Understanding Recurrent and Disruptive Risk in Supply Chains

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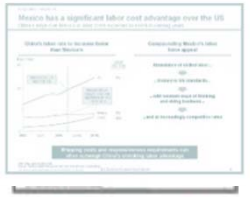
Outline

- Off shoring, near shoring, on shoring
- Dealing with recurrent risk
- Disruptive risk and its impact on supply chain design

Four main levers to determine manufacturing "Sweet Spot"

	Type of products benefiting	Output
Significant logistics costs	• High volume-to-weight and/or volume-to-value ratios - Large bulky products where shipping costs represent a sizable share of the cost structure	
Stringent responsiveness requirements	• Short, tightly scheduled supply chains - i.e. those with high volatility or short order cycles	
Large labor component	• Large labor component in cost structure given that Mexico's average labor is ~7 times lower than US - Although beneficial, not a source of Mexican competitive advantage	
Strong managerial involvement	• Require strong degree of managerial involvement, including physical presence - Continuous US management supervision - High quality local managerial talent	

Source: BCG analysis

Mexico has advantage when shipping costs represent sizable share of cost structure

Product	Typical US retail price	Units per two-TEU container[1]	Freight costs / unit (China[2]) (% retail price)	Freight costs / unit (Mexico[3]) (% retail price)	Advantage
Refrigerator	$500	~ 55	$100.00 (20%)	$48.70 (9.7%)	**Mexico**
Stove	$450	~ 95	$58.00 (13%)	$28.20 (6.3%)	**Mexico**
29-inch TV set	$450	~ 170	$32.00 (7.1%)	$15.90 (3.5%)	**China**
DVD/CD player	$150	~ 3,700	$1.50 (1.0%)	$0.73 (0.5%)	**China**

Other cost factors include raw materials, depreciation, electricity & tariffs

Logistic costs outweigh China's labor advantage on high volume-to-weight or volume-to-value products

1. TEU = 20-foot equivalent unit (container).2. Door-to-door freight costs from Shanghai to Pittsburgh, Pennsylvania. 3. Door-to-door freight costs from Aguascalientes to Pittsburgh, Pennsylvania
Source: BCG analysis; maritimeChain.com

Mexico's advantage greatest for high volume-to-weight ratio products where freight costs are significant

Mexico's advantage in bulky products

Considerable portion of global trade consists of high volume-to-weight ratio items (i.e. bulky)

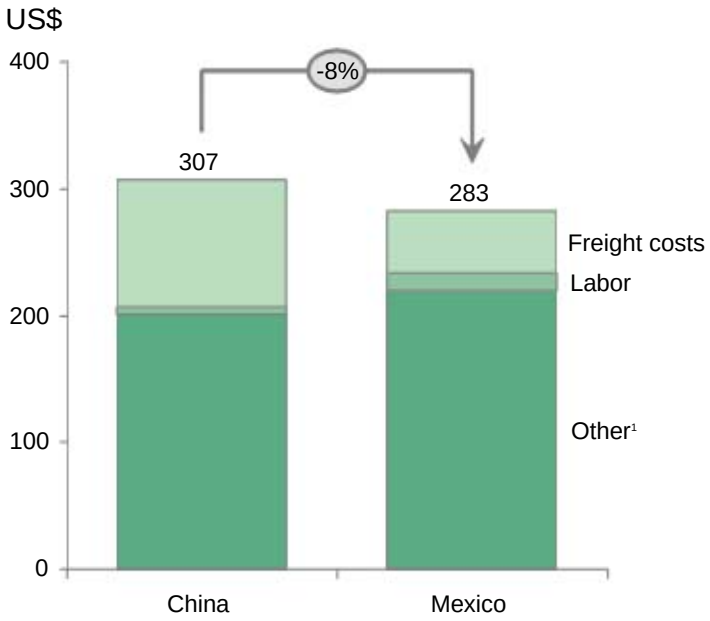
Shipping for these products represents a sizable component of retail price

Freight differentials can outweigh higher labor cost rates

"As [U.S.] retail prices begin falling towards $600 [per PC unit], the cost of logistics involved will put Mexico back on the map"

- Dell Latin America

Cost of producing a refrigerator



Key will be to find cheapest labor force within reasonable shipping distance to final market

1. Raw materials, depreciation, electricity, tariffs
Note: Assumes 4 hours of labor per unit Source: Press and web research, BCG analysis

Shipping from China to US slower and less predictable than shipping from Mexico

Shanghai to Chicago

	Shanghai portside activities	Trans-shipment, China[1]	Port-to port ocean transport	Trans-shipment, US[1]	U.S. portside activities	U.S. land transport	Total time
Scheduled time	1 day	3 days	10 days	<1 day	1 day	4 days	>19 days
Actual time	1 to 6 days	3 days	10 to 11 days	<1 day	1 to 5 days	4 to 8 days	19 to >33 days
Delays	Port entrance congestion or feeder congestion: up to 5 days		Missed berth slot: up to 1 day		Railroad congestion at port: up to 4 days	Railroad congestion en route: up to 4 days	

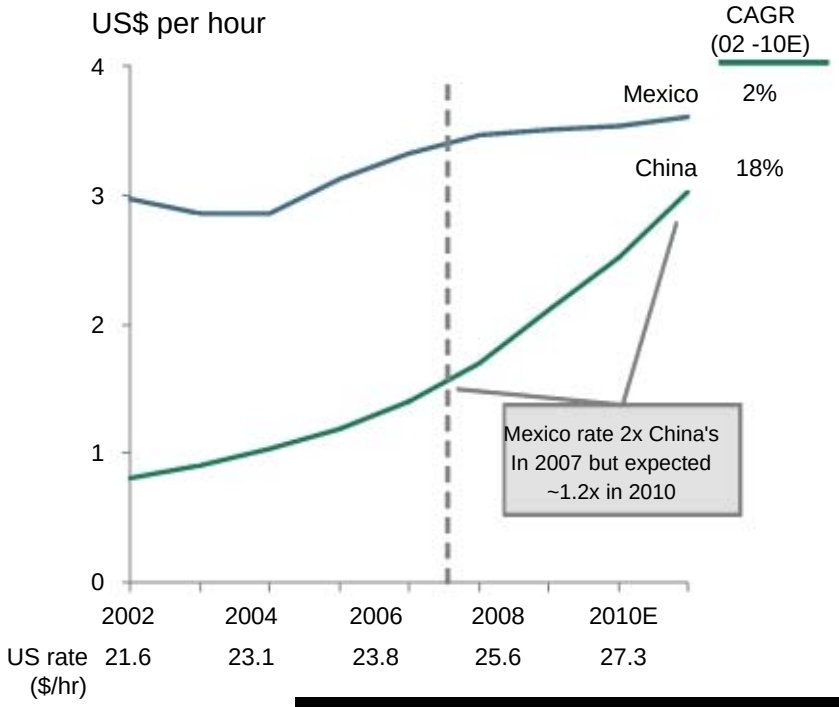
Monterrey to Chicago

	Land transport, Mexico	Border crossing	Land transport, US	Total time
Scheduled time	<1 day	<1 day	1 day	2 days
Actual time	1 to 3 days	up to 1 day	1 to 3 days	<7 days
Delays	Road congestion en route: up to 2 days	Unload and reload: up to 1 day	Road congestion en route: up to 2 days	

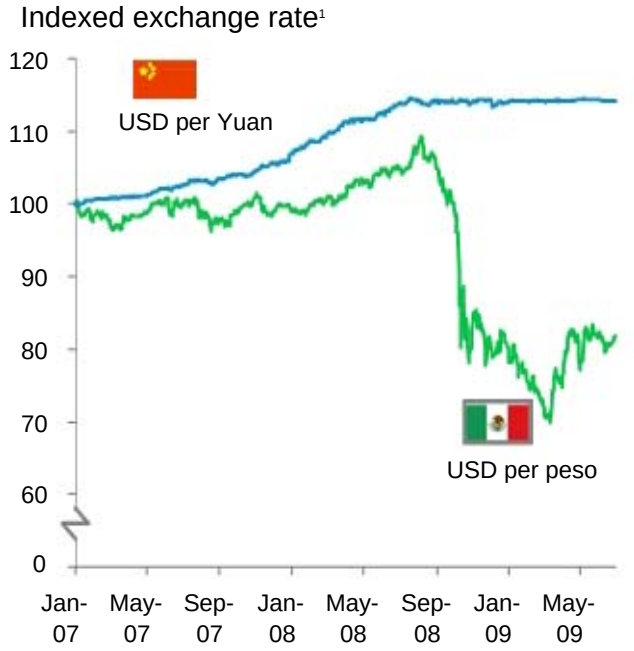
1.Trans-shipment is the transfer of a container from one conveyance to another, such as from truck to ship or vice versa
Source: BCG analysis

China's edge over Mexico in labor costs expected to shrink in coming years

China's labor rate to increase faster than Mexico's



Peso sharp devaluation also reducing China's cost advantage



Labor economics and Yuan appreciation quickly eroding China's cost advantage

1. Indexed to January 1, 2007 exchange rate (MX$ 10.82 = US$ 1; CH$ 7.81 = US$ 1)
Note: Manufacturing labor rate
Source: The Economist Intelligence Unit; International Labor Organization; FX History, Oanda Corporation; BCG analysis

And Then There is Risk

Higher recurrent risk

- SKU proliferation
- Shorter customer lead times
- Higher oil prices
- Currency and inflation risk in China

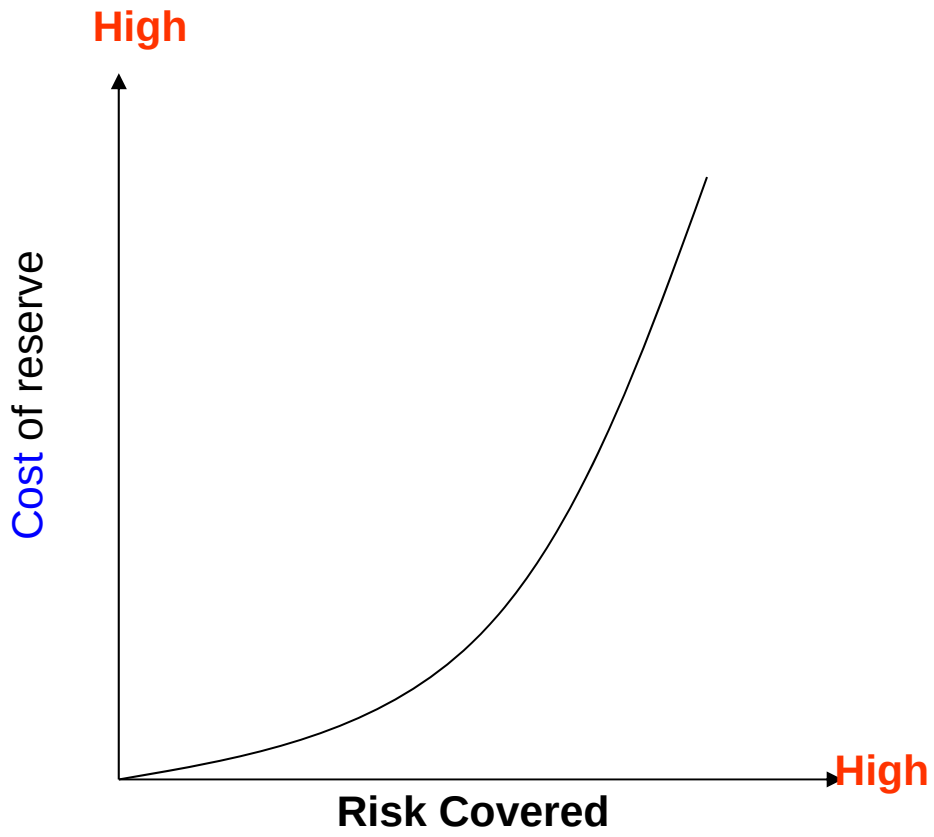
Higher supply chain disruption risk

- Japan Earthquake Impact
- Rare earth Hoarding by China
- Security Threats in Mexico due to Drug related violence

Dealing with Recurrent Risk

Building Reserves

- Inventory
- Capacity
- …



Dealing with Recurrent Risk

Risk Reduction

- Information and visibility
  - Seven eleven, Zara
- Speed
  - Zara (on shoring and near shoring)
- Pooling of risk
  - Amazon, Netflix

Rare Disruptive Events

In a *Financial Times* article in August 2007, David Viniar (CFO of Goldman Sachs) attempts to excuse the implosion of Goldman hedge funds by claiming, "**We were seeing things that were 25-standard deviation moves, several days in a row**."

Research Question: What can we do about disruptive events whose probabilities are very hard to estimate?

Rare Disruptive Events

Avoiding the Next Financial Contagion (Forbes, July 2010): Research in the ERIA project finds that a higher level of financial integration is not associated with an increase in business cycle synchronicity. **This suggests that the business risk smoothing opportunities created by integrated financial markets dominate the contagion effects.** Deeper financial integration, in other words, provides a buffer between economies that are integrated in other ways.

Research Question: Is more "integration" always better? Global or Regional?

The Difficulty of Estimating Disruptive Events in a Supply Chain

On March 17, 2000, Ericsson was one of the big international players in this industry, together with the Finnish company, Nokia, when a lightning bolt from a thunderstorm over Albuquerque in New Mexico hit a power line. This caused a surge in the power supply, resulting in a fire at a local microchip plant owned by Philips, the Dutch company, Ericsson's chip supplier. The fire was brought under control in minutes, but not before eight trays containing enough silicon wafers to make thousands of mobile phones were destroyed. Far worse, however, was the smoke and water damage that contaminated millions of chips — almost the plant's entire stock.

This disaster cost the Swedish company $400m (£235m) in lost sales.

Can suppliers bring down your firm? *Financial Times, November 2003*

The Difficulty of Estimating Disruptive Events

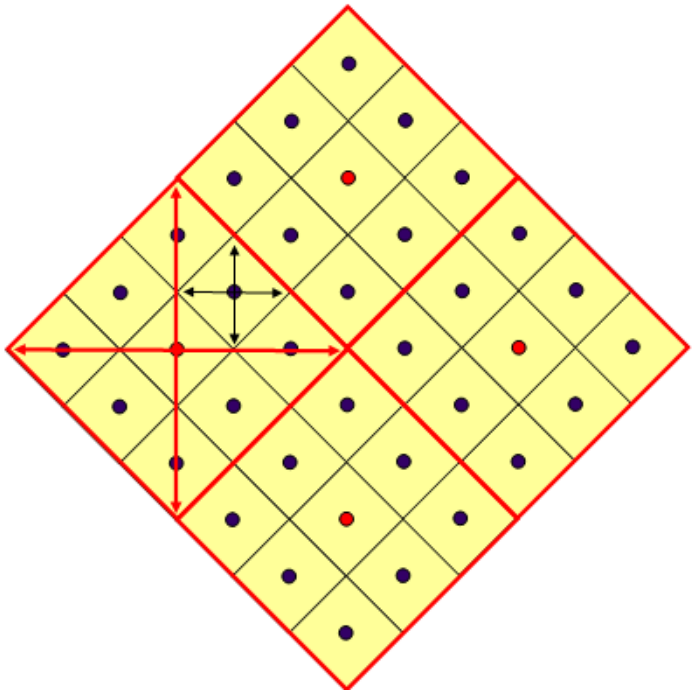
- Focus only on random disruption of nodes in a network design model

- Start with simple continuous model to draw insights
  - Easy to compute; Closed form results
  - Provides good insights
  - Very strong assumptions

- Test insights on more complex models

Model Description of Simple Continuous Model

- **Assumptions**
  - Demand is uniformly distributed on the plane
  - *Unreliable* (independently fail with prob. q) / *Reliable* (never fail)
  - Demand is covered in two ways:
    Primary assignment / Backup assignment

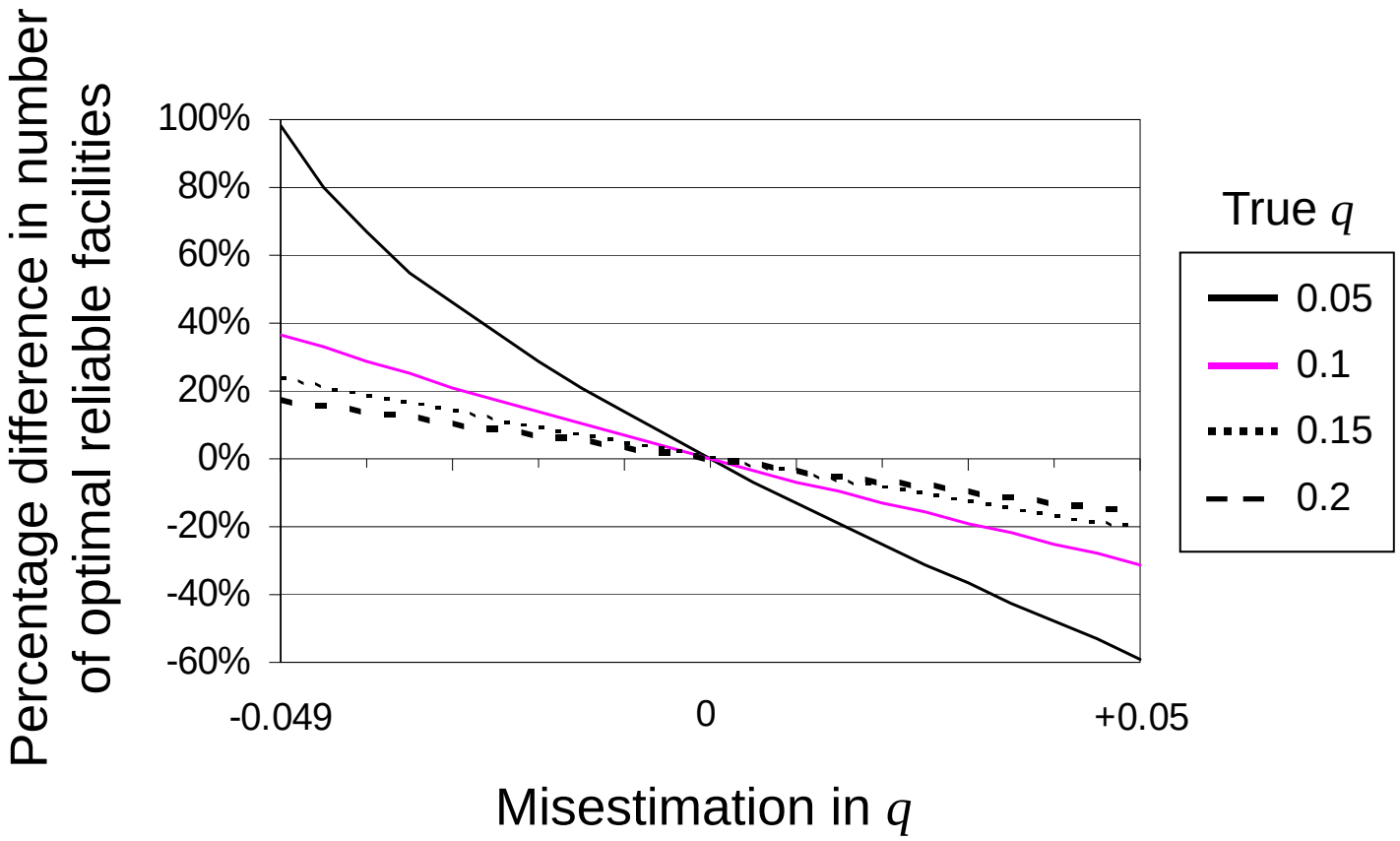


- n_R : 4 reliable facilities
- n_U : 32 unreliable facilities

- **Find**
  - Number and location of each type of facility
  - Assignments of demands to facilities

- **To minimize total costs**
  - Facility location cost + Expected transportation cost (Manhattan distance metric)

Impact of Misestimating Disruption Probability



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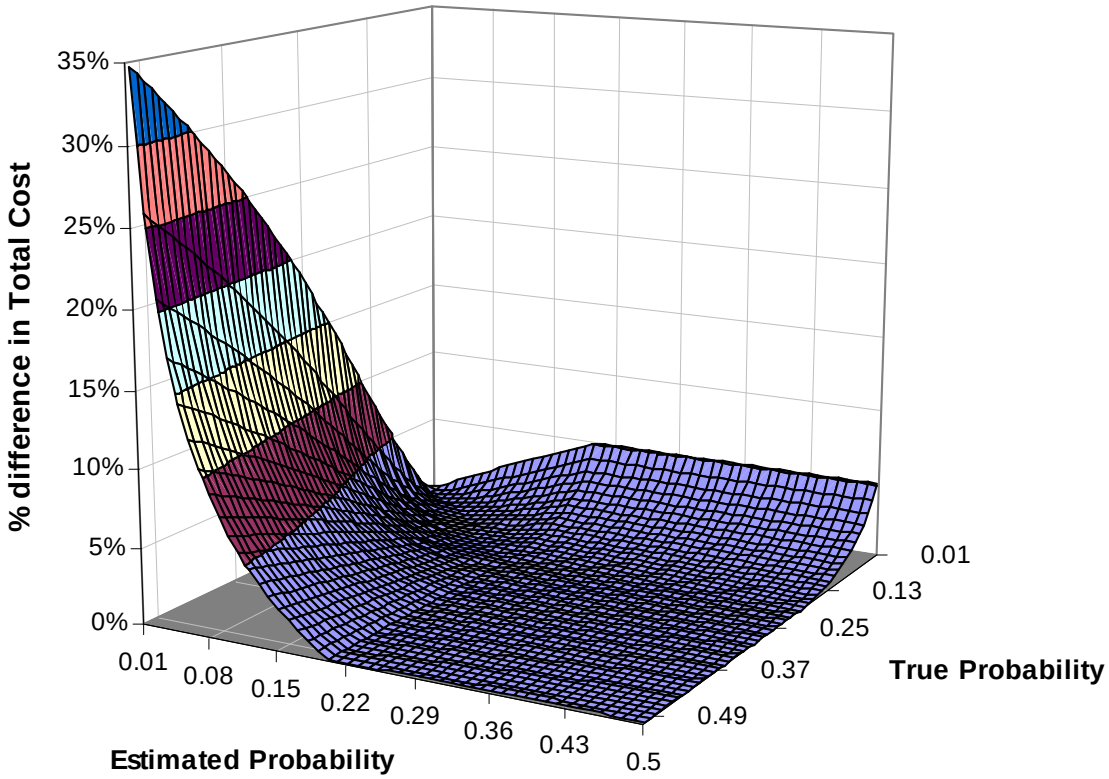


The Impact of Misestimating Disruption Probability

True Probability		0.01	0.05		0.10			
Estimated Probability		0.10	0.01	0.10	0.01	0.05	0.15	0.20
TC Diff. (%)	R=1.25	2.48	2.04	0.50	6.14	0.66	0.27	0.87
	R=1.5	2.70	16.75	0.51	20.11	0.89	0.26	0.91
	R=2	3.36	56.16	0.52	71.51	1.62	0.26	1.02
	R=5	5.07	65.47	0.76	78.20	2.28	0.37	1.40

Observations

- When true disruption probability is 0.10, the total cost does not change much if an estimate between 0.05 and 0.15 is used.

- When true disruption probability is 0.10, the cost of underestimating by a significant amount (0.01) is much higher than the cost of overestimating (0.20)

Insights when Probability of Disruption is Unknown

- As long as the hardening cost factor (ratio of fixed cost of reliable facility to unreliable facility) is not too large (under 10 in our analysis), some imprecision (e.g. ± 50%) in estimating disruption probability does not significantly effect total cost (it may significantly effect the network design).

- Underestimation is more expensive than overestimation of the disruption probability.

Is More "Integration" Always Better?

The Great **Recall** that has afflicted **Toyota** worldwide hasn't spared the company in Europe: It recalled eight models there, totaling 1.8 million vehicles, according to the AP. But now something worse is happening: Europeans are starting to question Toyota's identity, and the **recall** is becoming a media event.

Toyota Recall: The Contagion Spreads to Europe, and the Brand Gets Sicker

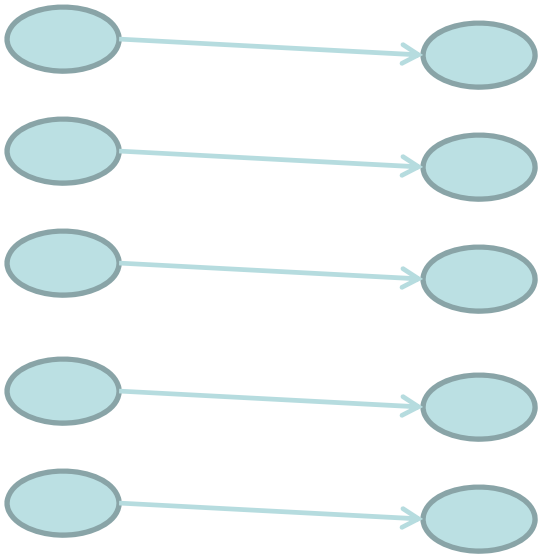
Toyota on Thursday extended its recalls to China and Europe, deepening the massive recalls that threatened to undermine the reputation of the world's top automaker as a manufacturer of safe, durable vehicles.

The automaker has informed Chinese authorities it will start a recall in February for 75,500 RAV4 vehicles that were manufactured in China between March 2009 and January 2010, said Toyota spokeswoman Ririko Takeuchi. Toyota is still unsure how many vehicles could have the defect in Europe.

Toyota extends recall to China, Europe

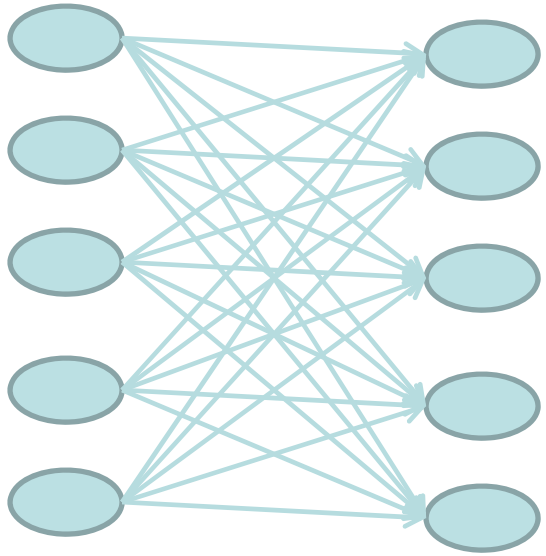
“Integration” in a Supply Chain

Supply Nodes Demand Nodes



No Integration
“Regional”

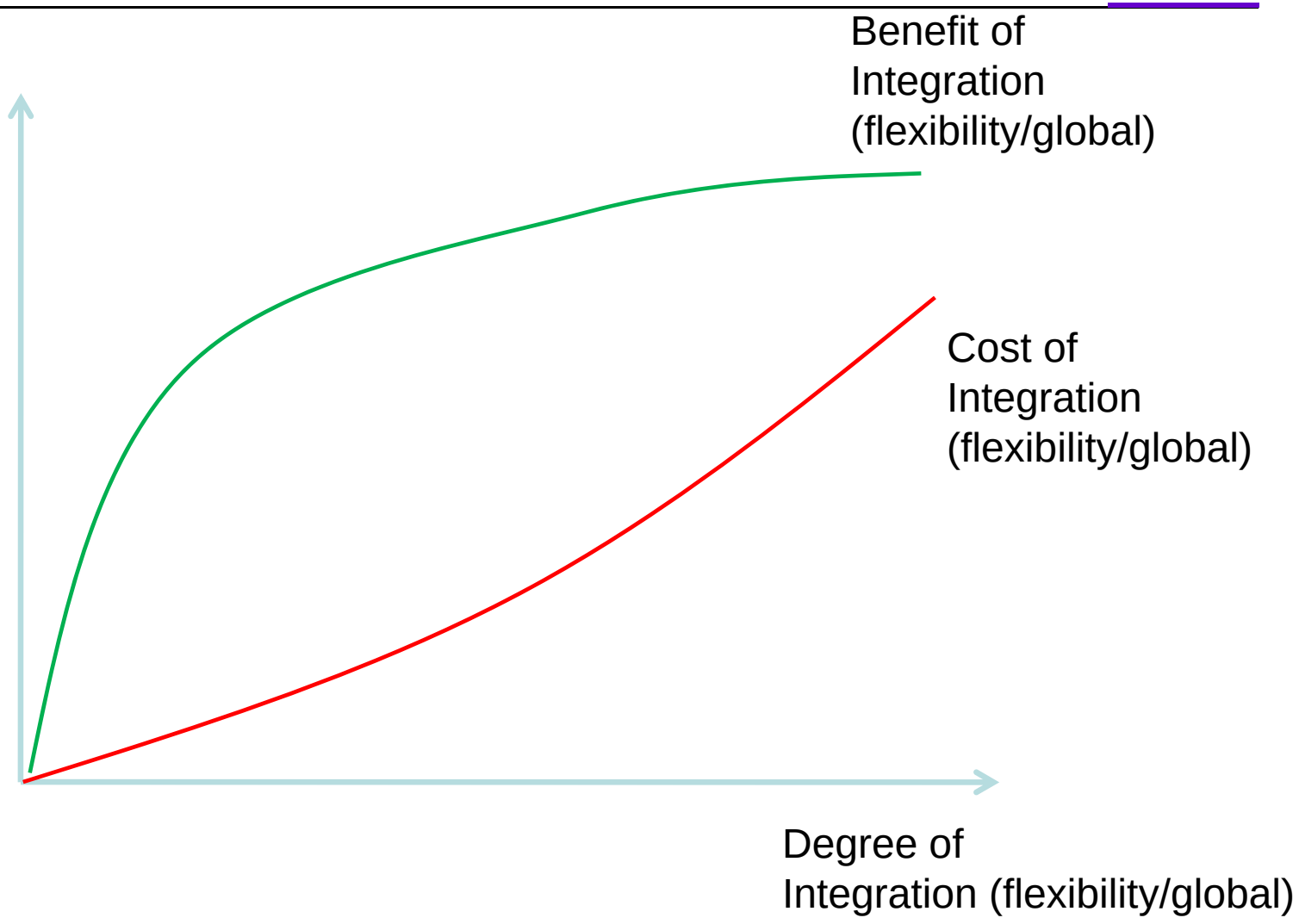
Supply Nodes Demand Nodes



Complete Integration
“Global”

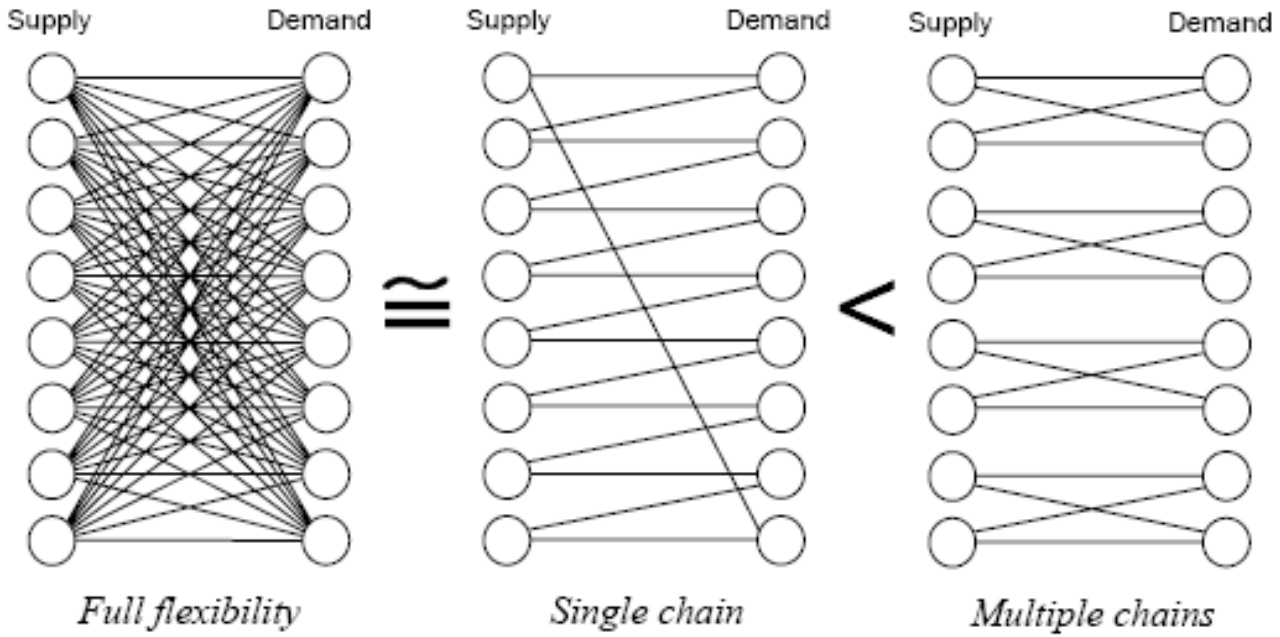
Integration = Flexibility in a supply chain

Benefits and Costs of Integration



Key Results from Jordan and Graves (1995)

- How much flexibility is enough?
  - Minimizing shortfall (unmet demand) against demand uncertainty



J-G's Flexibility Guideline: Chaining

To be most effective for meeting customers' demand, flexibility should be added in the configuration of fewer and longer chains

Key Features of our Model

- Flexibility cost (Fixed cost)

  Monotonically increasing with the level of integration

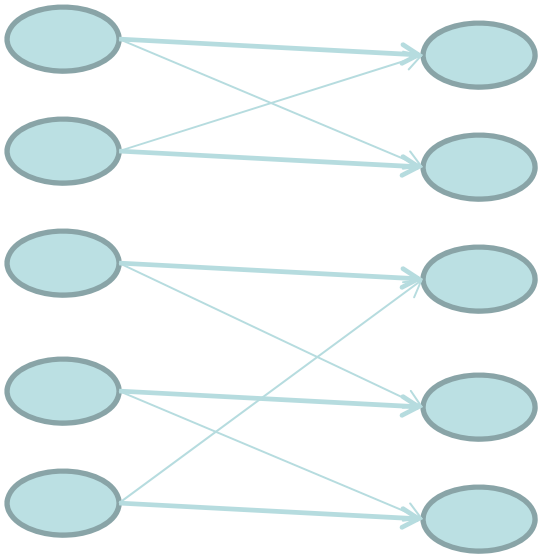
- Lost Sales cost (recurrent risk)

  Monotonically decreasing with the level of integration

- Supply chain disruptions (Fragility)
  - Link failure and Node failure

Network Design Strategies in a Supply Chain

Supply Nodes Demand Nodes



"Containment"
Limited Integration
Multiple Chains
"Regional"

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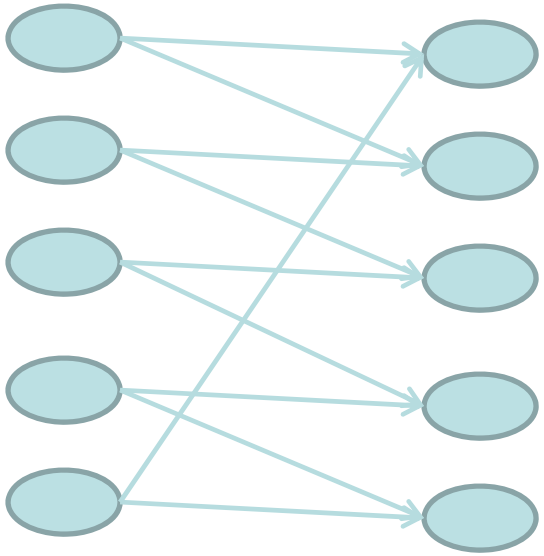
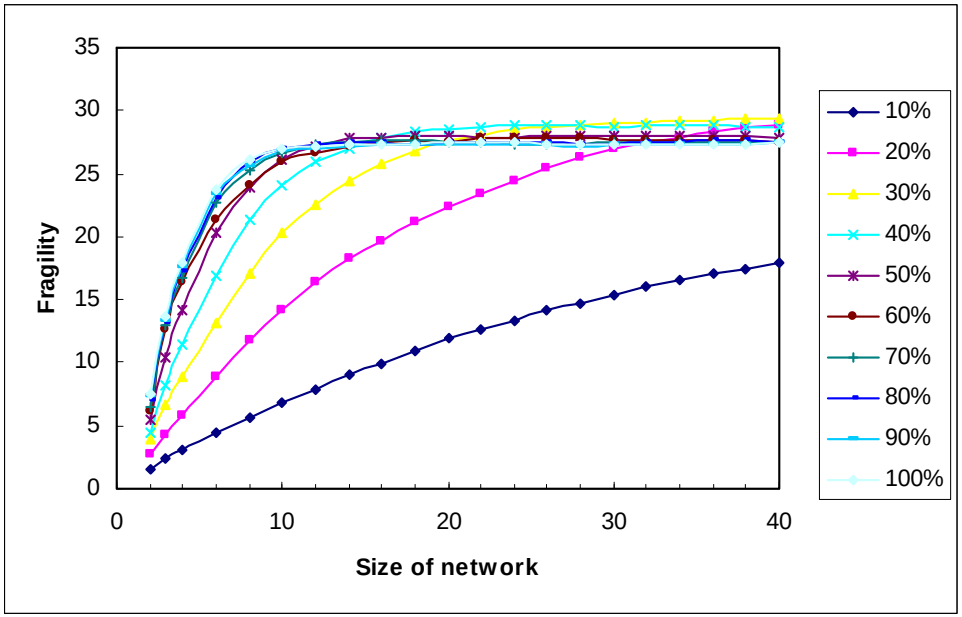


"Coverage"
Full Integration
Single Chain

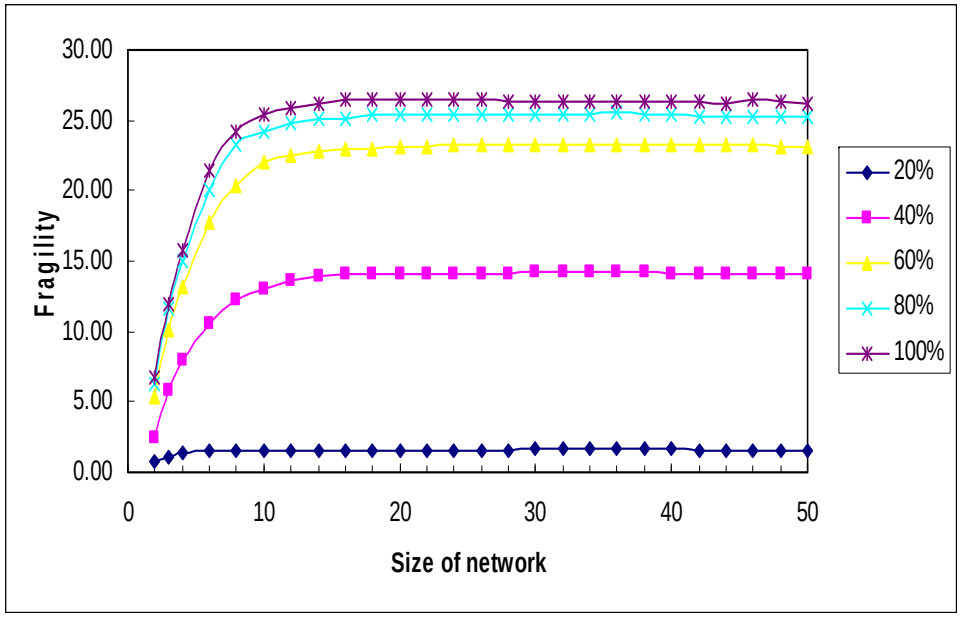
Which configuration has smaller fragility?

Numerical results: Single link failure

- Single link failure (1LF): Containment (regional)



Balanced system

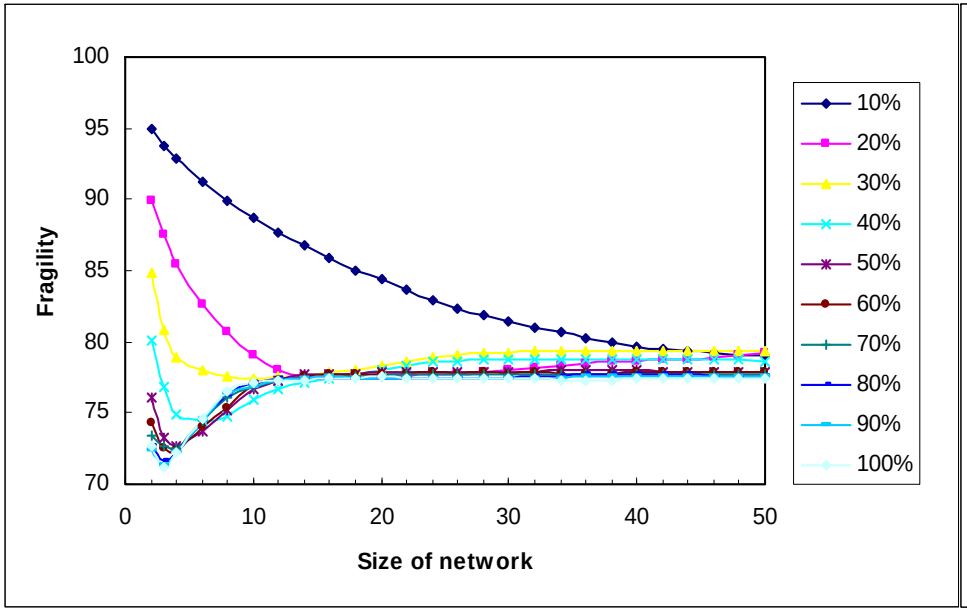


w/ excess capacity

- Fragility for 1LF increases as
  - the size of chain increases
  - the CV in demand increases

Numerical results: Single link failure

- Single node failure (1NF): Coverage (Global)



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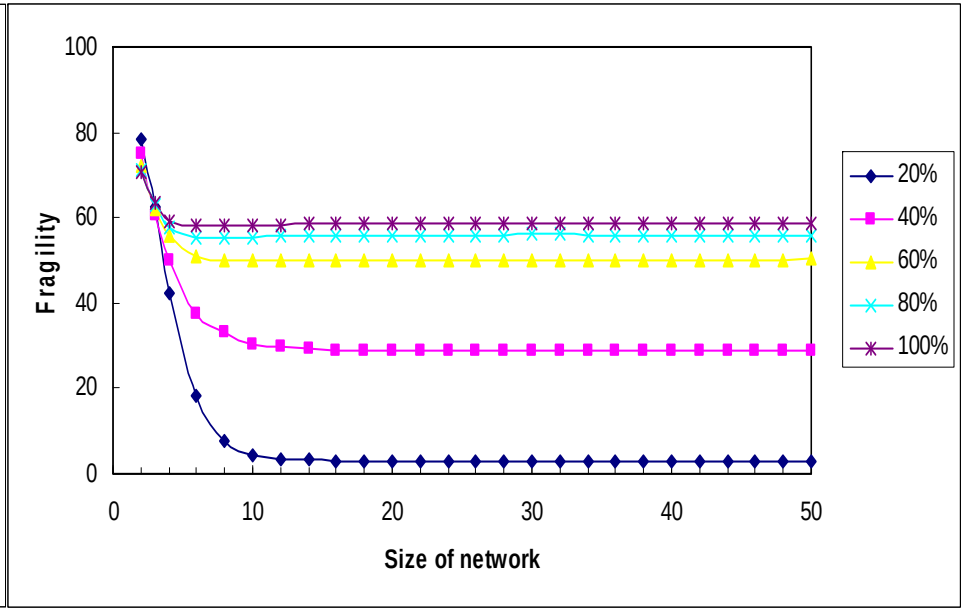

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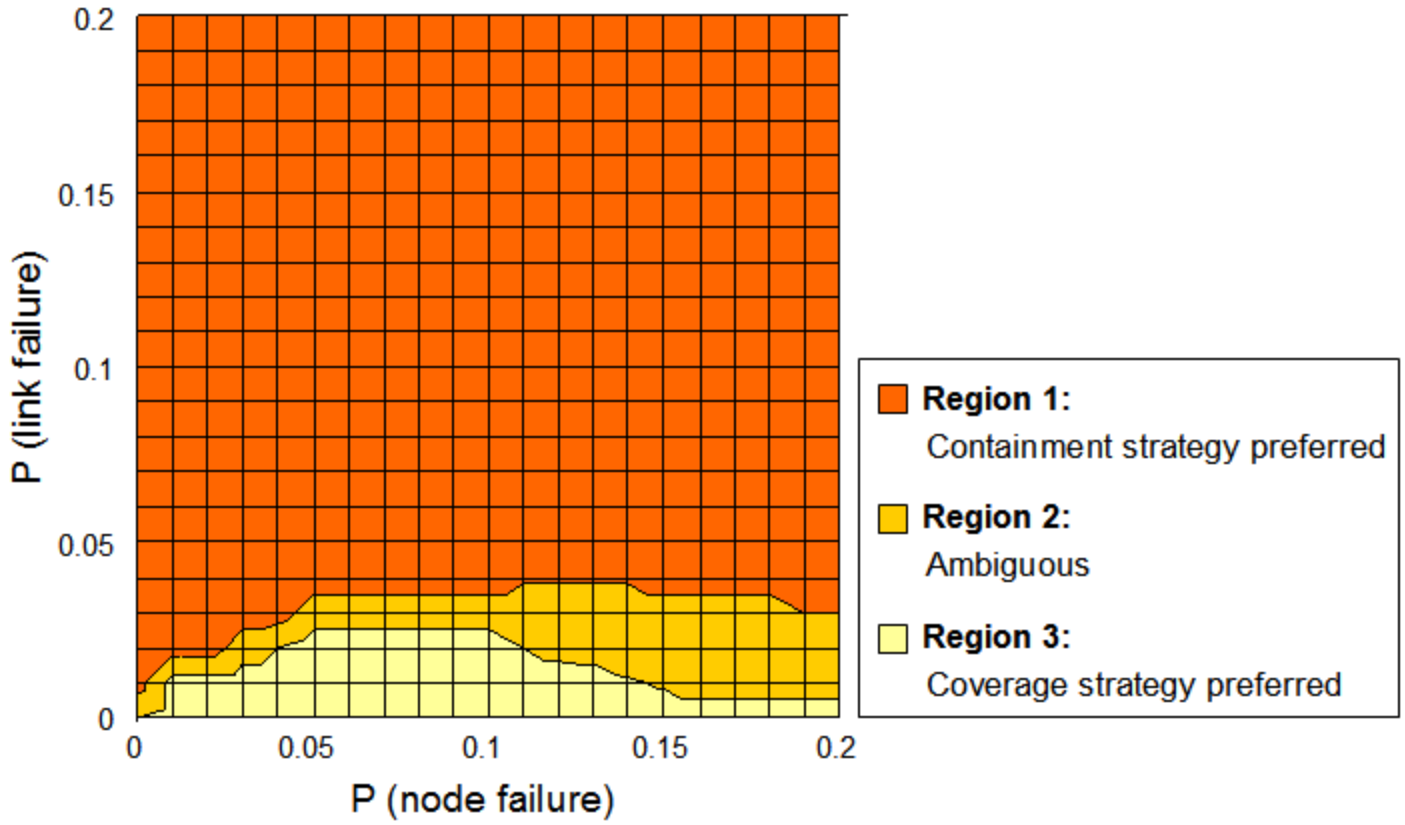
Simulation for Multiple Failures



- In most circumstances, containment (regional) is an effective strategy!

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BE CONSERVATIVE. DO NOT UNDERESTIMATE DISRUPTION PROBABILITY.

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