CIEM6210-U3/CIEQ6213/SEN173A
ASSIGNMENT

NETWORK DESIGN FOR EUROPEAN INTERMODAL CONTAINER TRANSPORT

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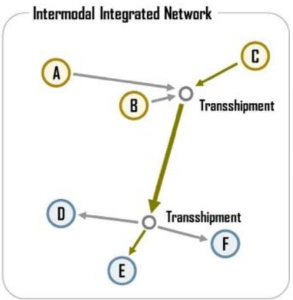

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OVERVIEW

GOAL & SUB-GOALS
To design a multimodal freight network for container flows in Europe

1. Determine user preferences related to the choice of freight transport mode
2. Identify priority locations for intermodal terminals
3. Design support policies to achieve desired societal impacts

OUTLINE
The assignment has 3 parts that are each focused on one of the sub-goals. In the first part, you will estimate a *logit choice model* based on observations of current flows over road and rail freight transport in Europe. In part 2, you will identify *locations for connecting* the modes of transport with multi-modal terminals, to allow for transhipments between them. By assigning flows to the new, connected networks using the model from part 1, you will get an idea of the transhipment flows through these terminals. In part 3 you'll use the model set to formulate and evaluate a set of policies to improve the sustainability of the freight network.

INPUTS
- Data about yearly container flow volumes for road and rail between countries, and data on mode and terminal performance
- Software to support the calculations
- Guidance during and around lecture times

DELIVERABLES & DEADLINE
The followed approach, calculation outcomes as well as a discussion of the results – for each of the parts - must be written in a group report. This should be small, 2 pages per part, excluding figures and tables. It should explain the main actions taken, the outcomes and a reflection. The report as well as the accompanying (Python) files need to be submitted on **Friday 16 JUN 2023 10:45** the latest.
Please name your files: "Group[number]_Assignment1_Report.pdf" and "Group[number]_Assignment1_Code.ipynb".

ASSESSMENT
For COSEM SEN173A students, the assignment grades count for 30% of the total course grade, next to the exams. For CE-TTE CIEM6210-U3 and TIL and other CIEQ6213 students, the assignment will not be graded, but can be assessed if you appreciate to receive feedback. Your report is evaluated with the following criteria in mind:

- Objective understood;
- No mistakes or bugs in execution;
- Logically correct interpretation of results;
- Report complete and concise.

The exam (for ***all students***, so TIL, TTE and COSEM) may include a question about the assignment. This is to test whether all group members have developed a sufficient understanding of all parts of the assignment.

PART 1) MODE CHOICE MODEL (TAVASSZY)

Introduction:

The objective is to estimate a simple aggregate mode choice model, so that you can predict the share of the 2 modes of transport. The choice model will be used further on to predict flows.

Tasks:

1. Build the cost and time matrices using distances given and the below data.
2. Specify the aggregate logit model to be estimated based on the input data available. Consider the following specification:
   - binomial logit choice model (standard MNL or log form, see e.g. our handbook[1])
   - an unknown (i.e. to be estimated) sensitivity parameter μ, and a value of time parameter
   - additional unknown "alternative specific constants" for rail, differentiated by country
3. Check the code in the Python program code allocated for this mode (fill in if needed: cost formula, ASC's, logit function, RMSE error measure).
4. Verify the working of the model (check for correct programming)
5. Estimate the model parameters using the data and solver provided
6. Interpret the estimated coefficients

Table: Performance of transport modes

	Road	Rail
Transport tariff (Euro/km)	1	0.4
Door-to-door speed (km/h)	60	30

PART 2) DETERMINE OPTIMAL TERMINAL LOCATIONS (FAZI)

Introduction:

We are interested in identifying opportunities for locating transhipment terminals in the European freight network (see fig. 1). The plan is to invest in the construction of terminals to facilitate transhipment for intermodal transport. Obviously, the more terminals are built, the more freight could use the intermodal system and the transport costs may go down further. However, this is also expensive. Your task is to evaluate a set of terminals (to be determined by you) to understand this trade-off.

The model calculates the best set of terminals and the associated transport costs, for a given construction budget (number of terminals). Optimality is defined here as lowest transport costs (not including terminal investment costs or emissions). The model does an exhaustive search of all terminal combinations and presents the best set. Every time an alternative is evaluated, the use of the alternative modes is calculated using the logit model. The optimal set is the spatial configuration that provides the lowest possible transport costs for that budget.

Tasks:

[1] See Freight Modelling book 6.3.1, via http://www.sciencedirect.com/science/book/9780124104006

1. Construct the efficient frontier of cost savings versus investments based on various numbers of terminals placed. To calculate total cost savings, you need to multiply savings per container with number of containers. To get the right volumes, consider as pragmatic assumption that 10% of all flows is containerized and that 1 container carries 10 tonnes of freight.
2. Determine the effects of terminal placement on the objectives of your design. With this data, how can one establish a cut-off point for investments, given the transport cost savings? You don't have to develop the model for this, but an evaluation on the basis of a rough calculation should be made.
3. Discuss the sensitivity of your terminal placements towards the variation of the estimated parameters (e.g. cost, travel time etc.) of the model.

Remarks: You are not required to present a mathematical model for this problem. However, you can consult the properties of the optimal solution when designing your graphs. Finally, you can have any smart assumptions (with justification) when necessary.

Table: Additional costs of transshipment terminals

	Road	Rail
Transshipment costs for intermodal transport (Euro/container)	50	

PART 3) DESIGN SUPPORT POLICIES TO ACHIEVE A REDUCTION OF CO2 EMISSIONS (VAN BINSBERGEN)

Introduction:

In the Climate Treaty and the national plans, significant CO_2 emissions must be achieved in society, and transport must take its part. We assume that the policy target for the freight transport system (as discussed in this assignment) is to reduce 30% of the CO_2 emissions, as compared to a base case.

There are various policy options to (try to) achieve this target, one of those is trying to change the modal split via pricing measures and network configuration in freight transport.
In this part of the assignment you're asked to apply two pricing variants and calculate the effects:

I. Internalize the external costs of CO_2 emissions for all transport modes (resulting in higher costs for modes that emit a lot of CO_2);
II. Subsidizing specific mode (so to reduce the price of CO_2 friendly modes).

Tasks:

1. Calculate the CO_2 emissions and the related CO_2 emission costs of ***the whole of the freight transport system in the base case*** (= Part 1 of this assignment);
(for emission and emission cost calculation, see the appendix)

2. Calculate the CO_2 emissions and the related CO_2 emission costs of ***the whole of the intermodal freight transport system*** (truck, rail and inland waterway transport; use the OD tables as calculated in part 2 of this assignment); calculate the resulting CO_2 emissions of the whole of the transport system and calculate the achieved CO_2 emission change (in %) as compared to the

base case (as calculated under 4.1 above);
(for emission and emission cost calculation, see the appendix)

3. Apply approach I: Recalculate transport costs for each transport mode if CO_2 emissions costs would be internalized (i.e. added to the transport costs); re-apply the modal split and network optimisation model as developed in Part 2 with the adapted cost structure; determine the resulting modal split and calculate the resulting CO_2 emissions of the whole of the transport system and calculate the achieved CO_2 emission change (in %) as compared to the base case (as calculated under 4.1);

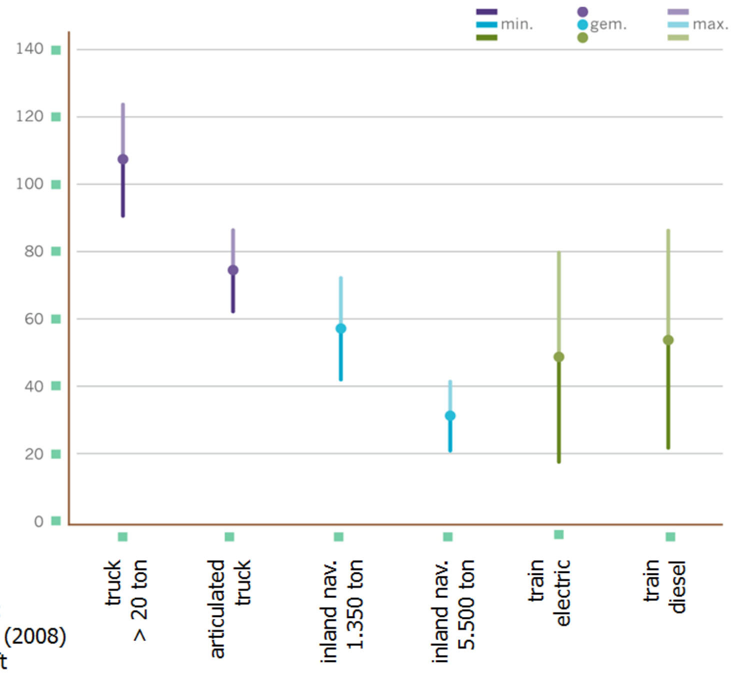
4. Apply approach II: Estimate a subsidy scheme to promote CO_2 friendly transport mode(s); recalculate transport costs for all modes; re-apply the modal split and network optimisation model with the adapted cost structure; determine the resulting modal split and calculate the resulting CO_2 emissions of the whole of the transport system and calculate the achieved CO_2 emission change (in %) as compared to the base case (as calculated under 4.1);

5. Compare and discuss the results of the three approaches I and II in terms of effects and costs (qualitatively, indicative).

Remarks:

- Note that for intermodal transport, transhipments will be necessary; for this assignment, you can set the CO_2 emissions for transhipments to zero.
- For task 4, in order to limit the workload, analyse only *one* subsidy scheme (i.e. one set of subsidies for CO_2 friendly modes).

APPENDIX – CO_2 EMISSION CHARACTERISTICS OF TRANSPORT MODES



Source:
Stream (2008)
CE Delft

(articulated) truck: CO_2 emission: 62 – 87, depending on vehicle and load characteristics; 72 g/ton-km average (note: assume an average container weight to recalculate emission per container/km!)

train: CO_2 emission: 18 – 85 g/ton-km, depending on mix in engines (Diesel-Electric or Electric) and the fuel mix for generating electricity, train length and load characteristics; assume 49 g/ton-km average (note: assume an average container weight to recalculate emission per container/km!)

inland navigation: CO_2 emission: 20 – 70 g/ton-km, depending on type of ship and load characteristics; assume 40 g/ton-km average (note: assume an average container weight to recalculate emission per container/km!)

The monetary value for CO_2 emission is 56 € per emitted ton CO_2.