Analyzing Impacts of Major Events: A Case Study of the Los Angeles Memorial Coliseum

PSR Speaker Series
Feb 18, 2021

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The ADMS project

Research team
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Background

- **Problem**
  - Los Angeles traffic congestion
  - More than 2,500 special events held in Los Angeles every year adds to recurrent congestion

- **Objectives**
  - Measure special event effects on traffic
  - Devise strategies to effectively manage special event traffic

- **Case Study**
  - Weekend football games at the LA Memorial Coliseum
Research Questions

• How do weekend football games at the Coliseum affect local and regional transportation?
  • How do games affect the highway system?
  • How do they affect local arterials near the venue?

• What can event organizers and transportation planners do to mitigate these impacts?
  • More real-time traffic information?
  • Parking management?
  • Transit incentives?
  • Other ???
Study area

- **Los Angeles Memorial Coliseum**
  - Home of Los Angeles Rams and USC Trojans

- **Examine**
  - Highway traffic on major access corridors (within 10 miles)
  - Arterial traffic around Coliseum (within 5 miles)

- **Study Period**
  - Weekend football games
  - Jan 1, 2016 to Dec 31, 2018
Research approach

- Compare game days with otherwise similar non-game days
  - **Treatment group**
    - 19 Rams game days
    - 10 USC game days
  - **Control group**
    - 39 non-game days
    - Weekend days without major events

- Test for traffic speed difference between treatment and control days
- 0-6 hours before the football game kickoff, in 15 minute intervals
Data sources

- **Highways**: traffic speed by location, minute from Caltrans highway detectors, stored in the Archived Data Management System (ADMS)

- **Arterials**: traffic speed by location, minute from LADOT ATSAC detectors, stored in ADMS

Black dots = highway sensor locations
Red dots = arterial sensor locations
Pre-game traffic pattern- I 110 S

Rams games

I-110 & I-105 interchange

Less congestion

More congestion

Mile per hour
Pre-game traffic pattern - I110 S

**USC games**

- **I-110 & I-105 interchange**

- **Mile per hour**

![Traffic Speed Difference between Treatment and Control Days (MPH)](image)

![Time to kickoff (hour)](image)
Pre-game traffic pattern- Arterials

Rams games

![Graph showing traffic speed difference between treatment and control days over time and distance to the Coliseum.]

Mile per hour

![Graph showing time to kickoff over distance to the Coliseum.]

Distance to the Coliseum (mile)
Pre-game traffic pattern- Arterials

USC games

Mile per hour
Estimate game-day traffic

\[ \Delta s_i: \text{Traffic speed difference at traffic detector } i \text{ between game days and control non-game days as a function of:} \]

**Temporal autocorrelation**
- 15-minute lagged speed difference for detector \( i \)

**Spatial autocorrelation**
- Weighted traffic speed difference of nearby detectors at the same highway corridor

**Temporal effect**
- Time to game kickoff in 15-minutes interval

**Spatial effect**
- Distance of detector \( i \) to Coliseum

**Control variables**
- Game attendance number, kickoff time dummy variables

**Fixed effects**
- Year, month fixed effects
Two models

- Model 1. **Ordinary Least Square (OLS)**
  - Linear regression
  - With spatial and temporal lags

- Model 2. **Random Forest (RF)**
  - Machine learning algorithm
  - Accounts for non-linear relationships
  - Provides ranking of variable importance

![Structure of a Random Forest model](image-url)
Result: OLS model

- The **spatial** and **temporal lag** coefficients are highly significant and account for most of the variance explained by OLS model.
- Other variables are of the expected signs but often not statistically significant.
- OLS does not account for complex nonlinear relationships between response variable and predictor variables.

### OLS results for Rams games

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>I-110 N</th>
<th>I-110 S</th>
<th>I-10 W</th>
<th>I-10 E</th>
<th>Arterials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time lagged term</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Spatial lagged term</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Distance to Coliseum</td>
<td>-</td>
<td></td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Time to kickoff</td>
<td></td>
<td></td>
<td>+</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Distance to highway interchange</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Attendance number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM game dummy</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>PM game dummy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Signs of significant coefficients only.
### Result Comparison: OLS and RF

<table>
<thead>
<tr>
<th>Rams</th>
<th>OLS</th>
<th>RF</th>
<th>OLS</th>
<th>RF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>RMSE</td>
<td>$R^2$</td>
<td>RMSE</td>
</tr>
<tr>
<td>I-110 S</td>
<td>0.70</td>
<td>6.04</td>
<td>0.90</td>
<td>4.03</td>
</tr>
<tr>
<td>I-110 N</td>
<td>0.73</td>
<td>6.54</td>
<td>0.88</td>
<td>3.84</td>
</tr>
<tr>
<td>I-10 W</td>
<td>0.72</td>
<td>4.81</td>
<td>0.88</td>
<td>3.18</td>
</tr>
<tr>
<td>I-10/SR 60 E</td>
<td>0.59</td>
<td>3.48</td>
<td>0.83</td>
<td>2.32</td>
</tr>
<tr>
<td>Arterials</td>
<td>0.40</td>
<td>3.42</td>
<td>0.75</td>
<td>2.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USC</th>
<th>OLS</th>
<th>RF</th>
<th>OLS</th>
<th>RF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>RMSE</td>
<td>$R^2$</td>
<td>RMSE</td>
</tr>
<tr>
<td>I-110 S</td>
<td>0.77</td>
<td>7.08</td>
<td>0.92</td>
<td>4.17</td>
</tr>
<tr>
<td>I-110 N</td>
<td>0.76</td>
<td>7.17</td>
<td>0.85</td>
<td>3.76</td>
</tr>
<tr>
<td>I-10 W</td>
<td>0.79</td>
<td>6.38</td>
<td>0.90</td>
<td>3.55</td>
</tr>
<tr>
<td>I-10/SR60 E</td>
<td>0.58</td>
<td>3.85</td>
<td>0.82</td>
<td>2.43</td>
</tr>
<tr>
<td>Arterials</td>
<td>0.39</td>
<td>3.38</td>
<td>0.76</td>
<td>2.28</td>
</tr>
</tbody>
</table>

- RF model performs better than OLS in all cases.
- RF allows for many different variable transformations.
- RF also allows for different combinations of variables and different relationships between the independent variables.
Non-linearities in spatio-temporal patterns: Highways

- **Rams** attendees tend to arrive 2-3 hours prior to the start of a game, while **USC** attendees arrive up to 6 hours earlier, due to the tailgating.
- Significant **non-linear** relationship between time and distance on freeways.
- Greatest impacts of game-induced traffic on freeways tend to be around existing **interchange** bottlenecks, rather than closest to the Coliseum.
- Similar pre-game traffic on freeways from north-bound and south-bound on I-110, and east-bound and west-bound on I-10 and SR-60.
Linearities in spatio-temporal patterns: Arterials

- More linear relationship between time and distance on arterials.
- Game induced traffic for arterials is limited to within two miles.
- Rams arrival pattern is more concentrated in time than USC.
Findings

- Dissimilar arrival pattern for Rams and USC games. Rams game attendees have a more concentrated arrival pattern.
- More complicated pre-game traffic on highways than arterials.
- For highways, greatest impacts of game induced traffic on freeways tend to be around existing interchange bottlenecks.
- For arterials, the impact of game induced traffic is limited to within two miles of the Coliseum.

What might be done to reduce congestion?

.....some preliminary results
1. Stagger attendees’ arrival pattern
2. Encourage attendees to take public transit
3. Do both
Method: Simulation modeling

Simulation 1:
Move 50% of game traffic in 3 to 0 hour time interval to 6 to 3 hour time interval

Simulation 2:
Reduce game traffic demand by 20%

Simulation 3:
Both time shifting and demand reduction

• Use VISSIM to build a network simulation model of the Coliseum area
• Use traffic data to simulate demand on the network
• Compare results to base case (no intervention)
• Simulation parameters
  • 1 PM Rams game
  • Time period: 6 to 0 hours before game
### Simulation 1 results

#### 0-3 hours before the game

<table>
<thead>
<tr>
<th>Category</th>
<th>Before VMT</th>
<th>After VMT</th>
<th>Change</th>
<th>Before VMT</th>
<th>After VMT</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>229199</td>
<td>188529</td>
<td>-17.74%</td>
<td>132247</td>
<td>145290</td>
<td>9.86%</td>
</tr>
<tr>
<td>Arterial (within 2miles)</td>
<td>28432</td>
<td>23156</td>
<td>-18.56%</td>
<td>14447</td>
<td>15805</td>
<td>9.40%</td>
</tr>
<tr>
<td>Highway</td>
<td>158925</td>
<td>133647</td>
<td>-15.91%</td>
<td>101852</td>
<td>111941</td>
<td>9.91%</td>
</tr>
</tbody>
</table>

#### 3-6 hours before the game

<table>
<thead>
<tr>
<th>Category</th>
<th>Before VMT</th>
<th>After VMT</th>
<th>Change</th>
<th>Before VMT</th>
<th>After VMT</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>229199</td>
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<td>132247</td>
<td>145290</td>
<td>9.86%</td>
</tr>
<tr>
<td>Arterial (within 2miles)</td>
<td>28432</td>
<td>23156</td>
<td>-18.56%</td>
<td>14447</td>
<td>15805</td>
<td>9.40%</td>
</tr>
<tr>
<td>Highway</td>
<td>158925</td>
<td>133647</td>
<td>-15.91%</td>
<td>101852</td>
<td>111941</td>
<td>9.91%</td>
</tr>
</tbody>
</table>
Simulation 2 results

<table>
<thead>
<tr>
<th></th>
<th>0-3 hours before the game</th>
<th>3-6 hours before the game</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>Before VMT: 229199</td>
<td>After VMT: 212148</td>
<td>-7.44%</td>
</tr>
<tr>
<td></td>
<td>Before VMT: 132247</td>
<td>After VMT: 133474</td>
<td>0.93%</td>
</tr>
<tr>
<td>Arterial (within 2miles)</td>
<td>Before VMT: 28432</td>
<td>After VMT: 26091</td>
<td>-8.23%</td>
</tr>
<tr>
<td></td>
<td>Before VMT: 14447</td>
<td>After VMT: 14450</td>
<td>0.02%</td>
</tr>
<tr>
<td>Highway</td>
<td>Before VMT: 158925</td>
<td>After VMT: 149033</td>
<td>-6.22%</td>
</tr>
<tr>
<td></td>
<td>Before VMT: 101852</td>
<td>After VMT: 102569</td>
<td>0.70%</td>
</tr>
</tbody>
</table>
## Simulation 3 results

### 0-3 hours before the game

- **Overall**: 229199
- **Arterial (within 2miles)**: 28432
- **Highway**: 158925

### 3-6 hours before the game

- **Overall**: 179366
- **Arterial (within 2miles)**: 21892
- **Highway**: 128078

<table>
<thead>
<tr>
<th></th>
<th>0-3 hours before the game</th>
<th>3-6 hours before the game</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before VMT</td>
<td>After VMT</td>
<td>Change</td>
</tr>
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<td>21892</td>
<td>-23.00%</td>
</tr>
<tr>
<td>Highway</td>
<td>158925</td>
<td>128078</td>
<td>-19.41%</td>
</tr>
</tbody>
</table>
Conclusions

- Simulation provides a useful way to evaluate possible policy strategies
- For RAMS games, spreading demand over a longer time period would reduce total congestion
  - Effectiveness of demand spreading strategy depends on overall temporal demand on the system
- The difference between spreading demand and shifting to public transit is the result of assumptions on how much demand is shifted
- Simulations assume incentive strategies – part of the research project
- Case study findings are generalizable to other major events in other locations
Thank You

Acknowledgement: This research is supported by the Los Angeles Metropolitan Transportation Authority under the LA SAFE program. Findings do not necessarily reflect the views or policies of the sponsor. All errors and omissions are the responsibility of the authors.