Advertising

Glenn Ellison

Empirical Advertising

The empirical literature on advertising is motivated both by academic questions and by interest from practitioners. Fundamental academic questions include why advertising has the impacts it has and the equilibrium effects on markets.

Some researchers have developed relationships with advertisers that allow them to conduct highly sophisticated experiments.

There is also a long tradition of using fairly complex structural demand models.

There has also been a recent rise in the use of the same types of causal methods that are popular in other applied micro fields.

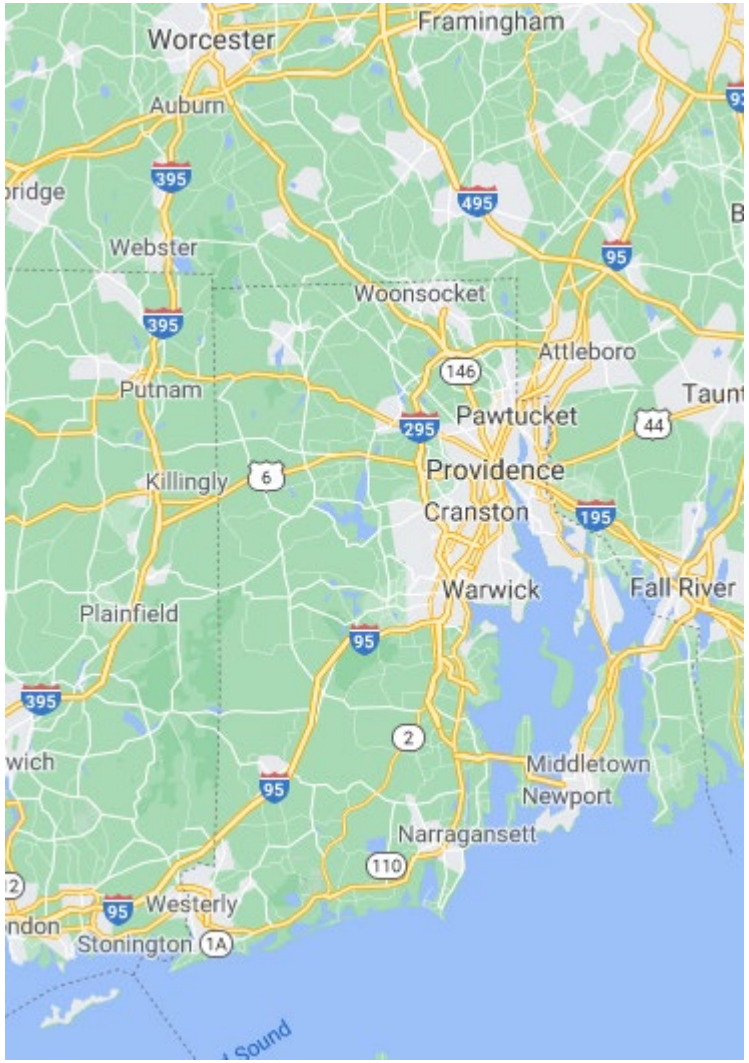
Simple difference-in-difference estimates can be particularly appealing when considering questions where general equilibrium effects are important.

Milyo and Waldfogel "The Effect of Price Advertising on Prices: Evidence in the Wake of 44 Liquormart," *AER* 1999

From 1956-1996 Rhode Island banned **all** advertising of alcohol prices.

On May 13, 1996 the US Supreme Court overturned the law as an unwarranted restriction on the freedom of speech.

Milyo and Waldfogel, "The Effect of Price Advertising on Prices"



Milyo and Waldfogel gambled that this outcome would provide a natural experiment. They started collecting prices for 33 alcoholic beverages from 115 liquor stores in June 1995. They continued through June 1997. The sample included about one-fourth of all RI stores and a control group of MA stores far from the RI border.

The data also include: (1) RI and MA wholesale list prices; (2) whether RI stores used print advertisements; (3) whether RI stores used window advertisements; (4) lottery ticket sales at RI stores.

when SC announced they would hear the case

proxy for quantity

Milyo and Waldfogel, "The Effect of Price Advertising on Prices"

TABLE 2—TIMING OF PRICE SURVEYS AND ADVERTISING

Dates	Number of stores visited		Number of stores advertising in Rhode Island		Number of newspaper advertisements in Rhode Island	
	Rhode Island	Massachusetts	Sample	All	Sample	All
June 1995	22	18	0	0	0	0
September 1995	30	39	0	0	0	0
February 1996	15	11	0	0	0	0
June 1996	49	39	3	10	4	15
September 1996	21	41	1	3	1	3
December 1996	52	46	5	15	27	45
March 1997	52	27	6	17	16	25
June 1997	26	44	0	13	4	17

before

after

Wow, done by hand! Got kicked out of multiple stores. Had to memorize prices sometimes.

This is another example of entrepreneurial, hand-collected data.

Milyo and Waldfogel, "The Effect of Price Advertising on Prices"

TABLE 1—PRODUCTS IN THE SAMPLE

Product	Number of observations	Average price
Liquor	2,667	$16.55
Bacardi 80 proof rum (0.75 liter)	224	$ 9.43
Bacardi 80 proof rum (1 liter)	298	$12.13
Jack Daniels Tennessee Whiskey (0.75 liter)	281	$14.94
Jack Daniels Tennessee Whiskey (1 liter)	457	$19.00
Kahlúa (0.75 liter)	283	$15.07
Kahlúa (1 liter)	436	$20.49
Stolichnaya Vodka 80 proof (0.75 liter)	130	$15.42
Stolichnaya Vodka 80 proof (1 liter)	134	$19.03
Tanqueray Gin (0.75 liter)	180	$15.91
Tanqueray Gin (1 liter)	244	$20.08
Beer	1,706	$ 7.15
Amstel Light 6-pack	56	$ 6.64
Budweiser 12-pack (cans)	491	$ 8.44
Coors 12-pack (cans)	173	$ 8.79
Heineken 6-pack (bottles)	195	$ 6.61
Labatts Blue 6-pack (bottles)	56	$ 5.67
Miller High Life 12-pack (cans)	138	$ 6.76
Molson 6-pack (cans)	78	$ 5.78
Narragansett 6-pack (cans)	28	$ 3.16
Sam Adams 6-pack (bottles)	491	$ 6.27
Wine	915	$ 5.68
E & J Gallo Cabernet Sauvignon	81	$ 4.68
E & J Gallo Chardonnay	394	$ 4.76
Fetzer Cabernet Sauvignon	41	$ 7.47
Fetzer Sundial Chardonnay	53	$ 7.27
Glen Ellen Chardonnay	57	$ 5.76
Glen Ellen Merlot	46	$ 5.81
Mouton Cadet (red)	54	$ 8.48
Mouton Cadet (white)	56	$ 8.37
Sutter Home Cabernet Sauvignon	60	$ 5.38
Sutter Home Chardonnay	73	$ 5.54
Champagne	1,192	$15.45
Freixenet Cordon Negro Brut	431	$ 8.07
Korbel Brut	361	$10.80
Moet & Chandon Brut	156	$30.07
Moet & Chandon White Star	244	$26.04
All	6,480	$12.34

Milyo and Waldfogel, "The Effect of Price Advertising on Prices"

Results:

1. The effect of ending the ban on overall price levels is estimated via a simple differences-in-differences regression. The estimates (<1%) rule out large effects.

TABLE 4—OVERALL EFFECT OF ADVERTISING ON PRICES

Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island
−0.51	−0.73	−0.39	−0.80
(−1.15)	(−1.58)	(−1.02)	(−1.94)
State-product and store fixed effects		Store-product fixed effects	

(Benham's (1972) classic paper on eyeglasses found effects of 20-50%.)

Milyo and Waldfogel, "The Effect of Price Advertising on Prices"

Results:

2. Goods featured in newspaper advertisements are 20-25% below regular prices. But prices of other goods at these stores and prices at non-advertising stores do not change after the advertising ban.

TABLE 5—EFFECT OF ADVERTISING ON PRICES, BY STORE TYPE

	State-product and store fixed effects		Store-product fixed effects	
	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island
Nonadvertising Rhode Island store [1,328]	−0.15 (−0.38)	−0.56 (−1.37)	−0.26 (−0.58)	−0.48 (−1.03)
Nonadvertised product at an advertising Rhode Island store [124]	−0.19 (−0.23)	−0.41 (−0.48)	−0.13 (−0.14)	−0.28 (−0.29)
Own-advertised product at an advertising Rhode Island store [22]	−21.43 (−11.83)	−22.14 (−11.41)	−24.16 (−13.14)	−24.84 (−12.94)
H_0: Same coefficient for all nonadvertised products (Probability value)	0.00 (0.86)	0.00 (0.96)	0.02 (0.88)	0.05 (0.83)

Notes: Coefficients are in percentages. *T*-statistics are in parentheses. Number of price observations by category in brackets reported in heading column. Regressions in columns 1 and 2 include separate product effects for each state, time effects, and store fixed effects. Regressions in columns 3 and 4 include time effects and store-product effects. All regressions are based on 6,480 observations.

Milyo and Waldfogel, "The Effect of Price Advertising on Prices"

Results:

3. Rivals do not respond to advertised prices.
4. Advertising stores' share of lottery ticket sales increased from 16.4% during the ban to 18.4% after the advertising ban ends. This suggests that they also increased their market share of alcoholic beverages.
5. Stores that eventually advertise had prices that were about 7% lower under the ban. Hence, average prices paid may have been reduced by a couple percent via two channels: a shift to lower-priced stores; and purchases of advertised goods.

In short, evidence of small effects on firm pricing behavior, plus some effects on consumer behavior.

Lewis and Reiley, "Online Ads and Offline Sales: Measuring the Effects of Retail Advertising via a Controlled Experiment on Yahoo," *QME* 2014

Here are some ads on Yahoo!

The authors were interested in the effectiveness of online ads. They worked for Yahoo! at the time, so they had an unusual opportunity to conduct experiments. They also had access to both online and **offline** purchases that may have been made in response to the ads.

Lewis and Reiley, "Online Ads and Offline Sales"

Lewis and Reiley estimate the online + offline return on an online advertising campaign using a randomized trial.

- Yahoo's database was matched to that of a large online/offline retailer to jointly identify 1.5m consumers.
- It used an 80-20 treatment-control split and run-of-network LREC ads were served to the treatment group when the campaign's fee selected them.
- Online and offline purchases were monitored before and after the campaign.

large rectangular

Lewis and Reiley, "Online Ads and Offline Sales"

click-through rate

The campaign had an 0.28% CTR, and 7.2% of those who saw at least one ad clicked at least once.

	The Campaign	Follow-up Campaign	Both
Time Period Covered	Early Fall '07	Late Fall '07	
Length of Campaign	14 days	10 days	
Number of Ads Displayed	32,272,816	9,664,332	41,937,148
Number of Users Shown Ads	814,052	721,378	867,839
% Treatment Viewing Ads	63.7%	56.5%	67.9%
Mean Ad Views per Viewer	39.6	13.4	48.3

Lewis and Reiley, "Online Ads and Offline Sales"

Observations:

1. Estimating the return-on-investment (ROI) of advertising can be very difficult. Two features of this particular environment contribute to the difficulty.

Had to report a fake currency unit.

- Individual-level sales data are very noisy. Sales in the treatment period average R$ 1.89 with a standard deviation of R$ 19.
- A percent of ROI is a very small fraction of sales. The cost of the campaign was about 1% of sales to the targeted consumers.

  If profit margins are 50% then the campaign would have a 10% ROI if sales increased by 2.2% and a -10% ROI if sales increased by 1.8%.

  To find significant evidence of a 10% ROI one would need a SE of 5% of ROI. This is about 1/10,000 of a standard deviation of sales, suggesting we need a sample of 100m consumers.

Lewis and Reiley, “Online Ads and Offline Sales”

Observations:

2. Viewing advertising is not an exogenous treatment.

   Whether a consumer sees an ad is determined by browsing behavior and the Yahoo! ad-serving engine.

   - Browsing is not random. People who browse are different from those who don’t as well as from their non-browsing selves.
   - Ad-serving engines have many ads available: untargeted; content; demographic; behavioral; retargeting. All can affect add views.

   Usually, this will lead us to overestimate ad effectiveness: people are more likely to make an online purchase when they’re online.

   In this experiment non-viewers in the treatment group spend more than viewers (R$ 2.04 vs. R$ 1.81). This could reflect a retailer that mostly makes offline sales and serves an older clientele.

Lewis and Reiley, “Online Ads and Offline Sales”

Observations:

3. Intent-to-treat estimates are inconclusive.
    - Sales during the treatment period are R$ 1.89 in the treatment group and R$ 1.84 in the control group. The difference is 5.3c with a SE of 3.8c. (In ROI terms this is 40% with a SE of 100%.)
    - A differences-in-differences estimate taking pre-period treatment-control differences into account gives an estimate of 8.3c with a SE of 5.9c.

Lewis and Reiley, “Online Ads and Offline Sales”

Observations:

4. Difference-in-difference estimates suggest that there may also be long-run benefits after the campaign ends. The point estimates on the additional benefits are 6.1c in the first week after the campaign and 7.4c in total for the first three weeks.

The paper’s “preferred” estimate is from the difference-in-difference models with individual fixed effects, but this is potentially problematic for the reasons noted above.

Aridor, Che, and Salz, "The Effect of Privacy Regulation on the Data Industry," 2022.

Advertising targeted with consumer-level information is central to many online businesses. Enhanced privacy standards (government or private) could have many follow on effects: decline in ad-supported content; favoring narrow vs. broad interest content; increasing the power of large vs. small firms; etc.

The EU's General Data Protection Regulation (GDPR) was adopted in April 2016 with firms required to comply by May 25, 2018. Websites cannot track consumers without explicit opt-in consent.

ACZ use a differences-in-differences design exploiting data from a single intermediary to explore a number of questions about GDPR:

1. How many consumers will opt out of data collection?
2. How does GDPR change the composition of consumers observed?
3. How does GDPR impact firms that rely on consumer data?

One interesting idea: GDPR could improve the quality of data on consumers not opting out, potentially offsetting revenue losses from tracking fewer consumers.

Aridor, Che, and Salz, "The Effect of Privacy Regulation"

Setting and Data:

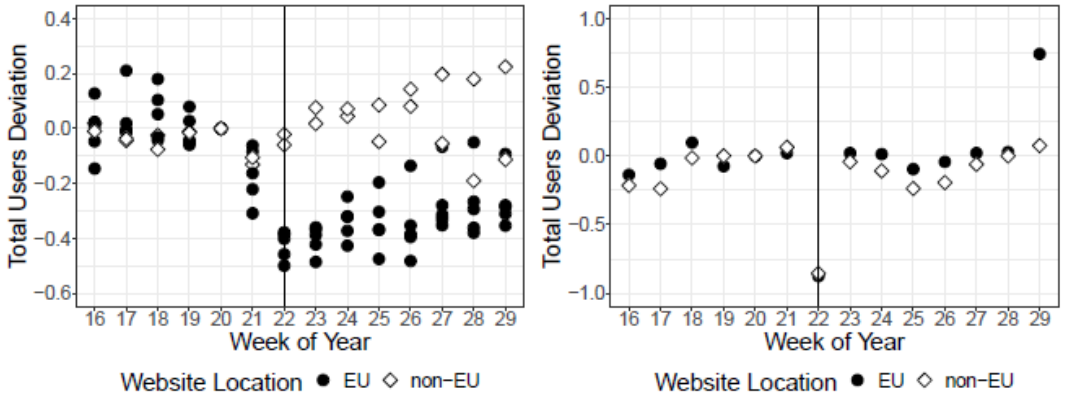
ACZ have data from a single advertising intermediary. It has contracts with almost all top EU and US travel sites. It examines each query on the sites and predicts whether consumers will purchase from the site. If the predicted probability is low, it auctions off right to display a tailored ad to rival sites.

Clickstream-level data is mostly aggregated to website-country-week level.

Sites operate in multiple countries enabling treatment-control designs comparing UK, France, Germany, Italy, Spain vs. US, Canada, Russia.

Simple plots indicate that GDPR had an immediate impact for sites that complied (and reflect that some sites did not immediately do so).

Figure 4: Total Number of Unique Cookies for Two Multi-National Website.

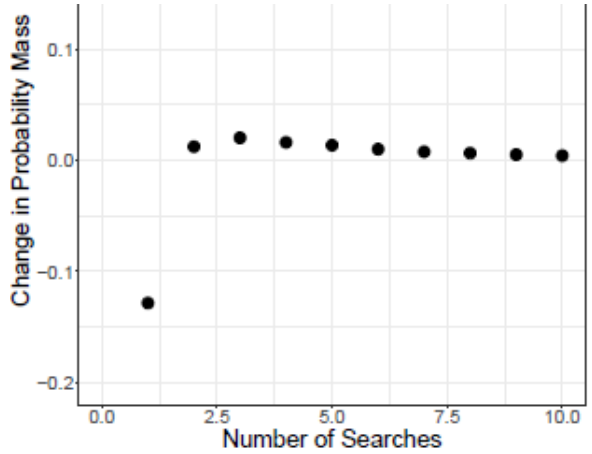


Aridor, Che, and Salz, "The Effect of Privacy Regulation"

1. Consumer reactions

Most consumers click the box allowing the firm to track them, but 10-15% appear to not give consent.

	(1) log(Unique Cookies)	(2) Unique Cookies	(3) log(Recorded Searches)	(4) Recorded Searches
DiD Coefficient	-0.125**	-1378.1*	-0.107*	-9618.3**
	(-2.43)	(-1.71)	(-1.87)	(-2.24)

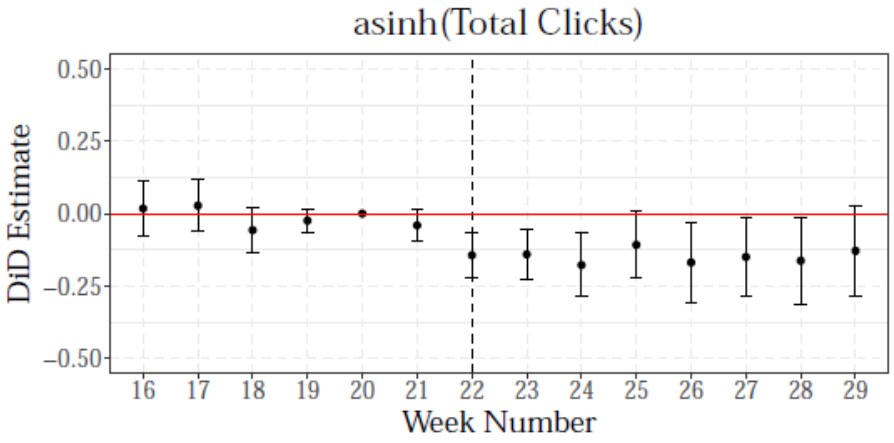


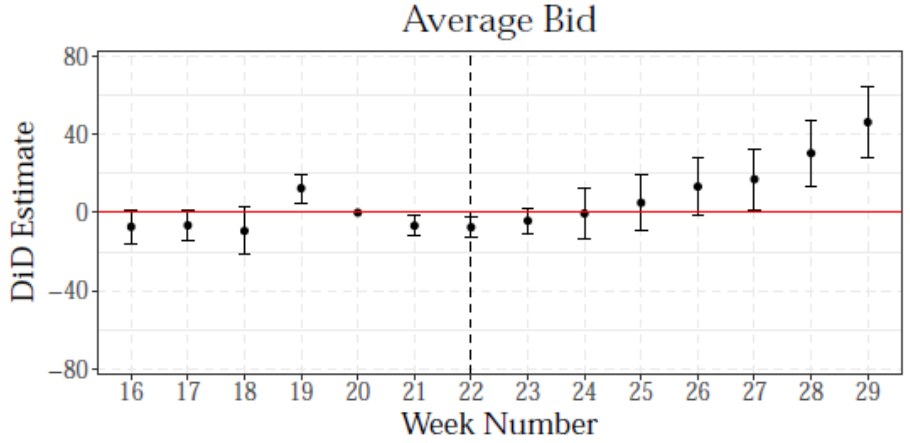
A drop in the fraction observed to do exactly one search suggests that some of those opting out may have previously been using other privacy technologies.

Aridor, Che, and Salz, "The Effect of Privacy Regulation"

2. Advertising Revenue and Advertiser Reactions

There is an immediate drop in clicks (13%) and advertising revenue (16%) when GDPR takes effect.





Per-click bids begin to rise within a few weeks. By week 7 this offsets about half of the revenue loss.

Two potential explanations for such a rise would be: (1) price goes up as quantity declines; and (2) prices goes up because the consumers who don't opt out are more valuable/better tracked.

Aridor, Che, and Salz, "The Effect of Privacy Regulation"

3. Predictability of Consumer Behavior

The intermediary predicts the probability that consumers will purchase from the website on which they are searching. ACZ have both the predictions and actual behavior.

Some observations on changes after GDPR goes into effect are:

- True purchase frequencies (of visible consumers) increase by about 0.009.
- MSE prediction errors increase in the immediate aftermath of the change (perhaps due to models being trained on old data) and then decline back to their pre-GDPR levels.

ACZ note that MSE will tend to be larger when purchase rates go up (because the mean is low), so the lack of a decline suggests prediction is improving.

An analysis of prediction errors as a function of consumer persistence, total searches, etc. suggests that predictions should be better in the new environment.

Shapiro, "Positive Spillovers and Free Riding in Advertising of Prescription Pharmaceuticals: The Case of Antidepressants," *JPE* 2018.

Shapiro investigates the extent to which television advertising of prescription drugs provides positive spillovers to a firm's competitors.

Magnitudes of spillovers (relative to magnitudes of business stealing) will affect views on whether advertising would be expected to be excessive or insufficient.

The paper also contributes to the literature on quasi-experimental methods for estimating causal impacts of advertising:

- Market border effects
- Temporal discontinuities due to lawsuits, regulations, expirations
- Spillovers from political advertising
- Effects of sporting events
- Migration

Shapiro, “Positive Spillovers in Advertising”

There are six main categories of anti-depressant drugs. Several SSRI drugs, introduced in the late 1980s and 1990s, were under patent protection and had high revenues in the period Shapiro studies (1997-2004).

Annual anti-depressant revenues grew smoothly from 5B in 1996 to 13B in 2003.

Television advertising of prescription drugs became feasible around 1997 and the first anti-depressant ads appeared in 1999.

Shapiro’s data includes:

- Prescriptions written by a 5% random sample of physicians. Include physician characteristics including office address. Aggregates to county-month level.
- TV advertising expenditures by brand in each of 101 markets from September 1999 – December 2003. Much advertising in national (spending a population), but there is also substantial local advertising.

Shapiro, "Positive Spillovers in Advertising"

Strategy for identification of advertising effects is to limit analysis to DMA borders (mostly rural areas) and treat monthly advertising as exogenous once one includes product-border-quarter and product-border-DMA fixed effects.

Advertising spillovers are quite large.

- A rival's advertising has almost 2/3 the effect of own advertising.
- There are decreasing returns and interactions also create an incentive to free ride.

Figure 5: Ohio and Its DMAs

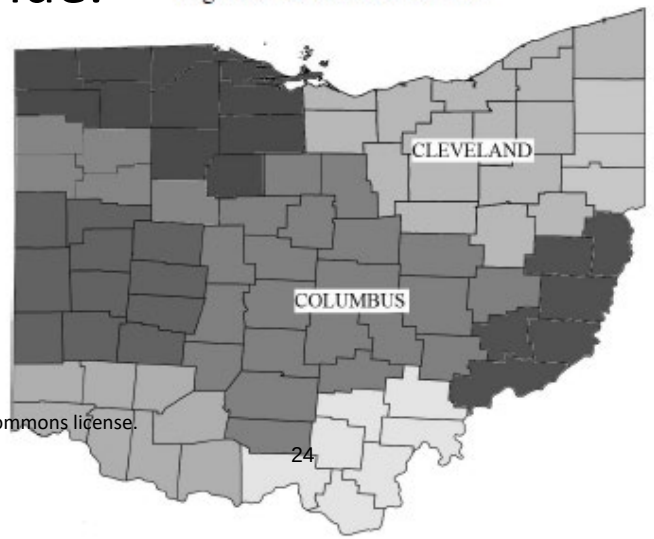


Table 2: The Effect of Own and Rival Advertisements on Sales

VARIABLES	(1) $log(Q)$
lagged $log(Q)$	0.334***
	(0.00746)
DTC	0.0240***
	(0.00621)
DTC^2	-0.00216*
	(0.00113)
DTC_{rival}	0.0164***
	(0.00266)
DTC^2_{rival}	-0.000938***
	(0.000252)
$DTCxDTC_{rival}$	-0.00134**
	(0.000631)
Product-Border-Time	yes
Product-Border-DMA	yes
Observations	316,428
R-squared	0.955

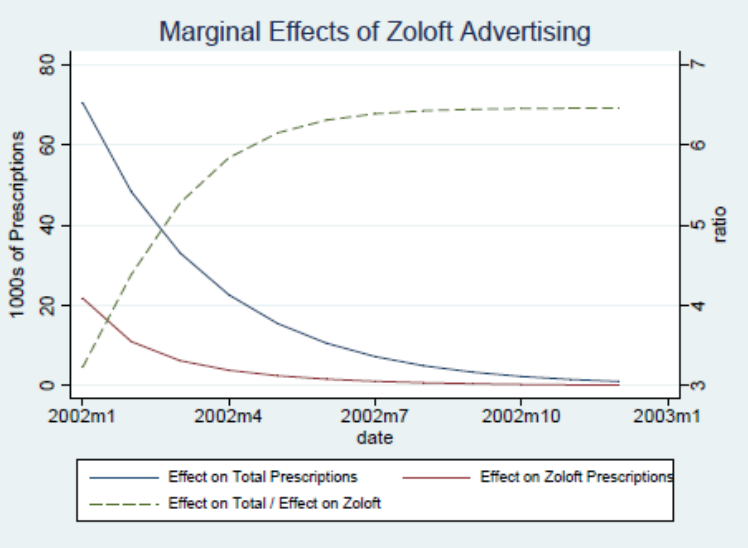
Shapiro, "Positive Spillovers in Advertising"

DMA-border variation is also used to estimate a nested logit model of demand that allows for demand persistence at the drug and category level.

- The effect of advertising on own demand is estimated to die out more quickly than the effect of advertising on category demand. This further contributes to any firm's advertising mostly benefitting other SSRI producers.

- A model simulation predicts that firms should advertise much more than they do. (This could reflect that advertising returns were not yet well understood.)
- An advertising cooperative would make further substantial increases in advertising, raising profits by about 15%.

Figure 8: Impulse Response Effect of Zoloft Advertisement on Own and Total Prescriptions



On Wednesday I'll be talking about online markets. I'll be covering several theoretical papers on search engines and one on retail platforms.

- Edelman, Ostrovsky, Schwarz
- Athey and Ellison
- Anderson and Renault
- Armstrong and Zhou

See you then!

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Fall 2022