Modeling wind auctions as a participation game

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- Consider the following case
- To entering a business
  - Need to win a license in an auction
  - considerable (sunk) bid preparation costs

- Renewables were supported by feed-in tariffs in many EU countries
  - big drawbacks (costly and hard to control)

- New system by auctioning the support in a reversed auction
  - Limited number of “support units”
  - Win support units by bidding the price you would like to have guaranteed.
  - Lowest prices win

- Focus on German auctions for support to onshore wind (EEG 2014)
  - Bid eligibility requirement
    - permits necessary for the realization of the project.
    - Form of (sunk) bid preparation costs
    - Can be up to 10% of total project cost!
- Bid preparation costs is a well-known phenomena
  - Recent case: British printing firm De La Rue
    - lost bid for printing order of new UK passports
    - profit warning, due to the large bid preparation costs.
    - £4m for contract of ~ £490m -> 0.8%!
- What are the effects of the much higher bid preparation costs in the German onshore wind support auctions?

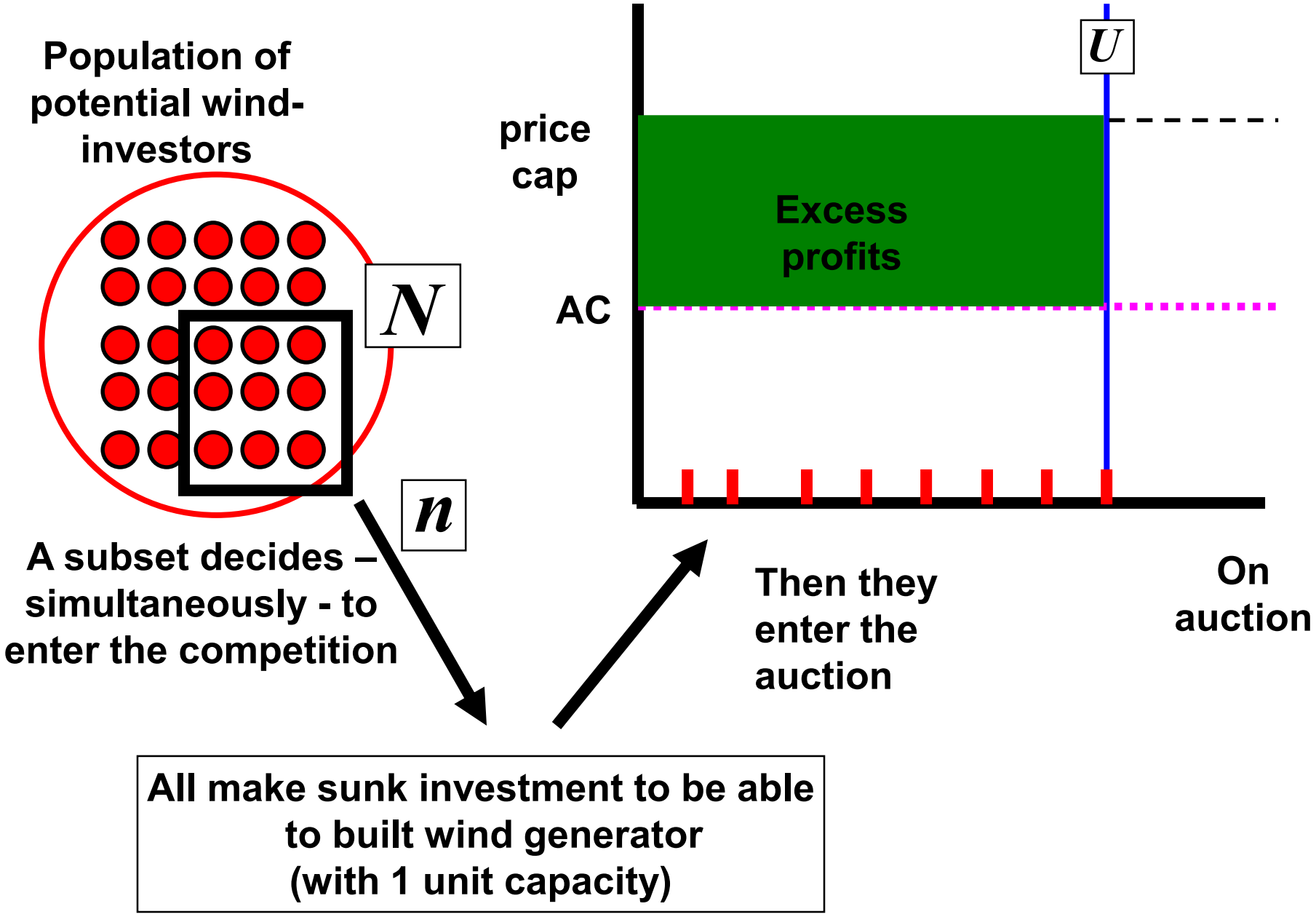
- The model - setup

Stage 1

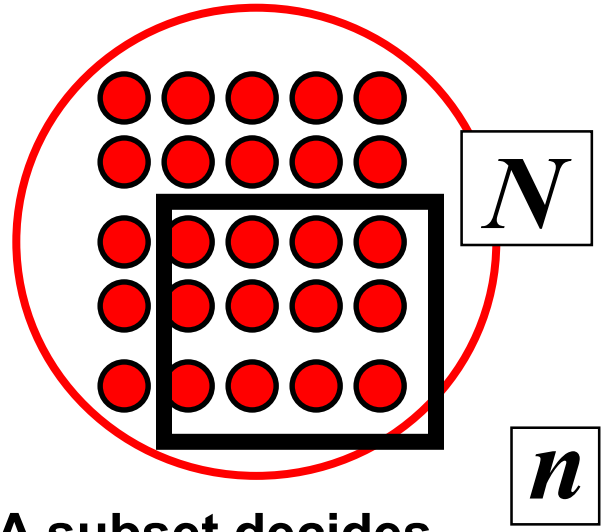
- The Auctioneer announces an auction with *U* units.
- *N* potential bidders decide simultaneously whether to enter and pay *LFC*
- Mixed strategy: each potential bidder enters with probability *q*

Stage 2

- *n* actual bidder entered (common knowledge)
- Other bidders receive outside option *OO*
- Actual bidders bid in an UPA auction.
  - Uniform price equal to first rejected bid


Population of potential wind-investors
N
n
A subset decides – simultaneously - to enter the competition
price cap
AC
Excess profits
U
Then they enter the auction
On auction
All make sunk investment to be able to built wind generator (with 1 unit capacity)

Population of potential wind-investors



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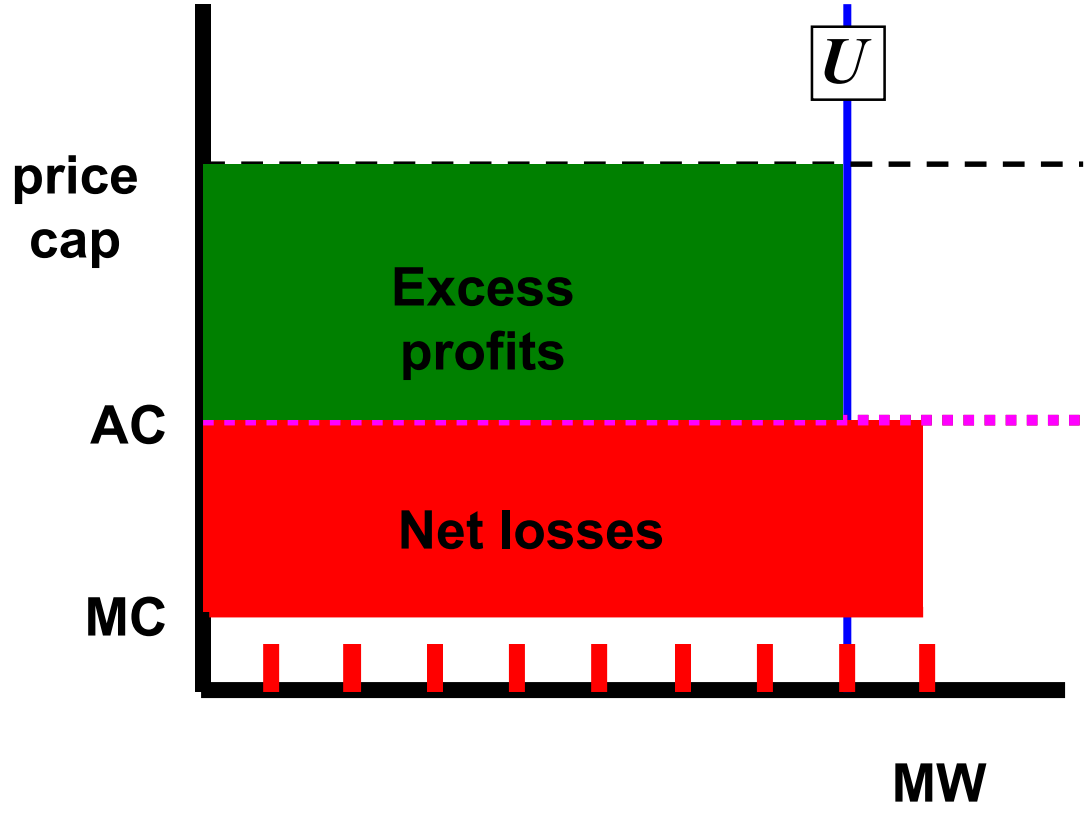


"Peak-load pricing" story

- If too many people show up -> price low
- If too few people show up -> price high

- The model - solving

Stage 1

- There are *N* potential bidders
- Bidder enters with probability *q*

$$q^*: \quad \Pr[n \le U \mid q] \cdot \pi^H + \Pr[n > U \mid q]\pi^L = OO$$

Stage 2

- *n* bidder entered
- If
  - *n* ≤ *U*: bid CAP $\pi^L = -\delta \cdot LFC$
  - *n* > *U*: bid $MC + (1-\delta)LFC$ $\pi^H = CAP - MC - LFC$

$$\alpha[q] = \sum_{n=1}^{U} \left(q^{n-1} (1-q)^{N-n} \right) \binom{N-1}{n-1}$$

The simulation

Simulation parameters

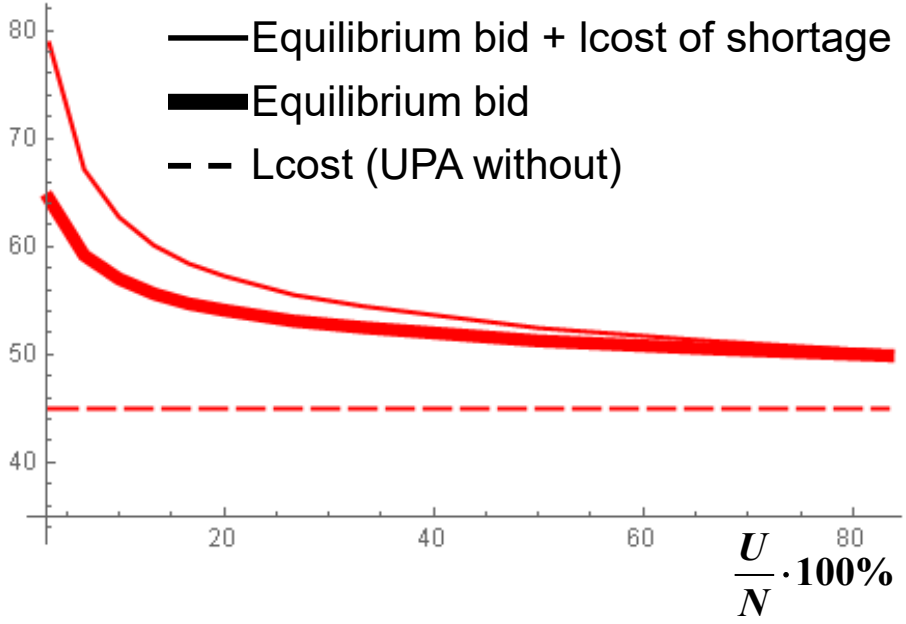
- *N=30* (Potential bidders)
- *n=1,..,25* (actual bidders)
- *MC=5*
- *CAP=100*

FIXED

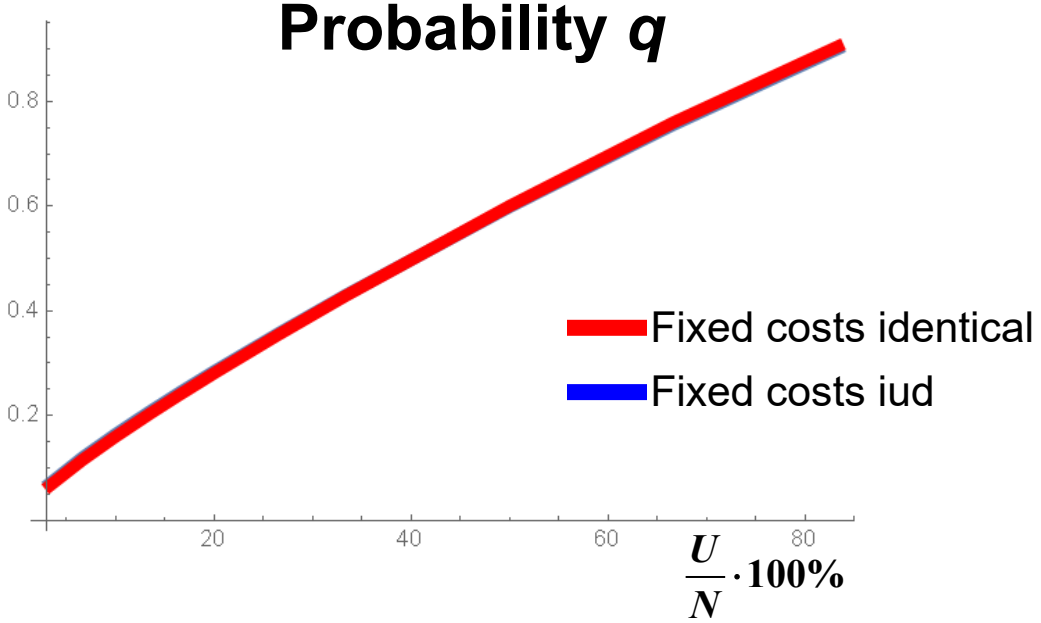
- LFC = 30

Fixed costs identical

CAP = 100



Probability *q*



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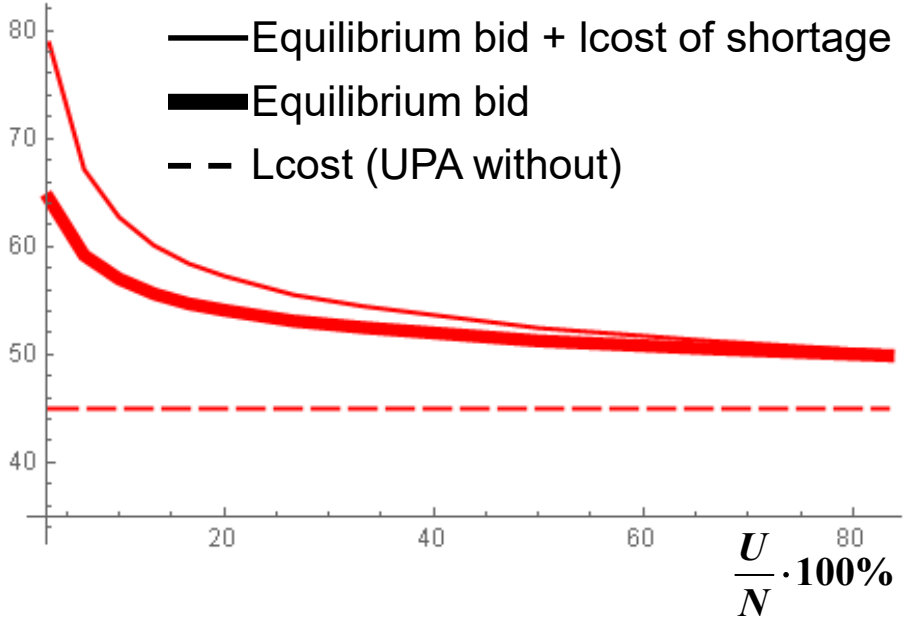
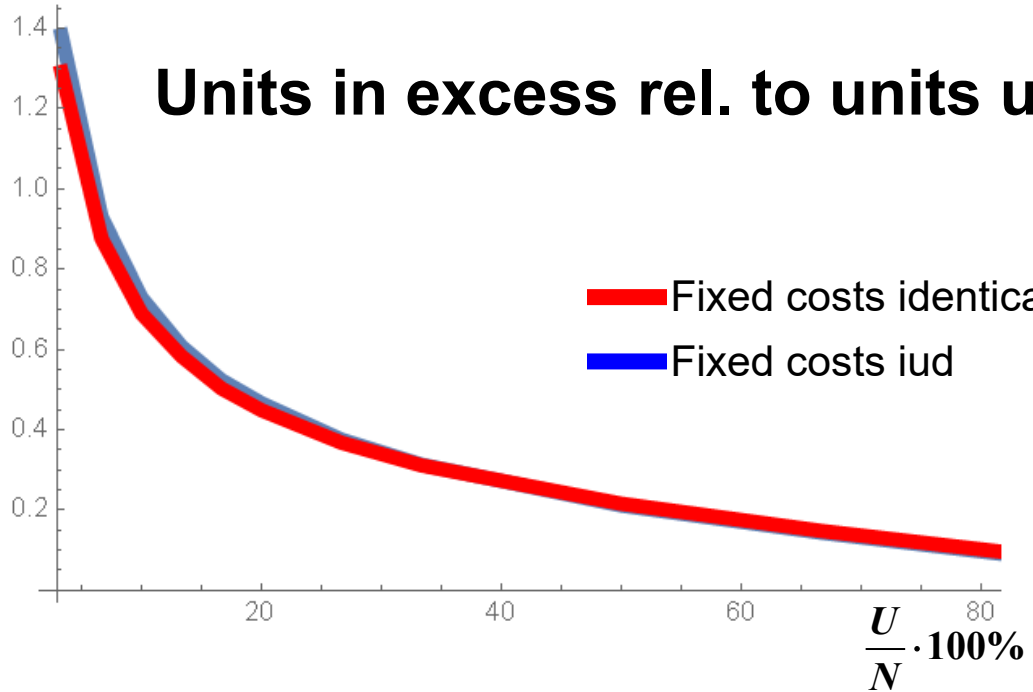


$$\left(\text{in mathematics } \frac{E\left[\max[0, m-\mathrm{U}]\right]}{E\left[\min[U, m]\right]}\right)$$

Units in excess rel. to units used



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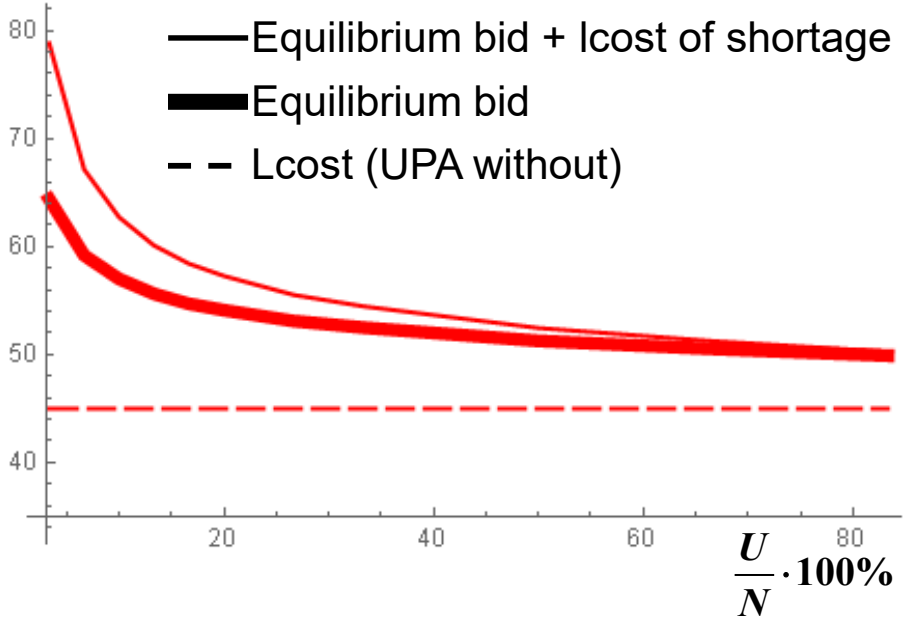
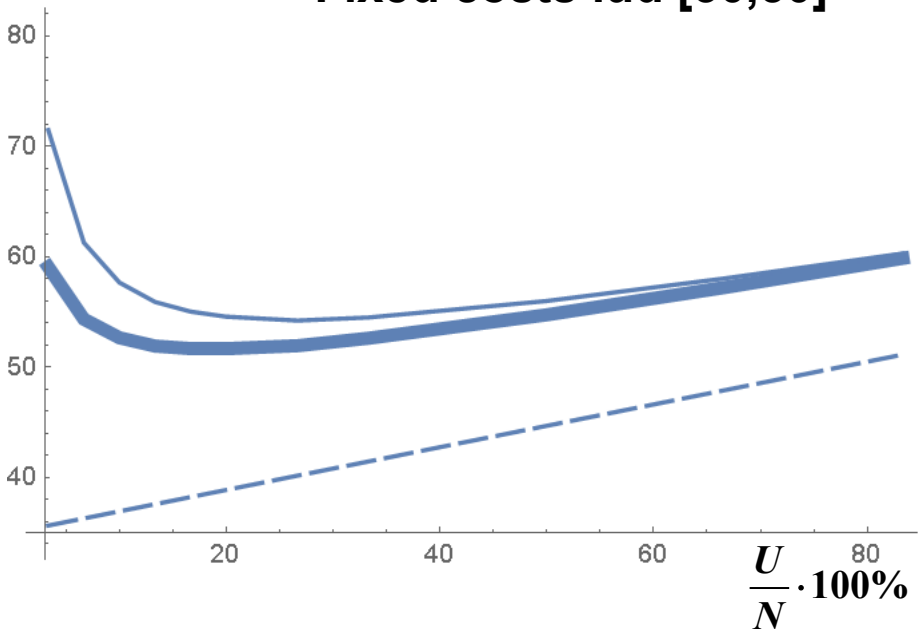
FIXED	**DISTRIBUTION**
• LFC = 30	LFC iud [20,40]

CAP = 100

Fixed costs identical



Fixed costs iud [30,50]



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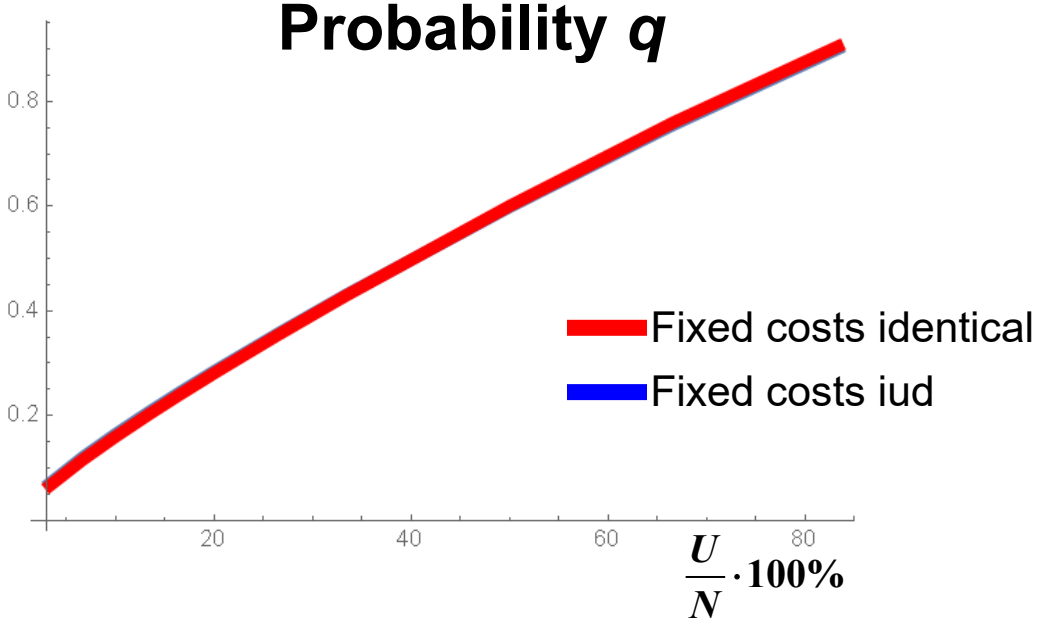

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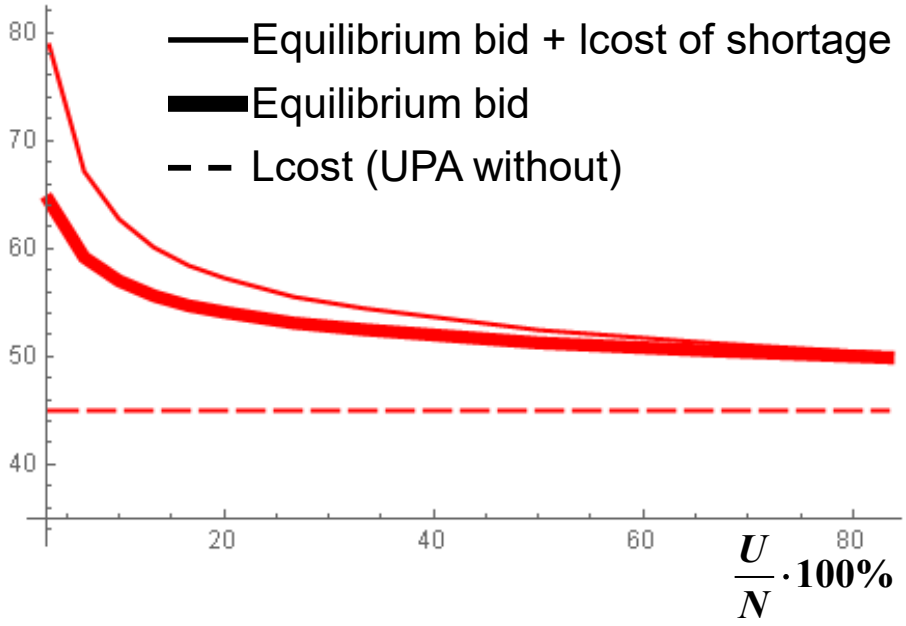

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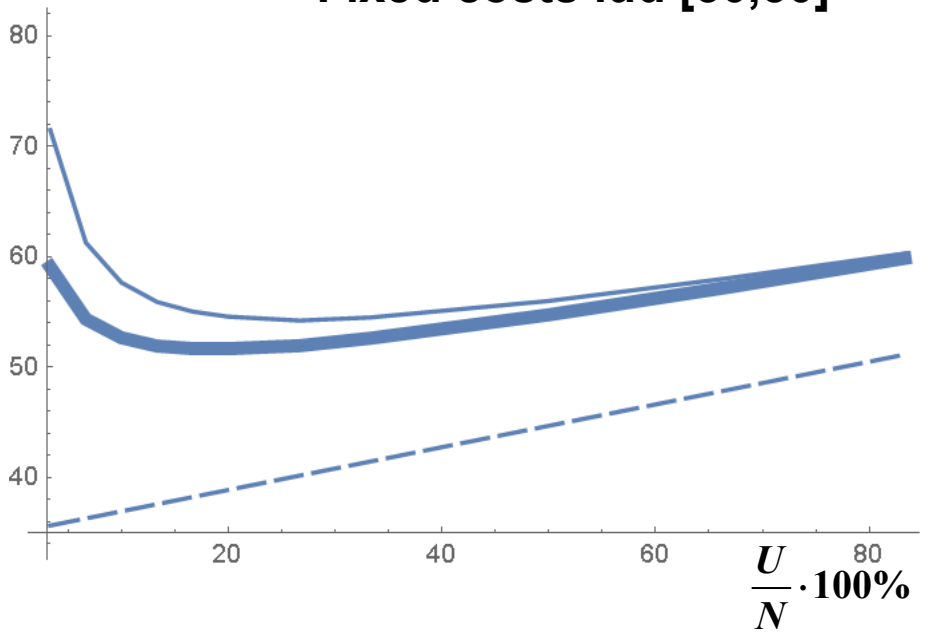

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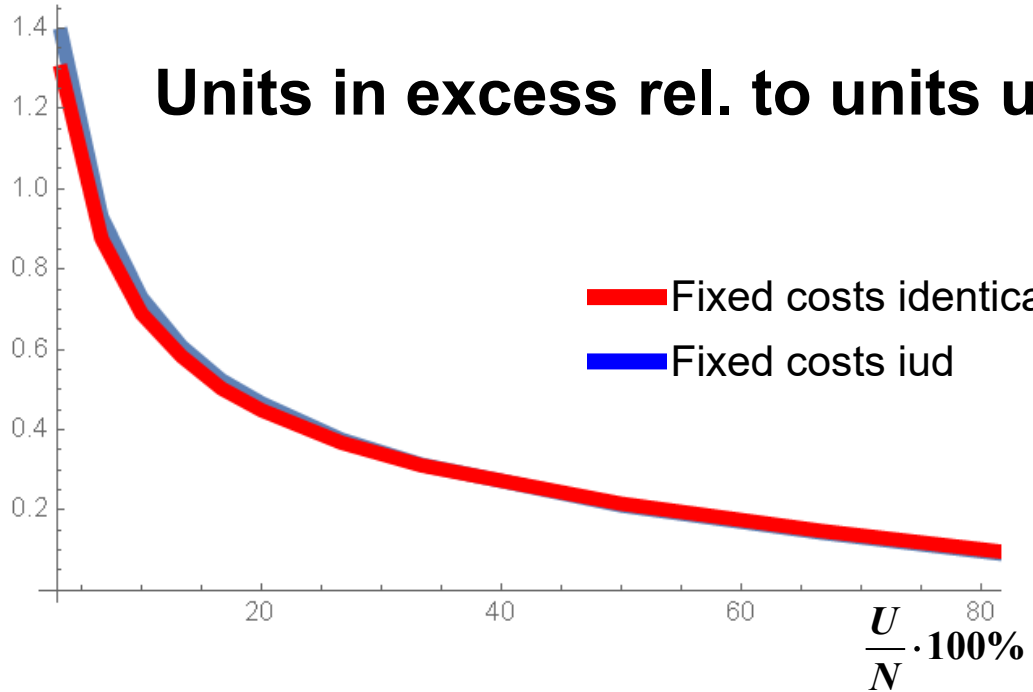
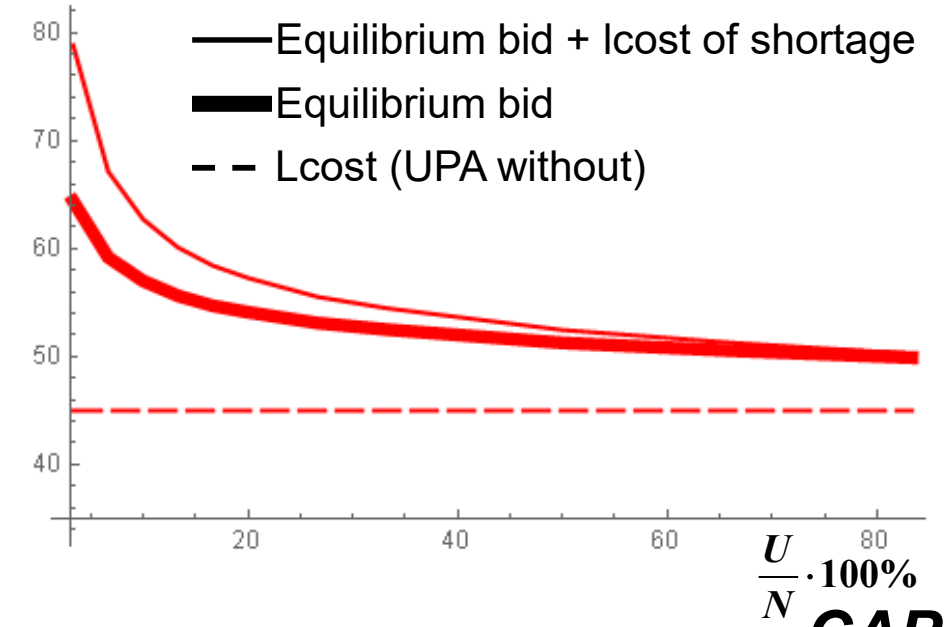


- Decreasing CAP may help?

CAP = 100

Fixed costs identical



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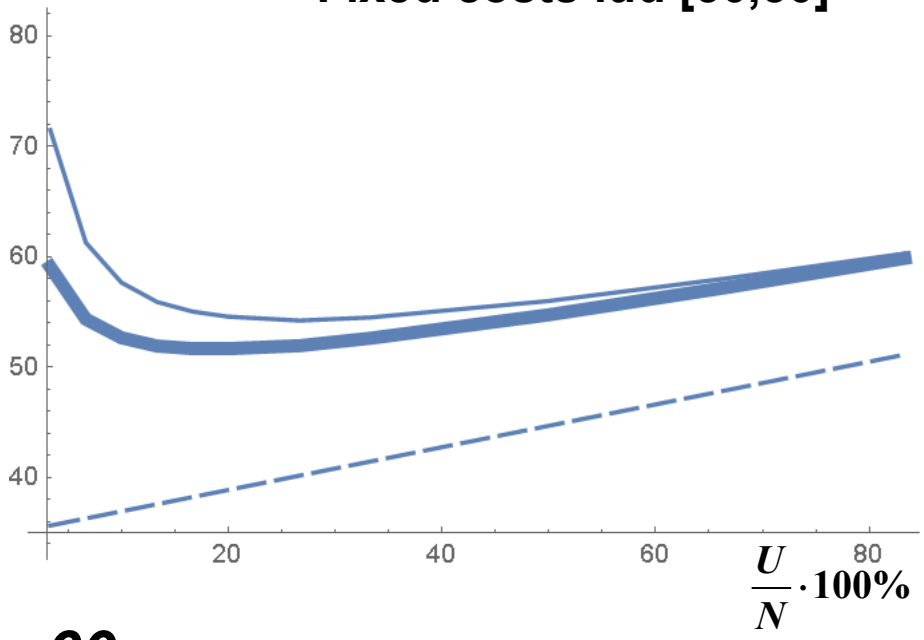
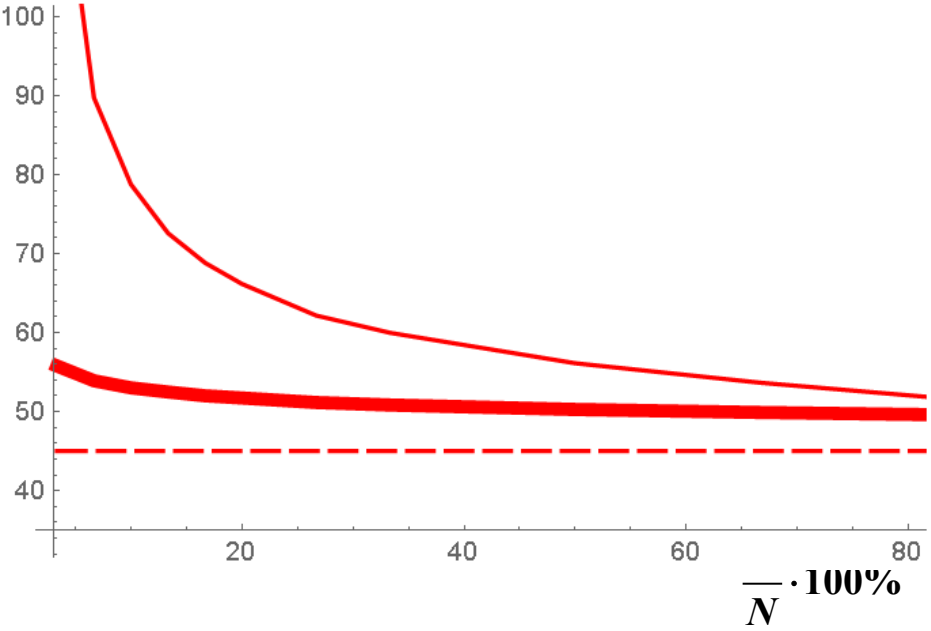


CAP = 60

Fixed costs identical



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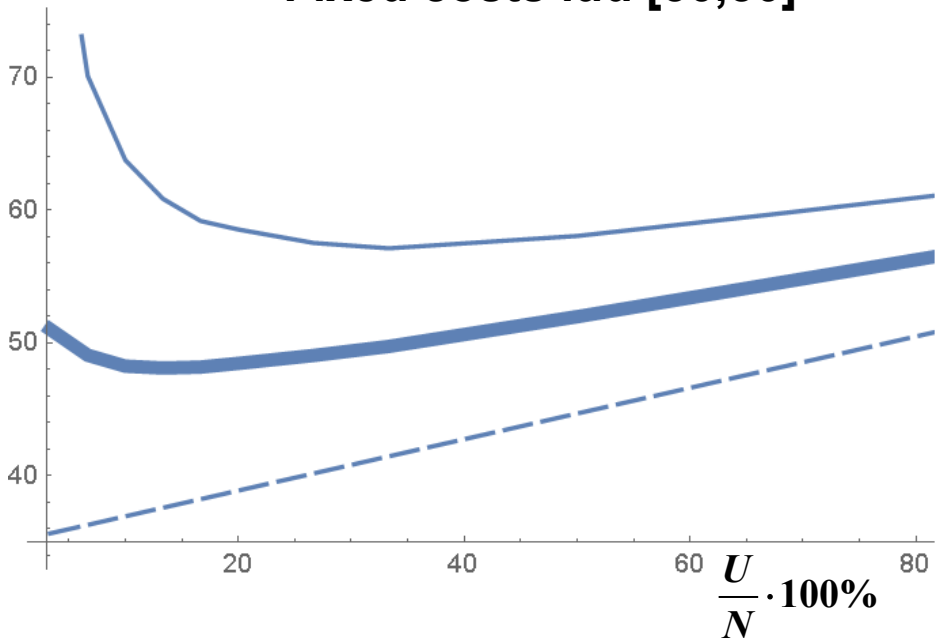
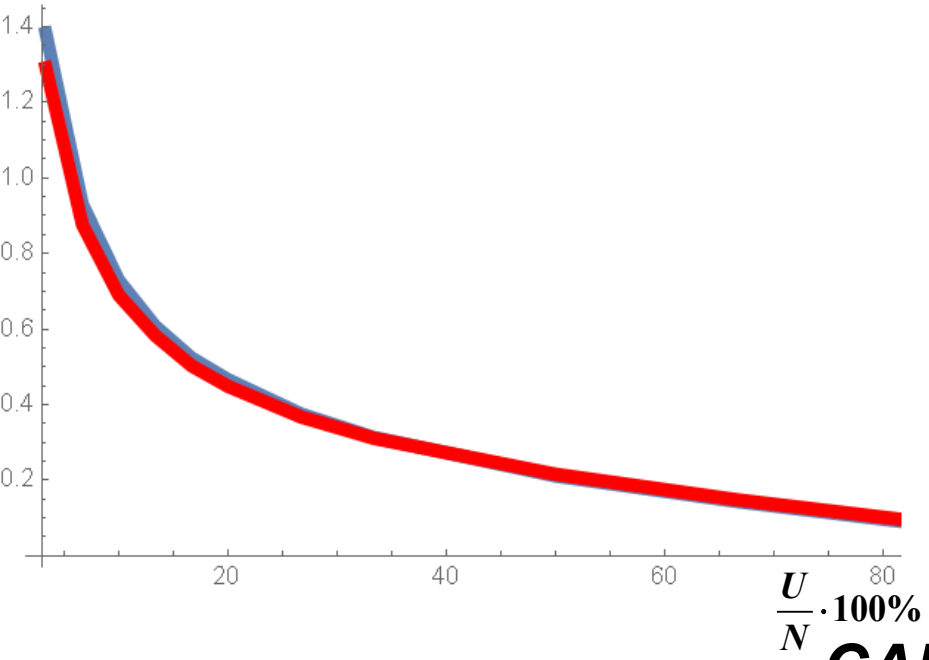


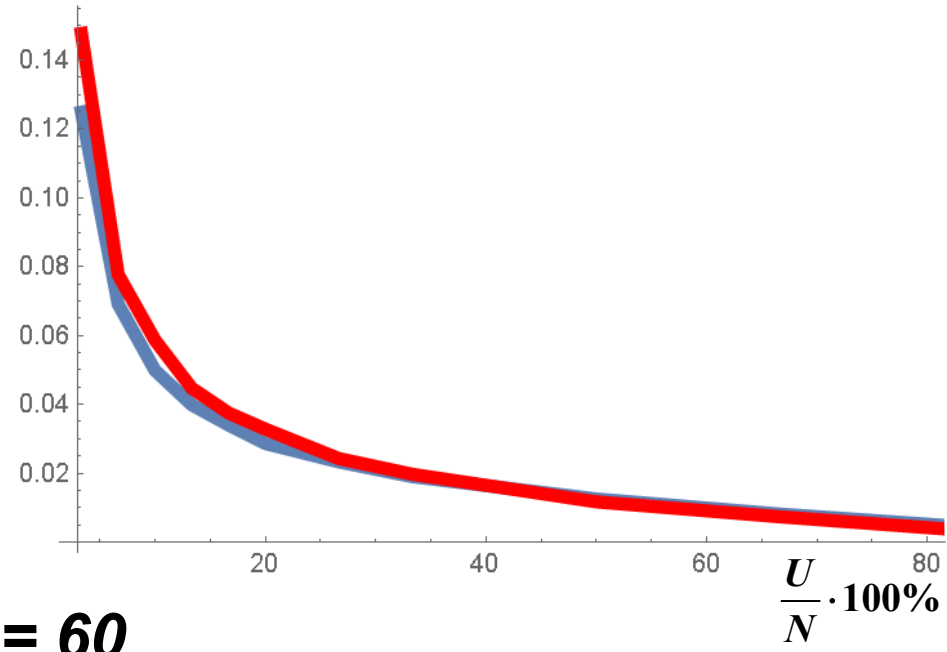
- Decreasing CAP may help?
  - Lowers cost due to excess entry
  - Increases cost due to shortage of entry

CAP = 100

Units in excess rel. to units used



Units in shortage rel. to units used



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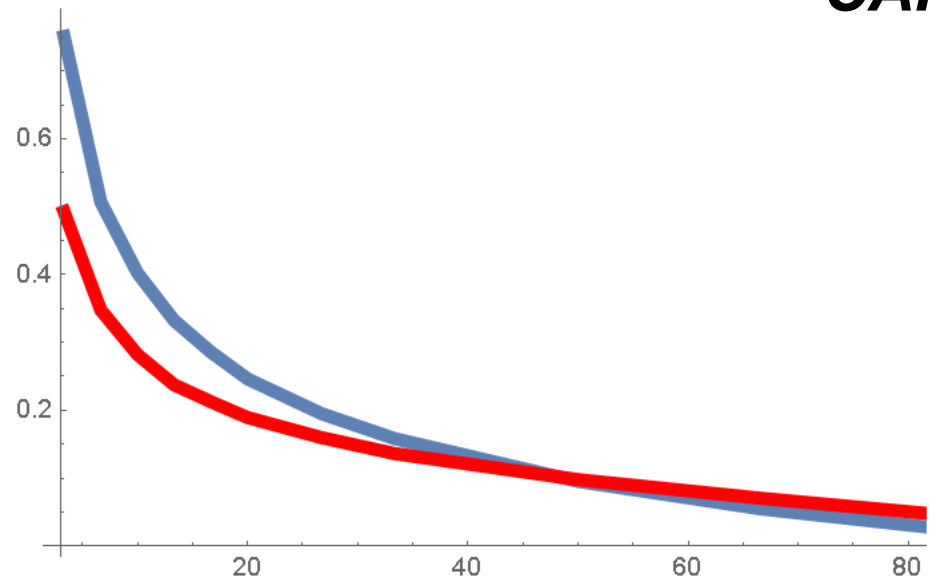
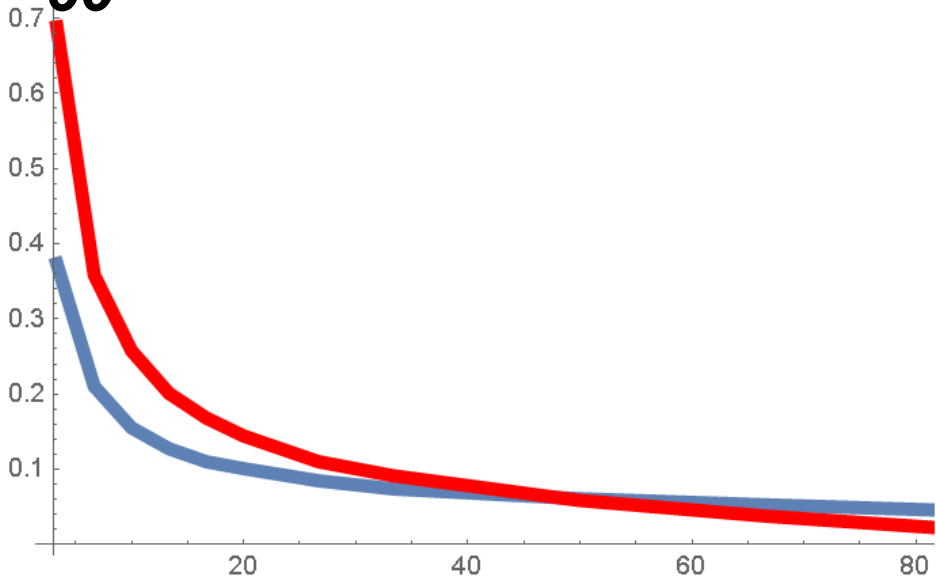
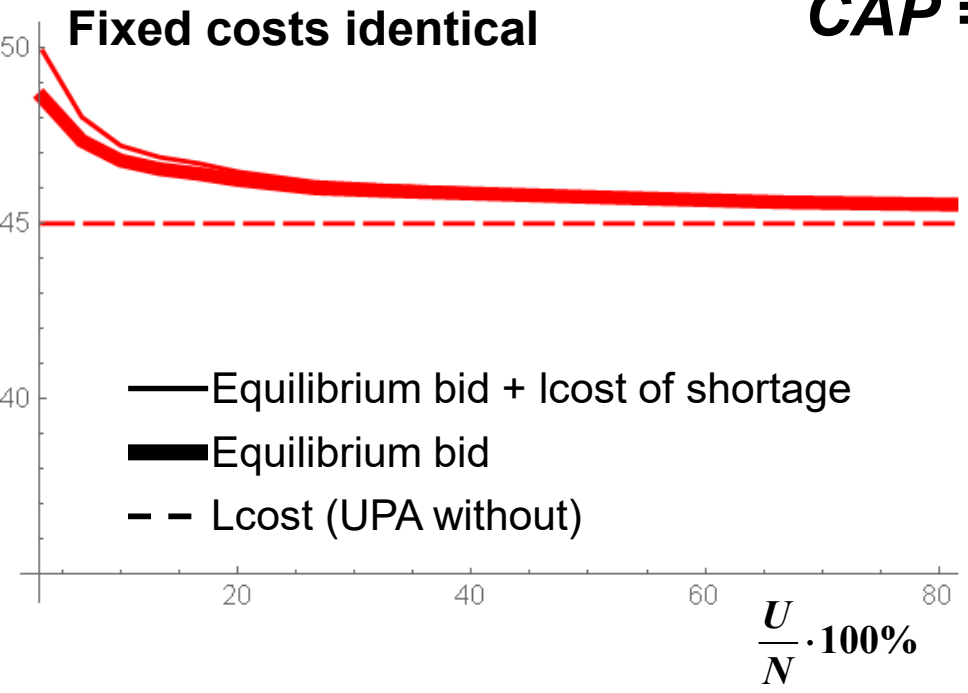
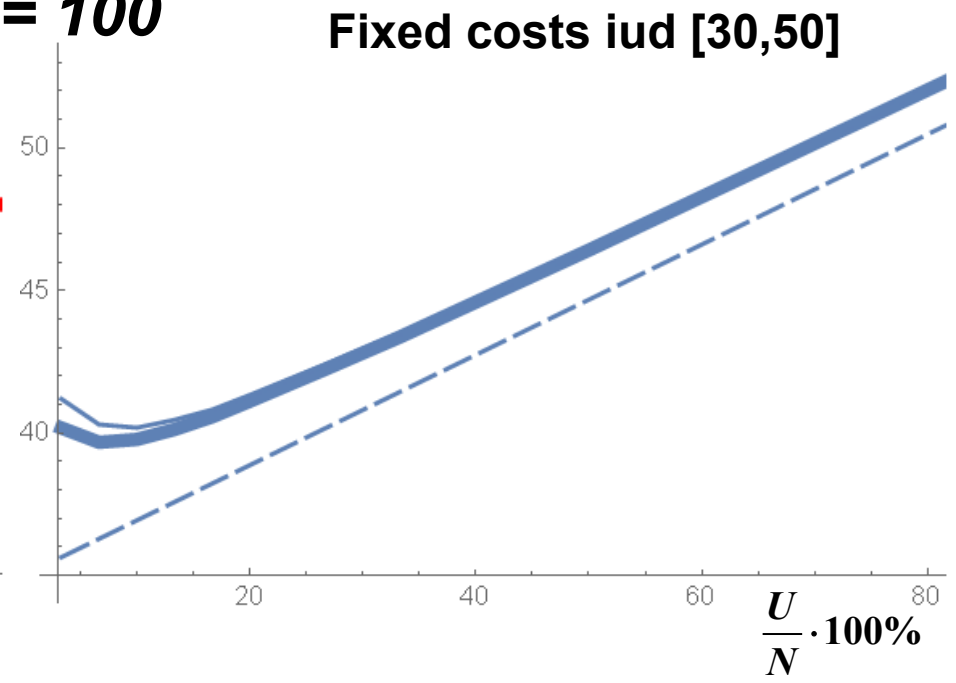




- Pre-investment costs only 1%

CAP = 100


Fixed costs identical
50
45
40
20
40
60
80
Equilibrium bid + lcost of shortage
Equilibrium bid
Lcost (UPA without)
$\frac{U}{N}\cdot 100\%$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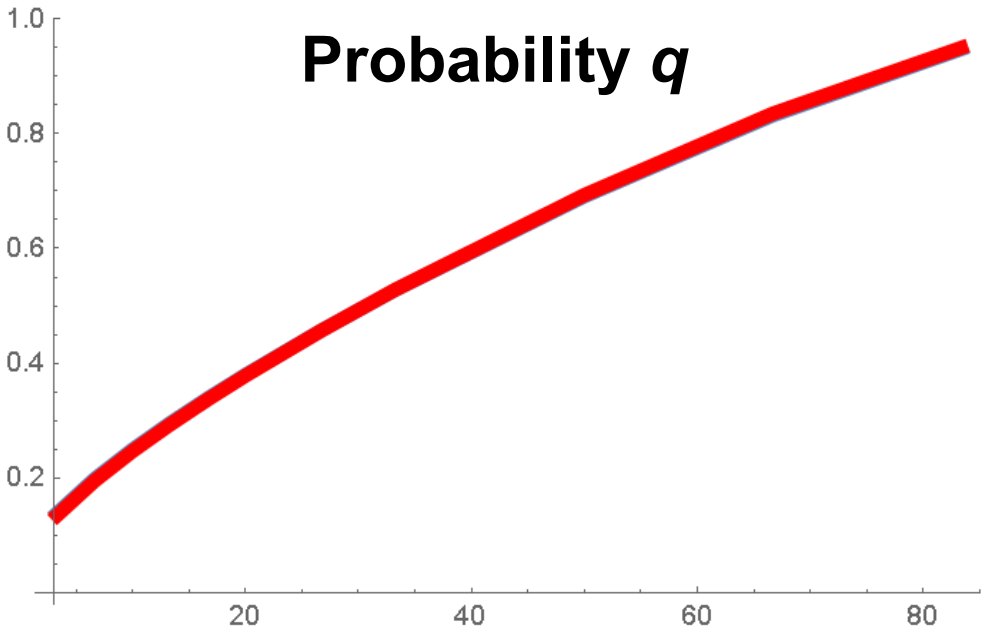
$\frac{U}{N}\cdot 100\%$


Probability *q*
1.0
0.8
0.6
0.4
0.2
20
40
60
80

- Conclusion
  - Theory predicts that sunk pre-investment in an auction:
    - Creates a stochastic process of entry
    - Excess entry
    - Shortage of entry
  - The increase in cost is paid by the government
    - Higher auction price
    - Cost of unimplemented projects

- Solutions
  - Lowering the CAP does not help
    - Reduces excess entry
    - Increases shortage of entry
  - Lowering the pre-investment helps
    - Lowers excess entry and shortage of entry
    - Perhaps refundable bonds for bidders' commitment?

- Assumptions
  - One-shot game
  - UPA instead of DA
  - Single-unit demand

Symbol	Reference
Exogenous variables	
U	Capacity on auction
N	Population of potential bidders
LFC	The levilized fixed cost for the full project
MC	Marginal cost of producing (assumed constant)
$\delta\overline{LFC}$ (where $0 < \delta < 1$)	The (administrative) cost of entry in the auction auction
CAP	A price cap set by the regulator
OO	The outside option of the potential bidders
$VOUL$	Value Of Uncontracted Load
RA	risk aversion parameter in the utility function $u[x] = x^{RA}$
Endogenous variables	
n	The number of actual bidders
q	Probability of entering (endogeneous)
$\alpha = P[n \leq U \mid M, q]$	Probability that the number of actual bidders is insufficient or just sufficient $n \leq U$