ESTIMATION OF ANNUAL TRAFFIC VOLUMES

A Model for Portugal

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João Cardoso
Introduction

Estimation of Annual Traffic Volumes – A Model for Portugal
C. Lima Azevedo, J. Cardoso
Classification of existing methods

- Traffic counts

Data available in many countries

Spatial & temporal sample

**Impossibility** of collecting data about the driver characteristics and travel purposes

 Allows the disaggregation of VKT by type of road, vehicle attributes, time periods or regions

\[
VKT_j = \left( \sum_{n=1}^{N} (AADT_n \times L_n) \right) \times \frac{L_{TOT,j}}{N} \times 365
\]
Classification of existing methods

Handbook on Statistics on Road Traffic – UNECE

- Traffic counts

- Driver surveys

  Can reach a high level of detail and flexibility in the collected data

  Different types of surveys

  Sampling errors, response bias and estimation errors

  High implementation costs
Classification of existing methods

*Handbook on Statistics on Road Traffic – UNECE*

- Traffic counts

- Driver surveys

- Fuel consumption

**Balance** between road transportation fuel consumption and national sales

Need **multiple data sources**

Estimation of **foreign vehicle consumption** in the national network and vice-versa

Need average **consumption models**

\[ n \times \text{dist}_{avg} \times \text{cons}_{avg} = FC \leftrightarrow FS \]
Classification of existing methods

- Traffic counts
- Driver surveys
- Fuel consumption
- Odometer readings

Only record of traveled distances available for the majority of the vehicles

Impossibility of VKT disaggregation by region

Usually limited to the inspected vehicles

Reading errors, limitation of the number of digits and illegal modification of odometer records

\[
VKT_i = \left( \sum_n \left( \frac{R_{T+\Delta T} - R_T}{\Delta T} \right) \times \frac{F}{N} \right) \times 365
\]
Available Data Sources in Portugal

Used Data Sources
- Odometer Readings (inspections)
- Inspected vehicles attributes
- Data on the National Vehicle Fleet
- Traffic and geometric characteristics of the NRN
- Traffic counts in the NRN

Traffic counts in the NRN

Heavy vehicles survey
- 5,030,034 Vehicles
- 14,942 MRRs and 14,358 km

560 traffic counts (2000–2003) representing a sample of 7,346 km of the NRN

Drivers information
- Initial and final link mileage
- Number of lanes

Annual Fuel Sales
- Type of use, brand, model, power, fuel consumption, noise levels...
- Fuel type, weight and engine capacity
- Year, between 2004 and 2008

Impossibility of using traffic counts from other roads

Number of lanes

Vehicle fuel consumption

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The proposed methodology

Data sources

- Odometer readings (inspections)
- Inspected vehicles attributes
- Data on the National Vehicle Fleet
- Traffic and geometric characteristics of the NRN
- Traffic counts in the NRN

Validation Process

- Existing Aggregate Estimates of the National Traffic Volume
- Fuel Sales in the National Road Transportation Sector
- Average Daily Traveled Distance (ADTD) by type of vehicle
- National Traffic Volume by type of vehicle
- Estimation of the National Fuel Consumption
- National Rolling Vehicle Fleet
- Traffic Volume outside the NRN
- Traffic Volume in the NRN by type of road
- Traffic Volume in the NRN by type of road

Estimation Process

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The proposed methodology

● Calculation of the Average Daily Traveled Distances (ADTD) for each inspected vehicle

● Error mitigation and outliers

Date: 26-02-2002
Odom.Read.: 53 201 km

Date: 14-02-2004
Odom.Read.: 89 068 km

Date: 21-02-2006
Odom.Read.: 121 591 km

718 days - 35 867 km
(average: 49.95 km/d)

739 days - 32 523 km
(average: 44.0 km/d)

- Year with inspection and partially covered
- Year with inspection and fully covered
- Year fully covered but without inspection
- Year not covered
The proposed methodology

\[
ADTD = e^{\beta_0} \times e^{\sum_i (\beta_i \times x_i)} \times e^\varepsilon = c_0 \times \prod_i (c_{ij}) \times c_\varepsilon
\]

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor</td>
<td>s</td>
<td>t</td>
</tr>
<tr>
<td>(c_0) (km/dia)</td>
<td>24.19</td>
<td>0.0007</td>
<td>4693.0</td>
</tr>
<tr>
<td>Fuel type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>1.46</td>
<td>0.0010</td>
<td>361.3</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1300 - 2999 kg</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3000 - 3500 kg</td>
<td>0.92</td>
<td>0.0016</td>
<td>-49.5</td>
</tr>
<tr>
<td>Engine (cm(^3))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1.4l</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\geq 2.0l</td>
<td>1.09</td>
<td>0.0014</td>
<td>63.9</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992 - 1996</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>1.43</td>
<td>0.0012</td>
<td>300.7</td>
</tr>
</tbody>
</table>

\(N = 4,576,791\) \(N = 4,379,275\) \(N = 3,525,088\)
The proposed methodology

- Estimation of the VKT by type of road in the NRN
- Based on the road characteristics database and a 2005 AADT
- Estimation of the share of each vehicle type in each road category using the data collected by traffic counts in the NRN
## Results

<table>
<thead>
<tr>
<th>(10^6 vkm)</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy vehicles</td>
<td>7 691</td>
<td>6 772</td>
<td>6 319</td>
</tr>
<tr>
<td>Light Vehicles</td>
<td>80 120</td>
<td>79 920</td>
<td>81 700</td>
</tr>
<tr>
<td>TOTAL</td>
<td>89 390</td>
<td>86 690</td>
<td>86 440</td>
</tr>
</tbody>
</table>

**Light vehicles** - 91.4% of the National VKM

**Diesel vehicles** - 99.8% of the heavy VKM and 60.7% of the light VKM

**Increase of the diesel light vehicle share**
60.7% in 2004  61.3% in 2005  64.8% in 2006

**Light vehicles VKT**
Age » **First year** - 9.11%  (5.4% of the national light vehicle fleet)

**Heavy vehicles VKT**
Gross weight » **40 tons** - 52.6%  (27.6% of the national heavy vehicle fleet)
## Results

<table>
<thead>
<tr>
<th></th>
<th>TOTAL</th>
<th>NRN</th>
<th>Other Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Vehicles</td>
<td>6 772</td>
<td>4 427</td>
<td>2 346</td>
</tr>
<tr>
<td>Light Vehicles</td>
<td>79 920</td>
<td>39 540</td>
<td>40 380</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>86 690</td>
<td>43 970</td>
<td>42 720</td>
</tr>
</tbody>
</table>

NRN represents **50.7%** of the national VKT *(2005)*

**Heavy vehicles**
The majority of their distances are traveled in the NRN - **65.4%**

**Light vehicles**
Less than half of their distances are traveled in the NRN - **49.5%**

**Motorways** represent the main share of the NRN with **38.8%** of its traffic volume in 2005
Validation Process

(10^6 vkm)

<table>
<thead>
<tr>
<th>Year</th>
<th>Proposed Method (ton)</th>
<th>Cardoso (ton)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>89 392</td>
<td>77 905</td>
<td>-3.7%</td>
</tr>
<tr>
<td>2005</td>
<td>86 984</td>
<td>69 597</td>
<td>-7.1%</td>
</tr>
<tr>
<td>2006</td>
<td>67 874</td>
<td>47 648</td>
<td>-10.8%</td>
</tr>
</tbody>
</table>

Agregate Models

Proposed Method

Sales

Estimated consumption

Difference (%)

Diesel

4 930 826

4 747 417

-3.7%

Gasoline

1 927 122

1 789 613

-7.1%

Gaz

20 134

17 961

-10.8%

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These results are the **first disaggregate VKT estimates** by type of road and vehicle for Portugal.

However, next applications of the proposed methodology must be undertaken under a **systematic plan** for **flexible, comprehensive and reliable** estimates, with the following **improvements**:

- Estimation using data in the type of use of each vehicle
- Inclusion of traveled distances by vehicles that are not subjected to periodical inspections (namely motorcycles)
- Additional information on traveled distances of new vehicles
- Additional information on the national vehicles traffic volume abroad, and vice-versa

**THANK YOU!**