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How to translate economic activity into freight transportation?

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Abstract

Economic activities imply freight transportation. However, the major question is: how much freight transportation is generated by which activities? In some analysis, the relationship between GDP and mileage or transport intensity is evaluated. There are different views, though, on whether such a coupling of these values is justified and needed or not. However in freight transport modelling issues the economy is a major influencing variable to describe the transport demand.

In this paper, the relationship between the amount of transported goods and economic activities by industries is investigated. Using historical EUROSTAT supply-use tables for Germany, we developed an economic indicator with which the interdependency between 59 industries (NACE classified) their 59 products (CPA classified) and the amount of 24 types of transported goods (NST/R classified) can be shown. In the results, we can observe a strong interdependency between the majority of the transported goods and the developed economic indicator. This enables us to explain statistically about 91% of the amount of the transported goods by economic activity in Germany. Therefore we can state that the developed indicator is suited to translate economic activity into freight transportation.

On the one hand, the findings might contribute to the coupling/decoupling discussion. Using the developed indicator we see how coupled the transport volume to economic development really is. On the other hand, the outcome and the developed economic indicator are highly relevant for the freight modelling community because the proper translation of economic activity into freight transportation is still a challenge. Models without an explicit freight generation module can use the economic indicator to derive the transport demand from economic development. Models with an advanced freight generation approach such as SCGE or MRIO can use the method to obtain a control variable for their model outcomes.

Keywords: *decoupling; freight generation; economic indicator; goods transportation*

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1. Introduction

Freight transportation is implied by economic activities. However, the major question is: how much freight transportation is generated by which activities? In some analysis, the relationship between the growths of GDP and mileage or transport intensity is evaluated. There are different views, though, on whether such a coupling of these values is justified and needed or not. However, a discussion of disaggregated GDP per industry is proposed in the literature. There is less focus placed on the step before: the generated amount and type of goods that has to be transported and can be directly explained by specific economic activity. We place more attention on the meso-level underneath the relationship between the aggregated GDP and a macroscopic transport indicator in this paper, namely on the amount of type of goods.

In freight transport models there is a strong need for the assessment of the generated amount of freight that is transported. Most models are based on the description of the economy. "Essential for a model is the notion that developments in freight flow demand are the result of changes in economic structures that create a demand and a supply of goods in specific geographic regions and form the basis for transport flows between regions" (Tavasszy et al. (1999)).

The model types currently considered as most advanced, MRIO (multi-region input–output models) and SCGE (spatial computable general equilibrium model), use input-output tables to describe the economic interaction between industries and zones. As a result the money flow between zones is described in these models. However the translation of money flows into freight transportation is still a challenge. This leads to the guiding research question of this paper: How can we translate economic activity into freight transportation?

In this paper we provide a new indicator based on input-output tables, which finally enables the translation of the gross value added (GVA) of 59 distinguished industries into the amount of 24 types of transported goods. First we discuss the relevance of input-output tables and other data for transportation concerns, and provide a short overview on the coupling of economic and transportation activities. In chapter 3 we describe the derivation of the new economic indicator. An example of the calculation for the product type metal products is provided. Afterwards we can show the explanatory power of this indicator for the amount of transported goods in the case of Germany. Finally, we discuss the correlation between economic activity and freight transportation and close with an outlook on further research needs.

2. Discussion of economic data according to freight transportation modelling

A challenge for the freight modelling community is the availability of data. Economic data are described in different classifications and units to transportation data. The first describe money flows, the latter freight and service flows. In modelling philosophies, the transformation from money flows to freight flows, the filter in between, is done by introducing logistics issues (Tavasszy et al. (1998)). For the economy and transportation activities, macroscopic data are provided by statistical offices. This is not the case for logistics and therefore there is an empirical gap in the translation from economic activity into freight transportation.

2.1. Relationship of economy and freight transportation

The relation between economic activity and freight transportation has been analysed in the international literature from different points of view. On the one hand the suitability of GDP as economic indicator is discussed, on the other the question of the coupling or decoupling between economy and freight transport is analysed. We will give an overview on significant literature and show that there is a lack of useful economic indicators other than GDP for such analysis and that the disaggregated use of GDP or GVA proves to be a suitable solution.

Pastowski (1997) concluded that statistical trends show a close relation between freight transport and growth in GDP in past decades. But this is not a proof of a continuation of this trend in the future. McKinnon (2007) analysed GDP development and the volume of freight movement in the UK. Before giving his analysis, McKinnon reviews further literature on the decoupling issue. For the UK McKinnon concludes that three causes out of a possible twelve are responsible for two-thirds of decoupling, which could be seen from aggregated data. The causes are the number of foreign road haulage operators, a decline in road transport's share of the modal split and increases in road freight cargo rates. All these three causes produce an apparently stronger decoupling than in other European countries and the USA. Lehtonen (2006) states that it is an apparent start of decoupling between GDP and road freight growth which is only partly to be seen. Kveiborg (2007) analysed economic growth and the development in freight traffic and freight transport in Denmark and points out that it is important to distinguish between industries. Furthermore the direct link between industries and goods in input-output analysis should not be a cause of great concern. Meersman and Van de Voorde (2013) analysed the relation between economic activity and freight transport. By using stability and co-integration tests they show that the aggregated use of GDP is not the best indicator for freight transport. They suggest alternatives to estimate the link between freight and economic-activity indicators, and conclude that disaggregated methods based on the microeconomic analysis of the behaviour of shippers and freight transport companies are needed. To bring such approaches to success, insights into developments in logistics are required. The German traffic prognosis used regional data on the structure and development of the economy (IWH (2006)) and partly the population to explain freight volume, whereas freight transport is a result of the model used. Different methods were used for the calculation of the development of inland traffic and transit traffic (ITP and BVU (2007)). Similar approaches were used for the current traffic prognosis (Intraplan and BVU (2014)). Unfortunately there is no statement on the quality of the resulting explanation. The authors will follow the given analysis and carry out their own regression analyses, clearly stating each single step for further discussion.

In the literature there is no better indicator given for the analysis of freight transport development and economic activity at the national level. In the next chapters, the data need of freight models concerning the freight generation modelling step and the suitability of supply-use tables are shown.

2.2. What do transportation models need and what do they use?

We investigated European large-scale freight models for their approaches to the translation of the economy into freight transport demand. We analysed models with an explicit freight generation approach and not those European models with external freight demand matrices as input. The models in our scope were the Italian National Model System (SIMPT) (e.g. Wang (2012)), the Netherlands model SMILE+ (e.g. Tavasszy et al. (1998)), the German model for national planning (ITP and BVU (2007)), the Norwegian model NEMO (e.g. Hovi and Vold (2003)), the Swedish model SAMGODS (e.g. Karlsson et al. (2012), SAMPLAN (2001)) the European model ASTRA (e.g. iTREN-2030 (2010)) and finally the Austrian model ETMOS (e.g. WIFO (2010)). Five models using (regional) input-output tables to describe the economic interaction of industries and regions. Values of goods are applied to translate money flows into freight flows. To find the right value of goods is a challenge because their values vary strongly between regions, industries, value-chain levels, etc. Supply-use tables are used in SMILE+ to create product chains and production networks. The next step in SMILE+ handles trade and describes economic activity. Thereafter a complex consideration of logistics translates economic activities into transportation. The German national planning model has integrated functions of the generation and attraction of goods. Within these functions for each good structure, values are weighted. The structure values consist of the GVA of up to three industries and sometimes the population. There is no publication on how the used structural values correlate to the freight volume demand, so the status assessment is not possible for externals.

The major indicator in models is GDP. "There are good reasons to use GDP, or any other indicator of economic output, as the freight flows are nothing more than the physical representation of the trade patterns captured in these indicators" (Holguin-Veras et al. (2011)). We see that these models need a conversion from money into freight. However, this conversion is crucial and affected by a lack of suitable data. A methodology to justify the model outcomes in sense of providing a test variable for the result of detailed trade and logistic modelling is needed because of the data gap. Moreover such a methodology is able to contribute to a freight generation approach for those models which currently don't have one included.

2.3. The relevance of supply-use tables for freight transportation

Economy interaction occurs with money flows, information flows and product exchange. For freight transportation concerns, we are interested in the product exchange or, more precisely, in the goods flows. Money flows and freight flows can be different. For example: when the freight has interim stops for consolidation or a mode shift, each single trip will be counted in the statistics. That means the same ton of freight can be counted several times. This logistics dimension between economic relation and economic freight exchange is difficult to capture. There is a natural difference in statistics on the production of goods and their transport.

The general information how an industry is related to which products on the supply and on the use side is contained in supply-use tables (also known as make-use tables). Supply-use tables are a subset of input-output tables. While, in input-output-tables, the relationship between business sectors to business sectors is shown, in supply-use tables the business sectors are related to products. Supply tables consider the cost of production from a business sector to a product. Use tables reveal the use of products by industry with delivery costs. Reading supply tables row by row (product by product), it is possible to evaluate the contribution of an economic sector to the production of a particular product group. The unit in which the relation is expressed is generally basic prices. Use tables, read product by product, show the input of products to industries at purchasers' prices (EUROSTAT (2008)).

To overcome the gap between economic and transport statistics we need a synthetic indicator. This indicator translates economic activity into related freight transport demand. The development of such an indicator is applied in the next chapter. A detailed example of the calculation process is given for the type of good 'metal products'.

3. The development of an economic indicator to explain freight transportation demand

In this chapter we provide the methodology to the developed indicator and utilized data. We did two major steps of work for the economic indicator. The first step was the use of the information on how much the industries supply or use specific products. Additional to this information is GVA our main descriptive factor for economic development. The second step is the reference of products to transported goods.

3.1. Added value with products

The database of supply-use tables is available at EUROSTAT for the years 1995-2007 (EUROSTAT (2013a)). In this period the industries are classified in NACE rev. 1.1 (Nomenclature statistique des activités économiques dans la Communauté européenne) and the products are classified in CPA 2002 (Classification of Products by Activity). The GVA in the NACE rev. 1 classification is also available for this period on EUROSTAT (EUROSTAT (2013b)). In our research, we used a sample of these data for Germany.

First we had to build a contribution function which is applied to the supply tables and also to the use tables with the variable GVA in form of Eq. 1 for each product.

Using the supply tables' information per row enables us to know which industries produce the same products. To obtain α we scaled each row to 1. This was done for each year. We then processed a specific α for each industry-product combination which can be used in the contribution function. The scaling was done in the same way for the use tables. Here the value α expresses the share of an industry to use a product group for value adding. Please note that two separated α were calculated, one is based on supply tables and one is based on use tables.

$$\widehat{\mathrm{EI}}_i = \sum_j \left(\alpha_{i,j} \cdot \mathrm{GVA}_j\right) \tag{1}$$

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

Multiplying α per industry with the GVA per industry and the summing up per product group finalises the first step of the set-up of the indicator. Please note: because of the two versions of α, we also obtained two versions of the indicator. Both are used to investigate the relationship between the indicator and freight transportation. However, up to now we have used economic products instead of transport goods, classified in CPA which is an economic classification. Therefore the next step is to refer economic products to transported goods.

3.2. Reference of economic products to transported goods

Transported freight is referred to the classification NST/R until 2007 and economic information is referred to CPA. The first one is counted in tons, the latter one in euros. There is no unique reference of CPA to NST/R. Thus we had to construct a bridge matrix to overcome this data gap (WIFO (2010)). In our case, we want to achieve the level of NST/R-24 where 24 types of goods are distinct. The challenge is to refer 59 products (CPA) to 24 transport goods. A basic notation is that not all economic goods are transported goods. We have to exclude services which may generate traffic but no freight transportation. The CPA contains 59 products numbered from 1 to 95. The physical goods which we may refer to freight transportation on road, rail or waterway, are goods up to number 37 (secondary raw materials). All products thereafter have negligible relevance for freight transportation because of their service character. By the use of relevant literature (Statistisches Bundesamt (2008), Amtsblatt der Europäischen Gemeinschaften (1998), WIFO (2010), TRAFICO et al. (2009), Eurostat (2014) and STATISTIK AUSTRIA (2014)) we created a bridge matrix (see Table 1) with a key that enables us to refer CPA classified goods to NST/R-24 classified goods. The reference key is hard to validate because there is no opportunity to prove it because of the lack of data. Therefore we varied the β by +/- 10% to test the robustness of the regression results later. We have seen no greater changes in the results what gives confidence in the developed bridge matrix. In the future the bridge matrix will have less relevance because the NST-2007 classification has been introduced since 2007 and can be referred directly to CPA classified goods. Unfortunately at the moment we are lacking time-series data for NST-2007 classified goods which are necessary for the statistical analysis. The bridge matrix we developed and applied is shown in Table 1 and can be read using Eq. 2.

$$EI_k = \sum_i \left(\widehat{EI}_i \cdot \beta_{i,k}\right) \qquad (2)$$

EI: economic indicator (€)
$\widehat{EI}$: CPA classified economic indicator (€)
i: index for products (CPA divisions 1-37)
k: index for commodities (NST/R-24 with 24 sub-chapters)
β: weight of product (CPA-classification) for commodity (NST-classification)
$\sum_i \beta_{i,k} = 1$ for each commodity k

For the correlation analysis between economic activity and freight transportation, we used EUROSTAT data for the transport modes of road (EUROSTAT (2012)), rail (EUROSTAT (2013c)) and inland waterways (EUROSTAT (2013d)) as the reference for freight transport in the correlation analysis. The data is for the available period 1999-2007 and covers domestic German freight transport, the import and the export of freight. In the next chapter, we demonstrate the calculation of the economic indicator for the product group NST/R-13 (metal products). The correlation of the economic indicator for all types of goods and the transported freight is shown in chapter 4.

3.3. Example of the calculation of the indicator for the NST/R-24 product group 6 (metal products)

In this chapter, the processing steps to obtain the indicator are demonstrated for the NST/R-24 type of good 13 (metal products) to provide a comprehensible tool to repeat our methodology. The processing is the same for supply and for use tables (SUT), therefore we limit our depiction to the calculation based on supply tables.

Table 1: Bridge matrix from CPA to NST/R-24 classified goods

NST/R-24	CPA	$\beta_{i,j}$	NST/R-24	CPA	$\beta_{i,j}$	NST/R-24	CPA	$\beta_{i,j}$
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			

As we can see in Table 1, the CPA products ‘27’ and ‘28’ are relevant for NST/R-24 product 13. The first processing step is the calculation of the weighting factors (α). The SUT are evaluated horizontally: the contribution of each industry to each product group is measured in production values (PV) and consumption values (CV). The weighting factor is the percentage of a PV to the sum over the PV or the CV to the sum over the CV. The row sum of the weighting factors per product group is 1. The resulting weighting factors (α) for the product group 13 when using the supply table are exemplary shown in Table 2.

The second processing step is the set-up of a contribution function, supply and use table based, for each product group. The function has the form as shown in Eq. 1. The GVA of an industry (EUROSTAT (2013b)) is multiplied with the specific weighting factors. Thereafter the sum over the contribution function (supply table based) was built to obtain the indicator classified per CPA (see Table 3).

The third processing step is the transformation of the CPA classified indicator to an NST/R-24 classified indicator under the use of Table 1. The specific formula for the NST/R-24 group 13 is given in Eq. 3.

$$\mathrm{EI}_{13,y} = \widehat{EI}_{27,y} \cdot 0.51 + \widehat{EI}_{28,y} \cdot 0.68 \tag{3}$$

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

Table 2: Example of the weighting factors of the NACE industries the use of CPA products for the contribution function

	1999		**2000**		**2001**		**2002**		**…**	
NACE	CPA 27	CPA 28	CPA 27	CPA 28	CPA 27	CPA 28	CPA 27	CPA 28	CPA 27	CPA 28
1-23					…					
24	0.01802	0.00027	0.00895	0.00031	0.00537	0.00031	0.00566	0.00045		
25	0.00113	0.00650	0.00164	0.00622	0.00170	0.00586	0.00102	0.00788		
26	0.00062	0.00203	0.00101	0.00190	0.00045	0.00192	0.00053	0.00205		
27	0.93253	0.01508	0.94620	0.01667	0.95381	0.01587	0.95775	0.01519	…	
28	0.01899	0.92104	0.01906	0.92076	0.01560	0.92730	0.01331	0.91630		
29	0.00625	0.02139	0.00600	0.01557	0.00724	0.01553	0.00650	0.01918		
30	0	0.00037	0	0.00085	0	0.00058	0	0.00060		
31-95					…					
sum	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 3: Example of the CPA classified economic indicator $\widehat{\mathrm{EI}}$

	1999		2000		2001		2002		…	
NACE	CPA 27	CPA 28	CPA 27	CPA 28	CPA 27	CPA 28	CPA 27	CPA 28	CPA 27	CPA 28
1-23					…					
24	709	11	371	13	230	13	249	20		
25	22	128	34	130	34	117	21	165		
26	10	33	17	32	7	30	8	30		
27	15,774	255	14,155	249	16,701	278	16,808	267	…	
28	698	33,839	770	37,189	616	36,628	502	34,554		
29	353	1,209	371	964	461	989	408	1,205		
30	0	2	0	5	0	3	0	3		
31-95					…					
sum	19,388	37,206	17,001	40,500	19,254	39,749	19,143	37,998	∑	∑

The final indicator for NST/R-24 (13), based on the supply tables, is shown in Table 4 for each year. The related tonnage of the NST/R-24 type of good 13 is referred to the years.

Table 4: Processed indicators (supply-table-based) for each year and the tonnage of NST/R-24 group 13

	Indicator [Mio. €]	Tonnage [1000t]
1999	35190.65	153,966.60
2000	36260.85	150,479.00
2001	36853.41	160,020.00
2002	35664.69	148,537.00
2003	36304.04	148,769.00
2004	36918.72	158,734.00
2005	37631.09	150,849.00
2006	43775.16	171,428.00
2007	43885.81	182,683.72

A linear regression between the indicator and the tonnage of NST/R-24 (13) can be done now. The result of the correlation analysis in our example is R^2=0.828.

In the following section, we show the results of the described methodology applied for Germany and for all 24 types of transported goods.

4. The correlation between economic activity and freight transportation

The data processing described in chapter 3 is done for all NST/R-24 in a database (postgreSQL). The resulting indicators based on supply and use tables are shown in the following tables (see Table 5 and 6).

We conducted a linear regression analysis with R^2 as the indicator for the fitness. The regression analysis was done in two ways. The first is looking for the correlation between the transported tons per type of good with the economic indicator based on the supply tables. The second analysis used the indicator based on the use tables. The results of the correlation for both analyses are shown in Table 7. We can observe that some products can be explained by the indicator based on the supply tables, others based on the use tables, some products have a strong correlation to both indicators. 12 product groups have a $R^2 > 0.5$ and represent about 75% of the transported amount of goods in Germany in 2007. A statistical significance we found for 91% of the goods. These types of goods and the best R^2 value are marked bolt in Table 8 and some graphical examples are provided in Fig. 1. However the remaining 9% of the transported amount of goods cannot be explained by any of both indicators.

Table 5: Supply-table-based indicators for Germany

Type of good (NST/R-24)	1999 [Mio. €]	2000 [Mio. €]	2001 [Mio. €]	2002 [Mio. €]	2003 [Mio. €]	2004 [Mio. €]	2005 [Mio. €]	2006 [Mio. €]	2007 [Mio. €]
1	7,786	6,498	7,369	7,244	6,211	7,366	5,653	4,887	4,901
2	8,494	7,088	8,039	7,902	6,775	8,035	6,167	5,332	5,346
3	2,899	2,441	2,734	2,692	2,354	2,757	2,120	1,859	1,867
4	11,810	12,557	11,210	10,954	10,320	11,193	10,212	10,401	10,270
5	1,969	1,866	1,841	1,887	1,896	2,015	2,003	2,062	2,130
6	31,496	33,657	30,848	31,770	33,711	33,747	34,206	33,293	32,030
7	2,215	1,878	2,083	2,054	1,823	2,115	1,629	1,443	1,452
8	4,639	6,195	5,089	4,980	3,891	4,178	3,326	4,188	4,971
9	75	93	108	83	62	73	65	82	66
10	7,395	9,220	10,687	8,227	6,176	7,243	6,420	8,138	6,575
11	72,317	4,250	4,814	4,786	4,484	4,481	4,937	5,845	5,740
12	6,449	510	578	574	538	538	592	701	689
13	35,191	36,261	36,853	35,665	36,304	36,919	37,631	43,775	43,886
14	16,932	16,844	15,462	14,291	14,070	13,542	13,542	14,525	14,327
15	8,851	7,437	6,974	5,796	6,776	6,109	7,122	7,506	7,725
16	4,773	5,036	5,090	5,276	5,315	5,562	5,688	5,875	6,056
17	601	635	638	662	666	699	713	738	759
18	45,576	48,085	48,575	50,362	50,724	53,093	54,285	56,080	57,797
19	8,017	7,800	8,020	8,633	8,796	9,012	8,776	8,796	8,511
20	132,841	144,398	151,559	150,004	157,793	161,498	165,899	177,468	192,321
21	11,288	11,646	11,827	11,443	11,656	11,855	12,076	14,046	14,084
22	1,347	1,340	1,230	1,137	1,119	1,077	1,077	1,155	1,140
23	18,712	17,768	17,546	18,000	18,104	19,267	19,154	19,739	20,409
24	110,094	122,809	119,806	116,822	118,560	121,266	125,957	131,568	137,945

Table 6: Use-table-based indicator for Germany

Type of good (NST/R-24)	1999 [Mio. €]	2000 [Mio. €]	2001 [Mio. €]	2002 [Mio. €]	2003 [Mio. €]	2004 [Mio. €]	2005 [Mio. €]	2006 [Mio. €]	2007 [Mio. €]
1	12,605	13,437	12,687	13,256	14,196	14,070	14,044	14,392	14,129
2	13,751	14,659	13,840	14,461	15,487	15,349	15,321	15,700	15,414
3	16,751	17,475	16,597	17,176	18,448	18,319	18,868	19,116	18,949
4	61,466	62,049	59,816	57,313	55,181	54,763	49,851	51,121	52,280
5	7,676	8,014	8,070	8,233	8,990	8,362	8,371	8,581	8,961
6	41,368	42,468	41,863	43,490	43,901	45,099	46,156	45,721	46,109
7	19,899	20,696	19,673	20,332	21,847	21,700	22,448	22,707	22,540
8	27,585	29,109	24,315	26,197	26,257	30,960	31,540	31,824	36,987
9	697	647	680	646	647	630	630	682	693
10	68,968	64,038	67,276	63,986	64,005	62,395	62,418	67,485	68,560
11	27,494	25,237	27,709	27,311	26,673	26,722	28,509	32,400	32,565
12	2,704	2,505	2,731	2,693	2,649	2,653	2,812	3,175	3,207
13	52,841	54,105	54,683	53,750	55,270	55,757	55,913	59,924	63,340
14	60,907	58,496	54,760	52,960	52,075	51,025	49,101	49,820	51,733
15	52,512	45,900	42,663	40,302	40,416	38,942	38,194	38,814	39,599
16	7,092	7,119	7,129	7,286	7,465	7,595	7,560	7,852	8,210
17	973	974	973	990	1,014	1,028	1,023	1,061	1,112
18	68,273	68,515	68,598	70,070	71,798	73,015	72,678	75,482	78,934
19	29,093	27,517	28,078	28,179	28,728	29,236	29,671	29,676	30,252
20	183,309	203,331	209,400	216,908	221,837	225,858	229,966	234,243	249,890
21	16,906	17,317	17,497	17,197	17,682	17,840	17,888	19,171	20,265
22	4,845	4,653	4,356	4,213	4,142	4,059	3,906	3,963	4,115
23	72,444	74,877	75,589	77,086	84,116	78,441	78,629	80,643	84,279
24	299,416	293,775	294,094	302,749	312,283	313,232	314,565	325,422	338,661

Table 7: Correlation between transported tons per type of good and the economic indicator for Germany

NST/R Code	Commodity	based on	R^2	p(m=0)	significance level	share of freight volume (2007)
1	Cereals	use	0.31	0.119	-	1.0%
2	Potatoes, fruits and vegetables	supply	0.067	0.500	-	0.9%
3	**Live animals, sugar beet**	use	0.344	0.097	90%	**0.8%**
4	Wood and cork	use	0.252	0.168	-	2.8%
5	Textiles, textile articles	supply	0.152	0.299	-	0,5%
6	**Foodstuff and animal fodder**	use	0.911	0.000	95%	**10.2%**
7	**Oil seeds and oleaginous fruits and fats**	supply	0.70	0.005	95%	**0.7%**
8	**Solid minerals fuels**	supply	0.369	0.083	90%	**2.7%**
9	Crude petroleum	supply	0.311	0.119	-	0.0%
10	**Petroleum products**	use	0.568	0.019	99%	**5.0%**
11	Iron ore, iron and steel waste	use	0.049	0.566	-	2.8%
12	Non-ferrous ores and waste	use	0.134	0.333	-	0.3%
13	**Metal products**	use	0.828	0.001	95%	**4.8%**
14	**Cement, lime, building materials**	use	0.89	0.000	95%	**5.1%**
15	**Crude and manufactured minerals**	use	0.981	0.000	95%	**33.4%**
16	**Natural and chemical fertilizers**	use	0.447	0.049	99%	**1.0%**
17	**Coal chemicals, tar**	use	0.529	0.026	99%	**0.1%**
18	**Chemicals**	use	0.355	0.090	90%	**6.7%**
19	Paper pulp and waste paper	use	0.153	0.298	-	1.0%
20	**Transport equipment, machinery, engines**	supply	0.967	0.000	95%	**4.0%**
21	**Manufactures of metal**	use	0.831	0.001	95%	**1.5%**
22	**Glass, glassware, ceramic products**	use	0.67	0.007	95%	**0.5%**
23	**Leather, textile, clothing**	supply	0.762	0.002	95%	**4.9%**
24	**Miscellaneous articles**	supply	0.917	0.000	95%	**9.8%**
	Share of transported freight statistically explained by the economic indicator					**91.2%**

What is behind the power of explanation for the correlations? We discuss this in the next chapter.

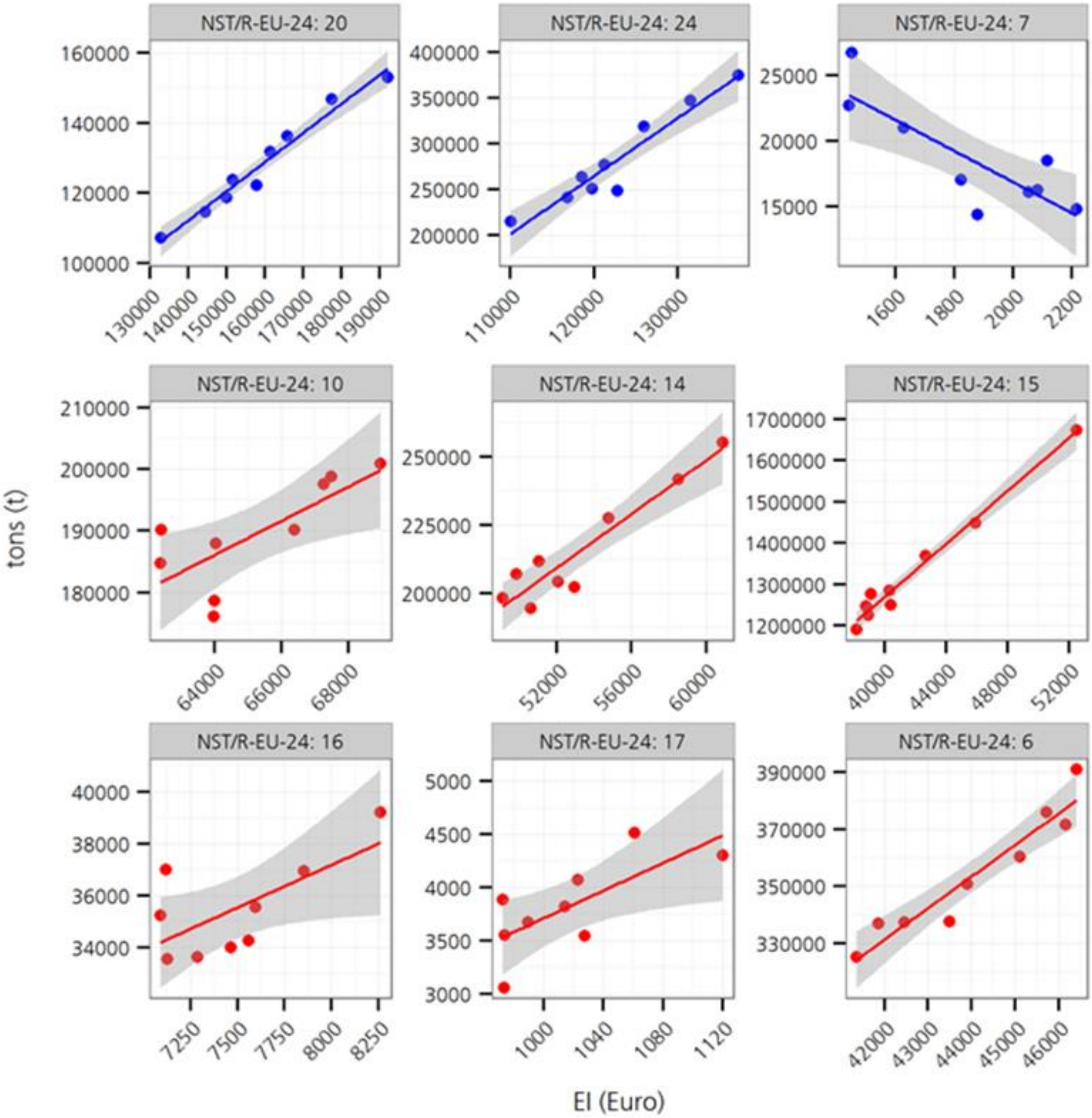

Figure 1: Graphical examples of the regression analysis referred to Table 7 for supply (blue) and use (red) table based EI

5. Discussion of the results of the method of disaggregated weighted GVA

It is noticeable for the commodities which have a high R^2 that the correlation is mostly given in the supply- as well in the use-based calculations. However, in the consideration of both results, the use tables reveal better results in total in terms of R^2. This could be because the weighting of different industries plays a more important role in use tables than in supply tables, where just few industries are relevant (mainly were CPA = NACE). The weighting of different industries seems to be a relevant and better method than to use just one or a few main industries. Moreover, upon closer examination of the data, we see that the tonnage is less volatile in that case than in those of commodities with a low R^2 (e.g. Type of good nr. 10 'vs.' 24). Furthermore we have done another test where we analysed the correlation between the indicator and just the domestic German tonnage (without import and export contributions). In this case the results are similar for the explainable commodities, in tendency slightly worse, however. But this result is expected with an SUT and GVA including imports and exports.

In fact, we are lacking empirically in some areas, and cannot definitively say why some commodities are explainable and others are not. However, with the described observations we can discuss aspects of the answer.

- Natural resources are more expensive when they become scarce, and cheaper when they are plentiful. For example, in the case of vegetable goods (e.g. types of goods 1 and 2), a bad season means high prices but less transported goods and a good season means the opposite. The price itself is negotiated on the market, sometimes influenced by speculation on the stock market. Companies can use stored input materials to reduce the influence of market prices by season or speculations. That could explain why either the SUT or GVA contains the familiar fluctuations rather than the tonnage.
- Price decrease/increase for commodities over years is another possible reason. For example, cereals (NST/R-24 type of good 1), whose tonnage is nearly constant (-5%) between 1999 and 2007 in Germany; the indicator, however, sank by 37% on the supply side (see Table 5) and is slightly growing (+12%) on the use side (see Table 6). Displacement of production and value added change as a consequence of globalization/international division of labour; increasing efficiencies etc. are possible influencing factors.
- Taking into account the handling in the transport of goods. In economic tables, the commodity is counted if the owner changes what influences the developed indicator. In transport tables the commodity is counted in each transport leg. Therefore the same unit of commodity can be counted several times. Logistics matters here: the logistics concepts and handlings behind the commodity groups have to be investigated more to come to an adequate consideration of complex transport chains. We can observe a general increasing integration of logistics functions in transport processes.
- The bridge matrix, which converts CPA-classified goods into NST/R-24-classified goods, is a great uncertainty. As noted before, there is no opportunity to prove the factors. However we varied the β by +/-10% with no significant change in the results. The robustness of the results gives confidence in the bridge matrix.

We applied the transported tons in our research. That implies that all the handlings of a commodity over all modes and means is included, although not logistics. The use of a logistics network, the choice of mode and means as well as the creation of forwarder-receiver-pairs are examples for remaining modelling tasks and logistics modules inside transport models. In our perspective, to use the transported tons and not the produced tons eases the modelling process partly because the amount which has to be transported is congruent to the official transport statistics.

Ultimately we found correlations with our methodology for 91% of the amount of transported goods in the case of Germany. For the remaining 9% the methodology does not work – new approaches are needed. Furthermore, the empirical knowledge must be enhanced to explain the correlations and the non-correlations as well.

In the last chapter we outline the upcoming research task from this investigation.

6. Conclusion

We investigated the correlation of disaggregated GVA and the amount of transported goods in this paper. A method was introduced where the weighted GVA of industries to specific products is used to describe economic activity. In the case of Germany, a correlation between this economic indicator and the amount of total transported type of goods is significantly high for 91% of the goods. This correlation is also robust, as an additional analysis has shown – the analysis with the domestic German amount of transported goods.

The guiding research question in this paper was: How can we translate economic activity into freight transportation? With the provided methodology, a possible solution is shown which is able to translate 91% of the 24 transported types of goods (NST/R-24 classified) in Germany by the economic activity of 59 industries. The identified correlations are strong and therefore we can expect to be suited for forecast intensions. No correlations are found for about 9% of the goods. In general this results show how coupled the transport to economy really is. We just need to use the right indications to reveal this correlation. However, both the correlation and the non-correlation open a need for further research.

- 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. A deeper look to specific market data, market characteristics, production accounts but also the constitution of classes of goods (e.g. NST/R-24) and transportation characteristics including logistics issues are necessary and a future scientific task.
- Moreover it is important to test the methodology and the indicator for other European countries than Germany. A comparison of the result will be possible because we deployed just public available data from EUROSTAT.
- 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.
- The logistics issue, which is a separated module in most of the freight models, has to be investigated in terms of the implementation of our empirical findings into freight models. Logistics as a sensible reactive module must sustain in freight models. However, its significance as the translation toolbox 'from money flows to transport flows' could be changed.

In future we will be able to use new statistic data, based on the NST-2007 classification. This classification will ease the elaboration of economic statistical data and transport statistical data because of a simplified transformation key. In our research, we needed help from a bridge matrix to overcome the mismatch of both statistics and unfortunately that introduces a source of uncertainty. However, the availability of time series with new classifications still needs time.

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