
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
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Storage: regulation and markets

- Storage: current and potential use
 - Storage before (optimization) and after liberalization (barrier to entry) → EU conclusions (2007)
 - Regulation ex-ante → Access rules: option negotiated/regulated (price & allocation)
 - Storage **is not a natural monopoly** But... **No divestiture No competition!**
 - There are storage substitutes → storage market or flexibility market? In practice storage is essential even to satisfy Public Service Obligations (PSO) according to ERGEG(2010)
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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...)
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Efficient rationing mechanism: **productive efficiency**
(Bertoletti, Cavaliere, Tordi, 2008)

- Only flexibility is considered as a production input
 - Storage tariffs 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' costs are higher)
 - Use the **shadow price of storage** $w_1^*(w_2, y, z)$ to implement an efficient allocation mechanism (cost minimization)
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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* $\rightarrow \frac{y_l}{z_l} = \frac{y_f}{z_f}$
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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 $w_{1l}^* < w_{1f}^* \rightarrow$ First satisfy completely storage requirements by the follower, then assign the residual capacity to the leader
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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)
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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) e x (storage substitute).
 - Linear production function: $y=z+x$.
 - Linear demand $Q(P) = a - P$
 - Storage capacity is given as S (normalized to 1), a share γ 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*.
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Market Equilibrium with Centralized Allocation of Storage

(gas suppliers cannot distort competition but the regulator can, through inefficient allocation mechanisms)

- $Y_1 = (a - z_f - x_{2f} - \alpha) / 2$
 - $Y = (a + z_f + x_{2f} - \alpha) / 2$
 - $P = (a - z_f - x_{2f} + \alpha) / 2$
 - NB: $\alpha = w_{2l} / w_{2f}$ (Lower prices and greater output with efficient leaders)
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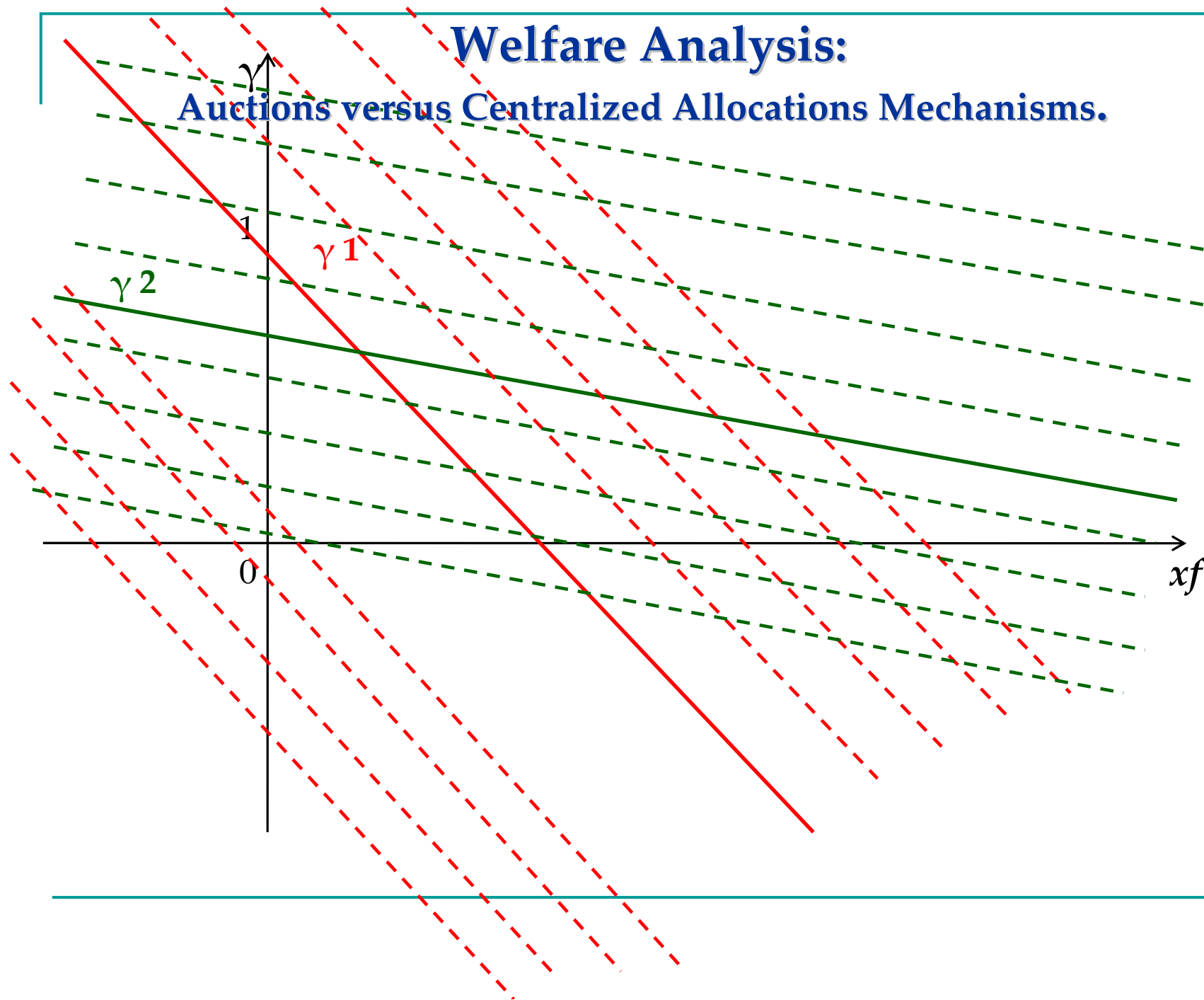
The Storage Auction

- *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
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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
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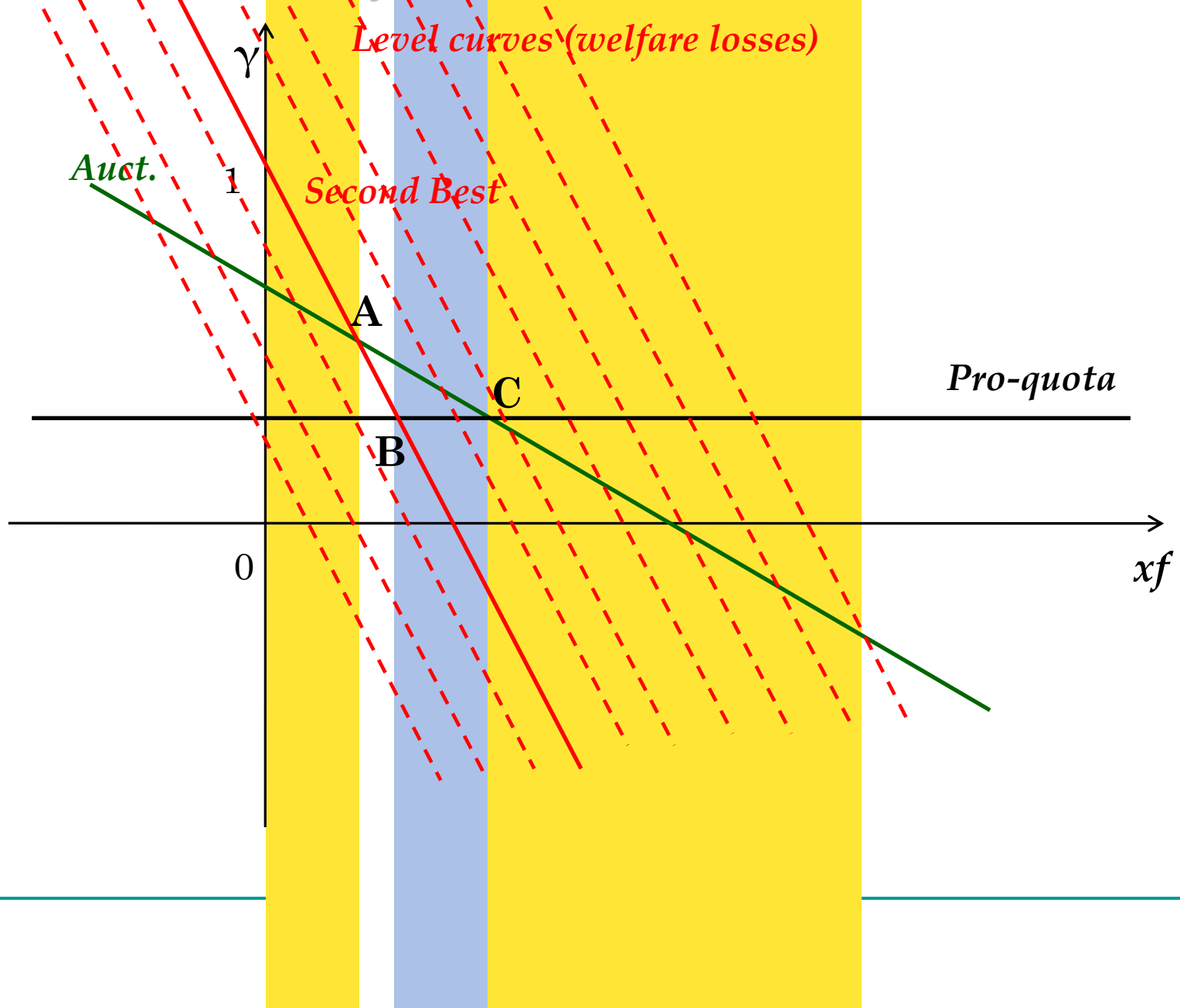
Welfare Analysis: Auctions versus Centralized Allocations Mechanisms.



Welfare Analysis (1)

- 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 γ 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?
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Welfare Analysis: Second best-Auctions-Proquota



Welfare Analysis (2)

- Auctions dominate as the leader is more and more efficient in providing the storage substitute with respect to the follower (α 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.
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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...)
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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?
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