Modeling the wind auctions as a participation game

Silvester van Koten
Jan Vavra
University of Economics, Prague
(kie.vse.cz)

Consider the following case

- To enter to an industry:
  - need to win a license in an auction
  - **To enter the 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 for your

- 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%!**

- The model - setup

Stage 1

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

Stage 2

- *n* actual bidders entered (common knowledge).
- Other bidders receive outside option *OO*.
- Actual bidders bid in an reverse

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

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

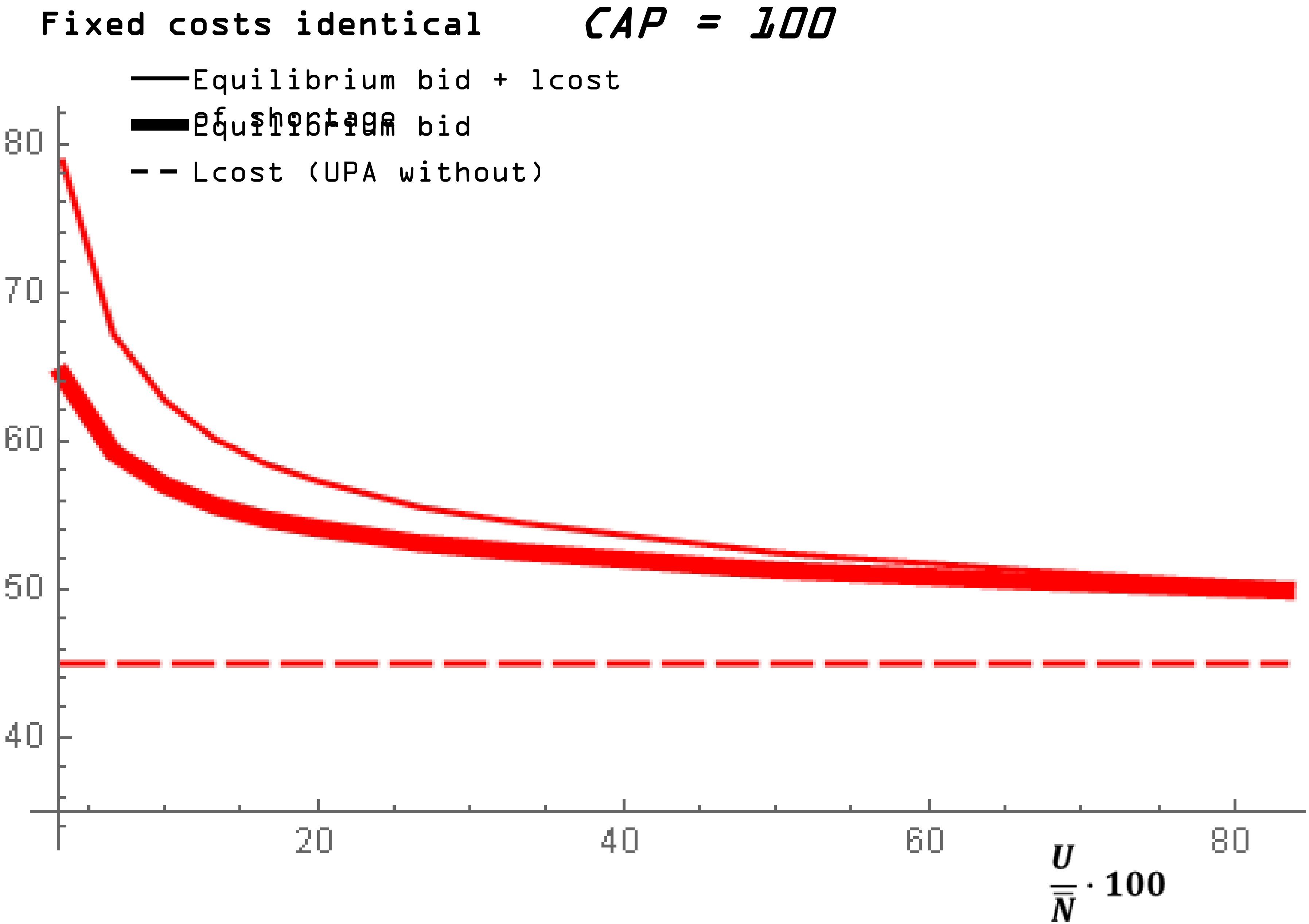
$$\Pr[n \leq U \mid q] \cdot \pi^H + \Pr[n > U \mid q] \pi^L = OO$$

The simulation

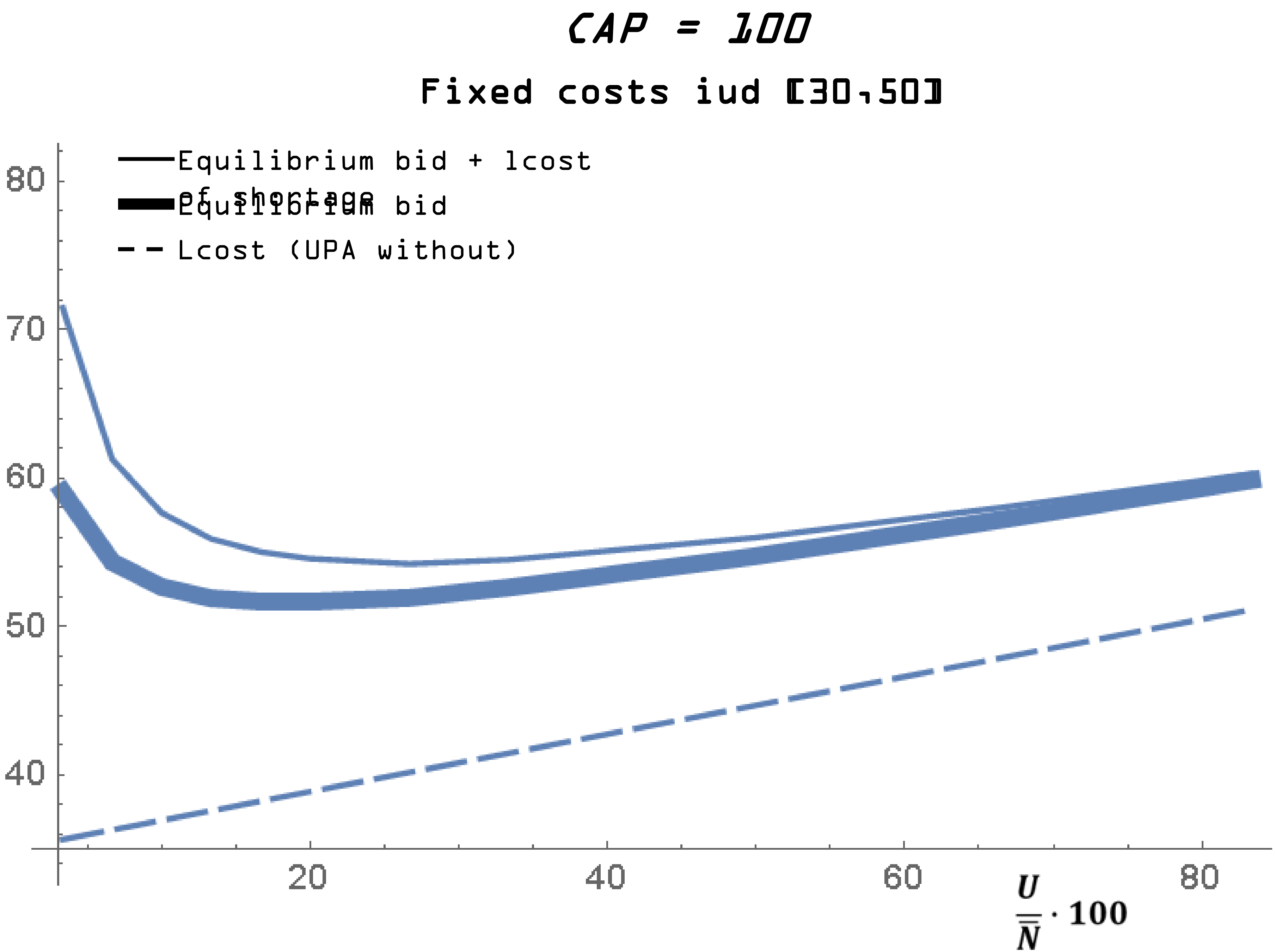
Simulation parameters

- $N = 30$ (potential bidders)
- $U = 1,\dots,25$ (units on sale, varies)
- $MC = 5$
- $CAP = 100$
- δ = 10%
- *average of 50 000 draws*

FIXED	DISTRIBUTION
• LFC = 40	LFC iud [30,50]



Fixed costs identical
CAP = 100
Equilibrium bid + lcost of shortage
Equilibrium bid
Lcost (UPA without)
80
70
60
50
40
20
40
60
80
$\frac{U}{\bar{\bar{N}}} \cdot 100$



CAP = 100
Fixed costs iud [30,50]
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Lcost (UPA without)
80
70
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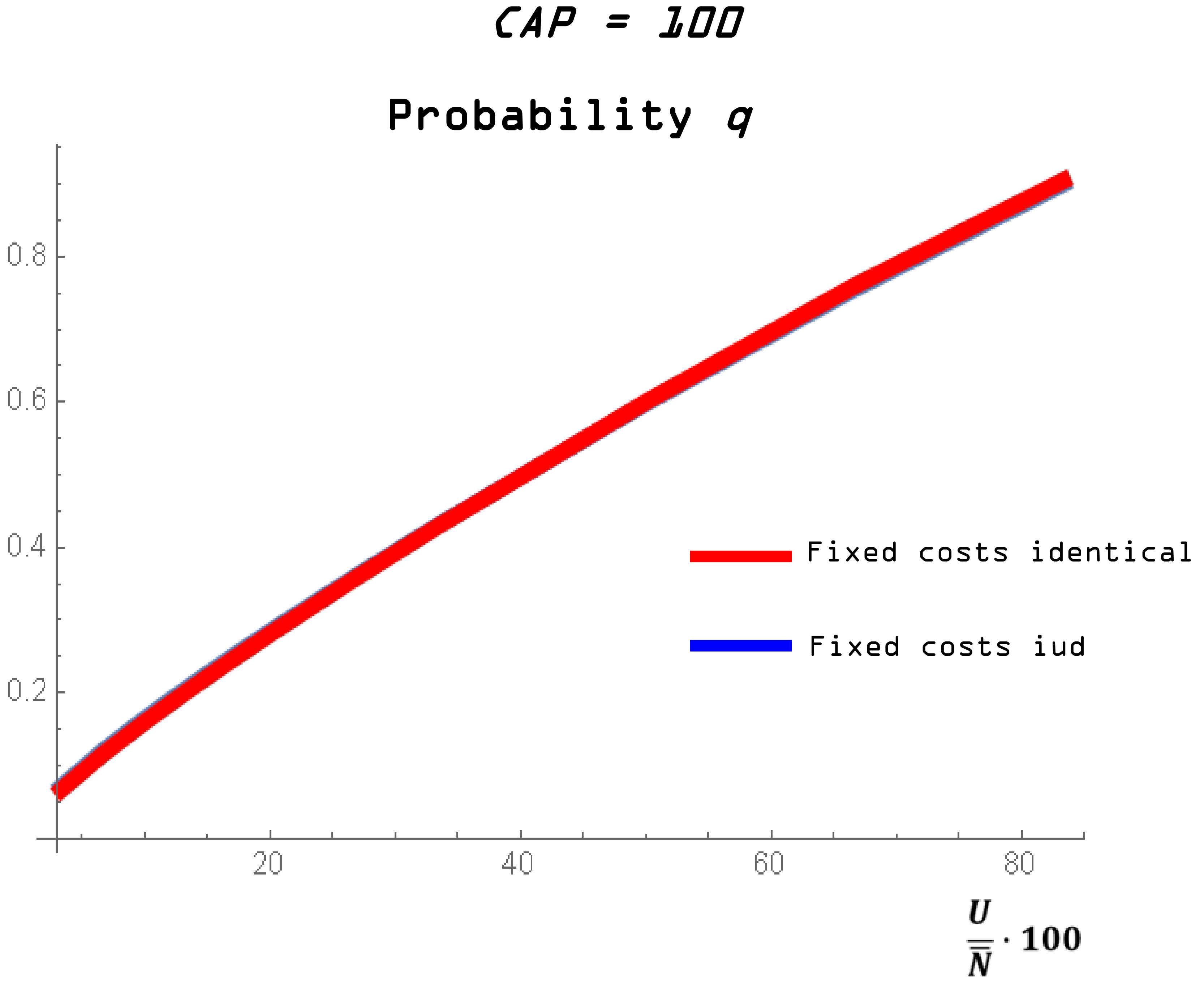
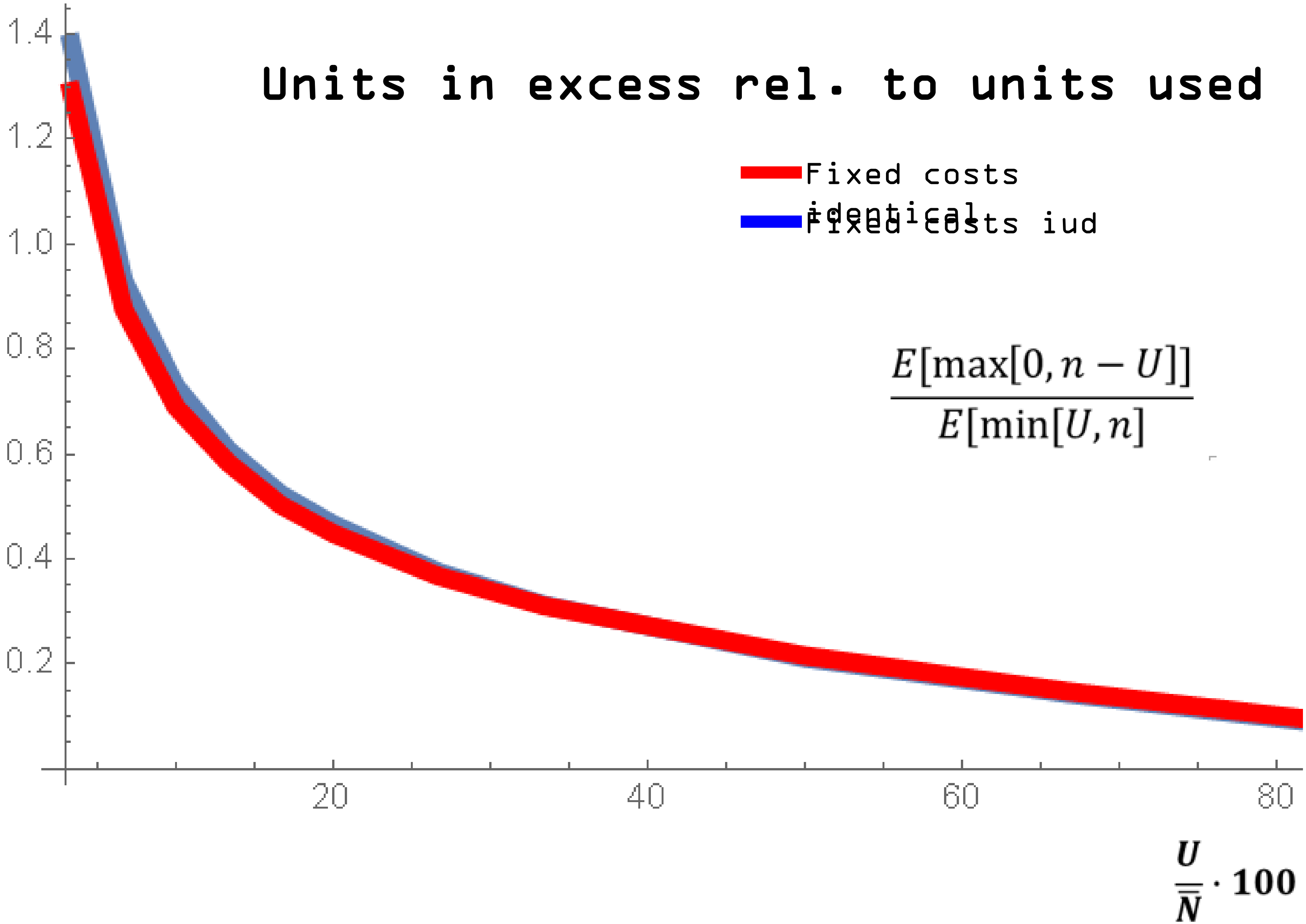
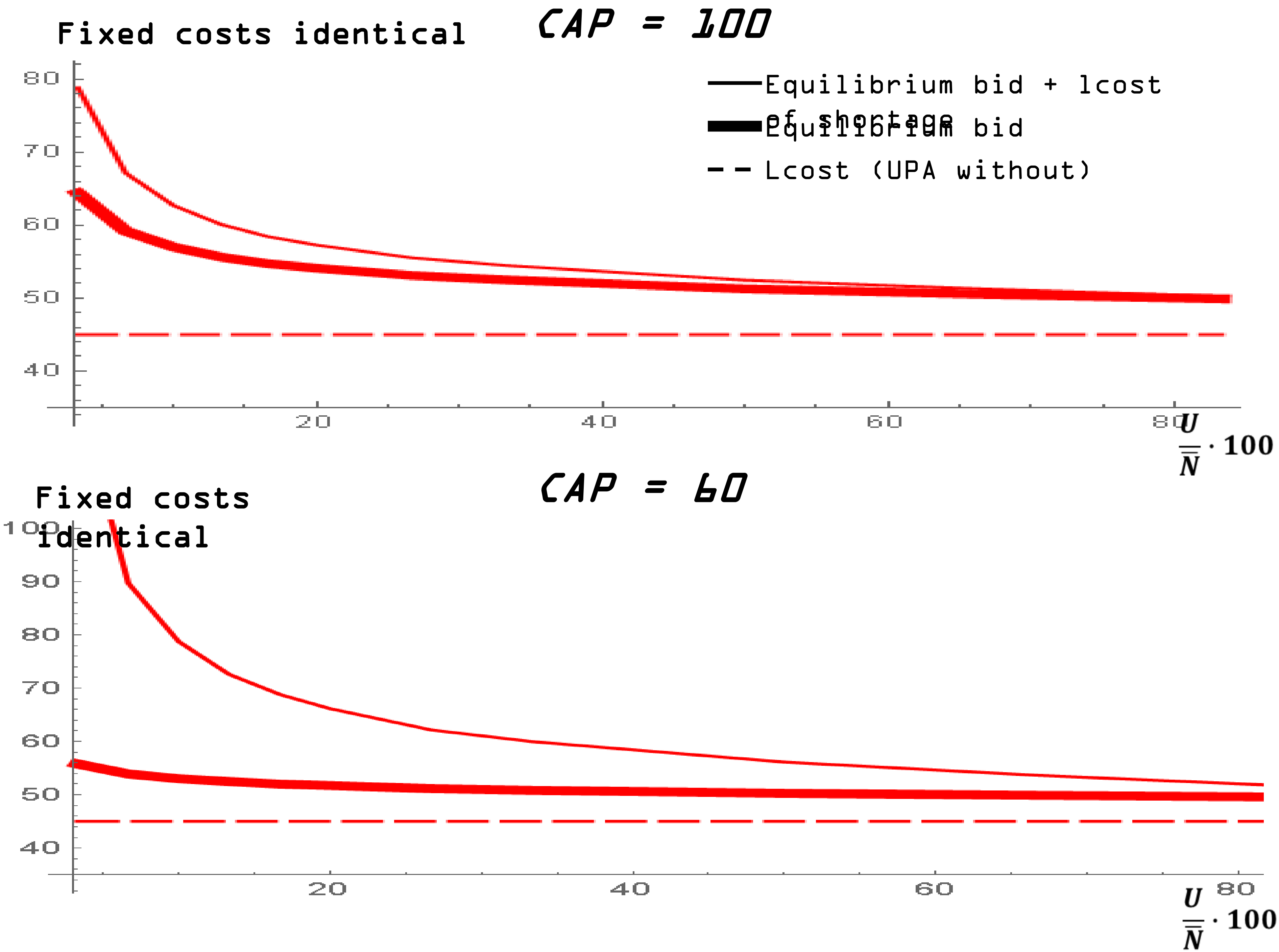
40
20
40
60
80
$\frac{U}{\bar{\bar{N}}} \cdot 100$


CAP = 100
Probability q
0.8
0.6
0.4
0.2
20
40
60
80
Fixed costs identical
Fixed costs iud
$\frac{U}{\bar{\bar{N}}} \cdot 100$

CAP = 100


Units in excess rel. to units used
Fixed costs identical
Fixed costs iud
$\frac{E[\max[0, n - U]]}{E[\min[U, n]]}$
1.4
1.2
1.0
0.8
0.6
0.4
0.2
20
40
60
80
$\frac{U}{\bar{\bar{N}}} \cdot 100$

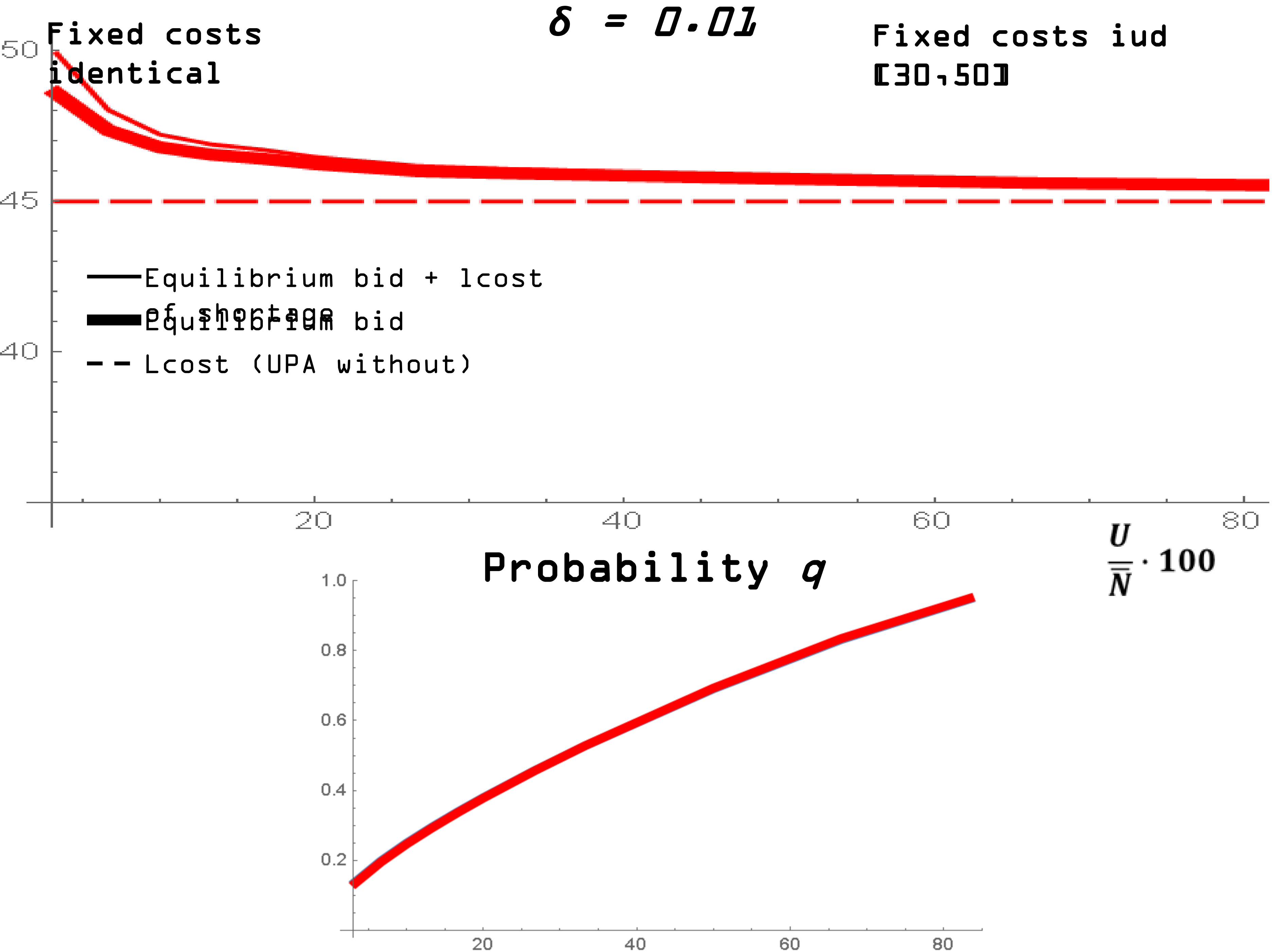
- Decreasing CAP may help?



Fixed costs identical
CAP = 100
Equilibrium bid + lcost of shortage
Equilibrium bid
Lcost (UPA without)
80
70
60
50
40
20
40
60
80
$\frac{U}{\bar{\bar{N}}} \cdot 100$
CAP = 60
Fixed costs identical
100
90
80
70
60
50
40
20
40
60
80
$\frac{U}{\bar{\bar{N}}} \cdot 100$

- Decreasing CAP may help?
  - Lowers cost
  - Increases cost of non-build capacity due to potential shortage of entry

- Pre-investment costs only 1%


δ = 0.01
Fixed costs identical
Fixed costs iud [30,50]
Equilibrium bid + lcost of shortage
Equilibrium bid
Lcost (UPA without)
50
45
40
20
40
60
80
U/N · 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 -> increases auction price, wasted sunk costs
    - Shortage of entry -> unimplemented projects
    - This results to higher bids then the same auction without pre-investment
  - Lowering the CAP price
    - Reduces excess entry
    - Increases shortage of entry
  - **Lowering the pre-investment**
    - Lowers excess entry and shortage of entry
    - Make auction closer to a ideal case (solar

- If anybody wants to know:

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

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

$$\alpha[q^*] \cdot u\left[\pi_P^H + W\right] + (1 - \alpha[q^*]) \cdot u\left[\pi_P^L + W\right] = u[OO + W]$$

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)
$\alpha = P[n \leq U\|M, q]$	Probability that the number of actual bidders is insufficient or just sufficient $n \leq U$