SUPPLY CHAIN GAME THEORY (GT)

strategic decision making

· Introduction. (GT) We explore what GT offers to a strategic framework for decision-making in SC. We include examples like cooperation, competition, and risk-sharing that can be modelled in SC networks.

1. GT basics.

GT analyzes strategic interaction between players (e.g., buyers and suppliers). Key components include:

a) Players. Entities making decisions.

b) Strategies. Actions available to players.

c) Payoff. Outcome from the strategy.

2. Examples. GT models in SC Management.

2.1. Prisoner's Dilema in Supplier relationships.

SCENARIO: a buyer and a supplier can cooperate or defect

- Cooperation: both agree to cooperate on reducing cost (e.g., sharing demand forecast).
- Defection: one party benefits from the loss of the other (e.g. supplier raises prices; or buyer delays payment)

PAYOFF MATRIX:

	Buyer Cooperates	Buyer Defects
Supplier Cooperate	(10, 10)	(2, 15)
Supplier Defects	(15, 2)	(5, 5)

(10,10): means if Buyer & Supplier cooperate, both win 10.
(2,15): means if Buyer defects & Supplier cooperate, supplier wins 2, and buyer wins 15.
(15,2): means if Buyer cooperate & supplier defects, supplier wins 15, and buyer wins 2.
(5,5): means if both defect, both win 5.

Analysis:
- Best collective outcome: both cooperate (10,10)
- Nash equilibrium: both defect (5,5)

At the N.E., each player strategy is the best response to the strategies chosen by other players.
In simpler terms:
- At a NE, no player can improve their payoff by changing the strategy alone.
- the NE represents a stable state of the game because no player wants to deviate from their strategy.

Key insight: without TRUST, the N.E. leads to suboptimal outcomes. Building trust or long-term incentives can break this cycle.

2.2. N.E. in Supplier Price Competition

SCENARIO: two suppliers compete for a buyer's business by offering discounts. Each supplier must choose between two strategies: (L) low price

and (H) high price. The buyer awards contracts based on price and service level.

PAYOFF MATRIX:

	Supplier B: H	Supplier B: L
Supplier A: H	(8,8)	(4,10)
Supplier A: L	(10,4)	(6,6)

Analysis: · If SupplierA chooses L, supplier's B best response is to also lower the price L.
· N.E · (6,6) where both choose L.

Key Insight: competitive pricing reduces profit for both suppliers. Differentiation (e.g., value-added services) could shift the game to higher payoffs.

2.3. Stackelberg Model: Leader-Follower Dynamics

SCENARIO: A dominant buyer (leader) sets order quantities, and suppliers (followers) respond by setting prices.

Example: · The buyer needs 1000 units and sets a max price of 50€/unit.
· Two suppliers compete by adjusting costs to meet the buyer's price.

Key Insight: the leader (buyer) influences market dynamics by setting thresholds that drive follower (supplier) behaviour.

3. Strategic Applications.

3.1. PRICE WARS. Balance Competition.

Profit = Revenue - Cost

① supplier A's price = 50€/unit
supplier B's price = 48€/unit

② Supplier A reduces price to 46€/unit.

③ Supplier B tries to match or undercut Supplier A's price.

key Insight: GT reveals when aggresive pricing erodes profits, encouraging suppliers to differentiate rather than compete.

3.2. AUCTION-BASED SOURCING.

SCENARIO: a buyer runs a reverse auction where three suppliers bid for a contract:

Supplier A : 50€/unit
B : 47€/unit
C : 45€/unit

Outcome: supplier C wins, but A & B will reasses their costs for future competitiveness.

Key Insight: GT helps predict bidding behaviour!

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4. Case Study. Automotive SC.

A car manufacturer relies on two Tier 1 suppliers:

· supplier A. Capacity 10000 units/month

Cost 50 €/unit

. Supplier B . Capacity 7000 units/month

Cost 55 €/unit

SZENARIO: A disruption (war) reduces supplier A's capacity by 50%.

Demand is 12000 units/month.

SOLUTION: relocate demand to supplier B despite higher cost.

Cost Analysis:

$$\text{T. Cost} = \underbrace{[5000 \cdot 50]}_{A} + \underbrace{[7000 \cdot 55]}_{B} = 635000\,€$$

Key Insight: combine network analysis with GT predicts cost trade-offs under disruptions.

Conclusion: GT provides a structured approach to understanding and optimizing supplier relationships. Through mathematical models and strategic applications, organizations can balance competition and cooperation. This can potentially enhance efficiency, and build more resilient supply chains.

BOOK: BEAUTIFUL MIND (John Nash)