Renewable Procurement Auction Design with Default: Pre-Qualification Requirements

Silvester van Koten CERGE-EI, CZ
Bert Willems Tilburg University, NL

udržitelná energetika strategie av21

Procurement auctions

Problems:

- Bidders win contracts, but do not realize them
  - Pay fine or go bankrupt
    - (Del Río 2017; Del Río and Linares 2014; Matthäus 2020)
- They see the contract as an option
- Why especially renewable power projects?
  - Implementing the contract takes years
  - In the meantime the costs of construction change
    - = Cost shock after the conclusion of the auction
    - Cost shock can cost-increasing or cost decreasing!

Procurement auctions

What to do?

- Use Pre-Qualification
  - Financial (FPQ)
    - Bidder must deposit funds with the auctioneer
      - Proportion δ of total cost
    - Funds are returned conditional on delivery
    - Basically a penalty
  - Physical (PPQ)
    - Bidder must build part of the project
      - Representing proportion δ of total cost
      - These are mostly sunk costs
    - Remaining costs till delivery are now less by δ
    - Non-delivery means lose sunk cost

Procurement auctions

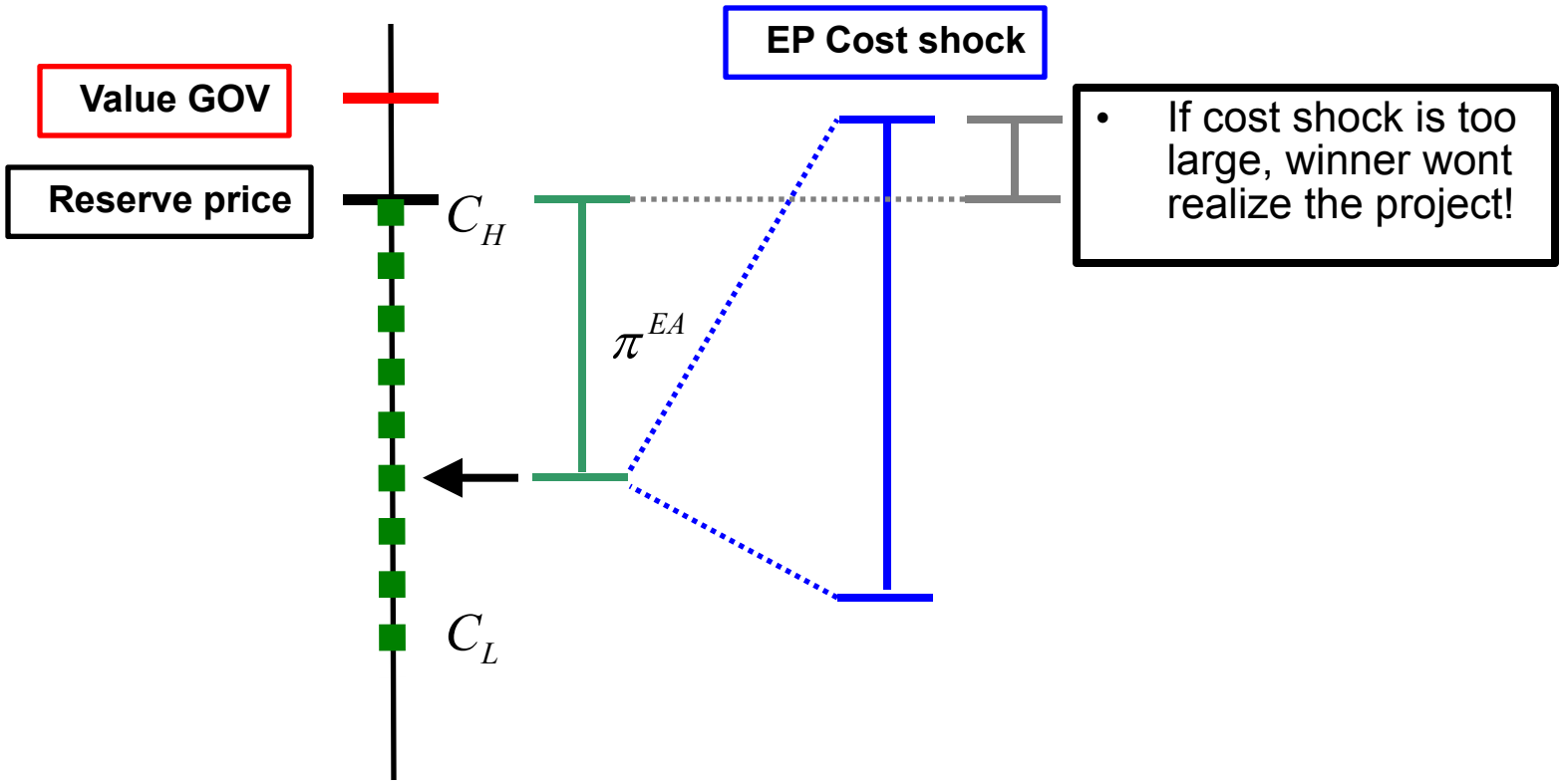
- FPQ
  - Makes total sense
  - Like penalties on non-performance

- PPQ
  - Notice: all bidders that enter the auction pay δ
  - Is like an **auction with entry cost**!
  - Sounds like nonsense
  - Why study it at all?
  - Used in Germany, proposed in other countries

- Analyzing PPQ.
- Model with private costs and a **common** shock
  - 1 contract,
  - bidders with different costs (private costs)
  - A common cost shock
  - default possible

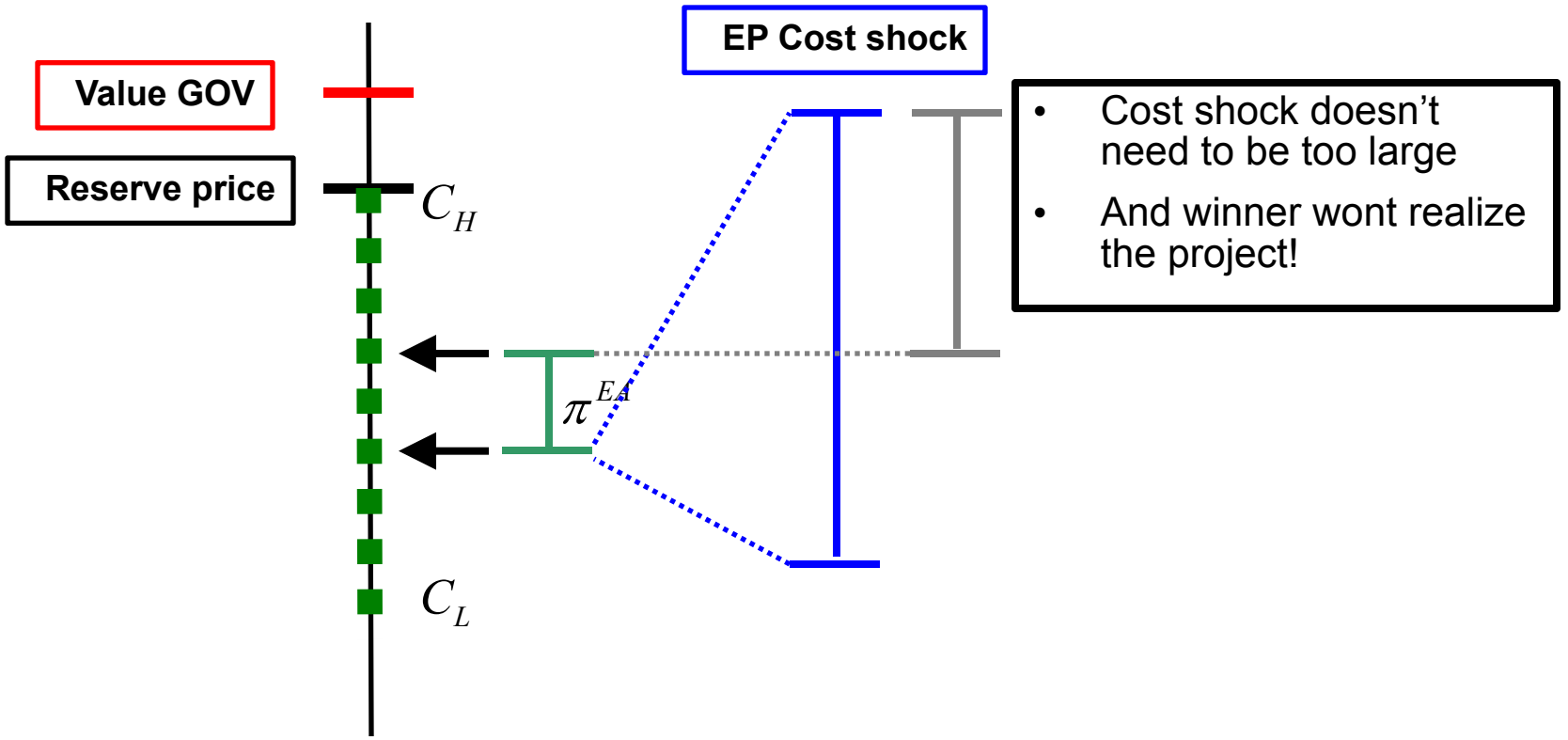
- Common costs makes “bidders curse” possible

1 bidders enters



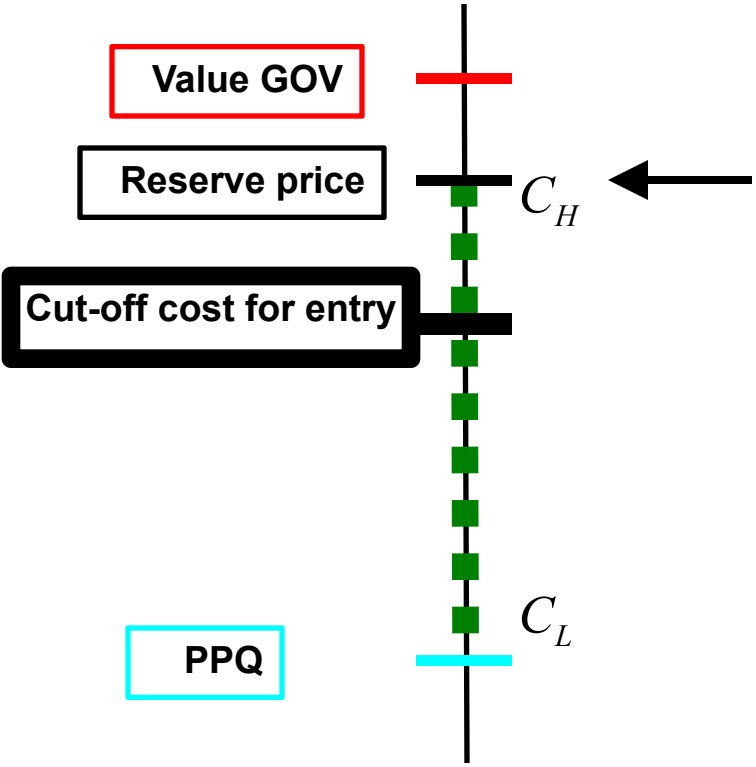
- If cost shock is too large, winner wont realize the project!

>2 bidders enters



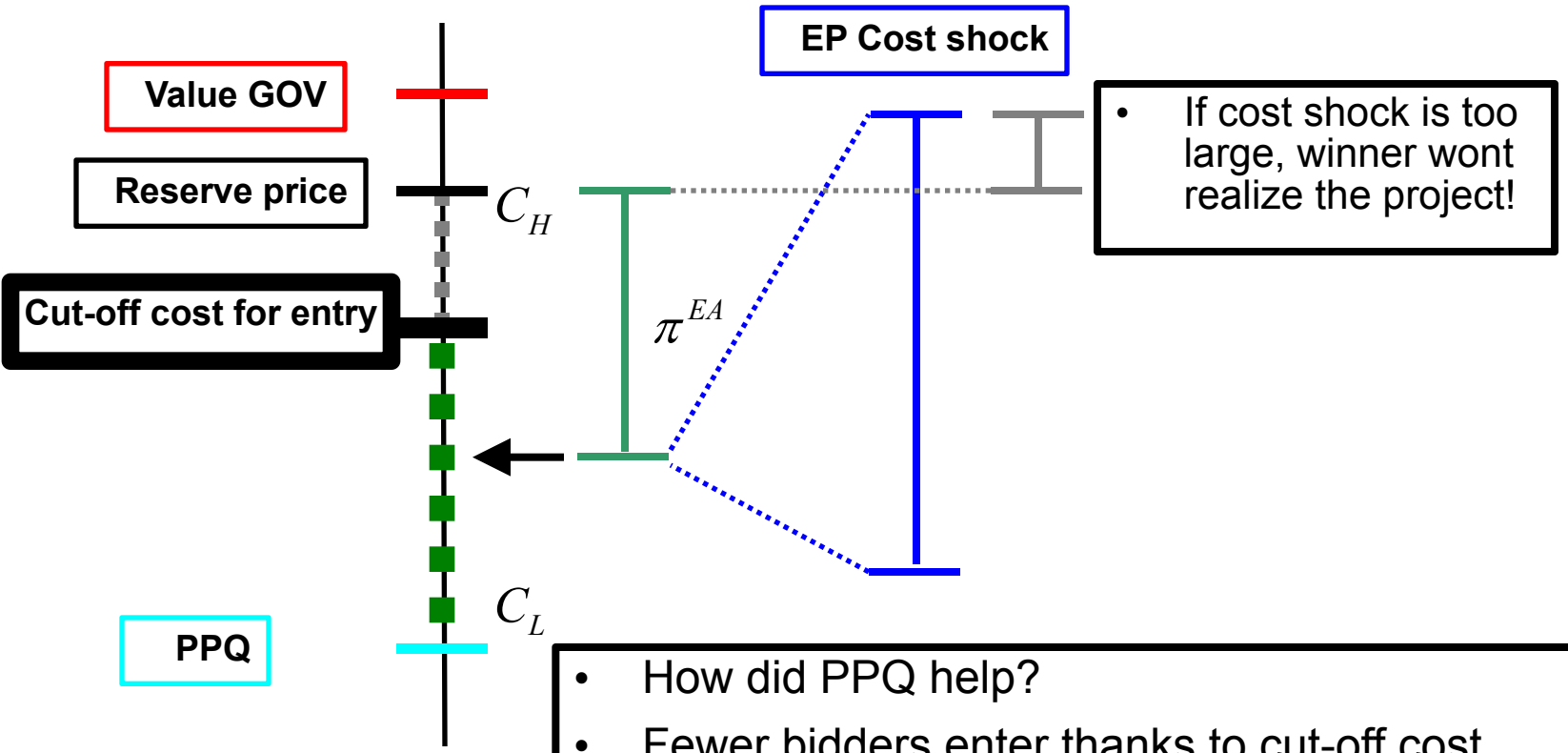
- Analyzing PPQ
  - Selling 1 contract
  - Many bidders with different costs
  - Must invest before entering auction

PPQ



- If enters,
  - Wins with Pr=0
  - Thus Eπ=-δ
- Thus does not enter!

PPQ - 1 bidders enters



- How did PPQ help?
- Fewer bidders enter thanks to cut-off cost
- Expected price for bidders is now higher
  - Chance on being the only bidder higher
  - Difference between lowest and 2nd lowest bid higher
- Bidders basically “randomize” hoping to be the only one
- **This explains under subscription outcomes in the German auctions!**

PPQ

- Analyze the profit of a bidder winning the auction and receiving price P

$$
\begin{aligned}
U_{win} &= E_{\xi}\left\{\max(P - C - \xi, -\delta)\right\} \\
&= E\left\{\max(P - C + \delta - \xi, 0)\right\} - \delta \\
&= \int_{\xi_L}^{P-C+c} (P - C + \delta - \xi) dG(\xi) - \delta
\end{aligned}
$$

Analyze optimal bidding

$$b \leq C - \delta$$

PPQ

- Analyze the utility of the auctioneer
  - Utility of the project minus the payment

$$U = \sum_{n=1}^{N_{tot}-1} \underbrace{Q_{n+1} \cdot U_{n+1}}_{A} + \underbrace{Q_1 U_1}_{B}$$

$$U_{n+1} = \int_{\underline{C}}^{C_E} \left[\int_{C}^{C_E} \frac{n+1}{p} (V + \delta - \hat{C}) G(\hat{C} - C) J_n'(\hat{C}) d\hat{C} \right] dF(C)$$

$$U_1 = (V - B) \cdot \int_{\underline{C}}^{C_E} G(B - C + \delta) dF(C | C < C_E)$$

$$Q_{n+1} = \binom{N_{tot}}{n+1} p^{n+1} (1-p)^{N_{tot}-n-1}$$

FPQ

- Parlane 2003 for SPA:

$$u[P,C] = E_{\bar{s}}\left[\max[-\delta^{FPQ}, P-(C+s)]\right]$$

$$u\left[P[C],C\right] = 0$$

- Continuing the analysis, we find:

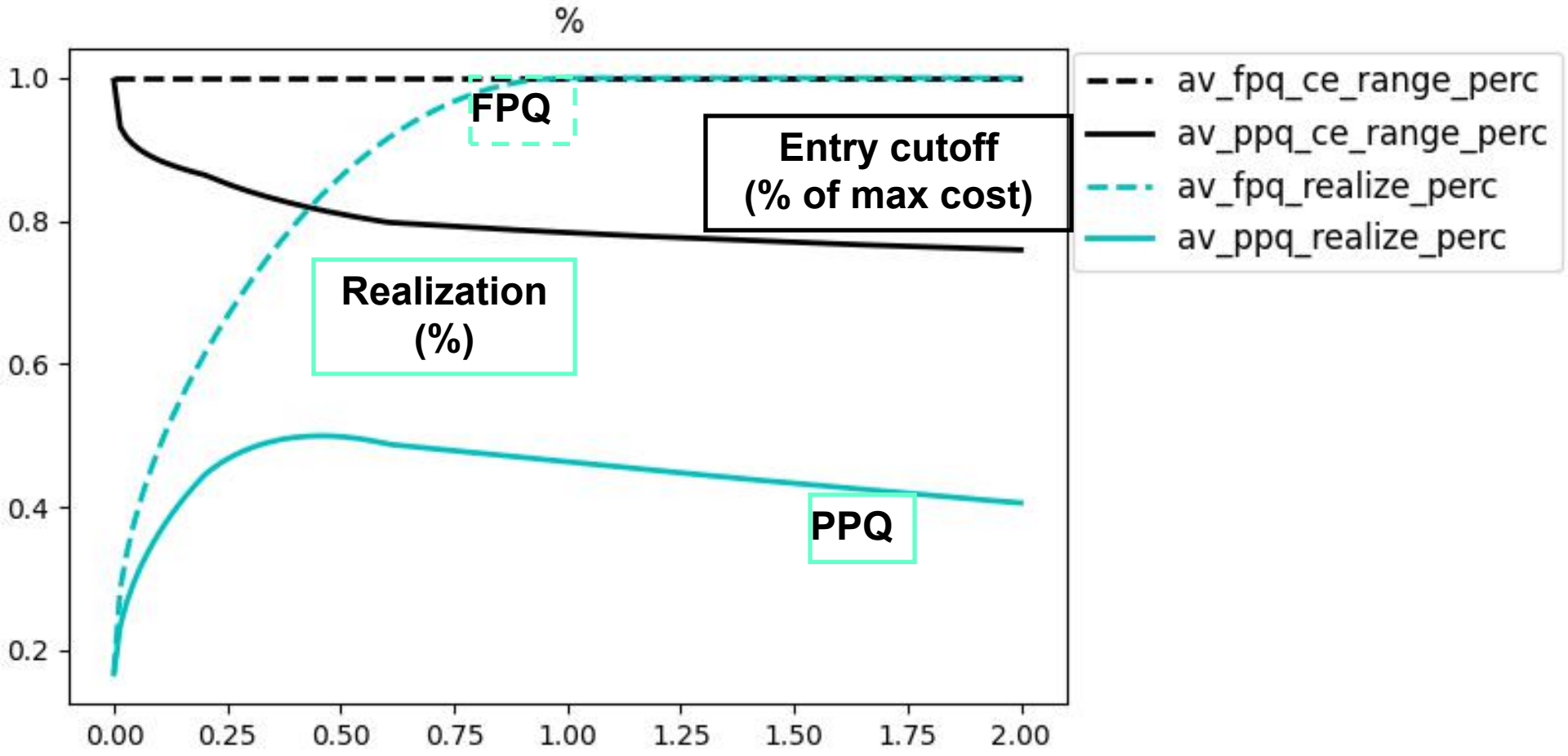
$$P[C] = \{P : \int_{\xi_L}^{P-C+\delta} G[\xi]d\xi = \delta\}$$

- Further solving:

Theorem 1. *The solution is then given by:*

$$P[C] = \begin{cases} \{P : \int_{\underline{\xi}}^{P-C+\delta} G[\xi]d\xi = \delta\} & \text{if } \delta \leq \int_{\underline{\xi}}^{\bar{\xi}} G[\xi]d\xi \\ C + \bar{\xi} - \int_{\underline{\xi}}^{\bar{\xi}} G[\xi]d\xi & \text{if } \delta > \int_{\underline{\xi}}^{\bar{\xi}} G[\xi]d\xi \end{cases}$$

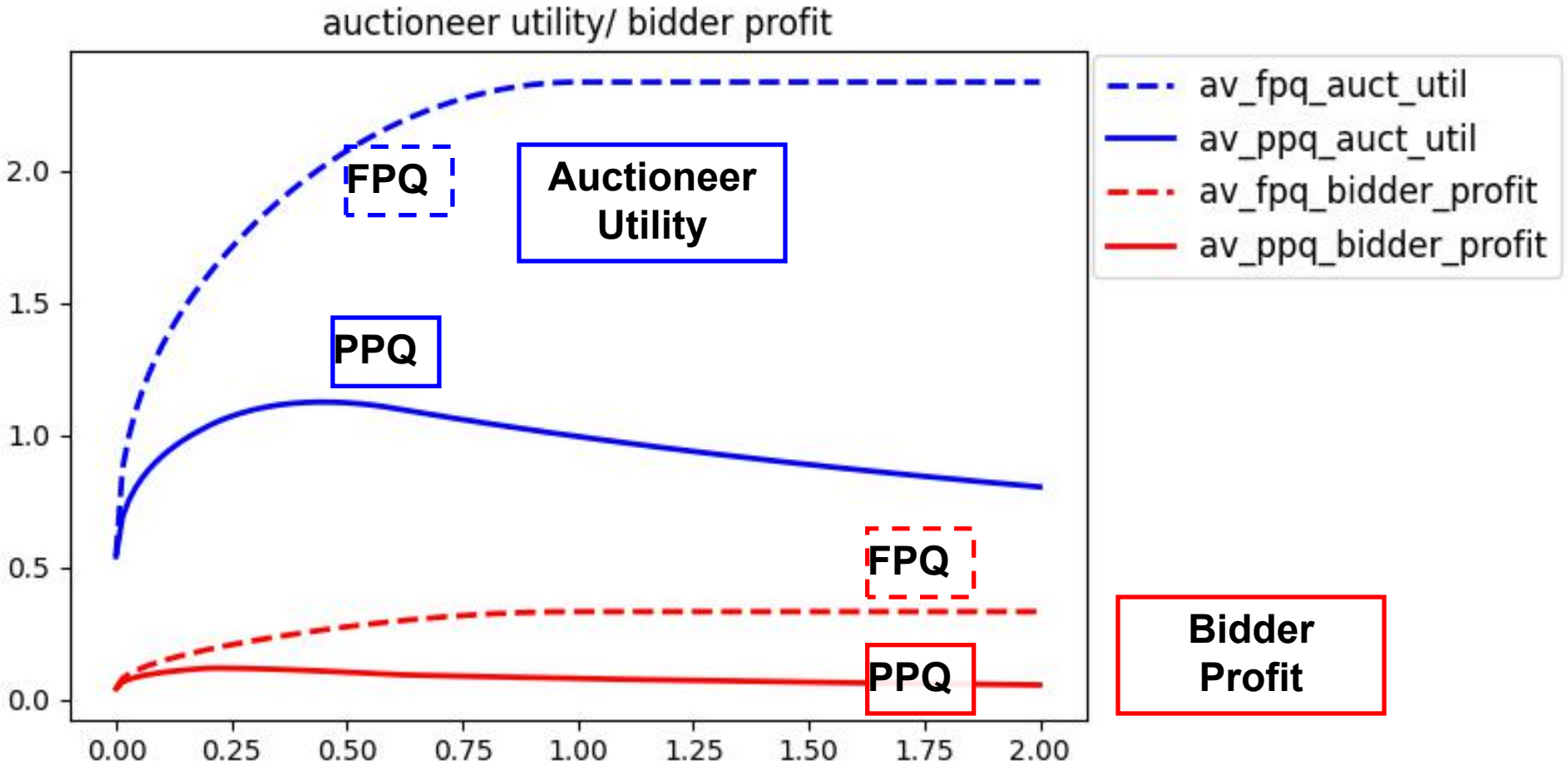
Entry & Realization Probability



δ (pre-qualification investment) PPQ/PPQ

N=2, vuu=6, B=opt_, c=[2 3], s=[0 2]

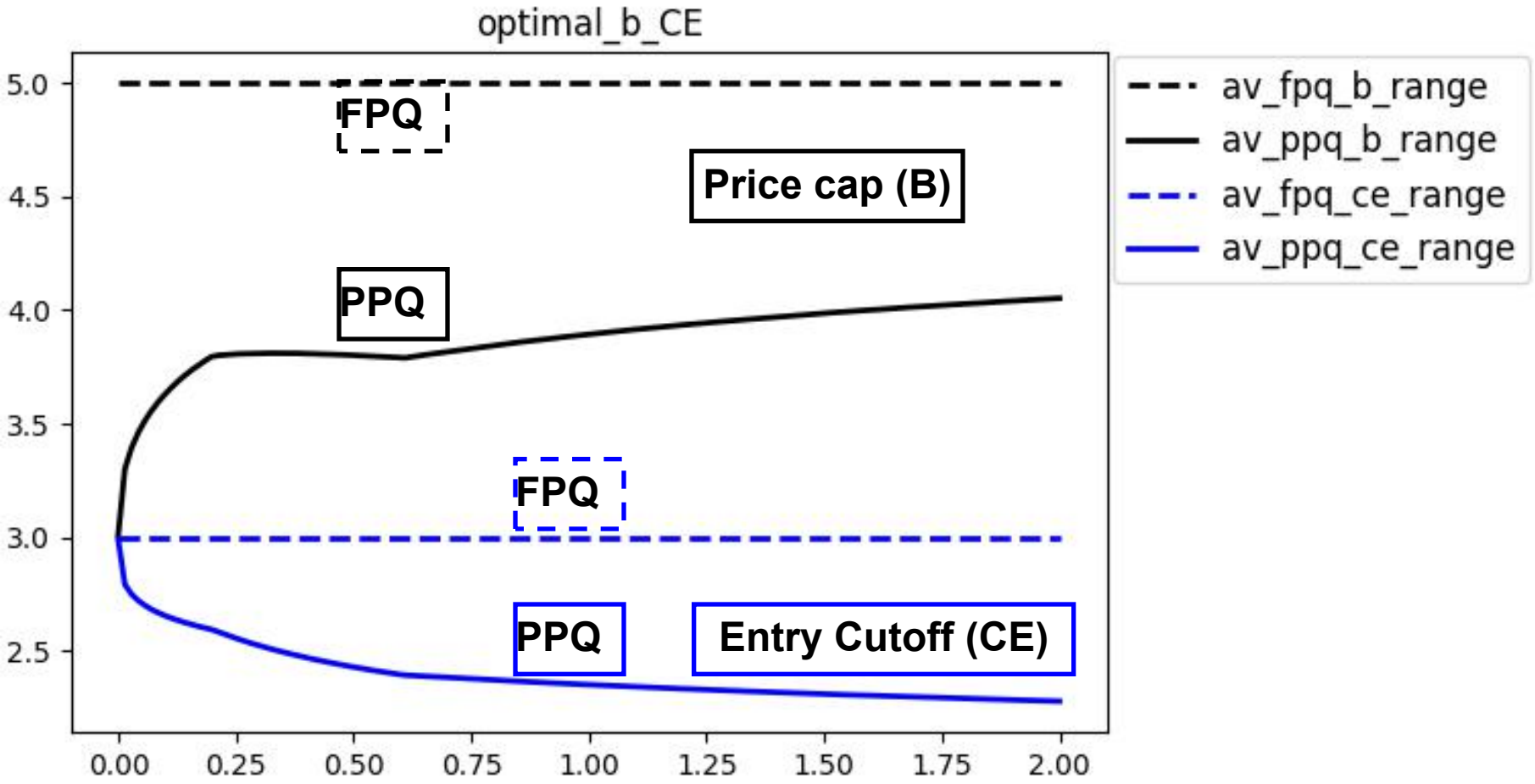
Auctioneer Utility



δ (pre-qualification investment) PPQ/PPQ

N=2, vuu=6, B=opt_, c=[2 3], s=[0 2]

Pricecap & Entry Cutoff



δ (pre-qualification investment) PPQ/PPQ

N=2, vuu=6, B=opt_, c=[2 3], s=[0 2]

Results so far

- Analytics indicate that:
  - Auction is non-competitive with (large) positive probability
    - German wind auction shows this
  - Comparing cost shock distributions that decrease costs with ones that increase costs
    - Their effects are identical! (project realization levels & auctioneer utility)

- Simulations indicate that:
  - For auctioneer utility, optimal pre-commitment level>0
    - Thus, both FPQ & PPQ help (a little)
  - Increasing the PPQ eventually leads to worse outcomes.
    - This not the case for the FPQ
  - FPQ is vastly superior to PPQ
    - Realization
    - Auctioneer utility

Work to do:

- Can formally prove that FPQ > PPQ?
- Experiment