Adjustment of Bidding Strategies after a Switch to First-Price Rules

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Display Ads at Yahoo: Switch in Pricing-Rule
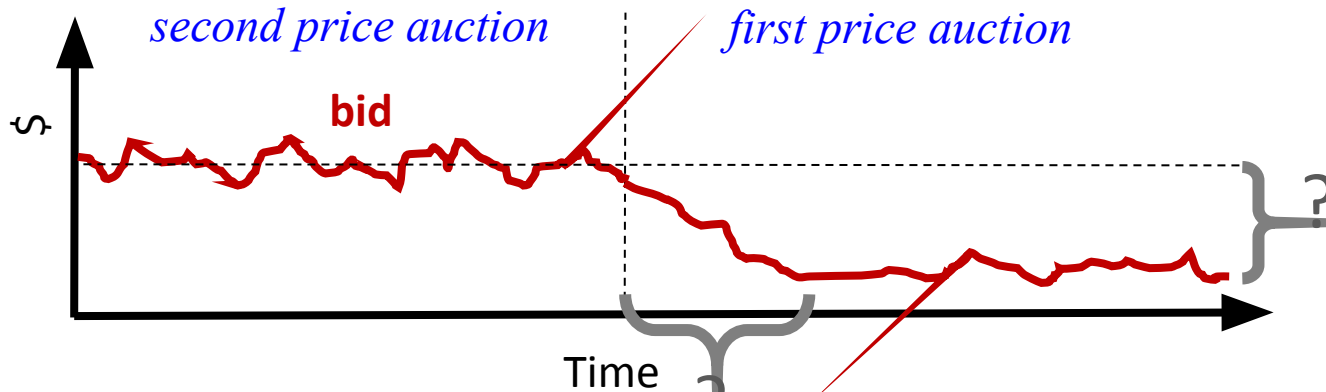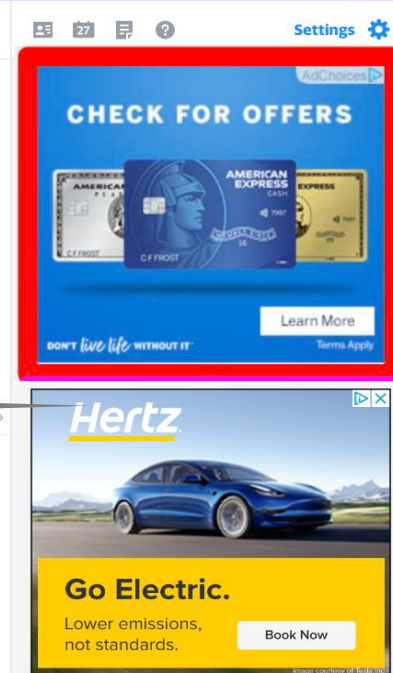

- In 2019, Yahoo display inventory switched from second to first-price

  Obvious prediction: bids should fall after the switch

- Questions

  1. Did bidders adjust bids down sufficiently?

  2. How long did it take them to adjust?
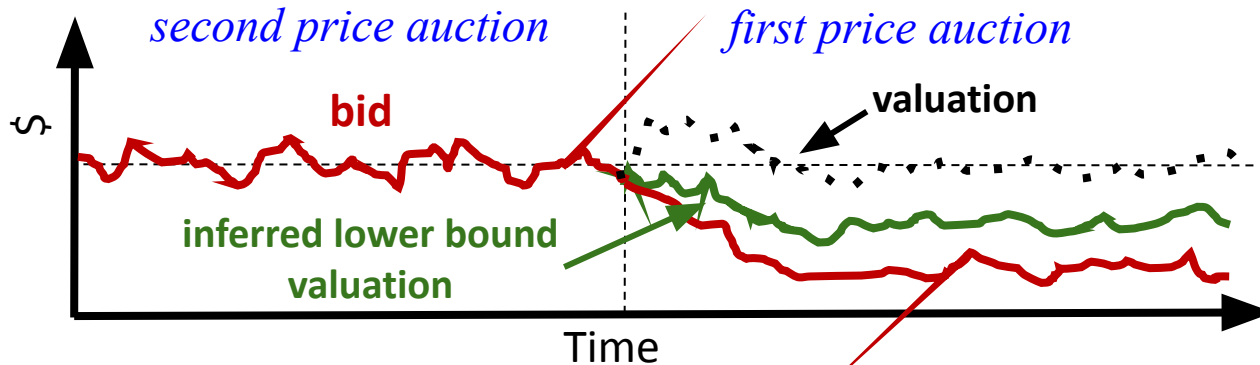
Display Ads at Yahoo: Methodology

- **Idea**: bound valuations ($\mathcal{V}$) from observed first-price bids, and compare with valuations (i.e. bids) before switch <u>keeping everything possible fixed</u>

- For each bid within a fixed {DSP,creative}:

    1. Calculate lower bound on $\mathcal{V}$ implied by observed bids & local competition

    2. Compare $\mathcal{V}$ before to lower bound on $\mathcal{V}$ after (should be ">")
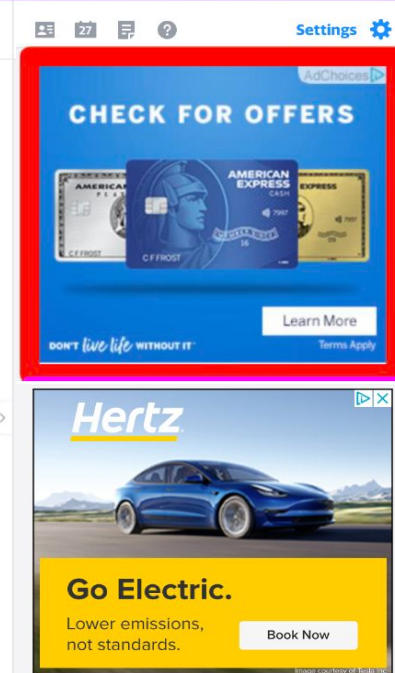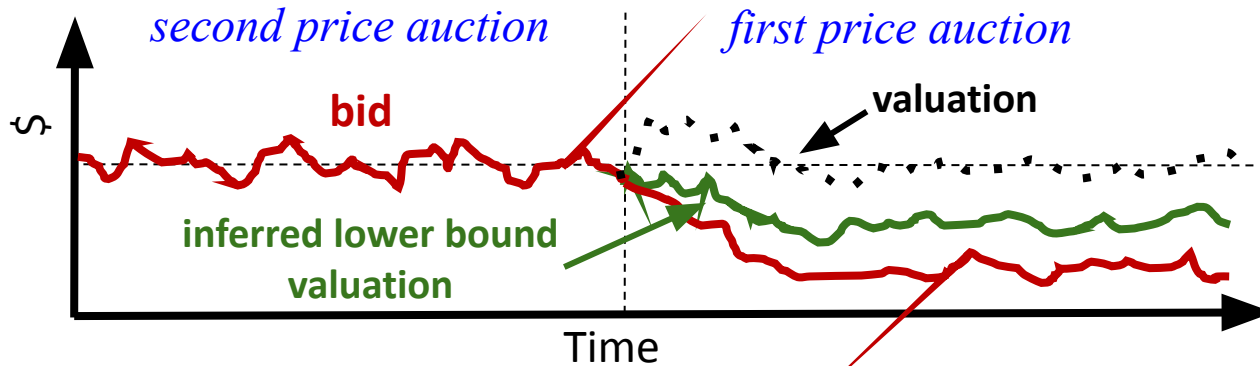
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Display Ads at Yahoo: Summary

- **Idea**: bound valuations ($\mathcal{V}$) from observed first-price bids, and compare with valuations (i.e. bids) before switch <u>keeping everything possible fixed</u>

second price auction · *first price auction*

\$ — **bid** — **valuation** — **inferred lower bound valuation** — Time

- Preview of answers
  1. Did bidders adjust bids down sufficiently? **NO**, many of them did not adjust enough, some did not adjust at all
  2. How long did it take them to adjust? **Months, not weeks or days**

Data

- In 2019, Yahoo display inventory switched from second-price to first-price

- **Focus of data collection:** how does the same bidder bid on showing the same creative in the same location on the same website before and after the switch?

  - Sample of bids in auctions between 1 month before the switch and 3 months after
  - 19 million auctions by 4 bidders (DSPs) on 11 total long-running creatives
  - **Key data**: both own bid and highest competing bid

- Disclaimer: our selection of long-running creatives is not necessarily representative of the average creative campaign (Not a characterization of the entire market)

Method for assessing bid shading by one bidder

Before switch: bids (b) = valuations (v)

After switch: bidders maximize expected surplus:

$$\max_b \underbrace{G(b|v)}_{Pr(competing\ bid < b|v)}(v - b)$$

- No market pure-strategy equilibrium (market in transition)
- Asymmetry of bidders
- Affiliated private value (APV)
- $G(b|v)$ Estimate using local competition

Calculate lower bound on v from additional bid shade s :

$$\underbrace{G(b|v)(v - b)}_{\text{Best expected surplus}} > \underbrace{G(b - s|v)(v - b + s)}_{\text{Sub-optimal expected surplus}}$$
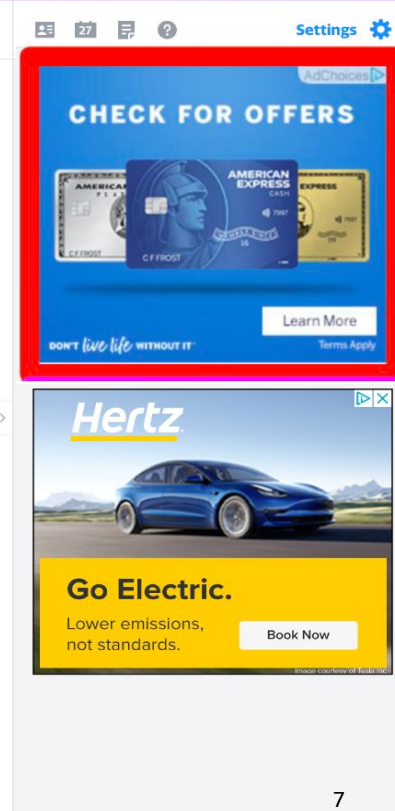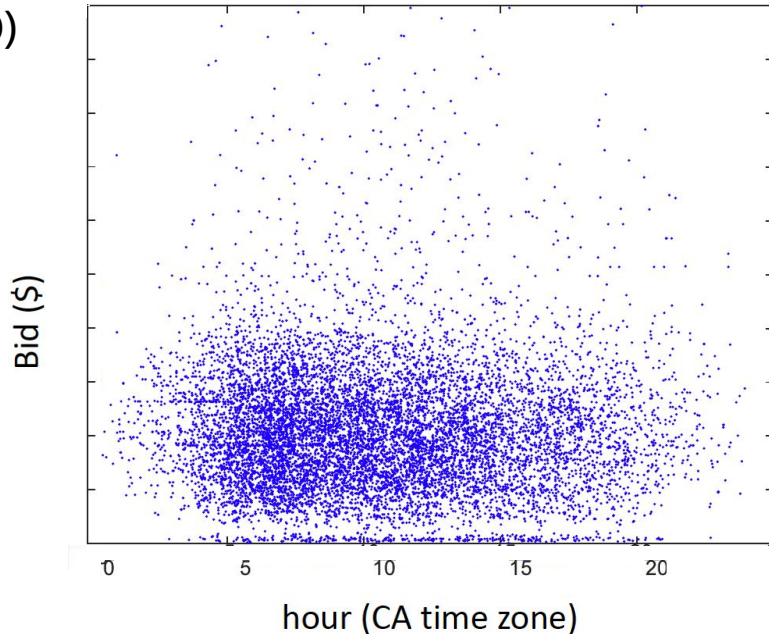
Display Ads at Yahoo

- Focus on ads displayed in one property (e.g. Yahoo Mail)

- One location (e.g. upper right)

- One ad size (e.g. 300 x 250)

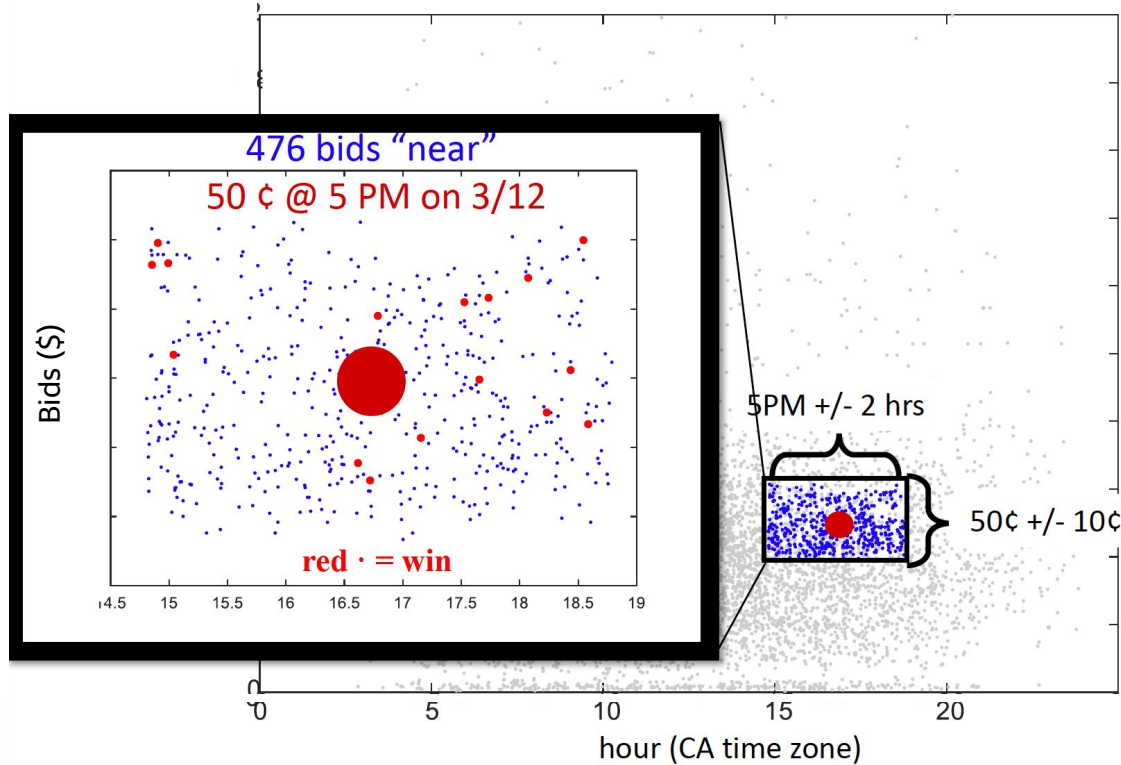- Fix DSP (e.g. AppNexus)

- Fix Creative (e.g. AMEX)

Bids Snapshot
(March 12th, 2019, few weeks after the switch)
- 10,757 sample bids
- 4.5% winning probability

Defining "local" competition

476 bids "near"
50 ¢ @ 5 PM on 3/12

red · = win

Bids ($)

hour (CA time zone)

5PM +/- 2 hrs

50¢ +/- 10¢

Question:

- How much does the bidder value the impression when bidding 50¢ @ 5PM on 3/12/2019?

Observations:

- $G(b|v)$: The highest competing bids against "near" bids teach us about the competition faced by the bidder
- 476 bids "near" 50¢ @ 5PM on 3/12
- 3.4% winning probability

Competition for a 50¢ bid @ 5PM on 3/12

CDF of highest competing bid of the 476 bids "near" 50 ¢ @ 5 PM

CDF $G(b|v)$

Reserve Price

Bid
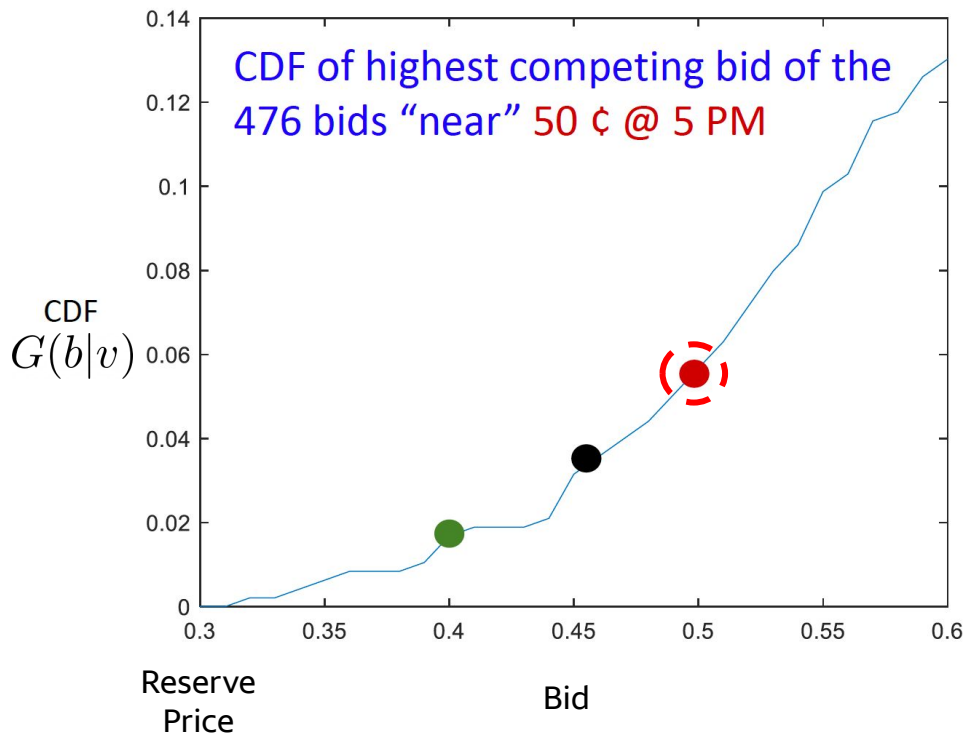
$$\max_b \underbrace{G(b|v)}_{Pr(competing\ bid\ <\ b|v)}(v-b)$$

Not bidding less than **50¢** given competition bounds v :

- **Example 1**: not bidding **40¢**

$$\underbrace{0.06}_{G(50)}(v-50) > \underbrace{0.02}_{G(40)}(v-40) \Leftrightarrow v > 55$$

- **Example 2**: not bidding **45¢**

$$\underbrace{0.06}_{G(50)}(v-50) > \underbrace{0.04}_{G(45)}(v-45) \Leftrightarrow v > 60$$

… so $\boxed{v > 60¢}$ here

Lower Bound Estimator on Valuation (LBV)

- Lower bound on v from additional bid shade S, sub-optimal by construction:

$$\underbrace{G(b|v)(v-b)}_{\text{Best expected surplus}} > \underbrace{G(b-s|v)(v-b+s)}_{\text{Sub-optimal expected surplus}}$$

$$\Updownarrow$$

$$\frac{v}{b} > 1 + \frac{sG(b-s|v)}{b[G(b|v) - G(b-s|v)]} \equiv stretch(s)$$

- Bidders prefers submitted bid to any other lower bid

  $\rightarrow$ try all feasible S, apply maximum

$$v > b \max_{0.01 < s < b-R} stretch(s) \equiv LBV(b)$$

where R: Reserve Price

Method for inferring LBV from 1PSB bid

For each bid within a fixed {DSP,Creative}:

1. Construct a non-parametric local estimate of G

2. Calculate the lower bound on valuation $\mathcal{V}$ implied by G and observed bid b

3. Compare $\mathcal{V}$ before switch to lower bound on $\mathcal{V}$ after switch (should be ">")

Recall: bids on 3 selected creatives raised questions
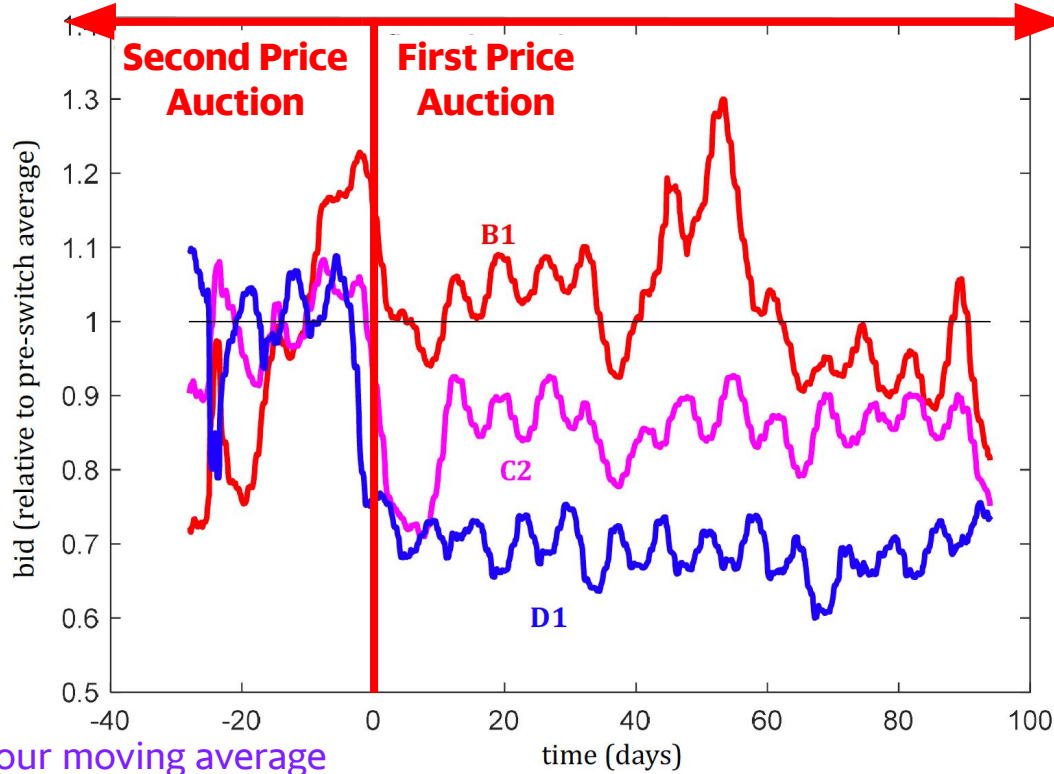
- Creative B1 does not seem to shade until the end of data. Enough then?

- D1 and C2 shaded their bids. Enough?

LBV on 3 selected creatives over time ...
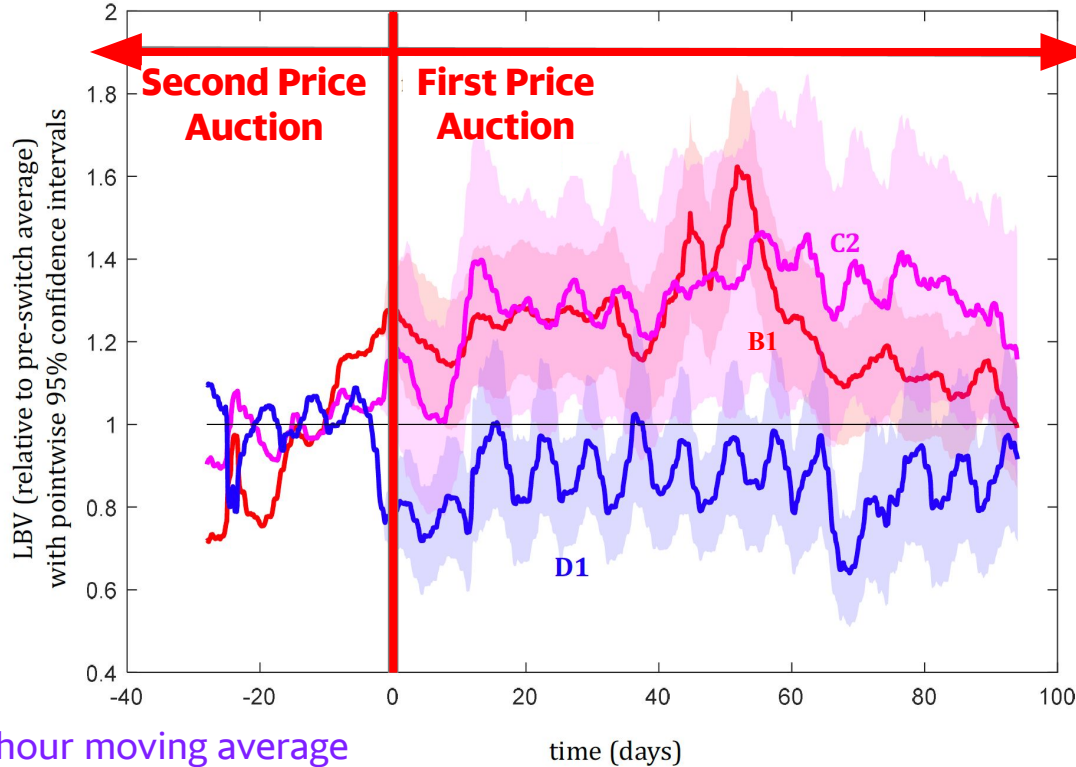
- **B1** does not shade until the end of data. Enough then? **Maybe**

- **D1** seems to **shade enough**

- **C2** shades bids, but **not enough** (as if valuations ↑~30%)

4-hour moving average

Conclusion

- Did the bidders adjust bids down sufficiently?
  - **No**,
    - Lower bound on post-switch valuations exceeds the pre-switch valuations in 8 of the 11 analyzed creatives
    - On average, bidders bid as if the switch increased their valuation by at least 30%
- How long did it take them to adjust?
  - On average, longer than 3 months (out sample period), if at all
- Revenue Measures (e.g. CPM) require to disentangle insufficient shading by the focal bidder from changes in local competition
- Disclaimer: bidding strategies have gotten more sophisticated, so our paper should be viewed as a study of bidders adjustment to a pricing mechanism with which they are not too familiar

Q&A