Investigating effectiveness of on-street parking pricing schemes in urban areas
An empirical study in Rome

Cristiana Piccioni, Marco Valtorta, Antonio Musso
“Sapienza” University of Rome, School of Engineering
DICEA - Department of Civil Engineering, Building and Environment

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Parking pricing is an effective tool for managing mobility, thus reducing main externalities generated by cruising for parking.

This study aims at proposing a further contribution to the debate on parking pricing, by focusing on the city of Rome.

The outcomes achieved by a survey involving car drivers moving in some high-attractive potential zones will be critically discussed.

A parking fee too high can likely affect the attractiveness of areas, by producing a loss of revenue for all local business activities.
The wide elasticity range can be traced to 3 specific issues:

1) *Methods used for collecting data*

2) *Context and base year*

3) *Estimating parking demand*
Parking price elasticity: a multifaceted topic

- **On-street parking demand is mainly inelastic** (-1<\(\eta\)<0): the demand variation is lower than the price one. The above allows parking operators to increase revenues, given the price increase;

- **Trip purpose affects price sensitivity:** within limited price variations users moving by shopping show a lower elasticity. Vice versa, a significant price increase can generate an economic loss for the local business operators but, at the same time, only marginally impacting on systematic users;

- **PT influences parking price elasticity:** e.g. a significant negative relationship between price sensitivity and number of transfer to reach the final destination;

- **Age and income affect parking demand elasticity:** younger people (< 40) are more inclined to change their habits; besides, users who have greater purchasing power are less sensitive to price changes;

- **A greater elasticity of off-street parking supply vs. the on-street one:** in this regard, a relatively elastic demand has been recorded;

- **SP approach shows a lower elasticity than the RP approach:** drivers are more sensitive to the parking price than they state to be.
The main variables describing impacts on substitutes services available in each zone have been identified, also setting the stage for a sort of users’ taxonomy.

Effectiveness of selected parking pricing measures has been then investigated, by comparing desired outcomes and the unwanted ones, thus recognizing the most suitable fare in relation to specific zones, parkers’ needs and decision maker’s policy.
Case study: the Municipality of Rome

- Daily trips: 6,300,000
- Private vehicles: 2,150,436
- Circulating cars: 1,754,755
- Motorization rate: 64 cars/100 inh.

<table>
<thead>
<tr>
<th>PGTU Zone</th>
<th>Population</th>
<th>Employees</th>
<th>Trips attracted*</th>
<th>% Trips attracted*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>129,168</td>
<td>192,649</td>
<td>98,524</td>
<td>17%</td>
</tr>
<tr>
<td>2</td>
<td>375,903</td>
<td>246,411</td>
<td>113,702</td>
<td>20%</td>
</tr>
<tr>
<td>3</td>
<td>1,017,572</td>
<td>312,050</td>
<td>188,560</td>
<td>33%</td>
</tr>
<tr>
<td>4</td>
<td>614,636</td>
<td>230,627</td>
<td>91,038</td>
<td>16%</td>
</tr>
<tr>
<td>5</td>
<td>522,210</td>
<td>174,663</td>
<td>63,478</td>
<td>11%</td>
</tr>
<tr>
<td>6</td>
<td>224,990</td>
<td>35,735</td>
<td>17,255</td>
<td>3%</td>
</tr>
<tr>
<td>Rome</td>
<td>2,884,481</td>
<td>1,192,135</td>
<td>572,557</td>
<td>100%</td>
</tr>
</tbody>
</table>

* Only in the morning rush hour

Modal Split

- Car: 50%
- Motor cycle: 28%
- Public Transport: 15%
- Other: 7%
Case study: Parking system in Rome

**Physical parking supply**

On-street public supply: **94,252 car spaces**

- Paid: 76,066 (81%)
- Free (t limited): 18,186 (19%)

**Parking critical issues**

- Low turnover;
- High cruising for parking;
- Illegal/irregular parking;
- PT commercial speed reduction.

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**Parking Fee Scheme**

<table>
<thead>
<tr>
<th>On-street</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hour inside LTZ</td>
<td>1,20 €</td>
</tr>
<tr>
<td>1 hour outside LTZ</td>
<td>1,00 €</td>
</tr>
</tbody>
</table>

**P&R outside the railway ring**

- 12 hours: 1,50 €
- 16 hours: 2,50 €

**P&R inside the railway ring**

- 12 hours: 2,00 €
- 16 hours: 3,00 €

**Fee reduction**

- 15 minutes: 0,20 €
- 8 hours: 4,00 €
- 1 month: 70,00 €

P&R for users with PT subscription: Free
Parking system in Rome: zones selection

Parioli

Provincie

Salaria «Sapienza»

Eudossiana «Sapienza»
### Study areas: main indicators

<table>
<thead>
<tr>
<th>Topic</th>
<th>Indicators</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-street parking</td>
<td>• Parking facilities/garages</td>
<td>1 to 8</td>
</tr>
<tr>
<td></td>
<td>• Parking spots (car spaces)</td>
<td>90 to 400</td>
</tr>
<tr>
<td></td>
<td>• Average price/h (€ for 1st hour)</td>
<td>3.40 to 4.30</td>
</tr>
<tr>
<td></td>
<td>• Average price/8 hours (€)</td>
<td>18.00 to 25.00</td>
</tr>
<tr>
<td>Area's attractiveness</td>
<td>• Commercial attractive power (shops/hm)*</td>
<td>7.6 to 10.2</td>
</tr>
<tr>
<td></td>
<td>• Tertiary attractive power (activities/hm)*</td>
<td>2 to 2.7</td>
</tr>
<tr>
<td></td>
<td>• Total attractive power (activities/hm)*</td>
<td>9.6 to 12.9</td>
</tr>
<tr>
<td></td>
<td>• Potential commuters (total students)**</td>
<td>3.835 to 10.783</td>
</tr>
<tr>
<td></td>
<td>• Classroom capacity (total seats)**</td>
<td>600 to 3.500</td>
</tr>
<tr>
<td>PT coverage</td>
<td>• Number of metro lines</td>
<td>0 to 2</td>
</tr>
<tr>
<td></td>
<td>• Metro vehicles-km/day</td>
<td>0 to 8.829</td>
</tr>
<tr>
<td></td>
<td>• Number of tram lines</td>
<td>0 to 2</td>
</tr>
<tr>
<td></td>
<td>• Tram vehicles-km/day</td>
<td>0 to 4.139</td>
</tr>
<tr>
<td></td>
<td>• Number of bus lines</td>
<td>6 to 12</td>
</tr>
<tr>
<td></td>
<td>• Bus vehicles-km/day</td>
<td>6.321 to 18.856</td>
</tr>
<tr>
<td></td>
<td>• Total PT vehicles-km/day</td>
<td>10.460 to 20.968</td>
</tr>
</tbody>
</table>

* Only for the multi-purpose zones
** Only for mono-purpose zones
Gathering information on:
1) **Users** (age, gender, income, household);
2) **Trips** (purpose, frequency, distance, cruising for parking, parking duration);
3) **User’s attitude** towards parking price variations

26 multiple choice questions

On-site interviews conducted on weekdays (8am-6pm)

400 valid respondents (100 people/zone);
Desired attitudes, preference for:

- Public Transport;
- Cycling and pedestrian;
- Off-street parking;
- Park & Ride;
- Sharing mobility.

Undesired attitudes, preference for:

- Closest free parking;
- Illegal or irregular parking;
- Renouncing the trip;
- 2-wheeled motorized vehicles.

They improve modal split towards more sustainable transport, reduce congestion and other car externalities.

They limit effectiveness of any pricing measure and causing a loss of utility for one or more stakeholders.
Desired attitudes in multi-purpose zones

![Graph showing desired attitudes in multi-purpose zones](image-url)
Undesired attitudes in multi-purpose zones

![Graph showing the relationship between parking price and sample elements for different parking behaviors.](image-url)
Main variables affecting effectiveness of a pricing measure

In order to better investigate how the main variables can affect the decision-making process of parking users, a further deepening has been carried out by using a **logistic regression**.

\[
\text{logit} [\pi(x)] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k
\]

**where:**

\[
\text{logit} [\pi(x)] = \log \frac{P(Y = 1 | X = x)}{P(Y = 0 | X = x)}
\]

Estimate of \( \beta \) parameters allowed interpreting the relationship between the dependent variable and the independent ones, by assessing the positive or negative influence that selected variables exert on users’ habits by following increasing parking price.
Main variables affecting effectiveness of a pricing measure

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>Exp(β)</th>
<th>Wald</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conservative scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X6 car occupancy rate</td>
<td>-1,397</td>
<td>0,247</td>
<td>3,645</td>
<td>0,056</td>
</tr>
<tr>
<td>X7 purpose</td>
<td>2,395</td>
<td>10,974</td>
<td>3,075</td>
<td>0,080</td>
</tr>
<tr>
<td>X9 OD distance</td>
<td>1,910</td>
<td>6,755</td>
<td>3,337</td>
<td>0,068</td>
</tr>
<tr>
<td><strong>TP - oriented scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X7 purpose</td>
<td>2,497</td>
<td>12,147</td>
<td>4,933</td>
<td>0,026</td>
</tr>
<tr>
<td>X8 frequency</td>
<td>-1,325</td>
<td>0,266</td>
<td>3,725</td>
<td>0,054</td>
</tr>
<tr>
<td>X9 OD distance dummy</td>
<td>1,766</td>
<td>5,849</td>
<td>3,577</td>
<td>0,059</td>
</tr>
<tr>
<td><strong>EU – oriented scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X7 purpose</td>
<td>1,788</td>
<td>5,977</td>
<td>3,650</td>
<td>0,056</td>
</tr>
<tr>
<td>X8 frequency</td>
<td>-1,199</td>
<td>0,302</td>
<td>4,655</td>
<td>0,031</td>
</tr>
<tr>
<td>X9 OD distance</td>
<td>1,917</td>
<td>6,801</td>
<td>5,656</td>
<td>0,017</td>
</tr>
<tr>
<td>X10 parking duration</td>
<td>0,005</td>
<td>1,005</td>
<td>2,868</td>
<td>0,090</td>
</tr>
<tr>
<td>X11 cruising</td>
<td>-1,196</td>
<td>0,302</td>
<td>3,904</td>
<td>0,048</td>
</tr>
<tr>
<td>X12 walking distance</td>
<td>-1,070</td>
<td>0,343</td>
<td>3,712</td>
<td>0,054</td>
</tr>
<tr>
<td><strong>Balanced scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X2 Gender</td>
<td>-0,822</td>
<td>0,440</td>
<td>3,121</td>
<td>0,077</td>
</tr>
<tr>
<td>X9 OD distance</td>
<td>2,120</td>
<td>8,329</td>
<td>7,451</td>
<td>0,006</td>
</tr>
<tr>
<td>X13 Info on PT</td>
<td>0,797</td>
<td>2,219</td>
<td>3,000</td>
<td>0,083</td>
</tr>
</tbody>
</table>
Main features affecting the attitudes of visitors for the *Conservative* scenario. In such scenario, the parking demand reduction allows to achieve a desired occupancy rate.

**Mono-purpose zones**

### «Desired» Effects
- Zone covered by rail-based service
- PT knowledge
- Holding an annual or monthly pass to PT
- Low frequency
- High and low household income
- Short parking
- Spend more than 20 minutes
- Only 1 PT

### «Side Effects»
- Zone covered only by bus service
- No PT knowledge
- No pass to PT
- High frequency
- Medium household income
- Long parking
- Spend between 11 and 20 minutes
- 1 transfers among PT systems
Some key points

1) Less model goodness-of-fit and variables descriptiveness in multi-purpose zone are caused by variables exogenous to the parking system (socio-cultural features);

2) In multi-purpose zones the variables linked to parking cost show a greater descriptiveness along with a larger impact. Vice versa, students are most sensitive to PT-related variables;

3) Parking duration has an opposite effect on the 2 models:
   - positive β coefficient for multi-purpose zones (+ parking duration - side effects)
   - positive β coefficient for mono-purpose zones (+ parking duration + side effects);

4) The transport features impact on the users’ behavioral approach. In areas served by the metro, users are more inclined to undertake virtuous attitudes. However, most of drivers do not have knowledge of PT supply;

5) The OD distance affects the habits of all types of users: travelers covering distances requiring a transfer in urban area are more likely to produce side effects. Users perceive PT interchange urban terminals as critical nodes affected by a scarce functionality.
Parking pricing policy is a valuable tool aimed at properly balancing parking demand and supply. However, the effectiveness of such policy is not always proved, also because it is mostly perceived by parkers as a way to “ask for money” without creating tangible benefits for road and parking users.

- A minimal increase in the on-street parking price (10%) would reduce the occupancy rate without discouraging drivers to reach the area.
- 15% - 30% of users are more inclined to take unwanted attitudes, by producing side effects.

According to such outcomes......

........ any kind of parking pricing measure will be complete success only if approached in a systemic perspective, by taking into account all endogenous and exogenous parameters affecting parker’s habits.
Conclusions

In order to improve such perspective, supplementary measures should be also aimed at:

- improving on-street parking enforcement;

- emphasizing and sharing the main objectives of a specific pricing policy;

- increasing information on alternative services in the areas of interest (PT, off-street parking, P&R, sharing mobility).
Thank you for your kind attention

cristiana.piccioni@uniroma1.it
marco.valtorta@uniroma1.it
antonio.musso@uniroma1.it