MSBA 7004
Operations Analytics

Class 9-1: Global Sourcing

2023

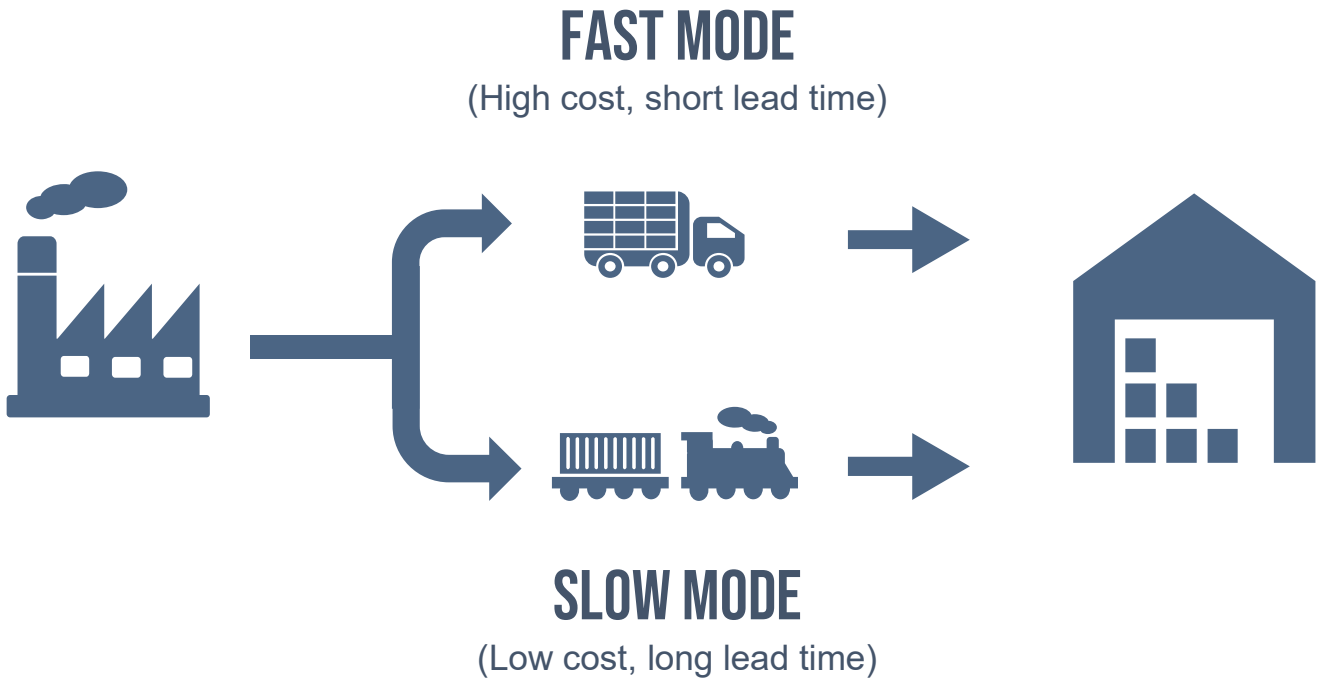
Manage a dual-source supply chain

- Dell can order computers in 2 ways:
  - Long lead time and cheap
  - Short lead time but expensi

The key strategic choice for supply chains:

Efficient? vs. Responsive?

Dual-mode transport faces exactly the same problem



Global dual sourcing is a challenge for many companies

Demand Volatility

- What product and customer traits drive demand fluctuations?
- How can sourcing decisions be tailored in light of shifting demand patterns?

Supply Risk

- What are the hard and soft costs of supply chain risk?
- How can sourcing be responsive to mitigate risk?

Cost Visibility

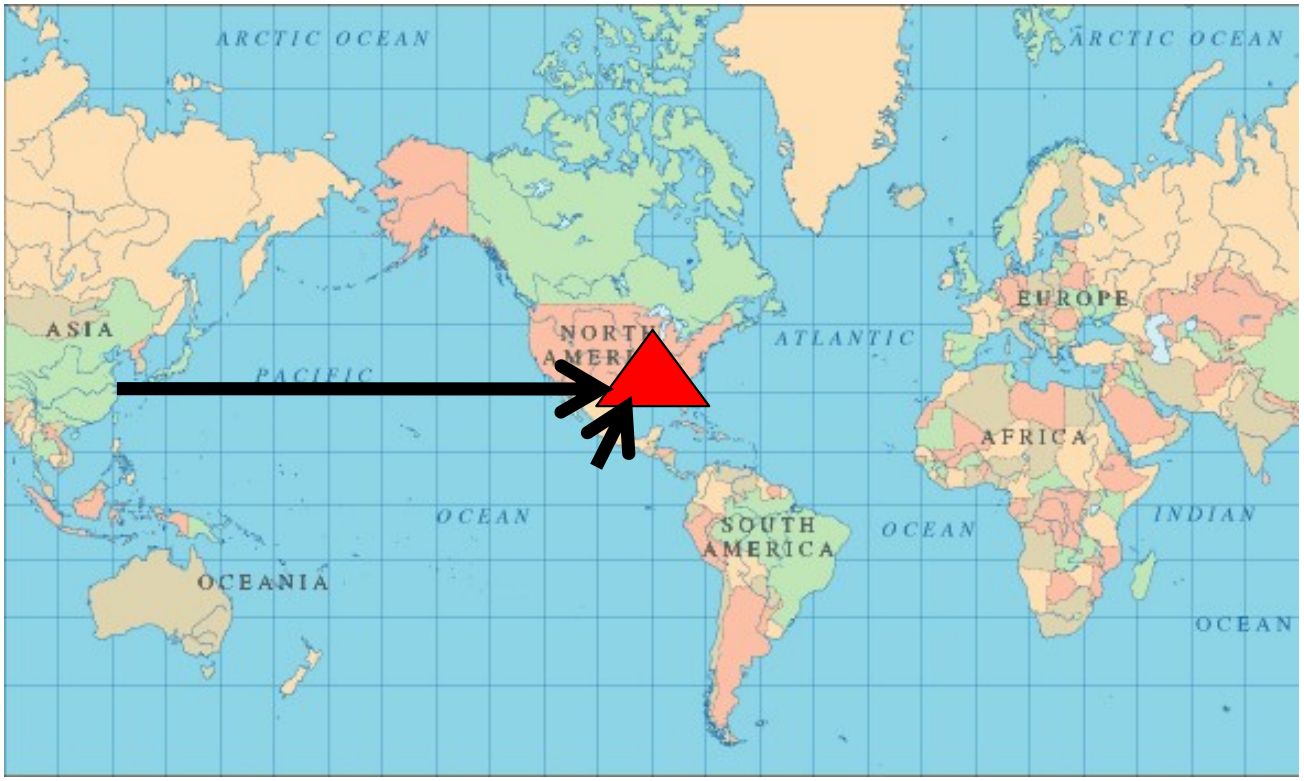
- What are the hidden costs of global sourcing?
- How can my total landed cost be determined?

Execution Complexity

- How do I make product to plant allocation decisions?
- What criteria should drive those decisions?

Real-time Simulation: Mexico-China?

- You are a $10B high-tech US manufacturer of wireless transmission components, about 20SKUs. Intense global competition put pressure on margins and working capital
- You have two assembly plants, one in China and another in Mexico, that supply a warehouse in McAllen, TX.
- *How can you best manage this existing global network?*



Strategic Global Sourcing

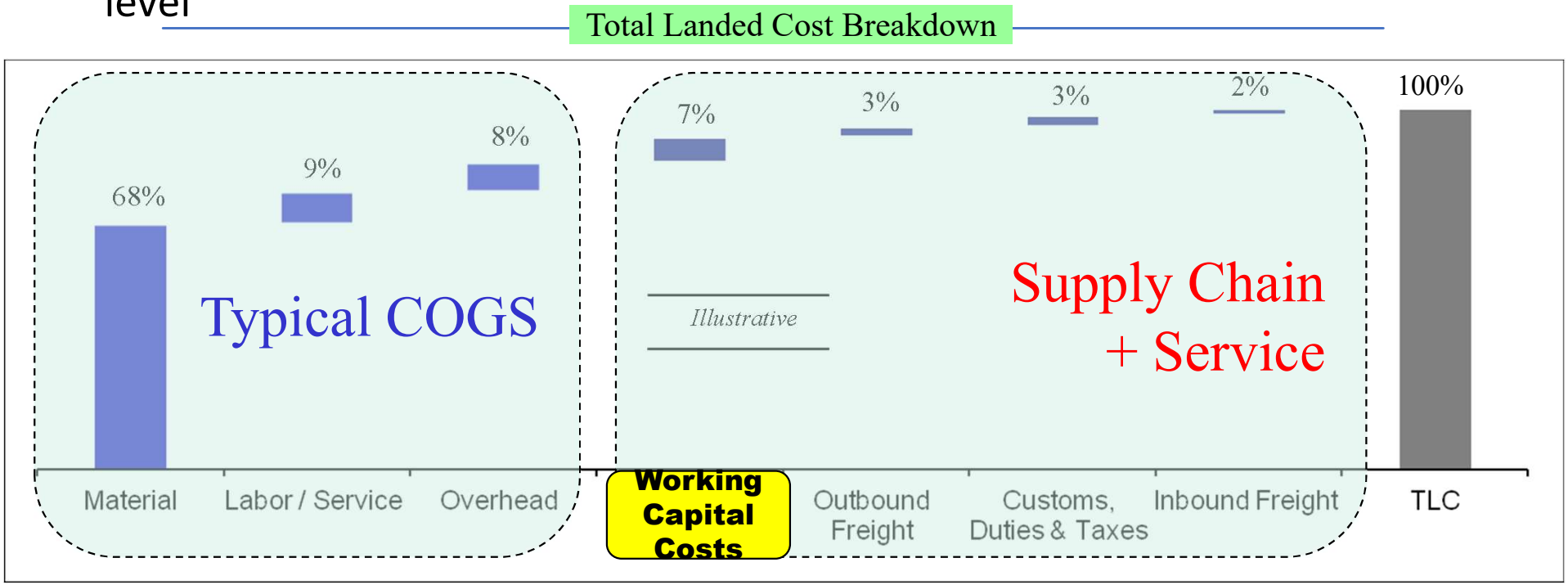
1. Total Landed Cost to optimize Global Networks

2. Mexico-China Sourcing Game

3. Take-away's
   - Academia: Principles for strategic dual sourcing allocation
   - Practice: Guidelines

Optimize global network allocation using Total Landed Cost

- TLC = total supply chain cost from origin to destination for a *given* service level



- TLC analysis enables improved business decisions without sacrificing customer service
  - Where to procure goods?
  - Where and how to deploy assets?
  - How to allocate resources to optimize costs?
  - How to optimize transportation services?

Strategic Global Sourcing

✓ Total Landed Cost to optimize Global Networks

➢ Mexico-China Global Sourcing Game

- Take-aways
  - Academia: Principles for strategic dual sourcing allocation
  - Practice: Guidelines

Strategic Global Sourcing Game Sales and Operations data

- Impatient customers: stock-out = lost sale
- New product, unknown demand, statistically similar to previous:

Sales Period:	5	6	7	8	9	10	11	12	13
SKU1	35	27	17	48	67	47	46	34	74
SKU2	28	31	48	26	84	61	19	33	48
SKU3	63	29	53	53	48	63	45	38	54
SKU4	42	69	48	29	63	26	22	54	36
SKU5	40	72	71	51	44	58	40	48	42
SKU6	64	52	44	52	74	70	43	53	33
SKU7	57	70	25	80	62	42	48	54	54
SKU8	41	49	48	72	80	35	40	58	44
SKU9	79	71	57	51	27	78	52	27	56
SKU10	54	59	54	48	31	51	42	31	49

  - Use to forecast the demand of “SKU11” (not the sum!)
- Order Leadtimes:
  - Mexico orders are received and available for sales next period (L = 1)
  - China orders are received after 4 periods (L = 4)

Sales price/unit	$ 10,000	Leadtime	
China sourcing cost/unit	$ 7,250.00	4 periods	
Mexico sourcing cost/unit	$ 8,000	1 period	
Interest rate per period	1%		

Use this sheet to enter demand and orders to simulate performance; also use it for tracking while playing the simulation in class

* Periods 1 to 4 allow you to order supplies and fill the pipeline before demand and sales starts in period 5
* The "historical order data" sheet shows representative historical demand information

	Demand	Orders placed to		Inventory Pipeline Status				Units	Period	Total	Bank account
eriod		China	Mexico	3 periods out	2 periods out	1 period out	on-hand	sold	Fill-rate	Fill-rate	value
1	0			0	0	0	0	0	-	-	$ -
2	0			0	0	0	0	0	-	-	$ -
3	0			0	0	0	0	0	-	-	$ -
4	0			0	0	0	0	0	-	-	$ -
5				0	0	0	0	0	0%	0%	$ -
6				0	0	0	0	0	0%	0%	$ -
7				0	0	0	0	0	0%	0%	$ -
8				0	0	0	0	0	0%	0%	$ -
9				0	0	0	0	0	0%	0%	$ -
10				0	0	0	0	0	0%	0%	$ -
11				0	0	0	0	0	0%	0%	$ -
12				0	0	0	0	0	0%	0%	$ -
13				0	0	0	0	0	0%	0%	$ -
14				0	0	0	0	0	0%	0%	$ -
15				0	0	0	0	0	0%	0%	$ -
16				0	0	0	0	0	0%	0%	$ -
17				0	0	0	0	0	0%	0%	$ -
18				0	0	0	0	0	0%	0%	$ -
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20				0	0	0	0	0	0%	0%	$ -
21				0	0	0	0	0	0%	0%	$ -
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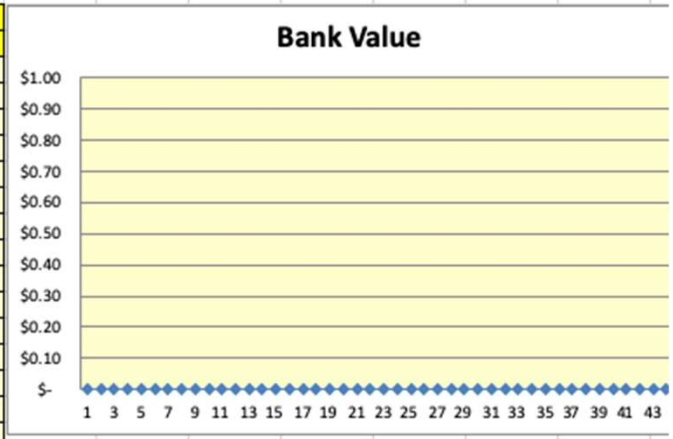


Strategic Global Sourcing Outline

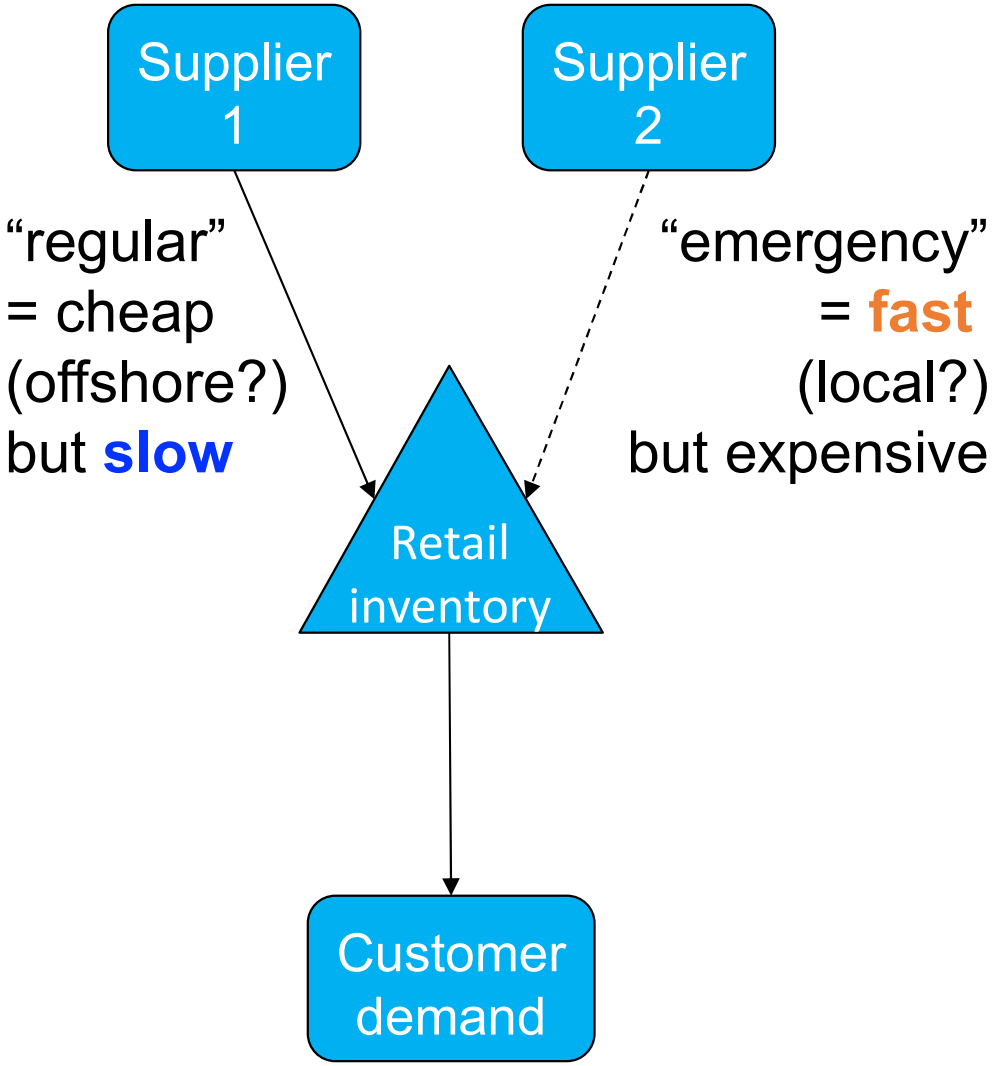
1. Total Landed Cost to optimize Global Networks

2. Mexico-China Sourcing Game
   - ➢ Debrief

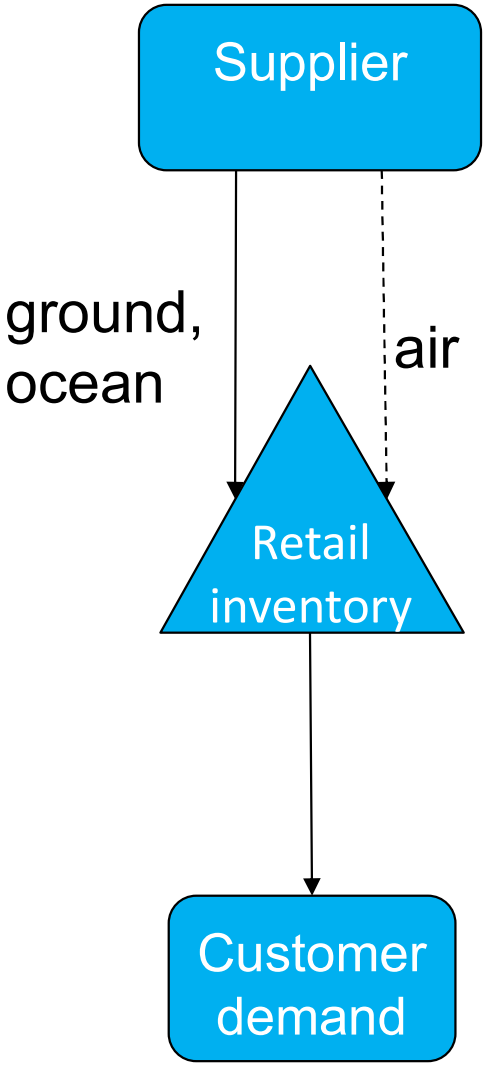
3. Take-aways
   - Academia: Principles for strategic dual sourcing allocation
   - Artificial Intelligence applications

Dual Sourcing is frequently practiced and gives strategic insight into offshoring & sourcing design

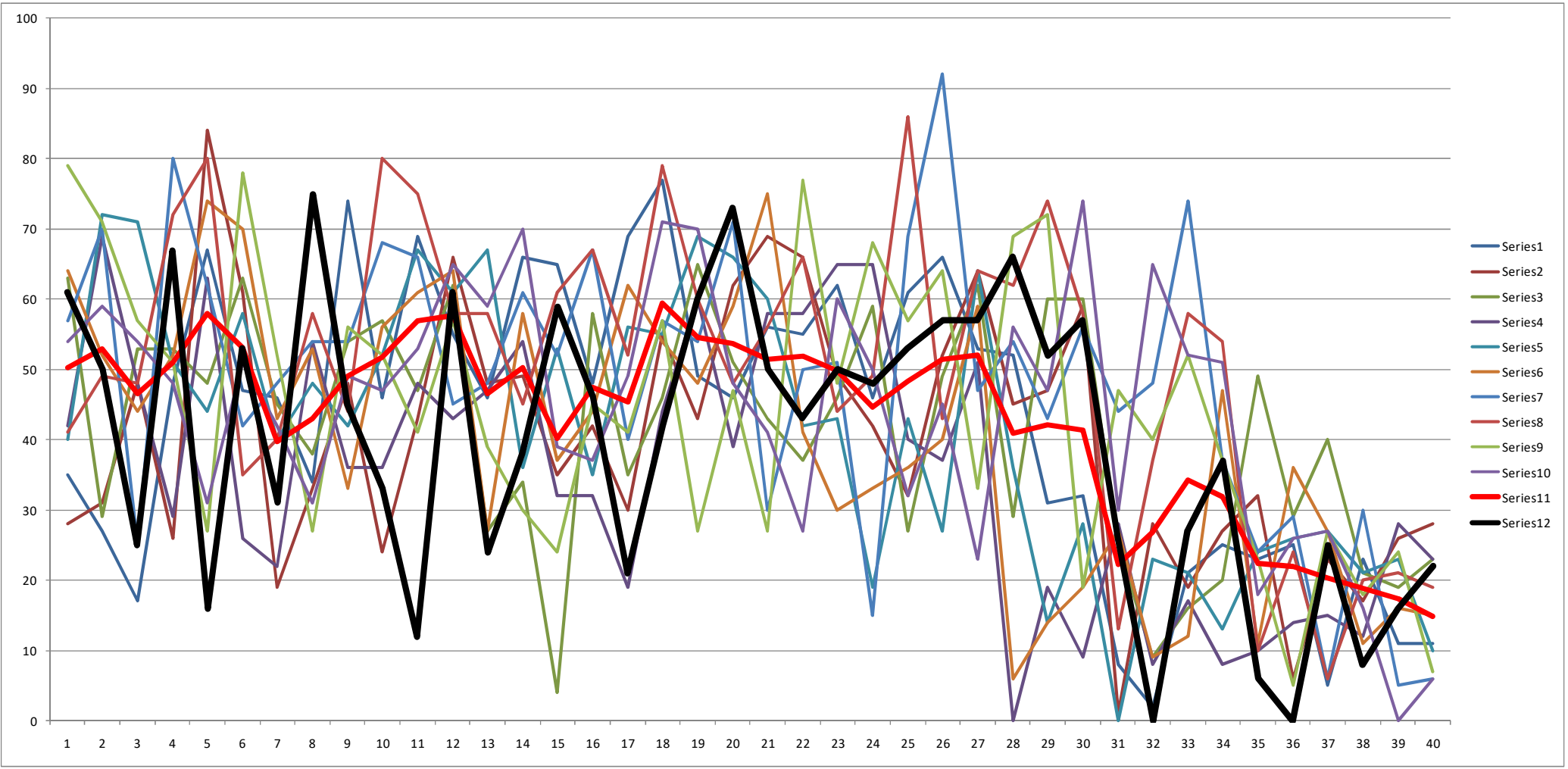
Two Suppliers



Two Modes

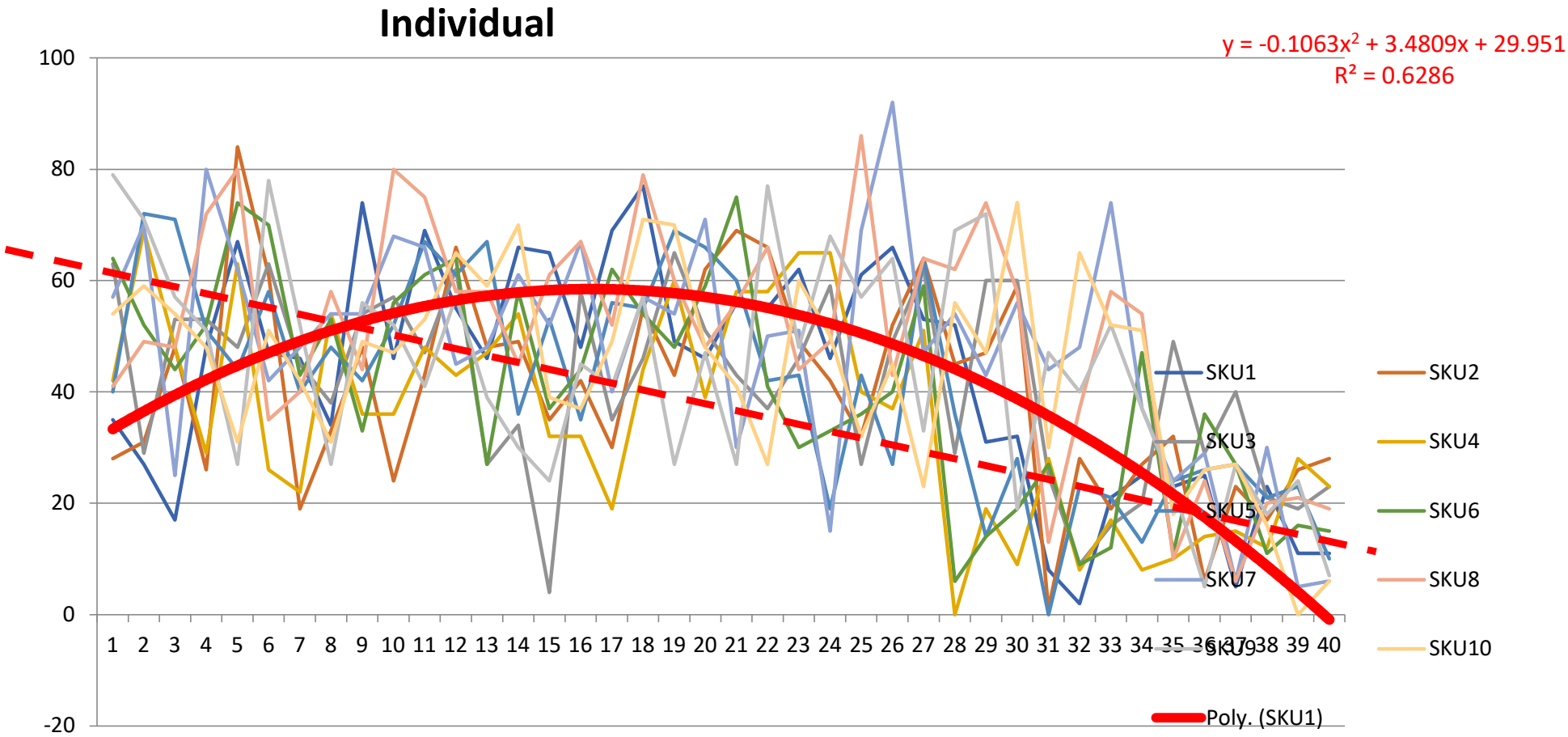


Step 1: Analyze
Demand forecasting and volatility

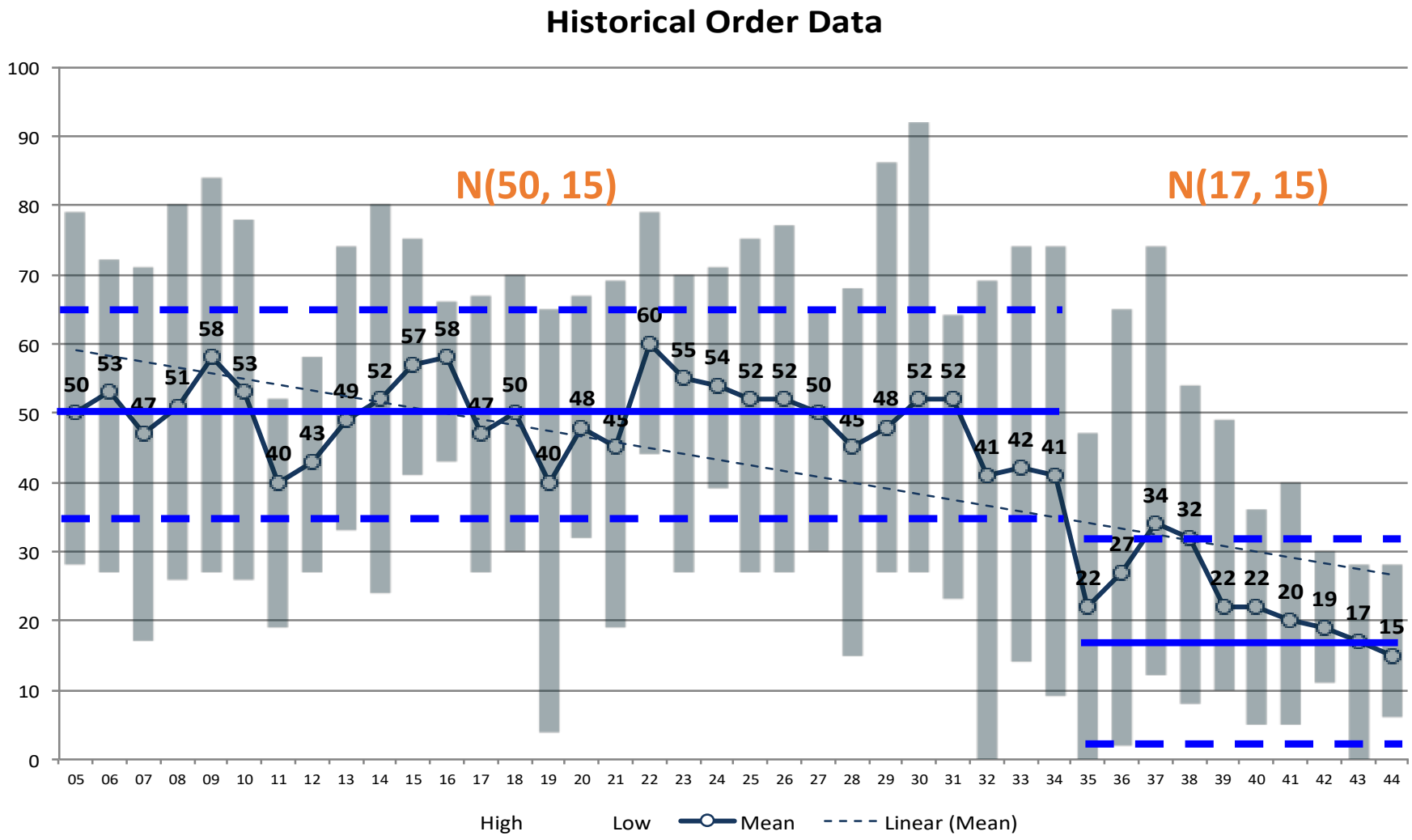


How to use the data to generate a Sales Forecast

- Created a best fit line for the individual SKU graph (below) and used those predicted sales as our demand forecast (~1700 units)

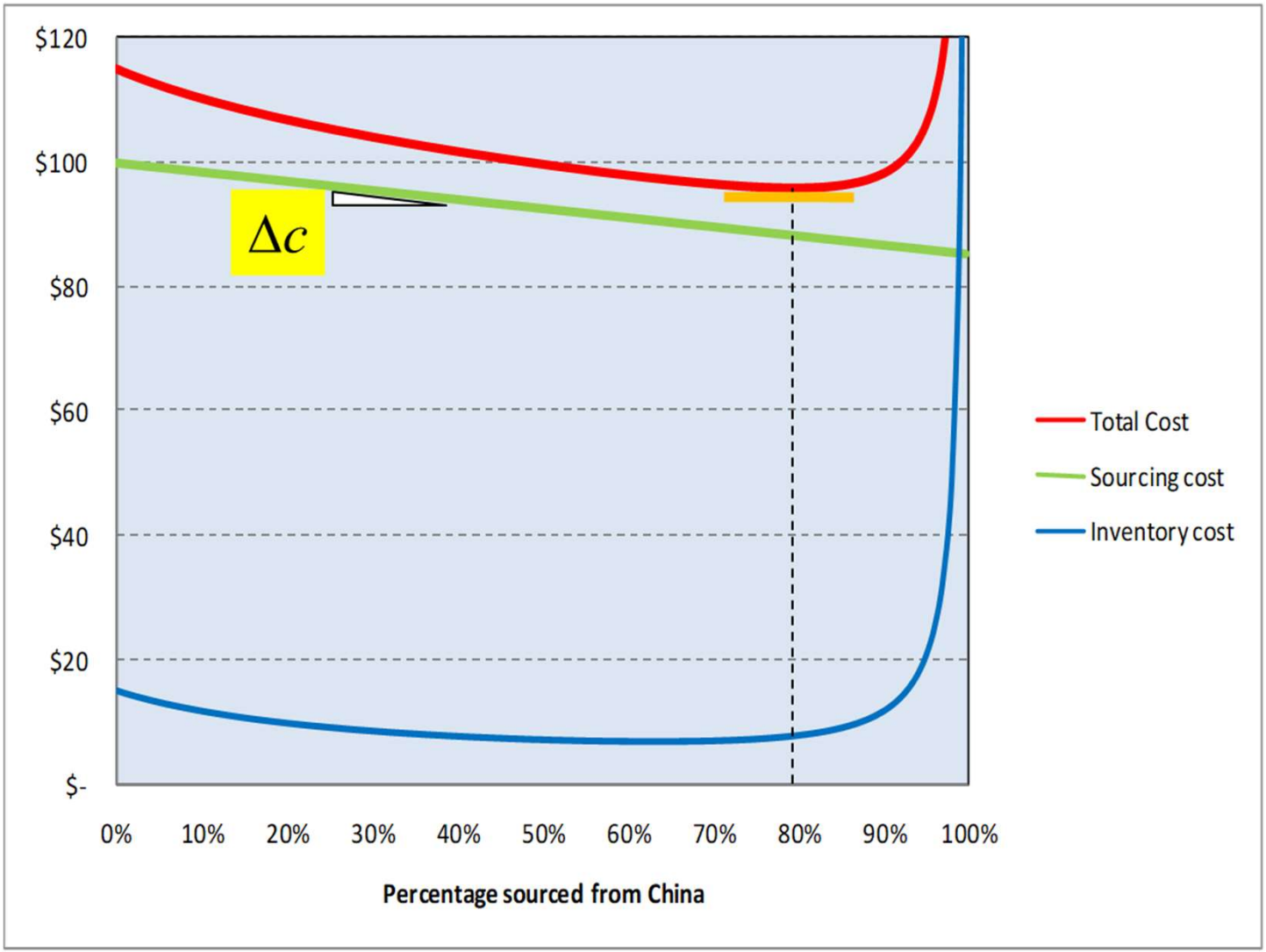


Statistical Process Control: Detecting mean shifts



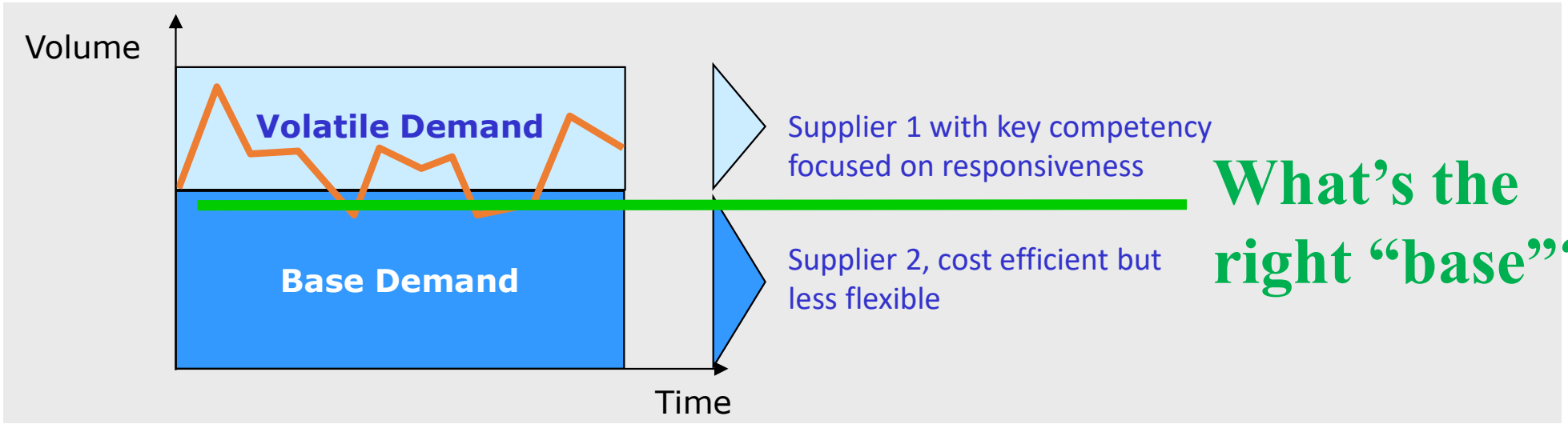
Dual Sourcing: Optimize Total Landed Cost

Illustrative example: China with 15% cash cost advantage



Dual Sourcing:
Tailored Base-Surge (TBS) Policy

- Allocate “base demand” to China
  - Source constant quantity per period from China
  - Allows China to minimize variations and maximize efficiency
- “Surge demand” is filled from Mexico
  - Takes advantage from proximity which allows responsiveness



Setting the Base Demand = base allocation * average demand

$$\text{base allocation ("offshored fraction")} \geq 1 - \sigma\sqrt{\frac{h}{2\mu\Delta c}}$$

- h = Holding cost <u>per unit</u> <u>per period</u>
- Δc = China's sourcing cost advantage <u>per unit</u>
  = Mexico cost – China cost
- μ = Average demand per period
- σ = Standard deviation of demand per period

This allocation expression is a reasonable approximation/starting point for a more refined analysis that can capture other factors not considered in development of expression.[1]

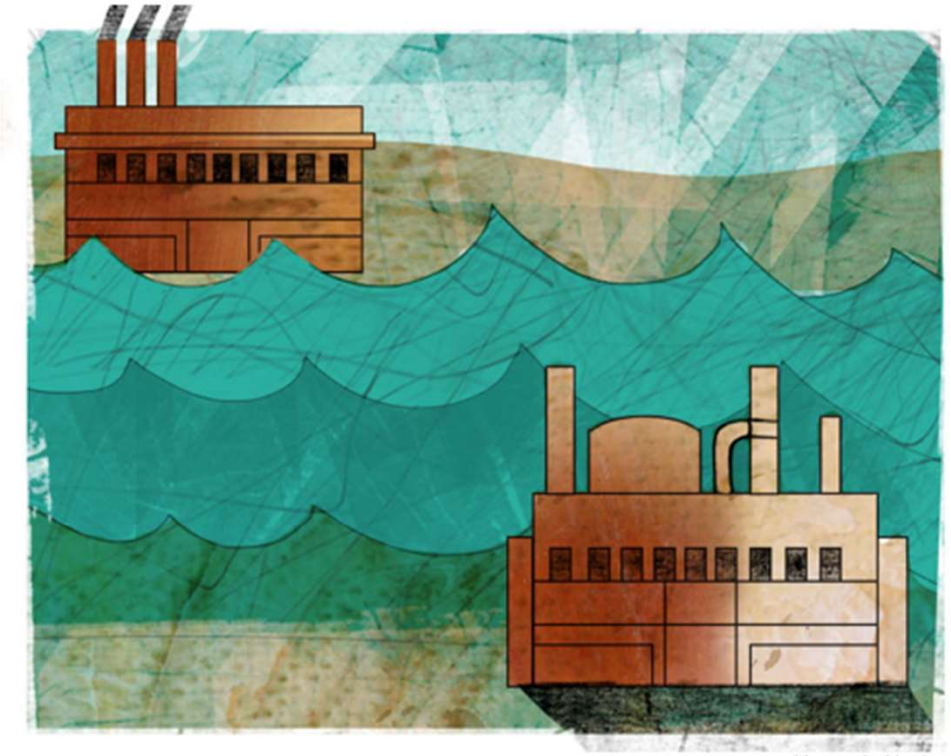
1. Based on Allon and Van Mieghem (2010) "Global Dual Sourcing: Tailored Base Surge Allocation to Near and Offshore." The prescription derives from an asymptotic analysis of a stylized theoretical model of inventory, demand and supply volatilities in continuous time. Prescription should be adjusted before implementation to reflect specifics and complexities of practice.

OPERATIONS | Jul 10, 2017

How Much Does It Cost to Manufacture Overseas Versus at Home?

A new tool helps companies calculate whether to offshore, manufacture locally, or dual source.

Based on the research of Robert Boute and Jan A. Van Mieghem



Yevgenia Nayberg

- https://insight.kellogg.northwestern.edu/article/how-much-does-it-cost-to-manufacture-overseas-versus-at-home
- https://dennisjzhang.shinyapps.io/no_capacity/

Key Points

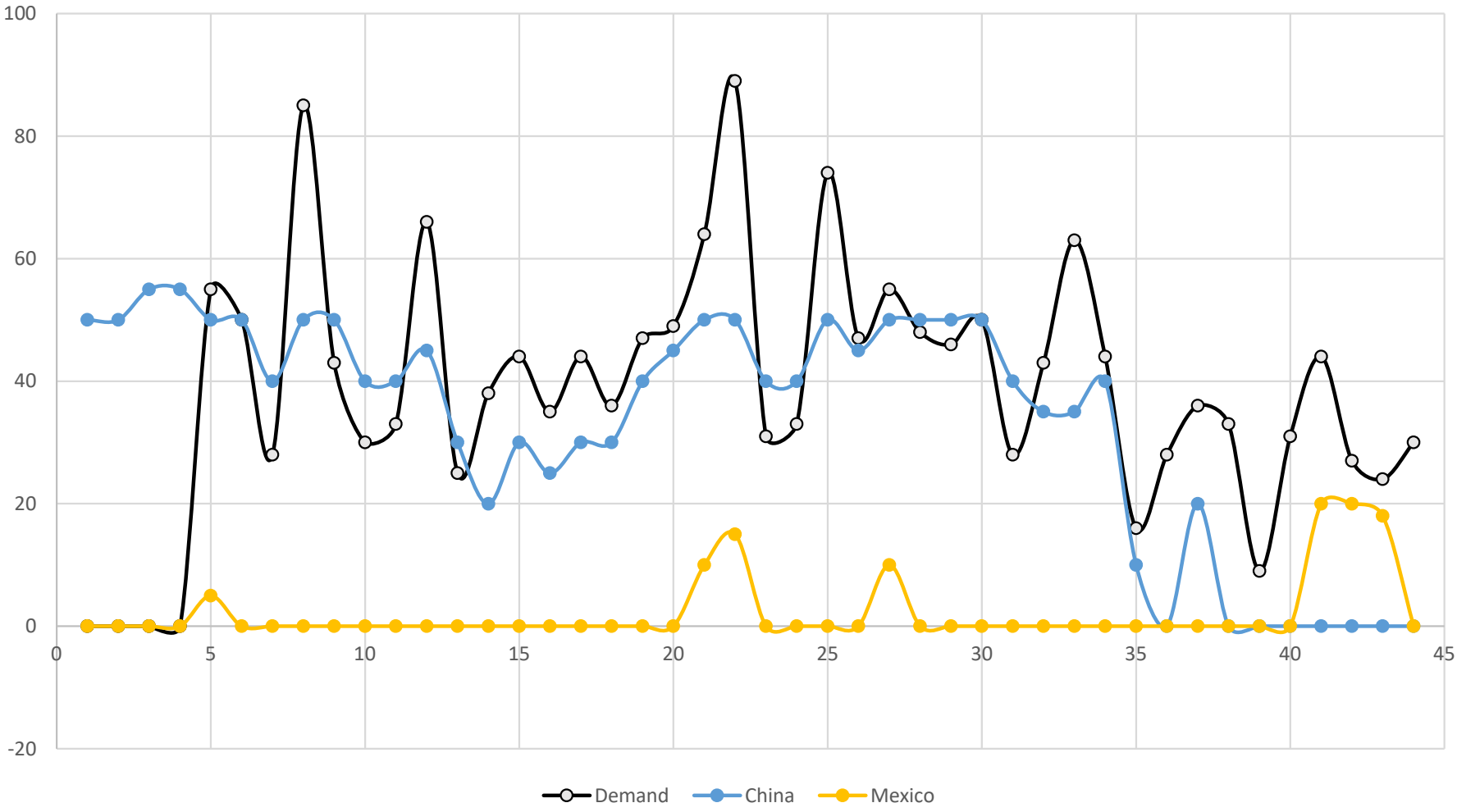
- Good sourcing portfolios combine sources with *different* competencies
  - expensive/quick versus cheap/slow suppliers
  - Dual sourcing allows you to trade-off cost and responsiveness

- Analytics: Always consider Total Landed Cost when configuring global networks
  - Quantifying, let alone optimizing, sourcing flexibility is difficult
  - Can use the square-root formula as a starting point; refine using simulation

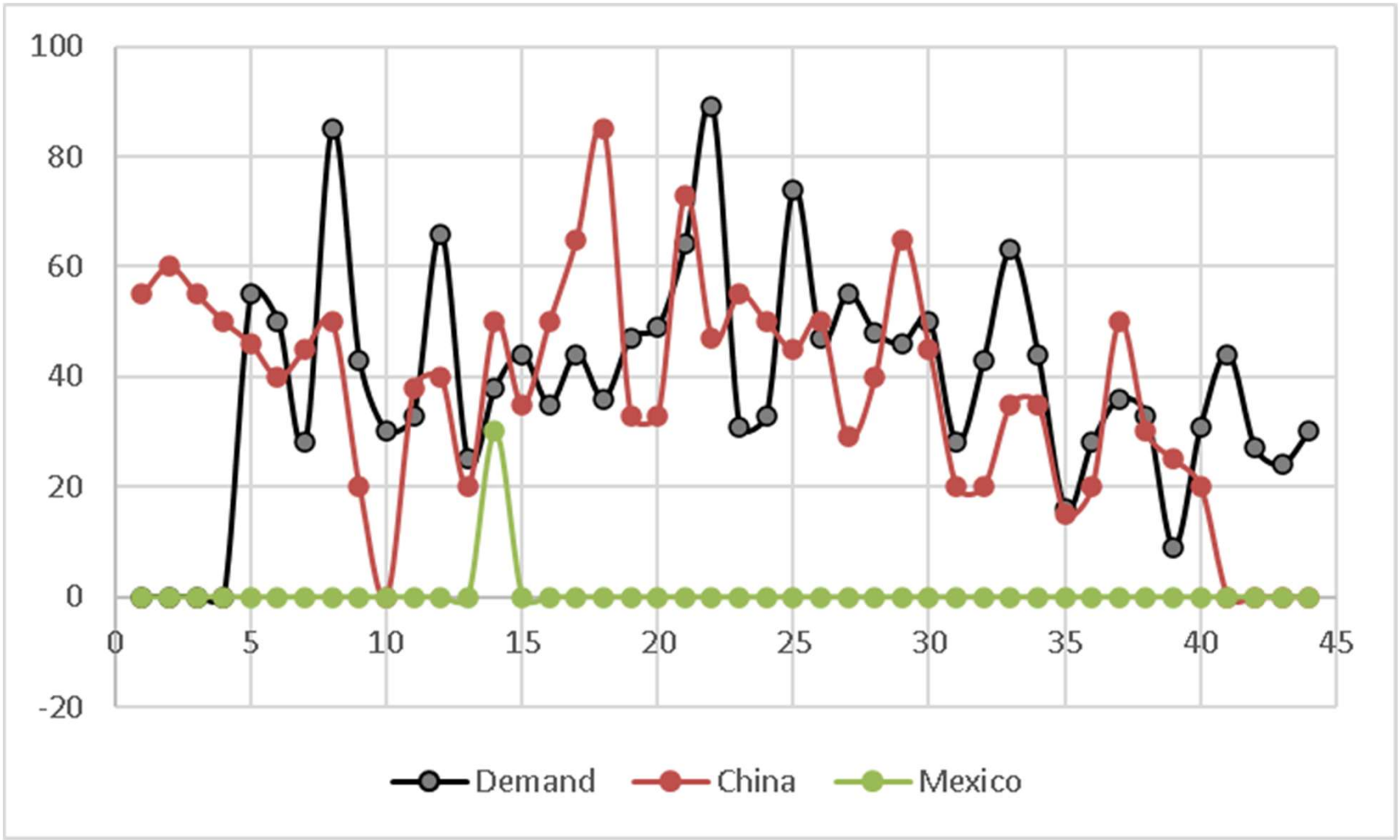
- Choose a robust strategy that you trust, can explain, and can stick to

- Tailored Base Surge (TBS) Policy:
  - Allocate a base (stable) demand to the cheap/slow supplier and use the expensive/quick supplier for surge demands (recurrent commercial risk).
  - Adapt strategic allocations over the product life cycle
  - The expensive/quick supplier is even more valuable for rare disruption risk

Order pattern



Order pattern



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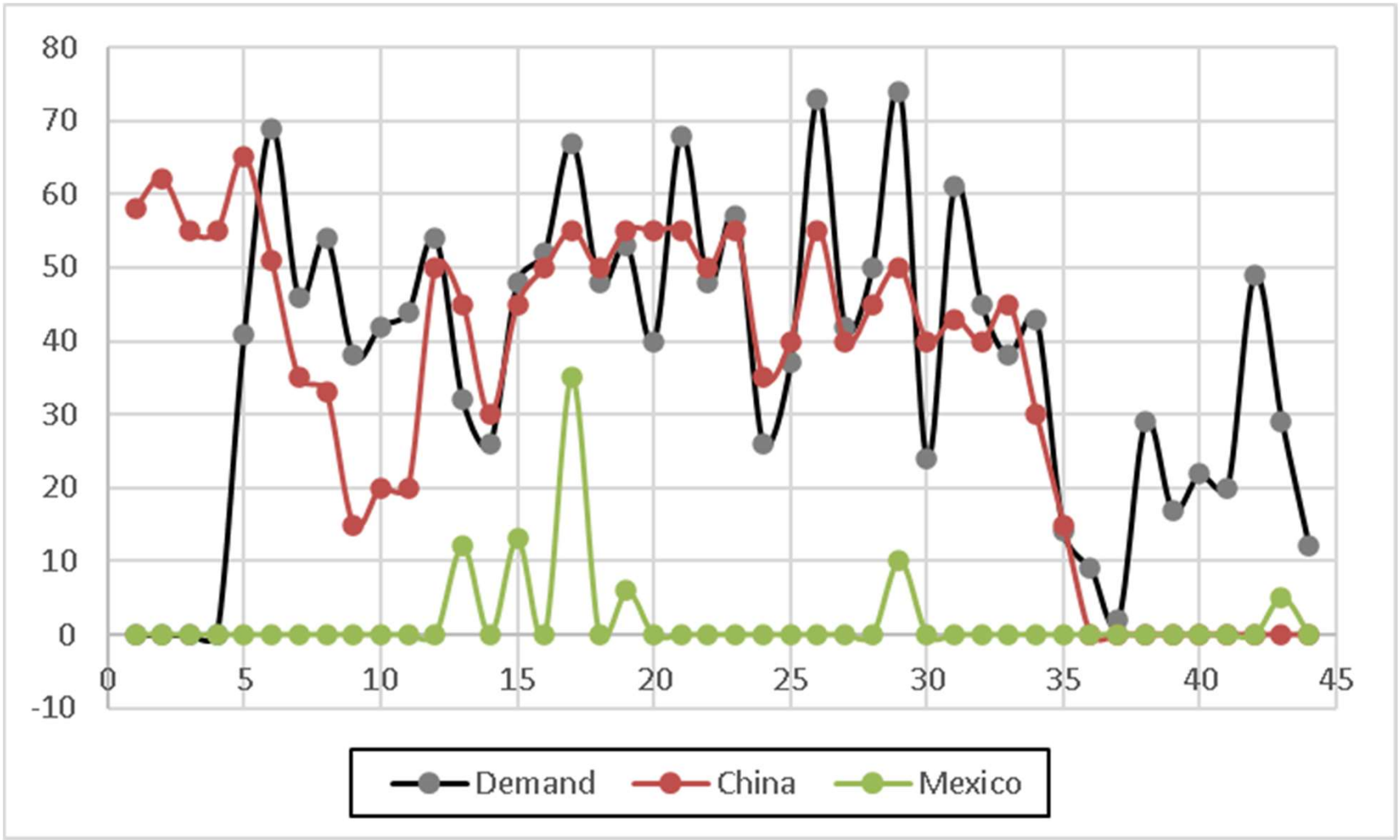
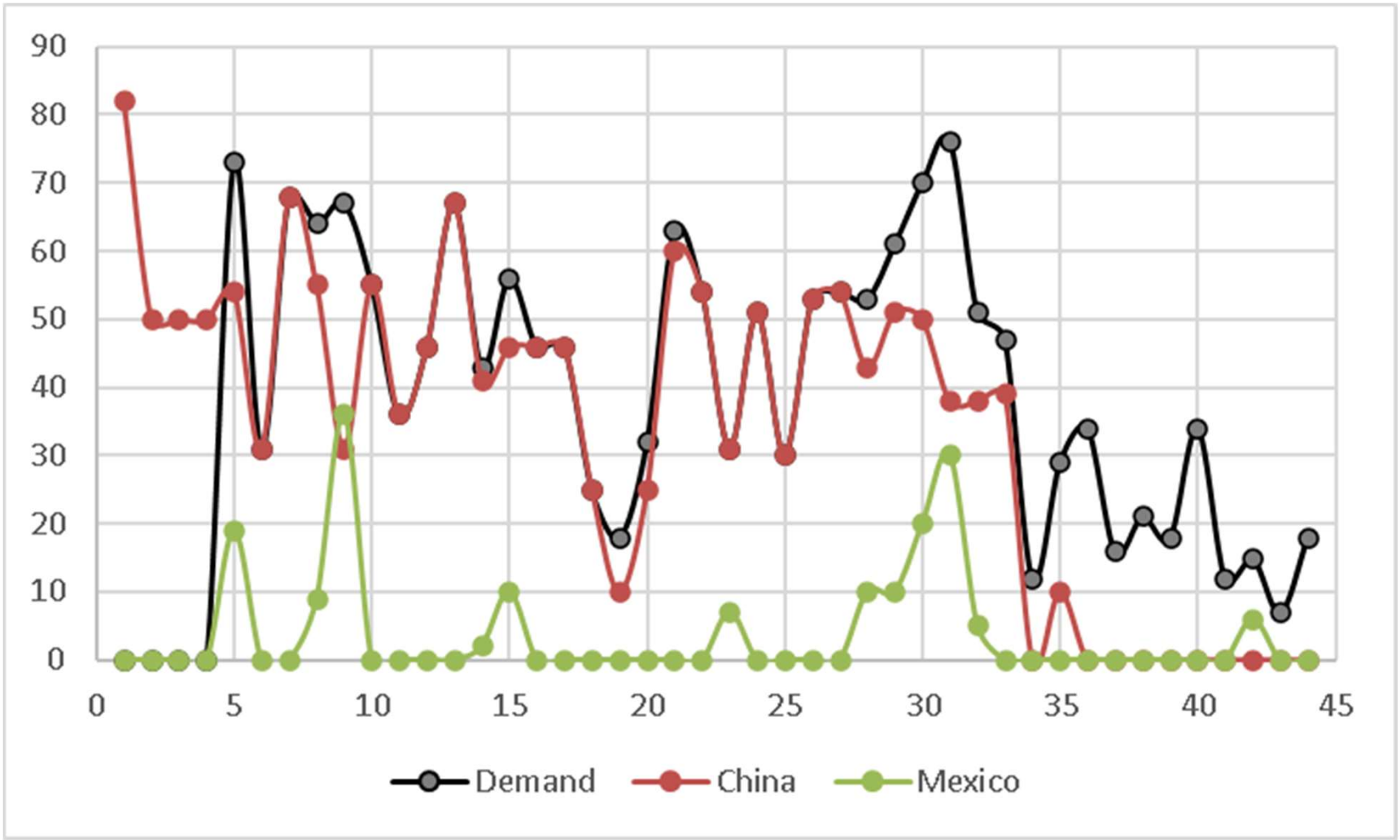
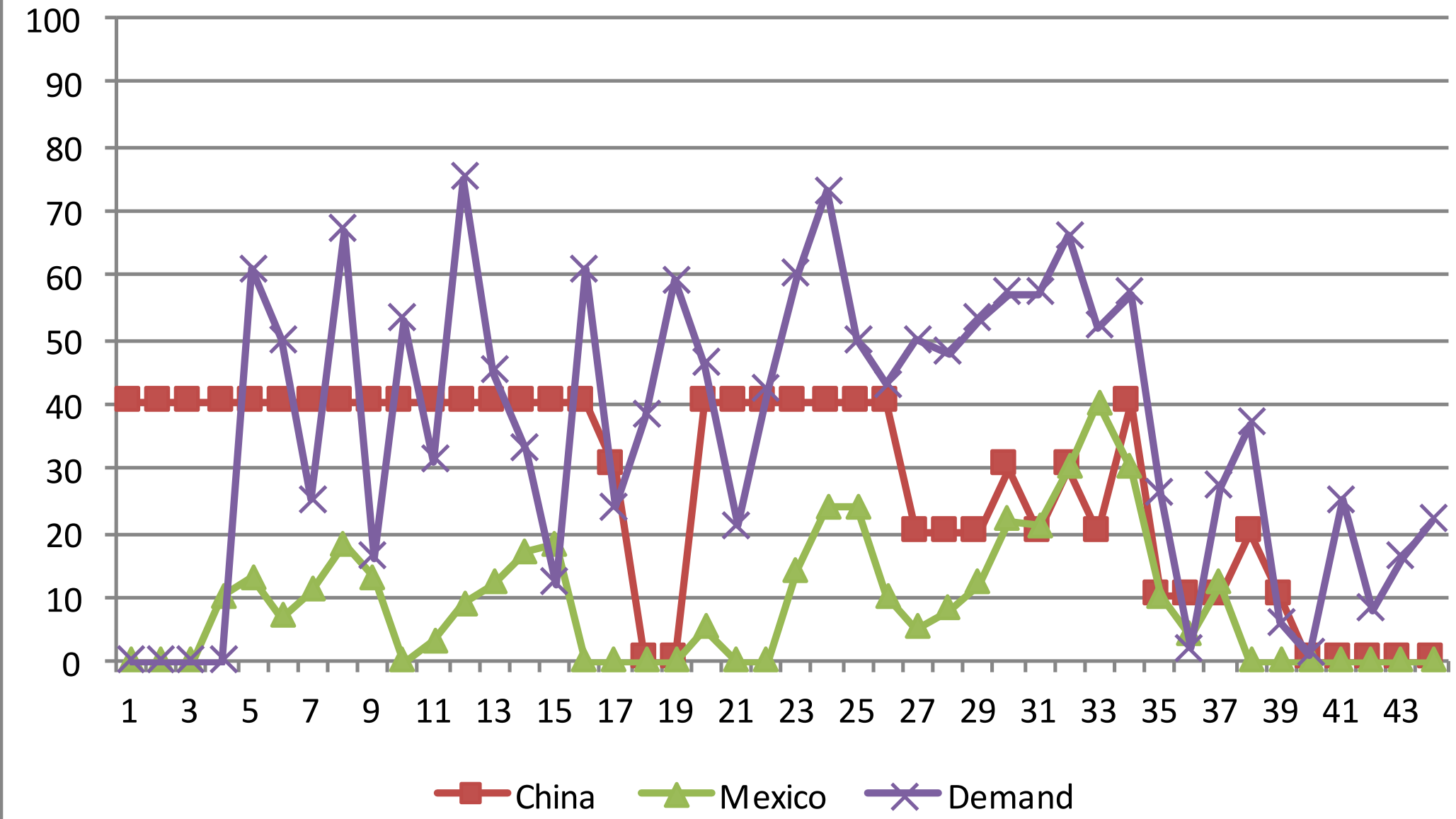


Order pattern



Distill the strategy from the actions?



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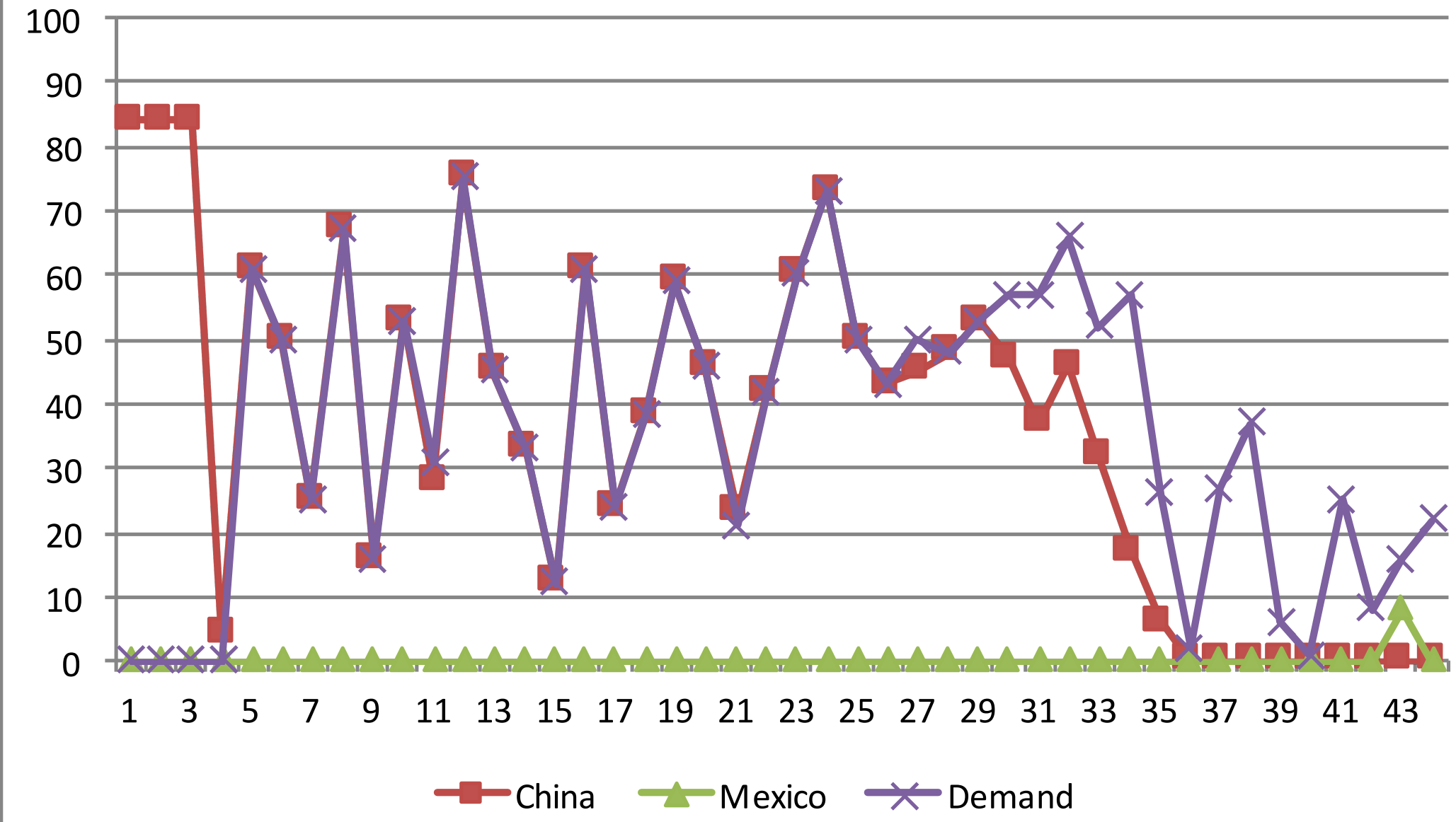

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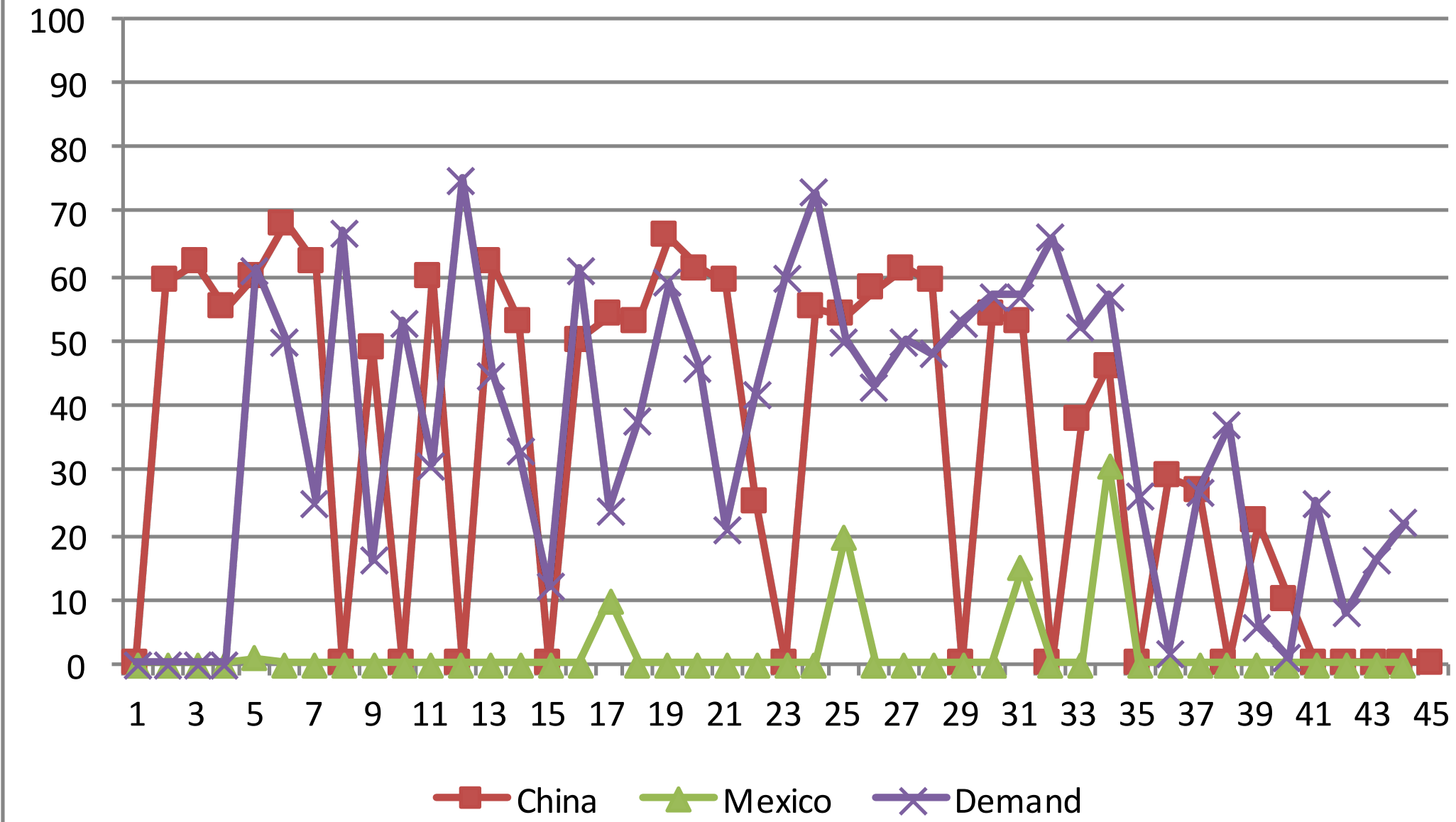

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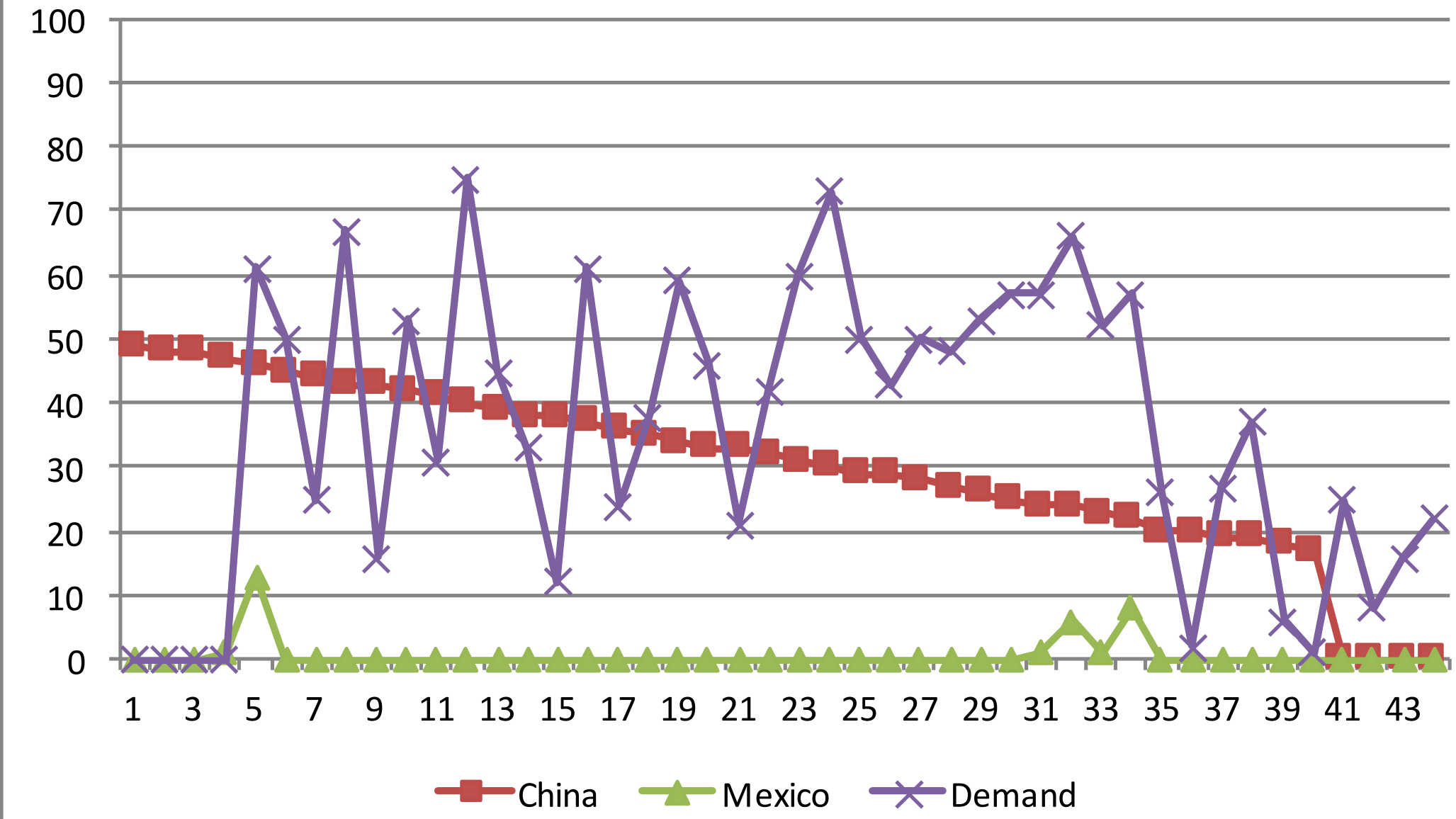


Step 2: Pick Candidate Strategies & Decisions

Strategy	Tactics / Decisions
Dual Source	• Inventory level (safety stock) • Quantity to order from China • Quantity to order from Mexico
Single Source from China	• Inventory level (safety stock) • Quantity to order from China
Single Source from Mexico	• Inventory level (safety stock) • Quantity to order from Mexico

Step 3: Optimize Decisions
How much safety stock to hold?
Single Sourcing

Inventory you currently have (after filling demand in the current period).

Past orders placed on supplier that have not yet arrived.

Inventory Position = On Hand + On Order

Policy

Each period (after demand), place an order to bring the Inventory Position up to a Target Inventory Level.

Notes:
If unfilled demand is backordered rather than lost, then Inventory Position = On Hand + On Order – Backorders.
This policy would need to be modified if there were fixed costs of ordering. Then, would not place order unless inventory position was a certain distance below the target.

What's the right Target Inventory Level? Single Sourcing

- Assuming no supply uncertainty and normally distributed demand;
  - L = Lead-time
  - μ = Average demand per period.
  - σ = Standard deviation of demand per period

$$\text{Target Inventory Level} = \underbrace{\mu L}_{\text{Pipeline Stock}} + \underbrace{z\,\sigma\,\text{SQRT}(L)}_{\text{Safety Stock}}$$

where z = NORMSINV(Service Level)

Note:

The average on-order inventory = pipeline stock

The average on-hand inventory = safety stock

What's the right Service Level? Single Sourcing

- Trade-off between the cost of holding inventory and the "cost" of not filling demand.
  - Often a managerial decision.

- Can use newsvendor-type analysis as a guide
  - Underage = selling price – variable cost = $2,000 (M) or $2,750 (C)
  - Overage = holding cost per unit per period = $80 (M) or $72.50 (C)
  - Service level = critical fractile
    - critical fractile = underage / (underage + overage)
    - 96.1% (M) or 97.4% (C)

Notes:
If can quantify a per-unit goodwill cost associated with not filling a customer order, then underage would be increased by the goodwill cost.
If unfilled demand is backordered rather than lost, then underage cost is the per-unit backordering cost, i.e., "cost" associated with making customer wait one period.

Target Inventory Levels under Single Sourcing

- During the “high sales season”
  - When single sourcing from Mexico:
    - L = 1 → Track only FGI
    - Target Inventory Level = 50 + normsinv(.96)*15*sqrt(1) = 76.5
  - When single sourcing from China:
    - L = 4 → Track total inventory = pipeline (ordered but not received) + FGI
    - Target Inventory Level = 4 * 50 + normsinv(.97)*15*sqrt(4) = 258

Target Inventory Levels under Single Sourcing

- During “end of product life”
  - When single sourcing from Mexico:
    - Target Inventory = 17 + normsinv(.20)*15*sqrt(1) = 17 + (-.84)*15 = 4
  - When single sourcing from China:
    - Target Inventory = 4 * 17 + normsinv(.275)*15*sqrt(4) = 68 + (-0.6)*30 = 50

Step 4: Implement

Performance of sourcing strategies (Optimization by simulation)

Constant Strategy	Inventory Targets	Expected Bank Value (% increment)
Single sourcing Mexico	$S_M = 65$	\$3,465 ± 14
Single sourcing China	$S_C = 210$	\$3,673 ± 18 (+6.0%)
Tailored Base Surge	$S_M = 45$, $Q_C = 15$	\$3,755 ± 15 (+8.4%)

1. Adapting is *most* important
2. Dual sourcing provides additional value and risk mitigation

Dynamic Strategy	Adapt parameters over 2 phases of PLC (mature > decline)	
Single sourcing Mexico	$S_M = 77 > 9$	\$3,810 ± 14 (+10.0%)
Single sourcing China	$S_C = 212 > 0$	\$4,434 ± 23 (+28.0%)
Tailored Base Surge	$S_M = 45$, $Q_C = 30 > 10, 0$	\$4,456 ± 17 (+28.6%)
Upper bound: Clairvoyant	(perfect information: know the future)	\$5,153 ± 17 (+48.7%)

MSBA 7004
Operations Analytics

Class 9: Inventory Analysis (III)
Review of Newsvendor Problem
2023

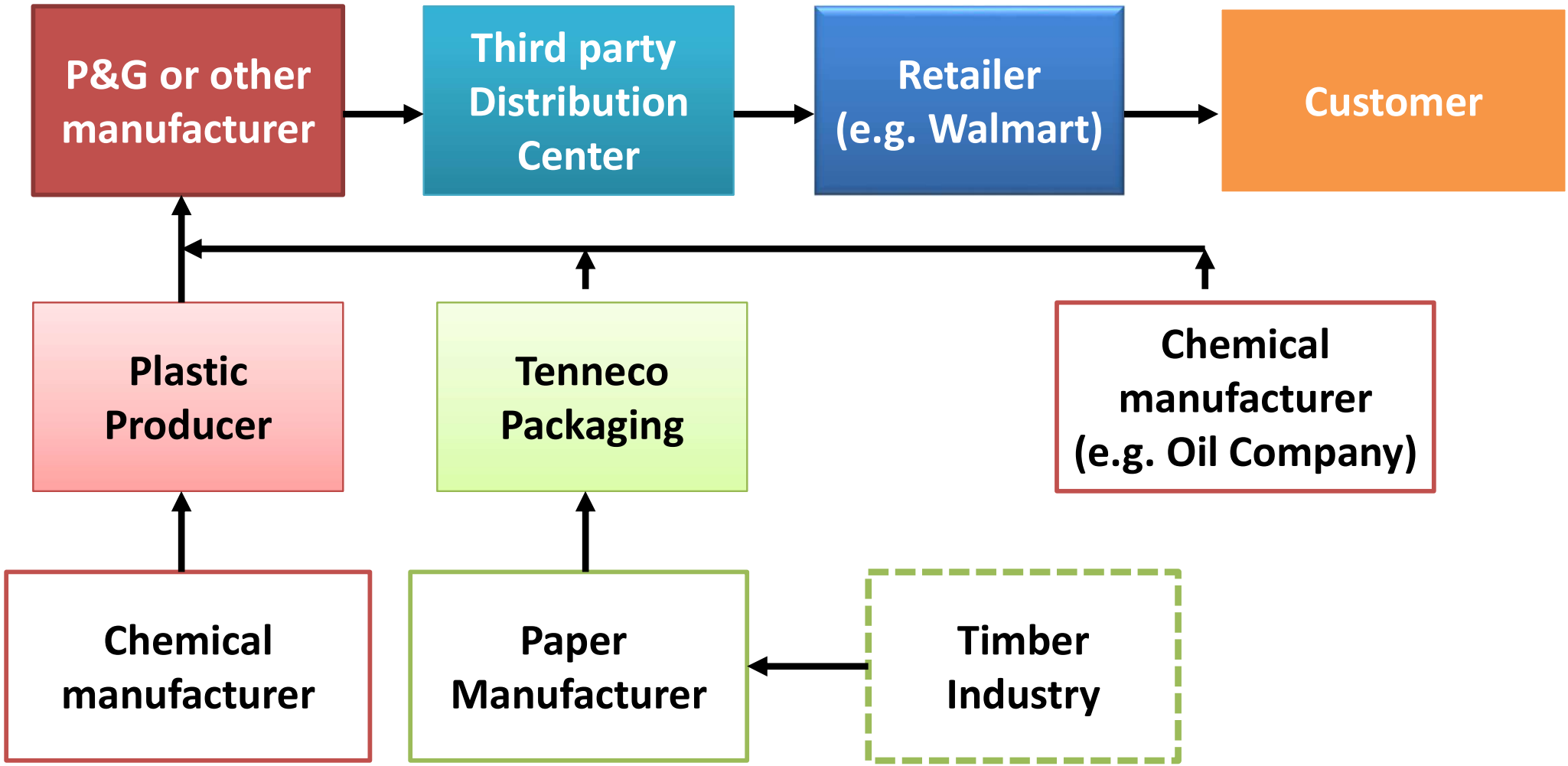
Learning Objectives

- What is a supply chain?
- What are the challenges in managing a supply chain?
- How can we solve the challenges?

Supply Chain Example: Detergent

What firms are involved in the supply chain of a detergent?

Example: Detergent Supply Chain

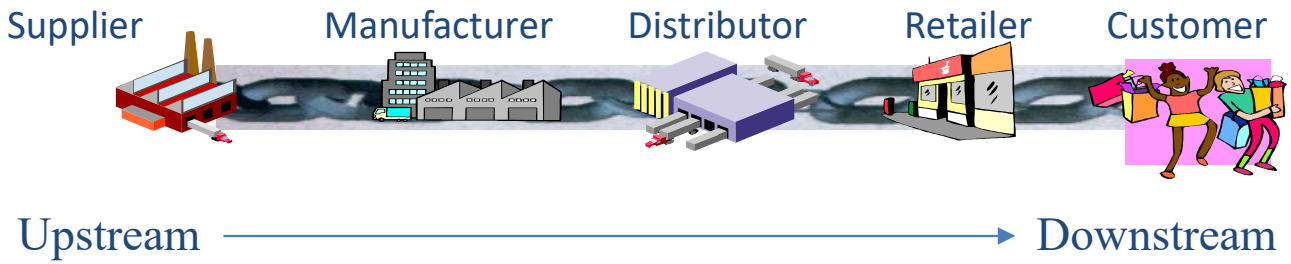


Supply Chain is a..

- Complex system of organizations, resources, and information involved in transforming raw materials to final products, and supplying the final products to customers
- Supply chain is composed of..
  - suppliers, manufacturers, transportation, distributors, and vendors (function)
  - Raw material, work-in-process, and finished goods (FG) in **inventory**
  - Information, capital, and people associated with the system
- Supply chain is also called: the value chain, the logistics network, the distribution network

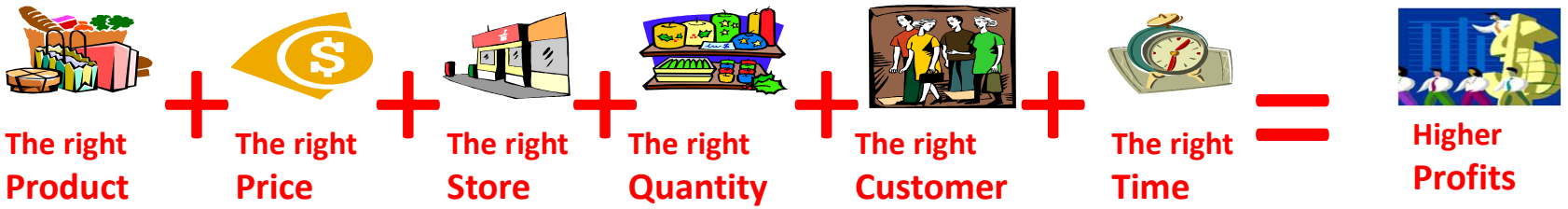
Supply Chain: Structure and Objective

- Consists of

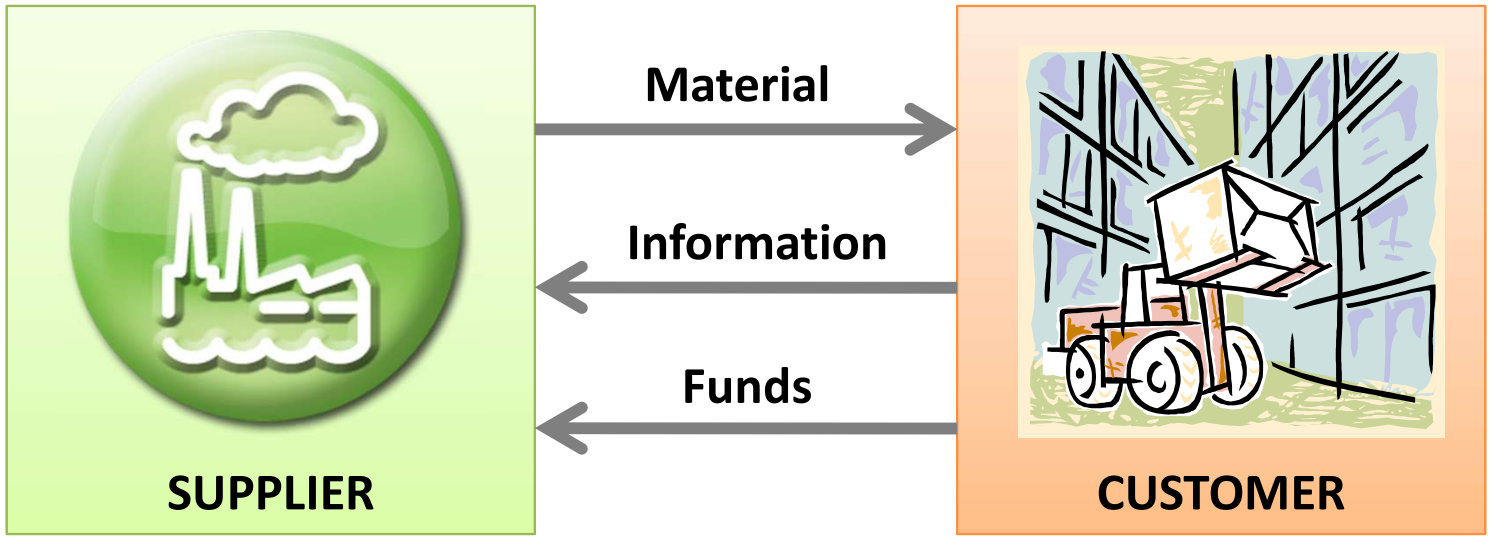


- Aims to match supply and demand (to generate profit for products and services)

- Achieved by..



Flows in a Supply Chain



- The flows resemble a chain reaction

Challenges in Supply Chain

Material Scarcity (insufficient inputs) becomes severe due to COVID

High inventories throughout the chain

Low order fill rates
High Stockout

supplier | factory | distributor | retailers | customers

Frequent supply shortages

Inefficient logistics (port congestion), High transportation costs (Increasing freight prices)

Difficult demand forecasting

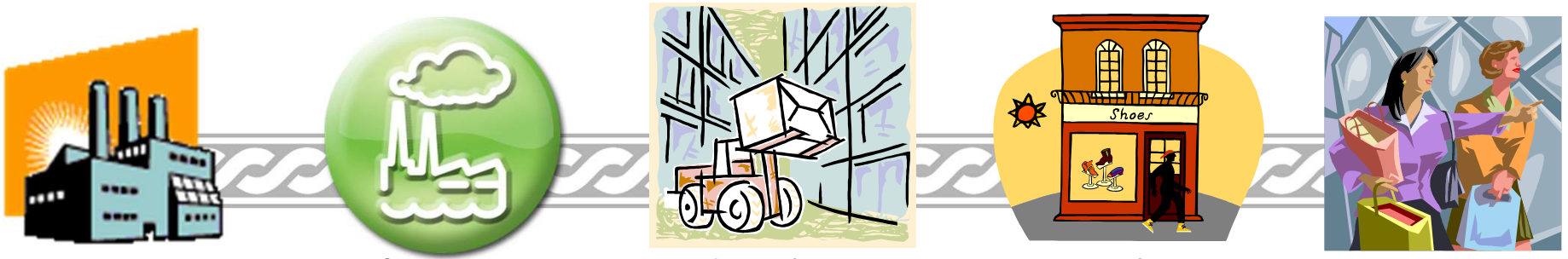
Source of Challenges: Conflicting Objectives

Purchasing / Suppliers

Supplier wants: Stable volume requirements, Flexible delivery time

Warehousing

Retailer wants: Low inventory, Reduced transportation costs
Distributer needs: Quick replenishment capability



supplier | factory | distributor | retailers | customers

Manufacturing

Long run production
High quality
High productivity
Low production cost

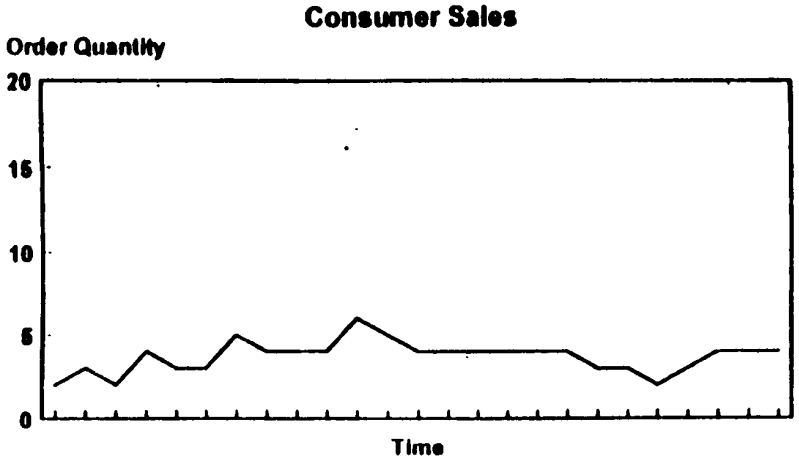
Customers

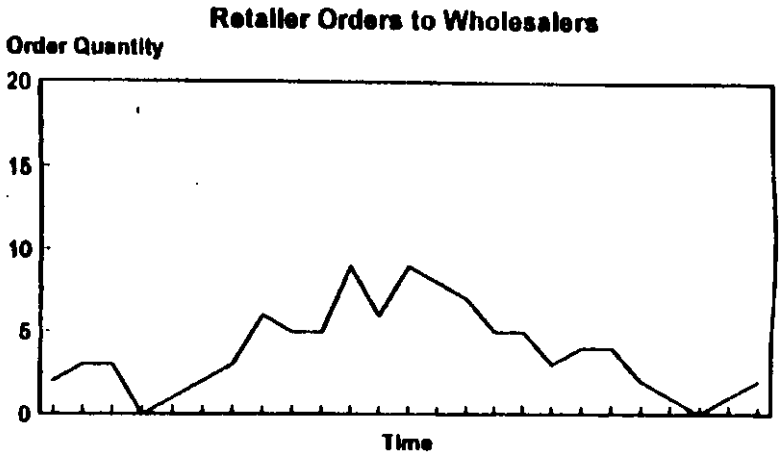
Customer wants: Enormous variety of products, Low prices
Retailer needs: Short order lead time
High in stock

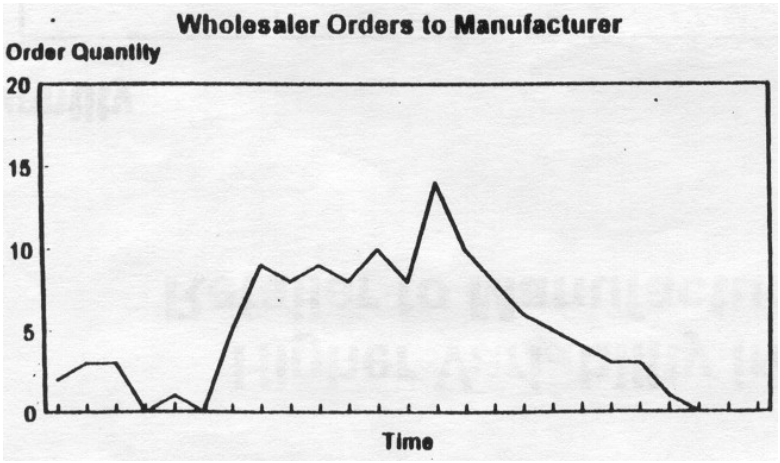
Challenges in Supply Chain

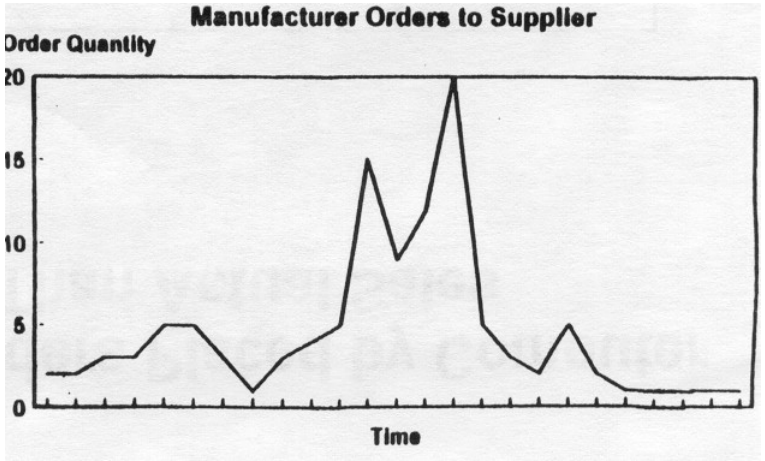
- Indeed, in many cases there are adversarial relationships between supply chain partners, as well as dysfunctional industry practices (e.g., price promotions), which lead to challenges in coordination of the supply chain.
- These main challenges are:
  - Bullwhip effect – demand variability increases as we move up the supply chain (from downstream to upstream)
  - Incentive conflicts

Increasing Variability of Orders Up the Supply Chain – Bullwhip effect





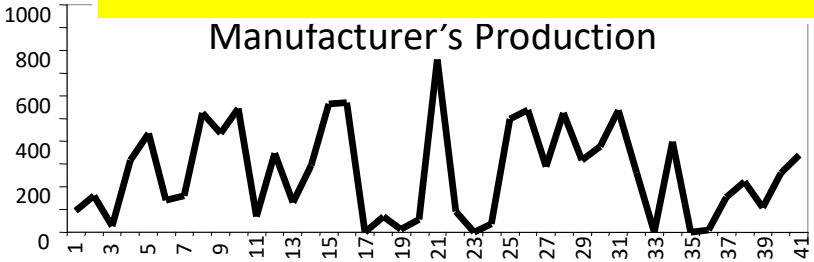




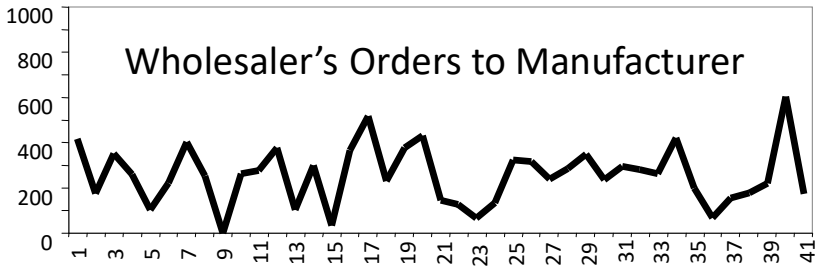
Lee, H, P. Padmanabhan and S. Wang (1997); (Disposal Baby Diapers SC)

The Bullwhip Effect

The variance of orders is greater than that of sales, and the distortion increases as one moves upstream in the supply chain

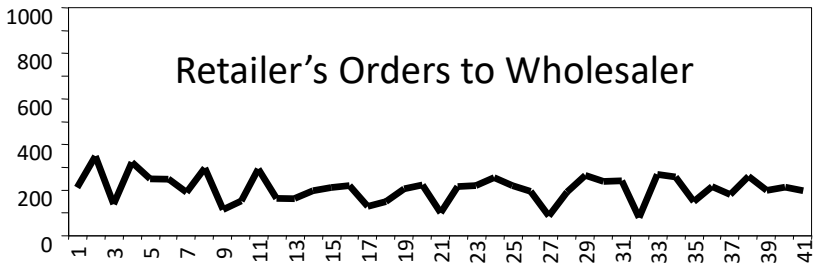


Delivery



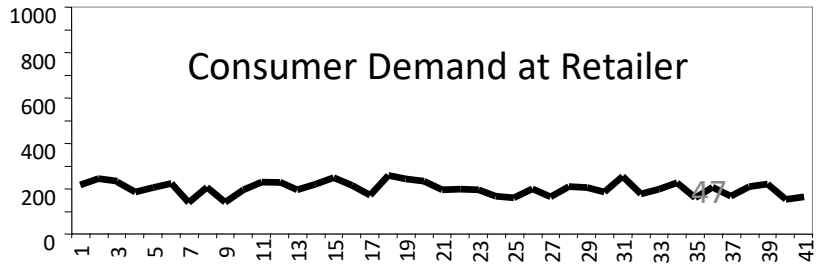
Order

Delivery



Order

Delivery

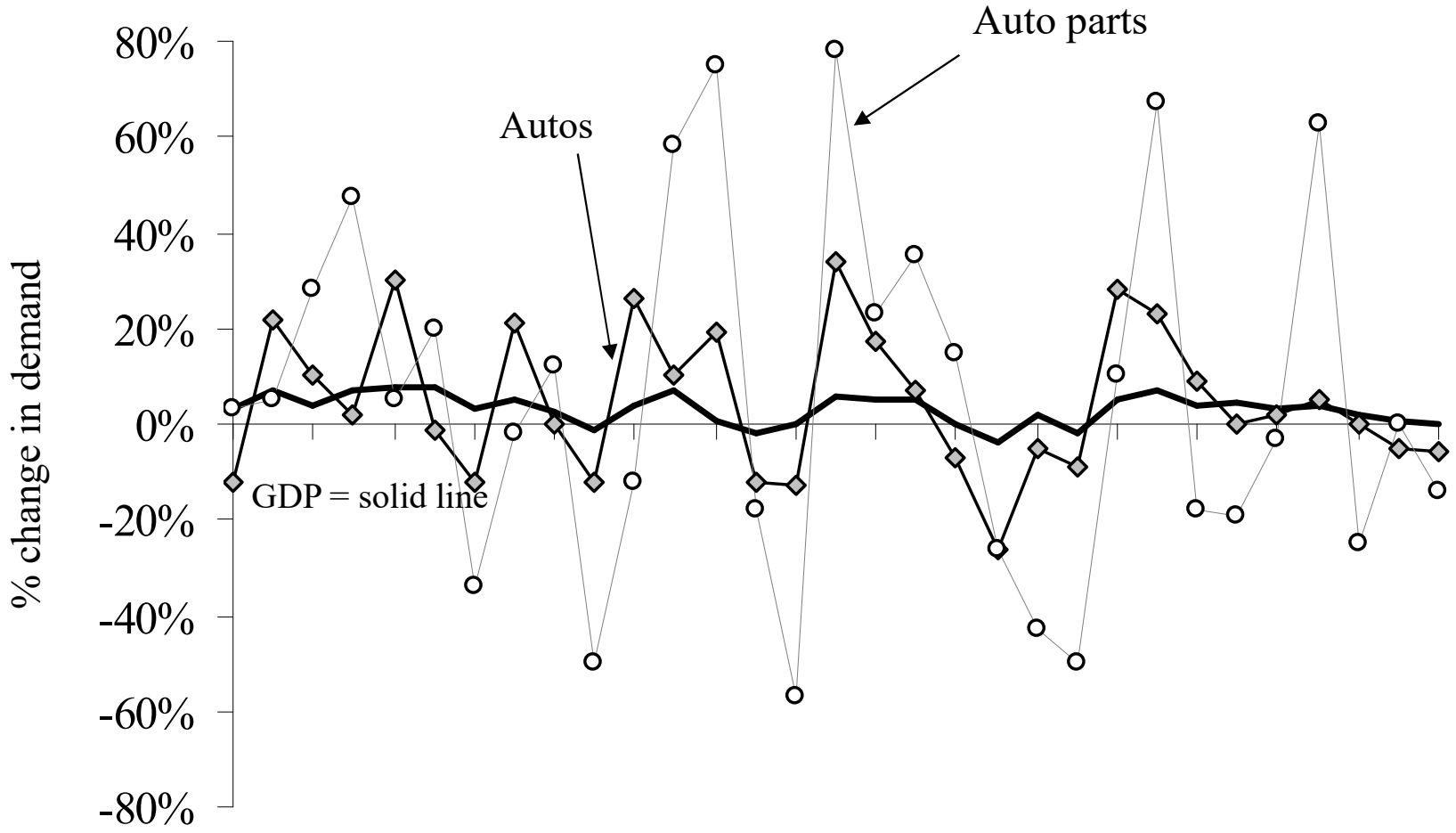


Order

Large swings at the tip

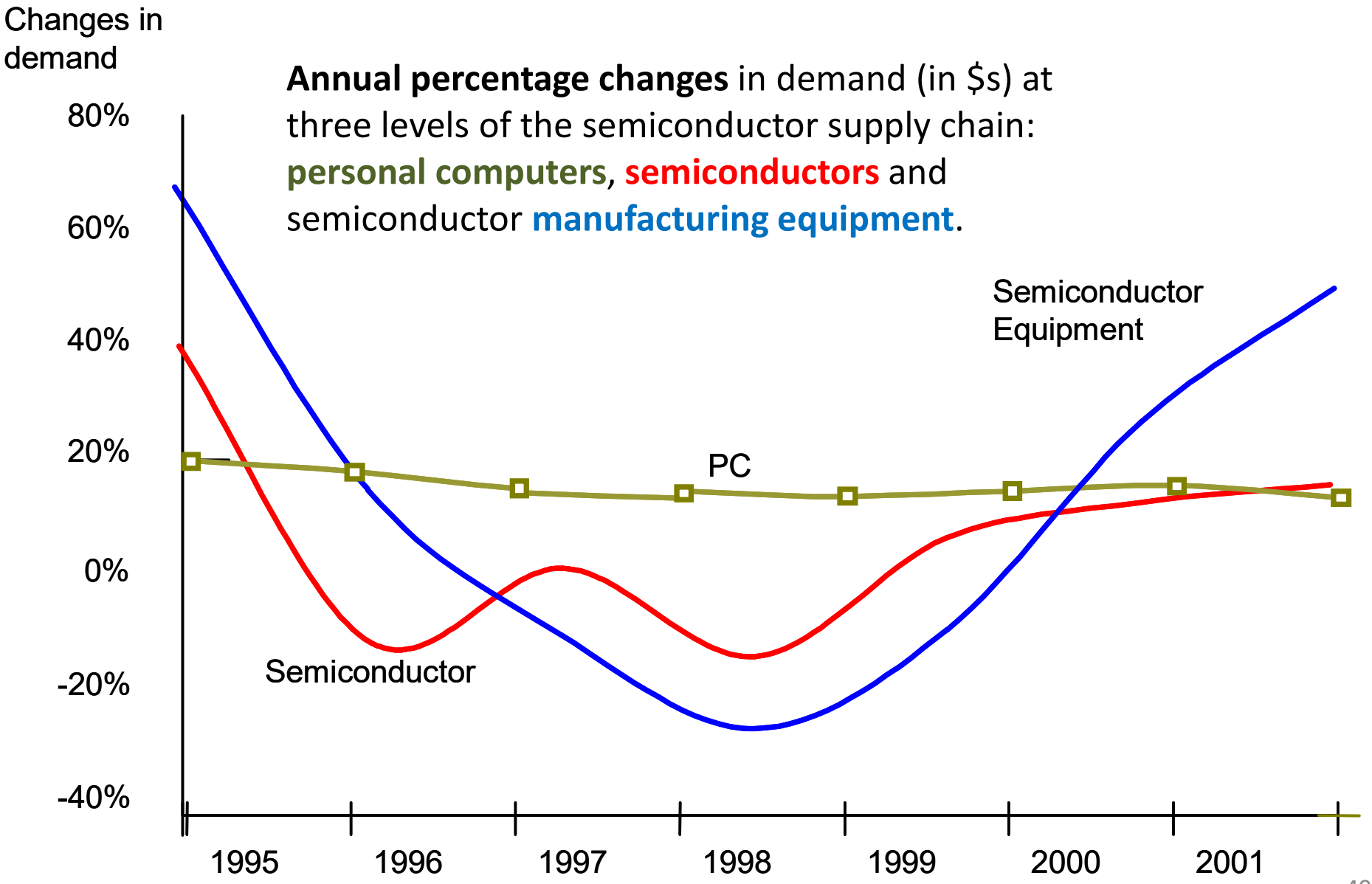
Small perturbation at the handle

Bullwhip effect in autos to machine tools



Source:Anderson, Fine and Parker (1996)

Another Bullwhip Effect Example: US PC Supply Chain



Why is the bullwhip effect bad?

- Inefficient production or excessive inventory
- Necessity to have capacity far exceeding average demand
- Poor customer service due to stock outs

What causes the bullwhip effect?

Forecasting Updates and Lead Time Delays

- **Every company forecasts its demand myopically**
  - The company sees fluctuations in demand caused by the bullwhip effect from downstream, company orders accordingly, creating further swings for the upstream suppliers.
- **Lead Time Delays and Variation**
  - Upstream companies may overreact to demand variations.

Forecasting Updates and Lead Time Delays

- **Avoid misleading forecast updates**
  - Share demand info throughout SC (EDI, electronic data interchange)
  - Increase visibility of inventory throughout SC (VMI)
  - Develop trust and good working relationships
- **Reduce Lead Times**

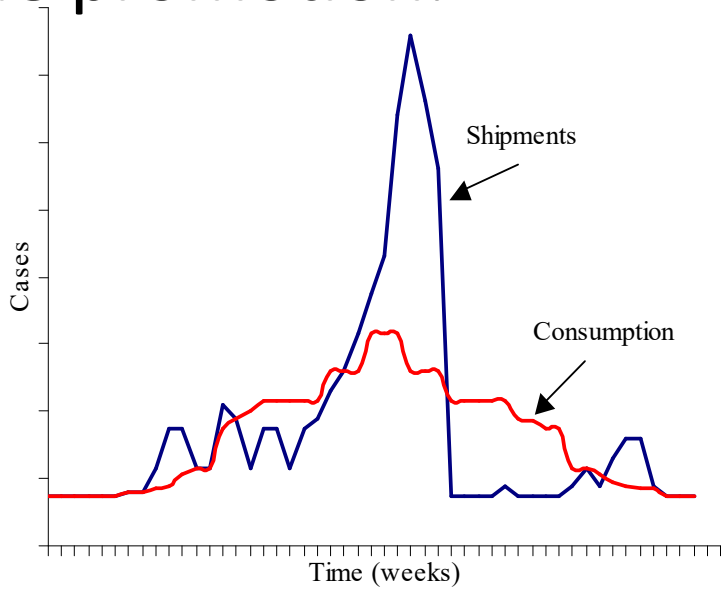
Order batching

- To reduce ordering cost (transaction cost, fixed transportation cost), upstream suppliers order in batch. (EOQ)

- Reduce/Eliminate fixed costs (EOQ quantity)
  - Reduce transaction costs through various forms of electronic ordering

Price fluctuations (trade promotions) and forward buying

- Supplier gives retailer a temporary discount, called a **trade promotion.**
- Retailer purchases enough to satisfy demand until the next trade promotion.



Total shipments and consumption

- Stabilize prices; avoid trade or price promotions

Rationing and Shortage gaming

- Setting (one supplier faces multiple buyers): Retailers submit orders for delivery in a future period. Supplier produces. If supplier production is less than orders, orders are rationed.
- To secure a better allocation, the **retailers inflate their orders**, i.e., order more than they need…
- … So retailer orders do not convey good information about true demand.

- Eliminate gaming and shortage situations
  - Encourage retailers to share demand information
  - Allocate orders based on past usage, not on present

The Bullwhip Effect

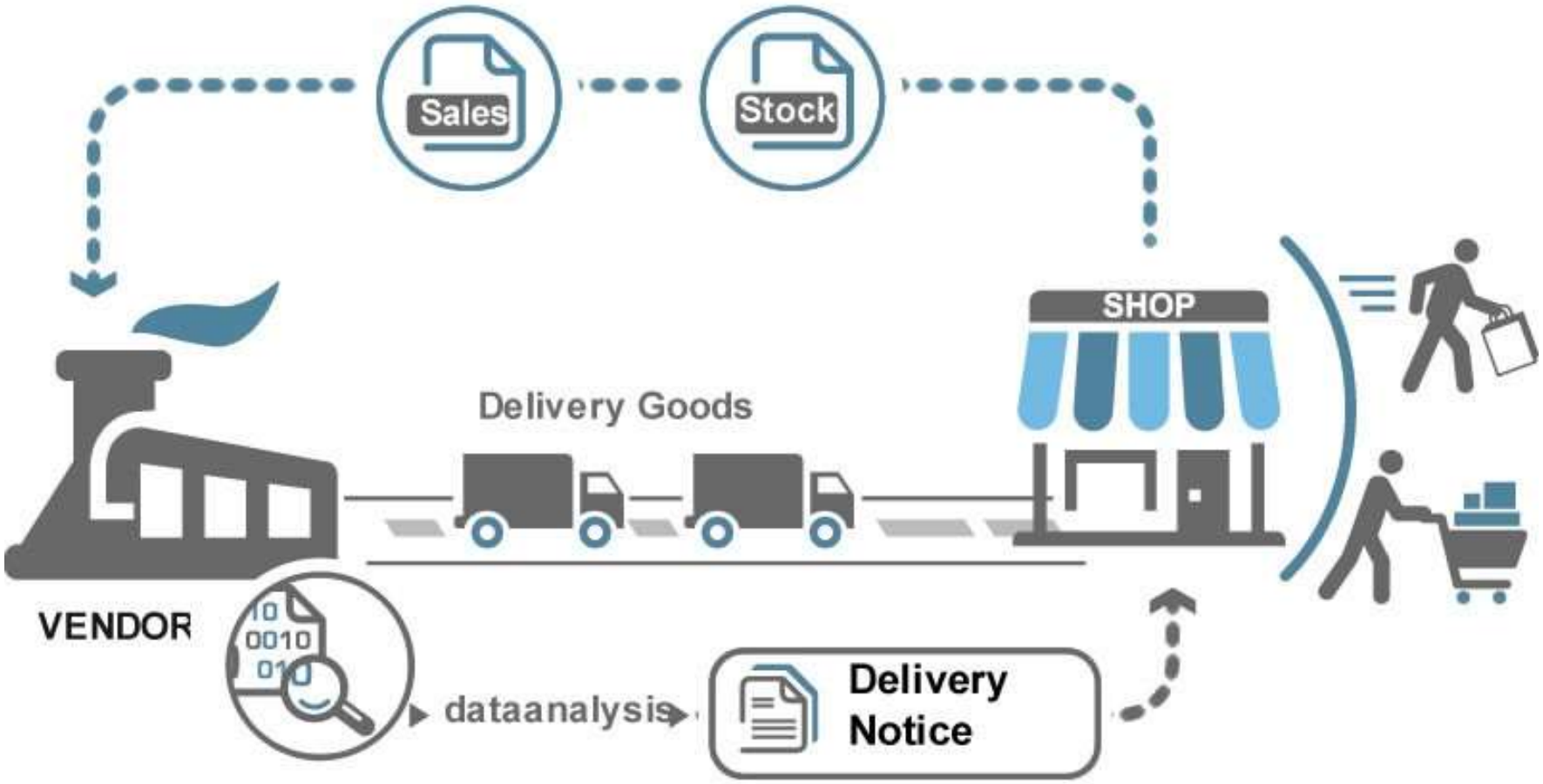
The variance of orders is greater than that of sales, and the distortion increases as one moves upstream in the supply chain

Causes	
Forecasting Updates and Lead Time Delays	**Avoid misleading forecast updates** – Share demand info throughout SC – Increase visibility of inventory throughout SC – Develop trust and good working relationships
	Reduce lead times
Order Batching (Fixed Costs)	**Reduce/Eliminate fixed costs**
Price Fluctuations ("Forward Buying")	**Stabilize prices; avoid trade or price promotions**
Rationing and Shortage Gaming	**Eliminate gaming and shortage situations**

Reducing the Bullwhip Effect

- Campbell Soup (CS) established electronic data exchange links with its retailers
- After CS started to receive demand information electronically, the retailers' weeks in inventory decreased from 4 weeks to 2 weeks
- This led to decrease in retailers' inventory costs and they became more incentivized to carry CS products

Information sharing: Vendor Managed Inventory



Vendor Managed Inventory : Success Story

https://www.datalliance.com/writable/resources/CGT_Datalliance_PG.pdf

Reducing the Bullwhip Effect (cont.)

- In a VMI, or Continuous Replenishment
  - The retailer no longer decides when and how much inventory to order.
  - The retailer and supplier jointly agree on objectives (e.g., service levels), and the supplier "manages" the retailer's inventory
  - Relevant sales data is shared
  - Supplier and retailer eliminate trade promotions

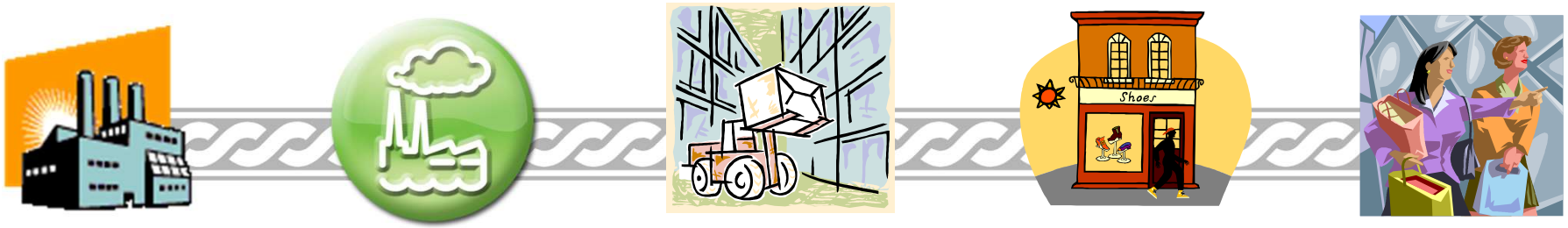
Vendor Managed Inventory: Failure Story

- Spartan Stores (now SpartanNash), a grocery chain, shut down its VMI effort about one year after its inception.
- Buyers
  - didn't trust the suppliers enough
  - Stop carefully monitor inventories and intervene at the slightest hint of trouble
- Suppliers
  - didn't do much to allay buyers' fears
  - didn't do as effective a job as buyers

The buyer and supplier do not have a jointly agreed objectives

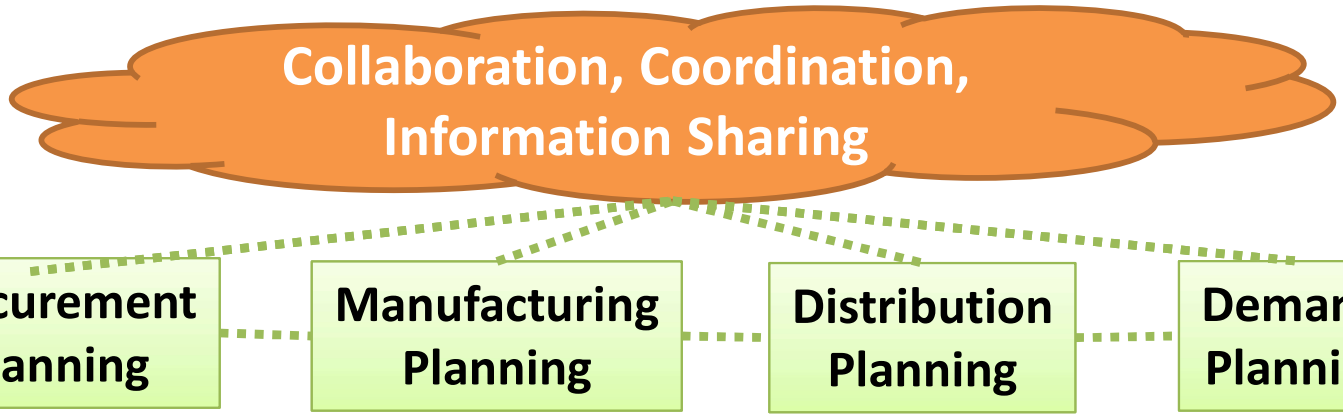
Remedy of Bullwhip Effect: Global Planning

- Sequential Planning



- Global Planning

Zara, and Amazon



Corporate strategy: Vertical Integration

Other Supply Chain Challenge: Incentive Conflicts

- Notwithstanding improved information sharing in the supply chain, there may be incentive conflicts among supply chain members

- Solution?
  - Profit sharing

Incentive Misalignment:

- Rent DVD/VCDs from Blockbuster store to watch movies.
- In the summer of 1997, movie fans flocked to their local Blockbuster, only to find that all ten copies had already been checked out.
- At $60 a copy, Blockbuster couldn't afford to stock the number of movies it needed. (At $3 per rental, Blockbuster had to rent a movie at least 20 times!)
- Its suppliers, the movie studios, had to charge $60 to earn enough revenue themselves.
- No one – not the suppliers, not the retailer, nor the customers – was happy.

Optional reading: Turning the Supply Chain into a Revenue Chain, by Cachon and Lariviere, Harvard Business Review, March 2001.

BB's solution: Revenue Sharing

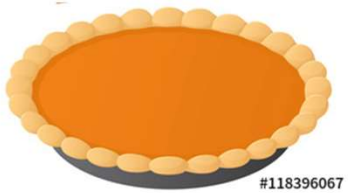
- In 1998, Blockbuster agreed to give the studios 50% of rental fees in return for $9 movie prices.

- How does revenue sharing affect Blockbuster?
  - Blockbuster keeps half of the revenue ($1.5 per rental), but it breaks even after each tape has been rented 6 times. Blockbuster purchase more tapes to satisfy more customers, which means higher profit.
- How does revenue sharing affect studio?
  - The studio also has higher profit from increased tape sales and the revenue share.
- Who wins?
  - Everyone: Blockbuster and Studio gain more revenue, and more customers are satisfied due to higher service level.

Turning the Supply Chain into a Revenue Chain: Revenue Sharing Contract

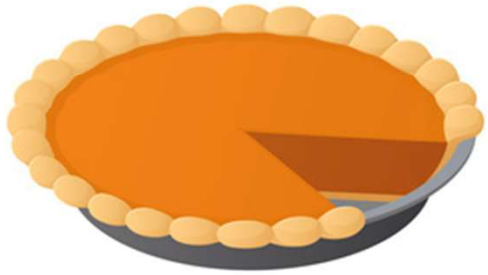
FOR THE RETAILER

	Traditional Pricing	Revenue Sharing
A. Number of tapes purchased	10	30
B. Price per tape	$60	$9
C. Purchase cost	$600	$270
D. Number of rentals	300	500
E. Total rental revenue (D × $3/rental)	$900	$1,500
F. Retailer's share of rental revenue	$900 (100%)	$750 (50%)
G. Retailer's profit	$300	$480
H. Profit per dollar of inventory	$0.50	$1.78



FOR THE SUPPLIER

	Traditional Pricing	Revenue Sharing
I. Number of tapes purchased	10	30
J. Price per tape	$60	$9
K. Revenue from selling tapes	$600	$270
L. Number of rentals	300	500
M. Total rental revenue (L × $3/rental)	$900	$1,500
N. Supplier's share of rental revenue	$0 (0%)	$750 (50%)
O. Supplier's total revenues	$600	$1,020
P. Supplier's production and distribution cost (I × $10/tape)	$100	$300
Q. Supplier's profit	$500	$720



NetFlix: DVD Rentals and Streaming Video

- Netflix has a similar revenue-sharing agreement for its DVD rentals with most studios in exchange for the opportunity to purchase new releases at production cost:
  - Blockbuster (rent in store), Netflix (rent by mail)
  - Allows Netflix to purchase more copies on a title and better meet demand without substantial capital investment of full ownership
  - After revenue-share period expires, the agreement generally grants Netflix the right to acquire the units at low cost
  - **Subscription model: customer usually use less times than they expect. Netflix needs a large amount of movies, it helps them to get a better revenue sharing contract with movie studios.**

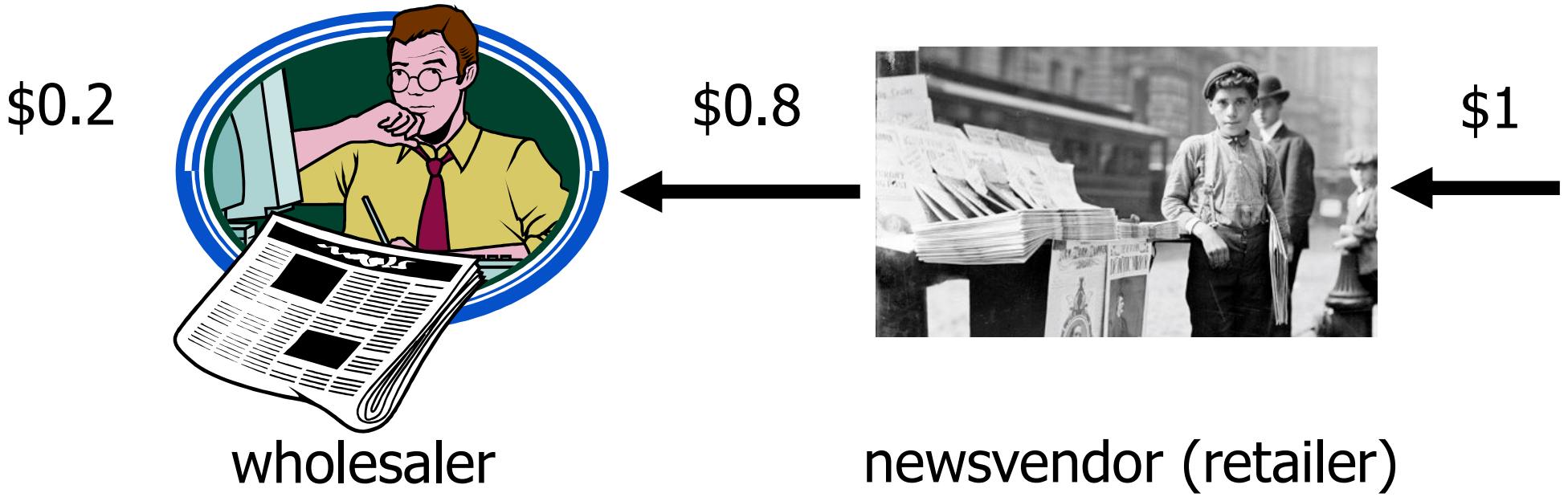
- However, for streaming movies and TV shows online Netflix pays a one-time licensing fee:
  - E.g. Netflix recently paid CBS $200M for the right to stream a large number of recent and classic TV shows
  - There is no stocking problem for streaming video, so a revenue sharing contract is not necessary.

Newsvendor Logic in Supply Chain Incentive Conflict

- A newsvendor (retailer) stocks newspapers to sell that day
- Usual newsvendor tradeoffs:
  - If stocks too few newspapers, misses potential sales.
  - If stocks too many newspapers, money wasted on unsold newspapers.

Selling to Newsvendor

- Suppose you are a wholesaler
- Your cost is 20 cents /newspaper
- You charge the retailer 80 cents /newspaper
- Newsvendor sells to customers at $1/newspaper



Supply Chain Incentives

- How many newspapers will the retailer purchase?
- Retailer figures out that

  C_u = 1–0.8= $ 0.2

  C_o = $ 0.8
- Retailer wants to maximize his own profit, so he purchase Q newspapers so that

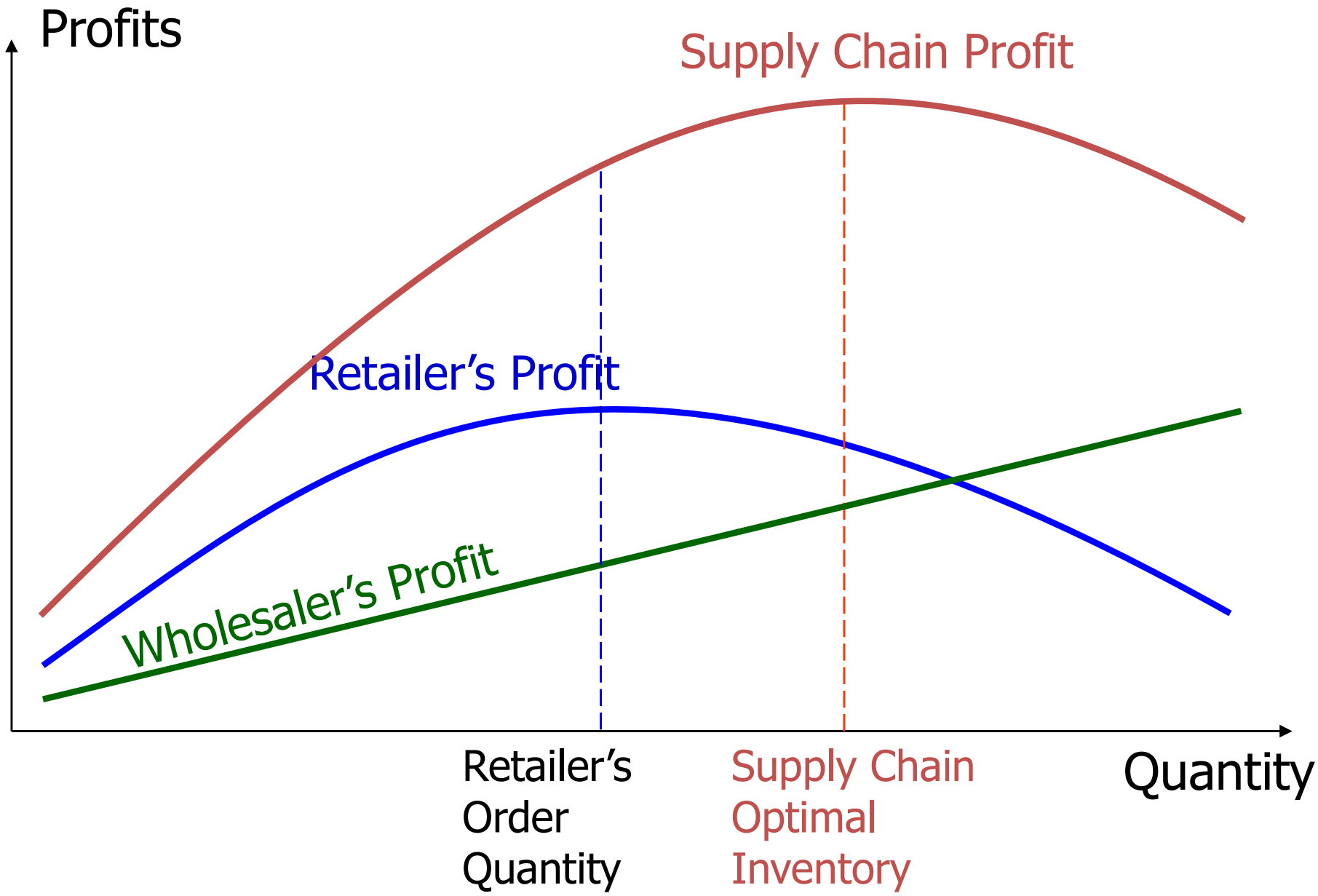
  $P(D \le Q) = C_u / (C_u+C_o)$ = SL* = 0.2
- What if the retailer and the wholesaler decide to maximize their total profit?

  C_u = 1–0.2= $ 0.8

  C_o = $ 0.2
- They should purchase Q^* newspapers so that

  $P(D \le Q^*) = C_u / (C_u+C_o)$ = SL* = 0.8

No Coordination vs. Centralization



Coordinating the Supply Chain

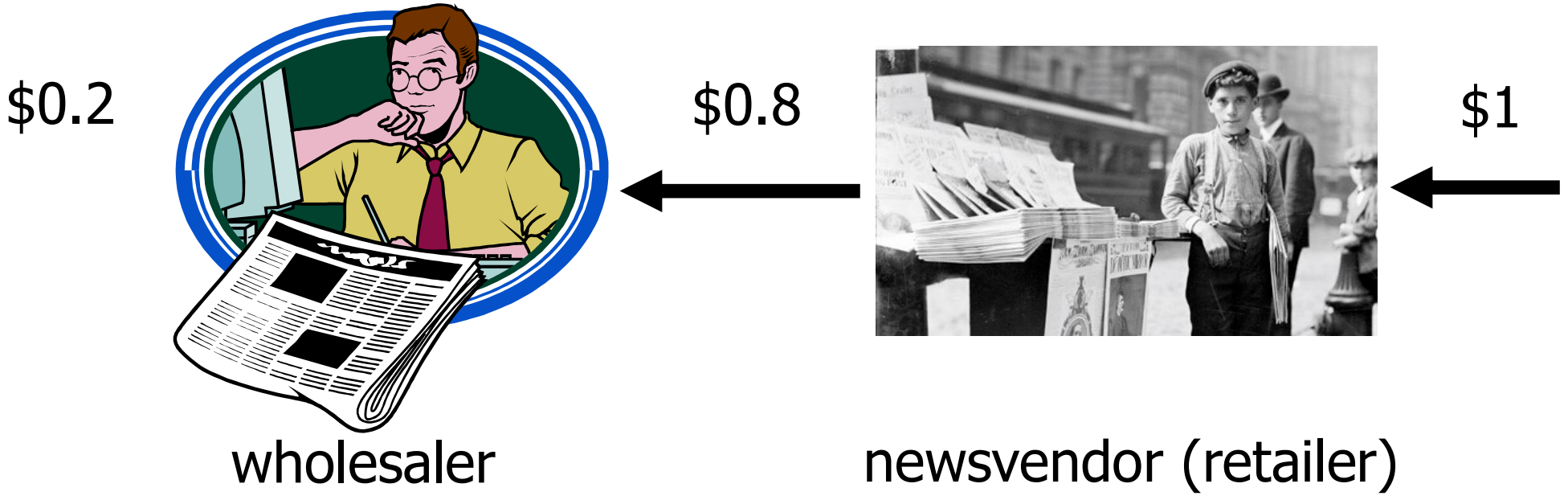
- Wholesaler wants to "induce" retailer to purchase more newspapers.
- Wholesaler agrees to "buy-back" unsold newspapers at price \$0.6/newspaper
- How many newspapers will the retailer purchase?
- Retailer figures out that

  C_u = 1 – 0.8 = \$0.2

  C_o = 0.8–0.6 = \$0.2
- Retailer wants to maximize his own profit, so he purchase Q newspapers so that

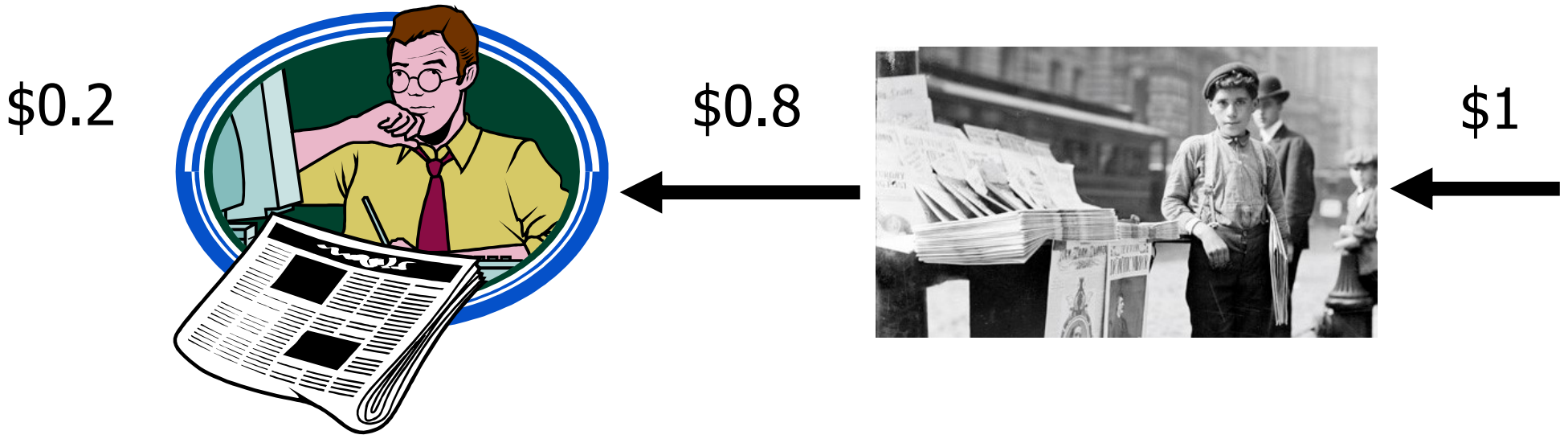
  $P(D \le Q) = C_u / (C_u + C_o)$ = SL* = 0.5

Coordinating the Supply Chain



- Wholesaler agrees to "buy-back" unsold newspapers at price $b/newspaper
- Practice: Find a buy-back rate that induces the retailer to purchase $X = Q^*$ (optimal for the supply chain)

Coordinating the Supply Chain



- Wholesaler agrees to "buy-back" unsold newspapers at price $b/newspaper
- Find a buy-back rate that maximize the wholesaler's profit.

$$\frac{C_u}{C_u + C_o} = 0.8$$

Example: Buy-back Contract

- Demand: Normally distributed, mean = 500, st dev = 100

Buy-back Price	Q	Wholesaler Profit	Retailer Profit	Supply Chain Profit
0	**416**	**249.50**	**72.00**	**321.51**
0.1	424	252.84	73.20	326.04
0.2	433	256.55	74.58	331.13
0.3	443	260.70	76.21	336.90
0.4	457	265.36	78.18	343.54
0.5	475	270.55	80.68	351.23
0.6	500	276.06	84.04	360.11
0.7	543	280.29	89.09	369.38
0.71	549	**280.40**	89.76	370.16
0.72	557	280.38	90.48	370.86
0.73	565	280.18	91.26	371.44
0.74	574	279.75	92.09	371.84
0.75	584	279.00	93.00	**372.00**
0.76	597	277.79	94.00	371.79
0.77	612	275.85	95.12	370.98
0.78	634	272.67	96.40	369.07
0.79	667	266.74	**97.92**	364.66

Buyback Contract

- Advantages:
  - Affect supply chain inventory by reducing retailer overage costs (risk sharing)

- Limitations
  - Transaction cost (Negotiation for buyback contract)
  - Shipping cost (for returns)
  - Sales effort for retailer to sell more

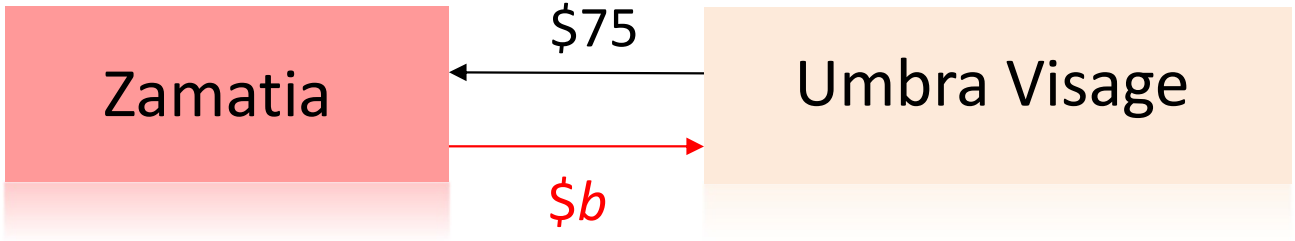
Zamatia ← $75 — Umbra Visage

Manufacturing cost = $35

Retail price = $115

Salvage value = $25

- U.V.'s newsvendor problem
  - C_u = $115-75 = $40, C_o = $75-25 = $50, SL* = 40/90 = 44%
- What is optimal for entire supply chain?
  - C_u = $115-35 = $80, C_o = $35-25 = $10, SL* = 80/90 = 89%

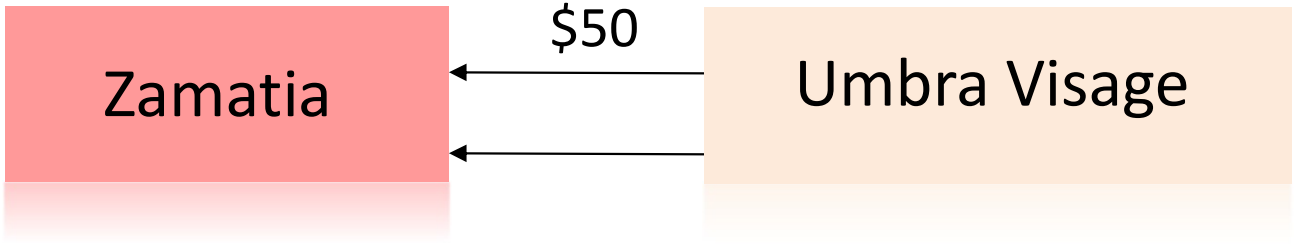


Retail price = $115

Salvage value = $25

- Zamatia offers to buy-back unsold glasses at *b* per unit. And UV incurs $1.5 cost to ship sunglasses back
  - C_u = $40 (same as before); C_o = $\underline{\$75 - (b\text{-}\$1.5)}$
- Is there a *buy-back price* wherein Zamatia can induce U.V. to act optimally for the entire supply chain? (U.V. achieves the service level that is optimal for the supply chain)

$$89\% = \frac{40}{40 + (75 - (b - 1.5))} \qquad \text{So, } b = \$71.50.$$



Revenue Sharing 20%

Retail price = $115

Salvage value = $25

- U.V.'s newsvendor problem
  - C_u = $115*80%-50 = $42, C_o = $50-25 = $25, SL* = 42/67= 63%

As the owner of Catch-of-the-Day Fish Shop, you can purchase fresh fish at $18 per box each morning from the Walton Fish Market. During the day, you sell boxes of fish to local restaurants for $120 each. Coupled with the perishable nature of your product, your integrity as a quality supplier requires you to dispose of each unsold box at the end of the day. Your cost of disposal is $2 per box. However, you have a problem because you do not know how many boxes your customers will order each day. You have collected several days' worth of demand data shown in the table below to address this problem.

You now want to determine the optimal number of boxes you should purchase each morning.

Demand	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Frequency	0	0	0	1	3	2	5	1	6	7	6	8	5	4	1	3

As the owner of Catch-of-the-Day Fish Shop, you can purchase fresh fish at $18 per box each morning from the Walton Fish Market. During the day, you sell boxes of fish to local restaurants for $120 each. Coupled with the perishable nature of your product, your integrity as a quality supplier requires you to dispose of each unsold box at the end of the day. Your cost of disposal is $2 per box. However, you have a problem because you do not know how many boxes your customers will order each day. You have collected several days' worth of demand data shown in the table below to address this problem. You now want to determine the optimal number of boxes you should purchase each morning.

Demand	3	4	5	6	7	8	9	10	11	12	13	14	15
Frequency	1	3	2	5	1	6	7	6	8	5	4	1	3
Prob.	0.019	0.058	0.038	0.096	0.019	0.115	0.135	0.115	0.154	0.096	0.077	0.019	0.058
Cumulative Prob. $P(d \leq x)$	0.019	0.077	0.115	0.211	0.23	0.345	0.48	0.595	0.749	0.845	0.922	0.941	1