# Ad Server and Firm Strategies in Contextual Advertising Auctions

Charlie Gibbons
Department of Economics
University of California, Berkeley

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# Overview

Contributions of this paper:

- Define a model of consumer behavior in ad listings,
- Derive firm equilibrium bidding strategies,
- Consider rationality of consumer behavior, and
- Compare ad server incentives to the desires of firms and consumers, including
  - Improving match quality,
  - Reducing search costs,
  - Establishing length of the listing, and
  - Privileging its own firm's ad.

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- Incentives for innovation
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# Structure

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Consumers have lexicographic preferences for the good being offered by firm $j$:

$$v_{ij} = \begin{cases} v_i & \text{with probability } q_j \text{ and} \\ 0 & \text{with probability } 1 - q_j. \end{cases}$$

$q_j$ is the *relevance* of firm $J$.

$v_i \sim F$

This formulation allows

- Product differentiation yielding
- Many firms with positive market share

# Firm qualities

All firms charge the same price $p$.

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Firm $j$ has relevance $q_j$ and a margin of $m_j$. Let the index $j$ reflect the rank of the firm's full expected margin $q_j m_j$.

We show that this ranking maps directly to the ad slot placement of firm $j \leq M$ in equilibrium for an arbitrary $M$.

# Consumer behavior

A consumer begins by deciding whether to look at the ads at all; this occurs with probability $s_0$.

If he does, he starts by visiting the site of the first ad. He determines whether that product is relevant for him and whether the price is less than his valuation. If so, he makes the purchase and his search ends.

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Consumers do not search for the best price; since prices are the same across firms, this does not matter.

# Quantities of interest

From this model, we can derive

- The *click through rate* $r_j$
  Proportion of consumers that visit site $j$,
- Demand for the product of firm $j$,
- Demand per click,
- Expected margin per click
  Relevant quantity when paying per click in ad auction,
- Equilibrium bids by firms for slots, and
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- Total revenue received by ad server.

Using our results for total ad revenue, we can consider the incentives facing the ad server to change the structure of the market and how these incentives compare to the desires of consumers and firms.

# Changing the probability of matches

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For concreteness, let:

- The number of firms be 10,
- The number of slots be 9,
- $s_j = 1$ for all slots
  Consumers don't give up,
- All firms have a relevance of $q = 0.2$, and
- Margins range from 0.1 to 1.0.

# Changes in revenue

Suppose that we increase $q$ proportionally.

- The expected full margin increases
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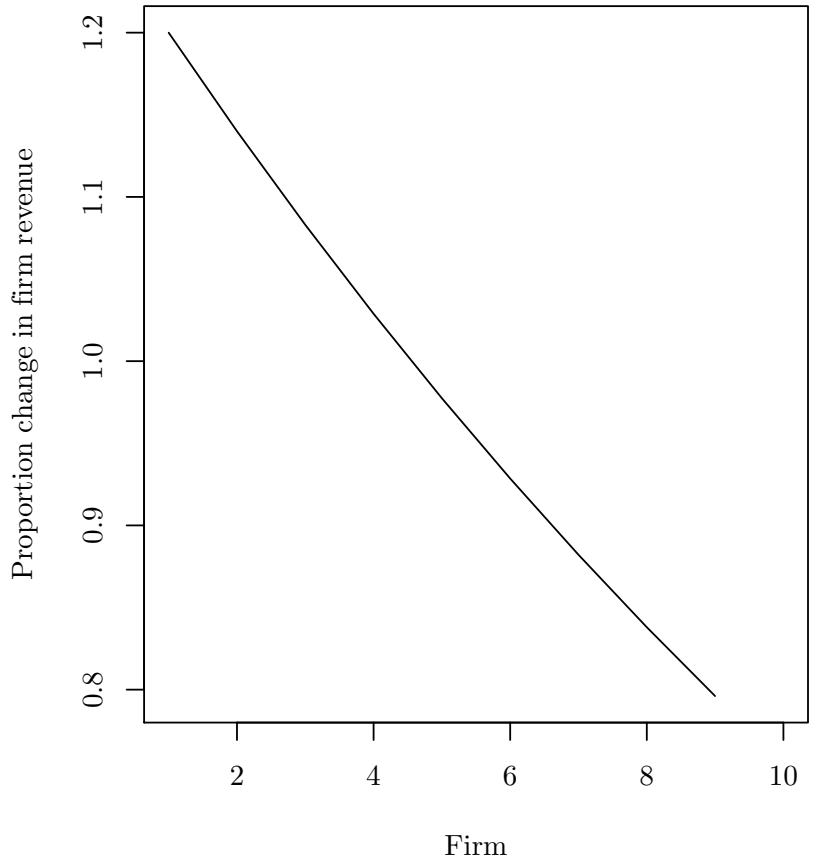
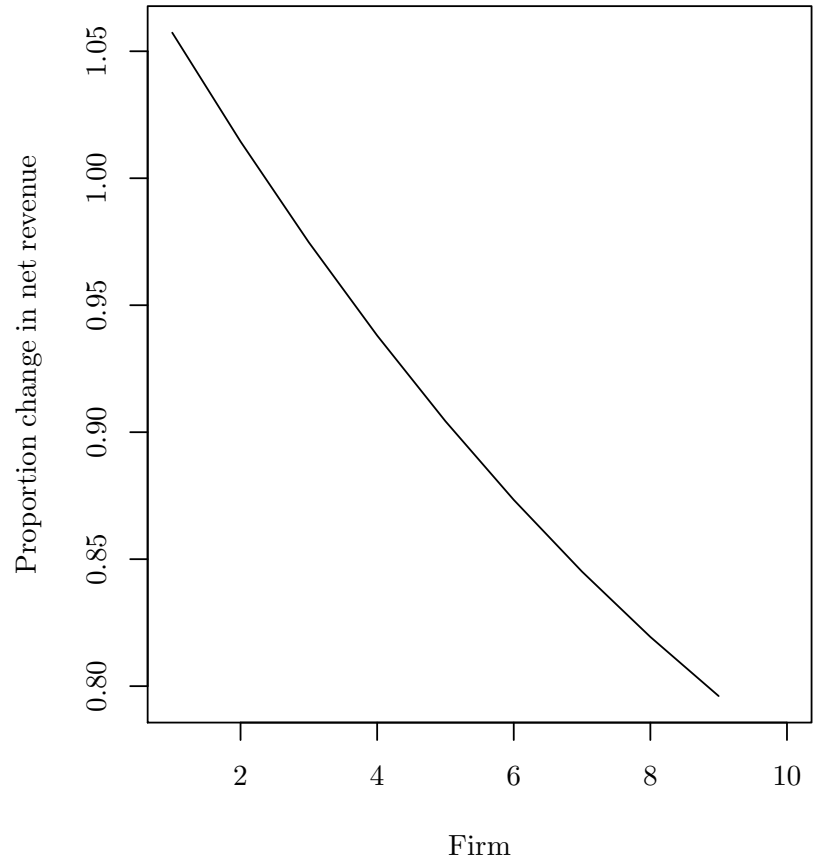
These opposing forces lead to an ambiguous impact on revenue generated by a particular slot.



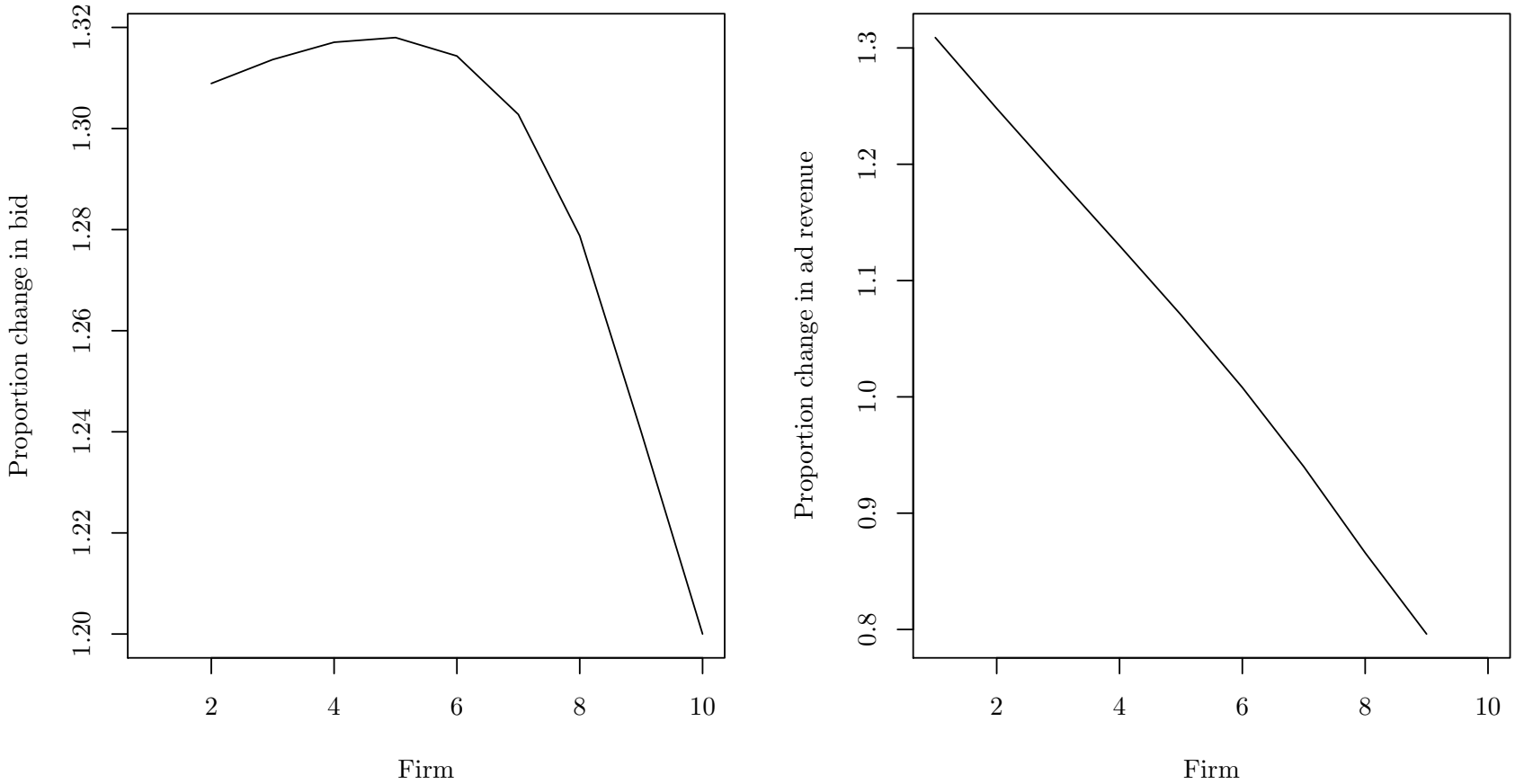

(a) Firm revenues




(b) Firm net revenues

Figure: Impact of a 20% increase in relevance from $q = 0.2$

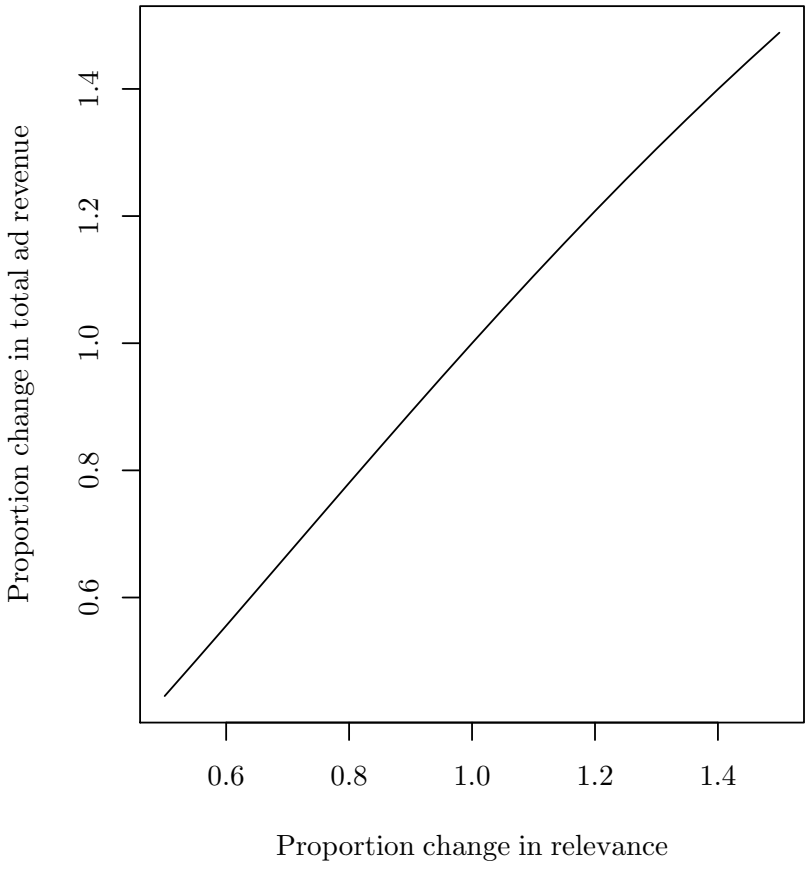
All but the top 2 firms lose net profit after the change; total net profit falls by 2.2%.



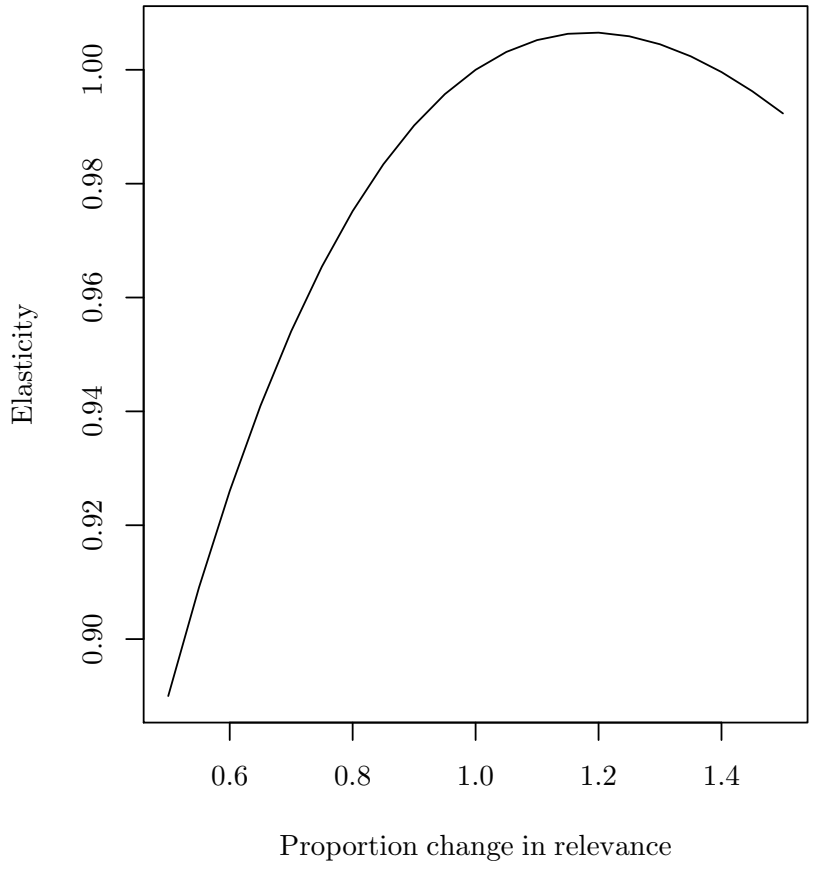

(a) Bids (b) Ad revenues

Figure: Impact of a 20% increase in relevance from $q = 0.2$

Bids increase by at least 20%, but impact on revenue is positive for top firms and negative for lower firms; overall revenue increases by 21%.

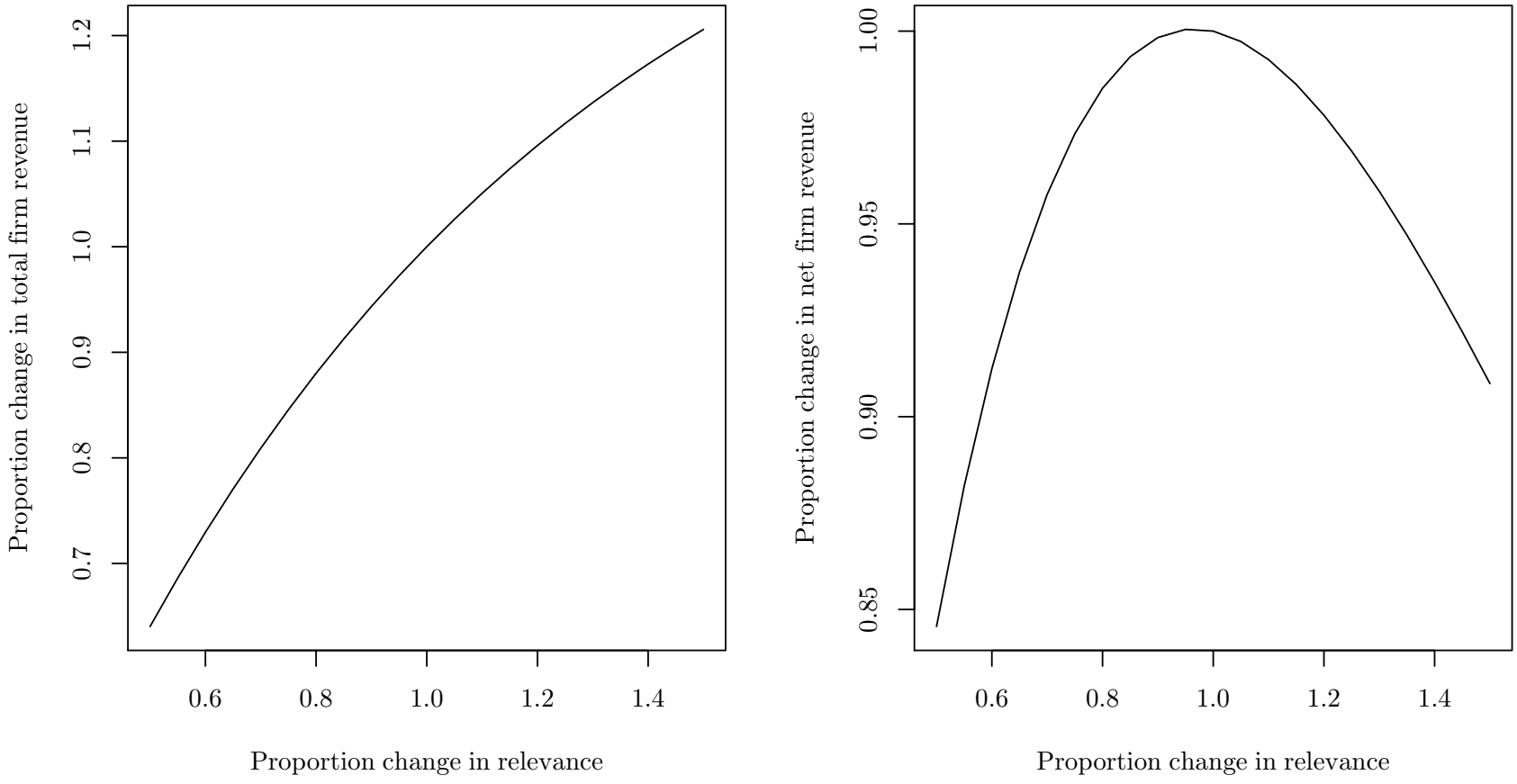



(a) Total ad revenue




(b) Ad elasticity

Figure: Impact of changes in relevance from $q = 0.2$ on aggregates




(a) Total firm revenues

(b) Total firm net revenues

Figure: Impact of changes in relevance from $q = 0.2$ on aggregates

Firms in total prefer $q = 0.19$.

# Summary of incentives in changing relevances

Firms in total have a clear preferred value for the relevance.

Even still, top-ranked firms gain, while low-ranked firms lose from increases in match probabilities.

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The relevance that maximizes the ad server's profit depends upon the cost of innovating, but may well be higher than that desired by firms.

Consumers unambiguously prefer higher relevances.

# Optimal number of ads

In choosing the optimal (from its perspective) number of ads $M$ to display, the ad server chooses to satisfy

$$\frac{m_{M+2}q_{M+2}}{m_{M+1}q_{M+1}} \geq \frac{M}{M+1};$$

the ratio of full expected margins between a firm and the next higher ranked firm must be large (the differences between them must be small).

This accords with the fact that the ad server wants to minimize the dispersion in full margins to maximize profits.

# Self-subsidization

Suppose that the ad server has a separate division that sells the product being advertised. What incentive does the ad server have to subsidize the bid of that firm to raise it to the top of the list?

# Incentives to self-subsidize

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Consider a case with

- All firms having margins of 1,
- $s = 1$, and
- Relevances that vary from 0.5 to 0.05.

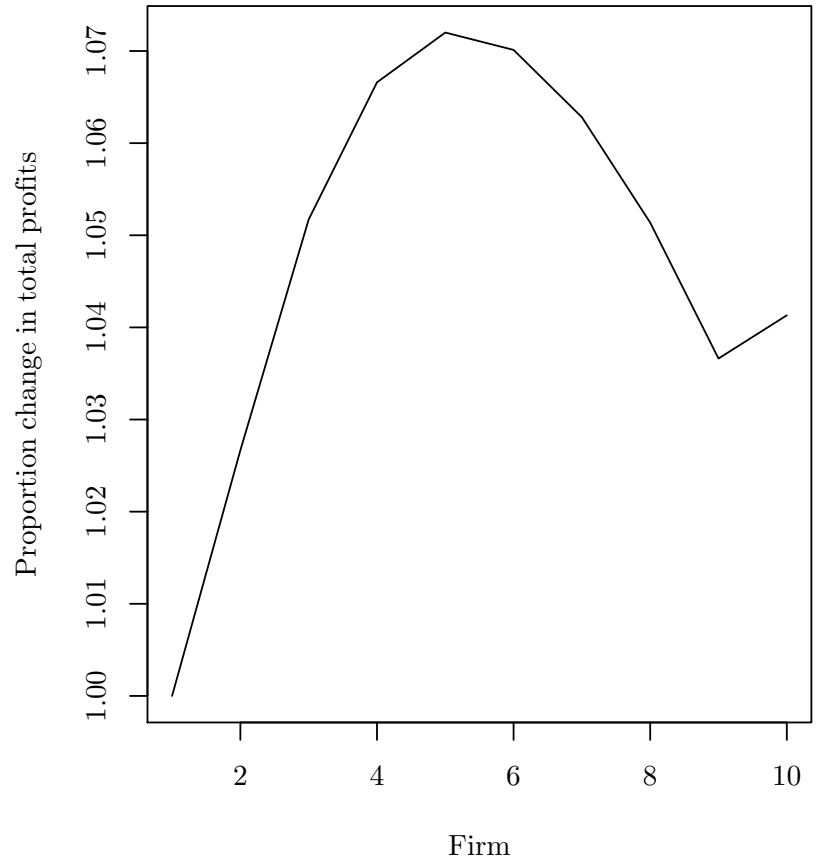


Figure: Change in ad server profits from ad and product sales from privileging its own firm

No matter which slot its own firm would be assigned under an unsubsidized ordering, the ad server has an incentive to place it at the top of the listing. This changes the sizes and distributions of producer and consumer surpluses.

# Conclusions

In the case of increasing relevances and decreasing search costs, the interests of the ad server and consumers align.

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The ad server wants fewer firms listed than consumers prefer and have an incentive to privilege its own firm selling the advertised product, reducing the matching probabilities for consumers. These actions also lowers total producer surplus.

These later points have important implications for competition policy.