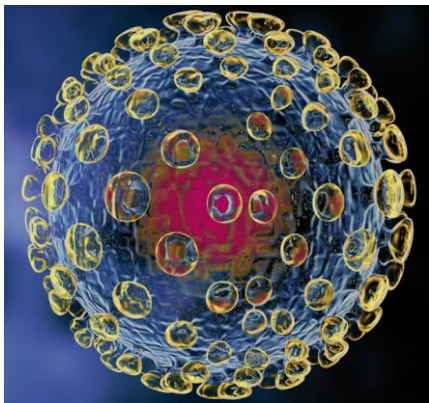
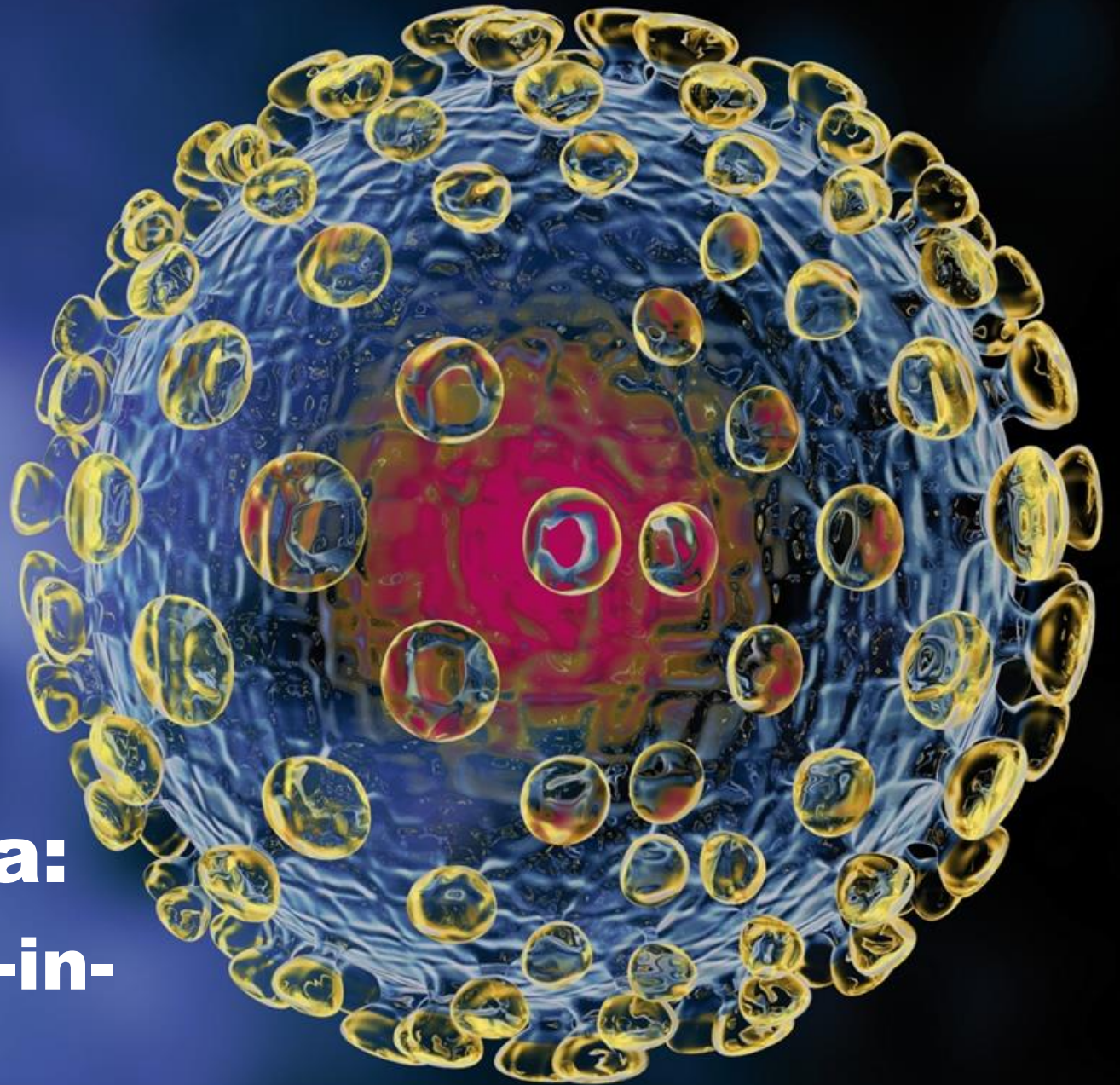
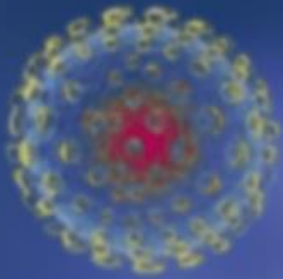


Pandemic Influenza Case and Hunger Chain Simulation



Dr. Yao Zhao
Professor in Supply Chain Management
Rutgers Business School





**Pandemic Influenza:
Just-in-Time vs. Just-in-
Case Strategies**

CORONAVIRUS

The U.S. has wasted over 82 million Covid vaccine doses

Vaccine providers say declining demand, large minimum orders and multidose vials make it hard to avoid waste while still offering shots to anyone who wants them.



June 6, 2022.

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Covid-19 Vaccine Doses, Once in High Demand, Now Thrown Away

Drugmakers and health authorities are discarding tens of millions of doses



Jul 6, 2022

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Manufacturers' Complains

- “just like you can't plan for a surge capacity in an emergency room of 500 or 1,000 patients from the 20 you see in a day, you can't have 100 million doses of vaccine supply sitting around waiting for something to happen.”
- “It’s kind of odd that the government would expect all those years for us to continue to throw millions of doses of vaccine away every year and never take a hit on it.”
- “We are a for-profit, publicly traded company. What I like to tell people is that neither Santa Claus nor UNICEF is listed on the NYSE.”

Conflict of Interests

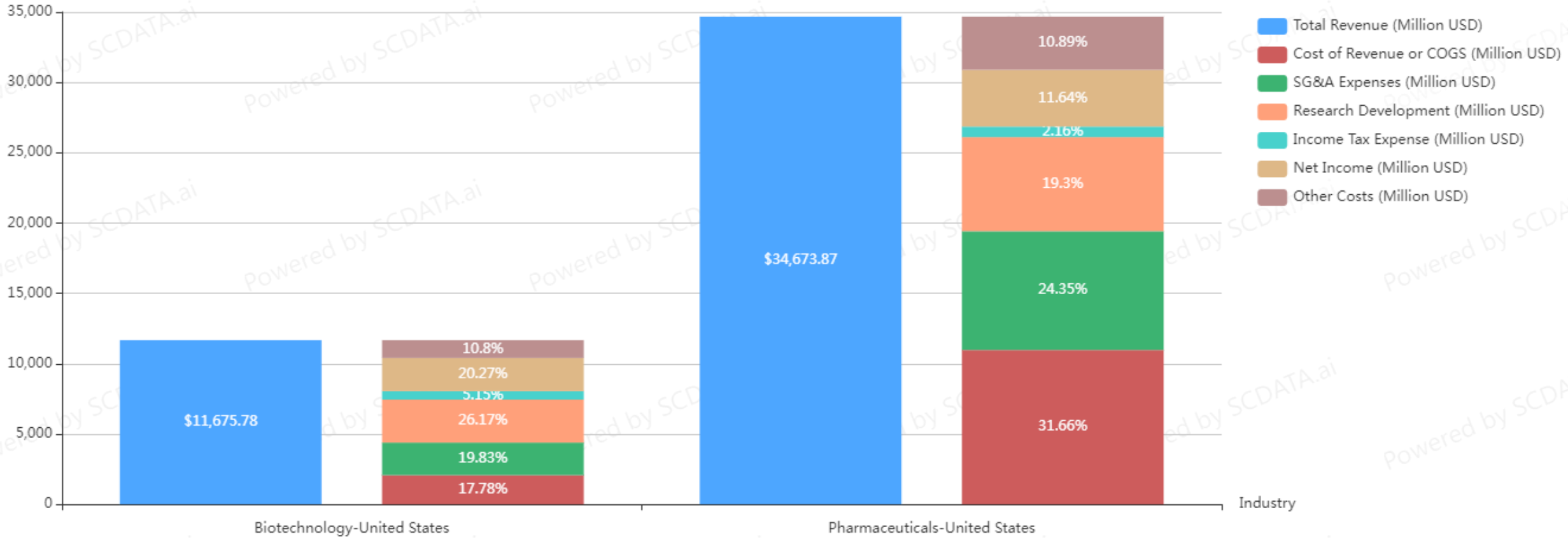
	Surplus/ Overage	Shortage/ underage
Manufacturers	Waste and destruction	Loss of profit
Society	Waste and destruction	Life loss & Social loss

- Manufacturers
 - Primary concern: surplus/overage
 - Conservative: just-in-time strategies
- Governments
 - Primary concern: shortage/underage
 - Aggressive: just-in-case strategies

Companies want to make money, governments want to save lives;

how to align the conflicted interests?

Average (Million USD)

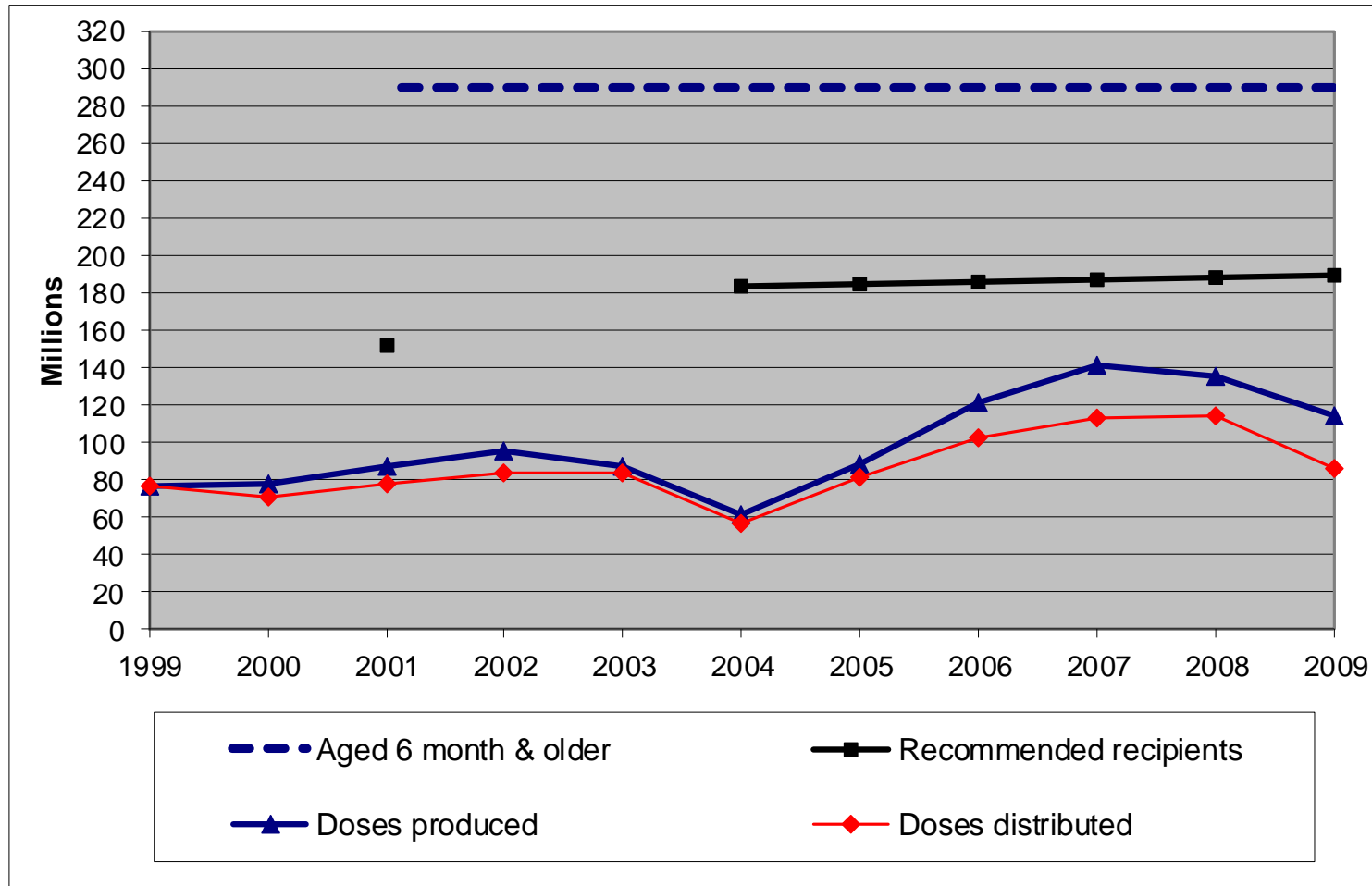


Revenue Breakdown, 2020, US SP500

Teaching Objectives

- Predicting rare but disastrous events
 - Historical events, population data, impact factors on vaccine demand ...
 - Regression vs. scenario forecasting
- Aligning commerce with public health
 - Cost sharing, fixed amount, absorbing overage, ...
 - Math models: newsvendor, probabilities, ...

Demand is Truncated → Regression Doesn't Work

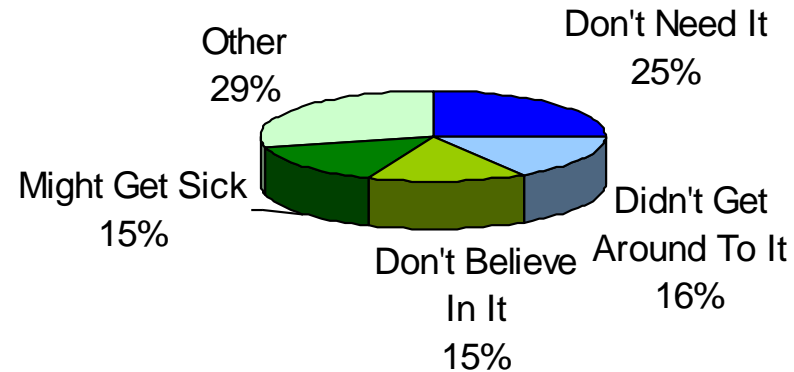


Demand Drivers: Demographics

- Compliance issues: In a mild year, less than 50% of target group is vaccinated

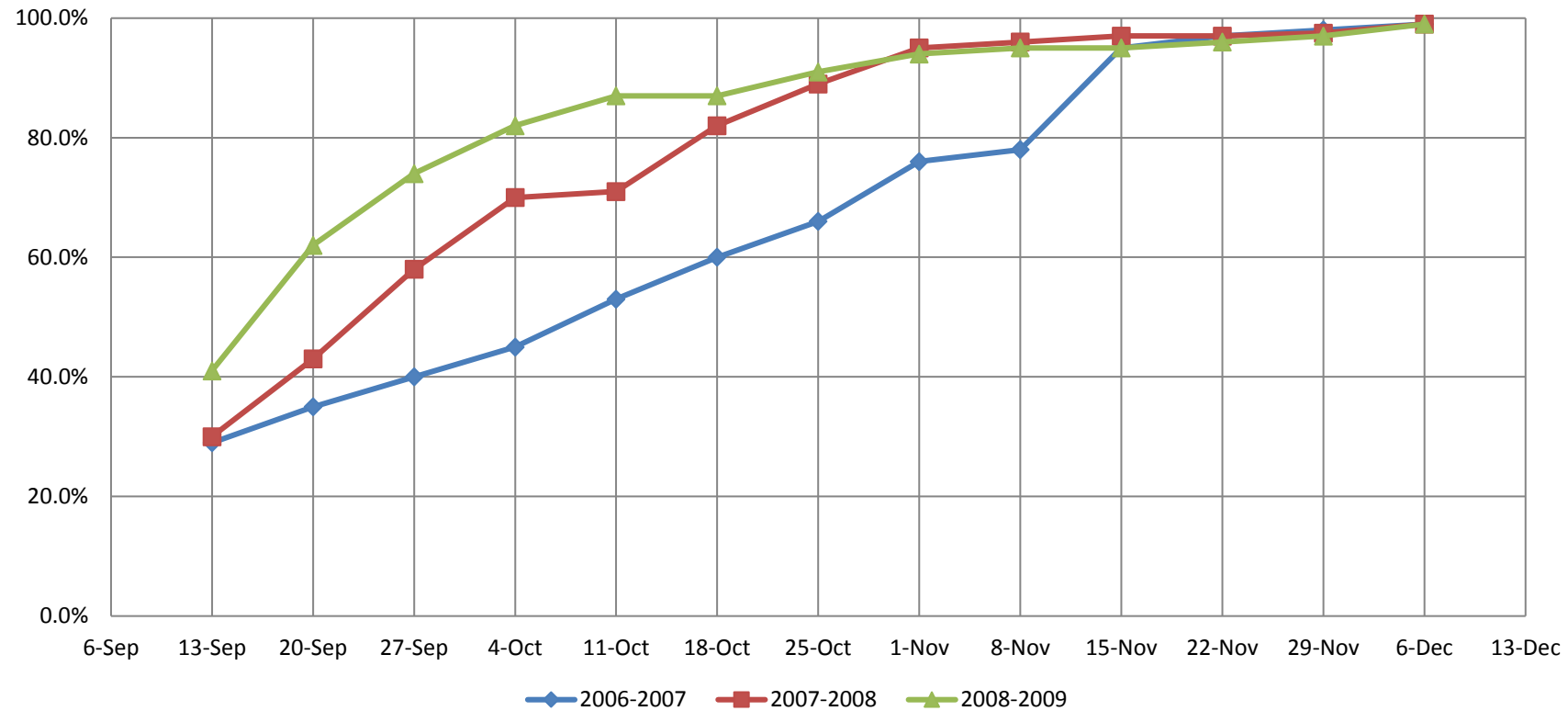
	White	Black	Hispanic
65 years of age or older	66%	48%	54%
Below poverty level	57%	49%	48%

Reasons for Not Getting a Flu Vaccination US Adults 18 and older (2008-2009 Flu Season)



Demand Drivers: Public Perception

- Early occurrences lead to panic demand

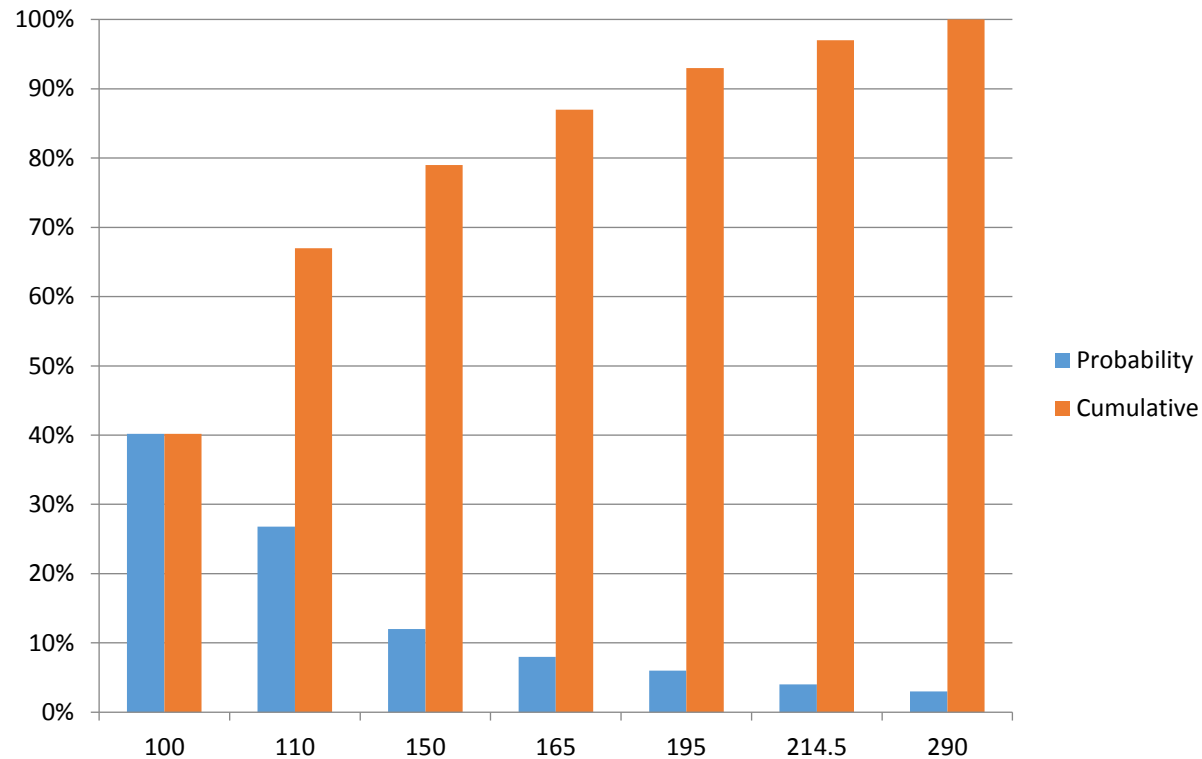


Scenario Forecasting

- Severe (pandemic) occurs 3 times in the last 100 years
- From 1999 to 2009, moderate occurs twice, moderately severe occurs once
- From 1999 to 2009, early occurrence happens four times

	Mild	Moderate	Moderately Severe	Severe	Marginal Probability
Early Occurrence	26.8%	8%	4%	1.2%	40%
Late Occurrence	40.2%	12%	6%	1.8%	60%
Marginal probability	67%	20%	10%	3%	100%

Scenario Forecasting: Demand Distribution



- **Just in Time** optimizes manufacturers' interest, is commercially recommended
- **Just in Case** optimizes the society's interest (including manufacturers), is recommended for public health purpose

JIT vs JIC Strategies

	Just-In-Time	Just-In-Case
Production quantity	150 million	195 million
Manufacturer profit	\$753.7 million	\$690 million
Society loss	\$466 million	\$333 million
Expected overage	30.8 million	68.8 million
Expected shortage	10.7 million	3.6 million

Aligning Commerce with Public Health

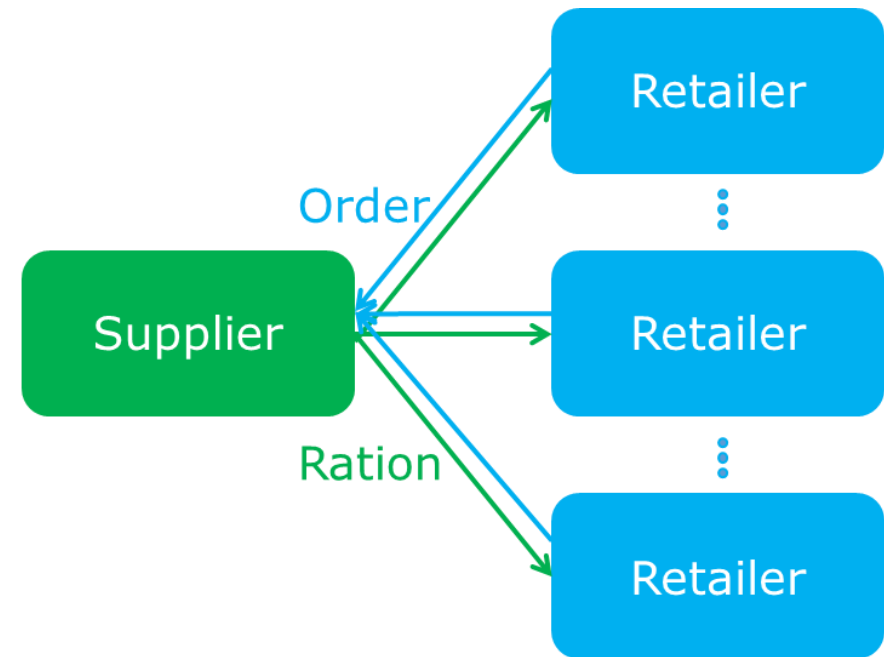
- How to incentivize the manufacturers to do the best for the society?
 - **Cost sharing:** Government shares a part of the variable production cost
 - **Fixed amount:** Government commits to purchase a certain amount
 - **Absorbing overage:** Government pays for all surplus at a certain price
 - Which is the prevailing practice? Which is the most effective strategy?

	Cost Sharing	Fixed Amount	Absorbing overage
Government Action	Share 60% variable cost	Buy 195 million doses	Buy surplus at \$2.1/dose
Government Cost	\$351 million	\$447 million	\$144 million

Hunger Chain Simulation – A Shortage Game

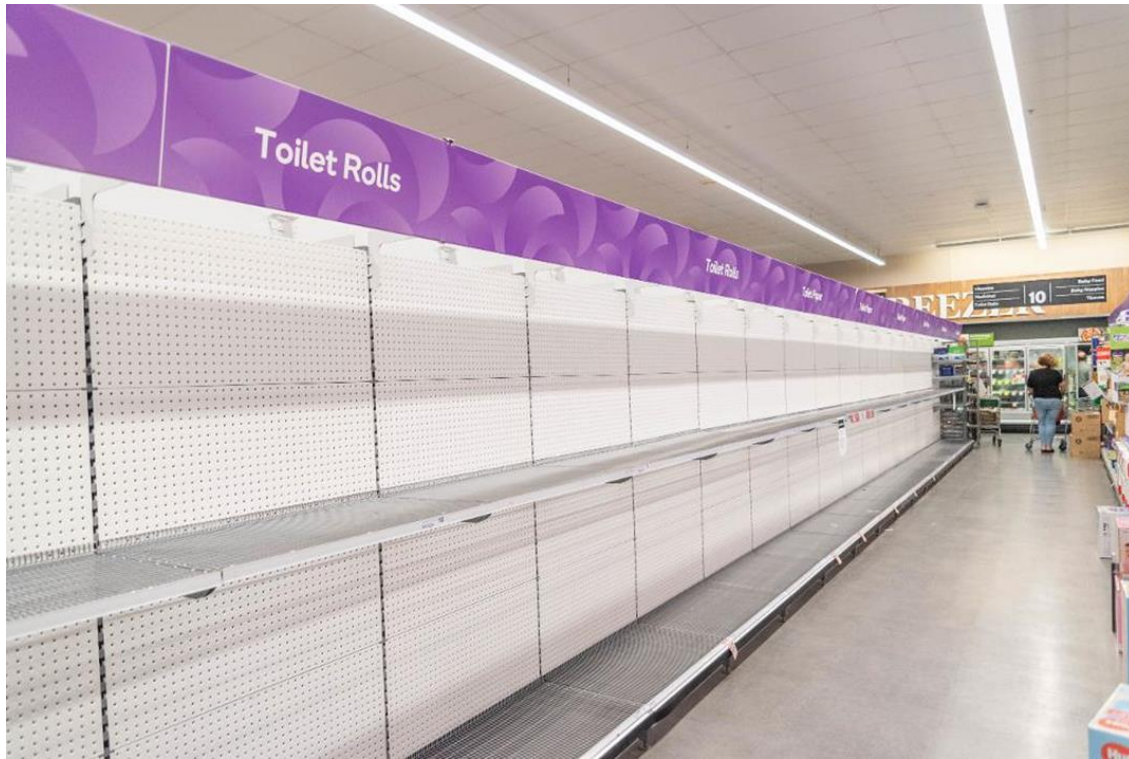


Mummy bird only has one worm, whom to give it to?



Supply is limited, how to allocate efficiently and fairly?

COVID-19 Shortages 2020

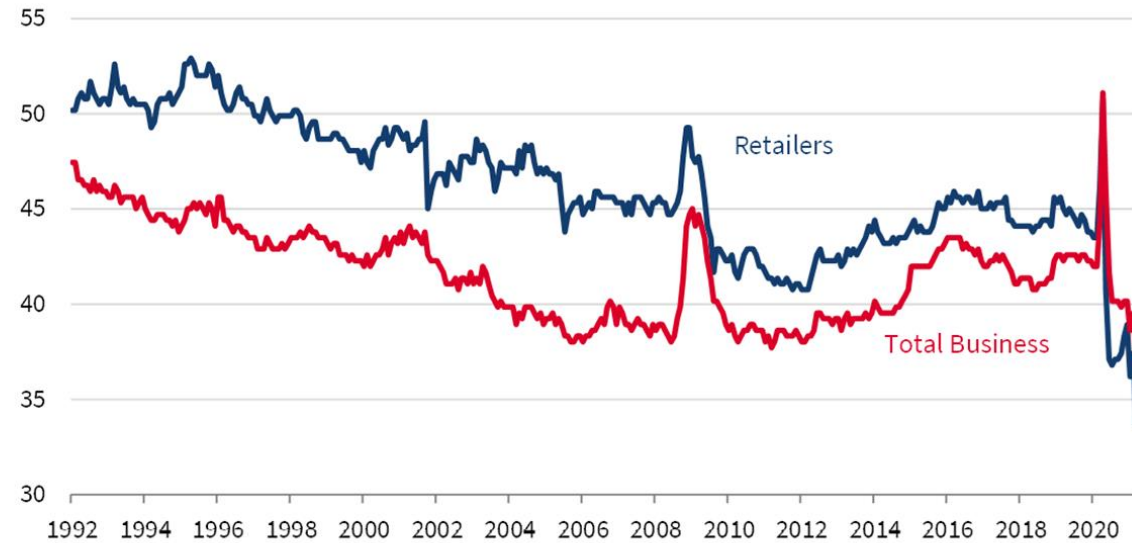


COVID-19, rare / disastrous events create significant shortages

Supply Chain Disruptions 2021

Figure 1. Businesses Have Little Inventory to Sell

Inventory-to-sales ratio (days of sales in inventory)



Sources: U.S. Census Bureau; CEA Calculations

<https://www.whitehouse.gov/cea/blog/2021/06/17/why-the-pandemic-has-disrupted-supply-chains/>



Bloomberg, 8/28/2021, U.S. Port Problems Reach Worst of Pandemic Amid Crush of Imports

Business Continuity – Russia-Ukraine Conflict in 2022

- 2021 U.S. dependence on Russian oil: About 8% of U.S. oil imports came from Russia *.
- 2021 EU dependence on Russian fossil fuels **:
 - 90 percent of the gas used in the EU is imported, ... with Russia providing 45 percent of those imports
 - Russia was also Europe's largest supplier of oil at **27 percent**, more than three times the next largest, Norway.

* <https://www.cbsnews.com/news/russian-oil-ban-heres-what-it-would-mean-for-consumers/>

** <https://www.nytimes.com/2022/03/08/business/european-union-russia-oil-gas.html>

Price Surge of Oil / Gas → Price Upswing in Supply Chain Downstream

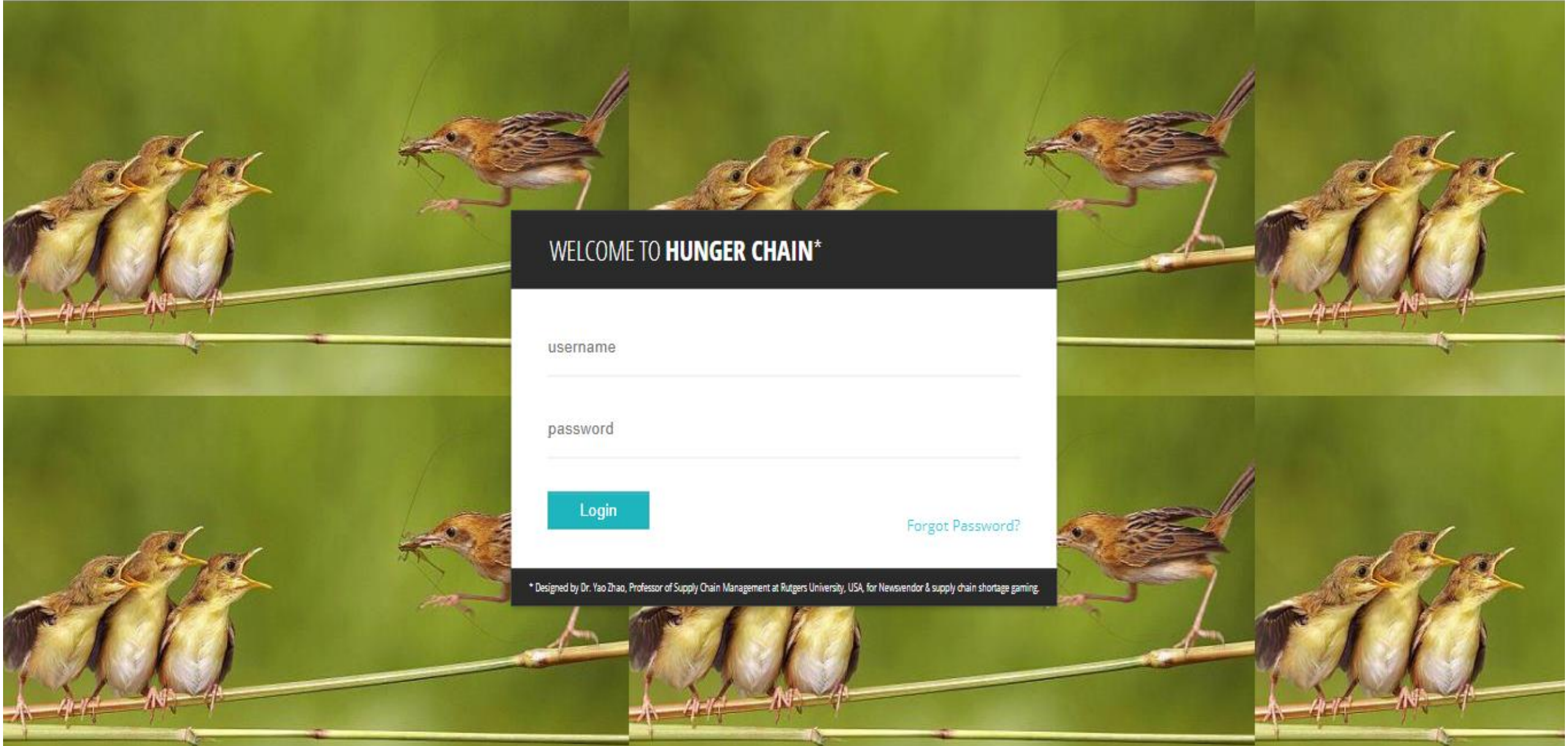


Panic Orders and Hoarding



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."



WELCOME TO HUNGER CHAIN*

username

password

[Login](#)

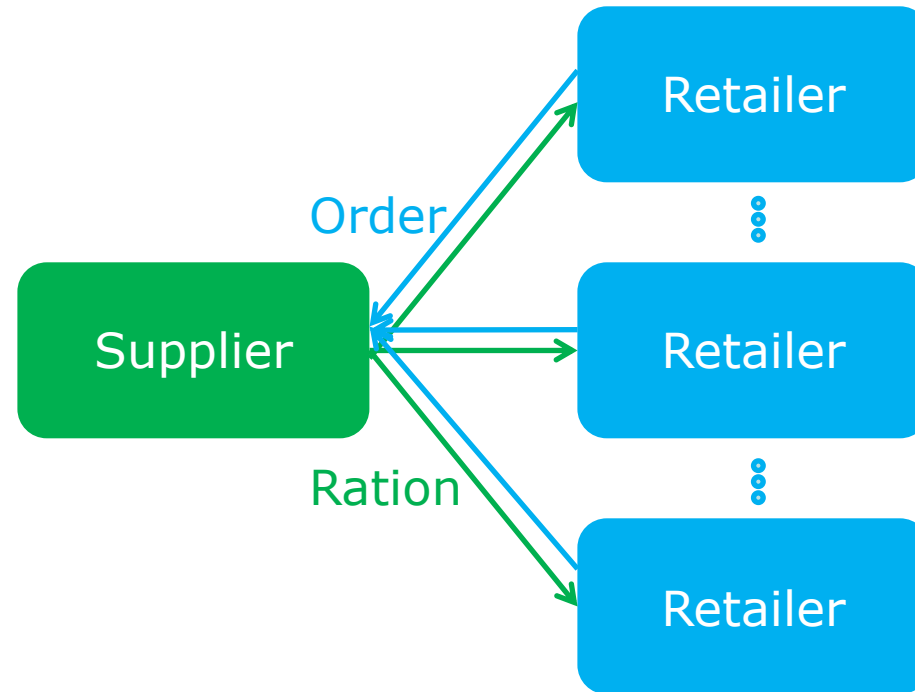
[Forgot Password?](#)

* Designed by Dr. Yao Zhao, Professor of Supply Chain Management at Rutgers University, USA, for Newsvendor & supply chain shortage gaming.

Teaching Objectives

- Hard to lecture but easy to play out.
 - Shortage gaming (**panic orders, hoarding**) and the value of information.
 - The **Prisoners' Dilemma**: Order inflation is inevitable.
 - Supply chain **competition**.
 - **Inventory rationing** for efficiency and fairness.

The Hunger 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 exceeds total supply,

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

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

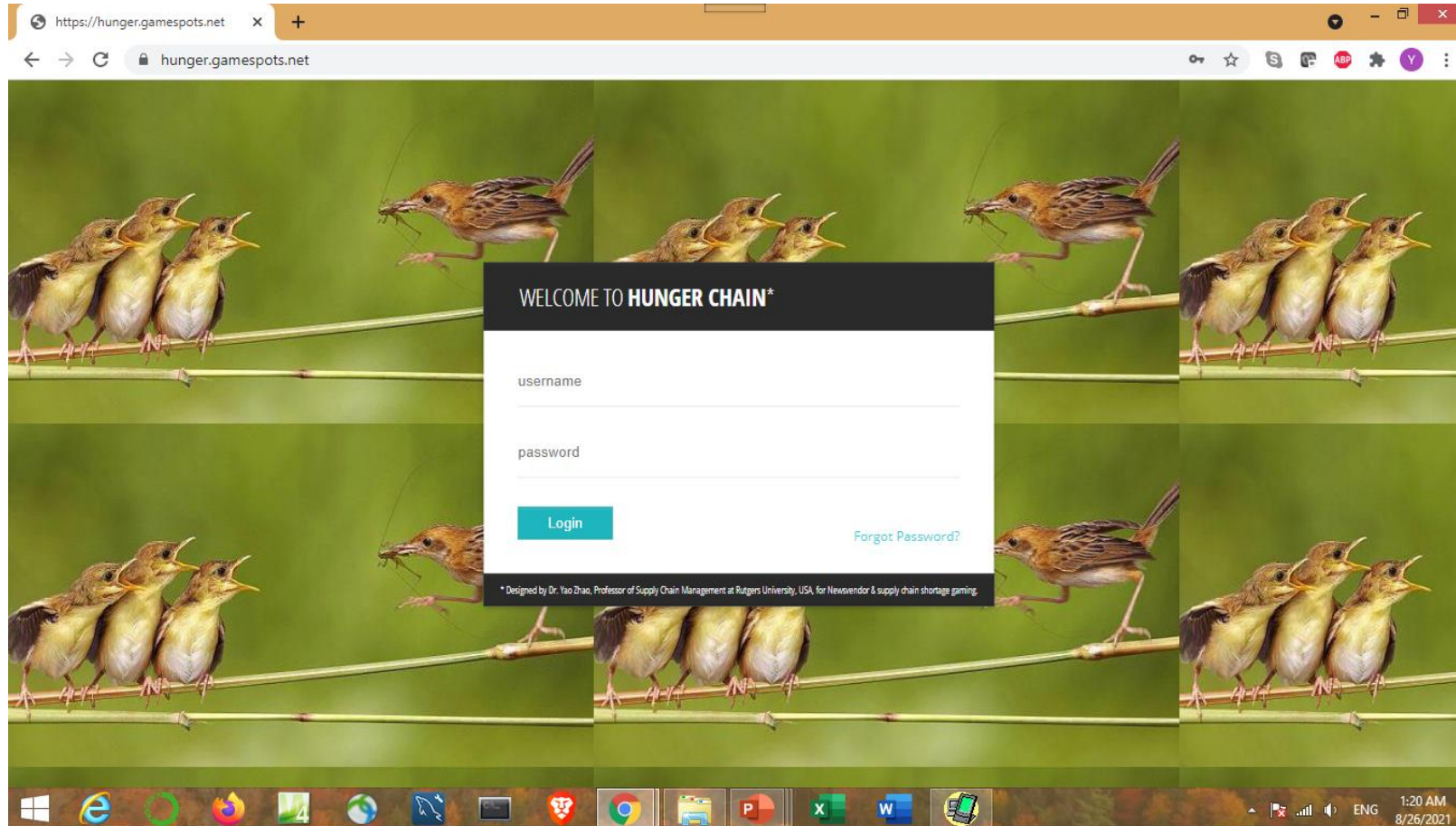
A Competitive Environment

Multiple Retailers

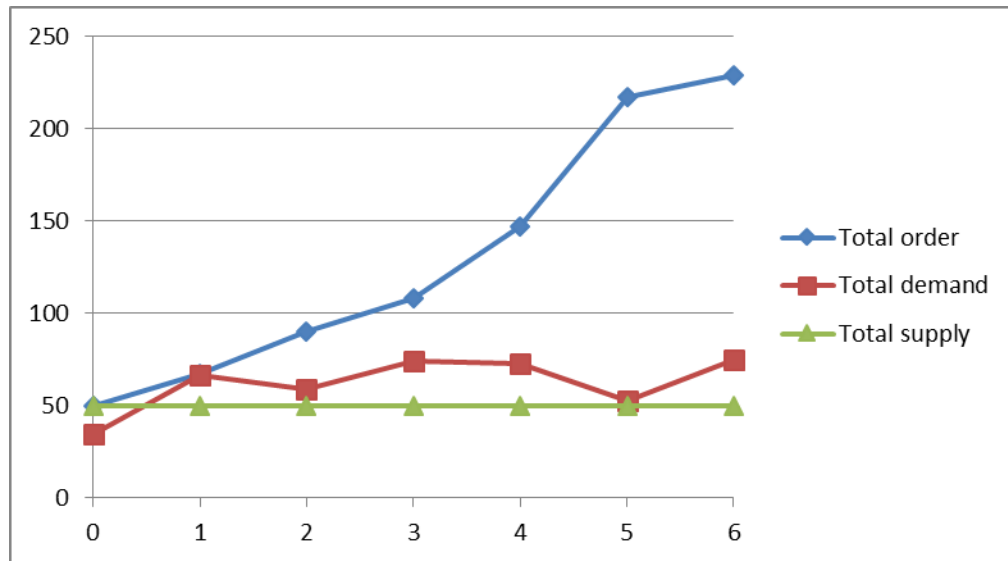


Compete for a limited supply

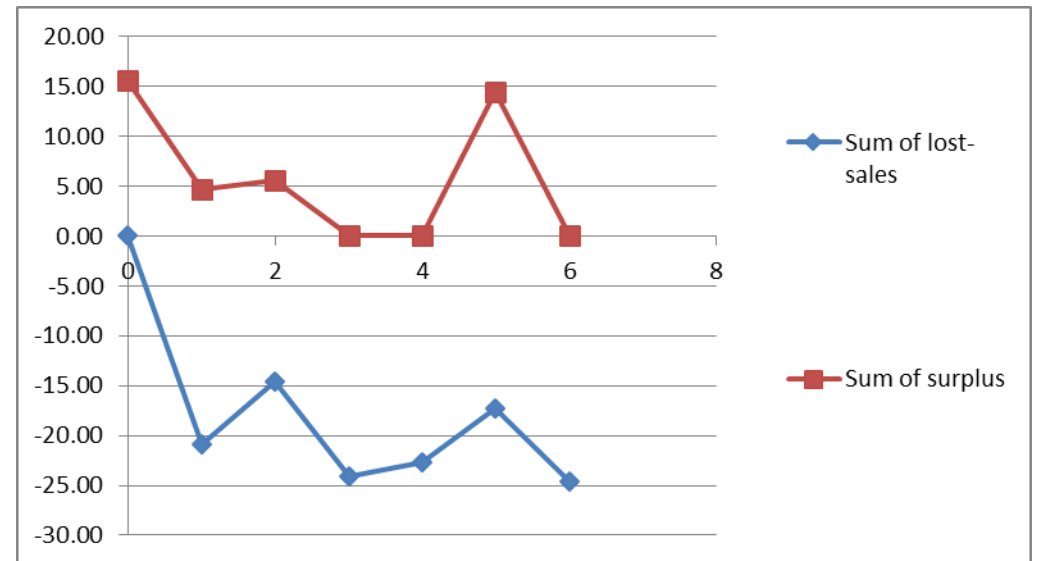
Let's Play



Game Trajectory (Example)



Panic orders



Hoarding

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 rosier 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."



*"Why the Supply Chain Broke Down" Businessweek, March 18, 2001.

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, ...



For more information

<https://yzhao12345.github.io/#hunger>