Transport Volume and Green Transport Modes Prognosis with GAMS

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1. Introduction

- Mobility and functioning traffic is vital for the economy
- Particularly true for Germany and applies to all of Europe
- In the past (until 2008) steadily increasing transport volumes and performance were assumed
- The economic crisis 2008/2009 taught us better: e.g. the total rail transport performance decreased sharply (Germany 2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Railway (Billion TonKilometer)</th>
<th>Inland (Ship)</th>
<th>Pipeline</th>
<th>Road (Billion TonKilometer)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>115,652 (-20%)</td>
<td>64,057</td>
<td>15,670</td>
<td>460,100</td>
<td>655,479</td>
</tr>
<tr>
<td>2009</td>
<td>95,834</td>
<td>55,497</td>
<td>15,950</td>
<td>414,600</td>
<td>581,881</td>
</tr>
<tr>
<td>2010</td>
<td>107,317</td>
<td>62,278</td>
<td>16,259</td>
<td>434,000</td>
<td>619,854</td>
</tr>
<tr>
<td>2011</td>
<td>113,160</td>
<td>55,027</td>
<td>15,623</td>
<td>460,000</td>
<td>643,810</td>
</tr>
</tbody>
</table>
The interaction between economic development and logistics includes a lever that allows an above-average growth in logistics in times of general growth – but may act on the other hand reversely in an economic crisis. > Prognosis should not take anything for granted.
2. Development of Freight Transport

- Increasing international trade in goods is an essential aspect of globalization

- The central challenge to which the (German) federal government responds with a master plan are
  - The dramatic result of globalization and increased economic division of labor is an expected increase in freight transport
  - Increasing specialization and division of labor will lead to a further increase in international trade
  - And thus more and more goods have to be transported over ever longer distances
The WTO mentions in its World Trade Report 2008 inter alia the following aspects:

- Because of the economic opening of the former Soviet Union, China and India the number of participants in the world economy rises from about 1.5 billion to 3 billion workers.
- With the introduction of freedom to provide services in freight transport in combination with newly found information and communication technologies new opportunities for cross site production were created.
- In addition: transaction and trading costs were reduced.
- The development of transport infrastructure and the containerization of international goods flows enable cost reduction and productivity increase.
2. Development of Freight Transport

- so important growth is ... there is also an other side
- by the short and medium term unchangeable dependence on fossil fuels in many parts of logistics the CO$_2$-emissions will rise as well
- all in all economic and trade growth is expected and thus increasing traffic volume
- but the GHG emissions should be reduced
- in order to avoid severe effects of the expected climate change to all mankind
3. Prognosis with GAMS

- To create a model, parameters have to be determined:
  - According to EU specifications GHG emissions have to be reduced in 2025 to 60% of emissions from 2004
  - Transport volume will increase by 80% to 914 billion tkm (prognosis of the German federal government, 2004 to 2025)
3. Prognosis with GAMS

- What opportunities of reducing CO\textsubscript{2} are conceivable?
  - Technological progress (efficiency increase is not feasible endlessly)
  - Restriction of mobility (not desired!)
  - Shift away from fossil fuels (only possible in long-term perspective)
  - Switching to eco-efficient transport modes/technologies (e-mobility)

- The modal split is subject to certain restrictions too
  - Capacity of rail freight is limited and not unlimited scalable (network)
  - Inland shipping is upgradeable but not available everywhere

- Therefore assumptions have to be taken to deal with this facts
3. Prognosis with GAMS

Transport capacity: waterway (left) and rail transport (right)
A first calculation has shown that even at 100% utilization of the CO$_2$-poorest transport carrier ship in a best case scenario, the reduction targets cannot be reached.

- What can be done?
- With GAMS, a modal with a limitation of CO$_2$ emissions over the guidelines can be calculated.
- The difference must then be borne by other sectors (for example, in electricity generation: renewable energy).
3. Prognosis with GAMS

- Equations:
  - co2total: co2 emission over all
  - coststot: costs in total
  - supply(i): obtain limit per mode
  - demand(j): demand of transport;

  - co2total .. sum((i,j), c(i,j)*x(i,j)) =l= 48000000 ;
  - supply(i).. sum(j, x(i,j)) =l= a(i) ;
  - demand(j).. sum(i, x(i,j)) =g= b(j) ;
  - coststot .. z =e= sum((i,j), f(i,j)*x(i,j)) ;

- Result:
  - road 682857.143; train 106142.857, ship 191000.000
That means for the German transport sector:

savings of about 750,000 tons CO$_2$ =

cost about half a billion Euro.
4. Outlook and Discussion

- Due to different infrastructure conditions (Europe-wide view)
  - Different circumstances need to be considered,
  - For example, the current allocation on various modes of transport,
  - Capacity restrictions or
  - National regulations and infrastructure.

- Advantages of this approach are that you can determine overall costs regarding specific carbon reduction targets and can discuss alternatives.

- In the future, other factors have to be included (e.g. demographic change) and cost assumptions have to be verified (increasing returns to scale and cost).
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Thank you for your attention.

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