Market Design in Energy and Communications

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Market design

- Establishes rules of market interaction
- Economic engineering
  - Economics
  - Computer science
  - Engineering, operations research

Market design accomplishments

- Improve allocations
- Improve price information
- Reduce risk
- Enhance competition
- Mitigate market failures

Applications

- *Spectrum auctions*
- *Electricity markets*
- Natural resource auctions (timber, oil, etc.)
- Emission allowance auctions
- Financial securities
- Procurement

Objectives

- Efficiency
- Transparency
- Fairness
- Simplicity

Principle

“Make things as simple as possible, but not simpler” -- Albert Einstein

Electricity

Goals of electricity markets

- Short-run efficiency
  - Least-cost operation of existing resources
- Long-run efficiency
  - Right quantity and mix of resources

Challenges of electricity markets

- Must balance supply and demand
  at every instant
  at every location
- Physical constraints of network
- Absence of demand response
- Climate policy

Three Markets

- Short term (5 to 60 minutes)
  - Spot energy market
- Medium term (1 month to 3 years)
  - Bilateral contracts
  - Forward energy market
- Long term (4 to 20 years)
  - Capacity market (thermal system)
  - Firm energy market (hydro system)
- Address risk, market power, and investment

Long-term market:
Buy enough in advance

Product

- What is load buying?
  - Energy during scarcity period (capacity)
- Enhance substitution
  - Technology neutral where possible
  - Separate zones only as needed in response to binding constraints
- Long-term commitment for new resources to reduce risk

Pay for Performance

- Strong performance incentives
  - Obligation to supply during scarcity events
    - Deviations settled at price > $5000/MWh
    - Penalties for underperformance
    - Rewards for overperformance
- Tend to be too weak in practice, leading to
  - Contract defaults
  - Unreliable resources
- But not in best markets: ISO New England, PJM

Spectrum

Spectrum auctions

- Many items, heterogeneous but similar
- Competing technologies and business plans
- Complex structure of substitutes and complements

- Government objective: Efficiency
  - Make best use of scarce spectrum
  - *Address competition issues in downstream market*

Key design issues

- Establish term to promote investment
- Enhance substitution
  - Product design
  - Auction design
- Encourage price discovery
  - Dynamic price process to focus valuation efforts
- Encourage truthful bidding
  - Pricing rule
  - Activity rule

Simultaneous ascending auction

Prepare

Italy 4G Auction, September 2010
470 rounds, €3.95 billion

- *Auction conducted on-site with pen and paper*
- *Auction procedures failed in first day*
- *No activity rule*

Thailand 3G Auction, October 2012

- 3 incumbents bid
- 3 nearly identical licenses; can only win one
- Auction ends at reserve price + 2.8%

US AWS-3 auction, 65 MHz, after 91 rounds

$43.7 billion, $2.65/MHzPop (paired)

Auction 97	
Auction Description	**AWS-3**
Dates	Opened: **11/13/2014** Closed:
Licenses	**1,614 licenses in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands**
Qualified Bidders	**70**

Round 91	
Rounds Completed	**91**
Bidding Days	**20**
Total PWB Amount	**$43,744,181,500**
Licenses with PWBs	**1,611**

The Future of Mobile Broadband

The future…as with electricity: multiple opportunities to contract

- Long term: investment market like today
- Medium term: one month to three years
- Short term (spot market)
  - One day
  - One hour
  - 5 minutes
  - 4 seconds
  - (10 milliseconds, 10 microseconds, …?)

Conclusion

- No auction design is perfect
- Design must be customized for setting
  - Simultaneous ascending clock
    - Simple settings (upcoming UK)
  - Combinatorial clock
    - Packaging is essential (UK 4G, Canada 700 MHz)
  - Two-sided clock
    - Incentive auction in US
- Never ignore essentials
  - Encourage participation
  - Demand performance
  - Avoid collusion and corruption

Telecom: *Auction spectrum*

Energy: *Pay for performance*