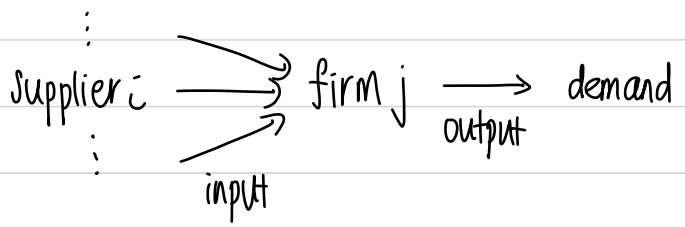
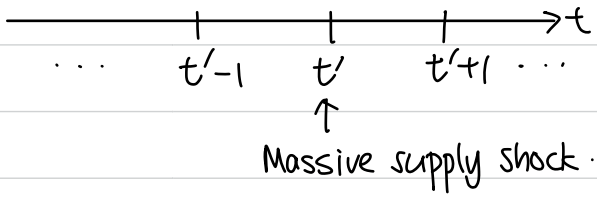
Optimization Project Idea

20230927



Simplification
- 1 input, 1 output



Problem Formulation

In a time period t,

- firm j pays $\sum_i C'_{ijt} * X_{ijt}$ for input materials and produces $k \cdot \sum_i X_{ijt}$ units of output (X_{ijt}: decision variable)
- firm j sells up to D_{jt} units, the rest goes into inventory $E_{jt} = \text{production}_t - \text{sold}_t + E_{jt-1}$ and incurs a holding cost of H_t per unit. Firm earns revenue of P_j per unit. (E_{jt}: decision variable)

- firm j wants to choose $\{X_{ijt}\}$ to maximize Π. (i.e. meet as much DD as possible)

Firm j plans as if

- Supplier i can only supply up to A_{ijt} units of input to firm j at time t.

Twist:

- There are unexpected shocks to supply. We can model this with $A_{ijt} + \Delta_{ijt}$, $|\Delta_{ijt}| \le \delta$. Or we can run the model in 2 stages, before and after the shock, with the shock defined as a fall in a_{ijt} by $\Delta_{ijt} = \delta' \cdot A_{ijt}$, where $0 < \delta' < 1$. Or both.

(firm takes this into account; firm does not take shock into account)

- Adding a supplier is hard. The cost per unit increases by how much more you're purchasing over the last time period.

$$C'_{ijt} = C_{ijt} + \alpha \max\{X_{ijt} - X_{ijt-1}, 0\}$$

(α: the main parameter that drives the utility of diversification / having holding.)

Objective

- How does Π and X_{ijt} change with changes in (δ, δ') and α?

$\Leftrightarrow$ To what extent do disruptions in supply change (δ, δ') and frictions in changing suppliers (α) affect the profitability of different supply chain strategies, in terms of quantity of holding inventory (E_{jt}) and diversification of suppliers?

↑ Just-in-time vs Just-in-case

↑ Cheapest suppliers vs Diverse suppliers

$\frac{1}{T} \sum_t \sum_i$ (Share of inputs by supplier i at time t)^2

$\frac{1}{T} \sum_t$: ave. across time periods

(Share of inputs by supplier i at time t)^2: Herfindahls (HHI)

Data needed

- 1 firm j (at least)
- 1 product/good
- 1 input (we just want to model 1 input)
- Suppliers of input, $[j]$.
- Over at least a few years, $t \in T$

Variables needed

- C_{ijt} (cost)
- D_{jt} (demand)
- H_t (holding cost)
- P_j (price)
- A_{ijt} (availability)
- $\Delta_{ijt}, \delta, \delta', \alpha$ (change parameters)

Raw data needed

- ✓
- ✓
- ✓
- ✓
- ✓
- ✗

relatively flexible w/ the quality of data we have.