Future of road transport?

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Issues in EU white paper for transport (March 2011)

• Key goals by 2050 include:
  – No more conventionally fuelled cars in cities (and 50% less in 2030)
  – 40% use of sustainable low carbon fuels in aviation
  – 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport (30% shift by 2030)
  – Triple length of HSR network by 2030
  – Near zero road casualties (and 50% less by 2020)
  – Move towards full application of user pays and polluter pays principles…
Future is

• Electric cars in cities?
• Mostly rail for passengers?
• Mostly rail + waterways for freight?
Outline

• Diagnosis of problems
• What long term trends?
• How to assess Climate Change policies?
• Survey & Assessment of solutions
  – Modal choice
  – What vehicle technologies make sense?
• Land use issues
## Diagnosis of road transport problems

<table>
<thead>
<tr>
<th>Source</th>
<th>Nature of costs</th>
<th>Orders of magnitude of costs(^a) (cents/mile, 2005 prices)</th>
<th>Public abatement and supply-type policies</th>
<th>Policies affecting demand and vehicle characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion</td>
<td>Volume of use approaches or exceeds design capacity per unit of time</td>
<td>4.2–35.7</td>
<td>Network capacity</td>
<td>Congestion charges, fuel taxes, access restrictions, land-use regulation, quantity controls</td>
</tr>
<tr>
<td>Climate change</td>
<td>Greenhouse gas emissions from fossil fuel use</td>
<td>0.3–3.7</td>
<td></td>
<td>Fuel efficiency standards, CO(_2) or fuel taxes, cap and trade</td>
</tr>
<tr>
<td>Traffic safety</td>
<td>High traffic density and heterogeneity in vehicle weight and speed, increase average accident risk</td>
<td>1.1–10.5</td>
<td>Adaptation of road infrastructure, emergency services, mandatory insurance</td>
<td>Traffic rules and procedures, risk-dependent insurance premiums</td>
</tr>
<tr>
<td>Air pollution</td>
<td>Fuel combustion and exhaust</td>
<td>1.1–14.8</td>
<td></td>
<td>Standards (vehicle equipment, fuel quality), access charges</td>
</tr>
<tr>
<td>Noise</td>
<td>Engines and movement</td>
<td>0.1–9.5</td>
<td>Sound barriers, silent road surfacing, curfews</td>
<td>Standards, curfews, tradable permits</td>
</tr>
</tbody>
</table>
What long term trends?

<table>
<thead>
<tr>
<th></th>
<th>2050</th>
<th>Share OECD</th>
</tr>
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<tbody>
<tr>
<td>Road use cars</td>
<td>x 2.5</td>
<td>From 50% now to 20% in 2050</td>
</tr>
<tr>
<td>Road use trucks</td>
<td>x 5</td>
<td>From 50% now to 20% in 2050</td>
</tr>
<tr>
<td>air</td>
<td>x 5</td>
<td></td>
</tr>
<tr>
<td>GHG emissions transport</td>
<td>x 2 or x 3</td>
<td>From 60% now to 35% in 2050</td>
</tr>
</tbody>
</table>
Outline

• Diagnosis of problems
• What long term trends?
• **How to assess Climate Change policies?**
  – The Economist’s way
  – Stock externality and uncertainty
  – International problem
• Survey & Assessment of solutions
The Economist’s way

MINIMIZE $TC(m_{tr}) + TC(m_{tr}) + TotalDamage(m_{tr} + m_{tr})$

$m_{tr} = \text{non transport measure saving 1 ton of CO2}$

$m_{tr} = \text{transport measure saving 1 ton of CO2}$

$TC = \text{total cost (including resources, comfort, time)}$

$TD = \text{total damage}$

$$ \frac{\delta TC(m_{tr})}{\delta m_{tr}} = -\frac{\delta TD(m_{tr})}{\delta m_{tr}} \quad (1) $$

$$ \frac{\delta TC(m_{tr})}{\delta m_{tr}} = -\frac{\delta TD(m_{tr})}{\delta m_{tr}} \quad (2) $$

cost efficiency = distribute efforts over non transport and transport so as to equal Marg costs

how much to abate: until Marg Cost = Marg Damage
Climate = stock problem+uncertain

• Stock:
  – it is not important to reach a specific target every year
  – one can wait, learn and adapt policies

• Uncertain
  – If Catastrophic: one needs to limit total stock (expected utility breaks down)
  – If not catastrophic: Marginal Damage is best policy guide – acts as maximal cost for a measure
International problem 1

• Every country enjoys the benefits of emission reduction efforts of the others (“common pool” or public good problem)

• International agreements are not enforceable by external party, so they have to be “self-enforcing”: it is in the interest of every country to be member even if the non members can enjoy the same benefits

• Theoretical result: for constant MB, linear MC and N identical countries, the number of signatories of an Int Climate Agreement is 3 whatever N>3...
Total abatement effort
Nash: $1\times10 = 10$
Int. Agreem. $3\times3 + 7 = 16$
Full cooperation (FB): $10\times10 = 100$
International problem 2

- International energy markets: reducing CO2 emissions unilaterally means decreasing total energy demand for fossil fuels
- This will lower prices on world markets of oil, gas and coal and increase consumption by non signatories
- “Leakage”
Transport and Climate policy in EU

• Dominant policy issue: climate change

• 3 major mistakes in policy making:
  – Transport has to do its fair share (not efficient as MCmtr>MCm_tr)
  – EU reduces to 20%, the others will do it too and anyway it does not harm us or it costs us nothing…(naïve)
  – Important to achieve the -30, -50 and -80% targets - no better to count on Marg Damage, as reaching the target can be very costly
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  – The Economist’s way
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• Survey & Assessment of solutions
  – Modal choice policies
  – Vehicle technology policies
  – Land use policies
Modal shift policies in urban areas (more bus, rail, more bike, walk..)

- **Differences between Europe and US:**
  - share of car trips in Amsterdam is 30%, in Houston it is 95%
  - In US, most transit systems do not pass Cost Benefit test

- **In Europe**
  - Heavily subsidized (second best policy- in Leuven there is 15% cost coverage of operation costs – free bus use by students makes that Leuven became bus city rather than biking city)
  - Bias in favour of light rail (usually much more expensive than bus)
  - But bus can only be as efficient as light rail if it gets reserved bus lane, but this is inefficient use of capacity, better is to make car use more expensive via road pricing
  - Road pricing will allow to increase speed, to lower cost of public transport (saving driver costs, bus rather than light rail) and to increase fares for public transport
Modal shift policies in non-urban areas (more rail, waterways..)

- Differences between Europe and US:
  - High Speed rail for passengers in EU, no HSR in US
  - More rail freight in US than in Europe
- In Europe
  - 30 TEN-T priority projects (600 billion €), including Brenner tunnel, Bridge to Sicily, many HSR projects etc.
  - We assessed most of these projects
Model 1: Continent wide Regional GE model (Bröcker)

- « New Economic Geography » Model:
  - EU divided into 260 regions that all produce a separate variant – trade (freight) = consumption of variants by different regions
  - Freight investment: lower trade costs and therefore new consumption opportunities and welfare gain
- Only 10 of the 22 projects studied pass the CBA efficiency test
- 9 out of the 22 projects have less than 10% of their benefits outside their own country
  - So « Transeuropean » character of these projects is very low
- The selected projects do not systematically favour the poorer member countries
Model 2: High Speed Rail and air competition model (Adler)

- EU divided in 71 zones
- Players:
  - 1 EU rail operator (best case to avoid double marginalization)
  - 3 hub and spoke airlines
  - 2 low cost airlines
- Business and leisure travellers
- 6 Compete in prices and frequencies
- Compare equilibria with/without extra HSR lines and with low/high accession charge for use of infra by train operator
High-Speed Rail Network (68 arcs)
Assessing the TEN-T priority projects

• Using 4 different models (New Economic Geography model, network model air-rail, freight corridor model, MOLINO II)
• Difficult to find a reasonable Cost Benefit Analysis in Fr or ENG (4? out of 22)
• Half of the projects have no net economic return
• The proportion of « transit » in many priority projects is small
• The priority projects do not systematically benefit the poorer regions
• Transport pricing matters (rail, road, ..)
Outline

• Diagnosis of problems
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  – **Vehicle technology policies (cars)**
    • Conventional pollutants (ozone, PM10, …)
    • Fuel efficiency of vehicles
    • New vehicle technologies and new fuels
  – Land use policies
Vehicle technology policies 1 (cars)

- Has been very successful for reduction of conventional pollution (NOx, VOC, PM10, ..) using catalytic converter and better fuels
- Emissions per car kilometer have been reduced by factor 10 or more
- One mistake: taxation policies still favor diesel cars in many countries
  - Diesel cars have 60 to 70% market share in B and FR
  - Are more polluting and pay less taxes per car kilometer because diesel is cheaper and they need less liter/km
  - These days they receive extra subsidies because they emit less CO2 per km
Regulation of conventional pollutants is a success

Figure 3.10. Baseline evolution of overall transport emissions (index: 2005 level = 100)

Source: Phd Jasper Knockaert with TREMOVE, 2010
Share of diesel in new passenger car registrations (%) (2000 and 2009)
What is wrong with current car taxes?

**OPTIMAL**

**TOTAL SOCIAL COSTS**

- Congestion externalities
- Air pollution damage
- Climate damage
- Fuel (excl. tax)
- Car (excl. tax) + time cost

**GASOLINE**

- Km tax revenue
- Congestion tax
- Air pollution tax
- Fuel tax
- Car (excl. tax) + time cost

**DIESEL**

- Km tax revenue
- Congestion tax
- Air pollution tax
- Fuel tax
- Car (excl. tax) + time cost

**2nd BEST IF No congestion tax**

**EXAMPLE OF OPTIMAL TAX IF ONLY FUEL TAX**

**CURRENT DIESEL FUEL TAX**

**NOW**

- Diesel excise tax
- Fuel (excl. tax)
- Car (excl. tax) + time cost

**TOTAL SOCIAL COSTS**

- Euro/km

**TOTAL SOCIAL COSTS**

- GASOLINE
- DIESEL

**TOTAL SOCIAL COSTS**

- OPTIMAL TAX SYSTEM

**TOTAL SOCIAL COSTS**

- 2nd BEST IF No congestion tax

**TOTAL SOCIAL COSTS**

- EXAMPLE OF OPTIMAL TAX IF ONLY FUEL TAX

**TOTAL SOCIAL COSTS**

- CURRENT DIESEL FUEL TAX

**TOTAL SOCIAL COSTS**

- DIESEL
Vehicle technology policies 2 (cars)

- Many countries use fuel efficiency standards to decrease fuel consumption per car km
- EU + Japan are the leaders
- Cost efficiency can be questioned because current fuel gasoline and diesel taxes are de facto already a very high carbon tax (200 €/ton of CO2 compared to value of carbon permits in EU of 10 to 20 €/ton of CO2)
- Adding a standard that bites can only increase the marginal cost of achieving the standard above 200 €/ton
  - Other disadvantage: rebound effect = more fuel efficient car has lower variable cost and is used more so increasing congestion etc.
- More fuel efficient cars receive often additional subsidies as one tries to achieve the average fuel efficiency objective by favouring the more fuel efficient cars
Figure 1. Fuel Economy Standards for New Passenger Vehicles by Country
## Example of tax and subsidy favours (B)

<table>
<thead>
<tr>
<th></th>
<th>VW Golf (77 kW)</th>
<th></th>
<th>BMW 320 (120 kW)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>units</td>
<td>Diesel</td>
<td>Fuel efficient</td>
<td>Diesel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>diesel</td>
<td></td>
</tr>
<tr>
<td>Difference w.r.t. gasoline version</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource costs (excl. taxes and subsidies)</td>
<td>euro/year</td>
<td>65</td>
<td>140</td>
<td>168</td>
</tr>
<tr>
<td>External air pollution costs</td>
<td>euro/year</td>
<td>24</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>External costs due to mileage</td>
<td>euro/year</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Social costs of raising public funds</td>
<td>euro/year</td>
<td>139</td>
<td>376</td>
<td>336</td>
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<tr>
<td>Net social cost</td>
<td>euro/year</td>
<td>228</td>
<td>526</td>
<td>523</td>
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<tr>
<td>CO₂ emissions</td>
<td>ton/year</td>
<td>0.225</td>
<td>0.525</td>
<td>0.575</td>
</tr>
<tr>
<td>Cost per ton of CO₂ savings</td>
<td>euro/ton</td>
<td>1012</td>
<td>1002</td>
<td>910</td>
</tr>
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</table>
Vehicle technology policies 3 (cars)
new fuels and new technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>GHG emissions index (well to wheel) per unit distance, OECD 2010 = 100</th>
<th>Major consumer disadvantages and costs</th>
<th>Other externalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD 2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OECD</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline (United States)</td>
<td>115</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline (EU)</td>
<td>90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel (EU)</td>
<td>80</td>
<td></td>
<td></td>
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<tr>
<td>OECD 2020–2040</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>80–45</td>
<td>Extra cost of 0–$2,000/vehicle</td>
<td>More conventional air pollutants</td>
</tr>
<tr>
<td>Diesel</td>
<td>80–45</td>
<td>Extra cost of 0–$2,000/vehicle</td>
<td>More conventional air pollutants</td>
</tr>
<tr>
<td>Hybrid gasoline</td>
<td>60–34</td>
<td>Extra cost of $2,000–$4,000/vehicle</td>
<td>More conventional air pollutants</td>
</tr>
<tr>
<td>Hybrid diesel</td>
<td>50–34</td>
<td>Extra cost of $2,000–$4,000/vehicle</td>
<td>More conventional air pollutants</td>
</tr>
<tr>
<td>Plug-in hybrid</td>
<td>30–19</td>
<td>Extra cost of $7,500/vehicle</td>
<td>Less conventional emissions in urban areas</td>
</tr>
<tr>
<td>Electric car</td>
<td>45–14</td>
<td>Smaller range, slower and more frequent refueling + extra cost of $10,000–$20,000/vehicle and requires adaptation of electricity distribution</td>
<td>Less conventional emissions in urban areas</td>
</tr>
<tr>
<td>Compressed natural gas, hydrogen, biofuels</td>
<td>With current technologies not certain that there is a decrease in GHG emissions</td>
<td>Requires new distribution network extra vehicle adaptation costs and smaller trunk space</td>
<td></td>
</tr>
</tbody>
</table>

Source: adapted from IEA (2009).
Some references