Driving Online and Offline Sales: The Cross-Channel Effects of Traditional, Online Display, and Paid Search Advertising

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Marketing in Israel Conference
In the Beginning . . .

Traditional World

Traditional Advertising → Offline Sales
And Here We Are Today . . .

Modern World

- Traditional Advertising
- Digital Advertising

- Offline Sales
- Online Sales

Own Effect

Cross Effects

Own Effect
Objectives

- Measure cross effects of traditional, online display, and paid search advertising on offline/online sales:
  - How important are cross effects?
  - Are they positive or negative?
  - Are cross effects ephemeral or do they exhibit carryover?
  - What is the interplay between traditional/online display and paid search advertising?
Agenda

- Modeling Framework
  - Direct Effect
  - Indirect Effect through Paid Search.
- Data
- Empirical Model
- Final Specification and Estimation
- Results
- Implications
Why Cross Effects: The Direct Effect

- Advertising stimulates need recognition and/or information search and consumer uses preferred channel, even if different from media channel.
Why Cross Effects: Paid Search and the Indirect Effect

- Traditional and online ads stimulate online keyword search.
- Search ad impression and CTR route consumer to the website.
- After gathering information online, consumer may purchase offline.
- Creates “indirect” cross or own impact of advertising on sales.
- Advertising determines impressions and CTR.

![Diagram showing the process from Need Recognition to Purchase with various nodes and connections.]
Modeling Framework

=> Four Dependent Variables: Impressions, CTR, Offline Sales, Online Sales
Data Overview

• Major high-end clothing retailer
• 25 US markets
• Two years of weekly data
  • Market level online and offline $ sales
  • National advertising $, impressions, and CTR
• 85% of sales are through offline channel
Model – Main Equations

- **Dependent Variables**
  - \(\ln(\text{OfflineSales})_{mt}\)
  - \(\ln(\text{OnlineSales})_{mt}\)
  - \(\ln(\text{Impressions})_t\)
  - \(\ln(\text{ClickThroughRate})_t\)

- **Stock Variables**
  - \(\ln(\text{TraditionalAdStock})_{mt}\)
  - \(\ln(\text{OnlineDisplayAdStock})_{mt}\)
  - \(\ln(\text{ClickthroughStock})_{mt}\)

- **Control Variables**
  - \(\ln(\text{OnlineSearchSpend})_t\)

- Autocorrelated, Cross-equation Correlated Errors:
  - \(\beta_{3,0} + \beta_{3,1} \ln(\text{TraditionalAdStock})_{mt} + \beta_{3,2} \ln(\text{OnlineDisplayAdStock})_{mt} + \beta_{3,3} \ln(\text{ClickthroughStock})_{mt} + X_{mt} \beta_{3,4} + u_{3,mt}\)
  - \(\beta_{4,0} + \beta_{4,1} \ln(\text{TraditionalAdStock})_{mt} + \beta_{4,2} \ln(\text{OnlineDisplayAdStock})_{mt} + \beta_{4,3} \ln(\text{ClickthroughStock})_{mt} + X'_{mt} \beta_{4,4} + u_{4,mt}\)
  - \(\beta_{1,0} + \beta_{1,1} \ln(\text{TraditionalAdStock})_t + \beta_{1,2} \ln(\text{OnlineDisplayAdStock})_t + \beta_{1,3} \ln(\text{OnlineSearchSpend})_t + \beta_{1,4} X_t + u_{1,t}\)
  - \(\beta_{2,0} + \beta_{1,1} \ln(\text{TraditionalAdStock})_t + \beta_{2,2} \ln(\text{OnlineDisplayAdStock})_t + \beta_{2,3} \ln(\text{OnlineSearchSpend})_t + \beta_{2,4} X_t + u_{2,t}\)
Model – Stock Variables

\[
\text{TraditionalAdStock}_{mt} = \lambda_{\text{Traditional}} \text{TraditionalAdStock}_{mt-1} + (1 - \lambda_{\text{Traditional}}) \ln(\text{TraditionalAdvertising}_{mt+1})
\]

\[
\text{OnlineAdStock}_{mt} = \lambda_{\text{OnlineDisplay}} \text{OnlineAdStock}_{mt-1} + (1 - \lambda_{\text{Traditional}}) \ln(\text{OnlineDisplayAdvertising}_{mt+1})
\]

\[
\text{ClickthroughStock}_{mt} = \lambda_{\text{Clickthrough}} \text{ClickthroughStock}_{mt-1} + (1 - \lambda_{\text{Traditional}}) \ln(\text{Clickthrough}_{mt+1})
\]
Model Specification and Estimation

• Model Specification:
  • Pooling test verifies pooling.
  • Hausman-Wu verifies endogeneity for sales equations.
  • Instruments = advertising by non-competing firms.
  • Sargan and incremental F-tests verifies validity of IVs.
  • Compared seven models to verify superior fit of final model.

• Estimation
  • 3SLS combined with grid search for λ’s.
## Control Variable Impact on Sales

<table>
<thead>
<tr>
<th>Control Variable</th>
<th>Offline Sales</th>
<th>Online Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christmas Dummy</td>
<td>0.191**</td>
<td>0.256**</td>
</tr>
<tr>
<td>Small Promotions</td>
<td>0.012**</td>
<td>0.005**</td>
</tr>
<tr>
<td>Large Promotions</td>
<td>0.046**</td>
<td>0.010**</td>
</tr>
<tr>
<td>Clearance Promotions</td>
<td>0.191**</td>
<td>0.256**</td>
</tr>
<tr>
<td>Trend</td>
<td>0.005**</td>
<td>0.007**</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>-0.332**</td>
<td>-0.727**</td>
</tr>
<tr>
<td>Competitor Traditional Ads</td>
<td>-0.003</td>
<td>-0.067**</td>
</tr>
<tr>
<td>Competitor Display Ads</td>
<td>0.011</td>
<td>-0.009</td>
</tr>
<tr>
<td>Test Banner Ads</td>
<td>0.011</td>
<td>-0.009</td>
</tr>
</tbody>
</table>
Indirect Cross Effect of Traditional Advertising on Online Sales

Indirect Cross Effect of Traditional Ads on Online Sales = (0.066 - 0.100) x 0.182 = -0.006
Total Cross Effect of Traditional Advertising on Online Sales

Indirect Cross Effect of Traditional Ads on Online Sales = (0.066 - 0.100) x 0.182 = -0.006

Direct Cross Effect of Traditional Ads on Online Sales = 0.035

Total Cross Effect of Traditional Ads on Online Sales = 0.035 - 0.006 = 0.029
## Total Long-Run Elasticities and Their Decomposition

<table>
<thead>
<tr>
<th></th>
<th>Offline Sales</th>
<th>Online Sales</th>
<th>Total Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media</td>
<td>Direct Effect&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Indirect Effect&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Total Effect&lt;sub&gt;off&lt;/sub&gt;</td>
</tr>
<tr>
<td>Traditional</td>
<td>0.084</td>
<td>-0.005</td>
<td>0.079</td>
</tr>
<tr>
<td>Display</td>
<td>0.119</td>
<td>-0.006</td>
<td>0.113</td>
</tr>
<tr>
<td>Search</td>
<td>0.136</td>
<td>0.136</td>
<td>0.136</td>
</tr>
</tbody>
</table>

Total Elasticity = 0.85 x Total Offline Elasticity + 0.15 x Total Online Elasticity

Note: All elasticities significant p < 0.05 using Delta Method
Profit Implications – Long Run ROI

<table>
<thead>
<tr>
<th></th>
<th>Offline ROI</th>
<th>Online ROI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Ads</td>
<td>$4.02</td>
<td>-$0.61</td>
</tr>
<tr>
<td>Online Display Ads</td>
<td>$5.25</td>
<td>$0.69</td>
</tr>
<tr>
<td>Paid Search Ads</td>
<td>$9.00</td>
<td>$1.43</td>
</tr>
</tbody>
</table>

Offline ROIs are generally higher than online ROIs: Elasticities are of same magnitude but offline is 85% of total sales.

Cross-Effect impact is highly profitable for digital advertising; not profitable for traditional advertising.

1 \[ \text{ROI} = \frac{\Delta S - \Delta I}{\Delta I} \]
2 \[ \eta = \frac{\Delta S}{S}/\frac{\Delta I}{I} \]

1 and 2 \[ \Rightarrow \text{ROI} = \eta(S/I) - 1 \]
Conclusions

• Cross-channel effects of advertising exist and are important
  • Own and cross-channel elasticities of same magnitude.
  • Exist for both offline=>online and online=>offline.
  • Particularly strong for online => offline.
  • Traditional ads decrease search CTR => lower traditional cross effect.
  • Traditional and display do not synergize with paid search.

• Research implications
  • Need to model multichannel impacts of advertising media.
  • Need more research on research shopping, CTR impact of traditional.

• Managerial implications
  • Not taking into account cross-effects significantly undervalues online advertising.
  • Need to develop traditional media that enhance, not inhibit, CTRs.
  • Online advertising can be used to develop the offline channel.
## Control Variable Impact on Impressions and Clickthroughs

<table>
<thead>
<tr>
<th>Control Variable</th>
<th>Impressions</th>
<th>Clickthrough Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christmas</td>
<td>-0.097**</td>
<td>0.111**</td>
</tr>
<tr>
<td>Trend</td>
<td>0.001</td>
<td>-0.007**</td>
</tr>
</tbody>
</table>
## Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store Sales (Per Market, Month)</td>
<td>324,685</td>
</tr>
<tr>
<td>Online Sales (Per Market, Month)</td>
<td>68,363</td>
</tr>
<tr>
<td>Traditional Advertising (National, Month)</td>
<td>46,021</td>
</tr>
<tr>
<td>Online Display Advertising (National, Month)</td>
<td>53,111</td>
</tr>
<tr>
<td>Paid Search Advertising (National, Month)</td>
<td>39,965</td>
</tr>
<tr>
<td>Paid Search Impressions (National, Month)</td>
<td>2,022,079</td>
</tr>
<tr>
<td>Paid Search Clickthrough Rate (National, Month)</td>
<td>3.1%</td>
</tr>
<tr>
<td>Paid Search Clickthroughs (National, Month)</td>
<td>58,772</td>
</tr>
<tr>
<td>Small Promotions (Market, Month)</td>
<td>5.67</td>
</tr>
<tr>
<td>Large Promotions (Market, Month)</td>
<td>1.71</td>
</tr>
<tr>
<td>Clearance Promotions (Market, Month)</td>
<td>0.07</td>
</tr>
<tr>
<td>Test Banner Advertising</td>
<td>0.023</td>
</tr>
<tr>
<td>Christmas Dummy</td>
<td>0.12</td>
</tr>
<tr>
<td>Unemployment Rate (%)</td>
<td>8.8</td>
</tr>
<tr>
<td>Competitor Traditional Advertising</td>
<td>73,514</td>
</tr>
<tr>
<td>Competitor Online Display Advertising</td>
<td>338</td>
</tr>
</tbody>
</table>
Literature

• Evidence of cross effects:
  • Online advertising most effective among offline buyers (Abraham 2008).
  • Online advertising influences offline consideration sets; offline ads influence online consideration sets (Naik and Peters 2009).
  • Search ads influence offline sales; flyers and faxes influence online sales (Wiesel et al 2011).

• We contribute:
  • Study traditional, display, and search advertising.
  • Model interplay between traditional/display and search advertising.
  • Model accounts for endogeneity, autocorrelation, cross-equation correlation, carryover, and competition.
Carryover Estimates ($\lambda$)

<table>
<thead>
<tr>
<th>Media</th>
<th>$\lambda$</th>
<th>90% Duration – Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>0.89</td>
<td>20</td>
</tr>
<tr>
<td>Display</td>
<td>0.84</td>
<td>13</td>
</tr>
<tr>
<td>Paid Search</td>
<td>0.00</td>
<td>0</td>
</tr>
</tbody>
</table>

- Particularly high carryover for traditional and display (billboard effect?)
- No carryover for paid search (Rutz et al. 2011)
## ROI Calculations

<table>
<thead>
<tr>
<th></th>
<th>Short Run</th>
<th>Long Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Own - Channel</td>
<td>Cross - Channel</td>
</tr>
<tr>
<td>Traditional</td>
<td>-$0.45</td>
<td>-$0.96</td>
</tr>
<tr>
<td>Display</td>
<td>-$0.73</td>
<td>$0.00</td>
</tr>
<tr>
<td>Paid Search</td>
<td>$1.43</td>
<td>$9.00</td>
</tr>
</tbody>
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\[
\text{ROI} = \frac{\Delta S - \Delta I}{\Delta I}
\]

\[
\eta = \frac{\Delta S}{\Delta I}
\]

1 and 2 =>

\[
\text{ROI} = \eta\left(\frac{S}{I}\right) - 1
\]

- **Traditional**
  - Not profitable short run
  - Long run profitable within-channel; cross-channel not profitable

- **Display**
  - Not profitable short run
  - Long run profitable both within- and cross-channel; cross-channel key

- **Paid Search**
  - Profitable short and long run
  - Cross-channel key
Impact of 6-Week Online Campaigns

Display

Paid Search

- Base Store Sales
- Store Sales with 6-Week 40% Increase in Traditional Advertising
- Base Online Sales
  - Online Sales with 6-Week 40% Increase in Online Display Advertising
  - Online Sales with 6-Week 40% Increase in Online Search Advertising