

AUCTIONS IN THE ONLINE DISPLAY ADVERTISING CHAIN: *A case for Independent Campaign Management*

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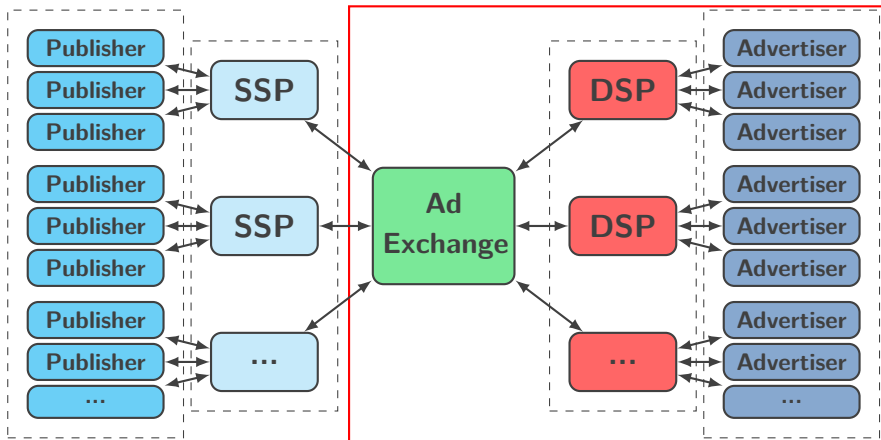
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*joint work with Amine Allouah

GENERAL MOTIVATION

- in many auctions, buyers hire firms to manage bidding process
- online display advertising
 - ~2009: Real Time Bidding market
advertisers bid through **intermediaries, Demand Side Platforms (DSPs)**, that manage **multiple campaigns in parallel**
 - ~2015: Header Bidding
advertisers' bids "transit" through DSPs and Ad exchanges...
- potential for **collusion** among buyers through intermediaries

ONLINE DISPLAY ADVERTISING CHAIN (RTB)



Main Question: what is the impact on the value chain of intermediaries such as DSPs?

QUESTION: SHOULD DSPs MULTI-BID?

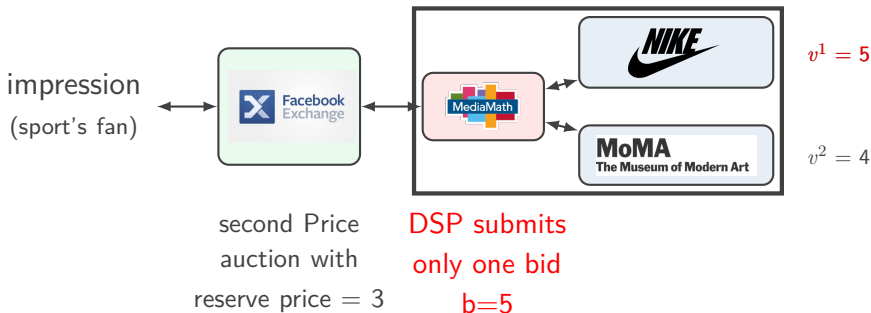
- DSPs should multi-bid

- sellers have advocated for this for many years to have more visibility on the market, increase market thickness
- some ad exchanges offer the possibility to multi-bid (Mansour et al., 2012)

- DSPs should optimize/coordinate campaigns in centralized fashion

- DSPs represent advertisers and not sellers
- DSPs have no incentive to multi-bid and compete with themselves

THE IMPACT OF DSPs: BASIC MOTIVATING EXAMPLE



	indep.	coord.	Δ
Seller's revenue	4	3	decrease of 25%
Buyers's side surplus	1	2	increase of 100%

To what extent do buyers systematically benefit?

PREVIEW OF CONTRIBUTIONS

- framework to analyze impact of coordinating role of intermediaries in value chain
 - general network of intermediaries/advertisers
 - anchor discussion about multi-bidding in online display advertising markets
- characterize the impact of intermediaries taking a **coordinating** role
 - **negative** effect on the seller's profit [**lack of visibility of bids**]
 - **negative** effect on the social welfare [**fewer transactions**]
 - **negative** effect for the buyers' side surplus for a broad set of market characteristics! [**fundamental inefficiency**]

potential for **Pareto improvement** in the value chain through multi-bidding as market norm

A CLARIFYING POINT

- What this paper is **not** about: advocating to eliminate DSPs
 - many frictions to access market
 - DSPs provide access to RTB market, reporting features, and analytics functionalities for campaign management
- **What this paper is about**: advocating to adjust the **tactical** role that DSPs play, or at least providing a framework to delineate its implications

SAMPLE OF RELATED LITERATURE

■ Collusion in Auctions

- Impact of collusion: McAfee and McMillan (1992)
- Collusion proof mechanisms: Pavlov (2008), Che and Kim (2009)

■ Online Display Ads Challenges

- Campaign delivery: Roels and Fridgeirsdottir (2009), Ciocan and Farias (2012), Balseiro et al. (2014), ...
- Design of contracts and multi-layered auctions: Feldman et al. (2010), Balseiro et al. (2015b), Mirrokni and Nazerzadeh (2015)
- Incentivizing truthful multi-bidding for intermediaries: Muthukrishnan (2009), Mansour et al. (2012), Hummel et al. (2016).

■ Multidimensional Mechanism Design

- Haghpanah and Hartline (2014), Belloni et al. (2010), Rochet and Choné (1998), Thanassoulis (2004), Myerson (1981), Mussa and Rosen (1978)

OUTLINE FOR REST OF TALK

I. Problem Formulation

II. Impact on Seller and Social Welfare

III. Impact on Buyers' side

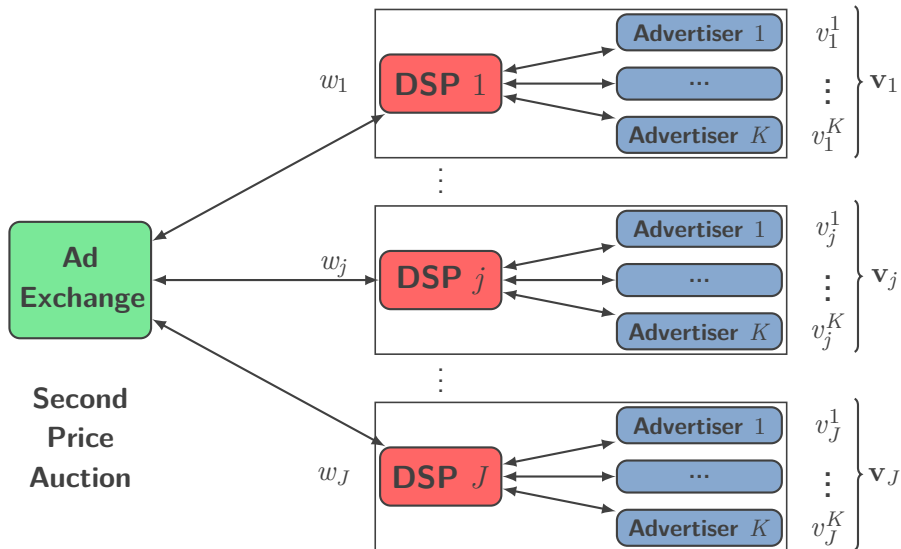
- no competition among intermediaries
- competition among intermediaries

IV. Takeaways

MODEL

- one seller with one indivisible good running a second price auction*
- J intermediaries, each representing K buyers
 - buyers have i.i.d values
 - intermediary assumed to have access to values of buyers it represents
- seller contracts with intermediaries

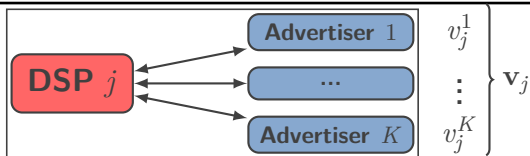
MODEL



VALUATION MODEL

- α : probability that a particular advertiser matches, i.e., is “interested” in the impression
- conditional on matching, advertiser’s value drawn from F (I.F.R).
 - $G_\alpha(\cdot) = (1 - \alpha) + \alpha F(\cdot)$
- related models used in recent literature: enables to capture large market with non-degenerate auctions

UTILITY OF INTERMEDIARIES



$$\text{Utility of DSP } j = \sum_{k=1}^K \delta_{jk} v_j^k - \text{Payment}_j$$

alloc. to k^{th} adv. of j^{th} DSP

DSP maximizes surplus of group of advertisers
(full alignment of incentives between DSP and adv.)

$$\text{submits } w_j = \max_k \{v_j^k\} =: v_j^{[1]}$$

INDEP. CAMPAIGN MANAGEMENT VS. COORDINATION

DSPs' strategy

Coordination of bids

DSP j submits

$$w_j = v_j^{[1]}$$

Multi-bidding/ Indep. Camp.

DSP j submits

$$(v_j^1, \dots, v_j^K)$$

Seller's side profit

$\leq? \geq$

Social welfare

$\leq? \geq$

Buyers' side surplus

$\leq? \geq$

IMPACT OF INTERMEDIARY ON SELLER AND SOCIAL WELFARE

When intermediaries coordinate the campaigns of their buyers

- i.*) reserve price increases: $r_{co} > r_{in}$.
- ii.*) seller's profit **strictly decreases**.
- iii.*) social welfare **strictly decreases**.

- seller suffers from collusion among advertisers
- fewer transactions take place

IMPACT OF COORDINATION ROLE ON BUYERS' SIDE SURPLUS

- expected surplus of the buyers when the seller is using a second price auction with a reserve price r and the intermediary is **multi-bidding**

$$U_{\text{in}}(r) = \mathbb{E} \left[(v^{[1]} - \max\{v^{[2]}, r\}) \mathbf{1}\{v^{[1]} \geq r\} \right]$$

- expected surplus of the buyers when the seller is using a second price auction with a reserve price r and the intermediary is **coordinating**

$$U_{\text{co}}(r) = \mathbb{E} \left[(v^{[1]} - \max\{w^{[2]}, r\}) \mathbf{1}\{v^{[1]} \geq r\} \right]$$

($w^{[2]}$ = second value among all reports of intermediaries)

- **impact of collusion on buyers's side**

$$U_{\text{co}}^* - U_{\text{in}}^* = U_{\text{co}}(r_{\text{co}}) - U_{\text{in}}(r_{\text{in}}).$$

TWO MAIN EFFECTS

$$U_{\text{co}}^* - U_{\text{in}}^* = U_{\text{co}}(r_{\text{in}}) - U_{\text{in}}(r_{\text{in}}) + U_{\text{co}}(r_{\text{co}}) - U_{\text{co}}(r_{\text{in}})$$

myopic benefit of collusion ≥ 0

seller's response effect ≤ 0

IMPACT OF INTERMEDIARY ON BUYERS' SIDE SURPLUS

- not possible to characterize dominating effect in general
- regimes we focus on for analytical tractability
 - no competition: one intermediary and two advertisers [main intuition]
 - competition (with large market)
- key quantity we will track: coefficient of variation of values

$$CV = \frac{\sqrt{\mathbb{E}[(v - \mathbb{E}[v])^2]}}{\mathbb{E}[v]}$$

NO COMPETITION: ONE INTERMEDIARY AND TWO ADVERTISERS

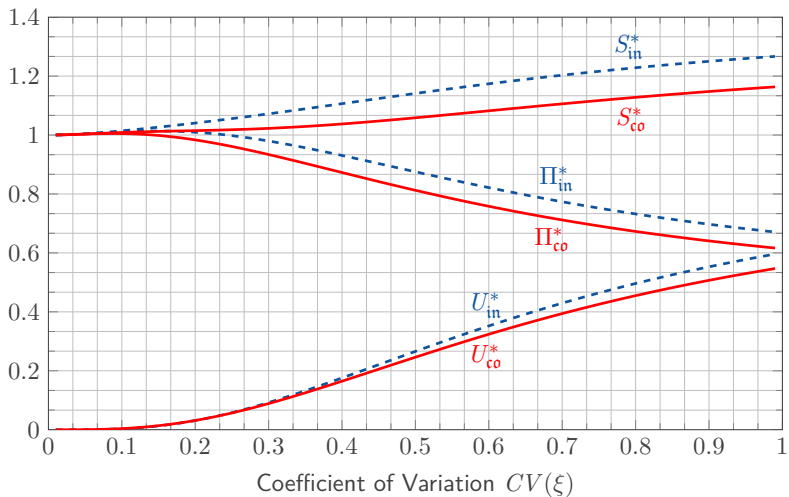
Class of distributions: Generalized Pareto Distributions
(coefficient of variation ranging from 0 to 1)

Theorem (Impact of intermediary on Adv.)

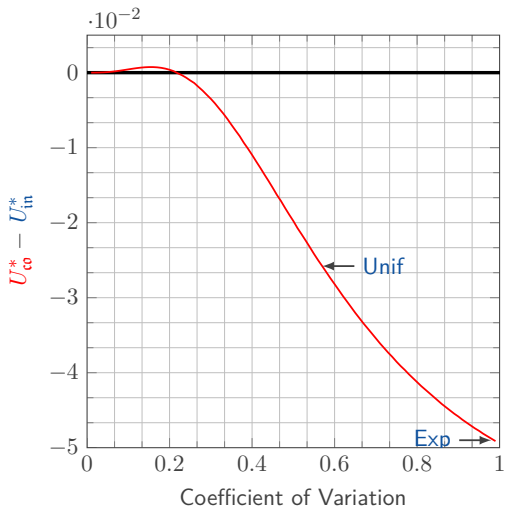
Under GPD, if the **coefficient of variation** is greater than some threshold τ ($\tau \leq 0.25$) then the **coordinating** role of the intermediary **negatively** affects the buyers' side.

- Seller's response effect dominates the myopic benefit of collusion
- Campaign coordination by intermediaries backfires
- **Independent campaign management leads to Pareto improvement in online advertising value chain** => advertisers should also advocate for it

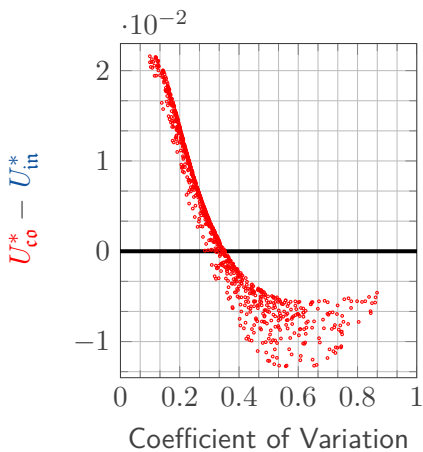
IMPACT ON VALUE CHAIN METRICS



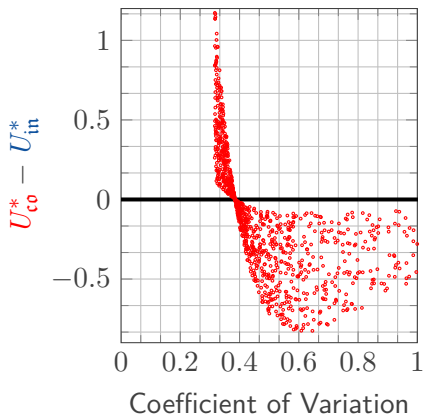
IMPACT OF INTERMEDIARY ON ADVERTISERS' SURPLUS



ROBUST ACROSS DISTRIBUTIONS



(a) **Beta distributions**



(b) **Gamma distributions**

MAIN RESULT: ANALYSIS UNDER COMPETITION

Asymptotic regime: allows to “localize” analysis

- J, K large, α small
- maintain expected level of competition in auctions constant
 $\alpha JK = c$.
- scale of inefficiencies: $1/J$

Theorem (Impact of coord. intermediaries)

The difference in advertisers' surplus, $U_{co}^* - U_{in}^*$ is bounded above as follows

$$U_{co}^* - U_{in}^* \leq \frac{c^2}{J} \left[\int_{r_{in}}^{\infty} (x - r_{in}) \bar{F}(x) f(x) e^{-c\bar{F}(x)} dx - \frac{r_{in} (\bar{F}(r_{in}))^2}{2\phi'(r_{in})} e^{-c\bar{F}(r_{in})} \right] + o(1/J),$$

where $\phi(x) = x - \frac{\bar{F}(x)}{f(x)}$ (virtual value function).

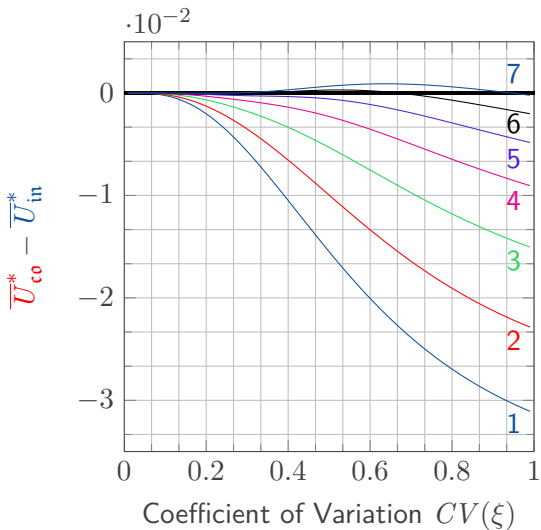
CHARACTERIZATION FOR GPD FAMILY

Theorem (Impact of coord. role)

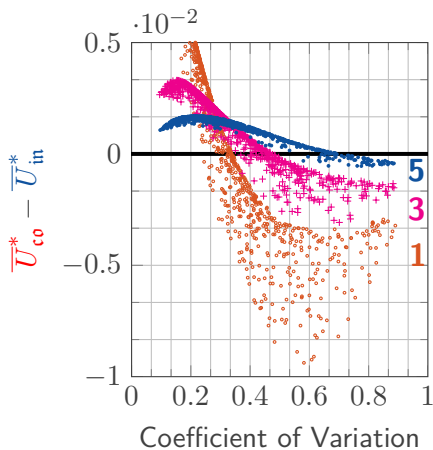
Under GPD, for a given average number of matches c , if the coefficient of variation is greater than some threshold, then the buyers's side is **worse-off** in a large market when the intermediaries play a **coordinating** role.

- fundamental inefficiency persists **despite competition**
- as long as average number of interested buyers is moderate and coeff. of variation is not small, **potential for pareto improvement**.

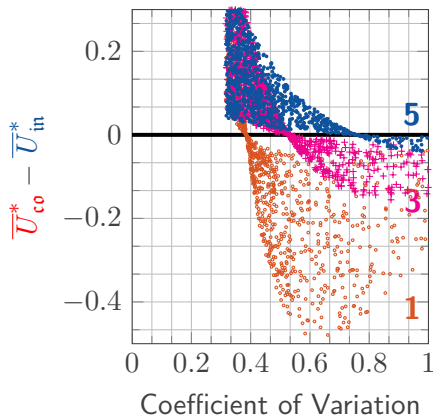
IMPACT ON ADVERTISERS IN LARGE MARKET UNDER GPD



ROBUST ACROSS DISTRIBUTIONS



(a) **Beta distributions**



(b) **Gamma distributions**

CONCLUDING REMARKS

- online display chain structure: impact of the tactical role of DSPs
- fundamental inefficiency: potential for Pareto improvement with independent campaign management
- inefficiency cannot be resolved at the interface between seller and intermediaries in a single shot auction
- Potential solutions
 - advertisers should advocate for independent campaign management / multi-bidding
 - technology to ensure verifiability of intermediaries' strategies / commitment power
 - potential for multi-period contracts to incentivize multi-bidding from DSPs