I’m not going to ride in weather like this!

Exploring the sensitivity of cyclists to changes in weather

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Presentation outline

• Rationale of the study
• Existing knowledge
• Knowledge gaps
• Variation of bicyclist volume
  - in Melbourne
  - in Portland
• Comparison across Melbourne Vs Portland
• Conclusion
Rationale

- Weather and climate change are high on the agenda for most cities around the world today
- To promote sustainable transport and enhance health outcomes, Governments have been promoting cycling
- However, bicycle users are directly exposed to changing weather and climate

- The aim of this research
  - is to understand how bicycle users are influenced with the changes in weather
Aim and Scope

The focus of this presentation is the comparative analysis of the effects of weather on bicycle demand in Melbourne and Portland.
Impacts of weather on cyclist travel behaviour

Temperature effect

• Temperature greater than 30°C and less than 10°C decreases cyclist volume
• Air temperature has a non-linear and non-symmetrical relationship with commuter cyclist volume
• Ideal riding air temperature is 25°C-28°C
Impacts of weather on cyclist travel behaviour

Precipitation effect

- Precipitation is the most influential weather parameter to decrease cyclist volume
- Precipitation has a non-linear effect

Wind effect

- Strong wind (defined as 40-62 kph) reduces the volume of commuter cyclist by between 11% to 23%
Knowledge gaps identified from literature review

• Little local research examining the impact of weather variations on cycling – either in the aggregate (in terms of impacts on aggregate ridership levels) or at the level of individual travelers
• Lacking of deeper understanding of rider’s decision making process
• No quantified measure of perceived cycling comfort (eg. Comfort index)
• No assessment of how cyclists adjust their travel behaviour
• No prediction of the effect of forecasted weather and climate change on cyclist volume
Comparison across Melbourne Vs Portland

St. Georges Road

Hawthorne Bridge
Aggregate model

\[
\log_e (Q_{it}) = \alpha_i + \sum_{n=1}^{6} \beta_{iDOW,n} DOW_n + \beta_{iTIME} TIME_t + \sum_{m=1}^{2} \beta_{iTEMP,m} TEMP_t^m + \sum_{j=1}^{2} \beta_{iRAIN,j} RAIN_t^j + \beta_{iPUB} PUB_t + \varepsilon_{it} \forall i_t
\]

- **Q** = Daily bicycle volume
- **i** = Site index
- **t** = Time index
- **DOW** = day of week
- **TIME** = Time based growth
Aggregate model

\[ \log_e (Q_{it}) = \alpha_i + \sum_{n=1}^{6} \beta_{iDOW,n}DOW_n + \beta_{iTImE}TIME_t + \sum_{m=1}^{2} \beta_{iTEMP,m}TEMP^m_t + \]
\[ \sum_{j=1}^{2} \beta_{iRAIN,j}RAIN^j_t + \beta_{iPUB}PUB_t + \varepsilon_{it} \forall_{i,t} \]

- Temp = Average daily temperature
- Rain = Total daily rainfall
- Pub = public holiday
Modelling results

- Melbourne
- Portland
- Comparisons
## Modelling results for Melbourne

### Explanatory variable

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<thead>
<tr>
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<th>Model number</th>
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<tr>
<td></td>
<td>(14.72)</td>
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<td><strong>Tue</strong></td>
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<td></td>
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<td>(15.51)</td>
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<tr>
<td><strong>Thur</strong></td>
<td>0.93</td>
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<td>(14.84)</td>
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<td><strong>Fri</strong></td>
<td>0.79</td>
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<td></td>
<td>(12.75)</td>
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<td><strong>Sat</strong></td>
<td>0.13</td>
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<tr>
<td></td>
<td>(2.09)</td>
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<tr>
<td><strong>Time based growth</strong></td>
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<td><strong>Temperature</strong></td>
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<td>(3.28)</td>
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<td><strong>Temperature^2</strong></td>
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<td>(-0.503)</td>
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<tr>
<td><strong>Precipitation</strong></td>
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<td>(-5.03)</td>
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<tr>
<td><strong>Precipitation^2</strong></td>
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<td>(4.36)</td>
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<tr>
<td><strong>Public holiday</strong></td>
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<td>(-4.72)</td>
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<tr>
<td><strong>Goodness of Fit (R^2)</strong></td>
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Modelling results for Melbourne

Day of the week

- Tuesday has the highest volume which is 165.1% higher than that of Sunday
- The other week days except Friday, the volume is around 155% higher than that of Sunday
- Friday is associated with the lowest bicycle volume

Public holiday effect

- The daily bicyclist volume is decreased by between 35 and 45% on public holidays
Modelling results for Melbourne

Temperature effect

• A rise of 1°C in the air temperature increases the bicyclist volume by 2%

Precipitation effect

• While excluding non-linear effect in models, each 1 mm increase in precipitation decreases the volume by 4% to 5%
• In contrast, for models including a non-linear effect, each 1 mm increase in precipitation decreases the volume by 12% to 13%
## Modelling results for Portland

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<th>Explanatory variable</th>
<th>Model number 1</th>
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<th>Model number 3</th>
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<th>Model number 5</th>
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<td>1.20 (11.67)</td>
<td>1.21 (11.58)</td>
<td>1.21 (11.53)</td>
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<td>1.02 (9.98)</td>
<td>1.03 (10.09)</td>
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<td><strong>Thur</strong></td>
<td>0.88 (8.70)</td>
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<td><strong>Sat</strong></td>
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<td>0.0017 (2.41)</td>
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<td>0.0007 (1.11)</td>
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<td>0.06 (9.22)</td>
<td>0.05 (4.14)</td>
<td>0.06 (4.99)</td>
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<td>0.03 (3.89)</td>
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<td><strong>Temperature</strong></td>
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<td>0.0021 (2.56)</td>
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<td>-0.96 (-7.78)</td>
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<tr>
<td><strong>Public holiday</strong></td>
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<td>0.76</td>
<td>0.82</td>
<td>0.83</td>
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</table>
Modelling results for Portland

Day of the week

- Monday has the highest volume which is 233.1% higher than the volume on a Sunday
- As the week progresses, the volume decreases
- Friday has the lowest volume during the workweek

Public holiday effect

- Daily bicyclist volume decreases by around 60%

Holiday in PSU

- When the university is closed bicycle volumes drop by around 40%
Modelling results for Portland

Temperature effect

• Each 1°C rise in air temperature increases the volume of bicycles by between 3% to 6%

Precipitation effect

• Each 1mm increase of precipitation decreases the bicycle volume by around 4%
Comparison across two cities

- Models in each city explain about the same proportion of the variability in the dependent variable (around 80%)
Comparison across two cities

Day of week

- Both cities experience a higher daily bicyclist volume during the workweek compared to the weekend

Public holiday

- Have almost twice the effect in Portland compared to Melbourne
Comparison across two cities

Temperature effect

• The effect of temperature is more pronounced in Portland than Melbourne

• Each 1°C increase in temperature increases the bicycle volume by
  - 2% in Melbourne
  - 3% to 6% in Portland
Comparison across two cities

Precipitation effect

• Portland is less sensitive to precipitation than Melbourne
• Each 1 mm increase in precipitation reduces the volume by
  - 4 to 13% in Melbourne
  - 3 to 4% in Portland
Comparison across two cities

Summary

• Cyclists in the two cities exhibit different sensitivities to weather
• Rain is a bigger deterrent to cycling in Melbourne
Whereas,
• Increasing temperatures does more to stimulate higher ridership in Portland
Future research

Expand aggregate model approach
- More time series data
- More locations

At the disaggregate or individual level
- Decision making process of the riders
- Development of a perceived cycling comfort index
- Rider’s execution of their travel plans

Analysis tools
- Detailed questionnaire panel survey
Conclusion

• Aggregate ridership models found to explain a large proportion of the variation in cyclist volume
• Statistically significant effects of weather
  - But cyclists in the two cities exhibit different sensitivities to weather
• Future research will seek deeper insight into individual’s travel decisions
Data sources for cyclist studies

- Travel behaviour data is exclusively collected by questionnaire surveys.
- In recent years, hourly bicycle volume have been collected through automatic counting systems:
  - Inductive loops
  - Piezo electric cables
- The Bureau of Meteorology is a rich source of weather data.
Methodologies adopted in cyclist studies

- Different statistical models have been employed
  - Time series model
  - Regression model
  - Ordered probit model
- Ridership has been directly modelled as the dependent variable - ‘daily ridership’ and ‘the change in ridership’ have been used
- The weather variables are often treated as categorical variables
Impacts of weather on cyclist travel behaviour

Summary

• Rainfall has the most influence on bicycle volumes with a non-linear effect
• Temperature has a non-linear effect with bicycle volumes
• Wind generally has least effect on bicycle volumes