Pricing in Search Advertising

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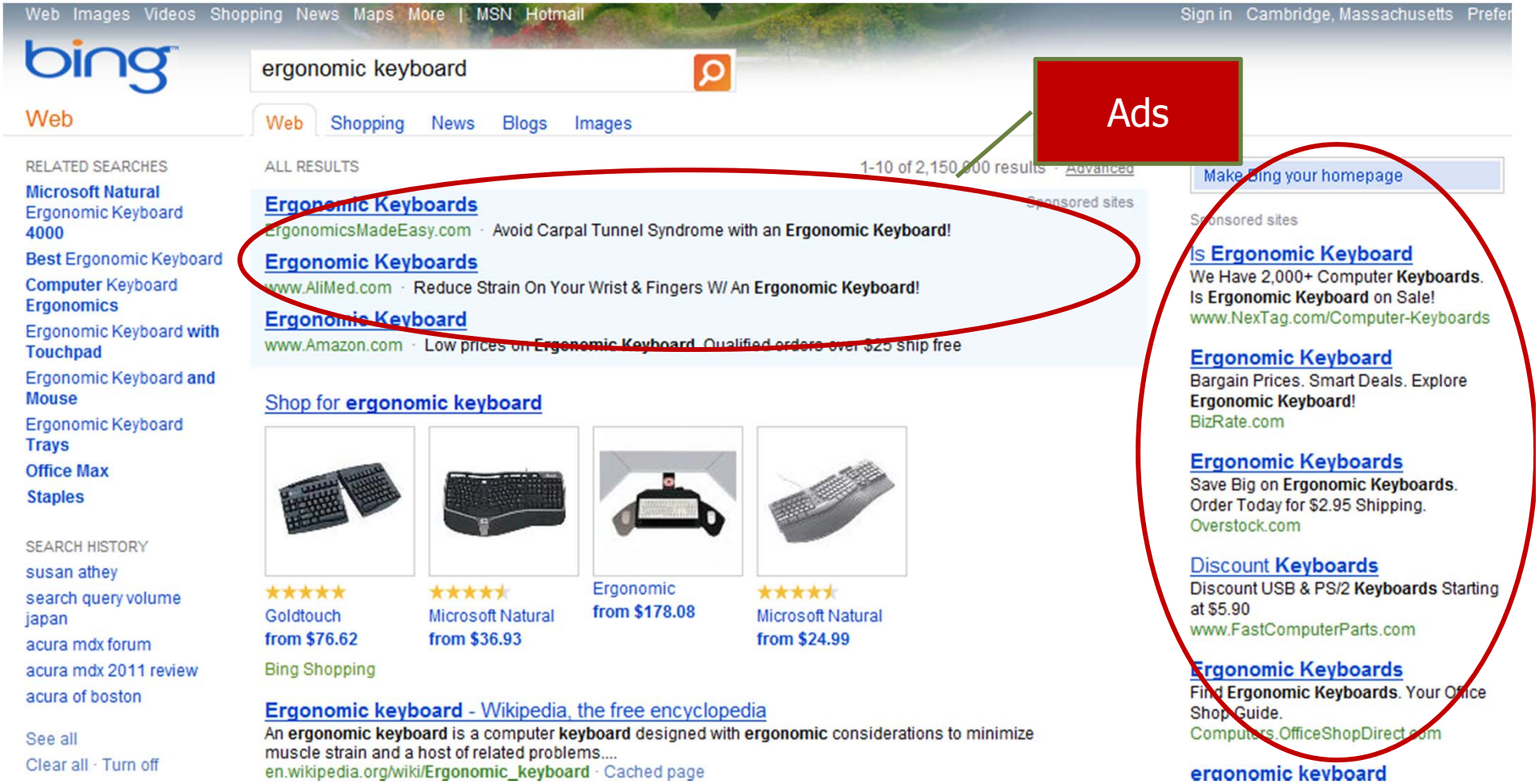
Disclaimer: The views in this presentation are my own and do not represent any institution.

Summary

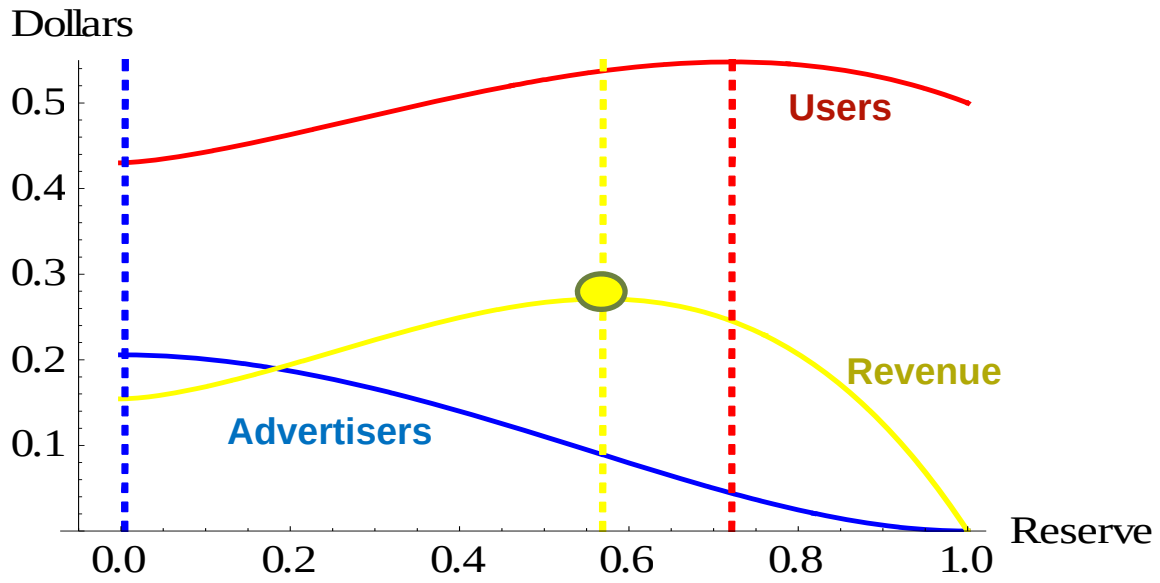
- **Pricing in internet search set by algorithms**
- **Technology allows for individualized prices and extensive price discrimination**
- **Economic principles carry over from standard *multi-sided* markets**
- **Measuring price changes and their efficiency consequences more subtle**
- **Literature:**
  - Varian; Edelman, Ostrovsky, & Schwarz (simplified auction overview)
  - Athey and Nekipelov; Edelman and Schwarz; Lahaie and Pennock (tradeoffs between efficiency and revenue)

Internet Search and Search Advertising



Balancing Constituents in Search Advertising

- Impact of raising reserve prices
  - Initially, allows better-quality algo results to appear
  - Eventually, ads are better than algo and users harmed
  - Advertisers and medium-term revenue in conflict



The click-weighted generalized second price auction

- **Opportunity cost of placing an ad is an *impression* in the same position**
- **Price for position *m* determined using *m* + 1st revenue per *impression***
- Multiply per-click bid by "clickability" score, *s,* to get per-impression bid
- "Clickability" is the click-through rate if ad were to be shown in top position
- **If *R* is a per impression reserve price, these would be prices:**

Per-Click Bid	Rank Score: Estimated Revenue Bid (normalized to 1st position)	Price Per Click	Estimated Revenue (normalized to 1st position)
b_1	$s_1 b_1$	$s_2 b_2 / s_1$	$s_2 b_2$
b_2	$s_2 b_2$	$s_3 b_3 / s_2$	$s_3 b_3$
b_3	$s_3 b_3$	$s_4 b_4 / s_3$	$s_4 b_4$
b_4	$s_4 b_4$	R / s_4	R

More Accurate Click Prediction Increases Efficiency, But Can Decrease Revenue

Per-Click Bid	Estimated Revenue Bid (normalized to 1st position)	Price Per Click	Platform Revenue (including position discounts)	Expected Clicks (including position discounts)
"Coarse" click predictor with two bidders with equal bids, clickability				
b	$b\,s$	b	$b\,s$	s
b	$b\,s$	$Rl\,s$	$\alpha_2\,R$	$\alpha_2\,s$
"Granular" click predictor identifies user types: Half of users like A better so true score is $(1+d)\,s$ for A and $(1-d)\,s$ for B Half of users like B better so true score is $(1+d)\,s$ for B and $(1-d)\,s$ for A				
b	$b\,(1+d)\,s$	$b\,(1-d)$ $/(1+d)$	$b\,(1-d)\,s$	$(1+d)\,s$
b	$b\,(1-d)\,s$	$Rl\,((1-d)\,s)$	$\alpha_2\,R$	$\alpha_2(1-d)\,s$
Differences in outcomes: "Granular" – "Coarse"				
			$-d\,s$	$(1-\alpha_2)\,d\,s$

Today, quality scores diverge from “clickability”

- **In practice, clickability replaced by the generalized quality score of the ad**
- Formulas not revealed, nor is objective of algorithm
- Can be set at search phrase x ad level
- Depends on landing page of the ad, and may include advertiser and industry characteristics
- **What can quality scores be used for?**
- Some advertisers could be individually penalized across the board
- Search engines have the ability to directly manipulate advertising prices via quality scores, through price discrimination practices such as “squashing”
- Quality scores can improve efficiency of rankings when clickability does not correspond to value creation, e.g. broad match, cases where ad text might confuse users

Quality scores and reserve prices in action

- **Notation:**
- c is true clickability, s is the score used, and α_j is the fraction of clicks an ad receives by being in position j instead of the top
- **Decreasing quality score for top bidder while increasing it for second bidder typically increases revenue collected**
- "Squashing" = put less weight on clickability (see Lahaie and Pennock)

Per-Click Bid	Rank Score: Estimated Revenue Bid (normalized to 1st position)	Price Per Click	Estimated Revenue (including position discounts)
b_1	$s_1 b_1$	$s_2 b_2 / s_1$	$b_2 (s_2 / s_1)\ c_1$
b_2	$s_2 b_2$	$s_3 b_3 / s_2$	$b_3 (s_3 / s_2)\ c_2 \alpha_2$
b_3	$s_3 b_3$	R / s_3	$R(1 / s_3)\ c_3 \alpha_3$

Tuning the Dials in Pricing and Allocation

- **There are a variety of dials and methods for managing marketplace**
- Number of ad slots, per-impression and per-click reserve prices, tweaking quality score formulas and algorithms, degree of discounting of poor-quality clicks from expanded matching or partner network
- Reserve prices price a substantial portion of clicks
- Marketplace management team "tunes dials" to balance users, advertisers and publisher revenue
  - Dials may be retuned for holiday season, in economic downturns, or to meet particular ad platform or publisher objectives
  - Third party publishers who syndicate search may have their own dial settings
- **There are a variety of other filters and restrictions on ads**
- Minimum relevance thresholds, quality scores, etc. for top ad blocks

Broad Match, Relevance Thresholds, and Pricing

- **Advertisers place bids on “broad match” keywords**
- Algorithms for matching are non-transparent
- Platform chooses which advertisers get to compete in the auctions
- Allowing more advertisers in increases prices at the expense of relevance
- Advertisers no longer bid in a single auction against the same advertisers, but rather each search query has a different set of competitors and a different auction

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