Capacity Allocation in Decentralized Supply Chains

by

Vinayak Deshpande

Krannert School of Management
Purdue University
The Business Scenario

• Single supplier/manufacturer selling to multiple competing retailers or manufacturers, whose orders are based on private demand information

• Focus on situation when total customer orders exceed supplier’s capacity or inventory
Tight Capacity: Examples

• **LCD panels** - many TFT LCD companies recently indicated that they are facing a 10-15% gap between their demand for glass substrates and what their glass suppliers will support.

• "**Hot" Christmas gifts** - Shortages of hot-selling gadgets and toys have become a commercial rite of the Christmas season

• **Nintendo's Wii** - In 2007, a year after the Nintendo Wii was launched, the system was still incredibly hard to find.

• **Carbon emission caps**
  This year the European commission has given its final nod to Poland's national carbon allocation plan.
Supplier Often Puts Customers “On Fixed-Price Allocation”

- Practices vary, but “on fixed-price allocation” generally means
  - Each customer gets some or all of its order, based on metrics (e.g., Past Sales, Days-of-Supply) instead of willingness to pay

... are regarded as “fair” by some

Ex: Law Suits by auto makers

...but *not* by others

Ex: Law Suits by auto dealers
can result in gaming behavior...

• In order to get higher allocations, customers exaggerate their real needs when they order.
• When demand cools, orders disappear and cancellations pour in.
• Companies such as Hewlett-Packard, Motorola, IBM have experienced this.
Research Questions

• How can gaming behavior by customers be avoided?
• Do capacity allocation policies exist that will maximize supplier profit?
• What level of capacity should the supplier provide to maximize his/her profit?
• What is the impact of customer competition on capacity allocation and capacity choice?
Research Insight - 1

• To prevent gaming behavior by customers, use variable pricing policies and/or capacity allocation policies that are independent of order sizes.
Research Insight - 2

• Some capacity allocation policies used in practice, such as the linear and proportional allocation schemes, can be optimal for the supplier if used in conjunction with variable pricing.
Insight 3: Linear Allocation Mechanism

**Definition:** Add the order quantities of all customers/retailers and subtract the supplier capacity to calculate excess market demand. Allocate capacity so that this excess demand (pain) is shared equally by all customers.

*Linear Allocation scheme is optimal for the supplier if marginal revenues (and information rents) are linear in the allocated quantities.*
Insight 4: Proportional Allocation Scheme

**Definition:** Calculate the ratio of the sum of order quantities of all customers/retailers to supplier capacity. Scale every customer order by this ratio to decide allocated capacity.

*Proportional Allocation scheme is optimal for the supplier if marginal revenues (and information rents) are scalable in the allocated quantities.*
Insight 5: Optimal Capacity Choice

Optimal capacity choice depends on a number of factors including number of customers, level of competition, level of demand uncertainty, and cost of adding capacity.

Increasing market competition results in a decrease in the level of optimal supplier capacity.

Supplier’s share of supply-chain profit increases with increasing retail competition.
Research Contributions

• Analyzed gaming behavior between customers and ways of overcoming them

• Established precise conditions under which commonly used allocation policies, such as linear and proportional allocation, are optimal for the supplier

• Described the determination of the optimal supplier capacity

• Measured the impact of competition on capacity choice and allocation.