HYBRID CHOICE MODEL TO DISENTANGLE THE EFFECT OF AWARENESS FROM ATTITUDES AFTER IMPLEMENTATION OF SOFT MEASURES

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Outline

- Objective of the work
- Motivations
- Data collection methodology
  - Information attributes
- Hybrid Choice Model
- Conclusions and Future Researches
Negative impacts of private car use can be mitigated by encouraging individuals to change their travel behaviour, using more sustainable modes.

Bamberg et al., 2011

**HARD MEASURES**
- Road pricing, parking fees
  - Poorly accepted and unable to produce lasting effects

**SOFT MEASURES**
- Voluntary:
  - Information and communication
  - Individuals are set free to choose what they like
Objective of the work

The object of this work is to build a Stated Preference (SP) experiment to measure:

1. the effect of soft measures on individual behaviour
2. to which extent awareness depends on the psychological effects
3. disentangle the effect of each information provided

We focus on the effect of making people aware of the benefit of the Park and Ride (P&R) instead of the car as driver, testing, in particular, the effect of reduction in CO$_2$, and reduction of Stress, and how these information should be presented to be effective.
Motivations

- None of the “Voluntary Travel Behaviour Change” programs have analysed which was the specific information provided that had led to the behavioural change;
  - Meloni et al. (2013) measured the effect of awareness for an increase in calories burned, however they use a small sample and revealed preference data.

- Stress has a very negative health effect in modern society, and the stress caused by traffic conditions is very relevant but has never been considered in transport studies;

- Travellers may also be affected by the manner in which information is presented, it is therefore important to find the best way to present the soft measure.
Data collection Methodology

Step 1
- A typical Revealed Preference (RP) survey was carried out

Step 2
- RP data was carefully analysed to identify individuals who can participate to the SP experiment
- A SP survey was built customised based on the information reported in the RP
- The SP was tested using simulated data in order to test whether the design allows us to recover the coefficients assumed to generate the design
- A set of statements was defined following the Theory of Planned Behaviour (TPB) to measure in particular individual (i) attitude toward environment, and (ii) personality with respect to stress

Step 3
- Individuals were contacted again and asked to answer the SP survey
Survey Context

Context:
Corridor served by a sustainable alternative mode (Light Rail) named *Metrocagliari*

Light Rail characteristics:
- *Metrocagliari* is a single line service, of 6.3 km length and 9 stops
- The travel time of the entire line is 18 minutes
- Unfortunately to date only 5,000 travelers/day use it, about 75% below its capacity

Thus, this context offers the opportunity to experiment individualized social marketing techniques to promote the use of an existing sustainable mode

Target Sample:
Prospective Park and Riders (PP&R), i.e. car users who could have conveniently use *Metrocagliari*, travelling by car to a parking area and then take the light rail to the final destination
**Survey Campaign**

**Campaign promotion**: web sites of the municipalities that are located along the corridor

<table>
<thead>
<tr>
<th>Survey Data collected</th>
<th>N.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>People who entered the survey</td>
<td>1236</td>
<td>-</td>
</tr>
<tr>
<td>People in the target</td>
<td>1158</td>
<td>93.69</td>
</tr>
<tr>
<td>RP Questionnaire completed</td>
<td>486</td>
<td>41.97</td>
</tr>
<tr>
<td>Not agree to be contacted again</td>
<td>6</td>
<td>1.23</td>
</tr>
<tr>
<td>Never travel to city centre</td>
<td>11</td>
<td>2.26</td>
</tr>
<tr>
<td>Trips made by car as driver</td>
<td>303</td>
<td>62.35</td>
</tr>
<tr>
<td>Do not pass the check on the trips</td>
<td>106</td>
<td>34.98</td>
</tr>
<tr>
<td>Individuals invited to answer to SP survey</td>
<td>197</td>
<td>65.02</td>
</tr>
</tbody>
</table>
Choice: binary choice between the status quo (car) and the P&R alternative

Scenario:
(i) all parking spaces at the destinations were charged
(ii) the parking cost increased
(iii) an increase in the in-vehicle travel time as a result of the congestions

Attributes:
• N. 4 Level of Service (LOS) Attributes (3 levels each): Travel Time, Parking Time, Parking Cost and Frequency
• N. 2 Information Attributes (2 levels each): CO$_2$ reduction, Stress reduction

Customised: 20 categories with homogeneous LOS characteristics

Orthogonal Design: 27 choice tasks randomly divided in 3 blocks of 9 choice tasks each
We carried out pilot survey to test the following aspects:

- whether to use:
  - only images
  - only text
  - both

- what type of context to include in the images:
  - general context
  - specific image of the study area

- whether to use:
  - abstracted (cartoon)
  - real images

- what type of information to include in the text:
  - percentage
  - absolute value

<table>
<thead>
<tr>
<th></th>
<th>P&amp;R</th>
<th>CAR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO₂</strong></td>
<td>![CO₂ cartoon]</td>
<td>![CO₂ specific]</td>
</tr>
<tr>
<td>General context</td>
<td>![General Cartoon]</td>
<td>![General Image]</td>
</tr>
<tr>
<td>Specific image</td>
<td>![Specific Cartoon]</td>
<td>![Specific Image]</td>
</tr>
<tr>
<td><strong>Stress</strong></td>
<td>![Stress Cartoon]</td>
<td>![Stress Image]</td>
</tr>
<tr>
<td>Abstracted</td>
<td>![Abstracted Cartoon]</td>
<td></td>
</tr>
<tr>
<td>Real</td>
<td>![Real Image]</td>
<td></td>
</tr>
</tbody>
</table>
SP Survey – Information Attributes

We defined 8 cases based on the combination of the aspects described above, with and without the text, and we asked to a sample of 20 individuals to express for each case their level of agreement/disagreement (5-point Likert scale) with respect to the following adjectives:

- Clear
- Relevant
- Effective
- Original

Finally we asked to the respondents to choose the best among the cases presented.

We found that the best way to present information was:
combination of text, with percentage and realistic images specific of Cagliari

- 18/20 individuals chose that combination
- Most of them gave to that combination the highest score in the Likert scale for all the 4 adjectives
TPB survey

We defined a set of statements (57 items) to measure all the items included in the Theory of Planned Behaviour (TPB)

In particular the statements are referred to:

- Public Transport use
- Car use
- Traffic Stress
- Environment
Pilot Survey Results

A discrete choice model estimated using a first pilot gathered (22 individuals), indicates that:

- Parking Time and Parking Cost are the most important attributes (highly significant)
- CO\(_2\) reduction has the correct sign but not highly significant (small sample size)
- Stress seems instead not to be perceived as important (opposite sign than expected, but low t-test)

We explored if the results of the stress was due to:

- Different attitudes toward stress
- The SP design (values presented)
- Difficulty in raise awareness

Actions:

- Reduced a bit parking cost
- Added explanation about stress in the SP

### Indicators Stress

<table>
<thead>
<tr>
<th>How much are you stressed by the following aspects?</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion</td>
<td>3.14</td>
</tr>
<tr>
<td>Car maintenance</td>
<td>2.14</td>
</tr>
<tr>
<td>Accidents</td>
<td>1.50</td>
</tr>
<tr>
<td>Problem to find a park</td>
<td>2.86</td>
</tr>
<tr>
<td>Traffic Noises</td>
<td>2.45</td>
</tr>
</tbody>
</table>
## SP Survey – Example

<table>
<thead>
<tr>
<th></th>
<th>CAR</th>
<th>P&amp;R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parking Cost</strong></td>
<td>4 €</td>
<td>3 €</td>
</tr>
<tr>
<td><strong>Travel Time</strong></td>
<td>12 min</td>
<td>18 min</td>
</tr>
<tr>
<td><strong>Parking Time</strong></td>
<td>12 min</td>
<td>2 min</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td></td>
<td>5 min</td>
</tr>
</tbody>
</table>

**If you use P&R instead of car as driver:**

- Reduce traffic stress by 30%. A study conducted among 10,000 car drivers in Europe has shown that 20 minutes driving in traffic is enough to increase psychophysical stress. One in three Italians ranks traffic as the major source of stress.

- Reduce CO₂ emissions by 45%. Were all commuters travelling into the centre of Cagliari (150,000 trips per day), to switch to P&R for just one daily trip, this would reduce CO₂ emissions by 36,920 tonnes, an amount offset in one year by 4,013 hectares of forest, roughly 140 times the area covered by the Monte Urpinu Park (a well known park in Cagliari)!
Hybrid Choice Model

The model allows to distinguish the effect of awareness due to the information provided in the SP from the psychological effects, provided in the TPB questionnaire, that affects individual choices

\[ U_{qj} = ASC_j + \theta_j LOS_{qj} + \beta_j SE_{q} + \tau_j Info_{qj} + \lambda_j (\alpha SE'_{q} + \omega_q) + \varepsilon_{qj} \]

- travel time by car from origin to park-and-ride
- travel time by car looking for parking
- travel time by car from origin to final destination
- parking cost
- waiting time at the Metro station

**Latent Variables**
1. Stress
2. Info Stress
3. Personal Norm

**Measurement equation:**

\[ I_{qk} = \gamma_k + \zeta_k LV_q + \nu_{qk} \quad k = 1, ..., K \]
## Latent Variables Indicators

<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>Questions</th>
<th>Items (Indicators of Latent Variables)</th>
</tr>
</thead>
</table>
| **Traffic Stress** | Which of the following aspects stresses you more | ✓ Traffic  
✓ Car maintenance  
✓ Accidents  
✓ Difficulties in finding a parking place  
✓ Traffic noise |
| KMO: 0.747  
No. Factors: 1  
Alpha factor 1: 0.703 | | |
| **Info Stress** | Do you think that receiving information about the level of stress associated with driving can: | ✓ Be important but not as much as travel costs and times  
✓ Increase people’s awareness as to the negative effects associated with car use  
✓ Provide an incentive to reduce car use  
✓ Make car users reflect about the possibility of switching to public transport  
Has absolutely no influence on the choice of travel mode  
✓ Be considered useless  
Make car users switch to public transport |
| KMO: 0.736  
No. Factors: 2  
Alpha factor 1: 0.548 | | |
| **Personal Norm** | Do you agree or disagree with the following statements | ✓ Regardless of what other people do, I feel a moral duty to travel in an environmentally more sustainable way  
✓ Regardless of what other people do, I feel bad if I am unable to travel in an environmentally more sustainable way  
✓ Regardless of what other people do, I feel good if I do not use the car a lot |
| KMO: 0.548  
No. Factors: 1  
Alpha factor 1: 0.588 | | |
<table>
<thead>
<tr>
<th>Variables</th>
<th>HCM 1 (Info Stress)</th>
<th>HCM 2 (Personal Norm)</th>
<th>HCM 3 (Stress)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant_P&amp;R</td>
<td>-18.90</td>
<td>-3.33</td>
<td>-6.75</td>
</tr>
<tr>
<td>P&amp;R and Car</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel time</td>
<td>-0.109</td>
<td>-0.068</td>
<td>-0.08</td>
</tr>
<tr>
<td>Time looking for parking</td>
<td>-0.087</td>
<td>-0.046</td>
<td>-0.04</td>
</tr>
<tr>
<td>Parking cost</td>
<td>-0.711</td>
<td>-0.498</td>
<td>-0.51</td>
</tr>
<tr>
<td>Travel time * Time looking for parking</td>
<td>0.018</td>
<td>0.024</td>
<td>0.047</td>
</tr>
<tr>
<td>LOS Attributes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P&amp;R LOS Attribute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waiting time</td>
<td>-0.162</td>
<td>-0.1</td>
<td>-0.13</td>
</tr>
<tr>
<td>P&amp;R Information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO₂ Reduction</td>
<td>0.535</td>
<td>0.345</td>
<td>0.371</td>
</tr>
<tr>
<td>Stress Reduction</td>
<td>0.699</td>
<td>0.489</td>
<td>0.546</td>
</tr>
<tr>
<td>P&amp;R Individual characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 18-30</td>
<td>-2.01</td>
<td>1.21</td>
<td>1.24</td>
</tr>
<tr>
<td>Age 31-40</td>
<td>1.21</td>
<td>4.88</td>
<td>4.26</td>
</tr>
<tr>
<td>Age &gt; 41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>0.719</td>
<td>0.836</td>
<td>0.778</td>
</tr>
<tr>
<td>Self-employed</td>
<td>1.65</td>
<td>4.36</td>
<td>3.75</td>
</tr>
<tr>
<td>Presence of children</td>
<td>0.77</td>
<td>3.35</td>
<td>1.13</td>
</tr>
<tr>
<td>P&amp;R Latent Variable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Info Stress</td>
<td>5.55</td>
<td>5.38</td>
<td>5.18</td>
</tr>
<tr>
<td>Personal Norm</td>
<td>0.299</td>
<td>1.66</td>
<td>1.66</td>
</tr>
<tr>
<td>Stress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV-Individual characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 31-40</td>
<td>-0.069</td>
<td>-0.38</td>
<td>-0.38</td>
</tr>
<tr>
<td>Age &gt; 41</td>
<td>-0.333</td>
<td>-0.68</td>
<td>-0.68</td>
</tr>
<tr>
<td>Female</td>
<td>0.093</td>
<td>0.205</td>
<td>0.205</td>
</tr>
<tr>
<td>Self-employed</td>
<td>0.144</td>
<td>0.623</td>
<td>0.623</td>
</tr>
<tr>
<td>Presence of children</td>
<td>0.145</td>
<td>0.16</td>
<td>3.57</td>
</tr>
<tr>
<td>Number of household members</td>
<td>-0.063</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of children</td>
<td>0.145</td>
<td>0.211</td>
<td>15.96</td>
</tr>
<tr>
<td>Random term</td>
<td>-1.23</td>
<td>-0.515</td>
<td>-0.22</td>
</tr>
<tr>
<td>L(max)</td>
<td>-3459.541</td>
<td>-2455.202</td>
<td>-4334.793</td>
</tr>
<tr>
<td>( \hat{\rho}^2 )</td>
<td>0.784</td>
<td>0.732</td>
<td>0.665</td>
</tr>
<tr>
<td>No. individuals</td>
<td>62</td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>Sample size</td>
<td>513</td>
<td>513</td>
<td>513</td>
</tr>
</tbody>
</table>
Conclusions and Future Researches

Implementing soft measures is important to encourage individuals to change their travel behaviour, however, given these first results, it seems that:

1. The P&R utility increases with the level of awareness reached thanks to information related to the light metro alternative (positive sign of parameters associated to information attributes are positive)

2. CO₂ seem to be less important than Stress and LOS attributes (cost and time)

3. All latent variables observed affect the choice of P&R and the results are in keeping with those obtained for the two information variables; thus cognitive dissonance does not appear to have any effect

This study is just a pilot (small sample) of a bigger study, we are collecting more data in order to test all these effects.
Thanks for your attention