



Tactics for Managing Supply Uncertainty

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Issue seen as a strategic concern

- “Multinational companies operating in India must overcome erratic electricity supplies, poor roads, and gridlocked seaports and airports.”
 - When to make India a manufacturing base. McKinsey 2005

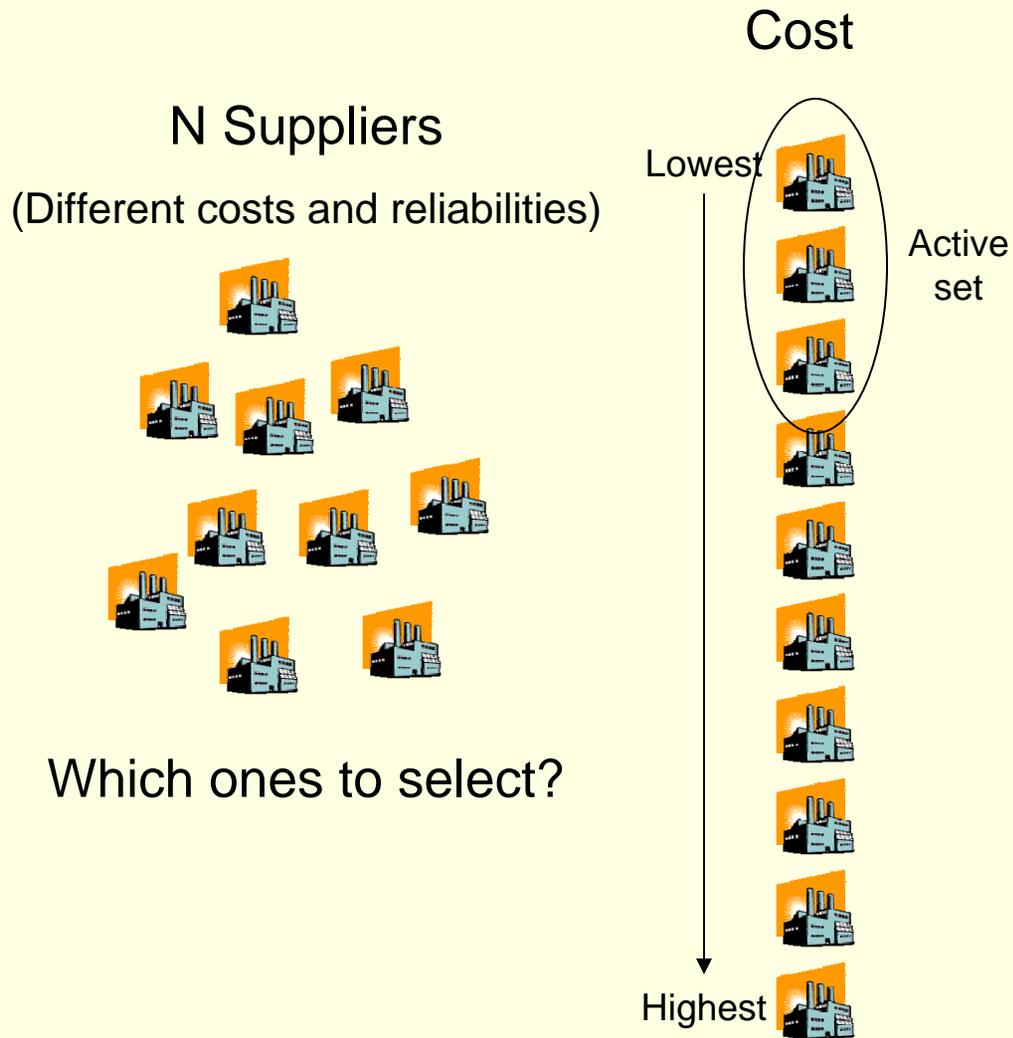
- “Sourcing from China means exposing a company’s supply chain to disruptions that are uncommon in the West.”
 - Overcoming the challenges in China operations. BCG 2005

- “There are signs that some companies are already alert to these concerns [disruptions] and may be planning to reorganise their supply chains to make them safer.”
 - When the chain breaks: being too lean and mean is a dangerous thing. The Economist. 2006

Agenda

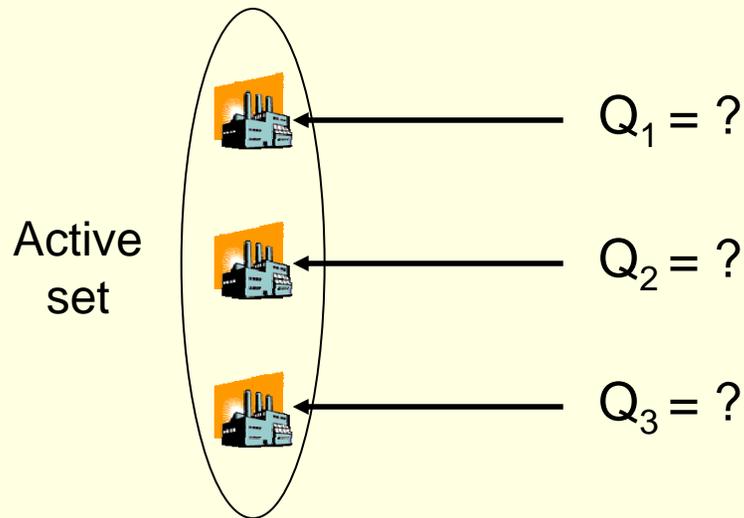
- Short life cycle products
 - Diversification
 - Demand management
- Long life cycle products
 - Inventory
 - Contingent supply
 - Risk monitoring
- Conclusions

Diversification: supplier selection



- Two suppliers: Anupindi and Akella (Mgt. Sci, 1993)
- General number of suppliers: Dada, Petruzzi and Schwarz (M&SOM, 2006, forthcoming)
- But not necessarily true if ...
 - Demand is discrete: Swaminathan and Shanthikumar (OR Letters 1999)
 - Firm pays for undelivered portion: Tomlin (2005a) [N=2]; Federgruen and Yang (2005) [general N]:
 - Federgruen and Yang (2005): establish indexing should be based on ratio of cost to reliability

Diversification: order sizes



■ Identical-cost suppliers

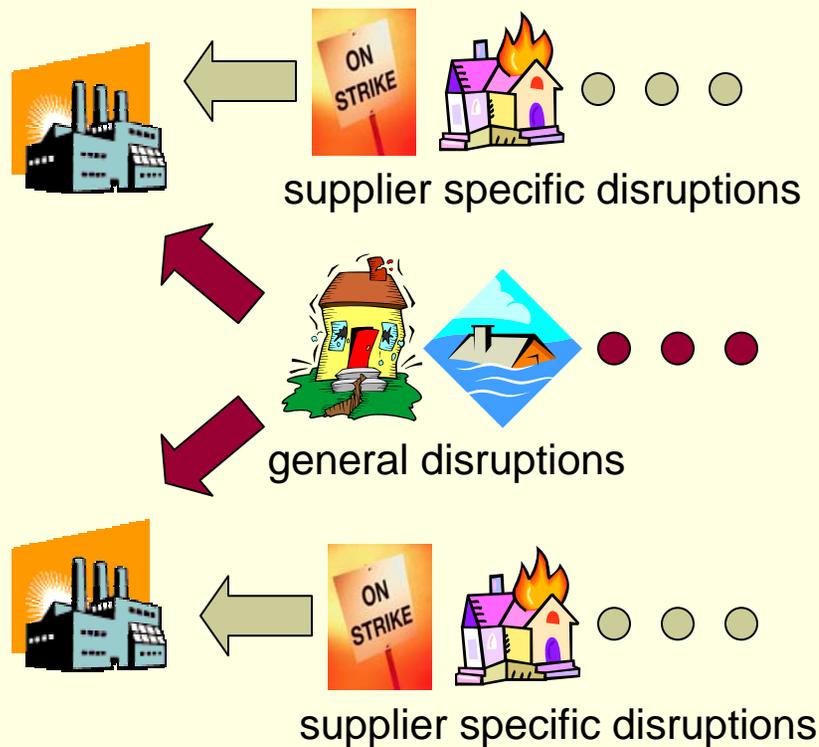
- “Order sizes are inversely proportional to the ratio of the variance and the mean of the fractional yield”, Agrawal and Nahmias (POMS, 1997)

■ Non-identical suppliers

- More complicated but still driven by supplier “reliability”, Dada, Petruzzi and Schwarz (M&SOM), Federgruen and Yang (2005)

- “Cost can be thought of as an order qualifier while reliability can be thought of as an order winner.” Dada, Petruzzi and Schwarz, 2006

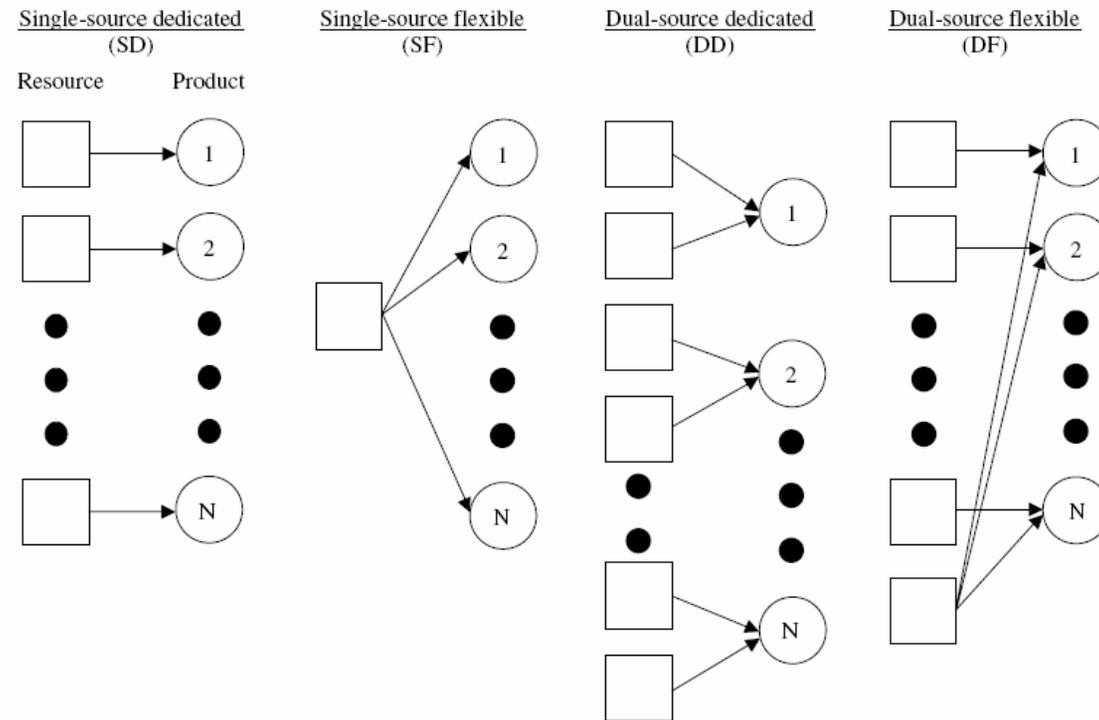
Diversification – effect of correlation



- Intuition suggests that correlation should decrease the value of supplier diversification.
- Intuition is sometimes correct.
 - e.g., Tomlin (2005b)
- But not always.
 - Babich et al. (2004)

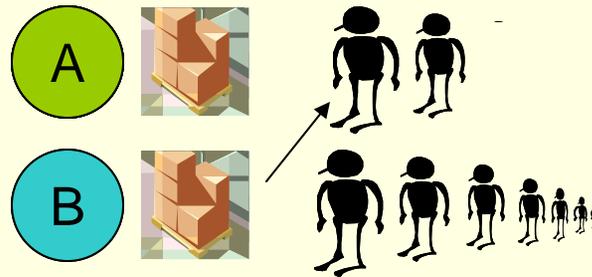
Diversification versus flexibility

Figure 1 Four Network Structures

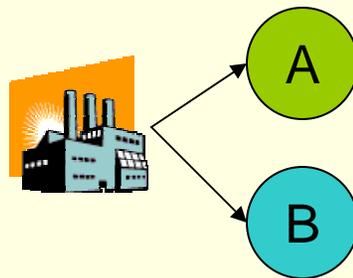


- For identical resources (costs and reliabilities), the flexible structure is preferred to the dedicated structure if (1) resources are perfectly reliable, or (2) the firm is risk neutral. If neither condition holds, then the dedicated structure can be strictly preferred to the flexible structure.
 - Tomlin and Wang, M&SOM, 2005

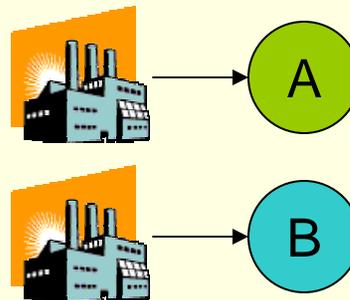
Demand management: substitution



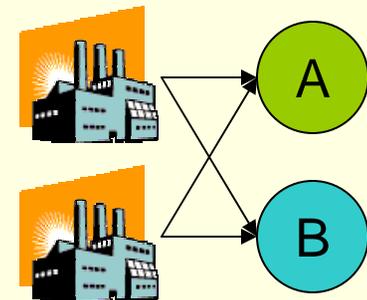
Single Source



Product
Diversification

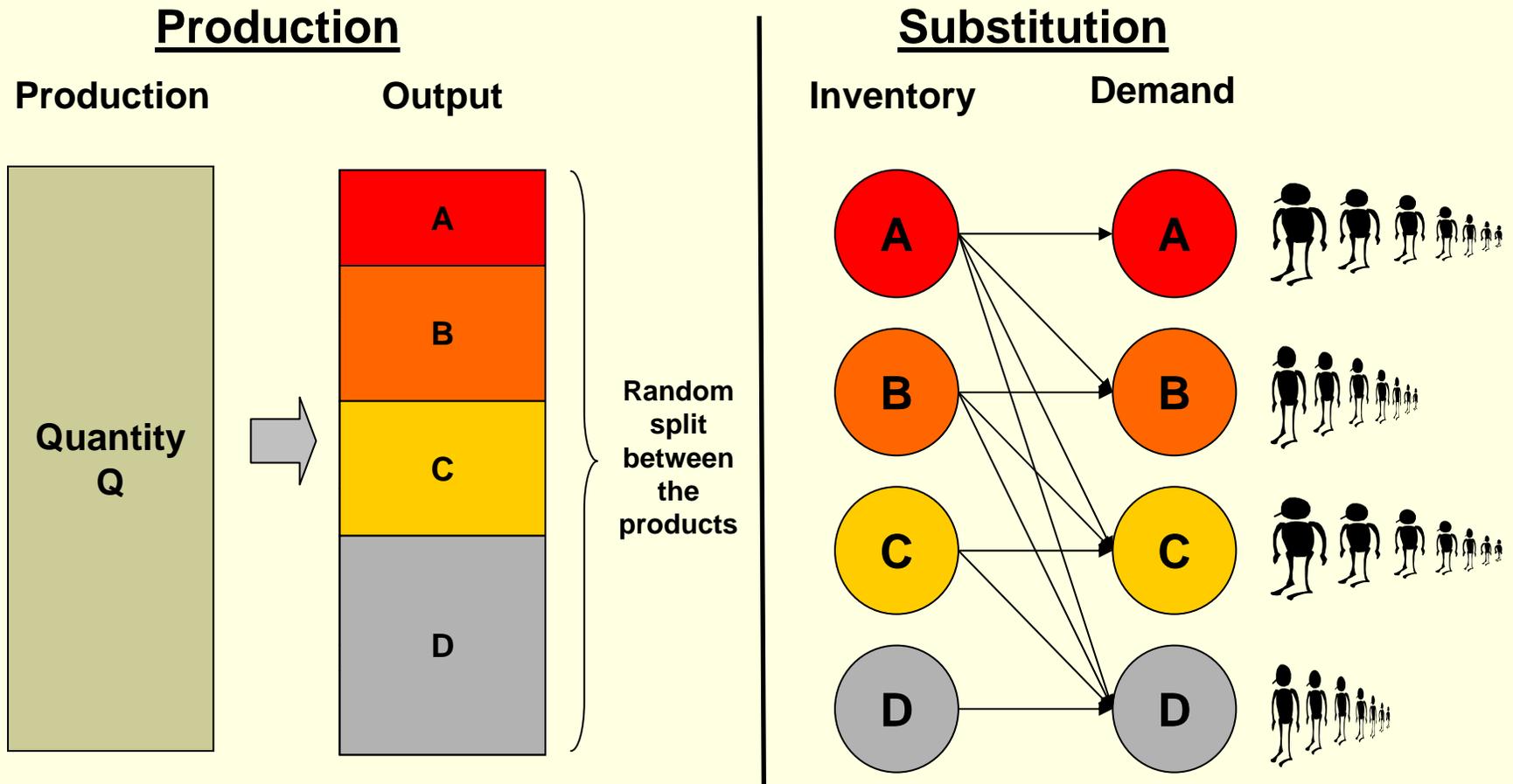


Supplier
Diversification



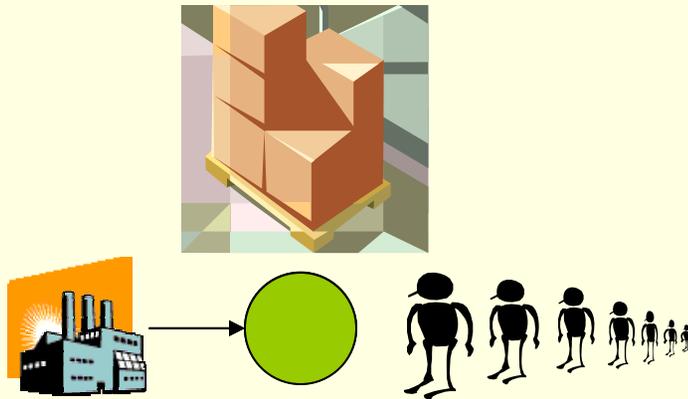
- Substitution (as a tactic for managing supply failures) is only valuable in the product-diversification structure, and then only if marginal revenue is very high relative to sourcing and substitution costs.
 - Tomlin (2005b)

Substitution and pricing in coproduction



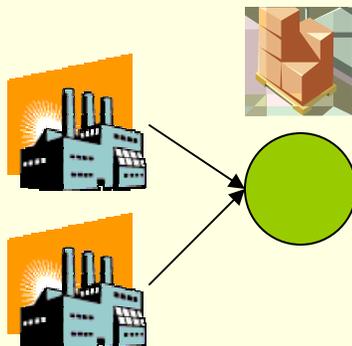
- Substitution is of value because product supplies negatively correlated.
- Price postponement is much more valuable than substitution and gives approximately the same value as completely eliminating supply uncertainty.
 - Tomlin and Wang (2005)

Long life-cycle products



- Inventory

- Meyer et al. MS 1979; Bielecki and Kumar OR 1988; Parlar and Berkin NRL 1991; Parlar and Perry EJOR 1995; Gupta INFOR 1996; Moinzadeh and Aggarwal MS 1997; Parlar EJOR 1997; Arreola-Risa and De Croix NRL 1998; Li et al. PEIS 2004; Snyder 2005.



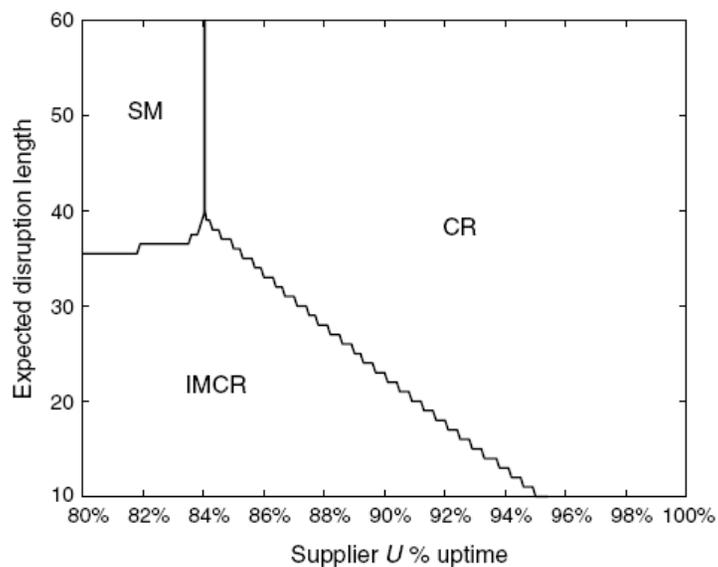
- Two suppliers

- Parlar and Perry NRL 1996; Gürler and Parlar OR 1997; Tomlin MS 2006

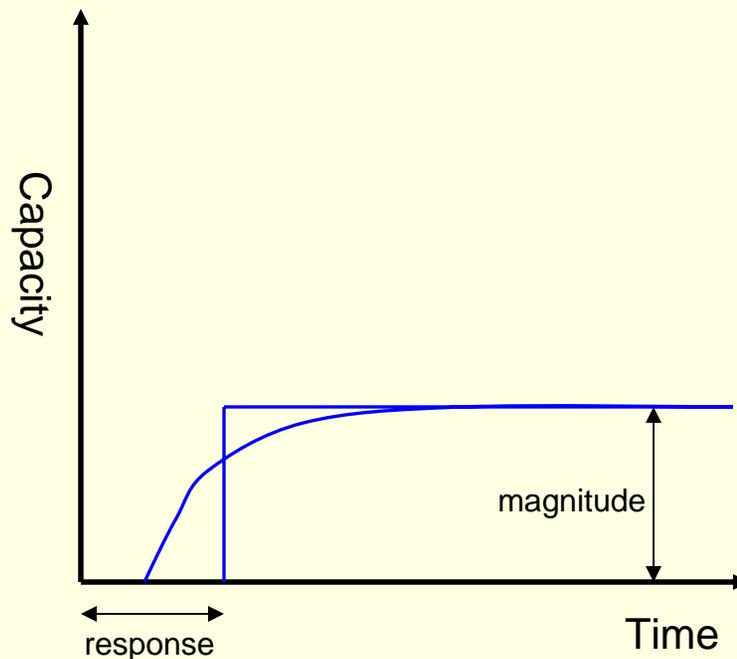
Mitigation and contingent tactics

Optimal Disruption Strategy

Figure 3 Optimal Disruption-Management Strategies for II-Flexibility Case ($c_f = 1.25c_r$)

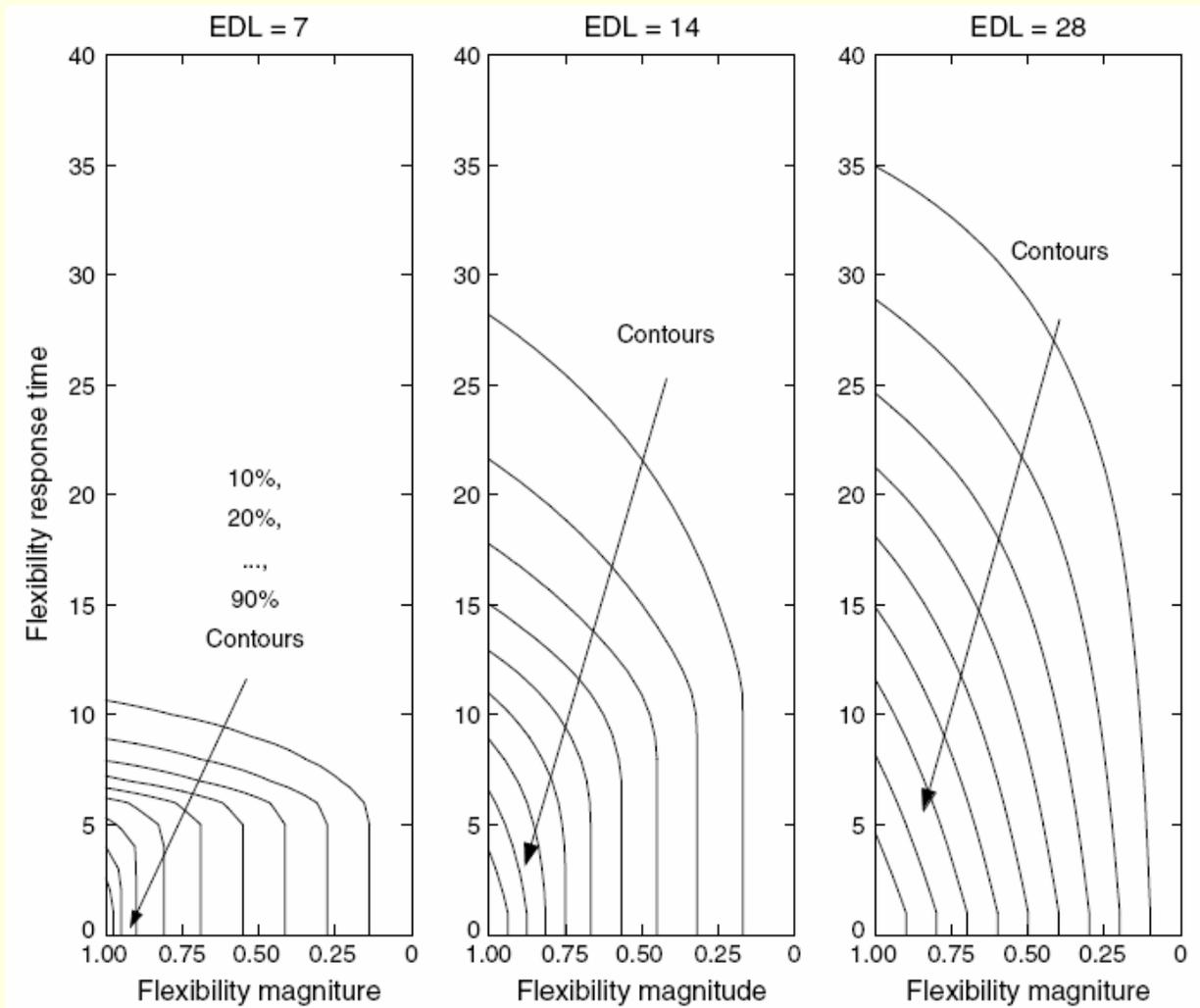


Flexibility of Contingent Supplier

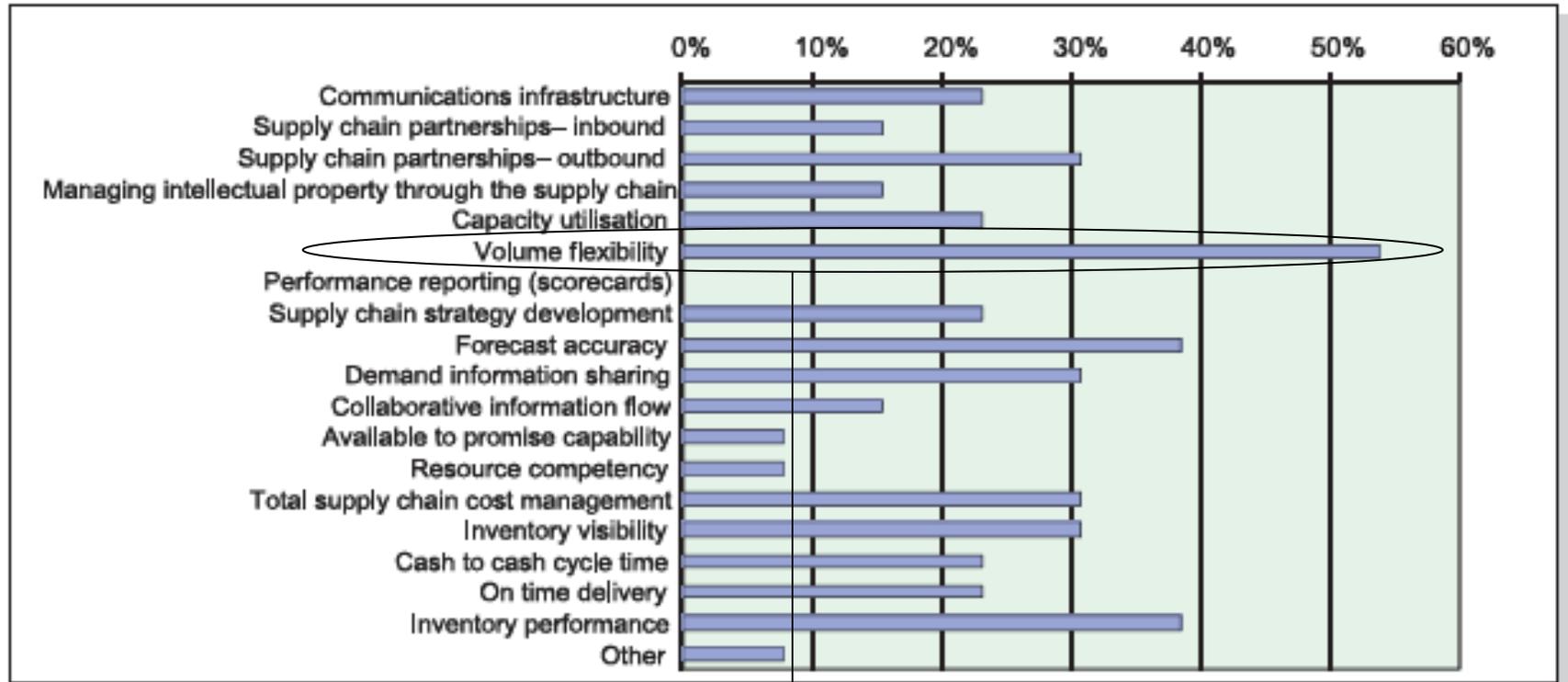


Flexibility profile and disruption type

Longer (and less frequent) disruptions

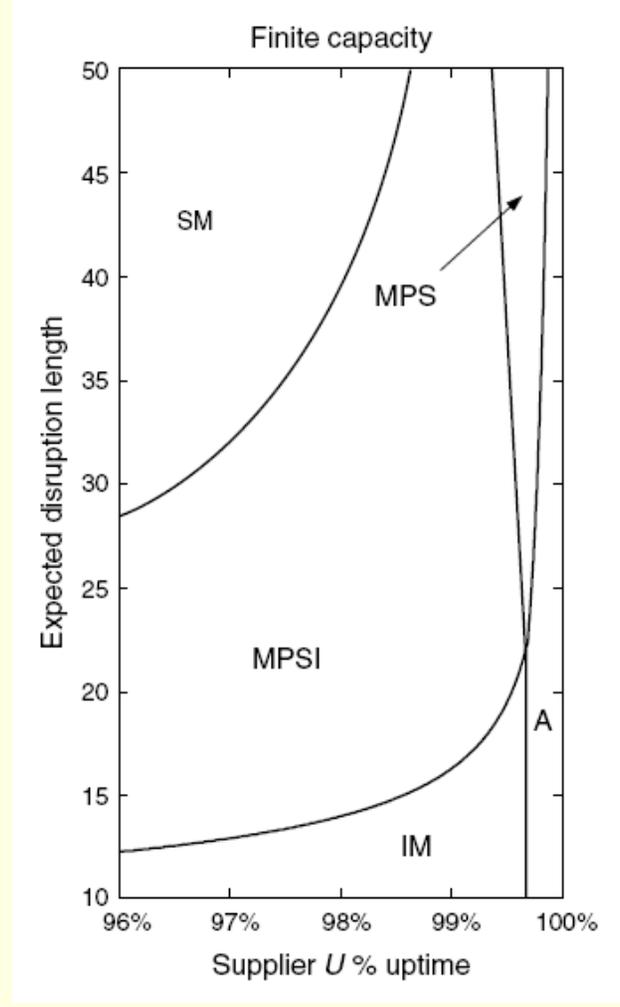
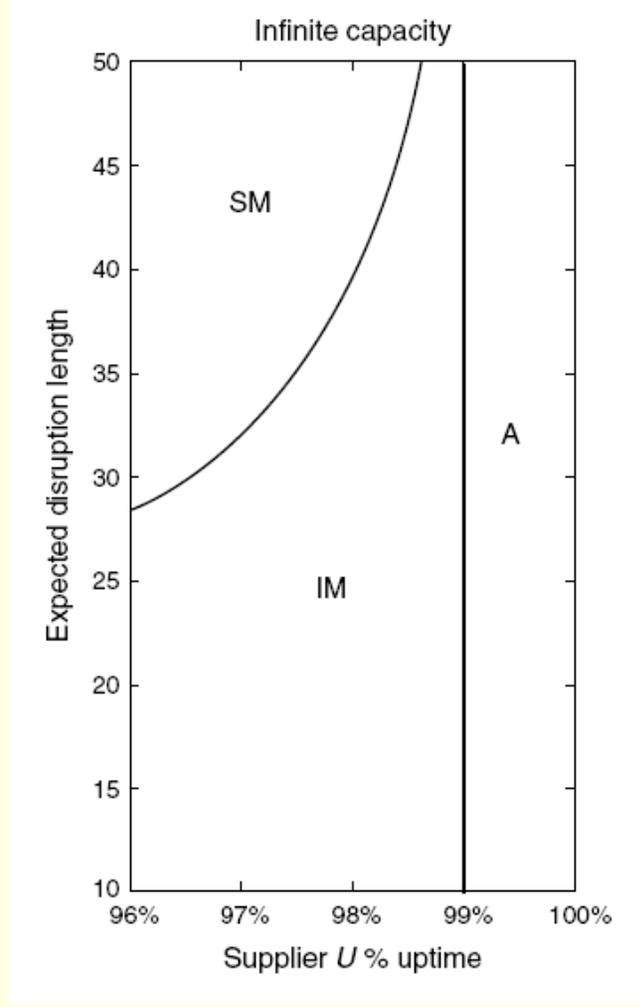


Volume flexibility a key concern



“More than 50% identified volume flexibility within supply chain management and operations as the key area for improvement.” PRTM survey, 2002.

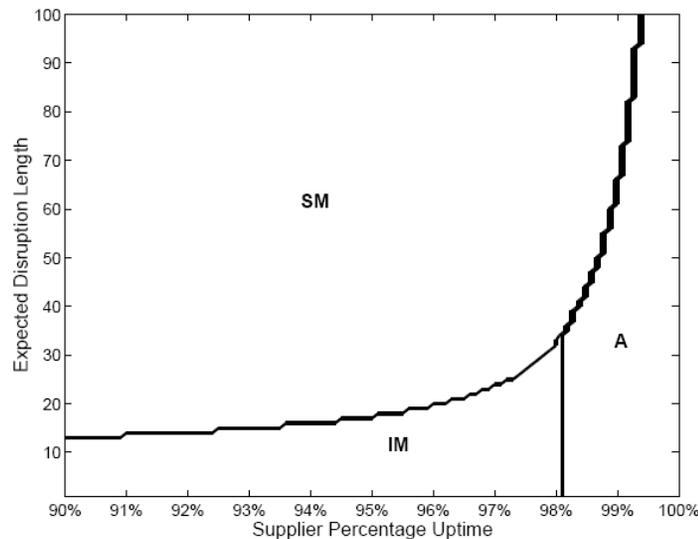
Capacity considerations: recovery time



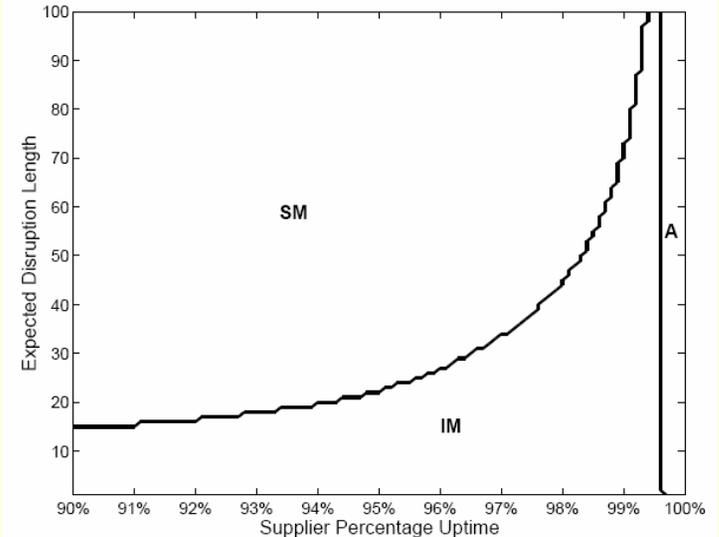
Risk monitoring

- United Technologies (UTC) uses pattern recognition software to “**constantly monitor supplier data** to determine if any of UTC's 18,000 suppliers are heading for trouble ... In August 2004 the **system generated a financial alert** [of a potential bankruptcy] for a key castings supplier ... UTC **increased its inventory buffer** as an added layer of protection.
 - Global Logistics & Supply Chain Strategies Magazine, Dec 2005.

No monitoring



With monitoring



In conclusion

- Managing supply uncertainty often requires a multi-faceted approach.
 - Inventory, diversification, contingent sourcing, demand management.
 - Distinguishing between intermittent and recurrent supply risks (Chopra et al., 2005).

- Some new research projects I'm working on ...
 - Business interruption insurance.
 - Disruptions in supply networks (with Kevin Shang, Duke).

- Many remaining areas for the community to explore, e.g.,
 - Competition, Information, Risk management, Real-time response, Service operations, etc.