Wasn't That Ad for an iPad? Display Advertising's Impact on Advertiser- and Competitor-Branded Search

Randall Lewis
Yahoo! Research*

Dan Nguyen
University of Chicago

*This research was done at Yahoo! during summer 2011. Randall Lewis now works at Google, Inc.

Outline

Outline

Introduction

- The purpose of this paper is to understand how display advertising affects consumers' online search behaviors.

Introduction

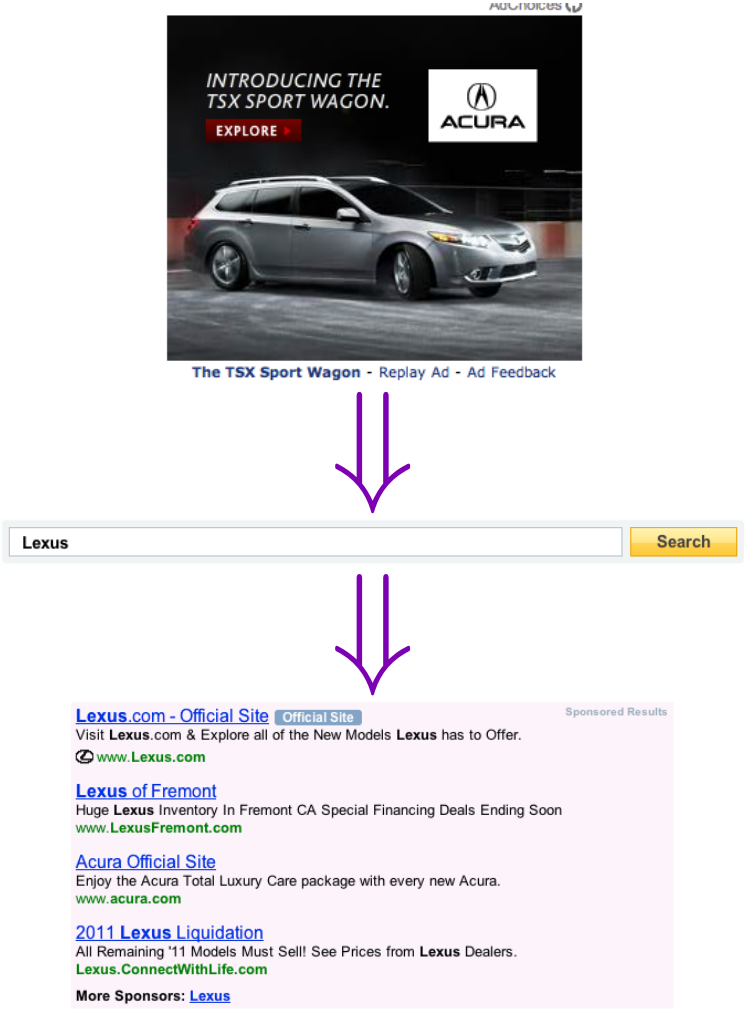
- The purpose of this paper is to understand how display advertising affects consumers' online search behaviors.
- We hypothesize that display ads cause consumers to search for the advertised brand.

Introduction

- The purpose of this paper is to understand how display advertising affects consumers' online search behaviors.
- We hypothesize that display ads cause consumers to search for the advertised brand.
- We also hypothesize that display ads cause consumers to search for competitors' brands because the ad also primes the product category.

Introduction

- The purpose of this paper is to understand how display advertising affects consumers' online search behaviors.
- We hypothesize that display ads cause consumers to search for the advertised brand.
- We also hypothesize that display ads cause consumers to search for competitors' brands because the ad also primes the product category.
- We use our findings to explore the economic impacts of advertising spillovers display advertising market on the search advertising market and on firms' investment in advertising.



Related Literature

Research on Advertising and Online Searching

- Mayzlin and Shin (2011): separating equilibrium in which high quality firms opt invite the consumer to search.
- Swasy and Rethans (1986): found in the lab that advertising for new products creates curiosity among consumers with high product category knowledge.
- Menon and Soman (2002): advertising that cued curiosity increased time spent and attention on gathering information but did not increase the number of clicks on links for more information.

Related Literature

Research on Advertising and Online Searching

- Mayzlin and Shin (2011): separating equilibrium in which high quality firms opt invite the consumer to search.
- Swasy and Rethans (1986): found in the lab that advertising for new products creates curiosity among consumers with high product category knowledge.
- Menon and Soman (2002): advertising that cued curiosity increased time spent and attention on gathering information but did not increase the number of clicks on links for more information.

Research on Effects Across Media Channels

- Alba and Chattopadhyay (1985): cueing a brand inhibited recall of other category and related brands.
- Nedungadi (1990): priming of a minor brand increases retrieval and consideration of major brand, but not vice versa.

Related Literature

Research on Display Advertising Effectiveness

- Dreze and Hussherr (2003): users avoid looking at display ads, but frequency increased unaided brand recall.
- Lewis (2010): click-through rates modestly decline in the number of impressions shown a user.
- Goldfarb and Tucker (2011a,b): limits on targeting reduce, but match and obtrusiveness increase ad effects on surveyed purchase intent.

Related Literature

Research on Display Advertising Effectiveness

- Dreze and Hussherr (2003): users avoid looking at display ads, but frequency increased unaided brand recall.
- Lewis (2010): click-through rates modestly decline in the number of impressions shown a user.
- Goldfarb and Tucker (2011a,b): limits on targeting reduce, but match and obtrusiveness increase ad effects on surveyed purchase intent.

Research using Search to Measure Ad Effectivness

- Joo, Wilbur, and Zhu (2011): consumers' exposure to branded TV ads is correlated with online searches for these brands.

Outline

Outline

The Natural Experiment

- Yahoo! sells the primary ad unit on Yahoo!'s front page, www.yahoo.com, to one advertiser for the whole day or splits the day between two advertisers.

The Natural Experiment

- Yahoo! sells the primary ad unit on Yahoo!'s front page, www.yahoo.com, to one advertiser for the whole day or splits the day between two advertisers.

- In an ad split, Yahoo! rotates delivery of the two advertisers' ads every second.

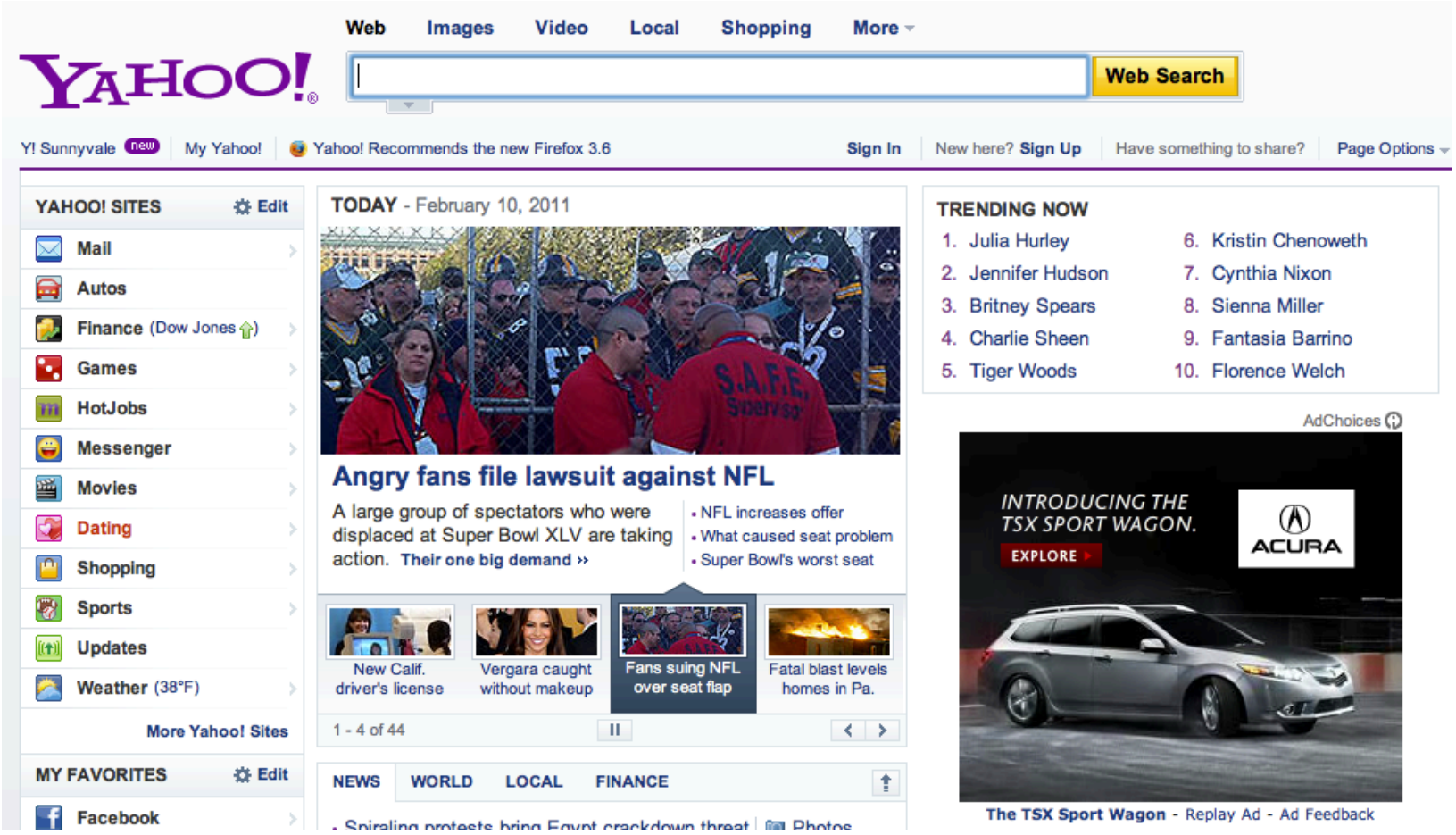
The Natural Experiment

- Yahoo! sells the primary ad unit on Yahoo!'s front page, www.yahoo.com, to one advertiser for the whole day or splits the day between two advertisers.
- In an ad split, Yahoo! rotates delivery of the two advertisers' ads every second.
- Users who arrive on "even" seconds see one advertiser's ad while those who arrive on "odd" seconds see the other ad.

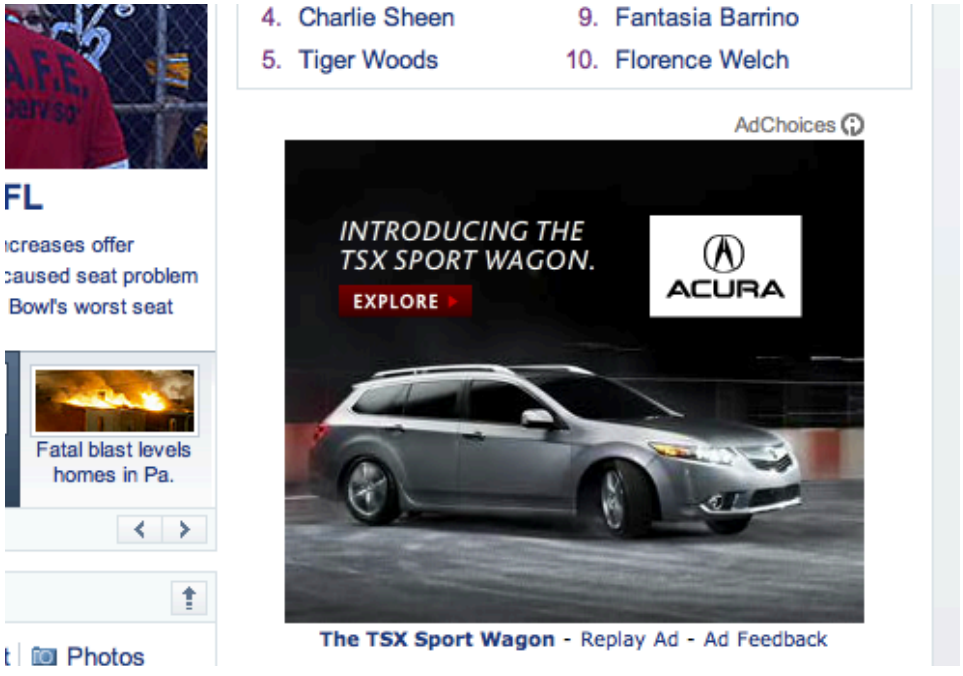
The Natural Experiment

- Yahoo! sells the primary ad unit on Yahoo!'s front page, www.yahoo.com, to one advertiser for the whole day or splits the day between two advertisers.
- In an ad split, Yahoo! rotates delivery of the two advertisers' ads every second.
- Users who arrive on "even" seconds see one advertiser's ad while those who arrive on "odd" seconds see the other ad.
- This provides a natural experiment to analyze the effects of advertising.

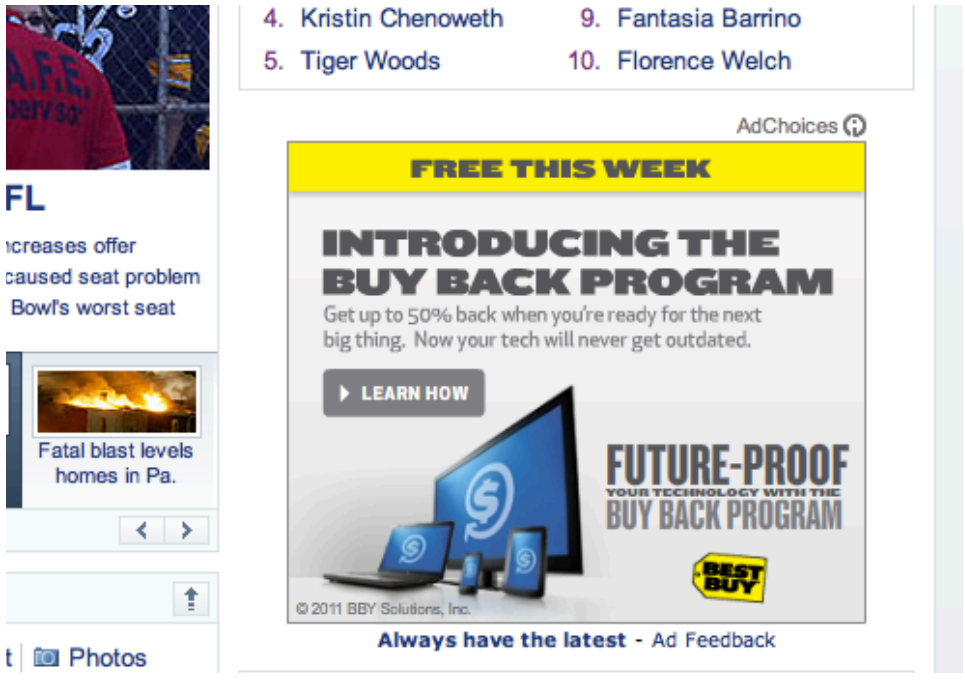
Example of Ad Split on February 10, 2011



Example of Ad Split on February 10, 2011



Example of Ad Split on February 10, 2011



Treatment v. Control

- We use ad splits where the target and control ads were from unrelated product categories.

Treatment v. Control

- We use ad splits where the target and control ads were from unrelated product categories.
- We record the anonymous user's searches on Yahoo! for ten minutes after the ad is delivered.

Treatment v. Control

- We use ad splits where the target and control ads were from unrelated product categories.
- We record the anonymous user's searches on Yahoo! for ten minutes after the ad is delivered.
- The delivery of each target (control) ad impression marks the start of a treatment (control) period.

Treatment v. Control

- We use ad splits where the target and control ads were from unrelated product categories.
- We record the anonymous user's searches on Yahoo! for ten minutes after the ad is delivered.
- The delivery of each target (control) ad impression marks the start of a treatment (control) period.
- Each period ends either after ten minutes or when another impression is delivered to the same user, whichever comes first.

Treatment v. Control

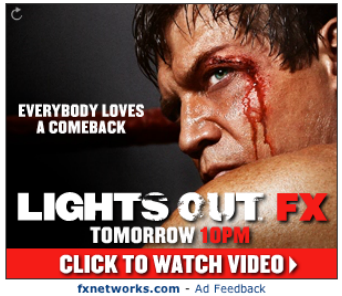
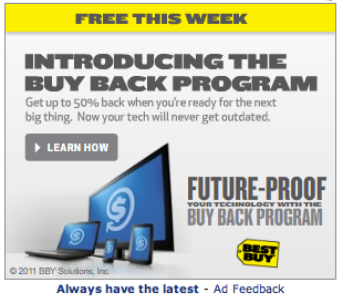
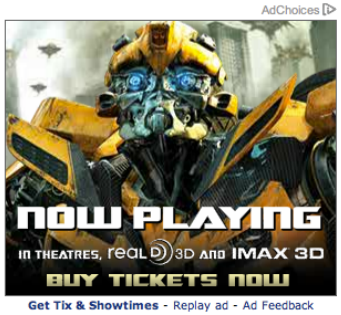
- We use ad splits where the target and control ads were from unrelated product categories.
- We record the anonymous user's searches on Yahoo! for ten minutes after the ad is delivered.
- The delivery of each target (control) ad impression marks the start of a treatment (control) period.
- Each period ends either after ten minutes or when another impression is delivered to the same user, whichever comes first.
  - Ten minutes should be long enough for users to act upon the ad and short enough to avoid misattributing activities to the wrong ad impression.

Treatment v. Control

- We use ad splits where the target and control ads were from unrelated product categories.
- We record the anonymous user's searches on Yahoo! for ten minutes after the ad is delivered.
- The delivery of each target (control) ad impression marks the start of a treatment (control) period.
- Each period ends either after ten minutes or when another impression is delivered to the same user, whichever comes first.
  - Ten minutes should be long enough for users to act upon the ad and short enough to avoid misattributing activities to the wrong ad impression.
  - A ten minute window also yields the most statistical power.

Outline

The Ad Campaigns

Date of Ad Split	Target Ad	Control Ad
11 January 2011	 Compare and Save - Ad Feedback	 fxnetworks.com - Ad Feedback
10 February 2011	 The TSX Sport Wagon - Replay Ad - Ad Feedback	 Always have the latest - Ad Feedback
29 June 2011	 It's Time to Tab - Ad Feedback	 Get Tix & Showtimes - Replay ad - Ad Feedback

The Search Keywords

- We recorded searches that had the advertiser's or competitors' brands as search terms.

The Search Keywords

- We recorded searches that had the advertiser's or competitors' brands as search terms.
- Lists of competitors' brands were collected online.

The Search Keywords

- We recorded searches that had the advertiser's or competitors' brands as search terms.
- Lists of competitors' brands were collected online.
- Progressive's Competitors' Brands
  - 14 brands.
  - Examples: State Farm, Allstate, Geico, and USAA.
  - Source: Dec. 2009 Mintel auto insurance industry report.

The Search Keywords

- We recorded searches that had the advertiser's or competitors' brands as search terms.
- Lists of competitors' brands were collected online.
- Progressive's Competitors' Brands
  - 14 brands.
  - Examples: State Farm, Allstate, Geico, and USAA.
  - Source: Dec. 2009 Mintel auto insurance industry report.
- Acura's Competitors' Brands
  - 36 brands.
  - Examples: Audi, BMW, Ford, and Lexus.
  - Source: Autobytel.com.

The Search Keywords

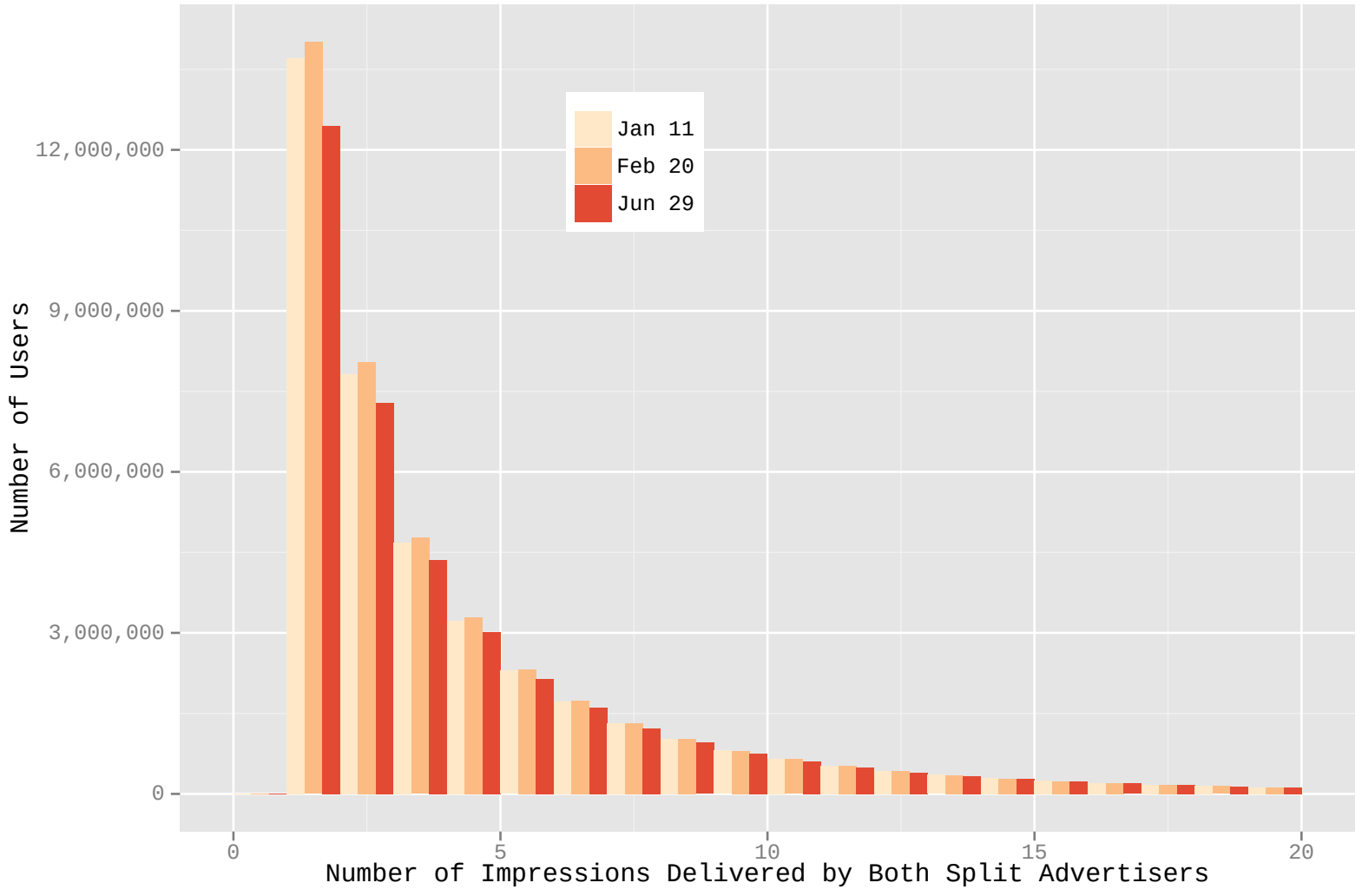
- We recorded searches that had the advertiser's or competitors' brands as search terms.
- Lists of competitors' brands were collected online.
- Progressive's Competitors' Brands
  - 14 brands.
  - Examples: State Farm, Allstate, Geico, and USAA.
  - Source: Dec. 2009 Mintel auto insurance industry report.
- Acura's Competitors' Brands
  - 36 brands.
  - Examples: Audi, BMW, Ford, and Lexus.
  - Source: Autobytel.com.
- Samsung Galaxy Tab's Competitors' Brands
  - 15 brands.
  - Examples: Apple iPad, Blackberry Playbook, and Motorola Xoom.
  - Source: "CNET looks at current and upcoming tablets" (July 29, 2011).

Outline

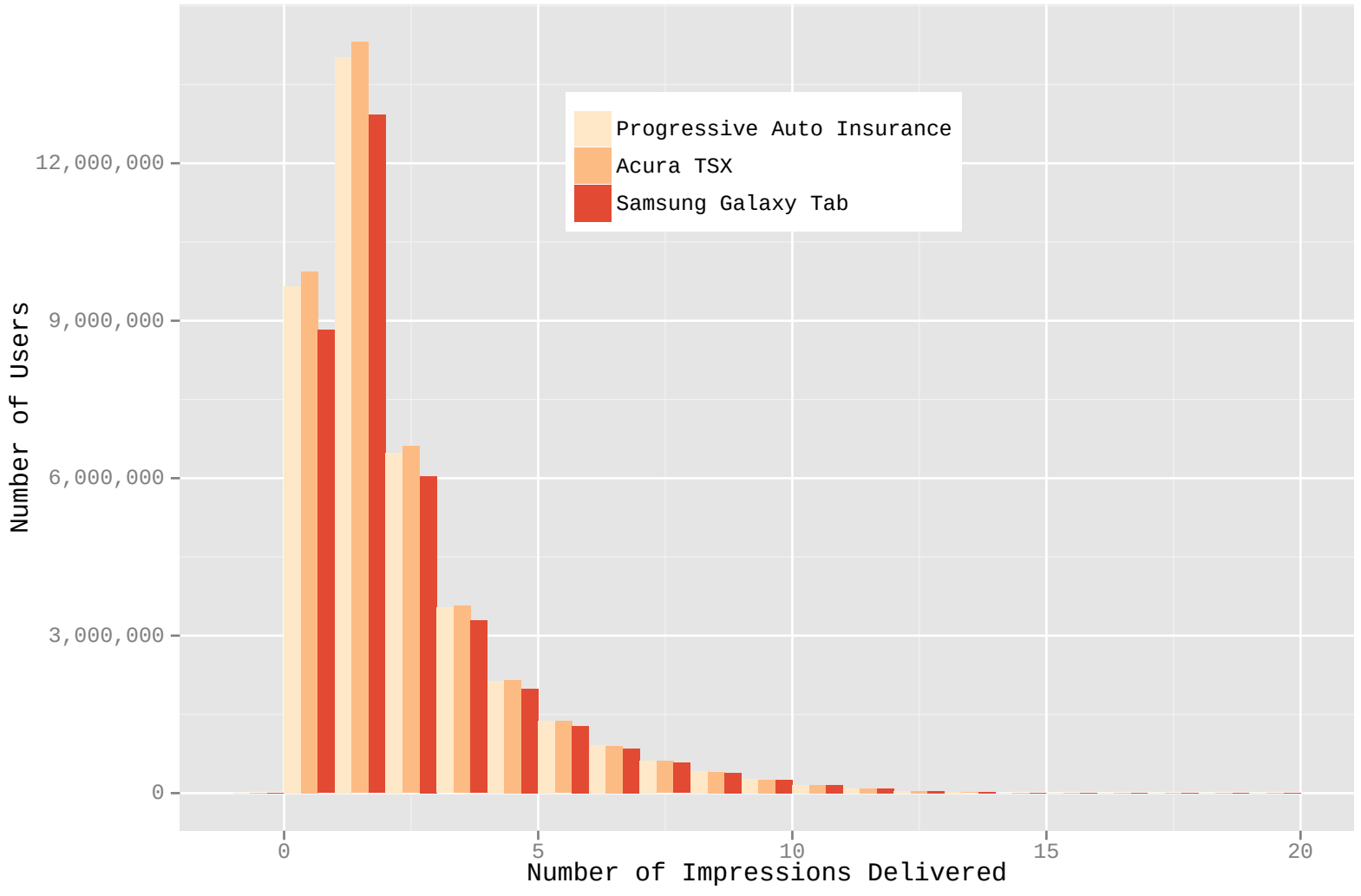
Data Summary

Variables and Statistics	Progressive Auto Insurance	Acura TSX	Samsung's Galaxy Tab
Date of Ad Split	2011/01/11	2011/02/10	2011/06/29
Sample Sizes			
Total Number of Unique Visitors	40,673,687	41,313,836	37,620,318
Total Number of Visits	171,953,331	171,593,781	161,460,200
Total Number of Exposures to the Target Ad	86,152,779	85,684,914	80,866,903
Percentage of Users Who Searched for Relevant Keywords	0.06%	0.80%	0.04%
Total Number of Visits per User			
Mean	4.23	4.15	4.29
Median	2.00	2.00	2.00
Total Number of Exposure to the Target Ad per User			
Mean	2.12	2.07	2.15
Median	1.00	1.00	1.00

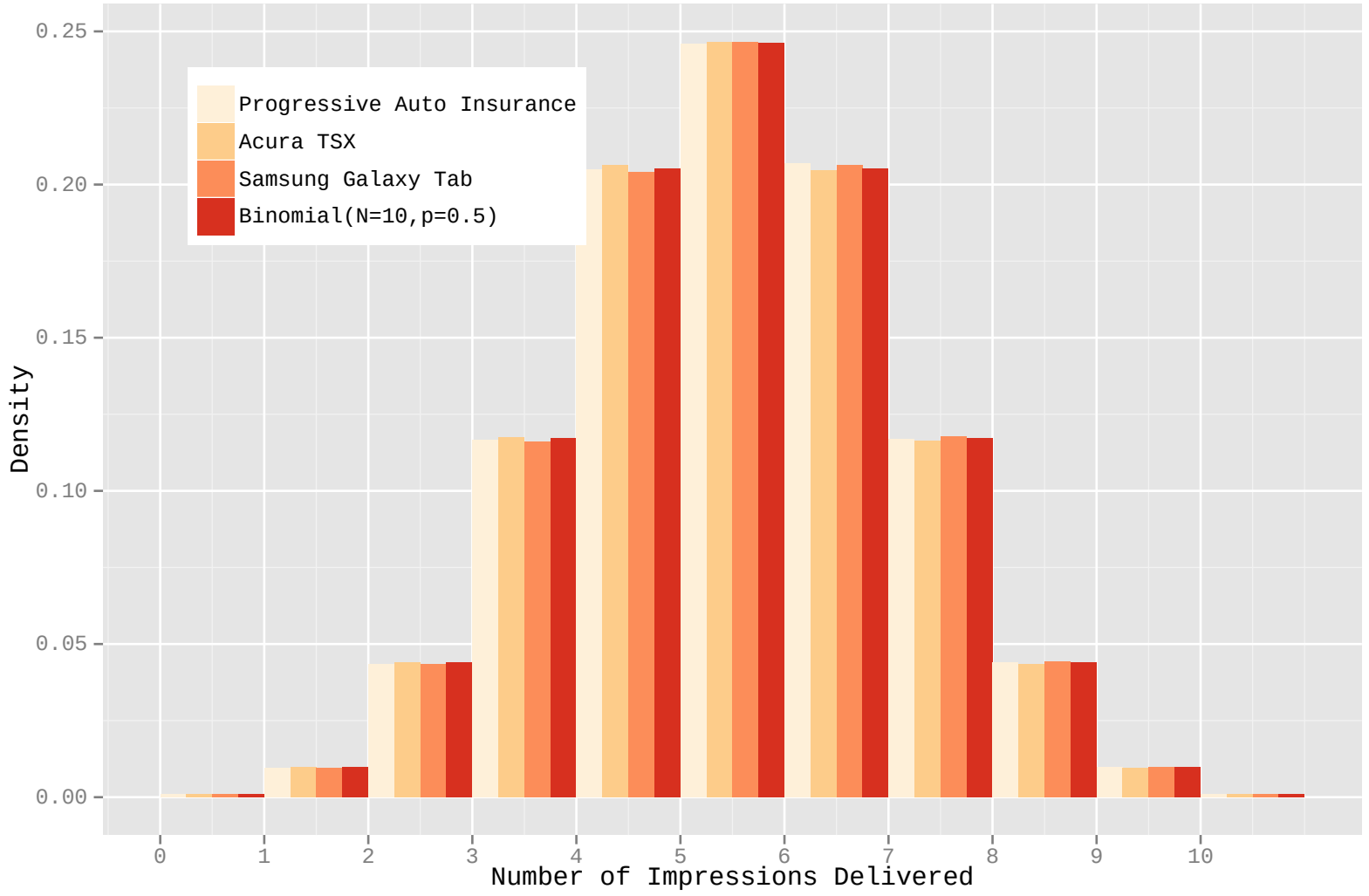
Distribution of Total Number of Visits



Distribution of Total Number of Exposures to the Test Ad



Distribution of Total Number of Exposures to the Target Ad for Users Who Visited the Front Page 10 times



Outline

Outline

Measuring the Search Lift

$$Search_{ijt} = \alpha_j + \beta_j AD_{it} + \epsilon_{ijt}$$

Measuring the Search Lift

$$Search_{ijt} = \alpha_j + \beta_j AD_{it} + \epsilon_{ijt}$$

- $Search_{ijt}$ is a indicator variable equal to one if user i searched for brand j during period t.

Measuring the Search Lift

$$Search_{ijt} = \alpha_j + \beta_j AD_{it} + \epsilon_{ijt}$$

- $Search_{ijt}$ is a indicator variable equal to one if user i searched for brand j during period t.
- AD_{it} is a indicator variable equal to one if user i is delivered the target ad at time t.

Measuring the Search Lift

$$Search_{ijt} = \alpha_j + \beta_j AD_{it} + \epsilon_{ijt}$$

- $Search_{ijt}$ is a indicator variable equal to one if user i searched for brand j during period t.
- AD_{it} is a indicator variable equal to one if user i is delivered the target ad at time t.
- ϵ_{ijt} is the residual which we cluster at the individual level in estimation.

Measuring the Search Lift

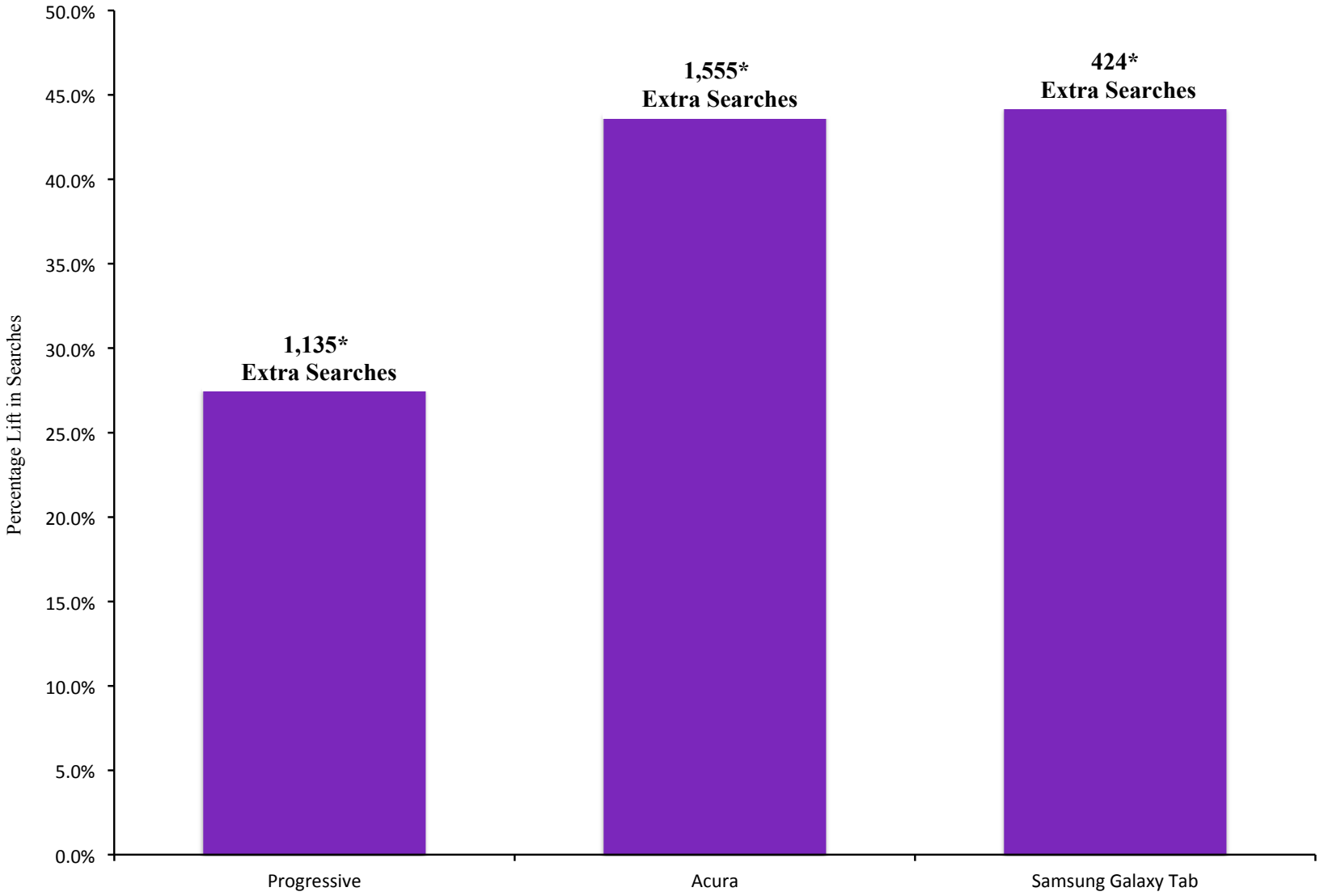
$$Search_{ijt} = \alpha_j + \beta_j AD_{it} + \epsilon_{ijt}$$

- $Search_{ijt}$ is a indicator variable equal to one if user i searched for brand j during period t.
- AD_{it} is a indicator variable equal to one if user i is delivered the target ad at time t.
- ϵ_{ijt} is the residual which we cluster at the individual level in estimation.

Using OLS, we estimate β_j to obtain the average increase in searches for product j caused by the display ad.

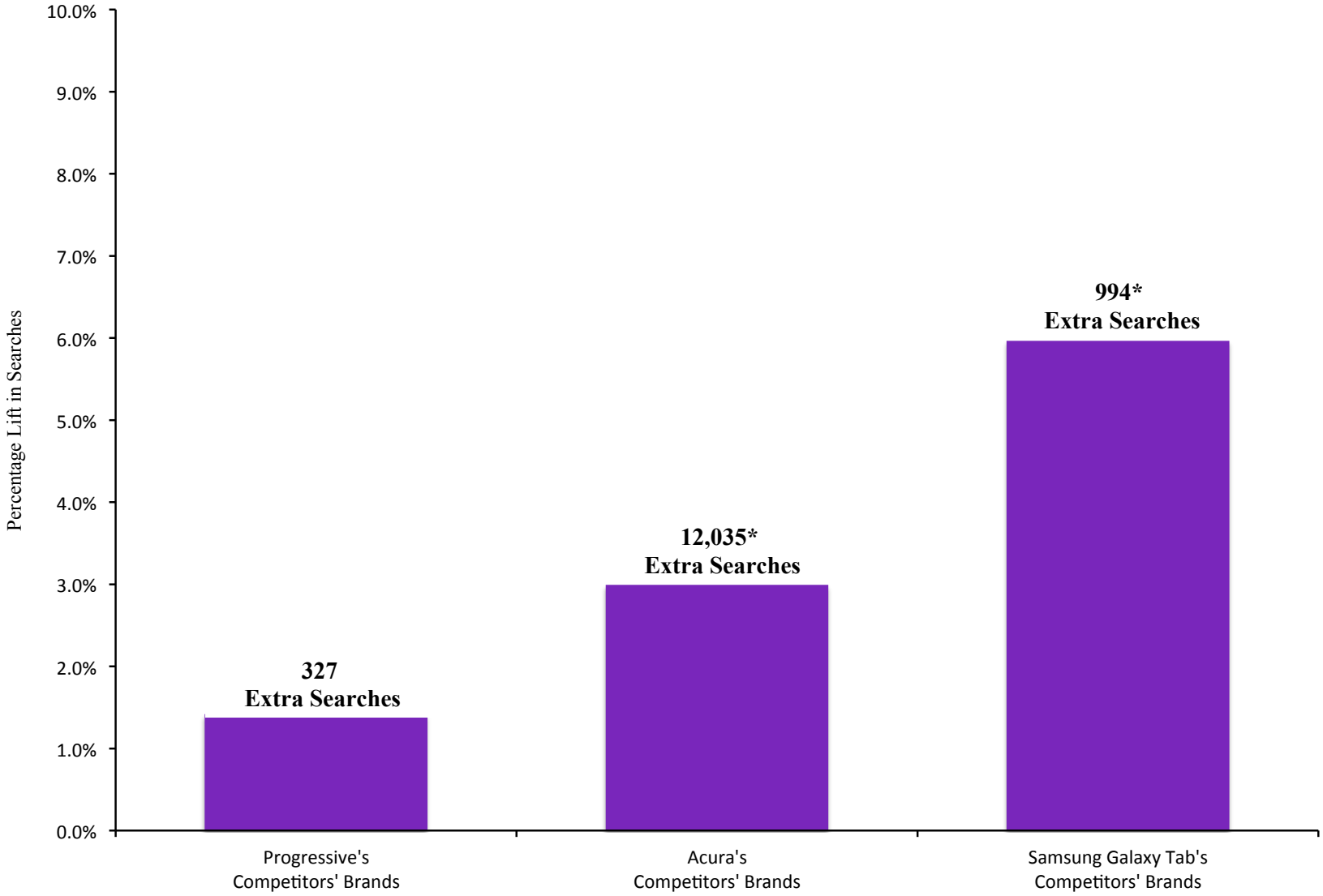
Outline

Significant Lift in Searches for the Advertiser



▸ Table

Significant Lift in Searches for the Competitors

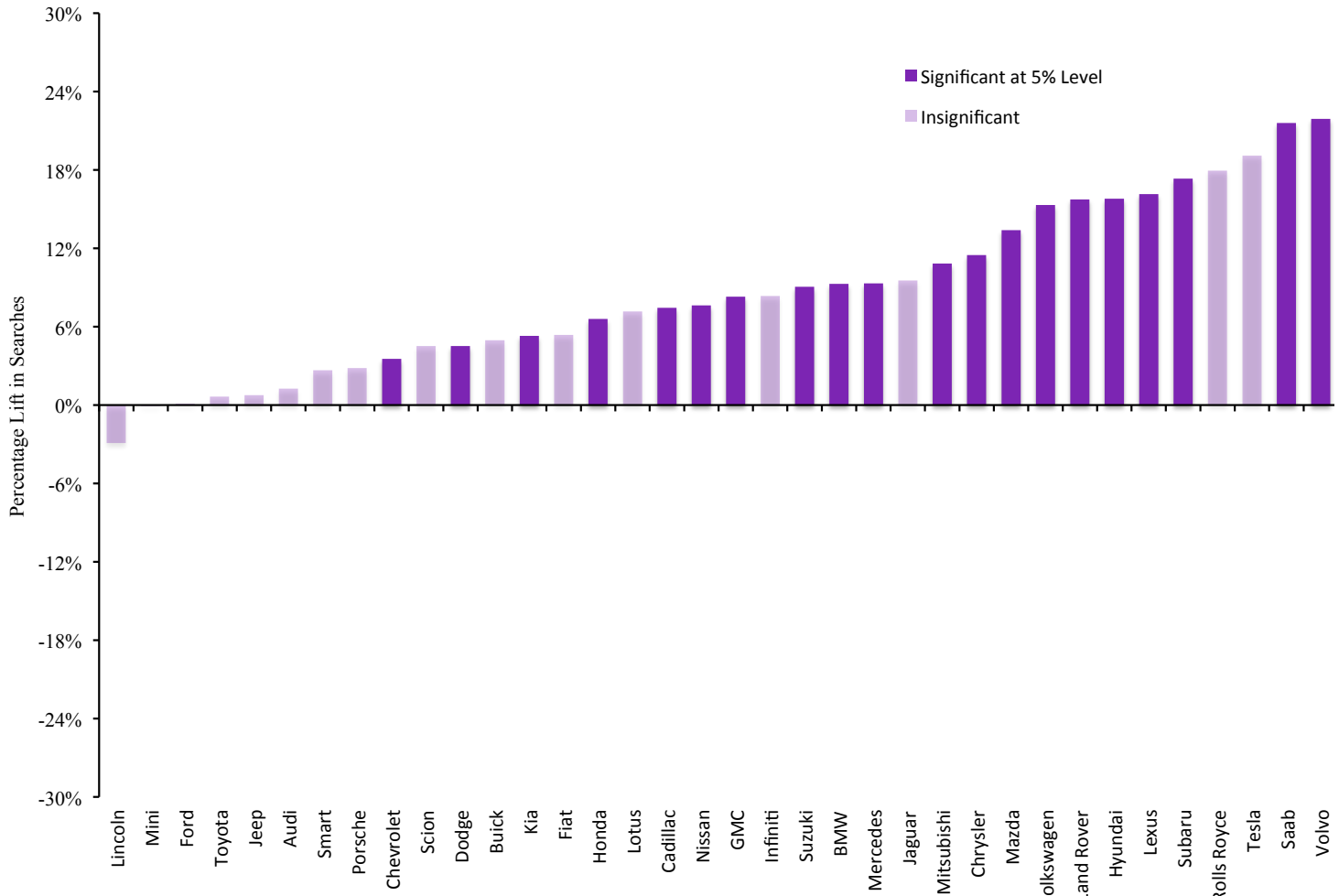


▸ Table

No Significant Decrease in Searches for Any Competitors: Progressive's Competitors

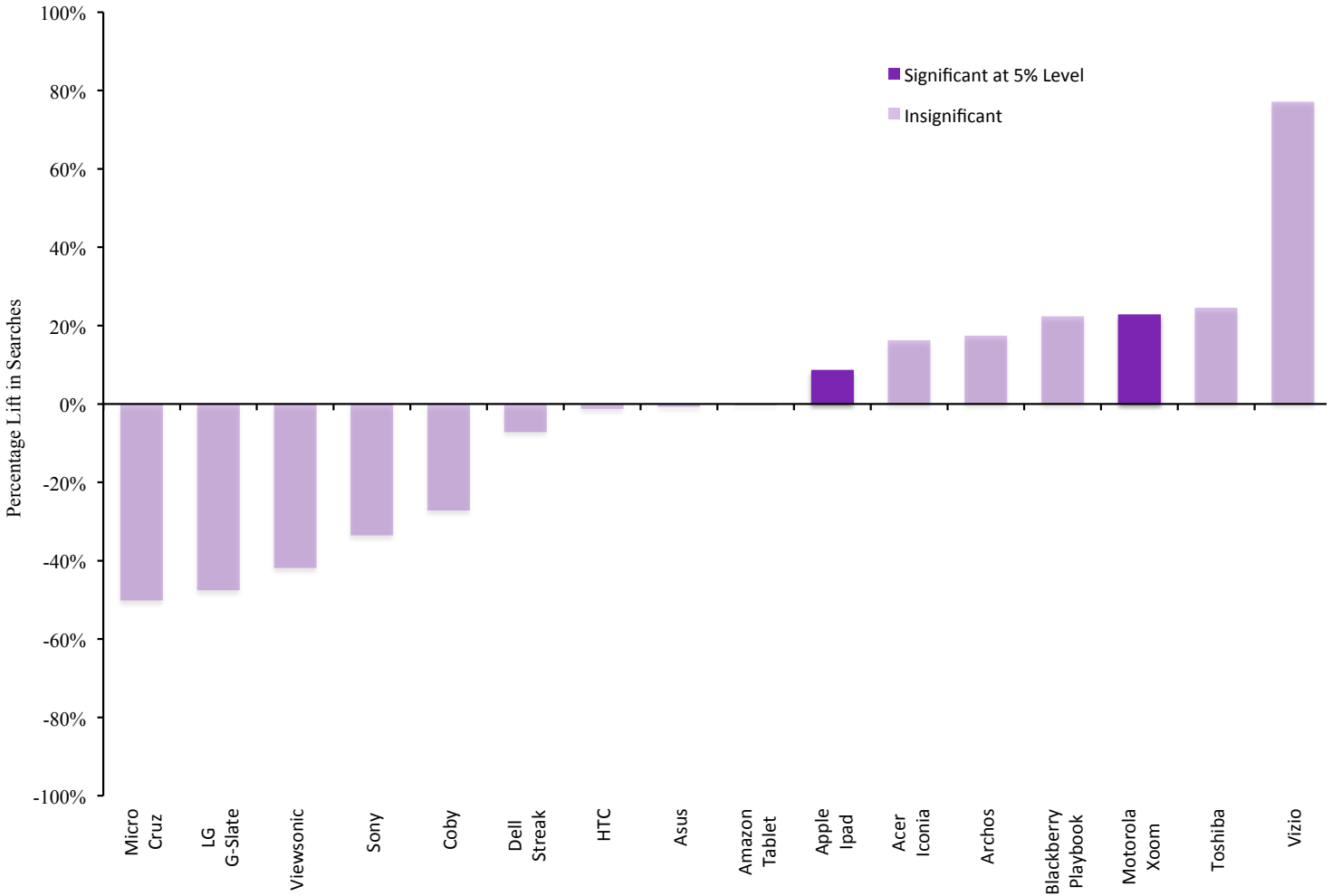
▸ Table

No Significant Decrease in Searches for Any Competitors: Acura's Competitors



▸ Table

No Significant Decrease in Searches for Any Competitors: Samsung Galaxy Tab's Competitors



▸ Table

Outline

Two Sets of Robustness Checks Confirm the Main Findings

Limiting the sample to just first impressions and to users who visit only once.

Two Sets of Robustness Checks Confirm the Main Findings

Limiting the sample to just first impressions and to users who visit only once.

- Pros: Eliminates concerns about misattributing.

Two Sets of Robustness Checks Confirm the Main Findings

Limiting the sample to just first impressions and to users who visit only once.

- Pros: Eliminates concerns about misattributing.
- Cons: Misses out on the majority of impressions, obtains a different average effect for a different composition of impressions, weaker results due to smaller sample sizes.

Two Sets of Robustness Checks Confirm the Main Findings

Limiting the sample to just first impressions and to users who visit only once.

- Pros: Eliminates concerns about misattributing.
- Cons: Misses out on the majority of impressions, obtains a different average effect for a different composition of impressions, weaker results due to smaller sample sizes.

Decompose the branded search counts into words, queries, and domains clicked.

Two Sets of Robustness Checks Confirm the Main Findings

Limiting the sample to just first impressions and to users who visit only once.

- Pros: Eliminates concerns about misattributing.
- Cons: Misses out on the majority of impressions, obtains a different average effect for a different composition of impressions, weaker results due to smaller sample sizes.

Decompose the branded search counts into words, queries, and domains clicked.

- Pros: Provides a much richer view of the effects of the advertising.

Two Sets of Robustness Checks Confirm the Main Findings

Limiting the sample to just first impressions and to users who visit only once.

- Pros: Eliminates concerns about misattributing.
- Cons: Misses out on the majority of impressions, obtains a different average effect for a different composition of impressions, weaker results due to smaller sample sizes.

Decompose the branded search counts into words, queries, and domains clicked.

- Pros: Provides a much richer view of the effects of the advertising.
- Cons: False discovery risks require higher levels of statistical significance to avoid spurious conclusions.

Robustness Checks Limiting the Sample to the First Impressions

	Full Sample	Limited to the first impression			Limited to users who were delivered one impression		
	Daily Total Search Lift	Daily Total Search Lift	Lower Bound 95% CI	Upper Bound 95% CI	Daily Total Search Lift	Lower Bound 95% CI	Upper Bound 95% CI
Samsung Galaxy Tab Advertising Campaign							
Samsung Galaxy Tab	424	503	190	817	-41	-603	521
All Competitors	994	257	-964	1,478	228	-1,893	2,348
Acura Advertising Campaign							
Acura	1,555	1,037	466	1,607	250	-724	1,224
All Competitors	12,035	10,161	4,259	16,062	7,437	-2,516	17,389
Progressive Auto Insurance Advertising Campaign							
Progressive	1,135	433	-234	1,100	607	-426	1,639
All Competitors	327	326	-1,225	1,877	237	-2,184	2,659

Search Composition Robustness Checks

- As expected, there were statistically significant increase in clicking on the Brands' URLs.

Search Composition Robustness Checks

- As expected, there were statistically significant increase in clicking on the Brands' URLs.
- There were statistically significant increase in clicking and searching for sales channels' websites.

Search Composition Robustness Checks

- As expected, there were statistically significant increase in clicking on the Brands' URLs.
- There were statistically significant increase in clicking and searching for sales channels' websites.
  - For example, Samsung Galaxy Tab increased clicking to Best Buy, Staple's, Target, Apple's Store website, and ebay.

Search Composition Robustness Checks

- As expected, there were statistically significant increase in clicking on the Brands' URLs.
- There were statistically significant increase in clicking and searching for sales channels' websites.
  - For example, Samsung Galaxy Tab increased clicking to Best Buy, Staple's, Target, Apple's Store website, and ebay.
- There were significant increase in clicking to review websites.

Search Composition Robustness Checks

- As expected, there were statistically significant increase in clicking on the Brands' URLs.
- There were statistically significant increase in clicking and searching for sales channels' websites.
  - For example, Samsung Galaxy Tab increased clicking to Best Buy, Staple's, Target, Apple's Store website, and ebay.
- There were significant increase in clicking to review websites.
  - Acura ad increase clicking to Motortrend.com, caranddriver.com, edmunds.com, and autobytel.com.

Search Composition Robustness Checks

- As expected, there were statistically significant increase in clicking on the Brands' URLs.
- There were statistically significant increase in clicking and searching for sales channels' websites.
  - For example, Samsung Galaxy Tab increased clicking to Best Buy, Staple's, Target, Apple's Store website, and ebay.
- There were significant increase in clicking to review websites.
  - Acura ad increase clicking to Motortrend.com, caranddriver.com, edmunds.com, and autobytel.com.
  - Samsung ad increase clicking to reviews.cnet.com and besttablet2011.com.

Outline

Outline

Increasing Searches Decreases Costs for Search Advertiser

- Increase in searches leads to a greater expected number of clicks on a search ad.

Increasing Searches Decreases Costs for Search Advertiser

- Increase in searches leads to a greater expected number of clicks on a search ad.
- The increase in clicks may make entry into advertising on new keywords cost-effective.

Increasing Searches Decreases Costs for Search Advertiser

- Increase in searches leads to a greater expected number of clicks on a search ad.
- The increase in clicks may make entry into advertising on new keywords cost-effective.
- More directly, it can also decrease the CPC for a fix expected number of clicks by the nature of the generalized second price (GSP) auction.

Decreasing CPC for a fixed expected number of clicks

- In the GSP auction, CPC is increasing with CTR on a given search result page.
  - In equilibrium of the GSP auction, CPC for ads at the top page of the page, a higher CTR spot, is more than that for ads at the bottom of the page.

Decreasing CPC for a fixed expected number of clicks

- In the GSP auction, CPC is increasing with CTR on a given search result page.
  - In equilibrium of the GSP auction, CPC for ads at the top page of the page, a higher CTR spot, is more than that for ads at the bottom of the page.

- Because the increase of searches increases the expected number of clicks, holding the expected number of clicks constant permits an advertiser to bid for a lower CTR ad position, lowering the CPC.

Decreasing CPC for a fixed expected number of clicks

- In the GSP auction, CPC is increasing with CTR on a given search result page.
  - In equilibrium of the GSP auction, CPC for ads at the top page of the page, a higher CTR spot, is more than that for ads at the bottom of the page.

- Because the increase of searches increases the expected number of clicks, holding the expected number of clicks constant permits an advertiser to bid for a lower CTR ad position, lowering the CPC.

- As a result, display advertising increases the marginal profitability of a click for both the display advertiser and its competitors by increasing the number of searches.

Decreasing CPC for a fixed expected number of clicks

- In the GSP auction, CPC is increasing with CTR on a given search result page.
  - In equilibrium of the GSP auction, CPC for ads at the top page of the page, a higher CTR spot, is more than that for ads at the bottom of the page.

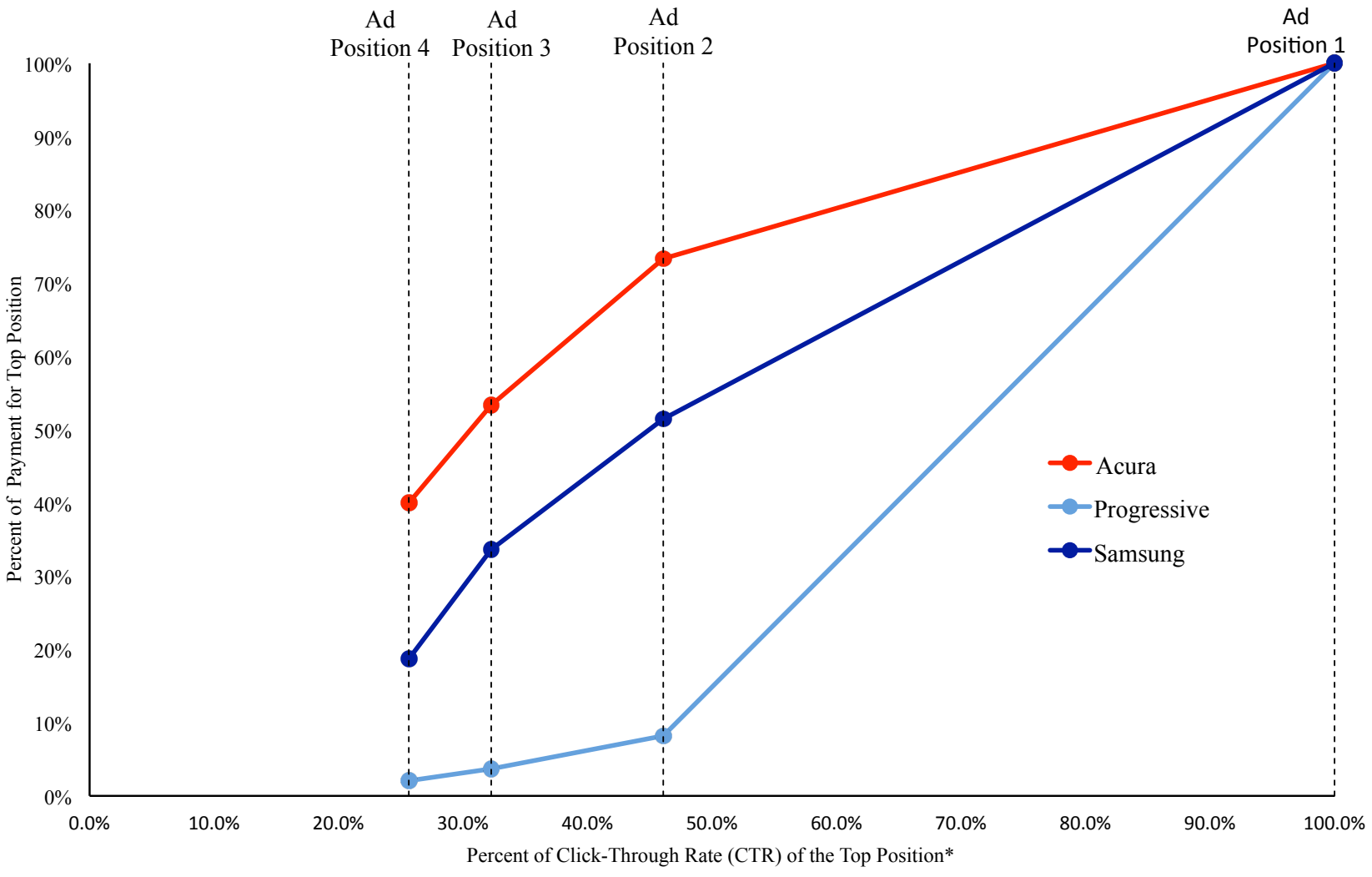
- Because the increase of searches increases the expected number of clicks, holding the expected number of clicks constant permits an advertiser to bid for a lower CTR ad position, lowering the CPC.

- As a result, display advertising increases the marginal profitability of a click for both the display advertiser and its competitors by increasing the number of searches.

Display advertising is both a strategic complement and complement to search advertising

▸ Formal Model

CPC Increases with CTR



* CTRs for the four search ad positions are averages for a sample of queries with at least four ads from Reiley, Li, and Lewis (2010).

Outline

Advertising Investment and Competitive Spillovers

- Grossman and Shapiro (1984) assume that advertising only increases awareness of the advertised product.

Advertising Investment and Competitive Spillovers

- Grossman and Shapiro (1984) assume that advertising only increases awareness of the advertised product.

- We extend their model to incorporate spillovers, allowing awareness of a firm's products to increase when customers receive a competitor's ad.

Advertising Investment and Competitive Spillovers

- Grossman and Shapiro (1984) assume that advertising only increases awareness of the advertised product.

- We extend their model to incorporate spillovers, allowing awareness of a firm's products to increase when customers receive a competitor's ad.
- We find:

Advertising Investment and Competitive Spillovers

- Grossman and Shapiro (1984) assume that advertising only increases awareness of the advertised product.

- We extend their model to incorporate spillovers, allowing awareness of a firm's products to increase when customers receive a competitor's ad.
- We find:
  - Advertising investment decreases in the magnitude of spillovers.

Advertising Investment and Competitive Spillovers

- Grossman and Shapiro (1984) assume that advertising only increases awareness of the advertised product.

- We extend their model to incorporate spillovers, allowing awareness of a firm's products to increase when customers receive a competitor's ad.
- We find:
  - Advertising investment decreases in the magnitude of spillovers.
  - Prices are increasing and decreasing in spillovers over different ranges of spillovers.

Advertising Investment and Competitive Spillovers

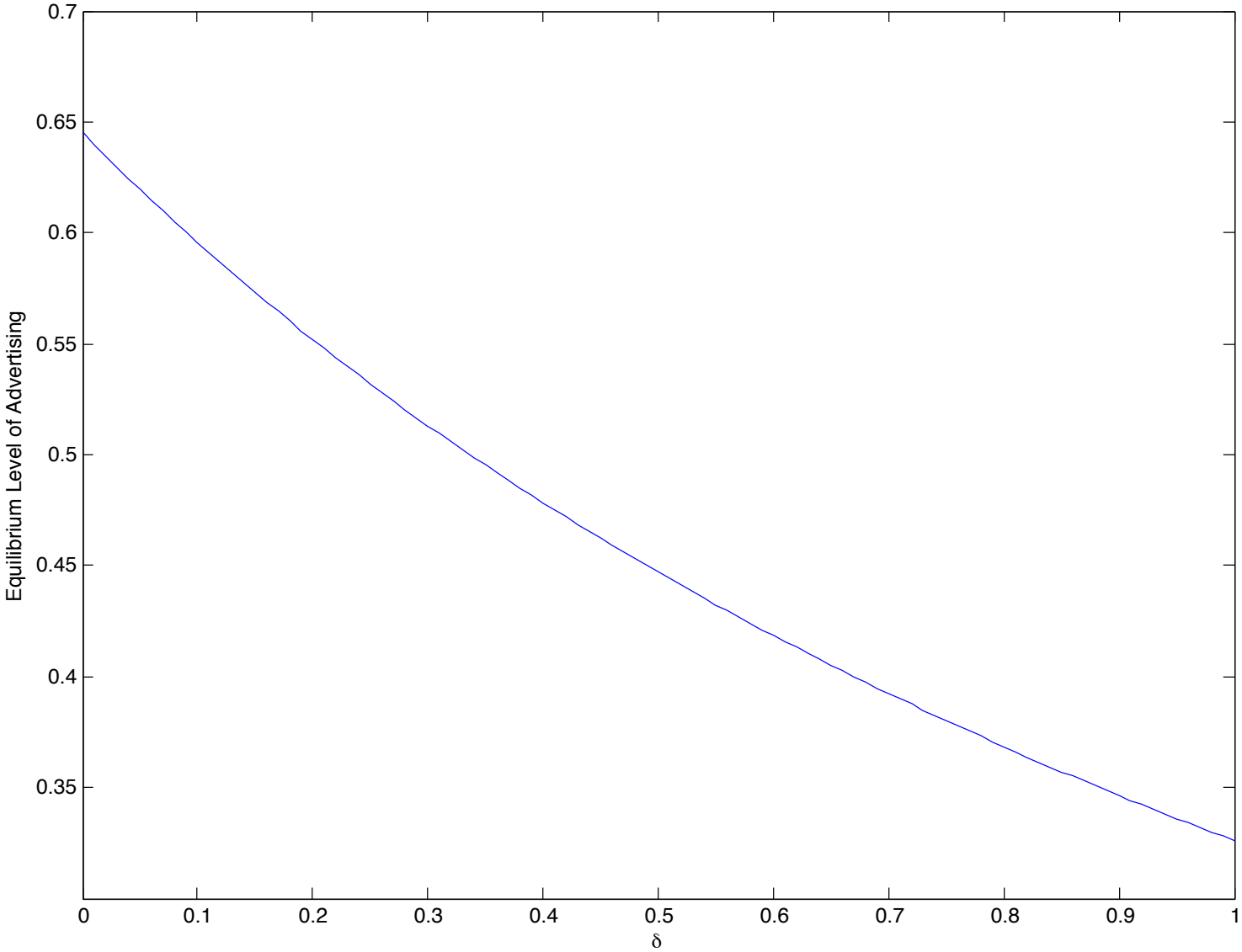
- Grossman and Shapiro (1984) assume that advertising only increases awareness of the advertised product.

- We extend their model to incorporate spillovers, allowing awareness of a firm's products to increase when customers receive a competitor's ad.
- We find:
  - Advertising investment decreases in the magnitude of spillovers.
  - Prices are increasing and decreasing in spillovers over different ranges of spillovers.
  - Profits are increasing in spillovers.

▸ Appendix

Magnitude of Spillovers vs. Equilibrium Advertising Levels

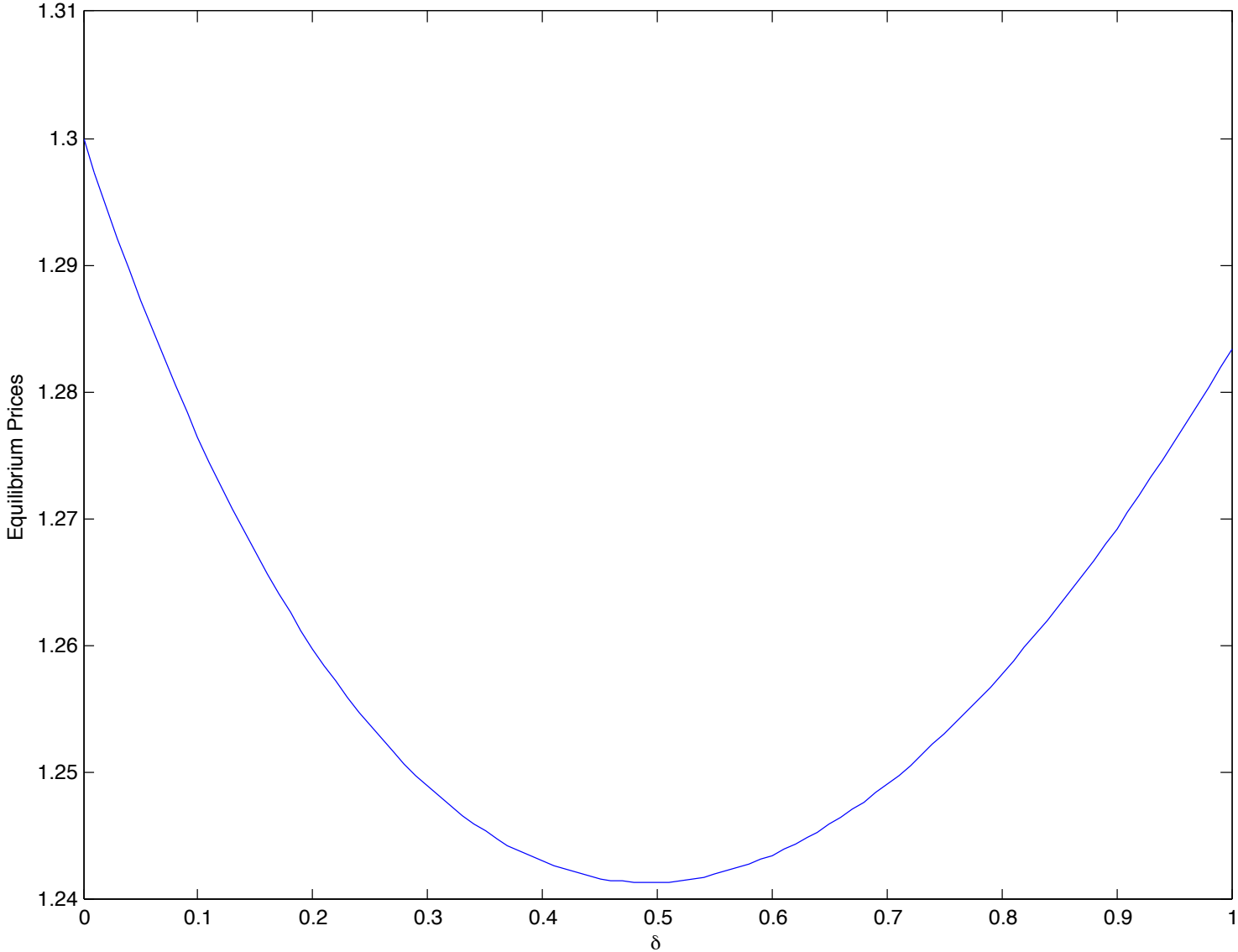
Advertising investment decreases in the magnitude of spillovers.



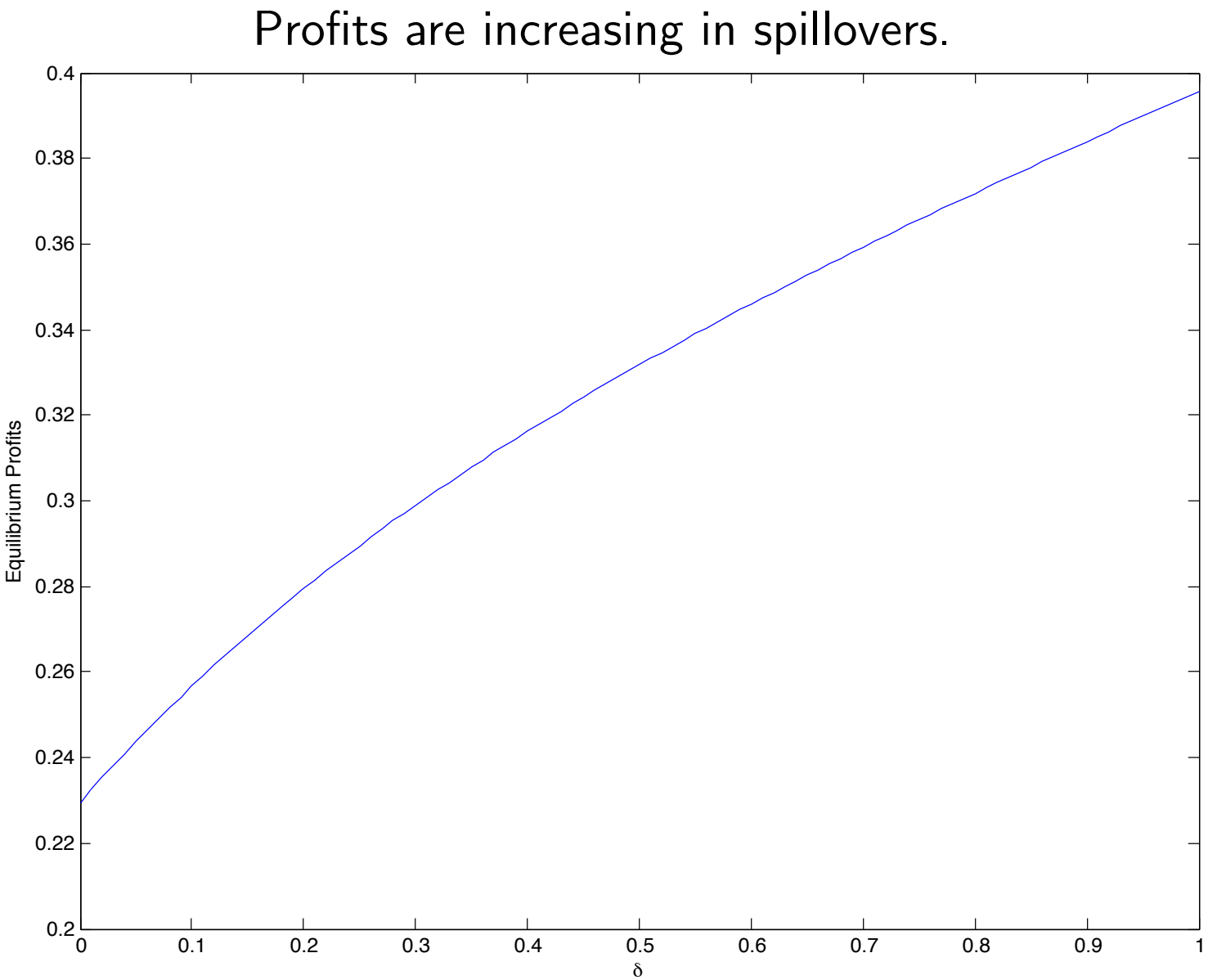
Spillovers

Magnitude of Spillovers vs. Equilibrium Prices

Prices are increasing and decreasing in spillovers over different ranges of spillovers.



Magnitude of Spillovers vs. Equilibrium Profits



Outline

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.
  - Advertiser's branded searches increased by 30% to 45%.

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.
  - Advertiser's branded searches increased by 30% to 45%.
  - Competitors' brands increased by as much as 23%.

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.
  - Advertiser's branded searches increased by 30% to 45%.
  - Competitors' brands increased by as much as 23%.
  - Total increase in competitor-branded searches was 2 to 8 times the increase for the advertiser's brand.

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.
  - Advertiser's branded searches increased by 30% to 45%.
  - Competitors' brands increased by as much as 23%.
  - Total increase in competitor-branded searches was 2 to 8 times the increase for the advertiser's brand.
  - "iPad" received twice as many incremental searches as "Galaxy Tab."

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.
  - Advertiser's branded searches increased by 30% to 45%.
  - Competitors' brands increased by as much as 23%.
  - Total increase in competitor-branded searches was 2 to 8 times the increase for the advertiser's brand.
  - "iPad" received twice as many incremental searches as "Galaxy Tab."
- The extra searches create a cost-complementarity between display and search advertising.

Conclusion

- Display ads increased searches for both the advertiser's brand as well as its competitors' brands.
  - Advertiser's branded searches increased by 30% to 45%.
  - Competitors' brands increased by as much as 23%.
  - Total increase in competitor-branded searches was 2 to 8 times the increase for the advertiser's brand.
  - "iPad" received twice as many incremental searches as "Galaxy Tab."
- The extra searches create a cost-complementarity between display and search advertising.
- The presence of positive spillovers may reduce advertising investment relative to no spillovers.

Future Research

Positive advertising spillovers raise many questions:

Future Research

Positive advertising spillovers raise many questions:

- Will researchers find proportional effects on sales and profits?

Future Research

Positive advertising spillovers raise many questions:

- Will researchers find proportional effects on sales and profits?
- Are there similar spillovers from all other forms of advertising?

Future Research

Positive advertising spillovers raise many questions:

- Will researchers find proportional effects on sales and profits?
- Are there similar spillovers from all other forms of advertising?
- Are the spillovers illustrated in online search a proxy for customer search behavior more generally?

Future Research

Positive advertising spillovers raise many questions:

- Will researchers find proportional effects on sales and profits?
- Are there similar spillovers from all other forms of advertising?
- Are the spillovers illustrated in online search a proxy for customer search behavior more generally?
- Are online search queries a proportional representation of causal attention induced by the ad?

Smart phones and tablets provide mobile access to online search allowing customers to inquire about people, locations, products, and services.

We hope to see future research explore these and other related questions, leveraging these new technologies, to help advertisers and publishers improve the effectiveness of advertising and the efficiency of advertising marketplaces.

Outline

Table: Percentage Lift in Searches

	Control			Search Lift from Advertising				
Searches	Estimate	OLS T-stat	Cluster T-stat	Estimate	OLS T-stat	Cluster T-stat	Percentage Lift	Competitor/ Own
Samsung Galaxy Tab Advertising Campaign								
Samsung Galaxy Tab	958	19.78	20.57	424	6.20	6.32	44.3%	1.00
All Competitors	16,662	89.87	82.42	994	3.79	3.81	6.0%	2.34
Apple Ipad	9,851	68.64	63.21	857	4.23	4.25	8.7%	2.02
Motorola Xoom	663	17.23	16.74	151	2.79	2.79	22.8%	0.36
Blackberry Playbook	317	11.92	11.34	71	1.89	1.90	22.4%	0.17
Viewsonic	18	2.55	3.00	14	1.39	1.39	77.2%	0.03
Acura Advertising Campaign								
Acura	3,539	38.12	38.34	1,555	11.84	11.78	43.9%	1.00
All Competitors	401,927	445.80	389.84	12,035	9.43	9.44	3.0%	7.74
Volkswagen	5,840	52.12	48.24	894	5.64	5.62	15.3%	0.58
Hyundai	5,399	50.05	46.94	853	5.59	5.55	15.8%	0.55
Lexus	3,907	42.54	39.37	631	4.86	4.85	16.2%	0.41
Volvo	2,183	31.39	29.31	478	4.86	4.75	21.9%	0.31
Progressive Auto Insurance Advertising Campaign								
Progressive	4,104	42.41	42.76	1,135	8.30	8.34	27.6%	1.00
All Competitors	23,035	106.84	99.34	327	1.07	1.08	1.4%	0.29
Allstate	2,968	38.09	36.52	124	1.12	1.13	4.2%	0.11
USAA	7,870	62.30	56.97	187	1.05	1.06	2.4%	0.17
Safeco	214	10.01	9.73	29	0.96	0.97	13.6%	0.03
Nationwide Insurance	880	20.64	19.81	54	0.90	0.91	6.2%	0.05

Go Back

Table: Percentage Lift in Searches

	Control			Search Lift from Advertising				
Searches	Estimate	OLS T-stat	Cluster T-stat	Estimate	OLS T-stat	Cluster T-stat	Percentage Lift	Competitor/ Own
Samsung Galaxy Tab Advertising Campaign								
Samsung Galaxy Tab	958	19.78	20.57	424	6.20	6.32	44.3%	1.00
All Competitors	16,662	89.87	82.42	994	3.79	3.81	6.0%	2.34
Apple Ipad	9,851	68.64	63.21	857	4.23	4.25	8.7%	2.02
Motorola Xoom	663	17.23	16.74	151	2.79	2.79	22.8%	0.36
Blackberry Playbook	317	11.92	11.34	71	1.89	1.90	22.4%	0.17
Viewsonic	18	2.55	3.00	14	1.39	1.39	77.2%	0.03
Acura Advertising Campaign								
Acura	3,539	38.12	38.34	1,555	11.84	11.78	43.9%	1.00
All Competitors	401,927	445.80	389.84	12,035	9.43	9.44	3.0%	7.74
Volkswagen	5,840	52.12	48.24	894	5.64	5.62	15.3%	0.58
Hyundai	5,399	50.05	46.94	853	5.59	5.55	15.8%	0.55
Lexus	3,907	42.54	39.37	631	4.86	4.85	16.2%	0.41
Volvo	2,183	31.39	29.31	478	4.86	4.75	21.9%	0.31
Progressive Auto Insurance Advertising Campaign								
Progressive	4,104	42.41	42.76	1,135	8.30	8.34	27.6%	1.00
All Competitors	23,035	106.84	99.34	327	1.07	1.08	1.4%	0.29
Allstate	2,968	38.09	36.52	124	1.12	1.13	4.2%	0.11
USAA	7,870	62.30	56.97	187	1.05	1.06	2.4%	0.17
Safeco	214	10.01	9.73	29	0.96	0.97	13.6%	0.03
Nationwide Insurance	880	20.64	19.81	54	0.90	0.91	6.2%	0.05

Go Back

Table: Percentage Lift in Searches for Progressive's Competitors

	Control			Search Lift from Advertising				
Searches	Estimate	OLS T-stat	Cluster T-stat	Estimate	OLS T-stat	Cluster T-stat	Percentage Lift	Competitor/ Own
Progressive	4,104	42.41	42.76	1,135	8.30	8.34	27.6%	1.00
All Competitors	23,035	106.84	99.34	327	1.07	1.08	1.4%	0.29
Allstate	2,968	38.09	36.52	124	1.12	1.13	4.2%	0.11
USAA	7,870	62.30	56.97	187	1.05	1.06	2.4%	0.17
Safeco	214	10.01	9.73	29	0.96	0.97	13.6%	0.03
Nationwide Insurance	880	20.64	19.81	54	0.90	0.91	6.2%	0.05
AIG	401	13.83	13.30	36	0.89	0.90	9.1%	0.03
Geico	3,389	40.84	39.67	94	0.80	0.80	2.8%	0.08
Liberty Mutual	607	17.37	16.31	6	0.11	0.11	0.9%	0.00
Erie Insurance	234	10.80	10.55	1	0.03	0.03	0.4%	0.00
Travelers Insurance	483	15.52	15.03	0	0.00	0.00	0.0%	0.00
American Family Insurance	263	11.48	11.11	-3	-0.09	-0.10	-1.2%	0.00
Farmer's Insurance	1,122	23.78	22.21	-23	-0.34	-0.34	-2.0%	-0.02
State Farm	3,824	44.04	41.23	-125	-1.02	-1.02	-3.3%	-0.11
21st Century Insurance	960	22.58	20.19	-116	-1.93	-1.92	-12.1%	-0.10

Go Back

Table: Percentage Lift in Searches for Acura's Competitors

	Control			Search Lift from Advertising				
Searches	Estimate	OLS T-stat	Cluster T-stat	Estimate	OLS T-stat	Cluster T-stat	Percentage Lift	Competitor/ Own
Acura	3,539	38.12	38.34	1,555	11.84	11.78	43.9%	1.00
All Competitors	401,927	445.80	389.84	12,035	9.43	9.44	3.0%	7.74
Volkswagen	5,840	52.12	48.24	894	5.64	5.62	15.3%	0.58
Hyundai	5,399	50.05	46.94	853	5.59	5.55	15.8%	0.55
Lexus	3,907	42.54	39.37	631	4.86	4.85	16.2%	0.41
Volvo	2,183	31.39	29.31	478	4.86	4.75	21.9%	0.31
Subaru	3,004	37.21	34.82	521	4.56	4.58	17.3%	0.33
Honda	19,594	97.46	87.44	1,293	4.54	4.57	6.6%	0.83
Chrysler	6,082	53.66	50.21	699	4.36	4.34	11.5%	0.45
Mazda	3,645	41.36	35.90	488	3.91	3.93	13.4%	0.31
Nissan	10,610	71.54	65.01	809	3.85	3.89	7.6%	0.52
BMW	7,105	58.31	51.95	659	3.82	3.79	9.3%	0.42
Mercedes	4,710	47.47	43.55	439	3.13	3.15	9.3%	0.28
Dodge	16,560	90.05	82.13	748	2.87	2.88	4.5%	0.48
GMC	4,930	48.68	44.34	409	2.86	2.85	8.3%	0.26
Chevrolet	25,185	111.32	99.35	893	2.79	2.78	3.5%	0.57
Saab	723	18.08	16.29	156	2.76	2.71	21.6%	0.10
Mitsubishi	2,613	35.23	32.93	283	2.70	2.67	10.8%	0.18
Kia	10,540	71.70	65.32	558	2.68	2.67	5.3%	0.36
Cadillac	4,121	44.60	41.45	307	2.35	2.35	7.5%	0.20
Suzuki	2,415	34.01	30.82	219	2.18	2.18	9.1%	0.14
Land Rover	763	18.82	17.29	120	2.09	2.10	15.7%	0.08
Tesla	425	13.95	14.01	81	1.88	1.91	19.1%	0.05
Smart	15,194	86.65	79.99	404	1.63	1.63	2.7%	0.26
Infiniti	1,560	27.38	25.35	130	1.62	1.61	8.3%	0.08
Jaguar	1,252	24.46	22.88	119	1.65	1.60	9.5%	0.08
Buick	2,984	38.18	34.94	148	1.34	1.34	5.0%	0.10
Rolls Royce	204	9.68	9.73	37	1.23	1.26	18.0%	0.02
Lotus	1,015	22.15	20.47	73	1.12	1.13	7.2%	0.05
Audi	21,416	103.23	91.61	270	0.92	0.92	1.3%	0.17
Scion	989	22.00	19.49	45	0.70	0.71	4.5%	0.03
Porsche	1,638	28.44	25.05	46	0.57	0.58	2.8%	0.03
Toyota	31,061	124.51	115.62	201	0.57	0.57	0.6%	0.13
Fiat	431	14.50	13.15	23	0.55	0.53	5.4%	0.01
Jeep	8,826	66.35	57.55	67	0.36	0.36	0.8%	0.04
Ford	134,093	259.13	239.98	156	0.21	0.21	0.1%	0.10
Mini	41,528	144.24	131.02	-32	-0.08	-0.08	-0.1%	-0.02
Lincoln	11,189	75.40	68.35	-325	-1.55	-1.55	-2.9%	-0.21

Go Back

Table: Percentage Lift in Searches for Samsung Galaxy Tab's Competitors

	Control			Search Lift from Advertising				
Searches	Estimate	OLS T-stat	Cluster T-stat	Estimate	OLS T-stat	Cluster T-stat	Percentage Lift	Competitor/ Own
Samsung Galaxy Tab	958	19.78	20.57	424	6.20	6.32	44.3%	1.00
All Competitors	16,662	89.87	82.42	994	3.79	3.81	6.0%	2.34
Apple Ipad	9,851	68.64	63.21	857	4.23	4.25	8.7%	2.02
Motorola Xoom	663	17.23	16.74	151	2.79	2.79	22.8%	0.36
Blackberry Playbook	317	11.92	11.34	71	1.89	1.90	22.4%	0.17
Vizio	18	2.55	3.00	14	1.39	1.39	77.2%	0.03
Toshiba	112	7.06	7.00	28	1.23	1.24	24.6%	0.07
Acer Iconia	252	10.79	10.43	41	1.24	1.23	16.3%	0.10
Archos	56	5.07	5.11	10	0.63	0.63	17.5%	0.02
Amazon Tablet	36	4.25	4.24	0	-0.01	-0.01	-0.3%	0.00
Asus	2,448	35.02	33.41	-18	-0.18	-0.18	-0.7%	-0.04
HTC	2,586	36.05	31.93	-33	-0.32	-0.32	-1.3%	-0.08
Dell Streak	146	8.70	7.74	-10	-0.44	-0.42	-7.2%	-0.02
Sony	6	1.90	1.73	-2	-0.45	-0.45	-33.6%	0.00
Micro Cruz	8	2.31	2.00	-4	-0.82	-1.00	-50.2%	-0.01
Coby	104	7.76	6.13	-28	-1.49	-1.44	-27.2%	-0.07
LG G-Slate	38	4.99	3.80	-18	-1.68	-1.68	-47.5%	-0.04
Viewsonic	96	7.79	5.00	-40	-2.31	-2.31	-41.9%	-0.09

Go Back

A Stylized Model of the Complements

Let

- A_d - Quantity of Display Ad Impressions
- A_s - Quantity of Expected Number of Search Ad Clicks
- v_s - Marginal Revenue for a Search Click
- v_d - Marginal Revenue for a Display Ad Impression
- $P_s(\cdot)$ - GSP Auction's Equilibrium CPC as a function of CTR.
  - $P_s'(\cdot) > 0$
- $Q_s(\cdot)$ - Quantity of Searches as a function of A_d.
  - $Q_s'(\cdot) > 0$.

Go Back

A Stylized Model of Complements

A Stylized Model of Complements

Profit Function

$$\Pi(A_d, A_s) = A_d v_d + A_s v_s + A_d P_d(A_d) + A_s P_s\left(\frac{A_s}{Q_s(A_d)}\right)$$

A Stylized Model of Complements

Profit Function

$$\Pi(A_d, A_s) = A_d v_d + A_s v_s + A_d P_d(A_d) + A_s P_s\left(\frac{A_s}{Q_s(A_d)}\right)$$

Marginal Profit w.r.t. A_s

$$\frac{\partial \Pi}{\partial A_s} = v_s - P_s\left(\frac{A_s}{Q_s(A_d)}\right) - \frac{A_s}{Q_s(A_d)} P_s'\left(\frac{A_s}{Q_s(A_d)}\right)$$

A Stylized Model of Complements

Profit Function

$$\Pi(A_d, A_s) = A_d v_d + A_s v_s + A_d P_d(A_d) + A_s P_s\left(\frac{A_s}{Q_s(A_d)}\right)$$

Marginal Profit w.r.t. A_s

$$\frac{\partial \Pi}{\partial A_s} = v_s - P_s\left(\frac{A_s}{Q_s(A_d)}\right) - \frac{A_s}{Q_s(A_d)} P_s'\left(\frac{A_s}{Q_s(A_d)}\right)$$

Change in Marginal Profit w.r.t. A_d

$$\frac{\partial^2 \Pi}{\partial A_s \partial A_d} = \frac{Q_s'(A_d)}{Q_s(A_d)^2}\left((1 + A_s) P_s'\left(\frac{A_s}{Q_s(A_d)}\right) + \frac{A_s}{Q_s(A_d)} P_s''\left(\frac{A_s}{Q_s(A_d)}\right)\right)$$

A Stylized Model of Complements

Profit Function

$$\Pi(A_d, A_s) = A_d v_d + A_s v_s + A_d P_d(A_d) + A_s P_s\left(\frac{A_s}{Q_s(A_d)}\right)$$

Marginal Profit w.r.t. A_s

$$\frac{\partial \Pi}{\partial A_s} = v_s - P_s\left(\frac{A_s}{Q_s(A_d)}\right) - \frac{A_s}{Q_s(A_d)} P_s'\left(\frac{A_s}{Q_s(A_d)}\right)$$

Change in Marginal Profit w.r.t. A_d

$$\frac{\partial^2 \Pi}{\partial A_s \partial A_d} = \frac{Q_s'(A_d)}{Q_s(A_d)^2}\left((1 + A_s) P_s'\left(\frac{A_s}{Q_s(A_d)}\right) + \frac{A_s}{Q_s(A_d)} P_s''\left(\frac{A_s}{Q_s(A_d)}\right)\right)$$

This implies that

- $\frac{\partial^2 \Pi}{\partial A_s \partial A_d} > 0$ if $P_s''\left(\frac{A_s}{Q_s(A_d)}\right) > -\frac{1+A_s}{A_s} Q_s(A_d) P_s'\left(\frac{A_s}{Q_s(A_d)}\right)$

Go Back

Ad Awareness Investment and Spillovers

We adapt Grossman and Shapiro (1984) to the setting with advertising spillovers. Given

- a unit mass of consumers, uniformly distributed on unit line
- two firms, located on opposite ends of the line
- that if a consumer is aware of a product, he is also knows its price
- that consumers know of a firm if they receive an ad
- that receiving an advertiser's ad also makes the consumer aware of the competitor's product with a certain probability

Go Back

Ad Awareness Investment and Spillovers

Let

- ϕ_i - Fraction of consumers to receive firm i's ad
- δ - Spillover of awareness to competitor from receiving an ad
- τ - Transportation cost
- R - Reservation price
- $D(\cdot)$, P, and c - Quantity demanded, unit price, and unit cost, respectively.

Go Back

Demand Curve for Firm i's Product

$$D_i(P_i, P_{i'}, \phi_i, \phi_{i'}) = (\phi_i + \delta\phi_{i'}) \left((1 - (\phi_{i'} + \delta\phi_i)) + (\phi_{i'} + \delta\phi_i) \frac{P_{i'} - P_i + \tau}{2\tau} \right) \tag{1}$$

Equilibrium Prices and Profits

$$\begin{aligned} P^e &= c + \tau \frac{2 - (1+\delta)\phi^e}{(1+\delta)\phi^e} \\ \Pi^e &= \tau \frac{(2 - (1+\delta)\phi^e)^2}{2} - \frac{a}{2}(\phi^e)^2 \end{aligned} \tag{2}$$

Equilibrium Advertising Level

$$\phi^e = \frac{(2+\delta) - \sqrt{(2+\delta)^2 - 4\left[\frac{(1+\delta)^2 - 2\frac{a}{\tau}}{1+\delta}\right]}}{(1+\delta)^2 - 2\frac{a}{\tau}}. \tag{3}$$