

# Targeting with Consumer Search: an Economic Analysis of Keywords Advertising

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# Introduction

Search engines make most of their profits through advertising.

Google : revenue of \$22 billion in 2008

How does advertising on search engines work?

# Introduction

- ▶ Choice of keywords
- ▶ Bidding : Generalized second price auction
- ▶ Sorting of ads according to bid and quality score
- ▶ Per-click payment

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Keyword advertising  $\implies$  better targeting of consumers by announcers (intent-related)

Questions:

- ▶ How does keyword advertising affect the strategic interactions between firms?
- ▶ Is the targeting technology welfare improving?
- ▶ What are the incentives of the search engine to manipulate the mechanism?

# Introduction

Basic ingredients of the model

Firms will choose

- ▶ Price of the good
- ▶ Set of keywords

Demand's characteristics

- ▶ Heterogenous tastes
- ▶ Search costs

# Introduction

Preview of the results:

- ▶ Targeting is welfare improving;
- ▶ The search engine will either improve or deteriorate the matching quality.

# The model

## Product space and preferences

- ▶ Heterogenous product space (à la Salop): unit circle, continuum of firms,  $c = 0$ , continuum of consumers.
- ▶ Utility  $u = v(d) - p$ , with  $v'(\cdot) < 0$ .

## Information frictions

- ▶ Consumers cannot observe the price nor the position on the circle directly.
- ▶ Search cost  $s$  to learn price and position.

# Timing

- ▶ Search engine sets advertising per-click fee  $a$ .
- ▶ Firm  $i$  sets price  $p_i$  and keywords  $K_i = [i - D; i + D]$
- ▶ Consumers enter keyword  $k = \text{ideal product}$ .
- ▶ Sequential search among  $\{i/k \in K_i\}$ : optimal stopping rule

# Equilibrium

I look for symmetric Perfect Bayesian Equilibria .

- ▶ Firms maximize their profits given other firms's strategies and consumers' stopping rule.
- ▶ Consumers choose the optimal stopping rule given firm's strategies.
- ▶ Search engine maximizes its profit w.r.t.  $a$

# Optimal search process 1

Consumers expect firms to play  $\sigma^* = (p^*, D^*)$ .

Expected value of a click

$$\int_{0^*}^{D^*} \frac{v(x) - p^*}{D^*} dx$$

Expected improvement after first offer at distance  $d$ :

$$I(d) \equiv \int_0^d \frac{v(x) - v(d)}{D^*} dx$$

## Optimal search process 2

If firms set  $p = p^*$ , reservation distance  $R^*$  such that

$$I(R^*) = s$$

If a consumer faces  $p \neq p^*$ , he buys iff

$$d \leq R(p, \sigma^*)$$

where  $R(p, \sigma^*)$  is such that

$$v(R(p, \sigma^*)) - p = v(R^*) - p^*$$

# Properties of stopping rule

Consumer's strategy: buy at price  $p$  iff  $d \leq R(p, \sigma^*)$

$$\frac{\partial R(p, \sigma^*)}{\partial p} < 0$$

$$\frac{\partial R(p, \sigma^*)}{\partial p^*} > 0$$

outside-option effects:

$$\frac{\partial R(p, \sigma^*)}{\partial D^*} > 0$$

$$\frac{\partial R(p, \sigma^*)}{\partial s} > 0$$

# Firms' strategy

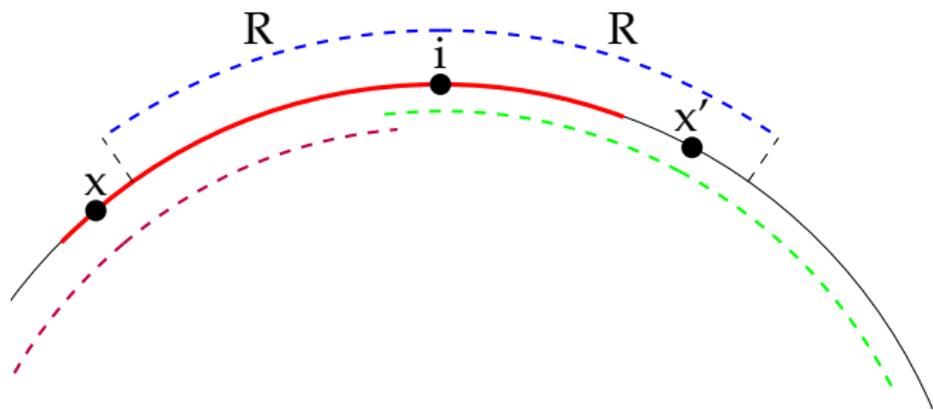
Advertising strategy: Firm  $x$  targets consumer  $y$  iff

$$p \Pr(y \text{ buys } x\text{'s product} | y \text{ clicks on } x\text{'s link}) - a \geq 0$$

Lemmas 1 and 2: In a symmetric equilibrium,  $D = R(p, p, D)$ :

no additional search.

# Intuition of the proof



**Profit:**  $\pi(p) \propto (p - a)(R(p, \sigma^*))$

# Existence and unicity of equilibrium

If

1. For any  $p$ ,  $R(p, p, 1/2) < 1/2$ .
2.  $\psi : x \mapsto v'(x) + xv''(x)$  satisfies the single crossing property.
3.  $\forall x \in [0; 1/2], xv''(x) + 2v'(x) \leq 0$

Then there exists a unique symmetric PBE.

The SE chooses  $a$  s.t.  $E[v(d)|d \leq D^*] - p(a) - s = 0$ .

# Effects of search costs

Holding  $a$  constant, price rises with search cost.

However, a rise in  $s$  leads the SE to lower  $a$ .

# A benchmark: Wolinsky 1983

In his model, firms cannot target consumers.

- ▶ Targeting reduces search costs.
- ▶ Targeting improves the quality of matches.
- ▶ Welfare unambiguously rises with targeting.
- ▶ Ambiguous effect on the price.

# Strategic search engine

Search engines are strategic intermediaries.

Examples:

- ▶ Maps;
- ▶ Weighting of bids according to a quality score;
- ▶ Broad match technology.

# Strategic search engine

SE chooses both  $D$  and  $a$ , while firms choose  $p$ .

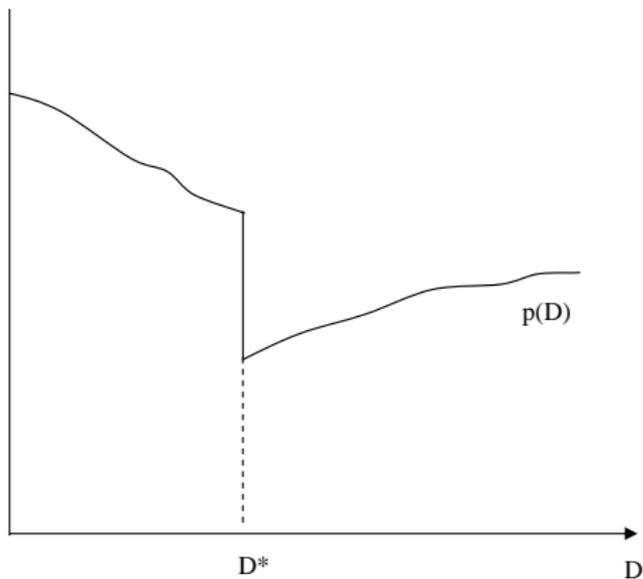
Suppose that SE set  $D = 0$ : perfect matching.

The only equilibrium is the “monopoly” price  $p = v(0)$ .

$$EU = v(0) - p - s = -s < 0$$

# Strategic search engine

Suppose SE chooses  $D$  and firms choose  $p$ .



# Intuitions

In order to sell to a consumer, 2 constraints:

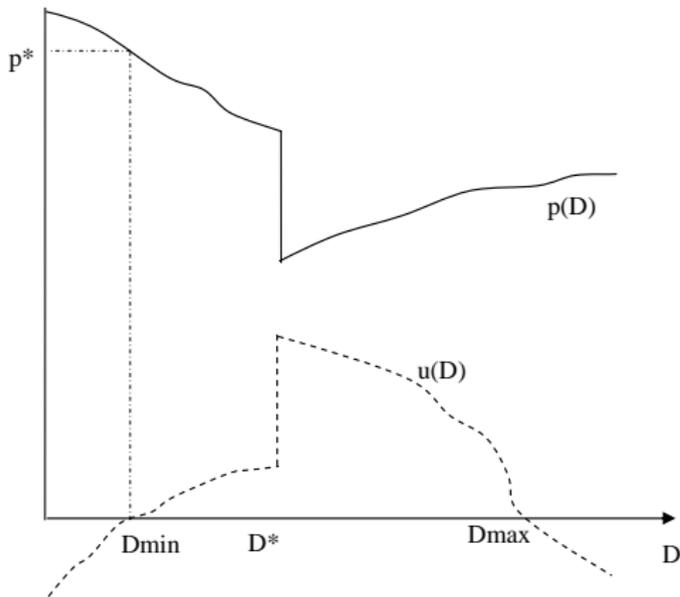
- ▶ utility  $\geq 0$  (IR);
- ▶ utility  $\geq$  outside option (OO);

For  $D$  small, (IR) $\Rightarrow$  (OO).

For  $D$  large, (OO) $\Rightarrow$  (IR).

# Optimal matching accuracy

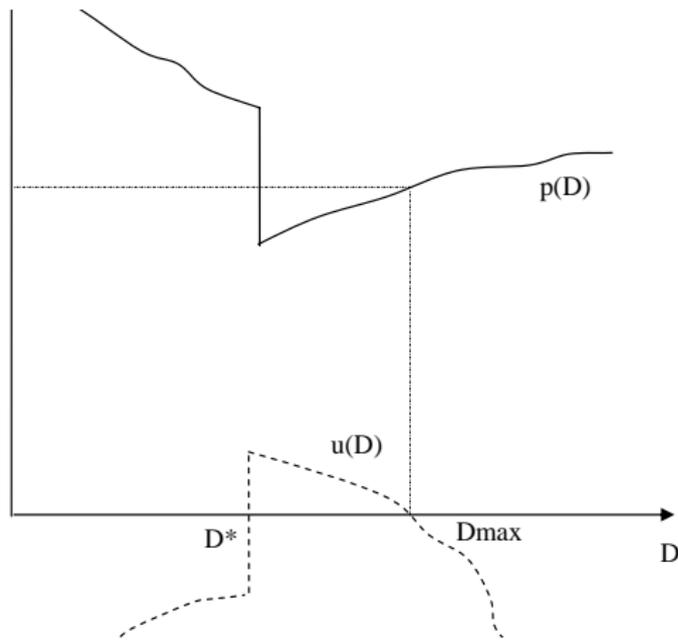
SE wants to implement a high price.



Here, the outcome is constrained efficient.

# Optimal matching accuracy

But the outcome may also be inefficient:  $b > 1$ .



## Related literature

- ▶ Wolinsky (1983), Bakos (1997): framework
- ▶ Athey and Ellison (2007), Armstrong, Vickers and Zhou (2007): search models with SE
- ▶ Diamond (1971), Anderson and Renault (2000): hold-up problem
- ▶ Iyer, Soberman and Villas-Boas (2005), Esteban, Gil and Hernandez (2001): Ability to target  $\implies$  Differentiation  $\implies$  Market power.
- ▶ Grossman and Shapiro (1984): targeting  $\implies$  better information  $\implies$  price drops.
- ▶ Two-sided markets; Baye and Morgan (2004), Hagiu and Jullien (2009), White (2008)

# Conclusion

“Methodological” contribution:

- ▶ model with search and targeted advertising

Results:

- ▶ Targeting is welfare improving
- ▶ Potential scope for manipulation, efficient or inefficient.