15.093 Optimization Methods Project Proposal

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1 Problem Description

- Project title: Is Just-in-Time really the most profitable supply chain strategy for Nike in an uncertain world?
- To what extent do disruptions in supply change (modelled by δ) and frictions in changing suppliers (modelled by α) affect the profitability (objective value) of different supply chain strategies for Nike, in terms of quantity of holding inventory (E_{ijt}) and diversification of suppliers (measured by Herfindahls, an average of market shares across time and product)?

2 Data

- We plan to use the following main data sources, with assumptions as needed to carry the analysis forward: (1) Nike manufacturing map: list of Nike's suppliers / factories; (2) Nike 10-K reports: revenue, cost; (3) Shipping cost: Drewry World Container Index; (4) Nike products: price.

3 Methods

- The primary decision variable is: X_{it} (quantity of shoes produced by supplier i (in producer region p(i)) at time t).
- The auxiliary decision variables are:
  - E_{it} (holding quantity of shoes by supplier i (in producer region p(i)) at time t)
  - S_{ijt} (the quantity of shoes made by supplier i sold in consumer region j at time t). The relationship is defined as $\sum_j S_{ijt} = \sum_j (X_{ijt}) + E_{it-1} - E_{it}$.
- The objective function is: profit = revenue - shipping cost - production cost - holding cost
  $= \sum_{ijt}(R_t - T_{ijt}) * S_{ijt} - \sum_{it} C'_{it} * X_{it} - \sum_{it} H_t * E_{it}$.
- Constraints: demand constraint D_{jt}, supply (availability) constraints by supplier A_{it} (Nike plans as if it knows supply)
- Excess goods go into inventory E_{it} (in the same producer region as the supplier) and incur holding cost H_t per unit.
- Demand and supply are region-specific. Shipping a good produced in the representative producer country of a region p (e.g. US in Americas) to the representative consumer country of a region j (e.g. Brazil in Americas) incurs shipping (transportation) cost $T_{p(i)jt}$ per unit, which can also be expressed as T_{ijt}.
- There is friction when trying to ramp up production; the cost per unit increases if Nike wants more inputs from the supplier compared to the previous year: $C'_{it} = C_{it} + \alpha M_{it}$, where marginal cost $M_{it} = \max\{\sum_j (X_{ijt} - X_{ijt-1}), 0\}$. α is a key parameter that drives the utility of having diverse suppliers and reasonable inventory levels.
- We run the model with varying parameters from 2014-2020 to get the best strategy (supplier availability is known). This is the first stage.
- Then we add a supply shock from 2021-2023 (supplier availability drops by a percentage δ and is unforeseen) and run the same model (with the past years' decision variables and parameters) and compare the profits. This is the second stage.

4 Expected Results

- As the extent of supply change disruptions and frictions in changing suppliers increase, we expect the quantity of holding inventory to increase and for Nike to get suppliers from more diverse sources.
- Profits from a just-in-time strategy will be lower than a just-in-case strategy given unexpected supply shocks, and the difference increases when the shock is greater.

5 Practical Implications

- Companies should rethink their lean supply chain strategy if they think it's the most profitable one.