Driving efficiency is difficult to analyze: we see this as an outcome of a comparative analysis between drivers.

- The temporal characteristics of driving efficiency are rarely researched.
- Driving profiles identification may link to accident risk.
- Far reaching implications to road safety.
- Personal and general feedback to drivers to reduce driving risk.
- Develop insurance pricing schemes (charge premiums based on driving efficiency).

Methodology

- Driving safety efficiency is comparatively estimated using the data Envelopment Analysis technique. The index estimated for each driver represents how risky he was during the period examined.
- Driving efficiency benchmarking in a sliding window: driving behaviour change (volatility measure), driving efficiency time-series analysis, Time-series decomposition (autocovariance, trend, volatility) assessment in each road type separately and in total.
- Identifying Driving Profiles with respect to the temporal evolution of driving characteristics with K-means using as inputs:
  - total driving efficiency (aggregately)
  - trend
  - volatility
  - with no accident history

Table 1: Comparative Characteristics of the Driving Clusters (unfiltered)

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Statistical character</th>
<th>Trend (%)</th>
<th>Volatility</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>0.145</td>
<td>0.455</td>
<td>0.722</td>
<td>0.045</td>
</tr>
<tr>
<td>Max</td>
<td>1.246</td>
<td>0.152</td>
<td>0.735</td>
<td>1.045</td>
</tr>
<tr>
<td>Average</td>
<td>0.255</td>
<td>0.123</td>
<td>0.430</td>
<td>0.625</td>
</tr>
<tr>
<td>Standard Deviation</td>
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<td>0.197</td>
<td>0.367</td>
<td>0.260</td>
</tr>
<tr>
<td>Kurtosis</td>
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<td>0.469</td>
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</tr>
<tr>
<td>Skewness</td>
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Table 2: Comparative Characteristics of the Driving Clusters (filtered)

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</table>

Conclusions

- Driver Profiles: Typical, Unstable and Cautious drivers.
- Temporal evolution of driving behavior with respect to road type:
  - Average volatility is approximately the same in both road types.
  - Average trend is approximately the same in both road types.
  - Stationarity is similar for all drivers and road types.
- Drivers should be continuously monitored and re-evaluated to capture temporal shifts.
- Information on driving accident data confirms the conclusions drawn in terms of safety for the clusters formed.

Results

- Least efficient drivers: - least volatile
- Most efficient drivers: + most volatile
- Typical drivers:
  - high number of drivers
  - low total efficiency
  - very low positive trend
  - medium to high volatility
  - low accident frequency (not included in clustering)
- Unstable drivers:
  - medium to high total efficiency
  - medium positive trend
  - high volatility
  - medium to high accident frequency (not included in clustering)
- Cautious drivers:
  - high total efficiency
  - trend:
    - medium negative for urban road
    - high positive for express urban road
  - medium volatility
  - low to medium for urban road
  - medium to high for express urban road
  - low accident frequency (not included in clustering)

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Abstract
This paper attempts to shed light on the temporal evolution of driving safety efficiency with the aim to acquire insights useful for both driver’s and road safety improvement. Data exploited herein are collected from a sophisticated platform that uses smartphone device sensors during a naturalistic driving experiment, at which the driving behaviour from a sample of two hundred (200) drivers during 7 months is continuously recorded in real time. The main driving behavior analytics taken into consideration for the driving assessment include distance travelled, acceleration, braking, speed and smartphone usage; these data serve as inputs in the models developed. Various statistical, econometric and machine learning techniques are applied on data collected to perform the analysis. Initial data analysis results to the most critical components of microscopic driving behaviour, which are used as inputs in the K-means algorithm to perform the clustering analysis. The main driving characteristics of each cluster are identified and lead to the conclusion that there are three main driving groups of the 200 moderate drivers, b) unstable drivers and c) cautious drivers.