

INFORMATION ASYMMETRIES IN COMMON VALUE AUCTIONS WITH DISCRETE SIGNALS

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Ad Auctions and Information Asymmetries

Web Impression

The screenshot shows the MSN homepage layout. At the top, there are links for Hotmail, Skype, Messenger, My MSN, Bing, and Latino. A search bar with the MSN logo and a Bing Web Search button is present. Below the search bar, a navigation bar includes categories like NEWS, ENTERTAINMENT, SPORTS, MONEY, LIVING, LOCAL, AUTOS, SHOP, SPRING, MORE, and NOW. A secondary navigation bar offers links for decision guide, compare vehicles, reviews & articles, new & used car research, used-car listings, pictures, and videos. The main content area features a 'Week in Review' section with three images: a house being destroyed by a twister, a roll of cash, and a Secret Service agent. To the right, there is a large advertisement for 'Ad Space' featuring a hand holding a gavel. Below the main content, there are sections for 'EDITORS' PICKS' with various news headlines, 'NEWS', 'SPORTS', and 'msnNOW' with small image thumbnails. A 'POPULAR SEARCHES' section is also visible, featuring a 'People with double lives' article.

hulu

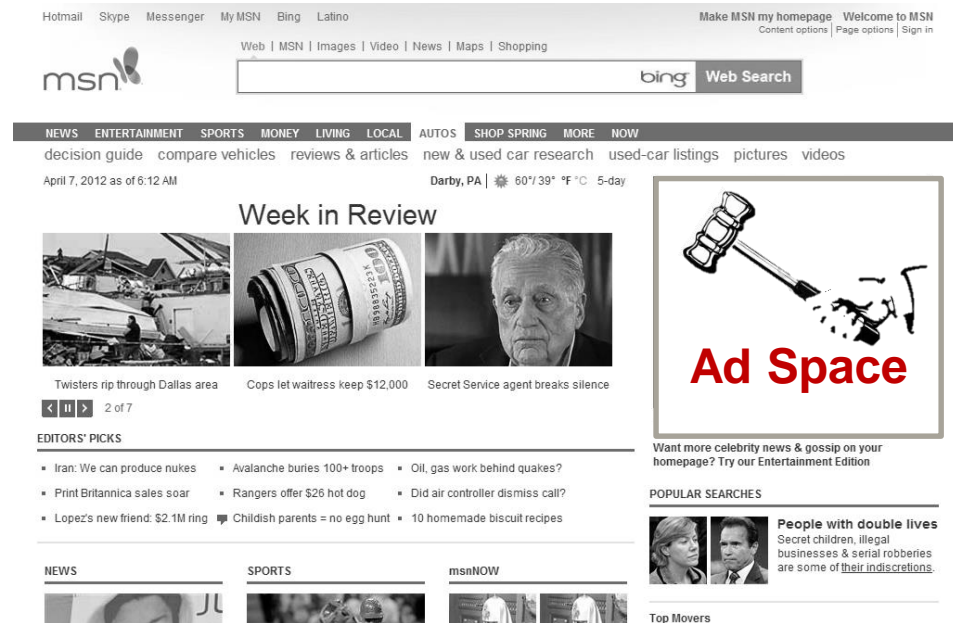


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Ad Auctions and Information Asymmetries

Web Impression



**Amazon
Cookie x**

hulu



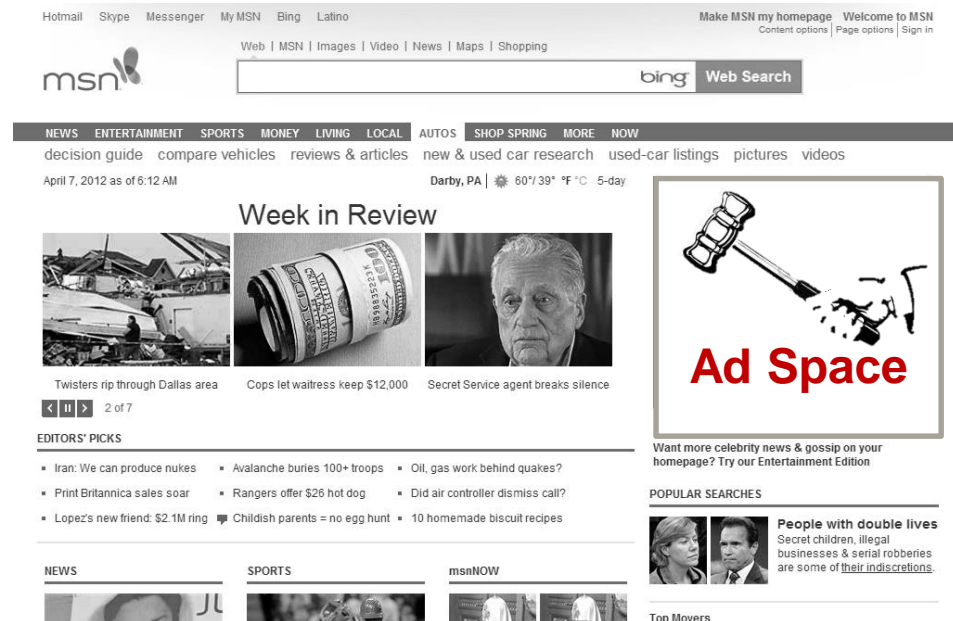
**Kayak
Cookie y**

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Ad Auctions and Information Asymmetries

Web Impression of
Unknown Common
Value V



Amazon
Cookie x

hulu



Kayak
Cookie y

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Common Value Single-Item Auction

Item of Unknown
Common Value V



**Private
Signal x**



**Private
Signal y**



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- Signal of each bidder comes from **Discrete Ordered Set**

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- **Informative:** Higher Signal – Higher Expected Value
- **Affiliated:** Higher Signal – Stochastically Higher Signal for Opponent
- **Signals Drawn from Arbitrary Asymmetric and Correlated Distribution (with full support)**

Traditional Applications

Oil Lease for land
with unknown
common value V



**Access
to Test x**



**Access
to Test y**



Main Questions

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- How does extra information affect player utilities and seller's revenue?

Auctions Considered – Hybrid Auctions

- Highest Bidder Wins.
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- $\kappa \rightarrow 0$: Limit Equilibrium of Second Price Auction
(Equilibrium Selection)

Related Work

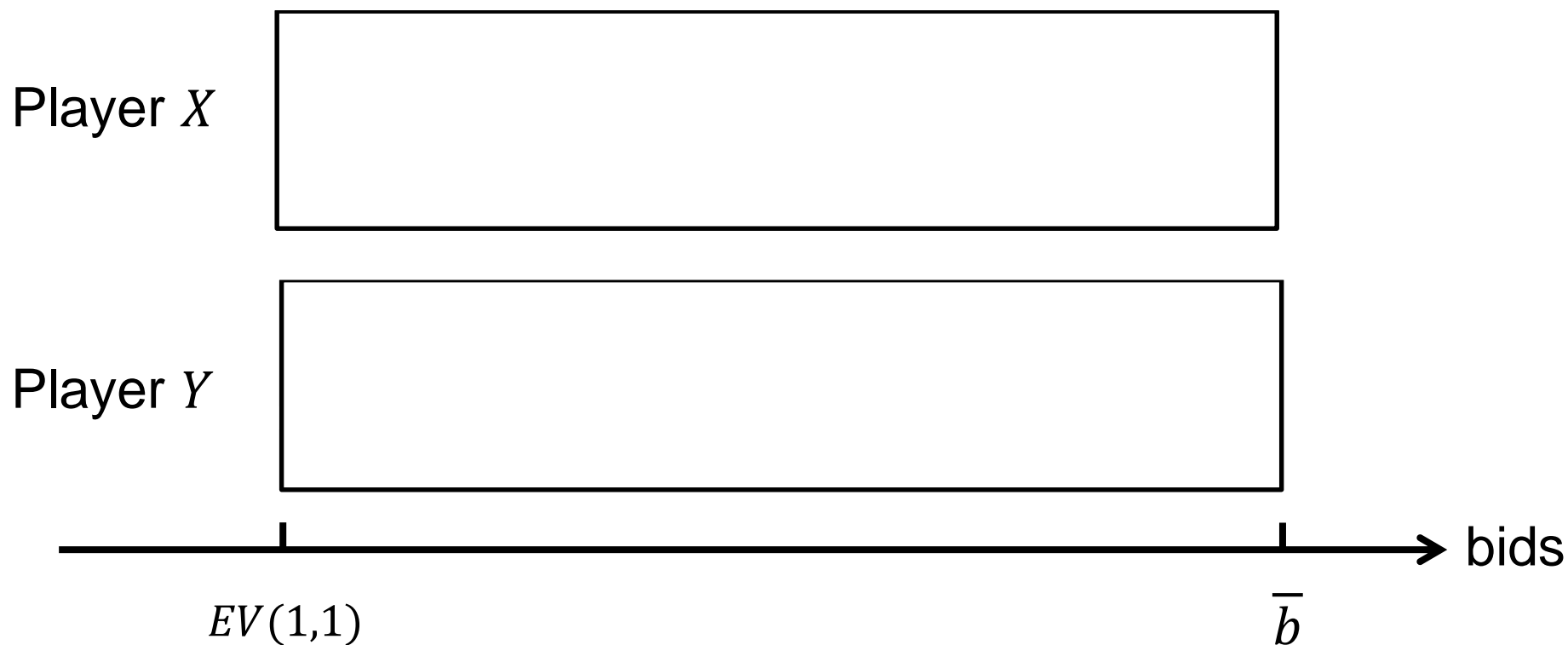
- Value of information in auctions: [Milgrom '79], [Milgrom/Weber '82], . . .
- Common-value auctions with binary signals: [Banerjee '05], [Abraham/Athey/Babaioff/Grubb '12]
- Continuous values/signals: [Engelbrecht-Wiggans/Milgrom/Weber '83], . . ., [Parreiras '06]
- Other common-value models: [Rothkopf '69], [Reece '78], [Hausch '87], [Wang '91], [Laskowski/Slonim '99], [Kagel/Levin '02].
- Value of information: [Lehmann '88], [Persico '00], [Athey/Levin '01], [Compte/Jehiel'07], [Es"o/Szentes '07]

How do bidders behave in equilibrium?

Theorem. There exists a unique equilibrium which is mixed and can be found constructively.

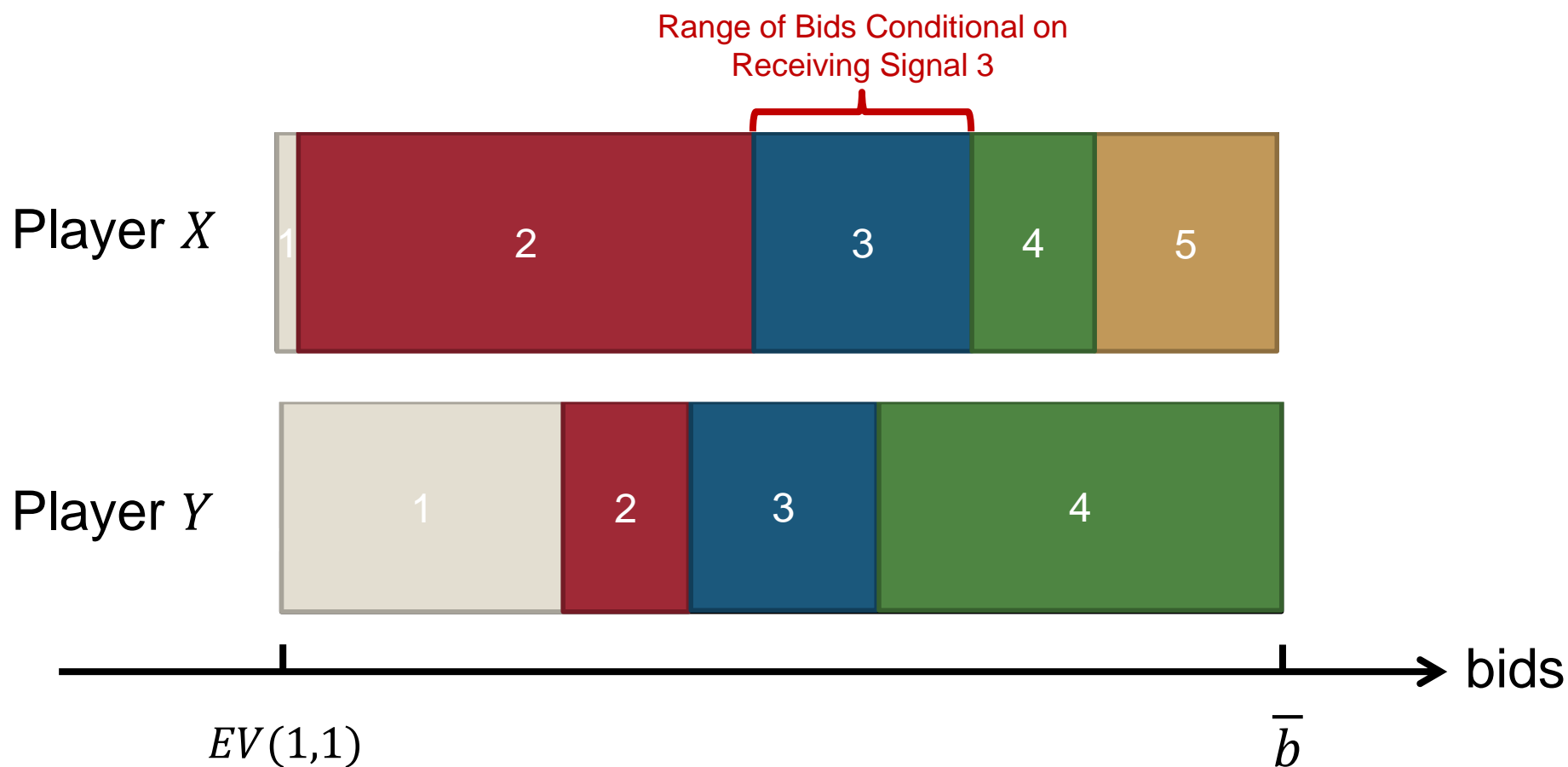
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- Mixed Nash Equilibrium must look as follows:



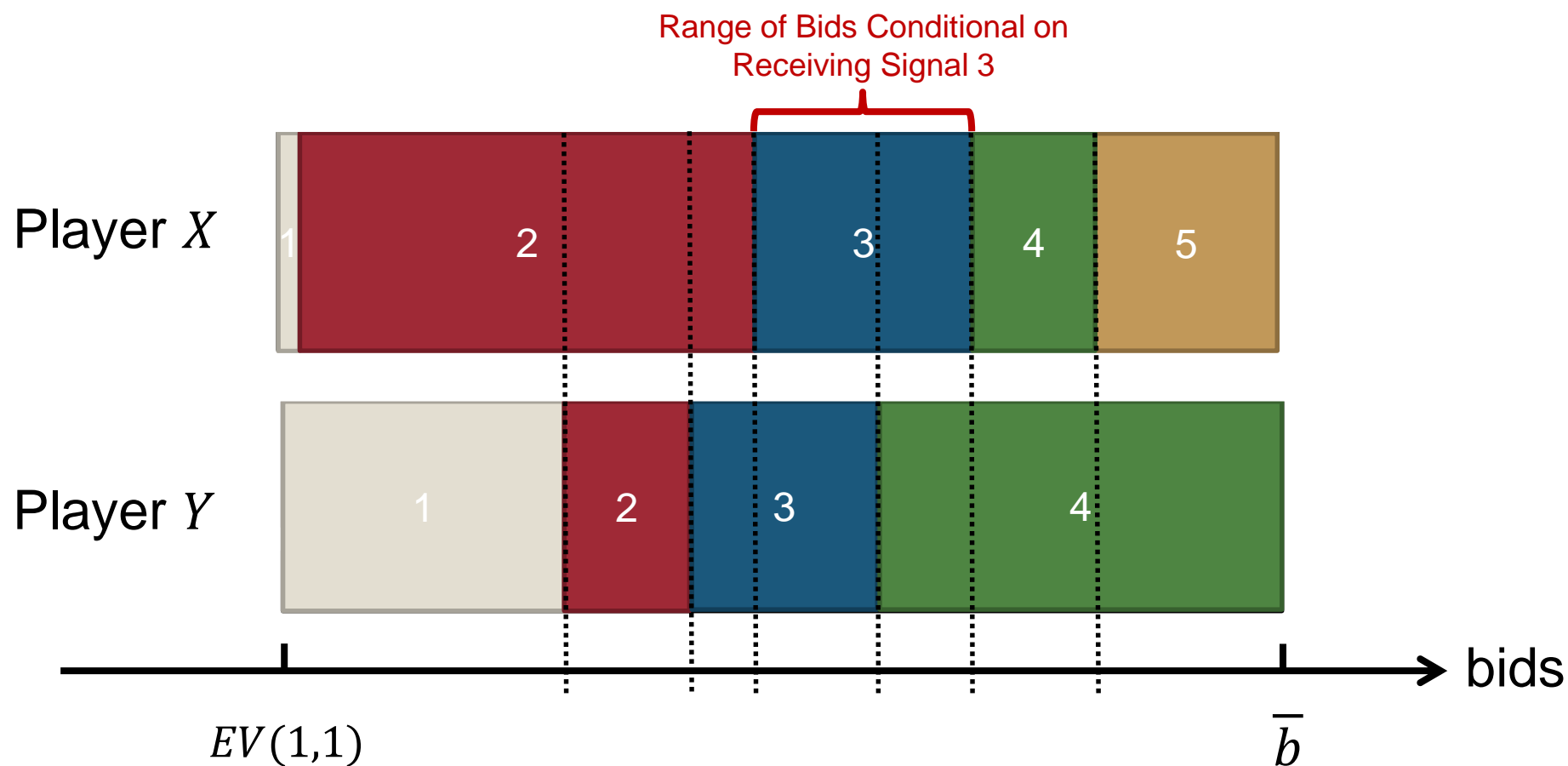
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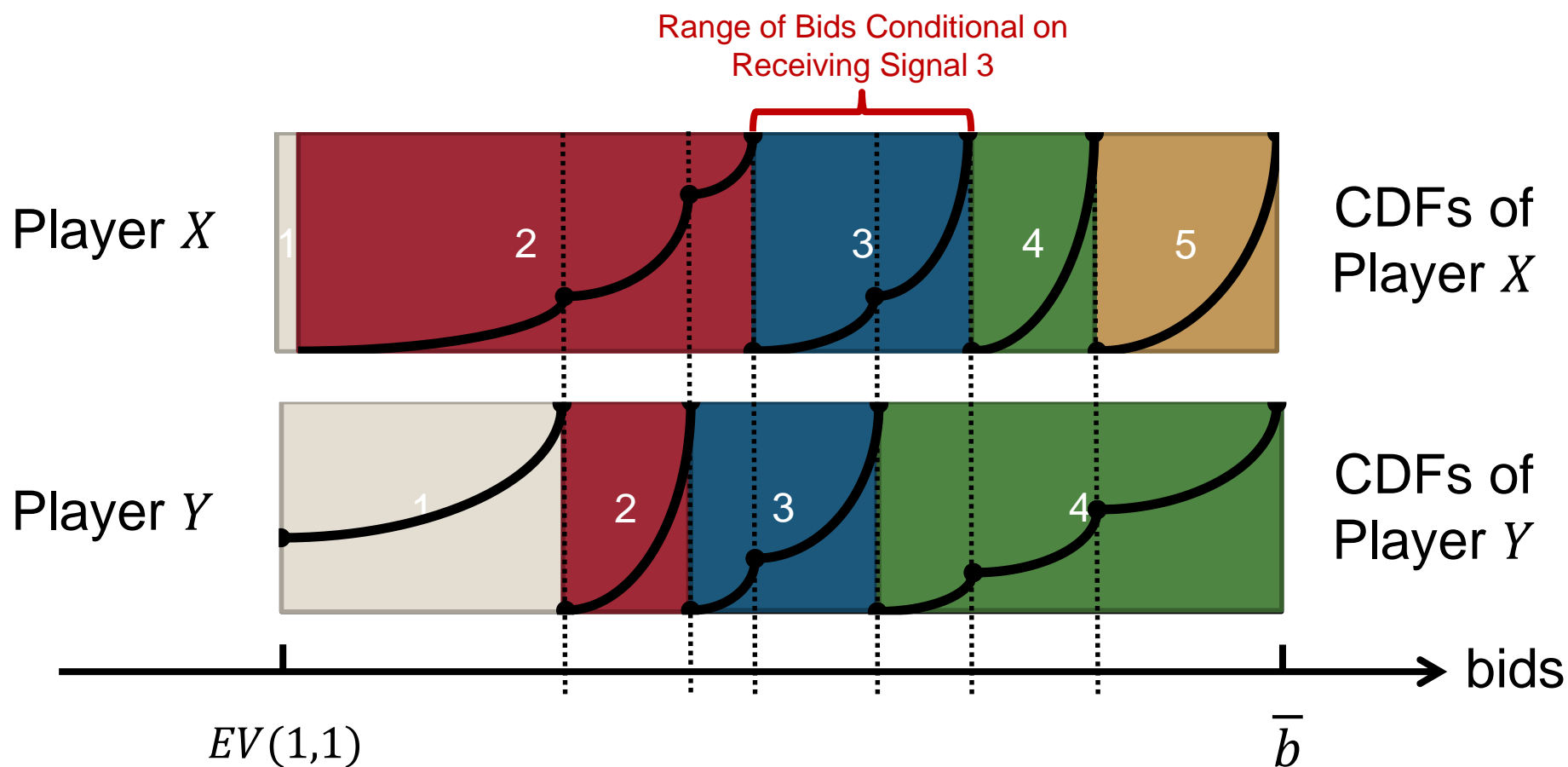
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Unique Equilibrium

- There exists a unique equilibrium defined by a **recursive process**:



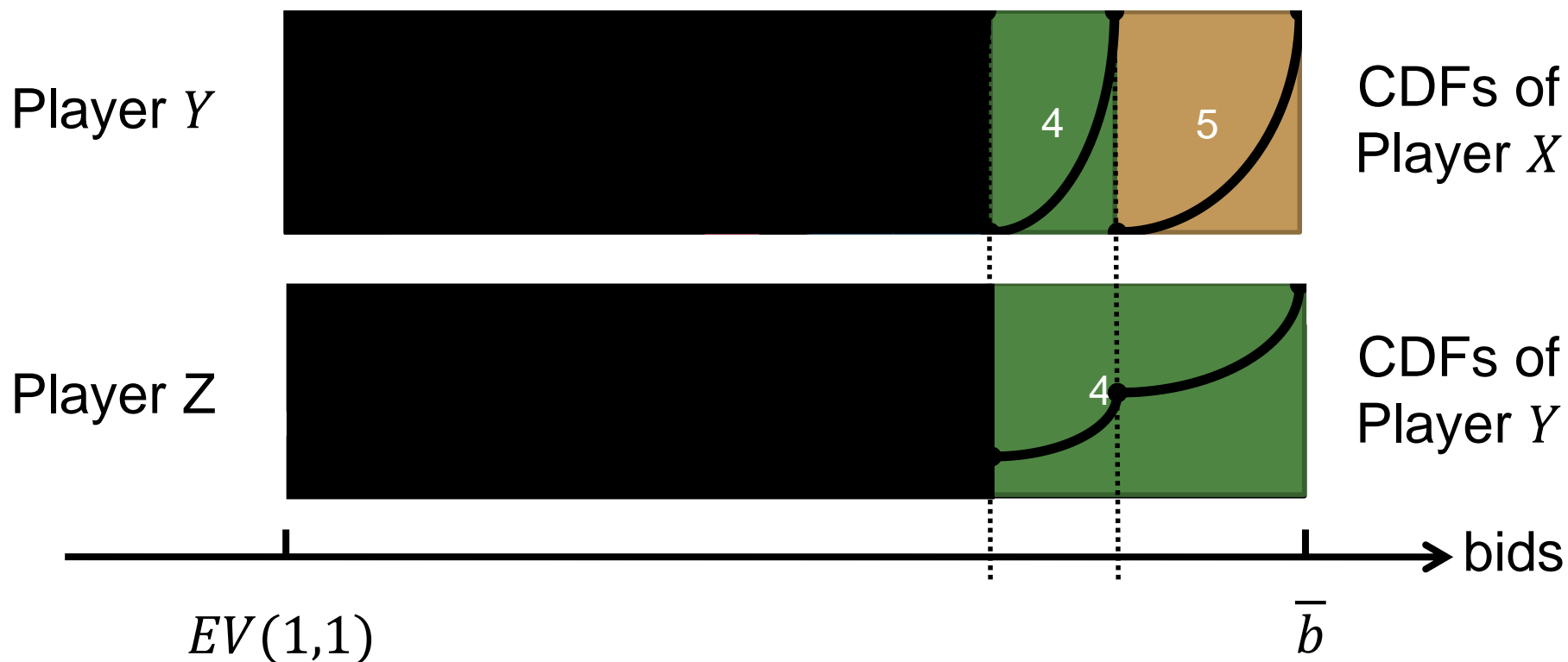
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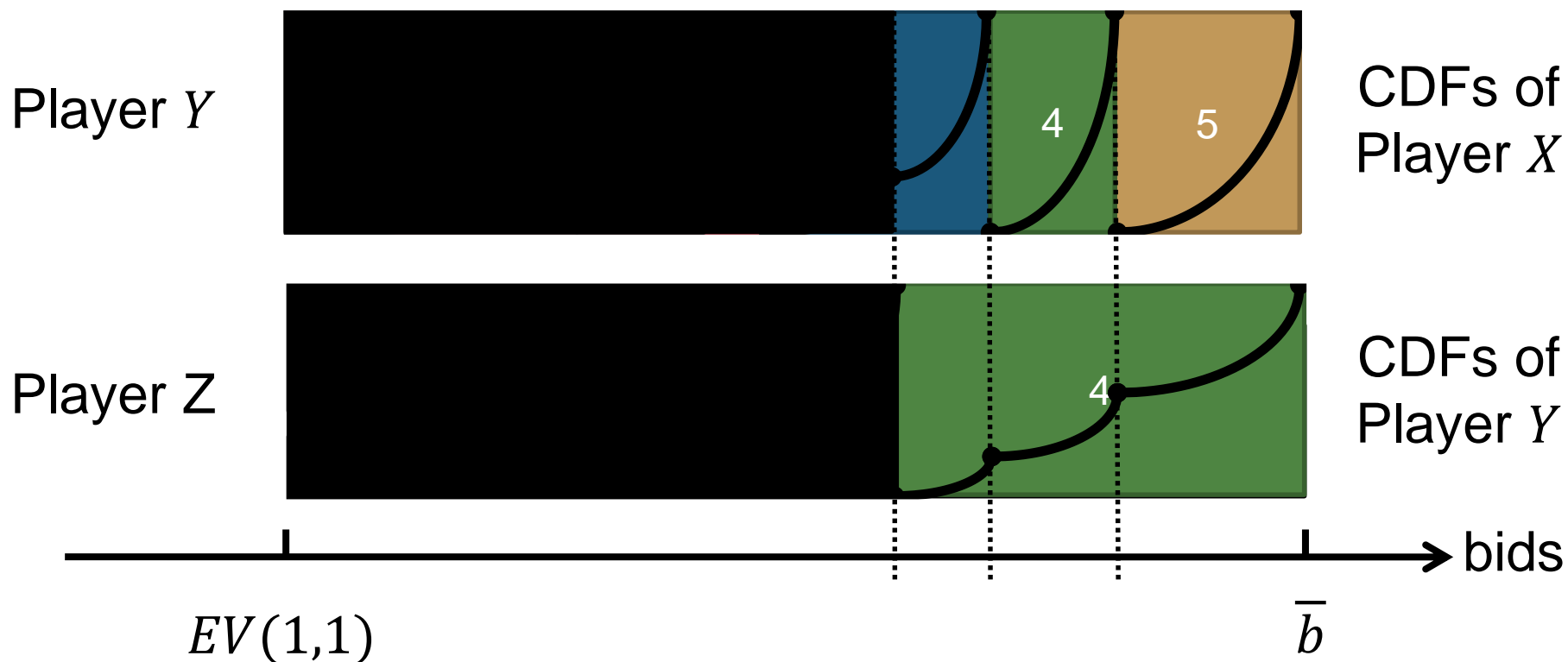
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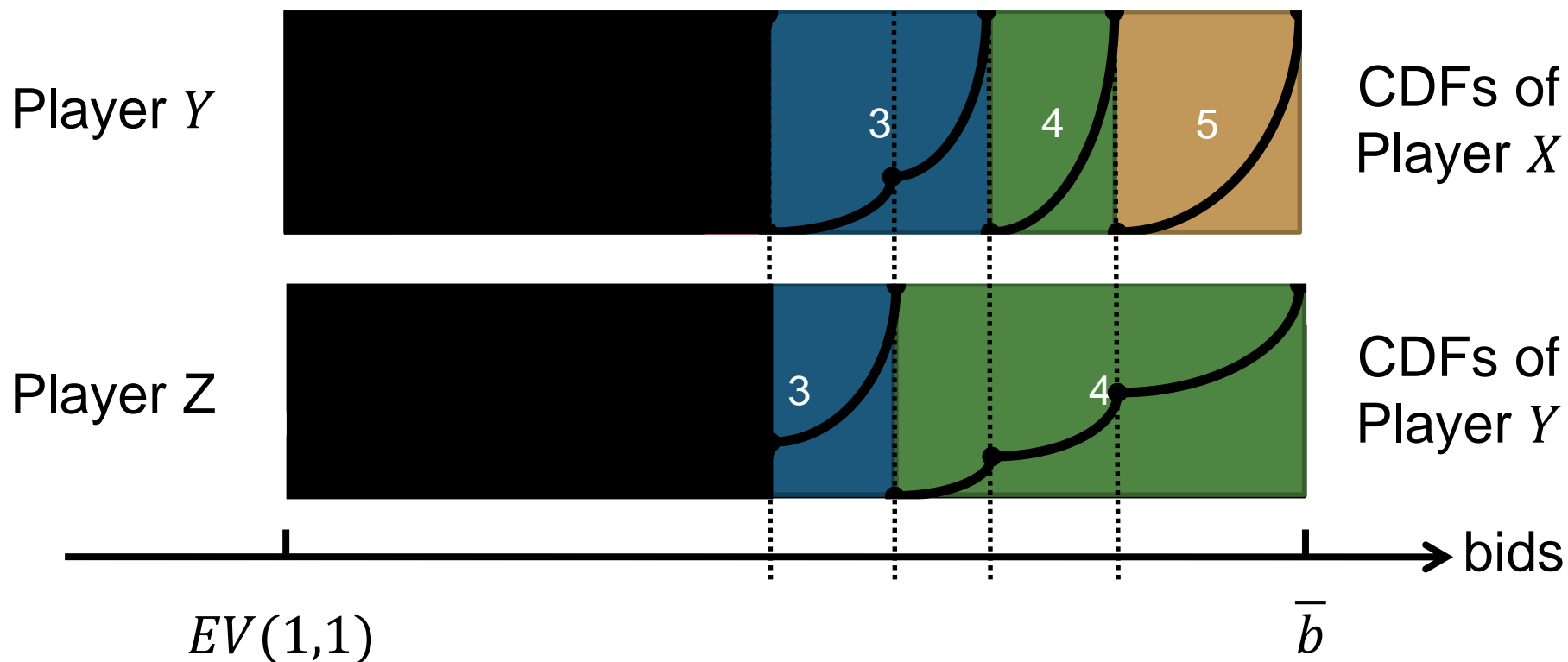
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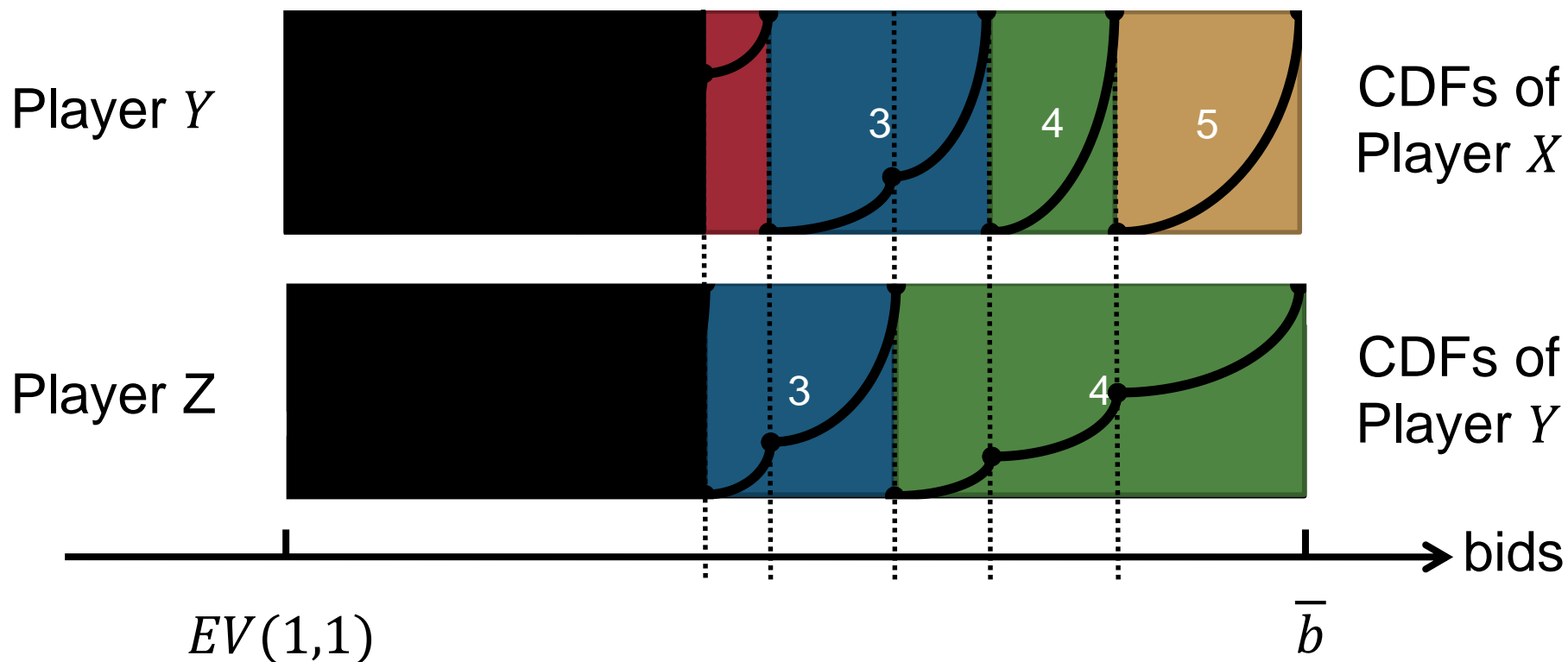
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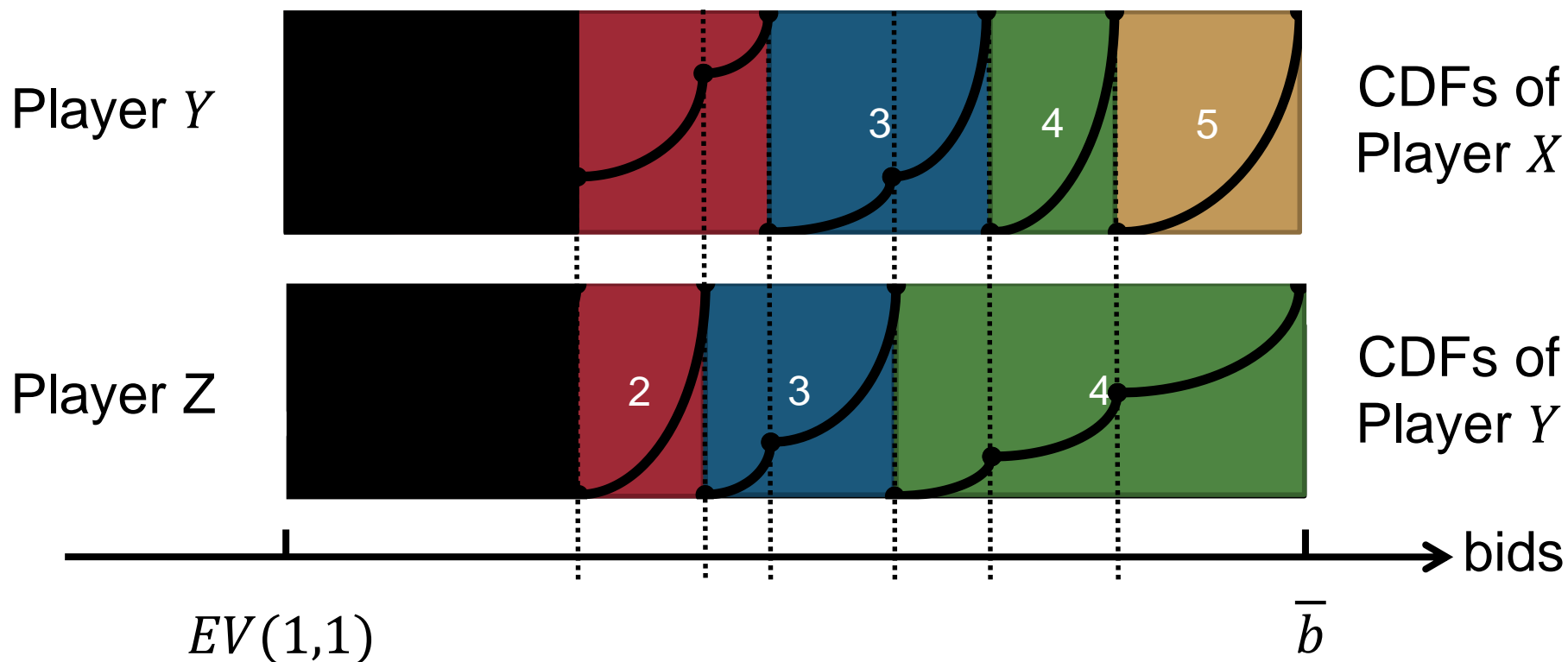
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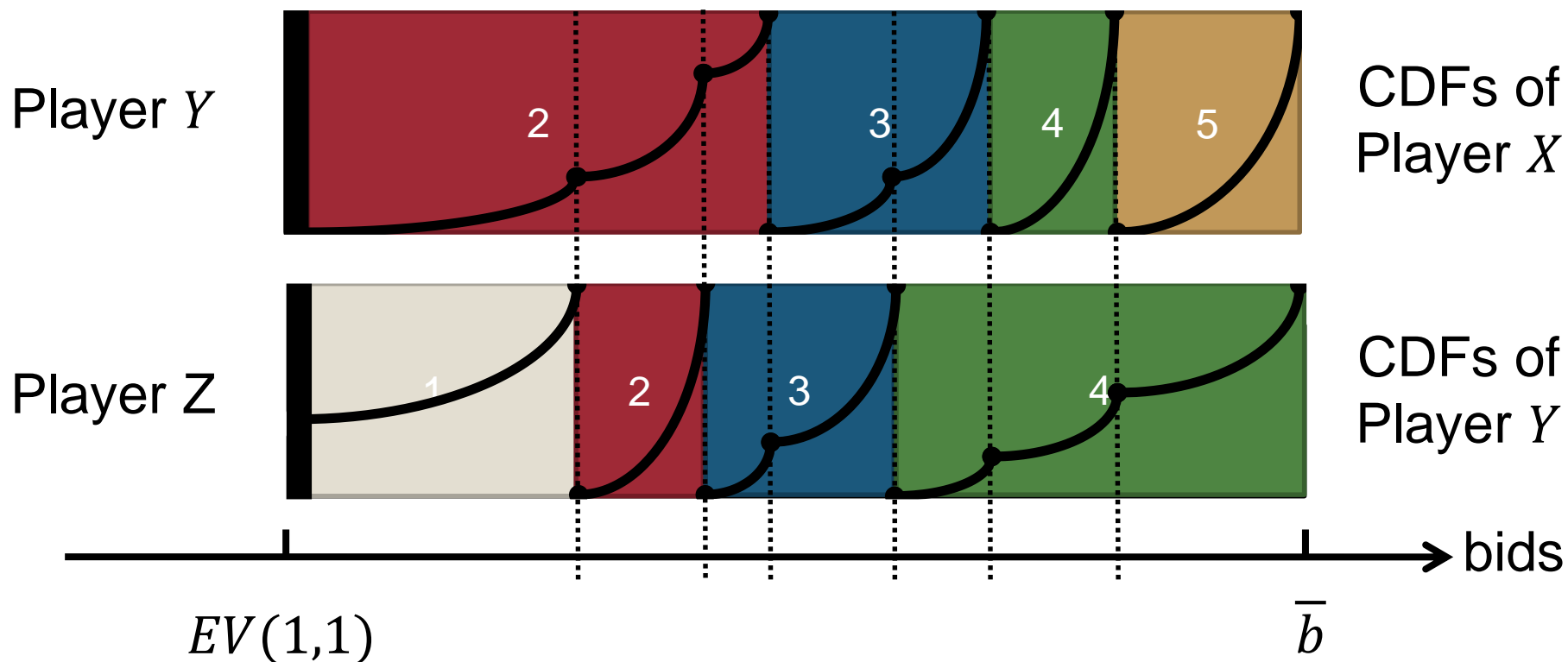
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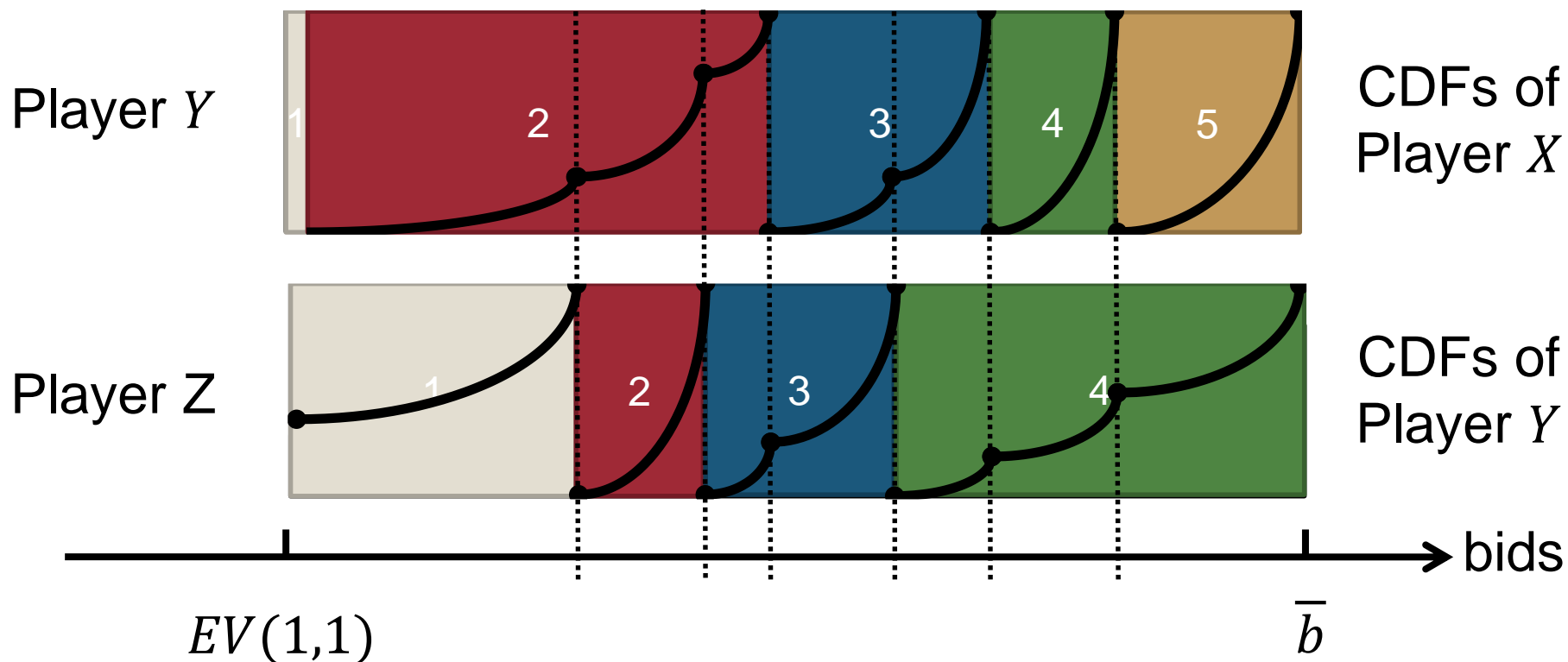
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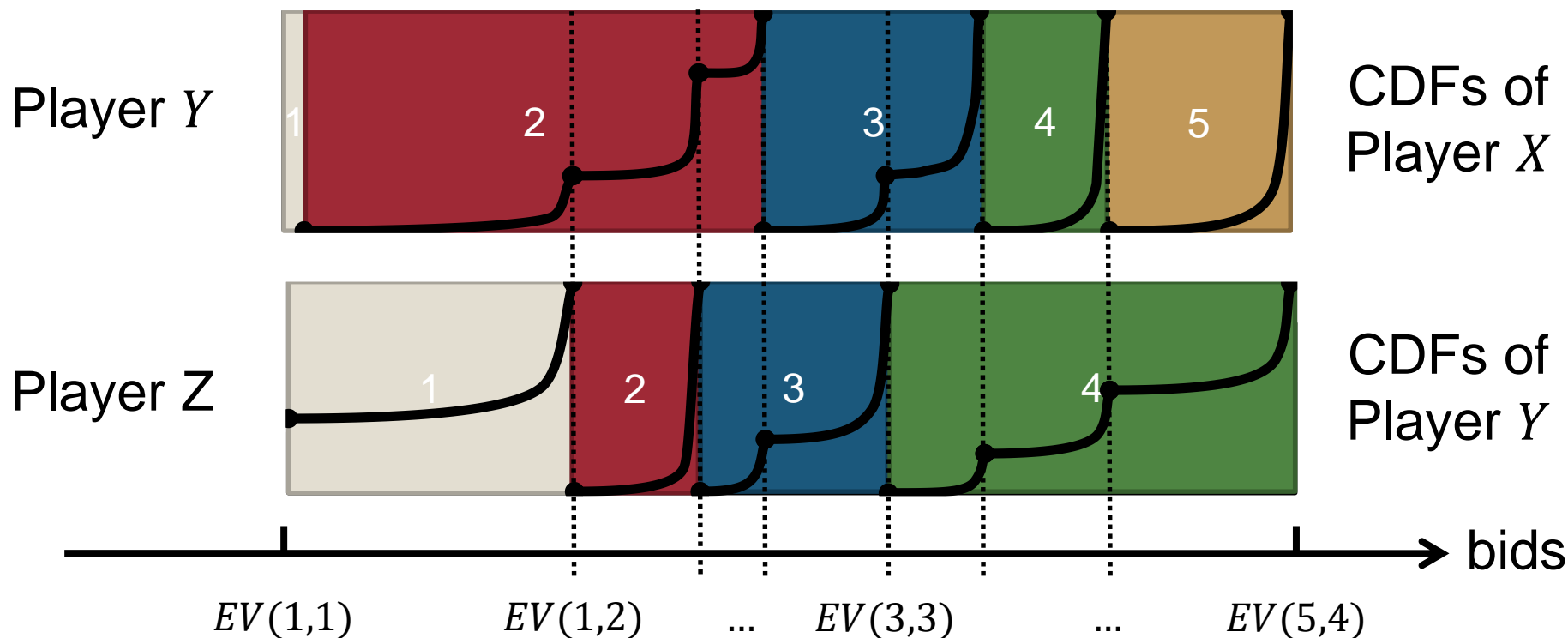
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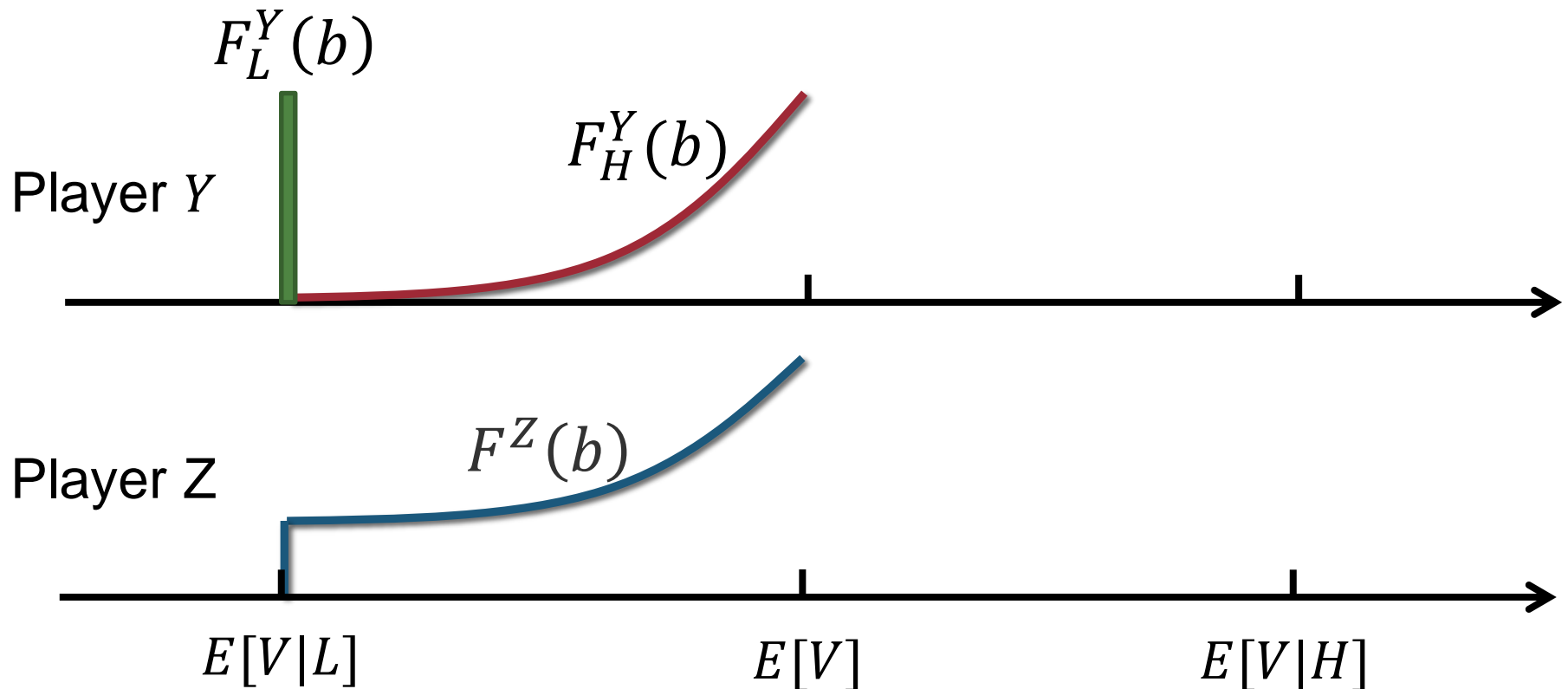
Unique Equilibrium

- As κ approaches 0 (Second Price Auction)



A Simple Example: First Price – Binary Signal

- One player receives a binary signal and the other is uninformed



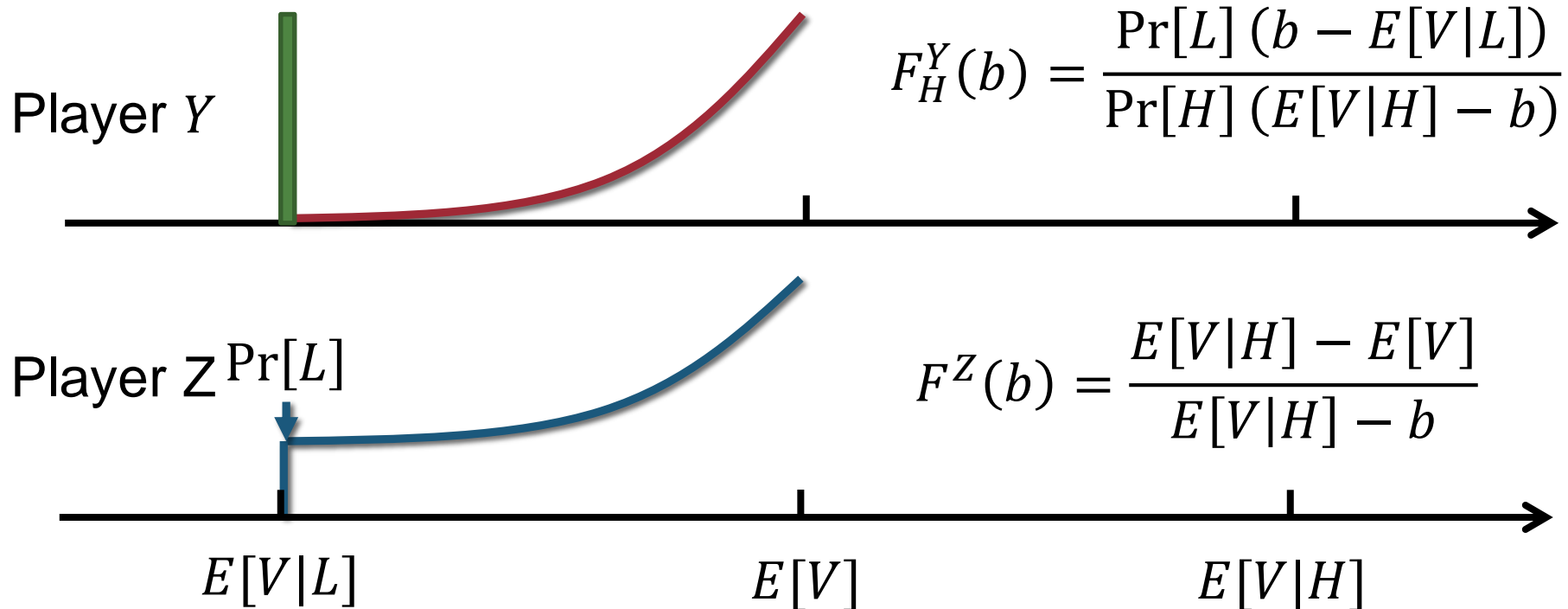
A Simple Example: First Price – Binary Signal

$$F^Z(b)(E[V|H] - b) = E[V|H] - E[V]$$

$$\Pr[H] F_H^Y(b)(E[V|H] - b) + \Pr[L] (E[V|L] - b) = 0$$

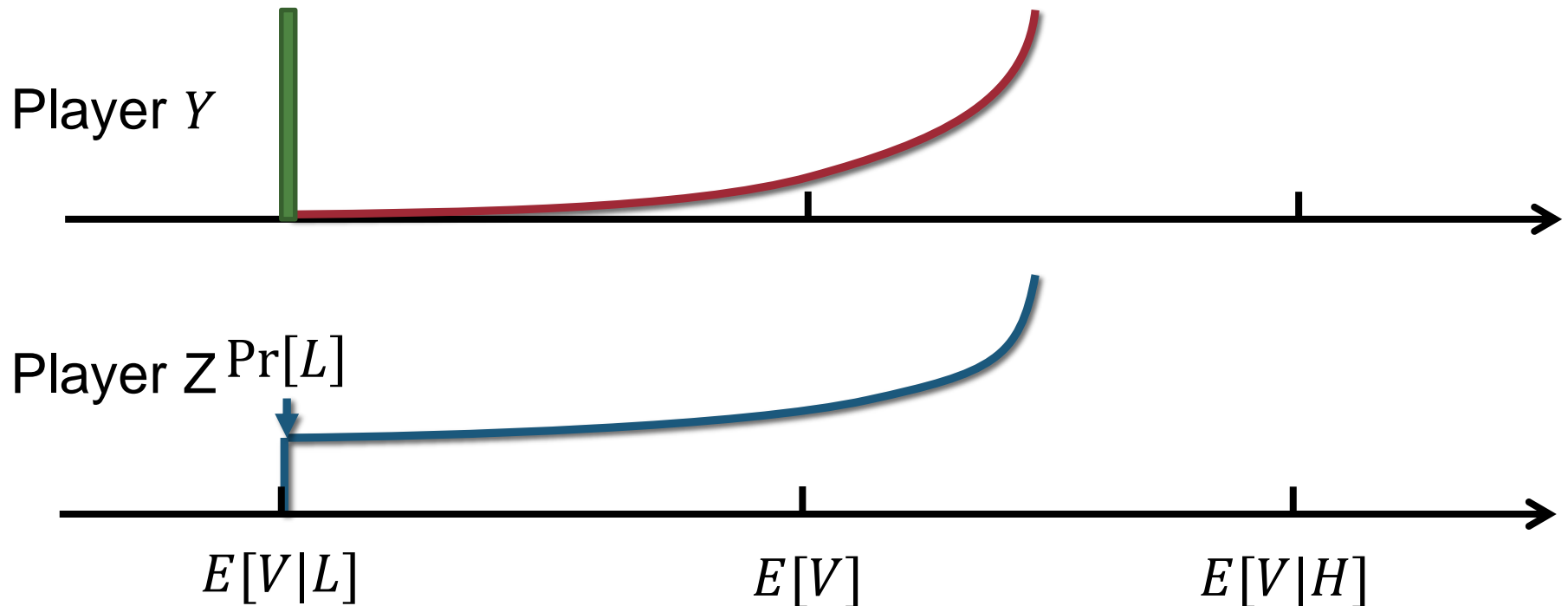
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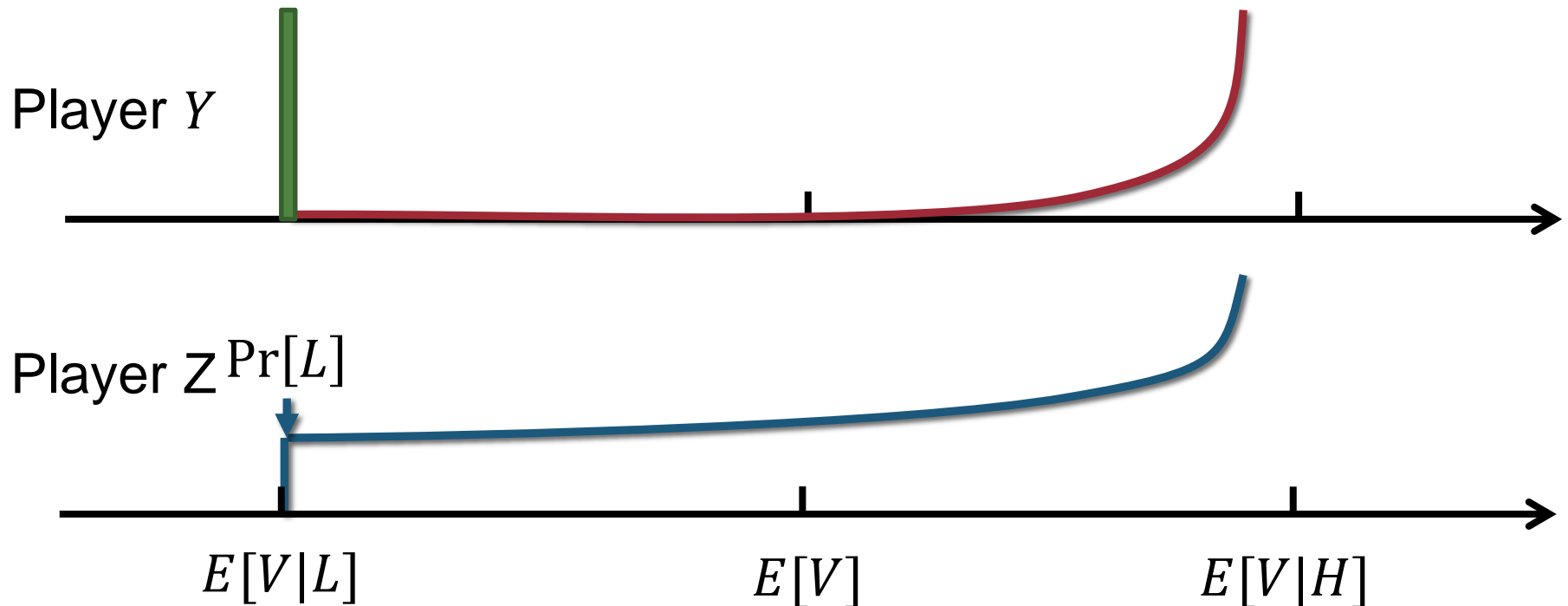
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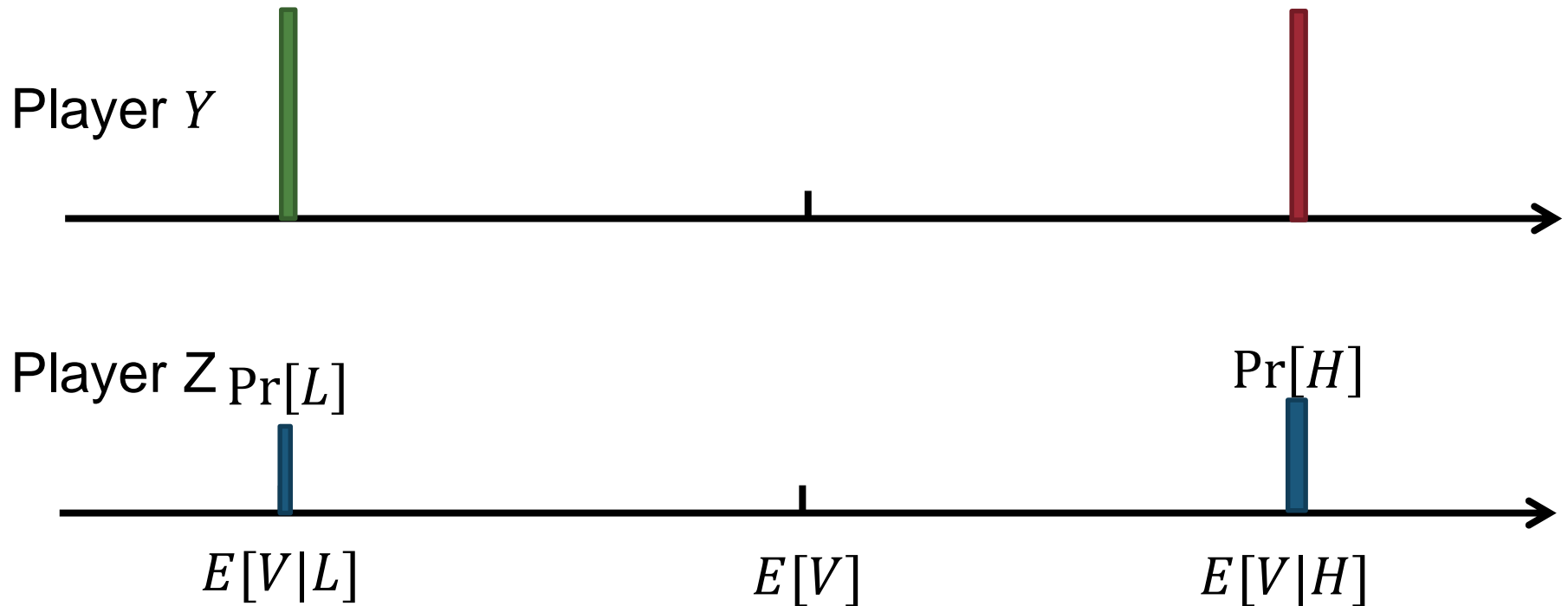


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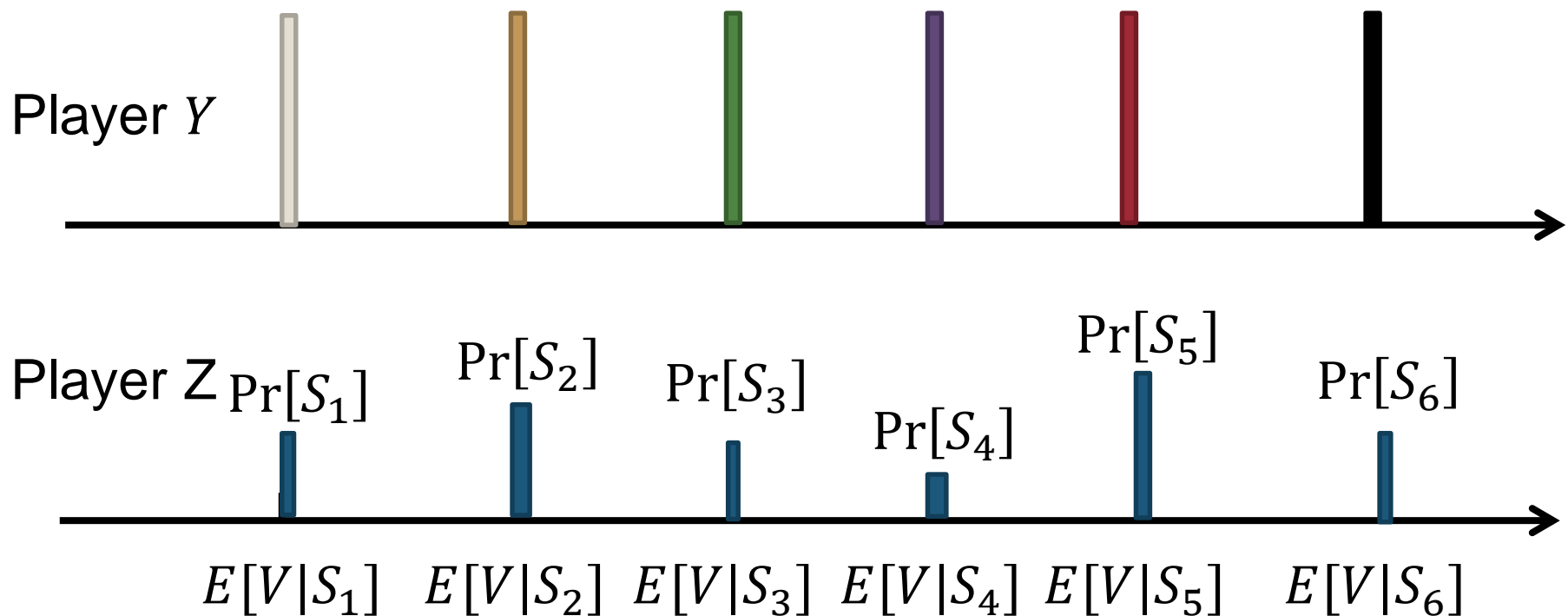
Second Price Selection – No Revenue Collapse



- Different prediction than the collapsed revenue equilibrium predicted by tremble-robust equilibrium selection of Abraham et al.

Only one informed bidder

- Informed Bidder bids “truthfully”
- Uninformed Bidder simulates informed bidder’s bid
- First and Second Price: Revenue Equivalent



Complete Revenue Ranking

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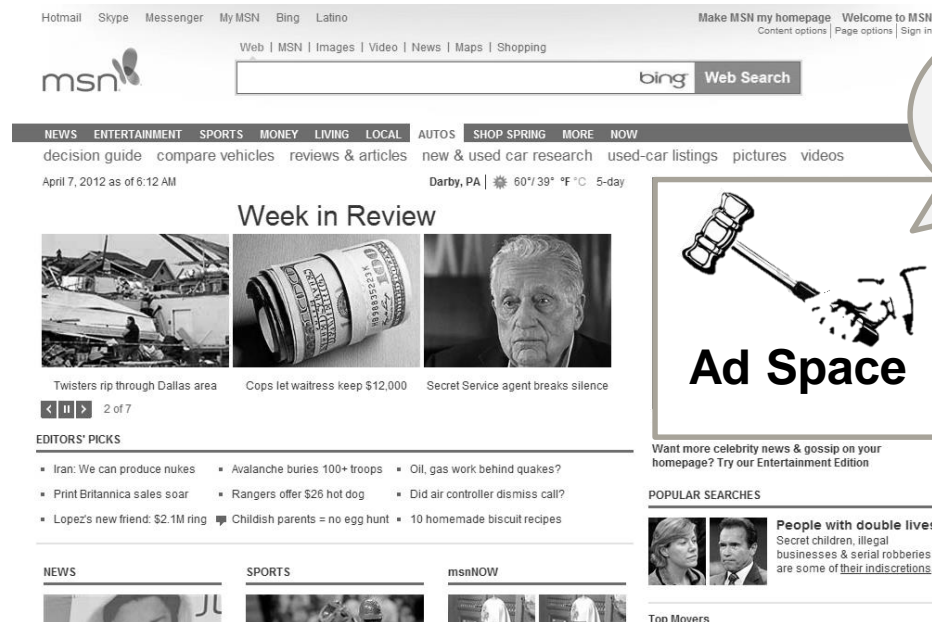
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- **Complete Revenue Ranking among Hybrid Auctions**
 - First Price – Worst Revenue
 - Revenue monotonically increases as we move from first price to second price
 - Limit Equilibrium of Second Price Selected, has highest revenue among hybrid auctions

Should seller reveal his private signals?

Web Site Visitor of
Unknown Common
Value V



**MSN
Cookie z**

**Amazon
Cookie x**

**Kayak
Cookie y**

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Failure of the Linkage Principle

- **Linkage Principle [Milgrom-Weber'82]:** In common value settings, the more information you link to the price of the winning bidder the higher the revenue.
- **Implication:** Seller should always reveal affiliated signals.

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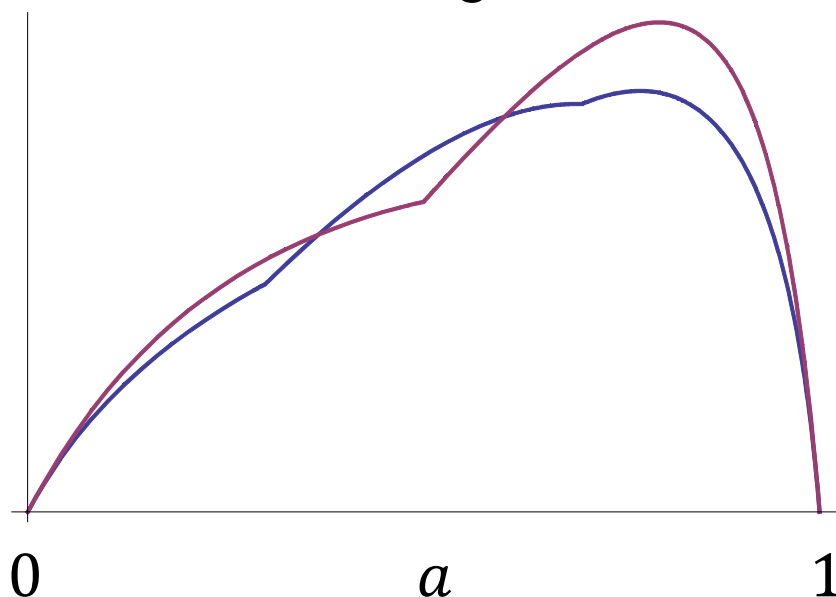
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- **Our Result:** Fails when bidders have asymmetric information!
- **Implication:** Revealing policy not necessarily optimal in a market with information asymmetry!
 - Breaks even in **first price auction** when each bidder and the auctioneer have **binary signals of different accuracy**

Failure of the Linkage Principle

- First Price Auction
- Value either 0 or 1, a prior is 1 with prob. a
- Player Y gets a binary signal that is correct with p_Y
- Player Z gets a binary signal that is correct with p_Z
- Seller has a signal that is correct with q



$U_Y + U_Z$: without revelation

$U_Y + U_Z$: with revelation

$p_Y = 0.9, p_Z = 0.75, q = 0.7$

How does extra information affect player utilities?

**Third Party
Information Sellers**



**Buy Access to
Extra Cookies**



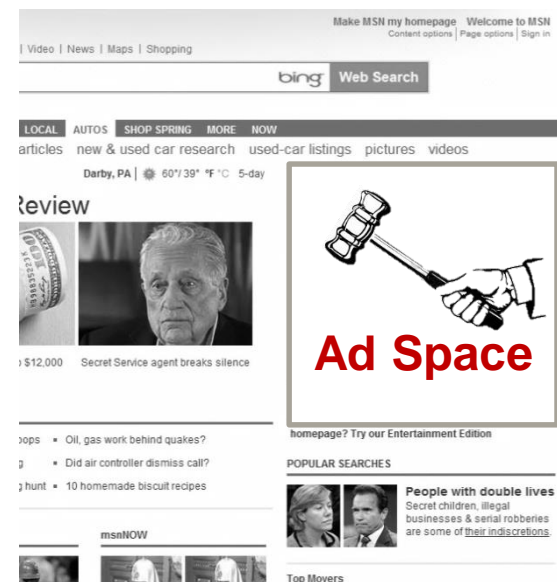
**Kayak
Cookie z**

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**Amazon
Cookie y**

hulu



Surprising Externality Effects

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But...

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But...

- Information can also have positive externalities
 - E.g. both bidders might strictly prefer that a specific bidder receives the extra signal

Recap

- **Information Asymmetries** in Common Value Auctions
- **Unique Equilibrium** if winner pays his bid with positive probability
- **Failure of the Linkage Principle** – Not always optimal for seller to reveal information even in pure common value
- **Complete Revenue Ranking**
Limit Equilibrium of Second Price \geq Hybrid \geq First Price
- Extra Information can have **positive externalities**