ESTIMATING ROAD TRANSPORT COSTS BETWEEN EU REGIONS

WITH AN APPLICATION USING THE SPATIAL CGE MODEL RHOMOLO

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Motivation (I): What is RHOMOLO for?

RHOMOLO is the multisectoral computable economic model developed by the DG JRC for the impact assessments of EU Policies.

It shows how policy shocks are expected to affect economic and social outcomes at the regional and sectoral level. Results are reported as a deviation from baseline.

Simulating how specific policy interventions can alter the spatial distribution of economic activities:

✓ Investment in infrastructure.
Motivation (II)

Several policy requests:

"Which are the effects of investing an $X$ amount of € in transport infrastructure in Region Y?"

Target:

"How can we translate investments in € into a policy shock that is easily implemented in a CGE model?"

...that uses iceberg-type transport costs?"
WHAT WE DO

Create matrices on road transport between regions:
- matrix with distance of optimal route (in km)
- matrix with time spend on optimal route (in minutes)
- matrix with cost estimate for 40 ton HDV (in euro's)
- matrix with iceberg costs (cost as % of value shipped)

Allow for policy shocks to affect the transport costs matrix: fuel prices, salaries, insurances...

Finally, we create a transport infrastructure policy tool to assess changes (upgrades) in roads (affecting travel speed and distance)
\[ GTC_{AB} = (\text{Distance Cost}_{AB} + \text{Time Cost}_{AB}) \]

**GENERALIZED TRANSPORT COST** (Heavy Duty Vehicle)

<table>
<thead>
<tr>
<th>Distance (Km)</th>
<th>Travel Time (Minutes)</th>
</tr>
</thead>
</table>

**DISTANCE COST**

<table>
<thead>
<tr>
<th>Fuel Consumption</th>
<th>Fuel Prices</th>
<th>Tolls/Eurovignette</th>
<th>Taxes</th>
<th>Maintenance costs</th>
</tr>
</thead>
</table>

**TIME COST**

<table>
<thead>
<tr>
<th>Salaries (transport sector)</th>
<th>Maximum Speeds</th>
<th>Gradients (Slopes)</th>
<th>EU Commission Regulation</th>
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All these GTC's components allow for new policy shocks within the Spatial CGE Model
Other data sources (I)

**Infrastructure costs:** *European Court of Auditors*

**Interregional trade flows:** *Thissen et al. (2018)*

**Fuel Prices:** *Europe’s Energy Portal*

**Ferry Prices:** *European Parliament*

**Taxes, Tolls and Legal Speed Limits:** *DG MOVE*
Other data sources (II)

Digital elevation Map: European Environment Agency

Population grid (for centroids and infrastructure cost): EU GEOSTAT 2011

Salaries: Eurostat


Indirect Costs: Zofío et al, (2014)
The Road Network

Real Geography

Source: OpenStreetMap
We extract

- All **highways, primary** and **secondary** roads
  - Over 4.000.000 road-segments
  - **Road properties**: maximum speed, # lanes, curvature, # traffic lights, roundabouts, road surface
  - Slope of road: using elevation of start and endpoint from space shuttle observations, at 25m horizontal resolution, 3cm interpolated.

- Calculation of optimal routes uses pgrouting in PostgreSQL, takes about 2 hours to run (on a server, 160GB RAM, 40 cores)
Sampling population for location points

In the original 1km x 1km grid, we represent each multiple of 100 individuals by 1 dot, and randomly locate this dot within the 1km-square.

We sample 250 points for internal distances.
We sample 160 points for regions closer than 125km.
... we sample 30 points for regions > 1200km.
The original population data: for example for Seville
An example: the 160 points (green) which were sampled to calculate the transport costs for the region of Andalusia to nearby regions, on top of a night satellite image.
From inter-centroid GTC’s to inter and intra region GTC’s

We calculate the GTC between two regions \((o)\) and \((d)\) as the simple average of the GTC between the centroids contained in them...

Given that points are more likely to be sampled from densely populated areas; this simple average will reflect the spatial distribution of the population.

*Some weighting is involved, because a single point may exceptionally be sampled multiple times*
Average Generalized Transport Cost

Distance Cost (2016)

Time Cost (2016)
Changes in transport costs for the spatial CGE model

Transport Policy Shock Implemented in spatial CGE model

Origins

Destinies

Baseline GTC Matrix (weighted)

Policy Shock

Origins

Destinies

NEW GTC Matrix

Origins

Destinies

Differences in GTC (Matrix)
Experiment: Fuel Price increases by 20%
THE ICEBERG TRADE-COST MATRIX

Once we have the GTC transport cost matrix (in €/truck)...
We calculate the **total costs** (in euros) as the **total tons** multiplied by the **loading factors** (trucks/ton) to get a measure of the **total costs in euros**:

\[
Total \ costs_{ij} = (\text{tonnes}_{ij} L^{EU}) \times GTC_{ij}
\]

Then, we calculate the **iceberg cost** (\(\tau_{ij}\)) according to:

\[
\tau_{ij} = \frac{Total \ costs_{ij}}{\text{Trade \ Flow \ (in \ value)}_{ij}}
\]

Where tons and value trade flows are taken from Thissen/Mandras (2018) interregional trade matrix.
Policy simulation tool

We approximate any type of transport infrastructure investment in a region, by upgrading roads primary and secondary roads where the economic benefit would be largest, to a highway (increasing max. speed, removing penalties for curvature, slope, traffic lights, surface...).

To calculate largest economic benefit we combine:

- **Estimated flows (trucks)** over the optimal routes using Thissen/Mandras (2018) data.

- **Economic cost of all trucks**, baseline.

- **Economic cost for all trucks** when improved.
Transport infrastructure investment

The predicted road improvements
(Cohesion Policy)

Roads to UPGRADE
Difference between baseline scenario and the new one with changes in roads

Largest Benefits

Smallest Benefits
Experiment II: Cohesion Policy Investment
Looking ahead…

- Different transport modes?

- More complete measure of transport costs: including fixed components (loading/handling)

- Using the iceberg cost matrix to calculate unique European inter-regional trade elasticities

- Publish the GTC database in euros on the Knowledge Centre for Territorial Development.
Thank for your attention and comments