate supply chain total order, supply, demand, lost-sales and surplus over time (via the **competitive information** table). How could we have both lost-sales and surplus inventory in the same time?!
- Show each retailers' orders and demand over time (via the **complete game information** table); why did you do that? What was your strategy?
- Significant order inflation and bullwhip effect!

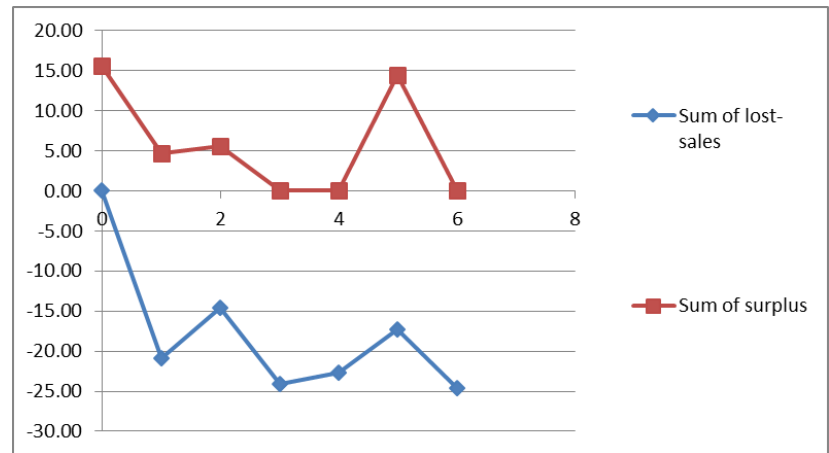
Game Trajectory

This is just an example, please plot **your** game data (competitive information table) in Excel.



Facing stable demand, why did total order increase significantly over time?!

Panic orders



Why do we have both lost-sales and surplus inventory in the same time?!

Hoarding

Order inflation is inevitable, why?

Retailer 1		↑		
Tell truth	Inflate order	↑	1: Lose badly 2: Win more	1: Win 2: Win
			1: Lose less 2: Lose less	1: Win more 2: Lose badly
Inflate order	Tell truth	↑		
			Retailer 2	→

Guess what is the final outcome?

- The Prisoners' Dilemma: Order inflation is inevitable under the proportional rule. Real life examples?

Melt-Down 2001: Solectron*

- In 2000, the telecom market was growing fast; the contract manufacturer, Solectron, has a short supply (capacity).
- Adding up orders from Cisco, Lucent & Ericsson, etc. exceeded the rosiest forecast – Solectron worried, but the telecom giants assured that they will pay.
- Meltdown happened in April 2001, it is too late to halt production from some 4000 suppliers, now Solectron sit on \$4.7 billion inventory.
- In the meeting to resolve inventory

"Everyone says it's yours."



NYC's coronavirus "fatality #s are inflated."



Brit Hume  @brithume · Apr 1

Very informative thread. Explains why NY's Covid 19 fatality numbers are inflated. They don't distinguish between those who die with the disease and those who die from it.



Adam Townsend @adamscrabble · Apr 1

Updated NYC Covid-19 numbers. Note the cases with no underlying conditions

[Show this thread](#)

Coronavirus Disease 2019 (COVID-19) Daily Data Summary



The data in this report reflect events and activities as of **April 1, 2020 at 9:30 AM.**

All data in this report are preliminary and subject to change as cases continue to be investigated. These data include cases in NYC residents and foreign residents treated in NYC facilities.

NYC COVID-19 Deaths

	Underlying Conditions ¹	No Underlying Conditions	Underlying Conditions Pending	Total
Age Group				
- 0 to 17	1	0	0	1
- 18 to 44	44	2	20	66
- 45 to 64	189	9	73	271
- 65 to 74	197	0	71	268
- 75 and over	358	3	172	533
Sex				
- Female	298	4	115	417

 3.9K

 9.8K

 16.6K



Hoarding Ventilators

- When President Trump noted that Cuomo's state had thousands of **unused ventilators** it hadn't even placed yet, Cuomo admitted this was true but said he still needed more: **"Yes, they're in a stockpile because that's where they're supposed to be because we don't need them yet. We need them for the apex,"**
- On April 2, Cuomo predicted the state would run out of ventilators in six days "at the current burn rate."
- But on **April 6**, Cuomo noted, **"We're ok, and we have some in reserve."**

Discussion and Extension

Why Allocation? Why Not FCFS?

- If FCFS, then the last few customers may get nothing and thus be really pissed off
- The last few customers can be anyone (Wal-Mart or some mum-pap shops)!
- Some kind of allocation/reservation is necessary
 - To provide a minimum satisfaction
 - To prevent disaster
 - Think about flu-vaccine, ...
- How to allocate supply for efficiency and fairness?

Fair Sharing

- Fair sharing: uses past sales to allocate supply
 - Allocates limited supply among customers by their %s of the last 13-week of shipments
 - Ex: if CVS accounts for 10% of the last 13-week of shipments, reserve 10% of the supply to CVS

Pros:

- No order → no game playing
- Provides a clear incentive for retailers to sell the products rapidly
- Assures that units are sent to markets where they are most needed.

Cons:

- Tend to lock in market shares – not really fair
- Eliminate retailers' forecast and business plans
- Still significant mis-match between demand and supply, ...

A Great Allocation Rule, But, ...

- Fair sharing creates a competition among retailers and encourages them to **increase the sales** by lowering prices
- The competition can be **so intense** that the retailers might **over-do** it, which leads to **their deteriorated profits** and the **supplier's greater gains**



Problems of Fair Sharing I

- Leads to **high-pressure** sales tactics
- Blamed for inducing dealers to **deceptively distort** their sales totals



GM warns allocation scammers

Dealers bend rules to get hot models



The GMC Terrain crossover is among the GM vehicles that were scarce at certain times last year.

- *“...General Motors is cracking down on dealers who it says are **“gaming”** its vehicle-ordering system to **finagle** more cars and trucks than they deserve...”*



- *“...a problem that has grown as retailers struggle to get **popular** models in light of GM's **tighter production schedules**...”*



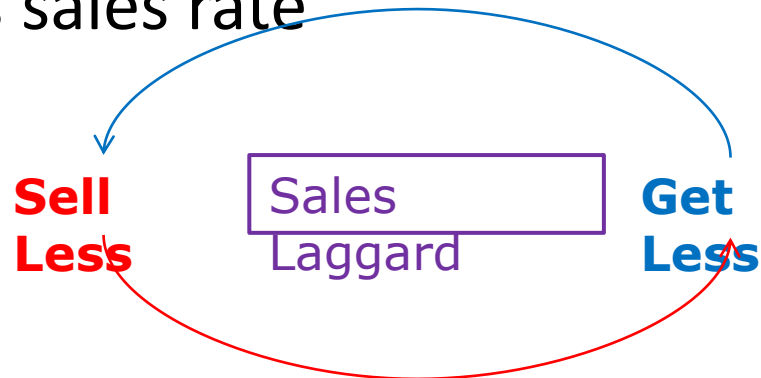
Problems of Fair Sharing II

2. Tend to **lock in** market shares

—**Sales Leader** vs. **Sales Laggard**



—Sales laggard **cannot catch up** unless sales leader reduce his sales rate



Sales Leadership Cases (Toyota)



Sales Leadership Cases (Toyota)



One Kansas Dealer, "we've been asking for more inventory for two years and now we finally got Siennas"

(Rechtin, Automotive News 2008)

Recap

- Demand uncertainty is common and the Newsvendor model is powerful!
- Supply shortage induces competitive games among the retailers and one's profit depends on others' actions.
- Shortage gaming can induce panic orders , hoarding and complete supply chain break-down.
- Information plays a critical role in the shortage gaming (either inflame or extinguish order inflation).
- Fair sharing eliminates the gaming behaviors but isn't really fair.



Questions?