Review of Inventory Management

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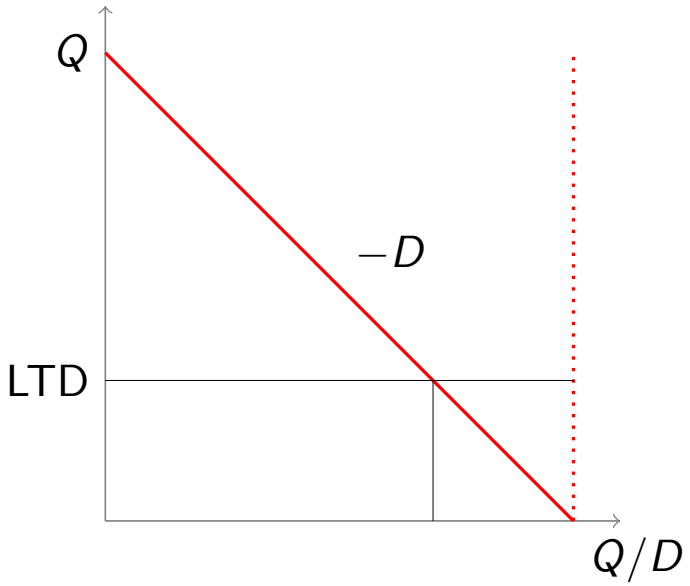
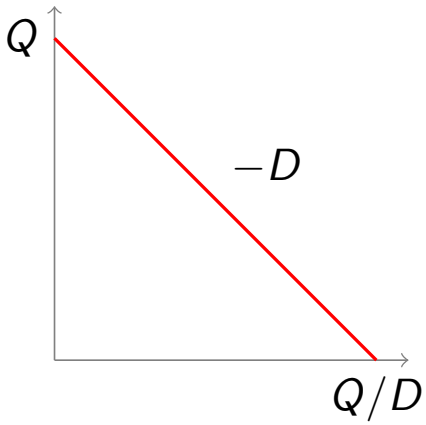
Outline

Inventory Level $I(t)$ Over Time



Inventory Costs



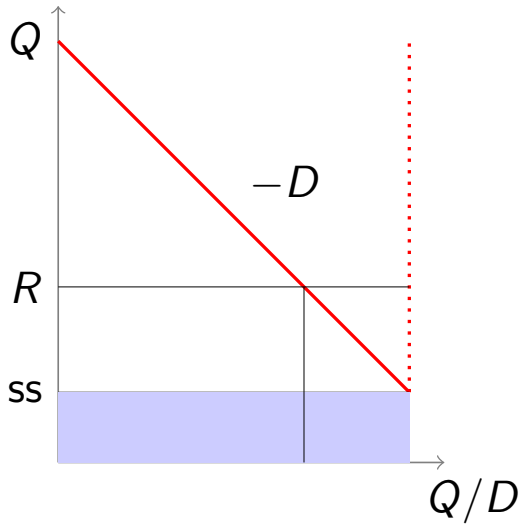
c_T Transaction (reordering) cost

c_H Inventory holding cost

Optimal Order Quantity

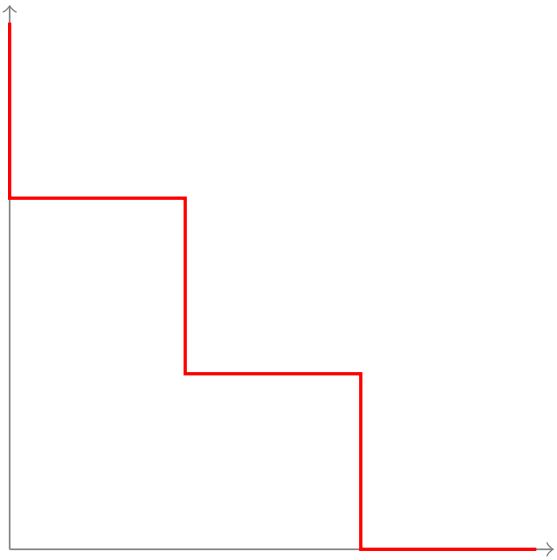
$$\begin{aligned}
\text{Cost of a cycle} &= c_T + c_H\left(\frac{Q^2}{2D}\right) \\
\text{Cost per unit-time} &= \left(\frac{c_T D}{Q}\right) + c_H\left(\frac{Q}{2}\right) \\
Q^* &= \sqrt{\frac{2Dc_T}{c_H}}
\end{aligned}$$

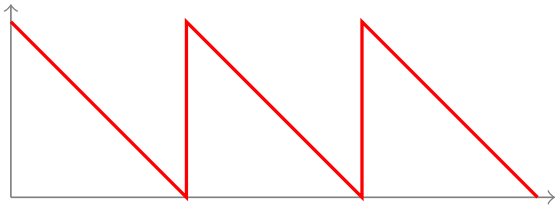
Safety Stock Protects Against Variance



Safety stock $= Z \times$ (std deviation of lead-time demand)

Orders In the Supply Chain





Bullwhip Effect

Definition

Increase in Coefficient of Variation of Q going up the supply chain

- Grocery Industry: \$30 billion of inventory in supply chain, *not* including the factory and retailer
- Pharmaceutical Industry: 100 days of supply scattered throughout the supply chain

Causes

- Forecast updating
- Order batching
- Price fluctuations
- Gaming the system

Complicating factors: Human overreaction, multiple stages, long or uncertain lead times

Traditional Supplier Relationship

- Retailer: Forecasts sales, places orders
- Manufacturer: Forecasts orders

The only data passing between Retailer and Manufacturer are the actual orders.

Vendor Managed Inventory (VMI)

- Retailer: Makes no decisions regarding replenishment decision-making)
- Manufacturer: Forecasts sales, plans shipments.
- Companies: Pampers, Campbell's Soup, Air Products/Praxair
- Retailer as vending machine

Other names:

VMI: Vendor-Managed Inventory

JITD: Similar to JIT in that it seeks to match product flow with demand, and reduces variance and inventory.

CRP: Continuous Replenishment Program

Collaborative Planning, Forecasting, and Replenishment

- Manufacturer and retailer meet in the middle.
- Collaborate on forecasting sales and planning shipments.

Can be something fundamentally different than traditional supply chain, but in practice is often little more than collaborative forecasting.

Pooling / Postponement

Pooling: Combine multiple inventory stockpiles into one.

Postponement: Delay product differentiation

Both aggregate demand streams:

Pooling: Demand streams are separated (for example, geographically).

Postponement: Demand streams are separated by product.

Other Examples of Postponement

- Gas Stations: Mix octane at pump
- Auto: Add AC, radios, etc at dealers
- Salad Bar: Postpone creation of salad
  - Risk-pool demand of ingredients to stock larger variety, less inventory
- Retail Paint: Mix any color from primaries
- Benetton: Dye sweaters at last opportunity
- Blockbuster/IBM: Make CDs at retail store

When to postpone

- Many similar varieties, customizations.
- Products can be modularized.

Why might you *not* postpone?

- Labor cost is high in Europe
- High costs to turn DCs into assembly sites
- Costly redesign of product
- Redesigned product may be costly to make
- LT for differentiation still too long to offset costs
- Excess transportation costs too high
- Lose regional presence
- Effects on quality control

Separate Versus Centralized Inventories

Simple model:

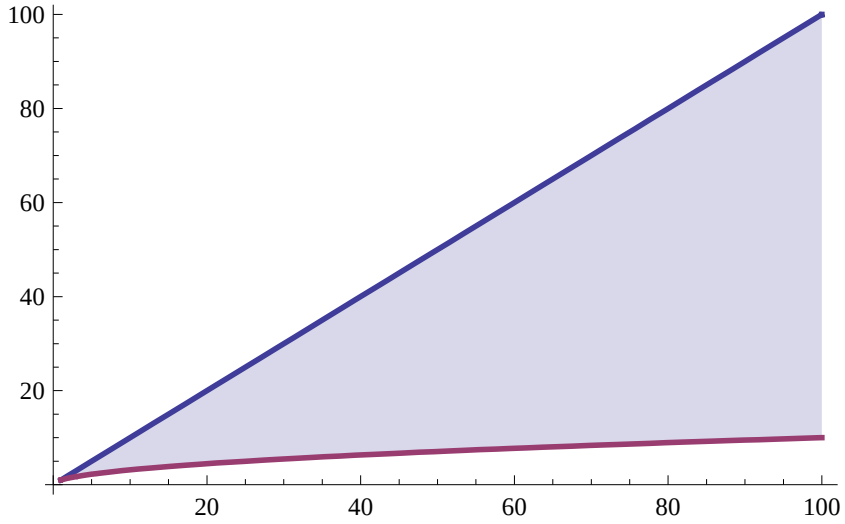
- All N sites experience the same distribution of demand: Normal(μ, σ^2).
- All demands are independent.
- All lead times have common value L.

Inventory Level
Order Quantity
Safety Stock and Reorder Points
The Bullwhip Effect
Supplier Relationships
Inventory Pooling, Postponement

Separate Versus Centralized Inventories

- Separate inventories
  - Safety stock for each $= Z\sigma\sqrt{L}$
  - Total safety stock $= N\,Z\sigma\sqrt{L}$
- Consolidated inventory (pooling)
  - Aggregate demand $=$ Normal($N\mu, N\sigma^2$)
  - Total safety stock $= \sqrt{N}\,Z\sigma\sqrt{L}$

Savings Due to Risk Pooling



$$\text{Average inventory reduction} = \left(N - \sqrt{N}\right) Z\sigma\sqrt{L}$$

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Forms of Pooling

Virtual Centralization: Linked by information system

Specialization: Each product stocked in only one location

Component Commonality: One component fits all

Product Substitution: Red satisfies demand for mauve, pink

Postponement: Stock generic items, customize-to-order

For more information

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