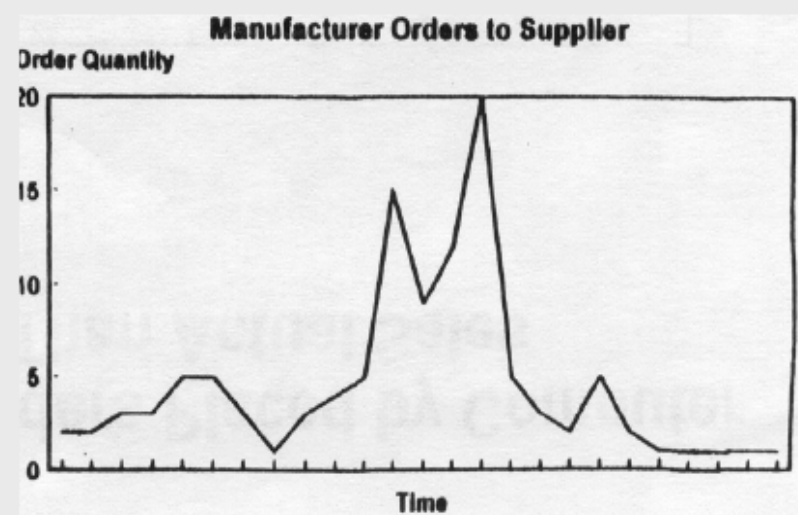
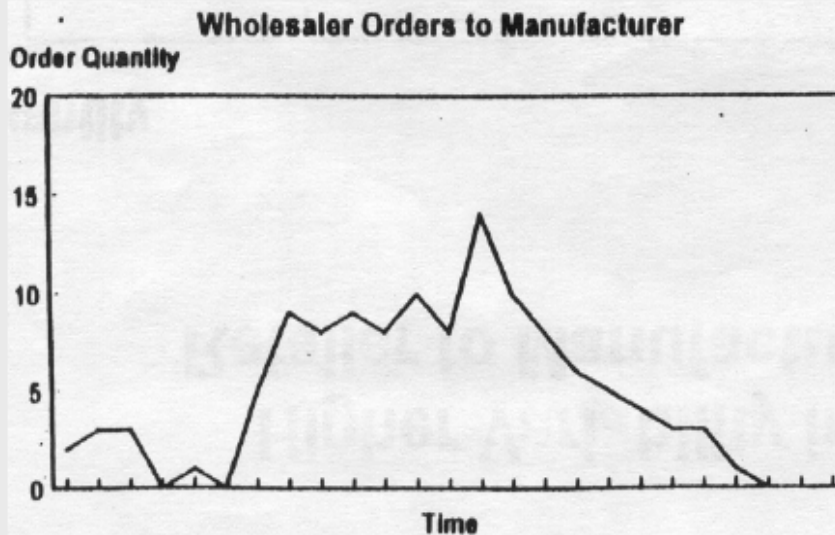
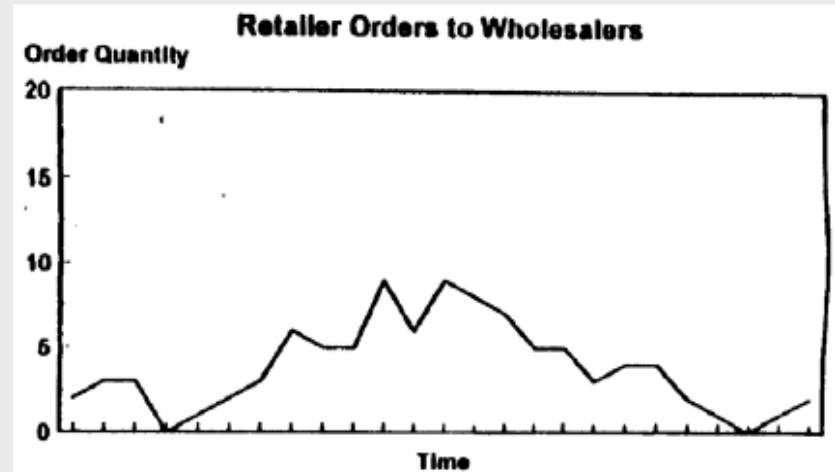
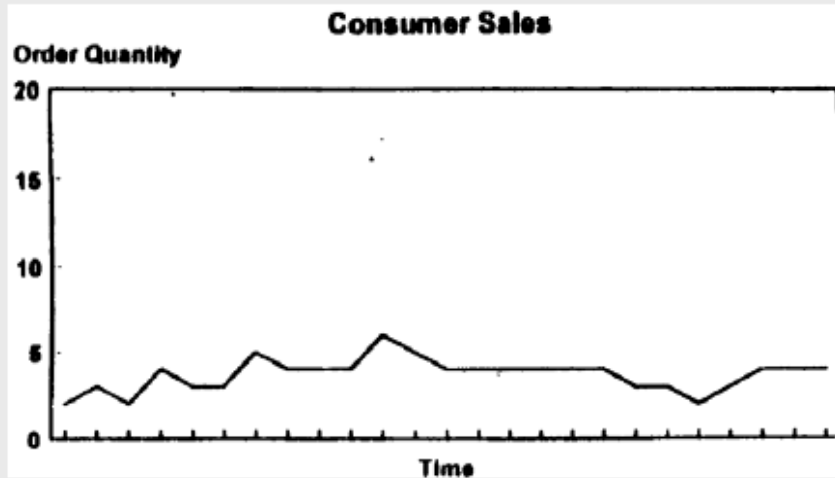


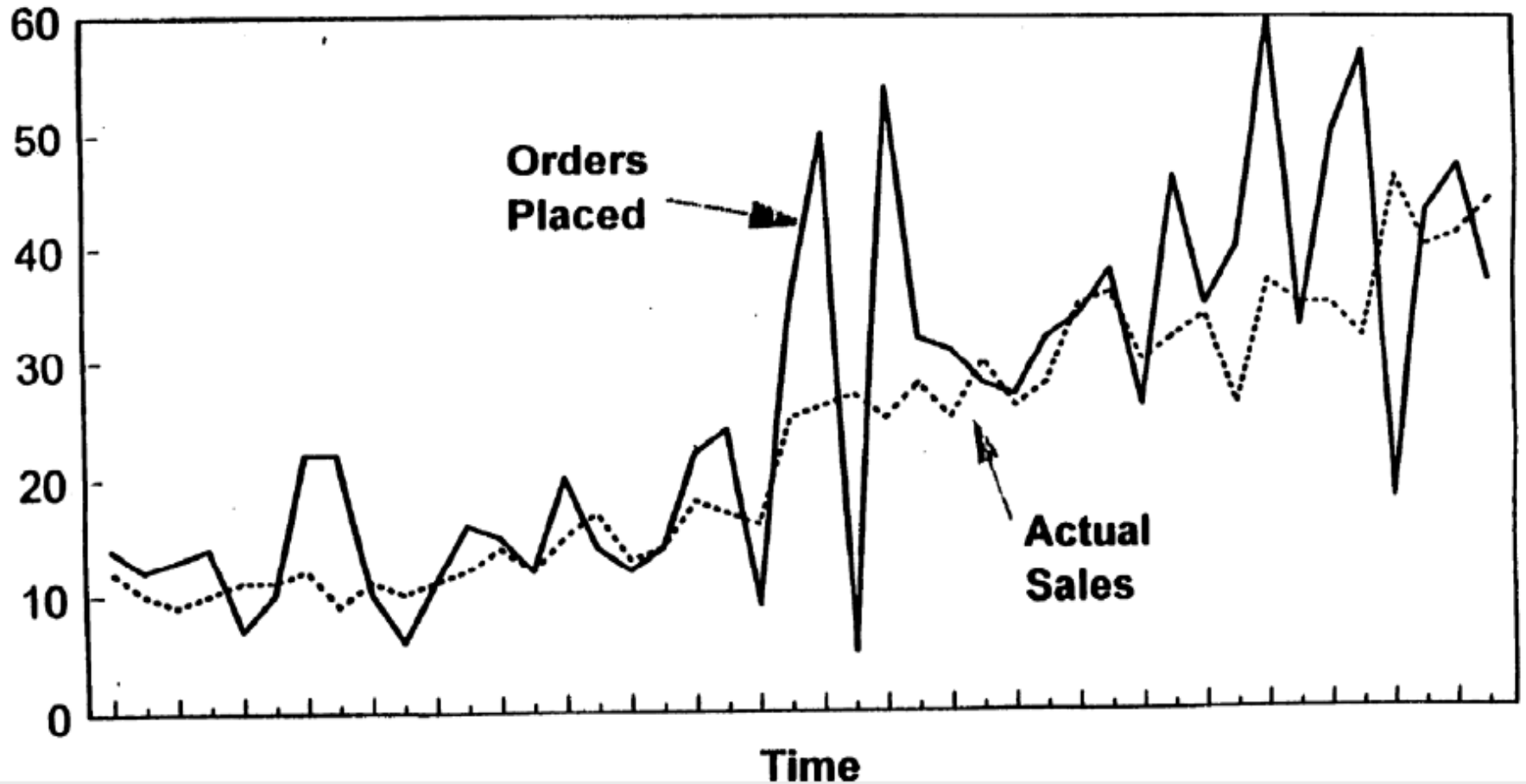
# Common Features: Increasing Upstream Orders



Source: Lee and Wang (1997)

## Further: Higher Variability in Orders Than Actual Sales

**Quantity**



Source: Lee and Wang (1997)

# Symptoms of the Bullwhip Effect

- Excessive Inventory
- Poor Forecasts
- Insufficient and/or excessive capacities
- Unavailable Products
- Long Backlogs
- Costs for Expedited
- Shipments and Overtime

# Explanations for the Bullwhip Effect

Unanticipated lead time

Lack of information

## Demand forecasting

- ↳ Each stage forecasts future demand for its own products based on own observations about their customer behaviour
- ↳ Safety stocks established at all stages to meet own expected demand

## Batch ordering

- ↳ Batching of orders in order to lower procurement and transport costs
- ↳ Inventory levels set on the basis of constant or variable order intervals
- ↳ Erratic demand for the supplier: peak demand followed by no sales

## Price fluctuations

- ↳ Special offers and discount provision allows forward buying: customer buys more than normal with buying less or nothing after
- ↳ Further, order policy is not aligned to customer demand behaviour: no replenishment until stock-out situation and lost sales after
- ↳ Generally, fluctuations of order quantity are in excess of demand fluctuations

## Inflated ordering

- ↳ Inflated ordering if a stock-out situation is feared
- ↳ Setting quotas for products if demand cannot fulfilled - may lead to excessive orders and their cancellation after quota is abandoned

# How to Avoid the Bullwhip Effect (1/2)

## Reasons

### Demand forecasting

### Batch ordering

## Improved information flows

- ↳ Understanding system dynamics
- ↳ Dissemination of Point-of-sales-Information (POS) via EDI, Internet

- ↳ Order transmission via EDI, Internet

## Collaboration and co-ordination

- ↳ Employing Logistics Service Providers
- ↳ Establishing vendor or co-operative managed inventory systems (VMI/CMI)
- ↳ Direct sales to final customer
- ↳ Lowering transport costs by employing groupage services or outsourcing of logistics operations

## Further process improvements

- ↳ Reduction of lead time in replenishment process
- ↳ Realisation of just-in-time (JIT) concepts
- ↳ Reducing procurement costs by employing EDI and/or Internet
- ↳ Standardizing order processes

# How to Avoid the Bullwhip Effect (2/2)

Reasons

Improved information flows

Collaboration and Co-ordination

Further process improvements

Price fluctuations

↳ Every day low price

↳ Every day low price

↳ Continuity in order policy

↳ Application of activity based costing (ABC)

↳ Abandonment of special offers

Inflated ordering

↳ Sharing information about demand, capacity and inventory levels along the supply chain

↳ Quantity allocation on the basis of orders in the past

↳ Higher sanctions in case of order cancellations

# Structure Drives Behavior: Causes of the Bullwhip Effect

- Lack of visibility
- Long lead time
- Many stages in the supply chain
- Lack of pull signals
- Order batching
- Price discount and promotions
- Forward buying
- Rationing

# Other Behaviors that Cause the Bullwhip Effect

- Over-reaction to backlogs
- Neglecting to order to reduce inventory
- Hoarding customers
- Shortage gaming for customers
- Demand forecast inaccuracies
- Attempts to meet end-of-month metrics



# Ways to Mitigate the Bullwhip Effect

- Reduce lead times
- Use/sharing of POS data
- Smaller orders
  - Work with suppliers on more frequent deliveries of smaller order increments
- Use stable pricing, “everyday low prices”
  - Levels out customer demand
- Allocation based on past sales