$$\min_{q_i^{da},\, q_i^{\sim t},\, q_i} \; p_{da}^{b} q_i^{da,b} - p_{da}^{s} q_i^{da,s} + \sum_{t\in T} p^{t} \left[p_{\sim t}^{b} q_i^{\sim t, b} - \ldots \right]$$

$$\mathcal{L}_i = p_{da}^{b} q_i^{da,b} - p_{da}^{s} q_i^{da,s} + \sum_{t\in T} p^{t} \left[p_{\sim t}^{b} q_i^{\sim t,b} - p_{\sim t}^{s} q_i^{\sim t,s} \right]$$

$$+ \sum_{j\in T_i} \zeta_{ij} \left(q_{ij} + q_{ji} \right) + \sum_{j\in T_i} \xi_{ij} \left(q_{ij} - \kappa_{ij} \right) +$$

$$+ \sum_{t\in T} \lambda_i^{t} \left(d_i - \Delta q_i^{t} - \sum_{j\in T_i} q_{ij} - q_i^{da,b} + q_i^{da,s} - q_i^{\sim t, b, t} + q_i^{\sim t, s, t} \right)$$

$$- \mu_i^{da,b} q_i^{da,b} - \mu_i^{da,s} q_i^{da,s} - \mu_i^{\sim t,b} q_i^{\sim t,b} - \mu_i^{\sim t,s} q_i^{\sim t,s}$$

$$\frac{\partial \mathcal{L}_i}{\partial q_i^{da,b}} = p_{da}^{b} - \sum_{t\in T} \lambda_i^{t} - \mu_i^{da,b} = 0$$

$$\frac{\partial \mathcal{L}_i}{\partial q_i^{da,s}} = -p_{da}^{s} + \sum_{t\in T} \lambda_i^{t} - \mu_i^{da,s} = 0$$

$$\frac{\partial \mathcal{L}_i}{\partial q_{ij}} = \zeta_{ij} + \xi_{ij} - \sum_{t\in T} \lambda_i^{t} = 0$$

$$\frac{\partial \mathcal{L}_i}{\partial q_i^{\sim t,b,t}} = p^{t} p_{\sim t}^{b} - \lambda_i^{t} - \mu_i^{\sim t,b} = 0$$

$$\frac{\partial \mathcal{L}_i}{\partial q_i^{\sim t,s,t}} = -p_{\sim t}^{s} \cdot p^{t} + \lambda_i^{t} - \mu_i^{\sim t,s} = 0$$

$$① \quad \frac{dL_i}{dq_i^{da,b}} = p^b_{da} - \sum_{t \in T} \lambda_i^t - \mu_i^{da,b} = 0 \qquad 0 \le \mu_i^{da,b} \perp q_i^{da,b} \ge 0$$

$$② \quad \frac{dL_i}{dq_i^{da,s}} = -p^s_{da} + \sum_{t \in T} \lambda_i^t - \mu_i^{da,s} = 0 \qquad 0 \le \mu_i^{da,s} \perp q_i^{da,s} \ge 0$$

$$③ \quad \frac{dL_i}{dq_{ij}} = \xi_{ij} + \xi_{ij} - \sum_{t \in T} \lambda_i^t = 0$$

$$④ \quad \frac{dL_i}{dq_i^{rt,b,t}} = p\, p^t_{rt} - \lambda_i^t - \mu_i^{rt,b,t} = 0$$

$$⑤ \quad \frac{dL_i}{dq_i^{rt,s,t}} = -p^t_{rt} \cdot p + \lambda_i^t - \mu_i^{rt,s,t} = 0$$

ξ_{ij} → congestion price is included, if ξ_{ij} then ξ_{ij} should account for it

$$① + ③ \rightarrow \xi_{ij} + \xi_{ij} = p^b_{da} - \mu_i^{da,b}$$

$$\xi_{ij} = p^b_{da} - \mu_i^{da,b} - \xi_{ij}$$

Can be non 0 only if $q_i^{da,b} = 0$, so when i is not trading with the grid "motivation"

Why $\xi_{ij} = p^b_{da}$?

$i \rightarrow j$, is it profitable to sell for $p^b_{da} - \varepsilon$?

Yes. then $\varepsilon \longrightarrow 0$ ∎

Proof:

$$\mu_i^{da,b} + \xi_{ij} = 0$$

$\mu_i \longrightarrow 0$

why? what means?

$// \; \underbrace{s(r_i, w) > s(r_c, w)}$ we can measure if

$// \; \underbrace{U > 0}$ we can't measure if

What we can do is:

have a fixed payoff $p(r)$ reputation

imagine $\rightarrow$ $p(r)\uparrow$ if $s(r_i, w) > s(r_c, w)$

$p(r)\downarrow$ otherwise

$p(r)$ should have some connection with

$$\mathcal{L}_i = p_{da}^{b}\, q_i^{da,b} - p_{da}^{s}\, q_i^{da,s} + \sum_{t \in T} p^{t} \left[p_{rt}^{b}\, q_i^{rt,b} - p_{rt}^{s}\, q_i^{rt,s} \right]$$

$$+ \sum_{j \in T_i} p_{da}^{b}\, q_{ij}$$

$$q_i^{rt,b} = \Big[\overbrace{d_i - \Delta g_i - q_i^{da,b} + q_i^{da,s} - \sum_{j \in T_i} q_{ij}}^{S_i} \Big] \text{ if } S_i > 0$$

else $q_i^{rt,s} = S_i$

$$Cost_i = p_{da}^{s}\, q_i^{da,b} - p_{da}^{s}\, q_i^{da,s} + p^{rt,b} \cdot S_i\, \mathbb{1}_{S_i > 0} -$$

$$- p^{rt,s} S_i \cdot \mathbb{1}_{S_i < 0} + \sum_{j \in T_i} p_{da}^{b}\, q_{ij}$$

$$p_{da}^{b}\, q_1^{da,b} - p_{da}^{s}\, q_1^{da,s} + S_1 \left(p^{rt,b} \cdot \mathbb{1}_{S_1 > 0} - p^{rt,s}\, \mathbb{1}_{S_1 < 0} \right) +$$

$$+ \sum_{j \in T_i} p_{da}^{b}\, q_{ij}^{1} - p_{da}^{b}\, q_2^{da,b} + p_{da}^{s}\, q_2^{da,s} - S_2 (\dots)$$

$$- \sum_{j \in T_i} p_{da}^{b}\, q_{ij}^{2}$$

$$p_{da}^{b} \left(q_1^{da,b} - q_2^{da,b} + \sum_{j \in T_i} q_{ij}^{1} - \sum_{j \in T_i} q_{ij}^{2} \right)$$