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Deploying Simulation to Compare among Different Risk Reduction Strategies for Supply Chains, Presentation

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Deploying Simulation to Compare among Different Risk Reduction Strategies for Supply Chains

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Japanese earthquake and tsunami

Previous research

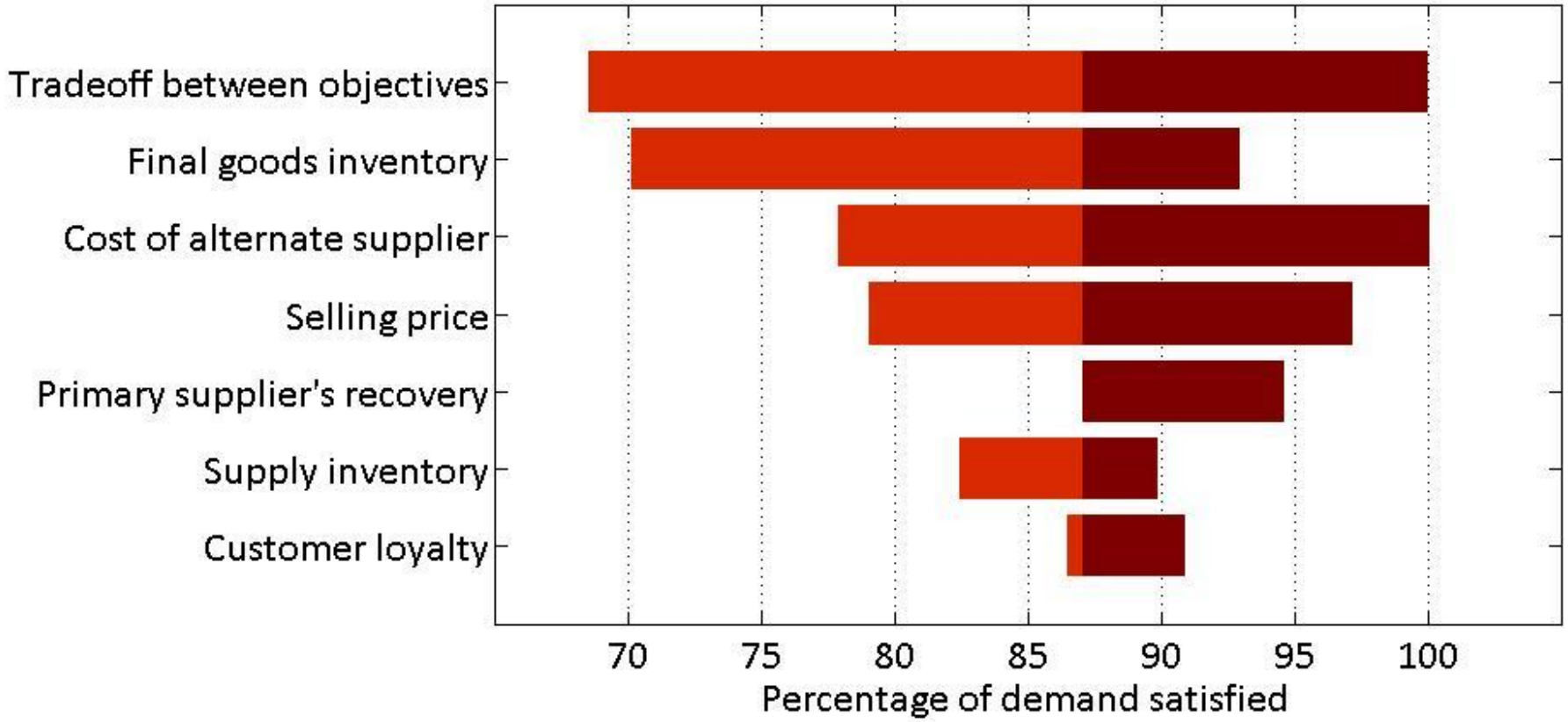
- Global macroeconomic impacts

  MacKenzie, C.A., Santos, J.R., & Barker, K. (2012). Measuring changes in international production from a disruption: Case study of the Japanese earthquake and tsunami. *International Journal of Production Economics*, 138(2), 293-302.

- Disruption management strategies in the automobile sector

  MacKenzie, C.A., Barker, K., & Santos, J.R. (2013). Modeling a severe supply chain disruption and post-disaster decision making with application to the Japanese earthquake and tsunami. Under review.

Risk management strategies



But this chart just shows benefits!
What about costs of strategies?

Challenges of determining optimal strategy

- No single objective function
  - Maximize profit
  - Maximize demand satisfied
  - Maximize percentage of demand versus competitors
- Different costs for each strategy
  - Spend $1000 on one strategy to save $10,000 in profit
  - Spend $500 on another strategy to save $7500 in profit
- Uncertainty over length of disruption, customer actions, and competitors' strategies
- No functional relationship between strategies and objective function and/or relationships are highly nonlinear

Supply chain disruption in auto sector

RENESAS
Everywhere you imagine.

CHRYSLER

MERCK

GM

Ford

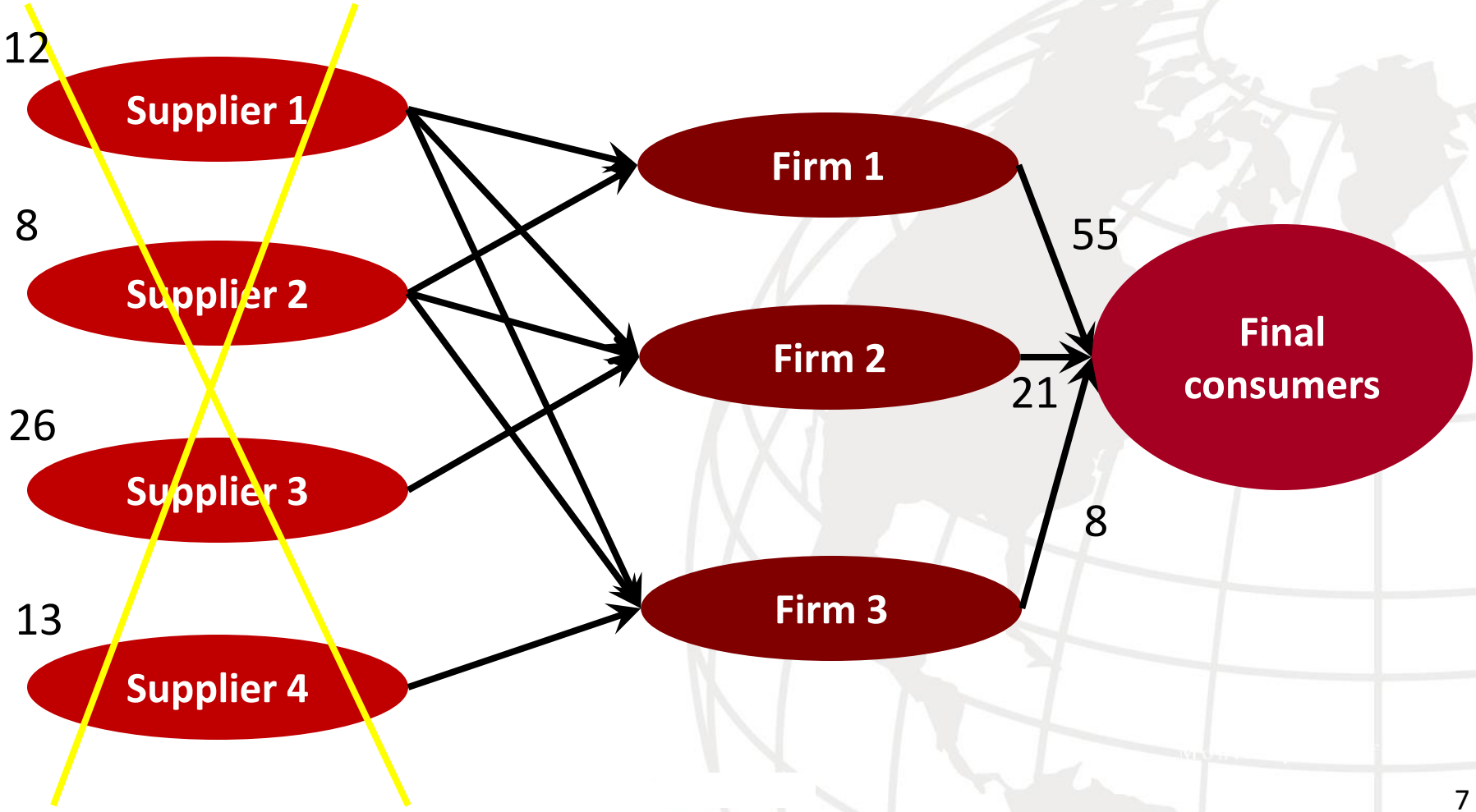
HONDA

TOYOTA

NISSAN

Illustrative example

Severe supply chain disruption: multiple suppliers cannot produce and multiple firms are impacted



Simulation

1. Discretize each strategy so that each strategy costs the same "small" amount
    1. Keep 10 units of raw material inventory for $100
    2. Buy 5 units of supply from alternate supplier for $100
    3. Spend $100 to help primary supplier recover more quickly
2. Simulate severe disruption with firm selecting one strategy
3. Choose strategy that performs the best according to an objective (e.g., profit, customer demand) or weighted combination of objectives
4. Repeat step 2 but assume that strategy chosen in step 3 is being pursued

Firm 2's risk management strategies

1. Purchase raw materials inventory
   - Supply 1
   - Supply 2
   - Supply 3
   - All supplies
2. Purchase finished goods inventory
3. Purchase from alternate suppliers at higher cost
   - Alternate supplier 1
   - Alternate supplier 2
   - Alternate supplier 3
   - All alternate suppliers
4. Help supplier 3 recover more quickly

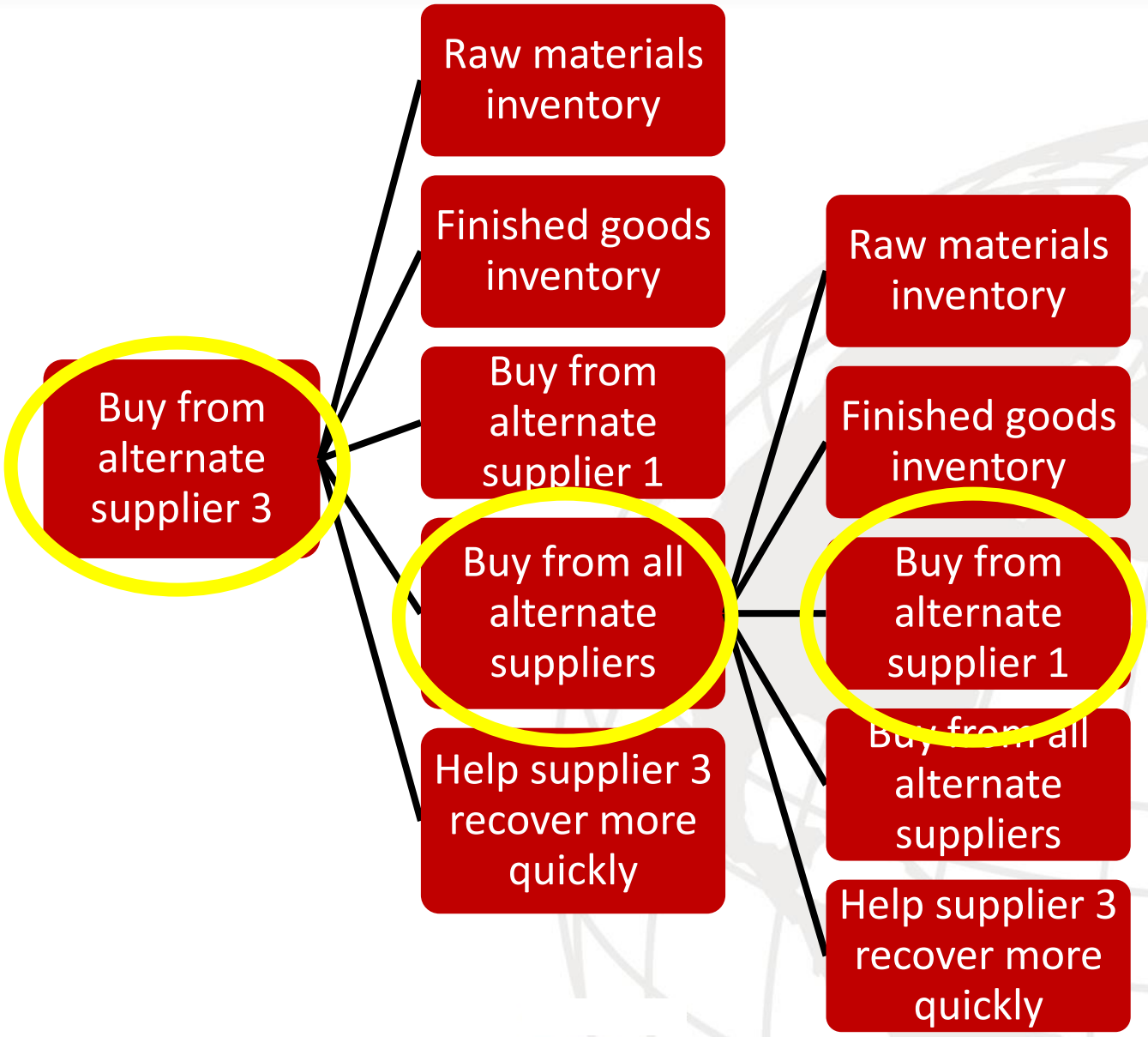
Results from maximizing profit

Strategy	Total expected profit lost due to disruption
Buy from alternate supplier 3	409
Buy from all alternate suppliers	252
Buy from alternate supplier 1	173
Raw material inventory for supply 2	151
Raw material inventory for all supplies	98
Help supplier 3 recover more quickly	92
Buy from alternate supplier 1	97
Finished goods inventory	95
Buy from alternate supplier 1	106

Results from maximizing demand

Strategy	Total expected demand lost due to disruption
Buy from alternate supplier 3	414
Buy from all alternate suppliers	235
Buy from all alternate suppliers	131
Buy from alternate supplier 1	17
Buy from alternate supplier 2	-72
Buy from all alternate suppliers	-114
Buy from alternate supplier 1	-165
Buy from all alternate suppliers	-196
Buy from alternate supplier 3	-252

Greedy algorithm



But algorithm may be too greedy

Future research

- Refine simulation further
  - Expand current path versus explore new path
  - Investigate number of simulation runs to obtain certain degrees of confidence
- Use simulation to generalize insights about optimal risk management strategies
  - Buying from alternate suppliers initially optimal
  - Holding inventory may become optimal later if firm is maximizing profit

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