Efficient Mechanisms for Access to Storage with Imperfect Competition in Gas Markets

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Outline

- Storage: regulation and markets
- Storage scarcity and current allocation rules ➔ Productive efficiency issues with regulated tariffs
- Imperfect competition in the downstream (gas) market ➔ Equilibrium analysis: centralized allocation of storage versus auctions
- Welfare analysis (1): compare both market equilibria on welfare grounds
- Welfare analysis (2): consider maximum welfare (benevolent dictator) and look at welfare losses due to 1) Auctions 2) “Pro-quota” mechanisms
Storage: regulation and markets

- Storage: current and potential use
- Storage before (optimization) and after liberalization (barrier to entry) \(\Rightarrow\) EU conclusions (2007)
- Regulation ex-ante \(\Rightarrow\) Access rules: option negotiated/regulated (price & allocation)
- Storage **is not a natural monopoly** But... *No divesture No competition!*
- There are storage substitutes \(\Rightarrow\) storage market or flexibility market? In practice storage is essential even to satisfy Public Service Obligations (PSO) according to ERGEG(2010)
Storage regulation

- Storage controlled by incumbents/De facto monopoly sometimes (no new investments) /Market power elsewhere (HHIndex)/Essentiality → Storage is an essential facility (Cavaliere 2009)
- Need to regulate storage
- However current problems with storage scarcity: cost reflective storage tariffs may not give good signals to gas suppliers
- What about storage rationing? current rules: FCFS, Pro-quota, CGWC, auctions
- Allocation according to storage costs or storage value (flexibility substitutes...
Efficient rationing mechanism: **productive efficiency** (Bertoletti, Cavaliere, Tordi, 2008)

- Only flexibility is considered as a production input
- Storage tariff are regulated
- The idiosyncratic nature of flexibility: different cost of storage substitutes: $w_2$
- Storage ($Z$) is a rationed input whose **price is regulated**
- Rationing affects optimization by gas suppliers (suppliers cost are higher)
- Use the **shadow price of storage** $\mathcal{W}_1^*(w_2, y, z)$ to implement an efficient allocation mechanism (cost minimization)
Example: 2 firms, 2 inputs, imperfect substitution (Cobb-Douglas with CRS)

- 2) two firms: a leader \((l)\) and a follower \((f)\)
- 3) idiosyncratic prices of alternative flexibility inputs: \(w_{2l} = \alpha w_{2f} \ (\alpha<1)\)

\[
\frac{y_l}{z_l} = \frac{1}{\sqrt{\alpha}} \frac{y_f}{z_f}
\]

- i.e., the firm with the worst access to storage substitutes should be “compensated” with more storage
- Pro-quota inefficient → \(\frac{y_l}{z_l} = \frac{y_f}{z_f}\)
Example 2: Perfect substitution

- $y = x_1 + x_2 \rightarrow c(w_1, w_2, y) = \text{Min}\{w_1, w_2\}y,$
- Shadow prices: $w^*_{1l} = w_{2l}; w^*_{1f} = w_{2f}$
- As $w^*_{1l} < w^*_{1f}$, First satisfy completely storage requirements by the follower, then assign the residual capacity to the leader
Centralized (even efficient) mechanism versus Market mechanism

- Availability of storage substitutes not considered
- Implementation difficult because of asymmetric information (adverse selection issues...)
- Relationship with imperfect competition downstream not considered
- Replace centralized allocation mechanism with market mechanisms
- Auctions should elicit the shadow price of storage but are not immune to strategic behavior → capacity hoarding (to raise rival’s cost)
Market Structure

- Dominant Firm Model: one leader and a competitive fringe of small symmetric firms grouped as a follower.
- Two inputs for Flexibility: $z$ (storage) and $x$ (storage substitute).
- Linear production function: $y = z + x$.  
- Linear demand $Q(P) = a - P$
- Storage capacity is given as $S$ (normalized to $\gamma$), a share $\gamma$ is assigned to the follower and a share $(1-\gamma)$ to the leader $(0 \leq \gamma \leq 1)$.
- The cost of the storage substitutes differs as before: $w_{2l} = \alpha w_{2f}$, $(0 < \alpha < 1)$ higher for the follower with respect to the leader.
Market Equilibrium with Centralized Allocation of Storage
(gas suppliers cannot distort competition but the regulator can, through inefficient allocation mechanisms)

- \( Y_1 = \frac{(a - z_f - x_{2f} - \alpha)}{2} \)

- \( Y = \frac{(a + z_f + x_{2f} - \alpha)}{2} \)

- \( P = \frac{(a - z_f - x_{2f} + \alpha)}{2} \)

- **NB:** \( \alpha = \frac{w_{2l}}{w_{2f}} \) (Lower prices and greater output with efficient leaders)
The Storage Auction

- Multiunit sealed bid uniform price Auction
- The auction assigns multiple units of S to each bidder
- For each unit, bidders specify their willingness to pay
- The S units are allocated to the S highest bids
- Bidders pay a uniform price P = lowest of the highest bids that are awarded the S units
Market Equilibrium with Auctions (Two-stage Model, equilibrium in the gas market is affected by suppliers’ bids within the Auction)

- Given the follower bid, the dominant firm bids strategically in order to maximise his profit downstream.

- The leader can set this price as an equilibrium, by bidding it for the total amount of storage demanded.

- The follower is never crowded out in storage (too costly a strategy even for the leader...)

- The less the storage substitute is available, the larger the storage capacity assigned to the follower (pro-competitive effect) → Yarrow (2003): issues related to the elasticity of storage demand within auctions implemented in the UK.
Welfare Analysis:
Auctions versus Centralized Allocations Mechanisms.
The more the leader is (comparatively) efficient in providing the storage substitute, the more the auction dominates centralized mechanisms (no trade-off between productive efficiency and resort to pro-competitive market mechanism).

The centralized market mechanism dominates auctions for average values of both $\gamma$ and $x_{2f}$-about equal shares of storage and substitutes→ more symmetric competition, more advanced stage of the liberalization process (UK)→ storage to storage competition in place?
Welfare Analysis: Second best-Auctions-Proquota

Level curves (welfare losses)

Aust.

Second Best

Pro-quota

Welfare Analysis

Second Best Auctions - Proquota

Level curves (welfare losses)
Welfare Analysis (2)

- Auctions dominate as the leader is more and more efficient in providing the storage substitute with respect to the follower ($\alpha$ decreases)

- In the majority of cases auctions dominate pro-quota for either low or high values of $x_{2f}$ (it is more likely being in cases where auction dominate than the opposite)

- In the meantime it is impossible that auctions always dominate the pro-quota mechanism.
Conclusions

- Current centralized rules do not follow efficiency criteria.
- Centralized efficient mechanism, just based on productive efficiency aims, neglect imperfect competition issues and are difficult to implement because of asymmetric information.
- Auctions can be better both from the efficiency point of view especially when liberalization is not advanced BUT consider unbundling issues (or correct for them...).
Further Research

- Consider capacity hoarding when suppliers obtain access to storage but do not use it
- Compare other types of auctions mechanism
- Consider pay-as-bid?
- What are the effects of Auctions on the incentives to invest in new storage capacity?