How to translate economy into freight transportation?

Stephan Müller and Jens Klauenberg

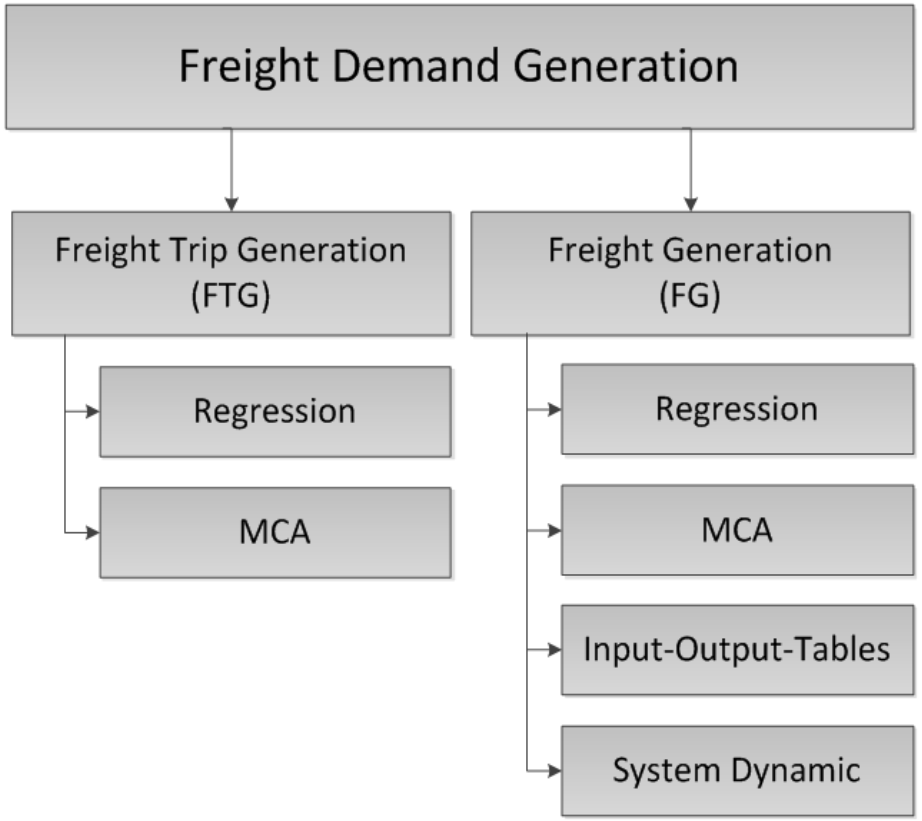
What is the challenge?

- Economy implies freight transport!
  - How much?
  - How much of which specific goods?
  - How much of which specific goods by which economic activity?

Picture source: ec.europa.eu/transport/, adapted

Who is mainly adressed by this challenge?

- Freight demand modelling
  - Not freight trip generation

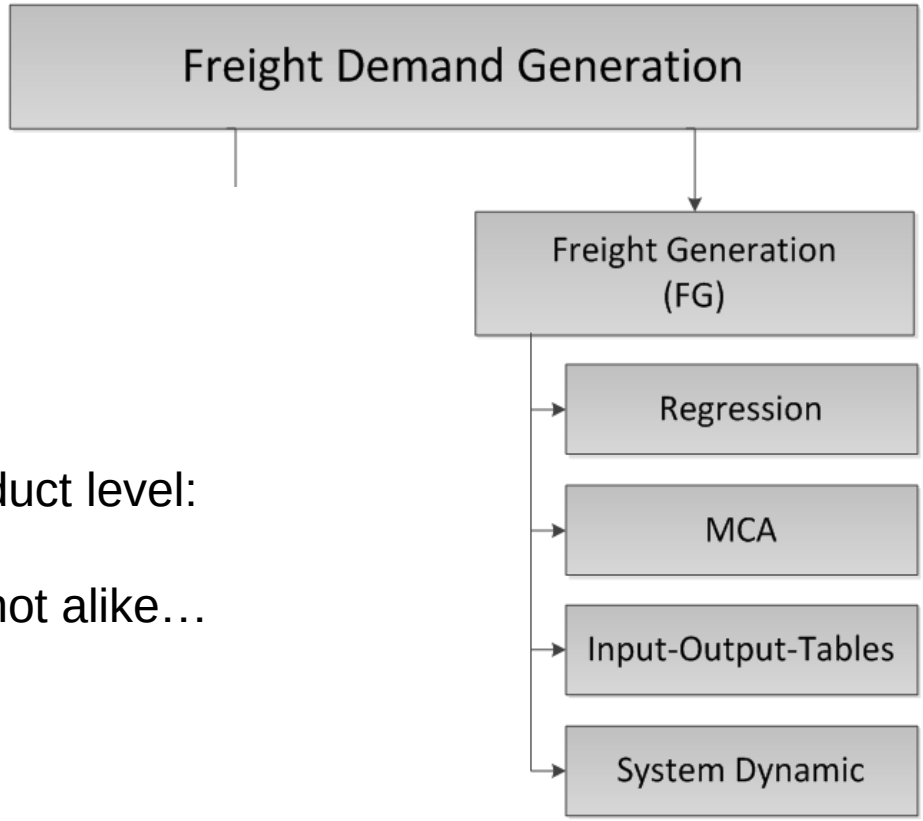


see Holguin-Veras et al. (2011): Freight generation, freight trip generation, and the perils of using constant trip rates

Who is mainly adressed by this challenge?

- Freight demand modelling
  - Not freight trip generation
  - But freight generation
    - Ratio: value of good
    - However, even on product level:

    Two bottles of wine are not alike…



see Holguin-Veras et al. (2011): Freight generation, freight trip generation, and the perils of using constant trip rates

The idea is:

- Using disaggregated economic indicators to estimate freight generation

    1. Build a production and a consumption function (PF, CF) based on supply-use tables

    2. Derive weighting factors for PF and CF from supply-use tables

    3. Weight GVA and calculate the indicators for goods (CPA-classified)

    4. Transform CPA – goods into NSTR-24 classified goods

    Perform a regression analysis

Step 1: production and consumption function

- Supply – Use – Table is the base
  - Supply tables containing producers prices
  - Use tables containing purchaser prices

Products (CPA)	Industries (Nace) 1	…	59
1	€	€	€
…	€	€	€
59	€	€	€

Step 1: production and consumption function

- We utalize supply tables to extract weighted production function
    - Using the supply tables' information per row enables us to know which industries produce the same products.
- We utalize use tables to extract weighted consumption function
    - Using the use tables' information per row enables us to know which industries use the same products.

Industries (Nace)

Products (CPA)	1	…	59
1	€	€	€
…	€	€	€
59	€	€	€

Step 1: production and consumption function

- We utalize supply tables to extract weighted production function
- We utalize use tables to extract weighted consumption function

$$\widehat{\mathrm{EI}}_i = \sum_j \left(\alpha_{i,j} \cdot \mathrm{GVA}_j\right)$$

$\widehat{EI}$: CPA classified economic indicator (€)
i: index for products (CPA divisions)
j: index for economic activities (NACE division)
α: relevance of economic activity j for transportation of product i (for each option: use based, supply based, core industry based)
$\sum_j \alpha_{i,j} = 1$ for each product i

Step 2: Derive weighting factors for PF and CF

- We utalize supply tables to extract weighted production function
- We utalize use tables to extract weighted consumption function

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Industries (Nace)

Products (CPA)	1	…	59
1	€	€	€
…	€	€	€
59	€	€	€

α = € scaled to 1 per row.

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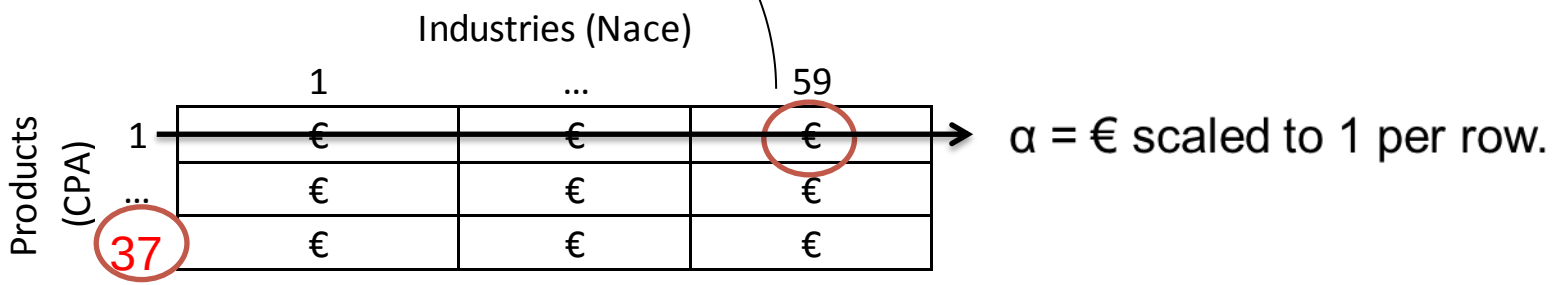


Step 3: Weight GVA and calculate the indicators

- We have the PF, CF and weigthting factor by empolying SUTs
- GVA from general economic statistics avialable
- Two economic indicators can be calulated now with PF and CF
    - 1 supply table based
    - 1 use table based

Step 3: Weight GVA and calculate the indicators

- We have the PF, CF and weigthting factor by empolying SUTs
- GVA from general economic statistics avialable
- Two economic indicators can be calulated now with PF and CF
    - 1 supply table based
    - 1 use table based
- However CPA classified → we intend a NSTR classified indicator
    - CPA are products in Euro
    - NSTR are transported commodities in tons
    - We need a brigde matrix

Step 4: Transform CPA – into NSTR-24

- We need a brigde matrix

Statistisches Bundesamt (2008),
Amtsblatt der Europäischen Gemeinschaften (1998),
WIFO (2010),
TRAFICO et al. (2009),
Eurostat (2014) and
STATISTIK AUSTRIA (2014)]

Picture source: blog.archisnapper.com, adapted

Step 4: Transform CPA –into NSTR-24

- We need a brigde matrix to re-classify CPA into NSTR

NSTR24	CPA	β	NSTR24	CPA	β	NSTR24	CPA	β
01	01	0.33	13	27	0.51	24	01	0.1
02	01	0.36	14	26	0.88	24	05	0.2
03	01	0.12	15	14	1	24	12	1
03	05	0.34	16	24	0.09	24	15	0.1
04	02	1	16	25	0.06	24	16	0.8
04	20	1	17	24	0.01	24	17	0.3
05	17	0.07	17	25	0.01	24	18	0.3
05	18	0.07	18	24	0.85	24	19	0.3
05	19	0.07	18	25	0.59	24	21	0.2
05	36	0.06	19	21	0.8	24	22	1
05	37	0.07	20	29	0.8	24	24	0.05
06	15	0.9	20	30	0.33	24	25	0.34
06	16	0.2	20	31	0.7	24	26	0.05
07	01	0.09	20	32	0.33	24	27	0.05
07	05	0.46	20	33	0.33	24	28	0.1
08	10	1	20	34	0.9	24	29	0.2
09	11	0.01	20	35	0.9	24	30	0.67
09	23	0.01	21	28	0.22	24	31	0.3
10	11	0.99	21	27	0.16	24	32	0.67
10	23	0.99	22	26	0.07	24	33	0.67
11	13	0.92	23	17	0.63	24	34	0.1
11	27	0.25	23	18	0.63	24	35	0.1
12	13	0.08	23	19	0.63	24	36	0.34
12	27	0.03	23	36	0.6	24	37	0.25
13	28	0.68	23	37	0.68			

Step 4: Transform CPA –into NSTR-24

- We need a brigde matrix

NSTR24	CPA	β	NSTR24	CPA	β	NSTR24	CPA	β
01	01	0.33	13	27	0.51	24	01	0.1
02	01	0.36	14	26	0.88	24	05	0.2
03	01	0.12	15	14	1	24	12	1
03	05	0.34	16	24	0.09	24	15	0.1
04	02	1	16	25	0.06	24	16	0.8
04	20	1	17	24	0.01	24	17	0.3
05	17							0.3
05	18							0.3
05	19							0.2
05	36							1
05	37							0.05
06	15							0.34
06	16							0.05
07	01							0.05
07	05							0.1
08	10	1	20	34	0.9	24	29	0.2
09	11	0.01	20	35	0.9	24	30	0.67
09	23	0.01	21	28	0.22	24	31	0.3
10	11	0.99	21	27	0.16	24	32	0.67
10	23	0.99	22	26	0.07	24	33	0.67
11	13	0.92	23	17	0.63	24	34	0.1
11	27	0.25	23	18	0.63	24	35	0.1
12	13	0.08	23	19	0.63	24	36	0.34
12	27	0.03	23	36	0.6	24	37	0.25
13	28	0.68	23	37	0.68			

$$\mathbf{EI}_{13,y} = \widehat{EI}_{27,y} \cdot 0.51 + \widehat{EI}_{28,y} \cdot 0.68$$

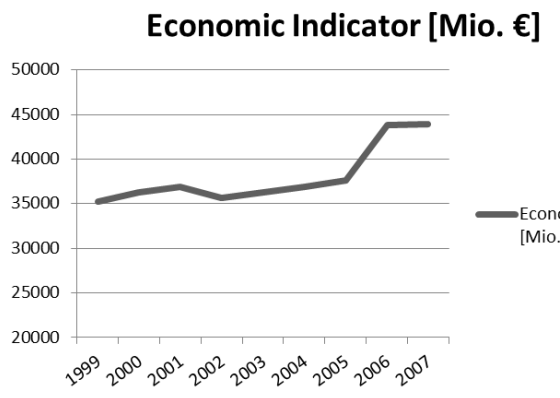
EI: economic indicator (€)

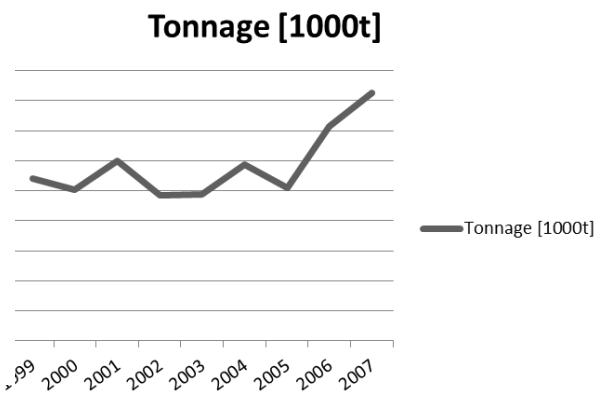
$\widehat{EI}$: CPA classified economic indicator (€)

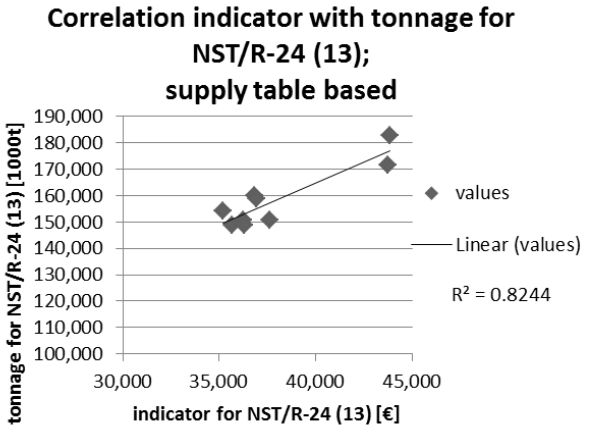
y: year

Finally: perform a regression analysis

- Now a regression analysis between the economic indicator and the transported tonnage is possible [data available from 1999-2007]
  - Example NSTR-24 (13): Metal Products

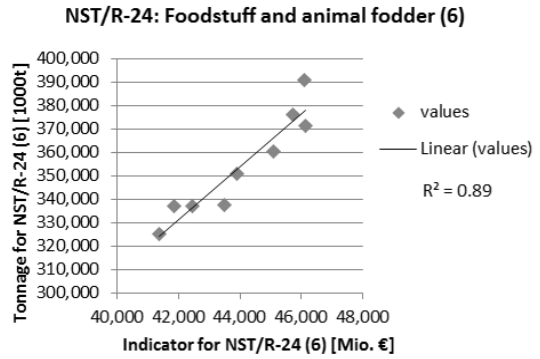


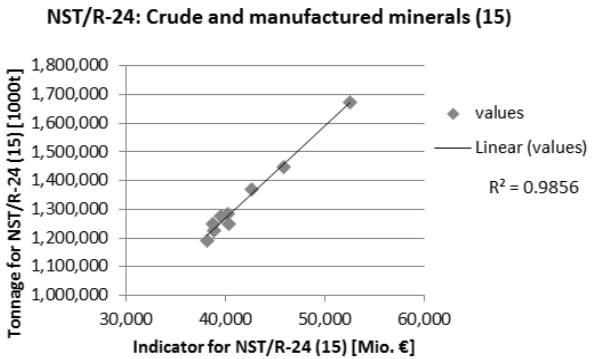


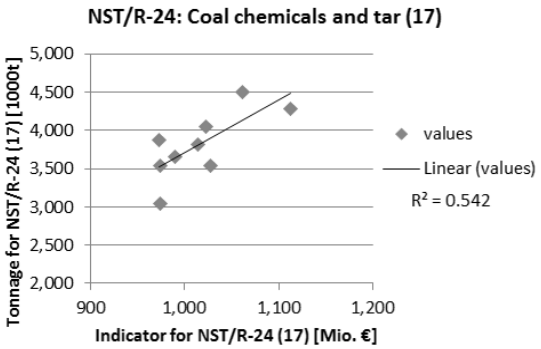


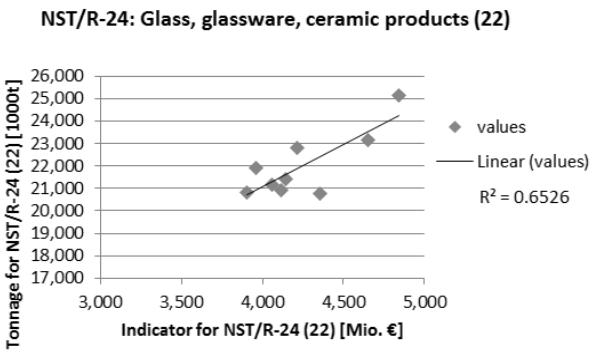
Finally: Result evaluation

- Now a regression analysis between the economic indicator and the transported tonnage is possible [data available from 1999-2007]









Result of the regression analysis

- Strong correlation is found for 11/24
- These 11 commodities represent 75% of the Tonnage in Germany (2007)
- Use-table based EI works slightly better 7/11

	kind of good (NST/R-24)	R^2 supply table based	R^2 use table based	importance in Germany (share of tons in 2007)
1	Cereals	0.00	0.30	1.0%
2	Potatoes, other fresh or frozen fruits and vegetables	0.07	0.01	0.9%
3	Live animals, sugar beet	0.23	0.36	0.6%
4	Wood and cork	0.05	0.16	2.6%
5	Textiles, textile articles and man-made fibres, other raw animal and vegetable materials	0.07	0.09	0.5%
6	Foodstuff and animal fodder	0.15	**0.89**	**10.2%**
7	Oil seeds and oleaginous fruits and fats	**0.70**	0.67	**0.7%**
8	Solid minerals fuels	0.37	0.09	2.7%
9	Crude petroleum	0.33	0.03	0.0%
10	Petroleum products	0.10	0.48	5.0%
11	Iron ore, iron and steel waste and blast furnace dust	0.00	0.05	2.6%
12	Non-ferrous ores and waste	0.03	0.13	0.3%
13	Metal products	0.82	**0.83**	**4.8%**
14	Cement, lime, manufactured building materials	0.84	**0.86**	**5.1%**
15	Crude and manufactured minerals	0.48	**0.99**	**33.4%**
16	Natural and chemical fertilizers	0.27	0.43	1.0%
17	Coal chemicals, tar	0.46	**0.54**	**0.1%**
18	Chemicals other than coal chemicals and tar	0.18	0.34	6.7%
19	Paper pulp and waste paper	0.02	0.21	1.0%
20	Transport equipment, machinery, apparatus, engines, whether or not assembled, and parts thereof	**0.97**	0.87	**4.0%**
21	Manufactures of metal	0.79	**0.83**	**1.5%**
22	Glass, glassware, ceramic products	0.56	**0.65**	**0.5%**
23	Leather, textile, clothing, other manufactured articles	**0.90**	0.53	**4.9%**
24	Miscellaneous articles	**0.92**	0.83	**9.8%**
		explained tonnage		75.0%

Discussion of the method

- The key to translate economy into freight transportation is:
  disaggregated economic indicator involving all industries

- Correlation is found
  - In case of Germany: 75% of the amount of goods is correlated
  - Useful in modeling issues: disagregated goods
  - Goods forecasts possible with time dependent value densities

- Just public available data are used (EUROSTAT)

- Correlation is better than with the core industry

Discussion of the m

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14	Cement, lime, manufactured building materials	0.84	**0.86**	0.78
15	Crude and manufactured minerals	0.48	**0.99**	no GVA data
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Discussion of the method

- We cannot derrive a pattern why some goods are explained and others are not
  - Natural resources are more expensive when they become scarce
  - Price decrease/increase for commodities over years
  - The bridge matrix, which converts CPA-classified goods into NST/R-24-classified goods, is a great uncertainty
  - Taking into account the handling in the transport of goods

- Logistics modules needs new formulation

- Classification change (NST2007, NACE rev. 2)

Next steps

- We discussed the results but ultimately we see importance in giving further attention to the reasons why some product groups can still be explained while others cannot.

- Time-dependent value densities

- test the methodology for other European countries

- a regional investigation, on federal state or NUTS 3 level would also be desirable. Especially for SCGE or MRIO modelling needs and for European wide model needs is this investigation reasonable

- Test the methodology for the CPA classified EI

Vielen Dank für Ihre Aufmerksamkeit!
(Thank you for your attention)

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