Issues in Supply Chain Strategy

Don Rosenfield

Supply chain strategy involves a number of issues

- **Understanding inputs and outputs**
- **Strategies for a dispersed network**
- **Dealing with some trends in globalization**
- **Methods for extending benefits**
- **New trends and what they imply**

Framework for strategic analysis: Strategic outputs

- **Delivery or service time**
- **Customization and breadth of product line or service**
- **Service level on inventory**
- **Variation of service level or delivery time**

As for the case of manufacturing, a logistics system needs to align logistics policies to further specific strategic goals
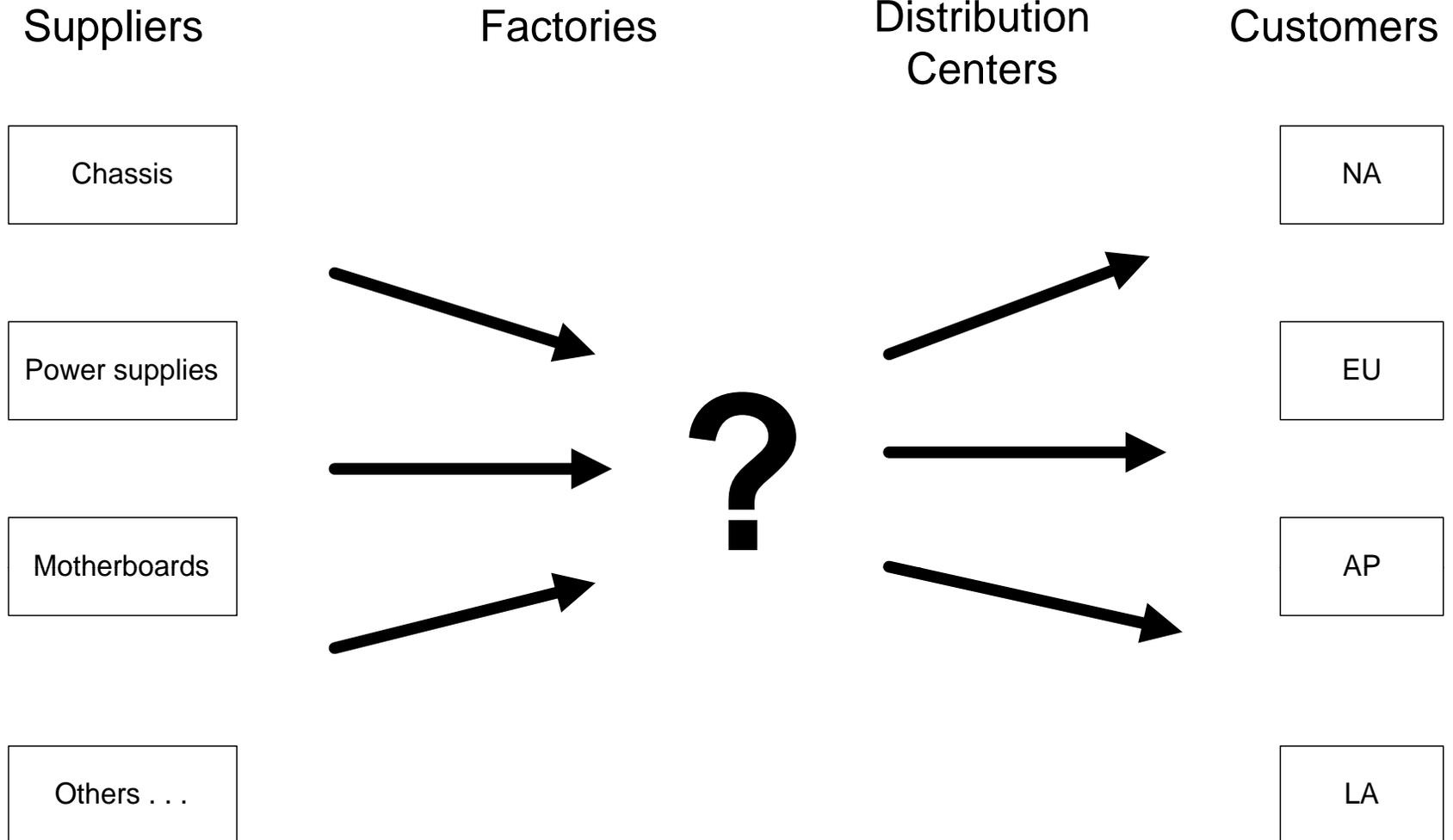
Supply chain and logistics decisions: inputs

- **Inventory position**
- **Inventory levels**
- **Transportation choices**
- **Supplier choices**
- **Structure – Number of facilities, number of stages**
- **Distribution flow**
- **Possible customization point (push-pull)**

Supply chain choices

source: HP

Suppliers   Factories   Distribution Centers   Customers

| Chassis |

| Power supplies |

| Motherboards |

| Others . . . |

?

| NA |

| EU |

| AP |

| LA |

Some factors to consider

- **Relative transportation costs**
- **Demand uncertainty (e.g. fast movers at many locations**
- **Product variety**
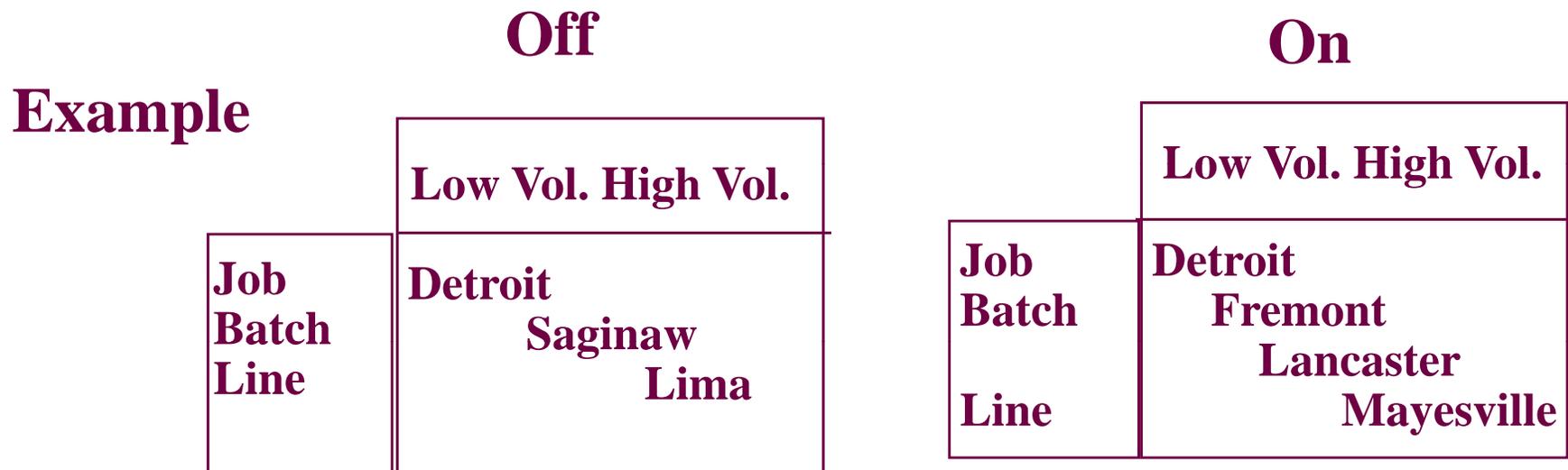
Dispersed supply chains address a number of issues

- Scale

- Logistics and flow patterns

- Focus

- Global flexibility and access

- Access to R&D

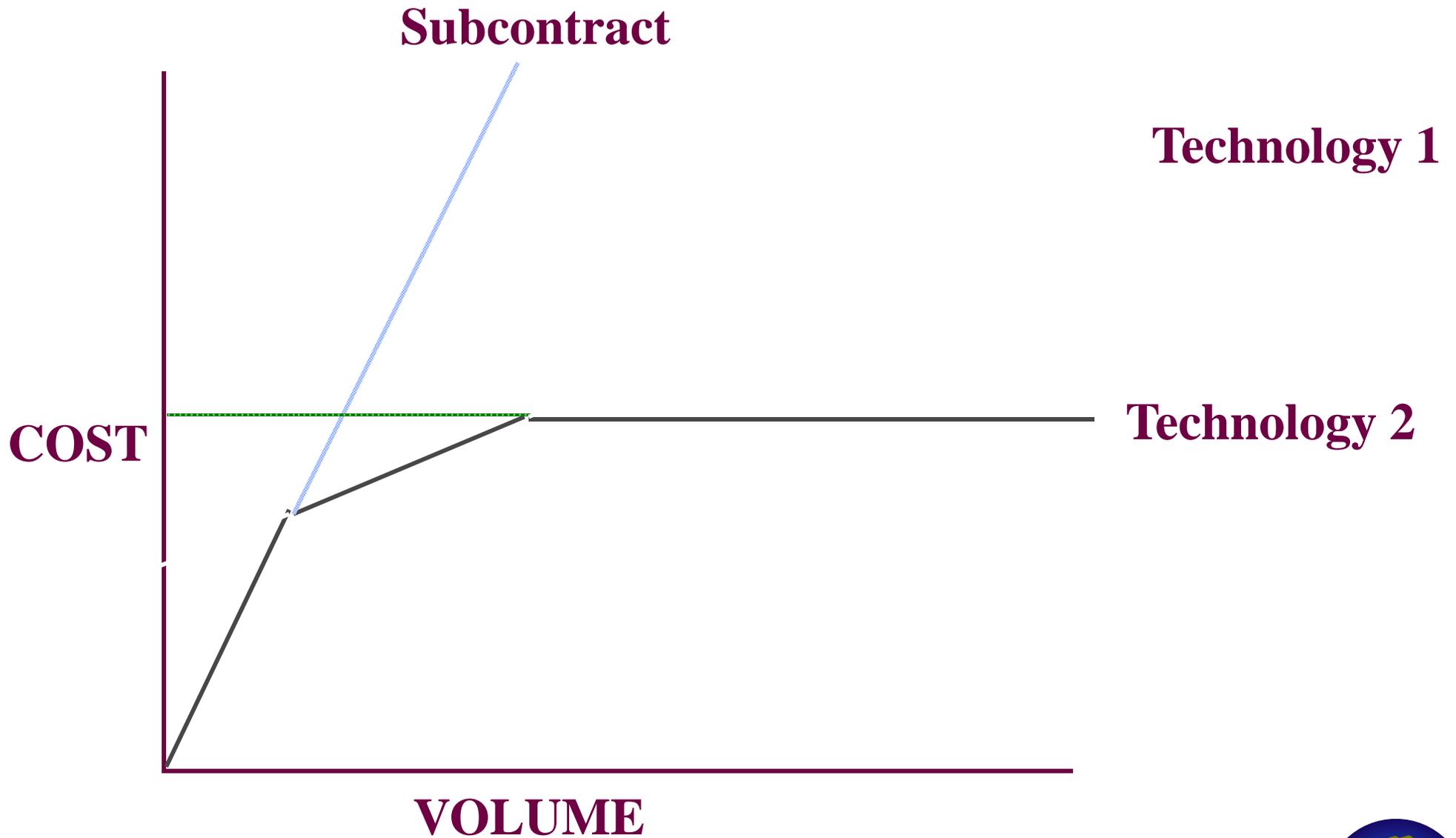# Product/Market-Process Focus

Mean of Focus

- **Volume**

- **Product**

- **Market**

- **Process**

Example

Off

	Low Vol. High Vol.

Job
Batch
Line
	Detroit
	      Saginaw
	           Lima

On

	Low Vol. High Vol.

Job
Batch
 	
Line
	Detroit
	   Fremont
	      Lancaster
	         Mayesville

Scale Analysis

Subcontract

Technology 1

Technology 2

COST

VOLUME

Consumer goods example

Cost
per
unit
($/unit)

1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3

0   2   4   6   8

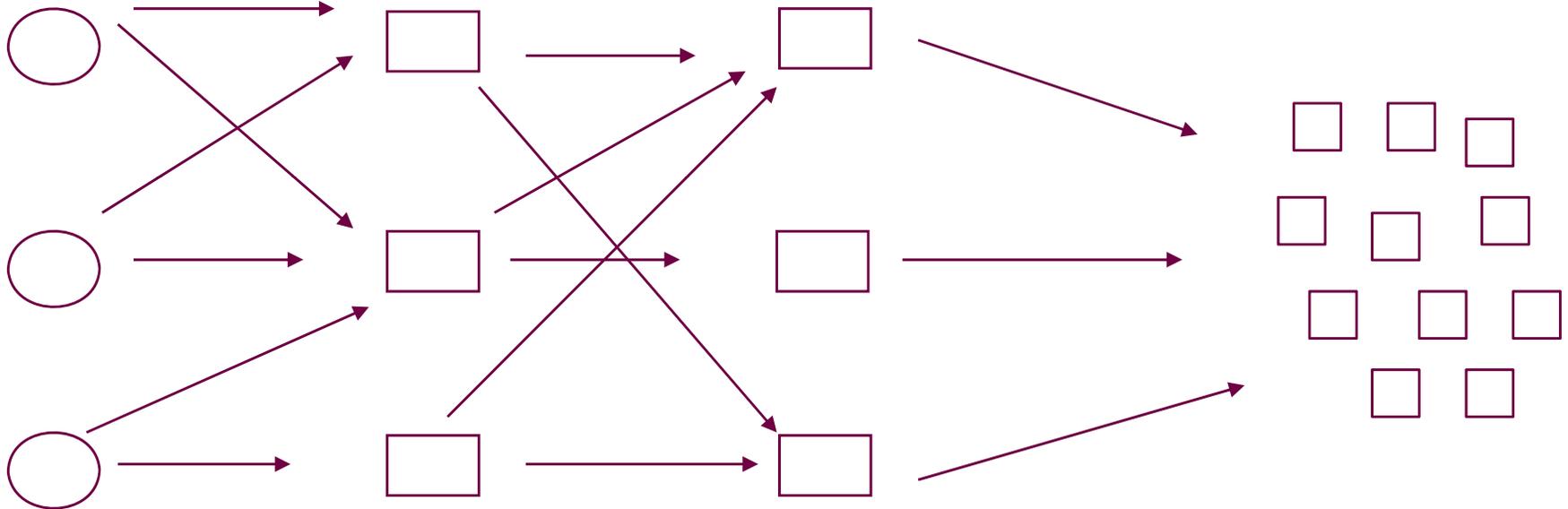Volume in millions of units
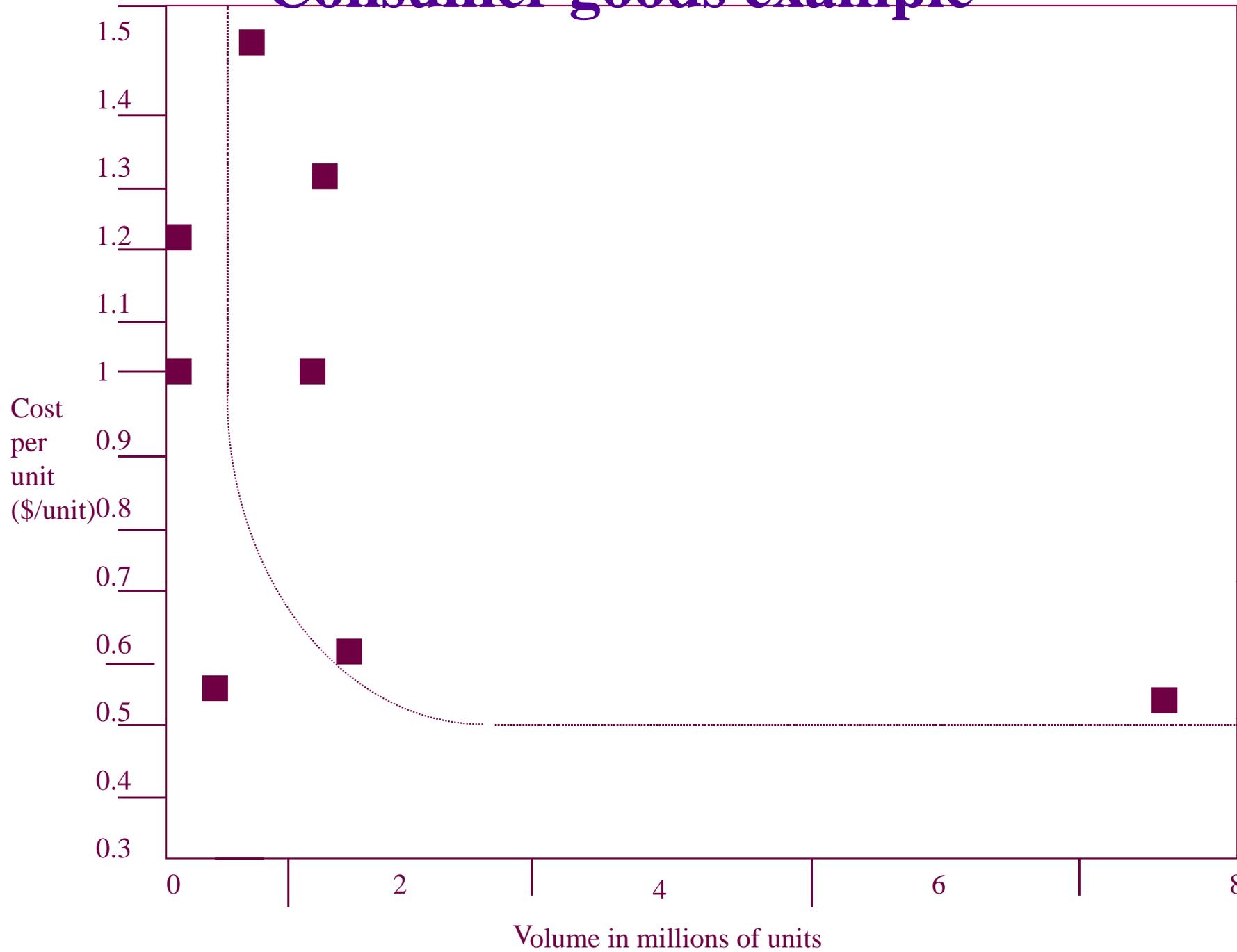
Suppliers   **Plants**   **Distribution Centers**   **Customers**

Network for
Multi-location supply chain

Formulation for general case

$$\sum_k y_{ikl} \leq A_{il}$$

$$\sum_{j,l} x_{lkj} f_l \leq A_k \qquad \text{where f is the unit usage of product } l$$

$$\sum_k x_{lkj} \geq D_{lj}$$

$$\sum_i y_{ikl} \geq \sum_j x_{lkj}$$

$$\sum_{lj} x_{lkj} \leq k z_k, \, z_k \qquad \text{is zero or one, forcing constraint}$$

Could also have shared cap at plants. With no warehouses, define plant variables to go to customers directly. Can add another level for sourcing or two stages of plants.

Some global modeling issues

- **Duties are generally linear, as are taxes**
- **The general multi-stage model applies**
- **The particular case of tax havens can be complex. For many countries, one generally assumes funds are reinvested or not repatriated.**
- **Sourcing can add an additional factor of complexity**
- **Data collection can be a major issue**
- **A different model is used for the "Asian" paradigm**

The Asian Paradigm Model

Examines long lead time replenishment subject to

- Dual modes of transportation
- Demand uncertainty
- Minimum container size
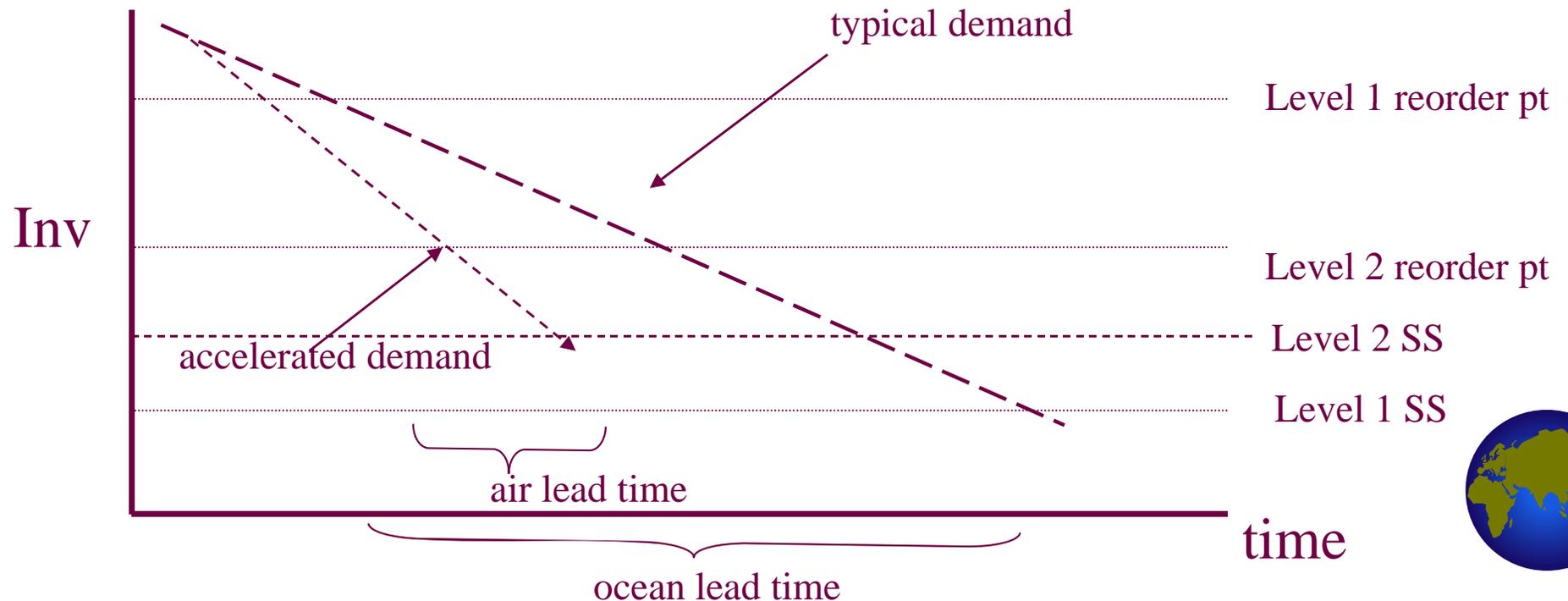- Accelerated requirements schedule with constrained production

Example: Polaroid JoyCams

The Asian Paradigm Model

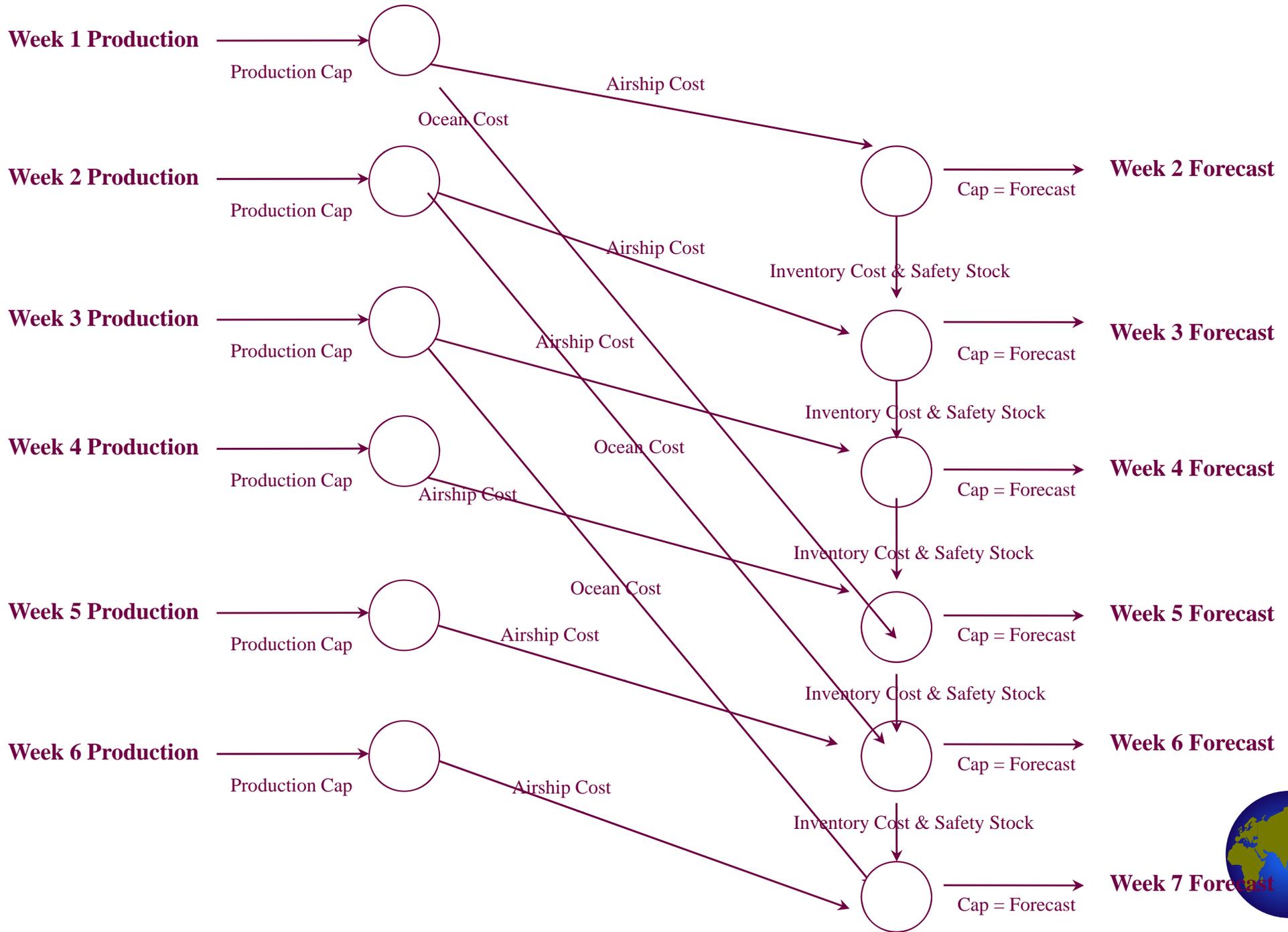## Approach:

- –Dual safety stock (one if by air two if by sea)
- –Order by ocean if one month demand less on-hand plus on-order exceeds level one safety stock
- –Order by air if one week demand less on-hand plus on-order exceeds level two safety stock

typical demand

Level 1 reorder pt

Inv

Level 2 reorder pt

Level 2 SS

accelerated demand

Level 1 SS

air lead time

time

ocean lead time

Network Solution to Polaroid Problem

Week 1 Production → ○
Production Cap
Ocean Cost
Airship Cost

Week 2 Production → ○
Production Cap
Airship Cost

Week 3 Production → ○
Production Cap
Airship Cost
Ocean Cost

Week 4 Production → ○
Production Cap
Airship Cost

Week 5 Production → ○
Production Cap
Ocean Cost
Airship Cost

Week 6 Production → ○
Production Cap
Airship Cost

○ → **Week 2 Forecast**
Cap = Forecast
Inventory Cost & Safety Stock

○ → **Week 3 Forecast**
Cap = Forecast
Inventory Cost & Safety Stock

○ → **Week 4 Forecast**
Cap = Forecast
Inventory Cost & Safety Stock

○ → **Week 5 Forecast**
Cap = Forecast
Inventory Cost & Safety Stock

○ → **Week 6 Forecast**
Cap = Forecast
Inventory Cost & Safety Stock

○ → **Week 7 Forecast**
Cap = Forecast

Some Examples of Strategies

1. Different process steps and scale, significant logistics

    ↖ **Central stage 1, decentralized stage 2**

2. Significant central R&D

    ↖ **Central plant for at least early life cycle**

3. Significant product flexibility

    ↖ **Decentralized satellite plants for some stages**

The examples underscore the need to develop a strategically consistent focus approach and then appropriately analyze scale and logistics

A suggested approach

- **Develop a strategy and appropriate means of focus**

- **Using data, benchmarking and analysis of technology, develop scale curves**

- **Identify major decision choices and service requirements covering plant and process options**

- **Do the analysis**

Case Study
Worldwide Consumer Goods Manufacturer

- **25 Product Groups**

- **About 10 Production Locations**

- **Variety of Product Values and Weights**

- **Over Capacity**

- **Lack of Focus**

- **Significant Tax Issues**

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│              │─────▶│              │─────▶│              │
│              │      │              │─────▶│              │
│              │      │              │─────▶│              │
└──────────────┘      └──────────────┘      └──────────────┘
   Stage 1                Stage 2              Customer
```

Why Separate?

- **Differing Scale**
- **Market presence**
- **Tax Laws**
- **Focus**
- **Technological complexity**

Approach

- **Cross sectional analysis**
- **Model of variable costs**
- **Tax analysis**
- **Detailed analysis of actual fixed costs**

Solution:

- **Move "light" products to tax havens**
- **Better focus facilities by product group**

Globalization adds some additional complexities beyond network issues

- **Increase in worldwide exports**

- **Business level trends**

  - **lower scale, higher-skill level manufacturing systems such as FMS**

  - **JIT systems that also underscore the need for sophisticated vendor infrastructure**

  - **TQM and organizational learning**

  - **Faster product development**

  - **Customization needs**

  - **High-value products such as wafers and chips**

Complexities (continued)

- **Macro level trends**
  - **Large, sophisticated overseas markets with local needs**
  - **Non-tariff barriers**
  - **Regionalized trading economies**
- **Variable factor costs**
- **Particular case of China**

Global strategies emphasize some additional factors

- Global product volumes

- Regional presence for some products

- Balancing infrastructure versus cost (Nokia vs. Motorola)

- Flexibility in several ways

- Global product and development supply chains

There are a number of tradeoffs in global operations

⬉ **Scale economies**

⬉ **Transportation costs, duties and other costs of servicing a market externally**

⬉ **Flexibility for servicing a high-cost market**

The Basic Model

N = **Number of markets of equal size**

M = **Number of plants**

D = **Total demand**

C_1 = **Cost to distribute and handle the same market**

C_2 = **Cost to distribute and handle to other markets** $(C_1 < C_2)$

F(X) = **Cost to produce X**

$$F'(X) > 0, F'' \leq 0$$

However, any significant insights depend on a stochastic model for market production costs

Two critical parts of the model:

1. **Costs of capacity and production**

    G_1 **(y) = Cost of plant size y with no production (fixed)**

    $xG_2(y)$ **− Variable cost to produce x given y (periodic)**

    G_1 **is concave, G_2 is non-increasing**

    Plants must satisfy at least their own markets

2. **Model for exchange rates and production costs**

    Production cost in any market in period n is equal to a base cost times a product of n IID multipliers

What is policy in each period?

Suppose there are **M** plants with capacities **Yj** and that demand (still deterministic) is **D.** Define

  j(l) = index of plant with the l-th highest cost multiplier

Thus, the number of plants with production being cut back is

$$l^* = l_1 + \frac{Y - D - \sum_{l=1}^{i_1}\left(Y_{j(l)} - D_{i(l)}\right)}{Y_{j(l_1+1)} - D_{i(l_1+1)}}$$

where

$$l_1 = \max\left\{ m : \sum_{l=1}^{m}\left(Y_{j(l)} - D_{i(l)}\right) \le Y - D \right\}$$

Example of Calculation

- ↖ **With M = 5 plants and a capacity of 133 1/3 units, the index is 2, so we seek the average of the top 2 multipliers**

- ↖ **The top multiplier is expected to be the 83 1/3 percentile and the next is at 66 2/3, yielding .97 and .43 standard deviations above the mean**

- ↖ **This yields .70 standard deviations above the log mean**

- ↖ **The savings from such higher costs might make up for the extra fixed costs**

Candidate optima are based on the piecewise-linear model

For M = 5, for example
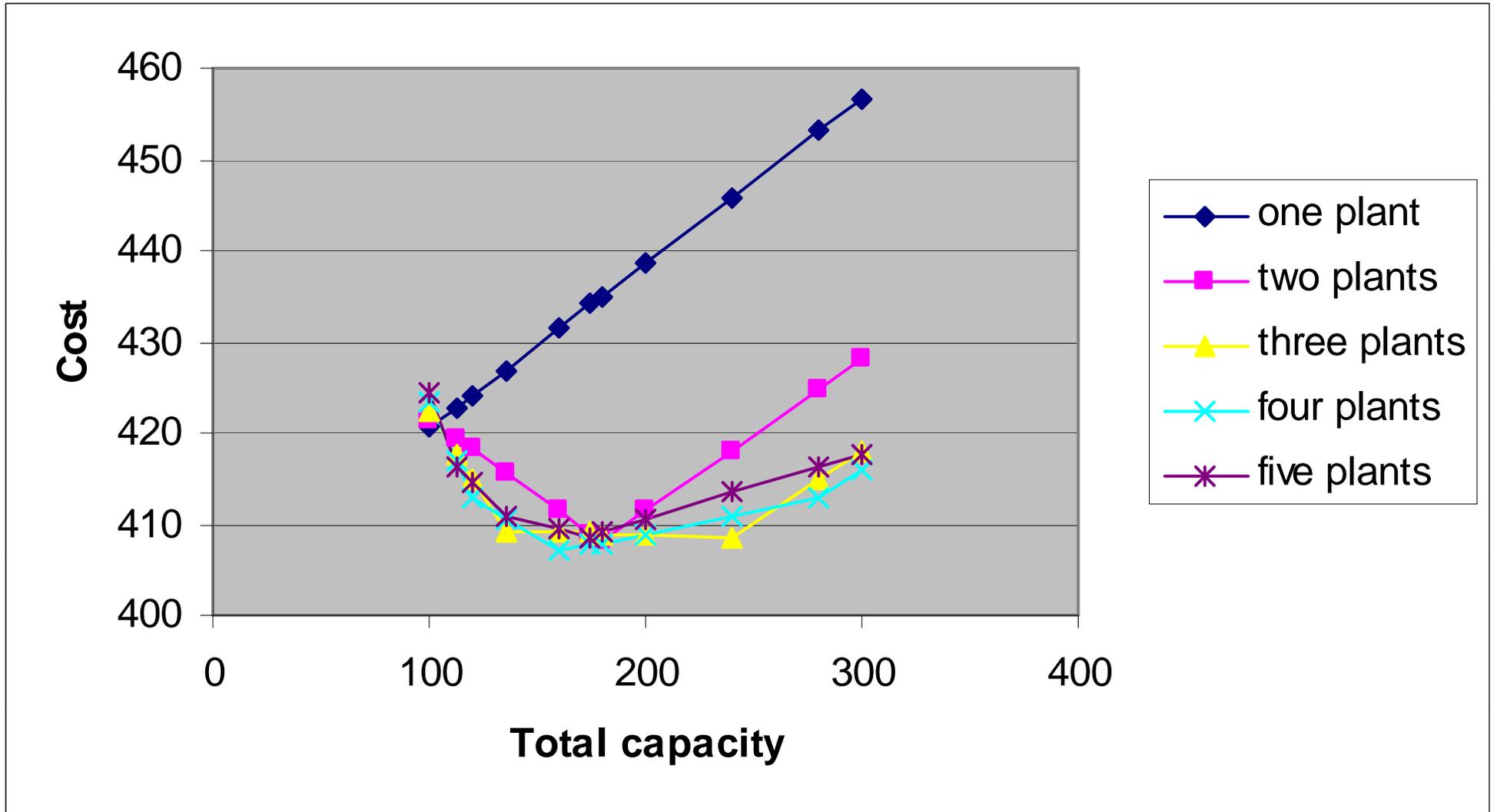
$$M = 1, Y = 100$$
$$M = 2, Y = 180$$
$$M = 3, Y = 135, 240$$
$$M = 4, Y = 120, 160, 280$$
$$M = 5, Y = 112.5, 133\ 1/3, 175, 300$$

Exchange rate model

The Multi-Period Model

V (t, random state, strategy in t) =

  Max (E(R(t-1,random state,strategy in t-1)

    + transition to t-1 strategy

     + aEV(t-1,random state, strategy in t-1))

R=single period return

V= Return over entire horizon

single period profit then becomes a mathematical program.
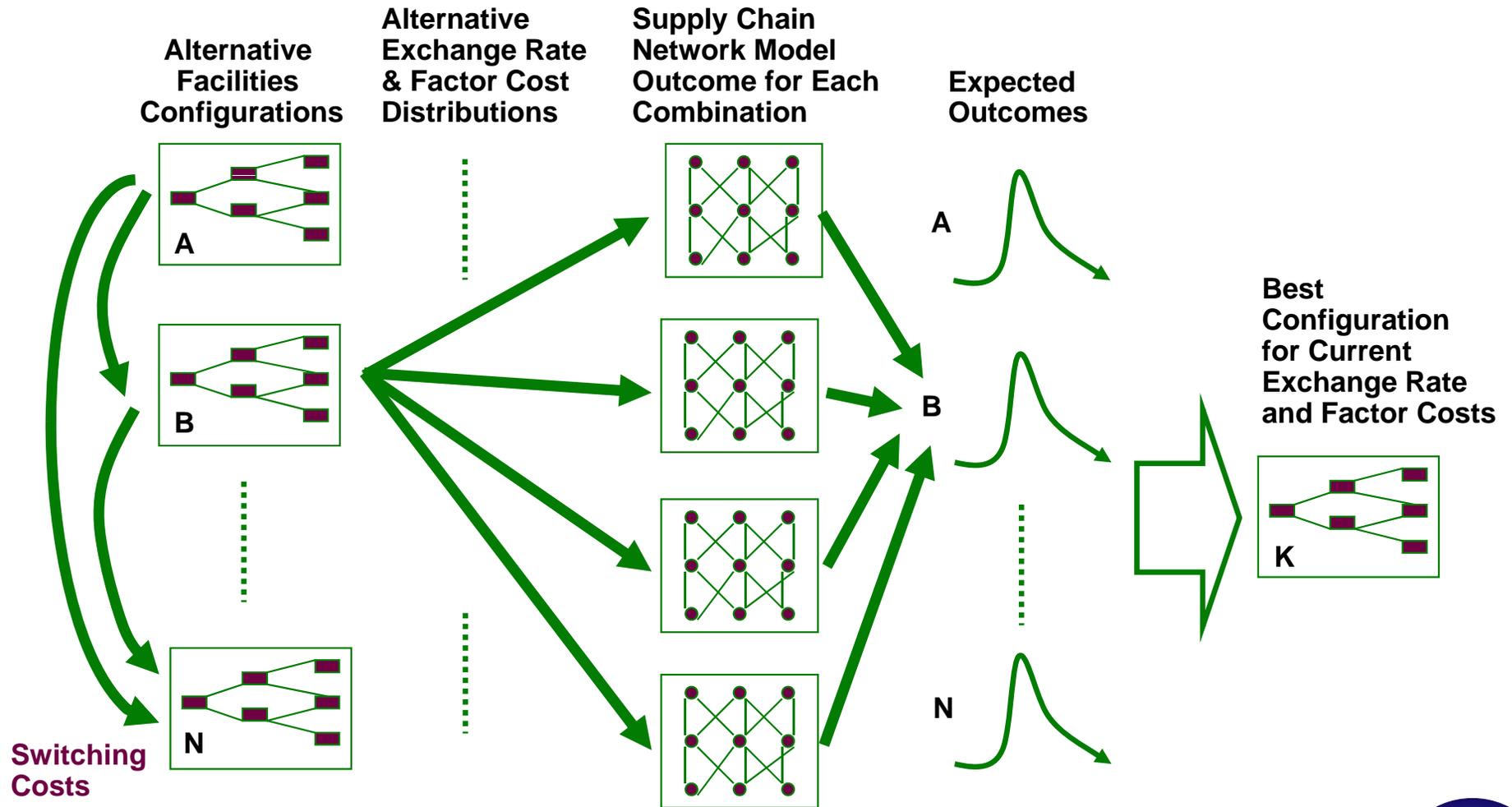

In simpler terms, you do the following

  - pose a strategy

  - determine immediate performance

  - chart future scenarios
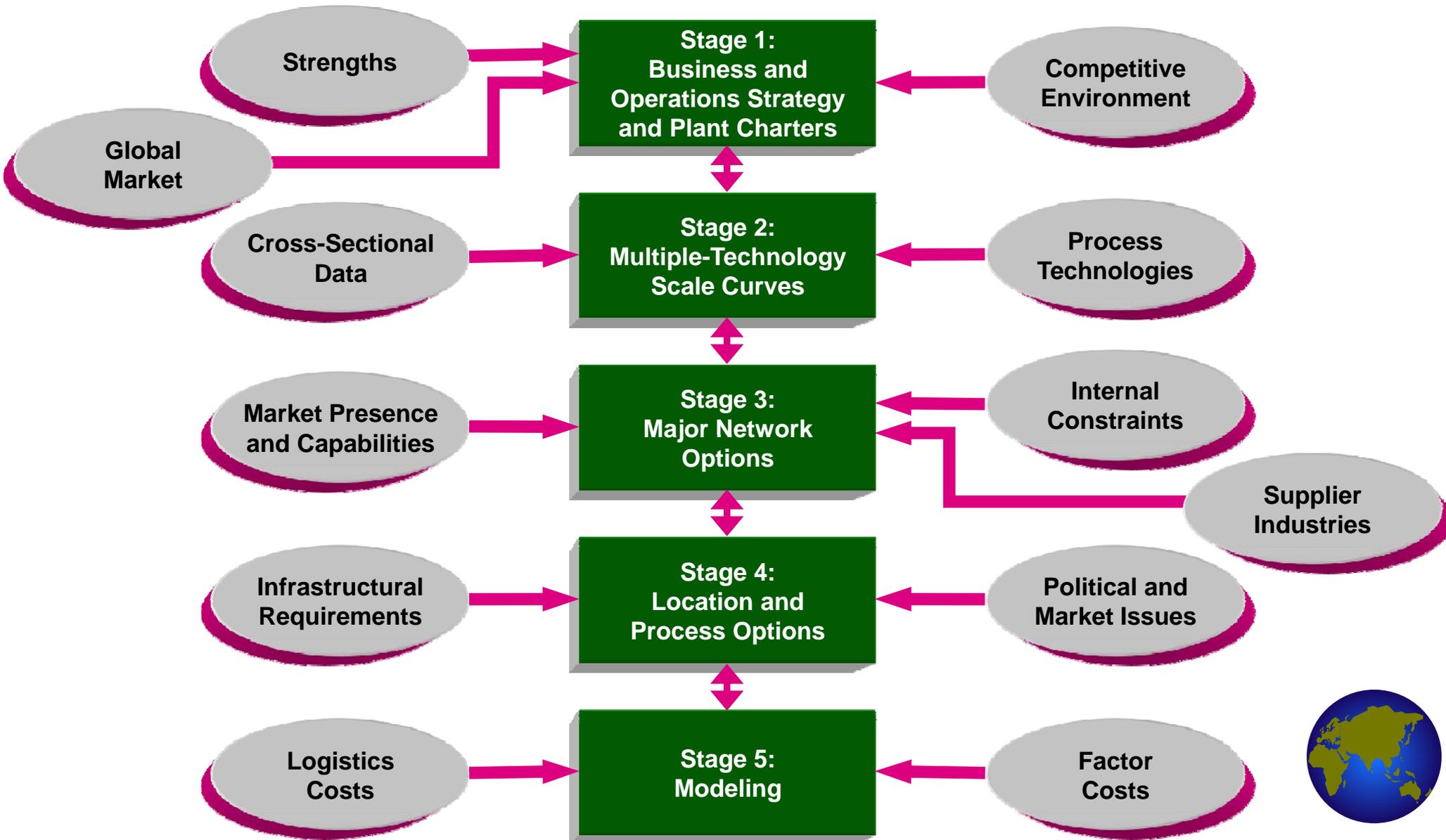
  - calculate expected outcomes

Facilities Strategy Given Uncertainty

(adapted from Huchzermeir and Cohen)

Alternative Facilities Configurations

Alternative Exchange Rate & Factor Cost Distributions

Supply Chain Network Model Outcome for Each Combination

Expected Outcomes

Best Configuration for Current Exchange Rate and Factor Costs

A

B

N

Switching Costs

A

B

N

K

Five-Stage Approach to Strategy Development

Strengths → **Stage 1: Business and Operations Strategy and Plant Charters** ← Competitive Environment

Global Market → Stage 1

Cross-Sectional Data → **Stage 2: Multiple-Technology Scale Curves** ← Process Technologies

Market Presence and Capabilities → **Stage 3: Major Network Options** ← Internal Constraints

Supplier Industries → Stage 3

Infrastructural Requirements → **Stage 4: Location and Process Options** ← Political and Market Issues

Logistics Costs → **Stage 5: Modeling** ← Factor Costs

Extending the supply chain: The Storefront concept:
This concept is based on the notion that the retailing or dealer
aspect of a distribution chain performs many functions

- **Sales**
- **Service**
- **Parts**
- **Demonstration merchandise**
- **Inventory**
- **Customer contact**

There is no reason why these cannot be separated

The Approach was implemented at Union Carbide's Packaged Gas Business

- Carbide delivers cylinders of gas (or bulk gas) and supplies to branches from plants.
- Carbide converted some branches to storefronts - Customer contact points and "walk-in" service points.
- The service was still the same.
- The economics was an elimination of three steps out of five.

1 - Filling and Storing cylinders and parts centrally

2 - Loading cylinders and parts on trailers and delivering them to branches

3 - Unloading and storing cylinders and parts at branches.

4 - Warehousing and handling

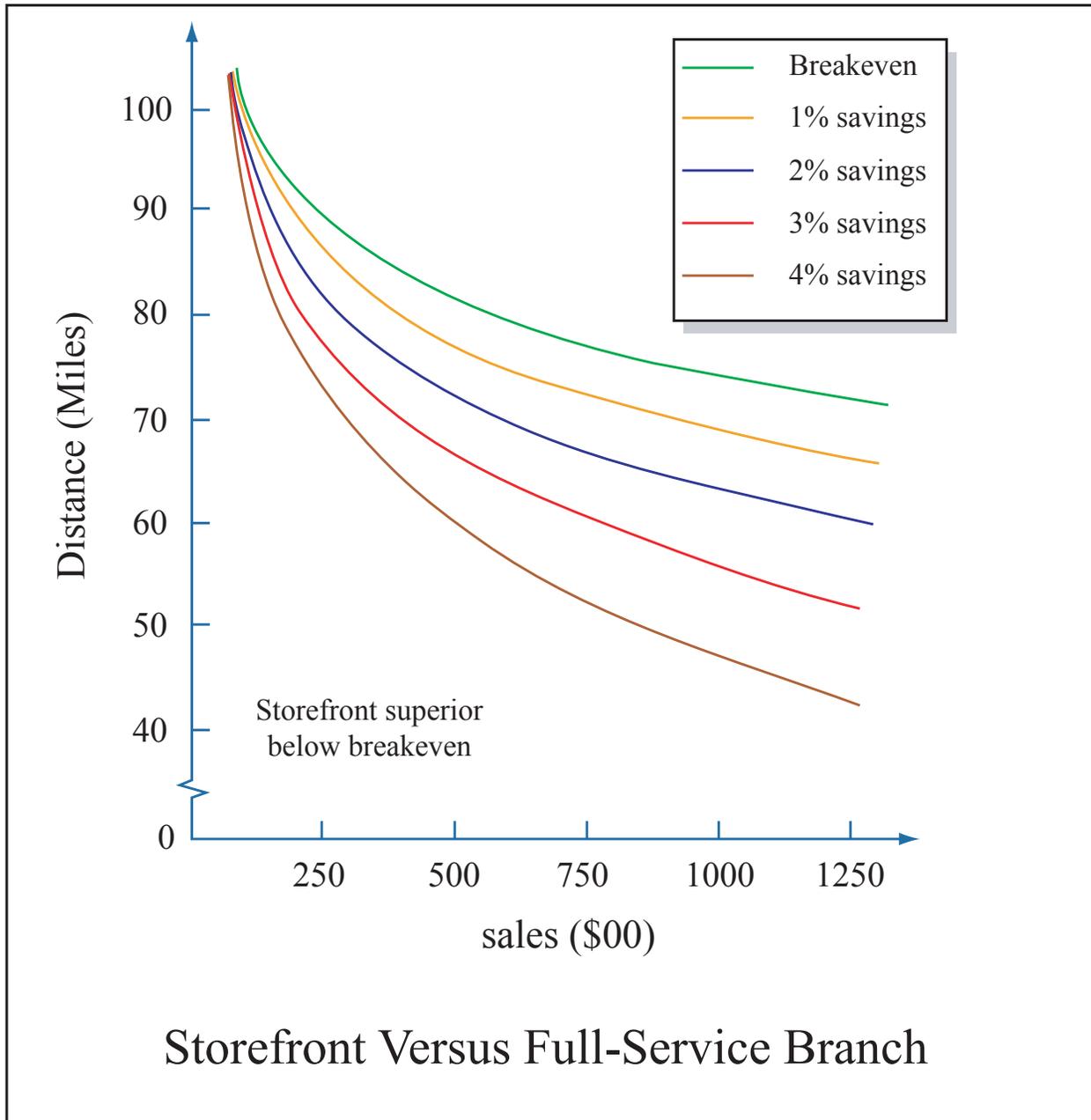5 - Loading parts and cylinders on truck routes and delivering them to customers

Storefront Versus Full-Service Branch

The most profound example is for the car companies

- Why do dealers need to be sales offices, service centers and inventory locations?
- Distribution and inventory can be centralized
- Sales can be decentralized and established on a different scale
- In addition, the other parts of the business can establish new service entities

Summary

- Methods for analyzing focus, scale flow, etc.

- Impact of new markets and technologies

- Global product design and flow patterns

- Long lead times

- Flexibility

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