Consumer Advertising Competition in Prescription Drugs

Michael Sinkinson (Wharton)
Amanda Starc (Wharton)
Consumer Advertising
Motivation

- Firms spend billions on advertising to consumers.
  - Why? Must generate positive returns to advertisers.
  - May also generate returns for competitors.
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  - Why? Must generate positive returns to advertisers.
  - May also generate returns for competitors.

- What are the welfare implications of advertising?
  - “Business Stealing”: shifting consumers from one firm to another
  - “Market Expanding”: informing consumers about a product
Unobserved market-level heterogeneity may increase or decrease the returns to advertising.
The Challenge

- Unobserved market-level heterogeneity may increase or decrease the returns to advertising.
- Data are generated by a game played by multiple firms. Firms are responding to rival actions in addition to market characteristics.
  - “... direct-to-consumer ads are expensive, and companies often buy them merely to blunt the impact of their competitors’ ads.”, Feb 9 2011, Ian Spatz, formerly of Merck
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- This project’s approach: we propose a novel instrument for advertising levels.
  
  We exploit exogenous shocks to local advertising markets caused by the US political process, using both primary schedules and competitiveness of races.
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- Reduced form analysis: IV regressions of revenue on ad levels.
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  - We exploit exogenous shocks to local advertising markets caused by the US political process, using both primary schedules and competitiveness of races.
  - Reduced form analysis: IV regressions of revenue on ad levels.
  - Structural analysis: Finite-horizon 2-player game. Transition matrix for consumers and policy functions for firms.
Motivation: Our Context

- Study advertising competition in the market for statins (anti-cholesterol drugs).
- Marketing drugs costs pharmaceutical firms more than R&D
  - Pfizer (Lipitor): Selling expenses are over 2X R&D expenses
  - DTCA is 11.3% of overall promotion spending
  - Industry-wide, $3 billion spend on direct to consumer advertising (DTCA) in 2012
- New Zealand is the only other country that allows DTCA
  - Presence of agency and insurance complicate welfare calculations
Statin advertising has a large business stealing effect among branded firms, implying that strategic interactions are important in this context.
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Branded statin advertising has a positive, statistically significant effect on demand for non-advertised and generic statins, which would not be detected via OLS.

Structural decomposition of ads says almost 60% of advertising is directly in response to rival ads, instead of in response to market conditions.

- Eliminating these ads alone would have a more modest effect on the total number of patients taking statins.
Data Sources

1. Political Advertising: Presidential, Senate, House, Governor, individual ad level 2007-2008 (U Wisc Data).


3. Drug Utilization: Market-month-drug level pills and revenue (Medstat). Estimation sample: 190 DMAs, 17 months, 4 advertised drugs plus all other (including generics).
Data Sources

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Data Sources

1. **Political Advertising**: Presidential, Senate, House, Governor, individual ad level 2007-2008 (U Wisc Data).

2. **Drug Advertising**: Market-month-drug 2006-2009 (Kantar)
   - Lipitor, Crestor, Vytorin and Zetia advertise most during this time period.

3. **Drug Utilization**: Market-month-drug level pills and revenue (Medstat)
   - Estimation sample: 190 DMAs, 17 months, 4 advertised drugs plus “all other” (including generics)
Unobserved heterogeneity and strategic interactions make measurement difficult.

Example: Demand shock increases returns to advertising; ads are business stealing.

- Positive shock to Lipitor demand increases Lipitor advertising
- Increase in Lipitor advertising increases Crestor advertising
- OLS measures a market expansion effect of Crestor’s advertising where there is no causal effect
- OLS likely underestimates own effect for Lipitor ads.

Direction of OLS bias depends on how demand shocks and rival advertising affect advertising decisions.
Implications

Challenge of regressing my market share on advertising levels

<table>
<thead>
<tr>
<th>A positive demand shock...</th>
<th>Increase Marginal Benefit of Advertising</th>
<th>Decrease Marginal Benefit of Advertising</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rival advertising is...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Stealing</td>
<td>Both advertise more;</td>
<td>Both advertise less;</td>
</tr>
<tr>
<td></td>
<td>Own effect bias: ↑</td>
<td>Own effect bias: ↓</td>
</tr>
<tr>
<td></td>
<td>Rival effect bias: ↑</td>
<td>Rival effect bias: ↑</td>
</tr>
<tr>
<td>Market Expanding</td>
<td>I advertise more, rival less;</td>
<td>I advertise less, rival more;</td>
</tr>
<tr>
<td></td>
<td>Own effect bias: ↑</td>
<td>Own effect bias: ↓</td>
</tr>
<tr>
<td></td>
<td>Rival effect bias: ↓</td>
<td>Rival effect bias: ↓</td>
</tr>
</tbody>
</table>
Political primary/caucus schedule and competitiveness of races lead different markets to get large amounts of political advertising at different points in the year.

Political advertising displaces drug advertising. For example, March 2008:

- Cincinnati OH, Charlotte NC, and Indianapolis IN have thousands of political ads (1,192, 1,471 and 1,996 respectively); zero local statin ads.
- Seattle WA has zero political ads, 57 local statin ads; Miami-Ft Lauderdale FL has zero political ads, 51 local statin ads.

Fast-forward to Oct 2008: Miami-Ft Lauderdale has 12,422 political ads; 8 statin ads.
Political Advertising in the 2008 Election

- First billion dollar election, with more than twice the spending of 2004
- No incumbent for either primary.
  - contest between Clinton and Obama extended into June
  - strength of Obama’s challenge was surprising
  - McCain clinched the Republican nomination in March
- Obama rejected public funding in the general election, relying on a larger amount of private funds.
  - substantial advertising spending in "swing states", including CO, FL, IN, MO, NV, NH, NM, NC, OH, PA, and VA
  - spent $740M, more than Kerry and Bush combined in 2004 ($640M)
Political Ads, December 2007
Political Ads, September 2008
Additional Variation

- We want to predict both firm and industry advertising levels.
- Late February 2008: Congress begins investigating a series of Lipitor ads featuring Dr. Robert Jarvik
- Pfizer halted the ad campaign in April-August 2008
- Political shocks will have differential effects on firms depending on the time period.
Drug Ads 2007-2008

- Advertising is driven by:
  - Information on effectiveness from clinical trials
  - Competitive interaction
  - Regulation (the case of Lipitor in early 2008)
  - Variation in availability due to political advertising
First Stage

Political Ads Displace Drug Ads
Binned Scatterplot, Market and Year-Month Fixed Effects
## First Stage Results

### Effect of Political Ads on Statin Drug Ads

<table>
<thead>
<tr>
<th>Model:</th>
<th>OLS (1)</th>
<th>OLS (2)</th>
<th>OLS (3)</th>
<th>Tobit (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political Ads (1000s)</td>
<td>-0.1895***</td>
<td>-0.1201***</td>
<td>-0.1201***</td>
<td>-0.2598***</td>
</tr>
<tr>
<td></td>
<td>(0.0098)</td>
<td>(0.0116)</td>
<td>(0.0117)</td>
<td>(0.0103)</td>
</tr>
<tr>
<td>Controls</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Market FE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Year-Month FE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drug FE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drug-Year-Month FE</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>24,035</td>
<td>24,035</td>
<td>24,035</td>
<td>24,035</td>
</tr>
<tr>
<td>R2</td>
<td>0.314</td>
<td>0.364</td>
<td>0.479</td>
<td>0.552</td>
</tr>
</tbody>
</table>
First Stage Summary

- Specification for main results uses political advertising, a dummy for months affected by Congressional action, their dummies, and higher order terms (quadratic and cubic).
- First stage F-Stats: 318.92 for own ads, 172.00 for rival ads
First Stage Summary

• Specification for main results uses political advertising, a dummy for months affected by Congressional action, their dummies, and higher order terms (quadratic and cubic).
• First stage F-Stats: 318.92 for own ads, 172.00 for rival ads
• No evidence of drug firms shifting ads to months before/after political ad spike
  • Political ads are not predictive of drug ad levels in earlier or later months; one exception is late 2007 Iowa where political ads highly serially correlated.
• No evidence of drug firms shifting ads to other media (radio, newspaper, magazine)
  • Effect of political process felt across all media.
• Unlikely that firms are able to alter physician detailing plans at the monthly level.
  • Discussions with industry sources indicate staffing levels are set annually, would not be feasible to adapt physician detailing to political shocks.
### Effect of Political Ads on Statin Drug Revenue for Advertised Drugs

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(Any Political Ads)</td>
<td>-0.0403***</td>
<td>-0.0365***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0057)</td>
<td>(0.0069)</td>
<td></td>
</tr>
<tr>
<td>1(Above Median Pol. Ads)</td>
<td></td>
<td>-0.0309***</td>
<td>-0.0079</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0062)</td>
<td>(0.0075)</td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market FE</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drug-Year FE</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>N</td>
<td>11,550</td>
<td>11,550</td>
<td>11,550</td>
</tr>
<tr>
<td>R2</td>
<td>0.841</td>
<td>0.841</td>
<td>0.841</td>
</tr>
</tbody>
</table>

Non-Parametric Effect on Revenues
Non-Parametric Spillovers

Effect of Primaries on Growth in Generic Drug Revenue

Placebo Test
<table>
<thead>
<tr>
<th>Exposure:</th>
<th>OLS</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-Month</td>
<td>3-Month</td>
</tr>
<tr>
<td>Log Own Ads</td>
<td>0.0239***</td>
<td>0.0316***</td>
</tr>
<tr>
<td></td>
<td>(0.0021)</td>
<td>(0.0020)</td>
</tr>
<tr>
<td>Log Rival Ads</td>
<td>0.0016</td>
<td>0.0008</td>
</tr>
<tr>
<td></td>
<td>(0.0027)</td>
<td>(0.0029)</td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market FE</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Product-Year FE</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>N</td>
<td>11,550</td>
<td>10,875</td>
</tr>
</tbody>
</table>

Instruments are a cubic of political advertising, a dummy for months affected by Congressional action, and their interactions. First stage for own ads F-stat 318.92 (2-month), 320.73 (3-month). For rival ads, 172.00 (2-month) and 169.90 (3-month).
**Branded vs Generic**

Dependent variable: Log Drug Revenue per pop

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>Products:</strong></td>
<td>Non-Advertised</td>
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</tr>
<tr>
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<td>0.0239***</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(0.0021)</td>
</tr>
<tr>
<td>Log Rival Ads</td>
<td>0.0018</td>
<td>0.0016</td>
</tr>
<tr>
<td></td>
<td>(0.0037)</td>
<td>(0.0027)</td>
</tr>
</tbody>
</table>

**Controls**

| X | X | X | X | X |
| Market FE | X | X | X | X |
| Product-Year FE | X | X | X | X |

N 3,146 11,500 3,146 11,500

Ad quantities are two-month trailing averages.
Reduced Form Summary

- Spillovers to generics from branded advertising.
- Large business-stealing effects from rival ads among branded, advertised drugs.
  - Implies that strategic interactions are important in this market.
- Results are robust to alternative specifications
  - placebo tests
  - estimate stability
  - regressions of revenue on political ad levels
  - lag structure
  - first stage
Lipitor spent $175M on advertising in 2009 ($15M/month)
US revenue was approx. $490M/month
Pfizer costs were 25% of revenue
Our elasticity estimates indicate a 1% increase in advertising ($150K) increases profit by 0.125% ($459K)
Right order of magnitude, but holds rival ads constant
Two-player game (i.e. Lipitor and Crestor) where firms choose advertising levels each period.

Transition matrix: every month \( t \), consumers are in a state \( j = 0...J \), where \( j = 1...J \) represent different drugs and \( j = 0 \) represents no drug. Consumers evolve each month according to logit probabilities, modeled as a function of advertising levels

\[
    u_{ijt} = \beta_{0j} + \beta_{1j} \log (1 + adv_{jt}) + \beta_{2j} \log (1 + adv_{jt}) + \xi_{jt} + \varepsilon_{ijt}
\]

Outside good (no drug) normalized to zero, but with coefficient on total ads. Allows for market expansion and business stealing effects.

Estimation via GMM: given a parameter vector, use observed shares to recover \( \xi_{jt} \). Construct moments \( E[\xi|Z] = 0 \) for instruments \( Z \), which are political advertising levels.
Optimal advertising level comes from firm first-order conditions. Define:

\[
 v_{jt}(s_t) = \max_{a_j, t \in [0, \bar{a}]} \left\{ M \cdot \rho \cdot s_{jt} - c_{jt} \cdot a_{jt} + \beta \cdot v_{j,t+1}(f_j(s_t, a_t)) \right\}
\]

where \( f \) represents the share transition process. First order condition:

\[
 \frac{\partial v_{jt+1}}{\partial a_t} = \frac{c_{jt}}{\beta}
\]

In final period, decision is static: solve for best response functions to rival advertising levels. Intersection of best responses is equilibrium ad level, \( \hat{a} \).

In earlier periods, numerically solve for optimal ad levels.

Recover “exit value” for each product via minimum distance estimation:

\[
 \hat{\theta} = \arg\min_{\theta} \sum_j \sum_t (\hat{a}_{jt} - a_{jt})^2
\]
Modeling Assumptions

- Allow for persistence in demand and dynamic effect of advertising
- The game if finite
  - Consumers can be characterized by a “scrap” or “exit” value when Lipitor loses patent protection
- Advertising affects profits by increasing quantity leading to patent expiration.
## Preliminary Results

### Simulation Results: Product Shares with/without Ads

<table>
<thead>
<tr>
<th>Model: Products</th>
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<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Advertised</td>
<td>Advertised</td>
<td>Non-Advertised</td>
</tr>
<tr>
<td>Baseline</td>
<td>1.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Banning Ads</td>
<td>1.6407</td>
<td>1.4901</td>
</tr>
</tbody>
</table>

- Simulation of three year period.
- OLS results are nonsensical.
- Ads benefit generics greatly.
### Simulation Results: Product Shares

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<td>Baseline</td>
<td>1.0000</td>
</tr>
<tr>
<td>Banning Ads</td>
<td>0.8157</td>
</tr>
<tr>
<td>Eliminate Rival Responses</td>
<td>0.9279</td>
</tr>
</tbody>
</table>

### Simulation Results: Ad Levels

<table>
<thead>
<tr>
<th>Ad Levels</th>
<th>Non-Advertised</th>
<th>Advertised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>-</td>
<td>1.0000</td>
</tr>
<tr>
<td>Eliminate Rival Responses</td>
<td>-</td>
<td>0.4242</td>
</tr>
</tbody>
</table>
Conclusions

- Preliminary conclusions: Significant portion of ads are “defensive” or “business-stealing”; rational for firms but potentially not beneficial to market.

- Ads have strong positive spillovers to generics, suggesting positive welfare effect and potential policy recommendations.

- Future counterfactuals:
  - Solve for optimal policies in the absense of political ads
  - Introduce PSA-style ads for generics (post-patent)
  - Extend patent life
Implications for Measurement

The true relationship is:

\[ E(Y|1, X_j, X_{-j}) = \beta_0 + \beta_1 X_j + \beta_2 X_{-j} \]

Assume the relationship between my ads and rival ads is given by:

\[ E(X_{-j}|1, X_j) = \gamma_0 + \gamma_1 X_j \]

If I do not include the effect of my rivals, I will estimate:

\[ E^*(Y|1, X_j) = (\beta_0 + \beta_2 \gamma_0) + (\beta_1 + \beta_2 \gamma_1) X_j \]

Under strategic complements and business stealing, the presence of competitive effects will bias the effect of advertising downward.
Implications for Measurement

The true relationship is:

\[ E(Y|1, X_j, X_{-j}) = \beta_0 + \beta_1 X_j + \beta_2 X_{-j} + \beta_3 \xi \]

Assume the relationship between the market or product level shock, my ads and rival ads is given by:

\[ E(\xi|1, X_j, X_{-j}) = \gamma_0 + \gamma_1 X_j + \gamma_2 X_{-j} \]

If I do not include the effect of my rivals, I will estimate:

\[ E^*(Y|1, X_j, X_{-j}) = (\beta_0 + \beta_3 \gamma_0) + (\beta_1 + \beta_3 \gamma_1) X_j + (\beta_2 + \beta_3 \gamma_2) X_{-j} \]

The bias depends on:

- how firms advertise in response to a positive demand shock (more advertising or less)
- strategic interaction between firms, especially if the shock is market wide
Drug Shares 2007-2008

Advertisements may impact sales, but we want to identify the causal effect. Placebo Test
Placebo Test

Placebo Test: Shift Primaries 10 Months

Percent Change in Generic Pills

-1.5
-1
-0.5
0
0.5
1

3-Month Lead
2-Month Lead
1-Month Lead
Primary
1-Month Lag
2-Month Lag
3-Month Lag

Months before/after Primary
### Business Stealing

**Dependent variable:** Log Drug Revenue per pop

<table>
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<th>3-Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Own Ads</td>
<td>0.0163*** (0.0030)</td>
<td>0.1252*** (0.0136)</td>
</tr>
<tr>
<td>Log Rival Ads</td>
<td>-0.0966*** (0.0112)</td>
<td></td>
</tr>
<tr>
<td>Controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market FE</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Product-Year FE</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>11,550</td>
<td>11,550</td>
</tr>
</tbody>
</table>