Master thesis

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Analysis and interpretation of interdependencies between economic activities and freight transportation for selected European countries

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Abbreviations

AT	Austria
BE	Belgium
BM	Bridge matrix
CPA	Statistical Classification of Products by Activity in the European Economic Community
DE	Germany
DF-Test	Dickey-Fuller-Test
DK	Denmark
EI	Economic indicator
ES	Spain
EU	European Union
FI	Finland
FR	France
GDP	Gross domestic product
GVA	Gross value added
IT	Italy
LU	Luxembourg
MRIO	Multi-region input–output
NACE	Statistical classification of economic activities in the European Community
NL	The Netherlands
NST/R	Standard goods Classification for Transport Statistics (revised version)
PA	Partial Adjustment Model
ReADLM	Reduced Autoregressive Distributed Lag Model
SCGE	Spatial Computable General Equilibrium
SE	Sweden
SUT	Supply and use table
t	tonne
tkm	tonne kilometre
VWR	Value-weight-ratio
WIFO	Austrian Institute of Economic Research
WVR	Weight-value-ratio

1. Introduction

A frequently discussed topic in transportation science is the coupling or rather decoupling of transport and economy. There is a general consensus about the basic axiom that economic activities imply freight transportation. However, there are a lot of uncertainties about this relationship. The outstanding questions concern the kind and intensity of the relation as well as influencing factors and the development over time due to changes in economic matters (e. g. structure of the economy, changing demands, etc.). The overriding question is: how much freight is generated by which economic activities?

It is the purpose of this thesis to take a closer look at the relation between transport and economy in a European context and to discuss a methodology in an attempt to provide an answer to the question above. The methodology considers the transportation side on a level of commodities, which are distinguished into 24 kinds of goods, instead of considering the transport volume on the whole. The economic side of the relationship is represented by a developed economic indicator, which is generated under usage of supply and use tables and gross value added. Both the disaggregated transport volume and the economic indicator are brought together in a regression analysis to reveal possible correlations. Such an indicator was developed in former research by Stephan Müller, Jens Klauenberg and Axel Wolfermann from the Institute of Transport Research at the German Aerospace Center (DLR) (51, 52), who showed that the methodology of considering an intermediate level instead of the aggregated level worked well in the case of Germany. They found a strong correlation of 16 out of 24 commodities representing the majority of the total transported tonnes, namely 91% in 2007. The primary objective of this thesis is to test the applicability of Müller, Klauenberg, and Wolfermann's methodology beyond Germany in other European countries. Furthermore, the results will be interpreted and any possibly patterns will be identified upon.

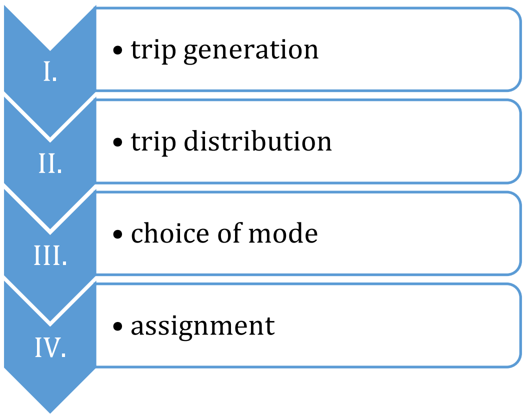
The transport volume is, apart from a few short breaks, constantly increasing on a national level as well as on a global scope. Germany's transport volume reached an all-time-high in 2014 in the amount of 4.5 billion tonnes (59). It is widely accepted that the economy is the driving force behind freight traffic; therefore, the influence of the economy on the freight transportation system is stronger and thus more important than the other way round. None the less, the transport sector itself as part of the economy contributes to the added value and generates jobs. A point of contention concerns the coupling or decoupling of economy and transportation. A question prevails: does economic growth inevitably lead to more transport activity – as it is observed in the past and mostly at present – or is a decoupling of the trends possible? Decoupling in this context means that the development trends of economy and transport are not mutually linked. A more independent development of economy and traffic is desired and fostered by the policy through passing corresponding laws and policies. There is no doubt that the population worldwide and especially in urban regions is increasing and with this the need for various resources rises.

Furthermore, the debate becomes more important against the background of efforts to reduce and avoid emissions in general and the damaging impact due to transportation in particular. To accomplish a sustainable development, the increase in need for transportation services has to be decoupled from growing demand due to economic growth.

In contrast to passenger transport, the debate and research on freight transport is newer and less established, and for this reason more attention must be paid to it. A main reasons for this is its greater complexity due to its more heterogeneous structure compared with passenger transport. As examples of this complexity, two attributes may be mentioned: first, long and multi-section transport chains due to specialisation and international division of labour, which result from globalization. Second, the amount and variety of goods and products is much bigger and their characteristics are more inhomogeneous, which influences the requirements on transport, handling and storage.

The modelling of freight transport has to be improved to represent the current system more precisely and to make simulations of consequences due to system modifications as well as forecasts possible. Especially the linking of economy and transportation is a particular requirement in the further development of freight modelling Tavasszy points out (62). Since the advent of the developing of freight transport models in the early 1970's, the 4-step modelling approach emerged, which comprises four successive steps: trip generation, trip distribution, choice of mode, and assignment (Figure 1). The trip or freight generation is of particular importance, because it is the basis and the initial step of the model. Its accuracy is decisive for the following steps: distribution, choice of mode, and assignment. Hilde Meersman emphasizes, "If this relation [between freight transportation and economic activity] is not represented in an appropriate way, it will weaken the rest of the model and the forecasts. Therefore, it should be modelled carefully using the most suitable variables, data and techniques." (50) The methodology applied in this thesis focuses exclusively on this first part of the modelling approach, the freight generation.

Figure 1 Procedure of the 4-step freight transport modelling approach (own representation)



If we are to accept that the economy influences the freight transport demand, the following questions arise: what are the driving parameters to derive the transport volume from economic activities? Or, in other words, which explaining variables describe the generation of freight and therefore should be mentioned in the first step of the model? Finding suitable input parameters enables a more realistic model of the current state and makes predictions of future conditions possible.

On a macro-level, the economic impact in freight generation models is only represent by the use of the gross domestic product (GDP) as the input parameter. The GDP is often used because it is a disposable variable for which forecasts are also available. However, Meersman demurs, that "[a]lthough this simple relationship seemed to work rather well, it became clear that it cannot be applied uniformly to all transport modes, all regions and all commodity types"(50). The GDP as an aggregated parameter can only project aggregated freight flows and is not suitable for forecasting specific commodities. Meersman further elaborates that "[a]lthough GDP is the main indicator of economic activity on a country Level, it is too general to be used in most of the aggregate freight models because it consists for a large part of value added generated in the services sector"(50). This argument is significant because most European economies are moving towards becoming more service-oriented and less dependent on transport-intensive sectors like agriculture.(1) In short, the GDP is unsuitable as an economic indicator because its structure is changing and thus the relation to freight is always in flux. Furthermore the link between economic activity and freight transportation is changing due to policies fostering the decoupling of the two sectors, as well as changes in business behaviour.(50) Finally, Vasallo and Meersman both conclude that more specific disaggregated approaches are needed to model the relationship between freight transport and economic activity. A few initial approaches offering alternatives outside of GDP-usage to determine freight trends already exist and should be mentioned shortly. One concept explains the freight transport demand in France by using an error correction method-estimation. In this example the production in the manufacturing sector is indicated as the relevant indicator for economic activity. Furthermore, the approach includes the export performance and the import penetration of the country(54). In a second example, the relation between world air freight and economic activity is modelled. Instead of GDP, the world merchandise exports and the share of manufactures in the value of world merchandise exports are used by the authors (47). Another approach investigates the relation between freight transport and economic activity in the case of the port of Antwerp covering a period of four decades. In this example, the amount of tonnes loaded and unloaded for a number of commodities and the economic activity expressed in imports and exports of the Belgium-Luxembourg Economic Union are linked. Moreover the quay length as a variable representing the capacity of the port of Antwerp and real wages in the port are used (42). More proper approaches depict the linking of economic models with transportation models, which occurs by the development of spatial computable general equilibrium models (SCGE) and multi-regional input-output models (MRIO). However, these sophisticated models have a high demand on disaggregated data, which are not available throughout Europe. For this reason, in freight generation modelling often easier and less data-hungry trend forecasting methods are used.

As shown above, there are various other existing forecasting methods aside from GDP; however, they are restricted. They are regionally constrained and consider only parts of the economy or take solely selected transport modes into account. Moreover, these approaches are in need of specific and detailed data. These approaches in fact reveal even more that the relationship between freight transport and economy is complex, involving several parameters.

1.1 Research question of the thesis

In light of this, this thesis presents a methodology on a meso-level in between and exclusively utilizes data which are freely accessible from the federal statistic office of the European Union, Eurostat, and are therefore available for European countries at a comparable level. On the one hand, the national freight volumes are explained by classified commodities, while on the other, the developed economic indicator representing the economic activities on a sectorial level involves supply and use tables and sector specific GVA. This meets the requirement addressed by Vasallo, who asks for a "look at the economic structure of a country in order to identity the key sectors driving […] freight transport demand"(1). The indicator will be developed through commodity-based data, so that a correlation with the freight volume expressed by even these commodities can be done.

However, one consideration was not taken into account in the previous research until now: statistical tests of the used data. Those checks must be done to validate if certain conditions for the performance of the regression analysis are fulfilled. Subsequently, all results and statements of the application of the methodology, with regard to freight modelling, forecasts, and the coupling/decoupling debate, must be assessed against the findings of the statistical tests.

Finally, the research question of this thesis is:

Assuming that, first, the economic indicator is calculated using the same method that was used in the case of Germany, and, second, the underlying data set fulfils the statistical test: ***Does the economic indicator also show for other European countries such a high coupling between economic activity and freight transportation?***

Assumed that the economic indicator has a similar explanatory power to the transport demand as in the case of Germany, the hypothesis that has to be verified by this thesis is:

If the economic indicator – as a result of the method – is to be used for other European countries, then a strong coupling between economic activity and freight transportation must also be evident.

Currently the translation of economic activity into freight transportation is still a great challenge, so the findings are highly relevant for the scientific community. The outcome of this thesis has additional value for several areas of application, including the comparison of the regression results between the countries, which offers new insights of the coupling of the economic activity and the transport demand – on a commodity specific level, which is a substantial improvement compared to models taking the freight amount on the whole into account. The analysis provides a lot of quantitative evidences to contribute to the coupling/decoupling debate objectively. Furthermore, the concept of the new economic indicator is of particular interest in the research community for modelling and forecasting freight transport. Altogether five possible applications may be affected by the results of the thesis. These and their beneficial contribution are listed in the following Table 1.

Table 1 Beneficial contribution of the thesis' research

Application	Contribution
Freight models, which do not have an own freight generation component	Input data for freight generation
Freight models, which have an own freight generation component (SCGE, MRIO)	Data to examine the results of the freight generation component
Discussion about coupling and decoupling	Contribution to the discussion in terms of quantitative evidences
Interpolation if transportation data basis is incomplete	Derivation of missing transportation data from economic data
Forward projection of future transport volume	Forecasting results

1.2 Description of the contents and structure of the thesis

After this introductory chapter, the methodology to develop the economic indicator representing the explanatory variable in the regression analysis will be elaborated on in great detail in chapter 2, *Methodology*. Thereby, particular importance is dedicated to the relationship between supplied and used products and transported commodities. The methodology and assumptions on which this thesis builds on are explained critically and, as a consequence, varied approaches with regard to the allocation of products to commodities are presented. Additionally, statistical tests and analyses in the course of the thesis are performed.

In chapter 3, *Data preparation and Selection of Countries,* the foundation for all succeeding statistical investigations is laid. The selection of the analysed data, as well as the classification systems of the used data, are introduced. Within this context, some difficulties are also presented along with a rationalised method to sidestep them, so that a consistent set of data can be utilized. Finally, the choice of analysed countries, modes of transport, and time period are justified.

The chapters 4, *Analysis and representation of the results*, and 5, *Interpretation of the results*, build the core arguments of the thesis, wherein the analyses are performed and the findings are presented and then afterwards are interpreted. The analytical emphasis of the thesis is the linear regression analyses for altogether 11 countries[1] and 24 commodities classified according to the classification NST/R over a time span of 9 consecutive years between 1999 and 2007. The regression analysis is done with the aim to identify commodities with a strong correlation between the freight variable (tonnes or ton kilometres) and the according economic indicator. Furthermore, in chapter 4, the topic of stationarity of the time series, which is a crucial condition for the regression analysis, is explained and tested in excerpts of the comprehensive data set. The chapter ends with the depiction of cross-sectional regression analyses, which are contrasted to the linear regression analyses.

Subsequent to the computation of the correlations expressed in the terms of coefficients of determination, in chapter 5, the findings will be interpreted. Due to the comprehensive quantity of outcomes, the results are first summarised in matrices, offering an overview at a glance. Then,

[1] Germany, France, Spain, Italy, Austria, the Netherlands, Belgium, Luxembourg, Sweden, Denmark and Finland

particular attention is payed to selected examples and commodities are identified for which the applied methodology works well or does not work well. A separate section concentrates on the relation between the weight and the value of a commodity.

The sixth chapter, *Implications and outlook for freight transport modelling*, takes up the initial posing of the scientific question from the introduction and the central conclusions of the thesis are highlighted. Thereby, consequences for transport modelling in a twofold respect are considered: on the one hand, with respect to the description of the relationship between economy and transportation, and on the other hand, with regard to conclusions in terms of forecasting future transportation systems. At certain points, some proposals to tie up the research work are presented.

In the final chapter 7, *Summary*, the contents of the several chapters and the thesis as a whole are described in short. Additionally, a short summary is given in German.

2. Methodology

The relationship between economic activities on sectoral levels and transported commodities should be ascertained with help of linear regression analysis. Provided that economy implies freight transportation, it can be concluded which variable is independent and which is dependent. In the following analysis, any commodity, either explained in tonnes or the corresponding ton kilometres, represents the dependent variable. The relevant data are given in free accessible statistics from Eurostat. The independent variable in the regression analysis is a so called *economic indicator*, which in contrast has to be calculated before running the analysis.

This chapter offers a methodology to determine the economic indicator. At first the development of an indicator for each product based on classification CPA 2002 is shown, corresponding to the approach from Müller, Wolfermann and Klauenberg (52, 51). The second subchapter then provides an approach to transform the product-based economic indicator into a commodity-based indicator. Therefore, a so called *bridge matrix* is used, which allows an allocation of product groups to transported goods. Müller and Wolfermann developed a bridge matrix for Germany with help of some assumptions from an Austrian research institute.

Since this methodology will be applied to several European countries, its construction is explained in critical detail. Then the application of the method is justified by some stability analysis, and at the end, the conclusion gives reasons for the derived selection of the methodology.

2.1 Calculation of the economic indicator

For the calculation of the economic indicator only two input parameters are needed. The first set of parameters is the gross value added (GVA) per economic sector and the second are supply and use tables (SUT). Both databases are available for the ascertained time span between 1999 and 2007 at Eurostat. More detailed information about the selection of the time span as well as about the different parameters used in the methodology are given in chapter 3.

The first set of parameter is simply constituted as a table that presents the gross value added for each industry (NST classified) on a national level (12). The other set of parameters is based on supply and use tables and needs some transformation. Supply and use tables are matrices in which industries (NACE-classified) and products and services (CPA-classified) are related to another (13). In the analysis only physical goods are considered, thus services can be neglected, because they are not transported physically.

Concerning this method, only the product flows within a national economy are relevant, because it is the country-specific relation between products and sectors that is of interest. The development of the indicator is divided into an indicator for supply and use, so in fact two indicators per commodity will be calculated. Further specification is achieved by performing this calculation for each European country and each single year in accordance with the particular supply and use tables. The calculation procedure of the two indicators is identical and comprises three steps.

In the first step, the calculation begins with a weighing of the values of the supply and use tables. For each product-industry combination a certain weight factor α is calculated by dividing the value of each single combination through the sum of the product over all industries. The factor α indicates the relative allocation of a product to the industries supplying or using it. In other words, α indicates the relevance of an economic activity for the transportation of a product. In case of supply tables for most products one α-factor is dominant and takes on a value of nearly or even exactly 1.

$$\alpha_{i,j}^{use} = \frac{ID_{i,j}}{\sum_j ID_{i,j}}$$

$$\alpha_{i,j}^{sup} = \frac{DS_{i,j}}{\sum_j DS_{i,j}}$$

i: index for products

j: index for economic activities

ID: intermediate demand from use table (€)

DS: domestic supply from supply table (€)

In the second step the gross value added is used, so that product-classified economic indicators result. To obtain the indicators, the factor α of every product-industry-combination is multiplied with the gross value added of the corresponding industry and then the sum per product is made. The resulting indicators, either based on supply or on use tables, take the relevance of the industries for a specific product into account.

$$\widehat{EI}_i = \sum_j (\alpha_{i,j} * GVA_j)$$

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

So far, indicators for CPA-classified products are evolved, but analogous to the transportation data, the indicators have to be based on NST-classified commodities to make regression analysis on the basis of commodities possible.

The transformation from the product-based indicator to the commodity-based indicator is done with the help of a further factor. The computation of this factor and the transformation procedure on the whole requires comprehensive elaborations. Before considering this in detail, the final calculation step, wherein the factor is used, is presented to complete the procedure at a glance. In the third and final step of the calculation of the indicator, the product-classified economic indicators will be multiplied with a factor β. Finally, as a result the commodity-based economic indicator representing the economic activities of a national economy is calculated.

$$EI_k = \sum_i (\widehat{EI}_i * \beta_{i,k})$$

k: index for commodities

EI: commodity-classified economic indicator (€)

2.2 Challenging transformation of products to commodities

As previously elaborated, the generation of the economic indicator, which is the independent variable in later analysis, consists of three steps. The procedure was shown in the first part of this chapter at a glance; however, now a closer look on the third step, a more precise calculation of the factor β, is necessary.

First, the necessity and importance of the transformation from a product-based economic indicator to a commodity-based one is explained. Afterwards, the construction of the bridge matrix and the calculation of the individual β-factors is elaborated. Then, some criticism is mentioned and, as a result, a sensitivity test of the bridge matrix is done to attest its stability towards variations of the β-factors.

2.2.1 Necessity of the transformation

In the regression analysis, the commodity-specific transport variable will be confronted with an equivalent variable representing the economic activity. These so-called economic indicators must also be commodity-indexed to ensure an identical basis for the analysis. As shown before, the indicator's construction is based either on supply or on use tables, thus consequently two indicators for supply and use each are built.

At the end of the second calculation step the economic indicator exists per product. Thus, the substantial function of the third and concluding step is to transfer CPA-classified products into NST/R-classified commodities. Such a transformation is necessary, because both variables are categorized in different classifications, which are not directly convertible in to each other in the used versions. The product-based indicator is a monetary value expressing the contribution of a product to total gross value added. In the CPA-classification 31 products are differentiated. On the other hand, commodities are measured in tonnes and the NST distinguishes 24 kinds of good. The transformations from products to commodities are expressed with a factor β, which become multiplied with the CPA-based economic indicator to receive the NST/R-based one. The final indicator is still a monetary value, because the factor β has no unit. The transformation comes about in two-parts: first, it must be determined which products are associated to which kinds of good. These product-commodity-combinations represent a qualitative allocation. Second, the several combinations have to be weighed against each other to obtain concrete values representing the relative shares. This is the quantitative part of the allocation. The summarised overview of all β-factors is called bridge matrix. The concrete combinations and the generation of the values are displayed in the next section.

2.2.2 Methodology and criticism of the present construction of the bridge matrix

The construction of the bridge matrix (BM) will now be explained in detail. Concepts about transferring products into commodities are scarce in the scientific debate, thus the methodology used by Müller, Klauenberg and Wolfermann takes up an approach of the Austrian Institute of Economic Research (WIFO) (7, 46). On this account, the bridge matrix-construction is shown for the case example of Austria. However, the work from Müller et al shows that the procedure works well in the case of Germany, too. The section closes with a criticism of the methodology and the simple adaption of it to other countries.

2.2.2.1 Qualitative allocation – the basic structure of the bridge matrix

In the CPA classification, the products are distinguished into 59 divisions. Several of them are services, which are negligible, because they do not contribute to freight transportation measurable in tonnes. The divisions 01 to 37 contain physical goods (see Annex Section 1). With the help of the bridge matrix these 31 products[2] can be referred to 24 commodities (see Annex Section 1).

The construction of the bridge matrix starts with building its basic structure. It is obvious that each product flows into a certain selection of commodities. These single product-commodity-allocations build together the structure of the bridge matrix.

This pattern of apportionment is a fundamental assumption, which is adopted from the Austrian Institute of Economic Research. The relevant product-commodity-allocations are labelled in Table 2. This allocation pattern is identical for all countries and hence constitutes the general part of the method.

As mentioned above, the versions CPA 2008 and NST 2007 can be linked directly, because of a coordinated categorization which allows the direct allocation of products to commodities. The classification systems are harmonized through all levels of classification and for transferring products to commodities, or the other way around. Correspondence tables offered by Eurostat are available (37). The Austrian auxiliary-allocation used here approximates the proper allocation based on the newer classifications CPA 2008 and NST 2007. Nonetheless, using the same pattern is acceptable, because the qualitative apportionments of products to commodities is independent of economic structures and is therefore uniform. The following examples reveal that this procedure is appropriate. In the apportionment in Table 2 (page 12), three types of allocations can be identified; however, in the majority of cases, several products are allocated to several commodities, which is equivalent to a combination of the differentiated types mentioned above.

(1) One product is allocated to exactly one commodity

e. g. CPA-14	Other mining and quarrying products to
NST/R-15	Crude and manufactured minerals

(2) One product is allocated to several commodities

e. g. CPA-11	Crude petroleum and natural gas; services incidental to oil and gas extraction, excluding surveying to
NST/R-9	Crude petroleum and
NST/R-10	Petroleum products

[2] The classification skips the numbers 3, 4, 6, 7, 8 and 9

(3) Several products are allocated to one commodity

e. g. CPA-2	Products of forestry, logging and related services and
CPA-20	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials to
NST/R-4	Wood and cork

An exceptional position holds the commodity NST/R-24 "Miscellaneous articles". It primarily consists of transport containers wherein the exact contents are unknown. They could contain many different kinds of product, from agricultural products to machine components. The consistent increase in container transports over the last few years makes the imprecise knowledge about this commodity even more difficult to ascertain. Due to the uncertainty in the Austrian approach a majority of 24 out of 31 products are allocated to NST/R-24. (7)

2.2.2.2 Quantitative allocation – the concrete values of the bridge matrix

While the general apportionment builds the qualitative framework of a bridge matrix, the quantitative β-factors individualises the bridge matrices. The coefficients β are the essential values of a bridge matrix, because they explain the apportionment of the products to the commodities.

First, tying up to the previous paragraph the determination of the concrete values for the β-factors starts with the factors of commodity NST/R-24, which holds an exceptional position. For these 24 factors (β_i,24) mapping the allocation of products to NST/R-24 "Miscellaneous articles" the values are determined by estimated shares. For example 10% of CPA-1 "Products of agriculture, hunting and related services" are assigned to NST/R-24 and for technical products higher shares up to two thirds are assumed (e. g. 67% for CPA-30, CPA-32 and CPA-33 each). In the Austrian publication, it is not documented how these values were chosen. It is likely that the factors are estimated, because the values are rounded percentages.

Based on the β_i,24-factors, the remaining values for the other product-commodity-pairs are determined. For this procedure a description in the Austrian approach is missing too. However, the research of Müller et al reveals that the allocation of the remaining share is made with help of transportation data. These data are available from Eurostat (15, 16) and are accessible on a national level, which, in consequence, offers individual bridge matrices for each country. The transportation data include two expressions: firstly, the amount of transported freight given in tonnes (also called tonnage), and secondly, the ton kilometres as expression of the transport performance. Thus, in the analyses two regressions per commodity and per country are made: one based on tonnes and another one based on ton kilometres. Both kinds of bridge matrices are built with data from 2007, which are the most current ones within the considered time span. To avoid confusion in the further explanation, only the tonnage is named, but all the declarations are valid for the construction of the bridge matrix based on ton kilometres analogously.

To become more concrete, the calculation is explained exemplary for Germany in case of product CPA-1 given in tonnes. As Table 2 depicts, CPA 1 is allocated to altogether five commodities, NST/R-1, -2, -3, -7 and -24. The freight volumes of the commodities in 2007 are in Table 3, whereby the relevant ones for CPA-1 are marked bold. Due to data availability and comparability reasons, solely data of road haulage and inland waterway freight transportation are considered. Further explanations about the data selection are given in chapter 3.

Table 2: "Allocation-table" – Pattern of the apportionment of the BM (own representation depending on (7))

NST/R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
CPA 2002																								
1	$\beta_{1,1}$	$\beta_{1,2}$	$\beta_{1,3}$				$\beta_{1,7}$																	$\beta_{1,24}$
2				$\beta_{2,4}$																				
5			$\beta_{3,5}$				$\beta_{5,7}$																	$\beta_{5,24}$
10								$\beta_{10,8}$																
11									$\beta_{11,9}$	$\beta_{11,10}$														
12																								$\beta_{12,24}$
13											$\beta_{13,11}$	$\beta_{13,12}$												
14															$\beta_{14,15}$									
15						$\beta_{15,6}$																		$\beta_{15,24}$
16						$\beta_{16,6}$																		$\beta_{16,24}$
17					$\beta_{17,5}$																			$\beta_{17,24}$
18					$\beta_{18,5}$																			$\beta_{18,24}$
19					$\beta_{19,5}$																			$\beta_{19,24}$
20				$\beta_{20,4}$																				
21																			$\beta_{21,19}$					$\beta_{21,24}$
22																								$\beta_{22,24}$
23									$\beta_{23,9}$	$\beta_{23,10}$														
24																$\beta_{24,16}$	$\beta_{24,17}$	$\beta_{24,18}$						$\beta_{24,24}$
25																$\beta_{25,16}$	$\beta_{25,17}$	$\beta_{25,18}$						$\beta_{25,24}$
26														$\beta_{26,14}$								$\beta_{26,22}$		$\beta_{26,24}$
27											$\beta_{27,11}$	$\beta_{27,12}$	$\beta_{27,13}$								$\beta_{27,21}$			$\beta_{27,24}$
28													$\beta_{28,13}$								$\beta_{28,21}$			$\beta_{28,24}$
29																				$\beta_{29,20}$				$\beta_{29,24}$
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35																				$\beta_{35,20}$				$\beta_{35,24}$
36					$\beta_{36,5}$																			$\beta_{36,24}$
37					$\beta_{37,5}$																			$\beta_{37,24}$

Legend: CPA 2002: index i NST/R: index k $\beta_{i,k}$

Table 3: Tonnage of road haulage and inland waterway for Germany in 2007 (15, 16)

NST/R k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Tonnage t_k [1,000 t]	**36,437**	**35,953**	**22,402**	89,018	20,267	388,643	**25,476**	52,575	413	156,229	67,330	9,842	121,231	185,863	1,244,39	31,340	3,285	233,672	35,542	141,659	54,810	20,794	176,822	**306,683**

The β-factor allocating CPA-1 to NST/R-24 is determined with a quantity of 10% (β_1,24 = 0,10). To conclude the remaining β_1,k-factors from the tonnage, first the tonnage of the commodities 1, 2, 3 and 7 are summed (see Table 4). Then, the tonnage of every single commodity is related to this sum. Taking NST/R-1 as an example, the tonnage of NST/R-1 in the amount of 36,437,000 t is divided by the aggregated value in the amount of 120,269,000 t. Therefore it must be considered that the sum is equivalent to 90%, because 10% are already dedicated to NST/R-24 and the sum of all β-factors per product is 1. Finally, in the exemplary case the result for the factor β_1,1 is 0.2727.

Table 4: Calculated β-factors for CPA-1 "Products of agriculture, hunting, and related services" (DE, 2007)

NST/R k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	$\sum_{k=1}^{24} \hat{\beta}_{i,k}$
Tonnage t_k [1,000 t]	**36,437**	**35,953**	**22,402**	89,018	20,267	388,643	**25,476**	52,575	413	156,229	67,330	9,842	121,231	185,863	1,244,39	31,340	3,285	233,672	35,542	141,659	54,810	20,794	176,822	**306,683**	**120,269**
$\beta_{1,k}$	**0.2727**	**0.2690**	**0.1676**				**0.1906**																	**0.1000**	**0.9000**

The complete bridge matrix based on freight transported by road haulage and inland waterway for Germany with data from 2007 is given in Table 5. The right column shows all product-commodity-pairs regarding NST/R-24 and the determined β-factors according to the Austrian approach. In the other two columns the calculated β-factors are given. The bridge matrix based on ton kilometres as well as all the bridge matrices for the other considered countries are available in the annex.

Table 5: BM from products (CPA) to commodities (NST/R) based on freight volume for Germany 2007

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2727	13	28	0.6198	24	01	0.1000
2	01	0.2690	14	26	0.8544	24	05	0.2000
3	01	0.1676	15	14	1.000	24	12	1.000
3	05	0.3743	16	24	0.1110	24	15	0.1000
4	02	1.000	16	25	0.0771	24	16	0.8000
4	20	1.000	17	24	0.0116	24	17	0.3000
5	17	0.0720	17	25	0.0081	24	18	0.3000
5	18	0.0720	18	24	0.8274	24	19	0.3000
5	19	0.0720	18	25	0.5748	24	21	0.2000
5	36	0.0679	19	21	0.8000	24	22	1.000
5	37	0.0771	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1906	20	32	0.3300	24	27	0.0500
7	05	0.4257	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0026	20	35	0.9000	24	30	0.6700
9	23	0.0026	21	27	0.2056	24	31	0.3000
10	11	0.9974	21	28	0.2802	24	32	0.6700
10	23	0.9974	22	26	0.0956	24	33	0.6700
11	13	0.8725	23	17	0.6280	24	34	0.1000
11	27	0.2526	23	18	0.6280	24	35	0.1000
12	13	0.1275	23	19	0.6280	24	36	0.3400
12	27	0.0369	23	36	0.5921	24	37	0.2500
13	27	0.4548	23	37	0.6729			

2.2.2.3 Criticism of the present approach

In the previous elaboration, it was shown that the development of the bridge matrix is based on an approach of the Austrian Institute of Economic Research. Although the procedure in general is logical, it is not documented completely. Thus, the methodology is not comprehensible in all its particulars and the concrete quantitative values are not explained at all. In their publication, the Austrian authors say themselves that the construction of the bridge matrix is "to a quite large extent 'ad hoc'" (7). The β-factors of NST/R-24 are the starting point of the quantification, but their determination is not justified. Müller et al adopted the Austrian approach and added a proposal to calculate the remaining β-factors, but left the principle concept unchanged. By doing so, they received highly promising results for the case of Germany. Due to the findings, the primary purpose of this thesis is to apply the methodology to further European countries. The question to be answered is: How suitable is the methodology for an international application? Even though the usage of the Austrian transformation for Germany leads to remarkable results, this must not be inevitably the case in the transformation to other European countries.

An extensive research do not reveal alternative approaches to link products and commodities and do not bring indications for a completely self-developed proposal. To define the β-factors manually requires a lot of expertise and thus, the determination of a completely new type of bridge matrix is no alternative within the scope of the thesis. It is possible that a comprehensive evaluation and questioning of experts would give information about the relationship between products and commodities.

As a consequence, this the presented methodology is maintained – on one condition. The bridge matrix resulting from the applied procedure must take and pass a sensitivity test to prove its stability. This test is explained in detail in the following subchapter.

In the previous research in the case of Germany the β-factors are calculated with an accuracy of two decimal digits. Thus, some β-factors are supposed nil (0.00), which consequently in the multiplication with the product-based economic indicator leads to the result nil for the transformed commodity-based indicator as well. However, due to the method of calculation, the factors never accept the value nil. For this reason, the β-factors calculated in this thesis are given with four decimal digits to take account of the present inaccuracy.

The execution of regression analyses for the purpose of identifying interdependencies, as well as time series analyses for projections, needs an important condition: the stationarity of the used data series. Until now this basic condition was not examined in the previous research of Müller et al. On the one hand, stationarity is a crucial condition for the correlation analyses with time series data to exclude spurious correlation between two variables. In other words, if the associated data series are not stationary, an ascertained correlation is very likely effected through external, non-considered parameters. On the other hand, stationarity is also a criteria to permit time series analyses with the aim to predict future values and developments. Therefore, the data series that should be extended, for instance the freight volume, must be stationary as well. The stationarity of the data used in further analyses is specifically tested for the case of Germany in chapter 4.

Another assumption for regression analysis is that the individual observed data points $(x_t|y_t)$ are independent of each other. The freight volume or the ton kilometres as well as the economic variables, which underlie the indicator, are obviously such time-dependent data series. However, the regression analysis takes individual observed data points for one country within a time interval into account. Thus, it is very likely that the assumption is infringed, because of the temporal dependency. The data at the present moment x_t is influenced by the value on an earlier point in time x_{t-1}. Independency of the time can be achieved if data points at one defined point in time for several countries are used for an analysis. For this reason, a cross-sectional analysis for a selected part of the data set will be done in chapter 4. Before both analyses can be performed, a consistent data set must be prepared (see chapter 3).

2.2.3 Sensitivity test of the Bridge matrix

The derivation of the bridge matrix is unsteady at some points and adds an element of uncertainty to the methodology in the aggregate. For this reason its stability will be proved with a sensitivity test, wherein the several β-factors will be varied so that modified bridge matrices result. With these modified matrices, the calculation of the economic indicator and afterwards regression analysis are done. Finally, the new findings make it possible to compare the original approach and statements to the impact of different bridge matrices on the final results. The findings reveal how strong the leverage effect of the β-factors are on the results, including the coefficients of determination and their significances.

The concrete testing is composed of two approaches, which are confronted with the previously presented approach based on the Austrian research. In sensitivity-test 1, the β-factors of the original bridge matrix are modified slightly, while in the second test, the generation of the β-factors is done in a completely different manner.

It is a fundamental condition that for the sensitivity test the same transportation data are taken as for the original approach. If the freight volume is unchanged, differing results of the regression analysis follow from changed values of the economic indicators. The following formula shall be brought back into memory:

$$EI_k = \sum_i (\widehat{EI}_i * \beta_{i,k})$$

The commodity-based economic indicator is the sum of all products of the product-based indicator and the according β-factor. Due to the fact that the stability of the β-factors should be tested, the product-based economic indicators remain unaffected. The focus of the sensitivity test is on the determined β-factors of the commodity NST/R-24 for two reasons: firstly, their determination in the Austrian approach is unclear, and secondly, these factors are the benchmark for the calculation of all other β-factors. Changing the β-factors of the commodity NST/R-24 inevitably affects the remaining β-factors.

Both sensitivity-tests are explained in the following exemplary for the case studies Germany and Austria with data from 2007. It is to be noted that the bridge matrices are constructed with the freight volume, whereas bridge matrices based on ton kilometres are not considered.

Original approach:
"Austrian bridge matrix"

Sensitivity-test 1:
"Modified Austrian bridge matrix"

Sensitivity-test 2:
"Radically changed bridge matrix"

2.2.3.1 Sensitivity-test approach 1: "Modified Austrian bridge matrix"

An obvious testing of the stability is to take the original approach and to modify it slightly. This is done first, before the values of the bridge matrix will be varied more radically. The modification of the bridge matrix starts with the selection of the five products, whose economic indicators are the highest (respectively the lowest[3]). Thereby it must be considered that only those products are taken into account, which are pursuant to Table 2 allocated to commodity NST/R-24. The selection of the product-based economic indicators for Germany and Austria is shown in Table 6. The five highest indicators resulting from supply and use tables are each marked.

[3] The sensitivity-test taking the products with the lowest indictors into account works analogously. The corresponding tables are depicted in the annex Section 3.

Table 6: Product-based economic indicators for Germany and Austria in 2007 (five highest are marked)

Product *i* CPA 2002	**Commodities *k*, to those a product is allocated**	**EI Germany**		**EI Austria**	
		EI_i_supply [€]	**EI_i_use [€]**	**EI_i_supply [€]**	**EI_i_use [€]**
1		14,850.00	42,456.66	2,848.00	5,000.29
2		2,310.00	7,386.30	1,259.36	2,040.30
5		250.00	40,508.33	10.00	7,235.03
10		4,968.13	37,485.49	1,051.00	3,096.84
11		2,098.40	20,533.25	1,006.16	2,380.98
12		0.00	0.00	0.00	0.00
13		0.00	23,131.60	0.00	0.00
14		7,830.85	39,125.84	2,129.34	9,076.68
15	6; 24	35,210.15	50,609.94	**5,285.09**	**7,889.85**
16		1,340.00	4,305.81	119.00	119.00
17		6,656.37	27,823.46	969.64	4,759.81
18		2,874.11	22,758.63	1,053.60	7,684.31
19		1,620.49	17,047.13	774.17	3,733.51
20		7,756.57	42,441.58	2,622.60	7,640.27
21		10,642.77	37,220.39	1,800.24	4,161.25
22	24	21,709.40	**78,504.69**	3,054.34	**9,694.78**
23		4,780.30	46,527.54	680.05	7,318.23
24	**16; 17; 18; 24**	**50,205.17**	51,329.21	**3,929.06**	5,824.19
25	16; 17; 18; 24	26,023.16	**60,692.74**	2,020.25	7,263.78
26	14; 22; 24	16,288.16	57,490.01	3,018.14	**12,206.64**
27	11; 12; 13; 21; 24	22,943.75	45,199.44	**3,698.21**	5,107.09
28	**13; 21; 24**	**47,040.24**	58,549.23	**4,956.55**	7,426.63
29	**20; 24**	**77,972.45**	**68,258.23**	**6,946.40**	7,247.05
30	20; 24	20,640.52	48,334.43	1,316.03	**8,099.31**
31	**20; 24**	**35,327.25**	57,381.64	3,465.05	6,475.98
32		19,060.45	36,222.94	1,838.80	3,720.45
33	20; 24	26,098.27	**81,787.82**	2,289.34	**8,549.59**
34	**20; 24**	**78,730.90**	**75,927.29**	3,306.55	3,578.66
35		13,803.11	34,739.87	1,488.31	4,337.33
36		14,610.84	46,553.26	2,753.15	5,240.43
37		5,446.56	15,669.95	513.73	3,623.84

Taking the supply-based economic indicators for Germany as an example (marked bold in Table 6), the following five products have the highest values: CPA-24, -28, -29, -31 and -34. According to the allocation table (Table 2), these five products are associated to seven commodities altogether: NST/R-13, -16, -17, -18, -20, -21 and -24. The modification of the β-factors concerns all the 13 product-commodity-pairs and is implemented by raising up the value of the factors for commodity NST/R-24 by 20%. The β-factors allocated to other commodities than NST/R-24 shrink accordingly, so that the sum of all factors for a product remains one. Table 7 and Table 8 show the modified β-factors as well as the original ones in comparison. The tables with the β-factors resulting for the use-based economic indicators are depicted in the annex section 3.

Table 7: Original and modified β-factors in the case of Germany (supply-based EI)

$\beta_{i,k}$	Original values	Modified values
β_22,24	1.0000	1.0000
β_24,16	0.1110	0.1098
β_24,17	0.0116	0.0115
β_24,18	0.8274	0.8187
β_24,24	0.0500	0.0600
β_25,16	0.0771	0.0692
β_25,17	0.0081	0.0072
β_25,18	0.5748	0.5156
β_25,24	0.3400	0.4080
β_28,13	0.6198	0.6060
β_28,21	0.2802	0.2740
β_28,24	0.1000	0.1200
β_29,20	0.8000	0.7600
β_29,24	0.2000	0.2400
β_31,20	0.7000	0.6400
β_31,24	0.3000	0.3600
β_33,20	0.3300	0.1960
β_33,24	0.6700	0.8040
β_34,20	0.9000	0.8800
β_34,24	0.1000	0.1200

Table 8: Original and modified β-factors in the case of Austria (supply-based EI)

$\beta_{i,k}$	Original values	Modified values
β_15,6	0.9000	0.8800
β_15,24	0.1000	0.1200
β_22,24	1.0000	1.0000
β_24,16	0.2784	0.2755
β_24,17	0.1878	0.1859
β_24,18	0.4837	0.4786
β_24,24	0.0500	0.0600
β_26,14	0.9128	0.9032
β_26,22	0.0372	0.0368
β_26,24	0.0500	0.0600
β_27,11	0.2915	0.2884
β_27,12	0.0148	0.0146
β_27,13	0.5499	0.5441
β_27,21	0.0939	0.0929
β_27,24	0.0500	0.0600
β_28,13	0.7688	0.7517
β_28,21	0.1312	0.1283
β_28,24	0.1000	0.1200
β_29,20	0.8000	0.7600
β_29,24	0.2000	0.2400
β_30,20	0.3300	0.1960
β_30,24	0.6700	0.8040
β_33,20	0.3300	0.1960
β_33,24	0.6700	0.8040

Now, with the new β-factors the economic indicators can be transferred from those based on products to those based on commodities. Thus, the commodity-based indicators as variable for a regression analysis are computed. The resulting coefficients of determination and significances are depicted in Table 9 and Table 10. For the purpose of comparison they are contrasted with the results of the original approach.

The data for Germany as well as Austria show that the usage of modified β-factors do not lead to remarkably different results. The values of the coefficients of determination and their significance are nearly identical and deviations concern only the second decimal digit. For both approaches – the "Austrian bridge matrix" and the modified version – the same kinds of goods achieve significant results (marked bold). Performing the analogous variation process for those five products, whose product-based economic indicator are the lowest, leads to the same findings. The pertaining tables are presented in the annex Section 3.

Altogether, the results of the first sensitivity-test lead to the conclusion that the modification of the β-factors does not have a remarkable impact on the results of the regression analysis.

Table 9: Comparative results of the regression analysis (coefficient of determination and significance) with original and modified β-factors in the case of Germany

Supply-based regression analysis…	**… with original β-factors ("Austrian BM")**		**… with modified β-factors ("Modified Austrian BM")**	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
13	**0.71**	**0.0045**	**0.71**	**0.0045**
16	0.23	0.1867	0.23	0.1863
17	0.25	0.1749	0.25	0.1747
18	0.09	0.4454	0.09	0.4448
20	**0.97**	**0.0000**	**0.97**	**0.0000**
21	**0.78**	**0.0017**	**0.77**	**0.0017**
24	**0.94**	**0.0000**	**0.94**	**0.0000**
Use-based regression analysis…	**… with original β-factors ("Austrian BM")**		**… with modified β-factors ("Modified Austrian BM")**	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
16	**0.38**	**0.0751**	**0.37**	**0.0809**
17	0.31	0.1169	0.31	0.1164
18	0.23	0.1925	0.22	0.2046
20	**0.89**	**0.0001**	**0.89**	**0.0001**
24	**0.79**	**0.0015**	**0.78**	**0.0016**

Table 10: Comparative results of the regression analysis (coefficient of determination and significance) with original and modified β-factors in the case of Austria

Supply-based regression analysis…	**… with original β-factors ("Austrian BM")**		**… with modified β-factors ("Modified Austrian BM")**	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
6	**0.80**	**0.0011**	**0.80**	**0.0011**
11	**0.42**	**0.0608**	**0.42**	**0.0608**
12	0.00	0.8707	0.00	0.8707
13	**0.47**	**0.0407**	**0.47**	**0.0407**
16	0.19	0.2374	0.19	0.2375
17	0.02	0.6938	0.02	0.6932
18	0.10	0.3974	0.10	0.3980
20	**0.83**	**0.0006**	**0.83**	**0.0006**
21	**0.82**	**0.0007**	**0.82**	**0.0007**
24	**0.63**	**0.0103**	**0.64**	**0.0094**
Use-based regression analysis…	**… with original β-factors ("Austrian BM")**		**… with modified β-factors ("Modified Austrian BM")**	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
6	**0.86**	**0.0003**	**0.86**	**0.0003**
14	**0.52**	**0.0273**	**0.52**	**0.0273**
20	**0.74**	**0.0030**	**0.71**	**0.0044**
22	0.24	0.1847	0.24	0.1847
24	**0.73**	**0.0033**	**0.73**	**0.0032**

2.2.3.2 Sensitivity-test approach 2: “Radically changed bridge matrix”

The first sensitivity-test revealed that a slight modification of the original bridge matrix do not affect the results of the regression analysis. It is for this reason that the β-factors now should not just be modified, but be calculated in a new way. The crucial difference to the original approach is that the before determined β-factors for commodity NST/R-24 now will be computed. Analogous to the original approach, the freight volume of the commodities is the same as shown in Table 3. Again, the sum of the commodities linked to a product is derived; however, this time the amount of NST/R-24 is included in the sum. The aggregate of the freight volumes of the commodities NST/R-1, -2, -3, -7 and -24 is 426,952,000 t. Table 11 shows the results of setting the tonnage of every single commodity in relation to this sum. The results are equivalent to the searched β-factors for product 1.

Table 11: Calculated β-factors for CPA-1 “Products of agriculture, hunting and related services” (DE, 2007)

NST/R k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	$\sum_{k=1}^{24} \hat{\beta}_{i,k}$
Tonnage t_k [1,000 t]	**36,437**	**35,953**	**22,402**	89,018	20,267	388,643	**25,476**	52,575	413	156,229	67,330	9,842	121,231	185,863	1,244,39	31,340	3,285	233,672	35,542	141,659	54,810	20,794	176,822	**306,683**	**120,269**
$\beta_{1,k}$	**0.0853**	**0.0842**	**0.0525**				**0.0597**																	**0.7183**	**1.0000**

Due to the very high amount of NST/R-24 compared to the other commodities, the values for the corresponding β-factors is much higher than in the original bridge matrix. Consequently, the relative allocation the β-factors for the remaining commodities are much smaller. The complete bridge matrix based on freight transported by road haulage and inland waterway for Germany with data from 2007 is given in Table 12. In comparison with the original bridge matrix in Table 5, the β-factors highly changed. As the right column of the table presents, the lowest factor pertained to NST/R-24 “Miscellaneous articles” is about 44% and most of the values exceed 50%. The share of products allocated to this kind of good is far too much, the values are overdetermined. It is not the case that half of the amount of almost all products is allocated to this commodity, which consist mainly of container transports.

Again, the new β-factors are used to transfer the product-based economic indicator to those based on commodities and the regression analysis are done. The resulting coefficients of determination and significances for the case of Germany are depicted in Table 13 and Table 14. For the purpose of comparison they are contrasted with the results of the original approach. The outcomes for the case of Austria are presented in the annex Section 3.

The description of the results and the differences compared to the original Austrian approach focusses on the commodities, whose results are significant at a level of 10%. To put it shortly, only few and little differences occur compared to the both approaches elaborated before, although the β-factors for commodity NST/R-24 are markedly higher and the other β-factors are lower. All kinds of good, which reveal significant results in the original approach (marked bold), also show significant results in the regression analysis with the newly calculated bridge matrix. The only exception is NST/R-6 in the case of use-based regression. In 15 out of 24 cases the significant coefficients of determination are identical for both approaches. In five cases the original approach leads to the higher coefficients of determination and in the remaining four cases the radically changed bridge matrix reveals the higher results.

With regard to the findings for Austria, it was found as well that the results of the new-calculated bridge matrix do not remarkably differ from those of the original approach (see annex Section 3). Here, in the case of NST/R-6 no deviation is observed.

Table 12: Bridge matrix from CPA to NST/R for Germany 2007 approach 3

Commodity *k* NST/R	**Product *i* CPA 2002**	**Factor $\beta_{i,k}$**	***k***	***i***	**$\beta_{i,k}$**	***k***	***i***	**$\beta_{i,k}$**
1	01	0.0853	13	28	0.2511	24	01	0.7183
2	01	0.0842	14	26	0.3621	24	05	0.8650
3	01	0.0525	15	14	1.0000	24	12	1.0000
3	05	0.0632	16	24	0.0545	24	15	0.4411
4	02	1.0000	16	25	0.0545	24	16	0.4411
4	20	1.0000	17	24	0.0057	24	17	0.6088
5	17	0.0402	17	25	0.0057	24	18	0.6088
5	18	0.0402	18	24	0.4064	24	19	0.6088
5	19	0.0402	18	25	0.4064	24	21	0.8961
5	36	0.0402	19	21	0.1039	24	22	1.0000
5	37	0.0402	20	29	0.3160	24	24	0.5334
6	15	0.5589	20	30	0.3160	24	25	0.5334
6	16	0.5589	20	31	0.3160	24	26	0.5974
7	01	0.0597	20	32	0.3160	24	27	0.5478
7	05	0.0719	20	33	0.3160	24	28	0.6353
8	10	1.0000	20	34	0.3160	24	29	0.6840
9	11	0.0026	20	35	0.3160	24	30	0.6840
9	23	0.0026	21	27	0.0979	24	31	0.6840
10	11	0.9974	21	28	0.1135	24	32	0.6840
10	23	0.9974	22	26	0.0405	24	33	0.6840
11	13	0.8725	23	17	0.3510	24	34	0.6840
11	27	0.1203	23	18	0.3510	24	35	0.6840
12	13	0.1275	23	19	0.3510	24	36	0.6088
12	27	0.0176	23	36	0.3510	24	37	0.6088
13	27	0.2165	23	37	0.3510			

Table 13: Comparative results of the supply-based regression analysis (coefficient of determination and significance) with original and new-calculated β-factors in the case of Germany.

Supply-based regression analysis…	**… with original β-factors ("Austrian BM")**		**… with new-calculated β-factors ("Radically changed BM")**	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
1	0.06	0.5319	0.06	0.5319
2	0.09	0.4431	0.09	0.4431
3	0.23	0.1912	0.23	0.1893
4	0.08	0.4545	0.08	0.4545
5	0.15	0.2952	0.14	0.3172
6	0.14	0.3151	0.04	0.6297
7	**0.69**	**0.0056**	**0.69**	**0.0057**
8	0.00	0.8594	0.00	0.8594
9	**0.45**	**0.0477**	**0.45**	**0.0477**
10	0.29	0.1316	0.29	0.1316
11	0.01	0.7581	0.01	0.7608
12	0.02	0.7243	0.02	0.7173
13	**0.71**	**0.0045**	**0.71**	**0.0041**
14	**0.84**	**0.0005**	**0.84**	**0.0005**
15	**0.46**	**0.0459**	**0.46**	**0.0459**
16	0.23	0.1867	0.25	0.1720
17	0.25	0.1749	0.25	0.1659
18	0.09	0.4454	0.09	0.4218
19	0.02	0.7526	0.02	0.7526
20	**0.97**	**0.0000**	**0.96**	**0.0000**
21	**0.78**	**0.0017**	**0.77**	**0.0019**
22	**0.51**	**0.0304**	**0.51**	**0.0304**
23	**0.75**	**0.0024**	**0.73**	**0.0034**
24	**0.94**	**0.0000**	**0.97**	**0.0000**

Table 14: Comparative results of the use-based regression analysis (coefficient of determination and significance) with original and new-calculated β-factors in the case of Germany.

Use-based regression analysis…	… with original β-factors ("Austrian BM")		… with new-calculated β-factors ("Radically changed BM")	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
1	**0.47**	**0.0416**	**0.47**	**0.0416**
2	0.02	0.7090	0.02	0.7090
3	0.34	0.1006	0.32	0.1102
4	0.26	0.1623	0.26	0.1623
5	0.17	0.2734	0.16	0.2933
6	**0.92**	**0.0001**	0.01	0.7657
7	**0.64**	**0.0097**	**0.60**	**0.0138**
8	**0.79**	**0.0014**	**0.79**	**0.0014**
9	0.10	0.4124	0.10	0.4124
10	**0.62**	**0.0122**	**0.62**	**0.0122**
11	0.00	0.8605	0.01	0.8367
12	0.10	0.4031	0.09	0.4354
13	**0.70**	**0.0047**	**0.70**	**0.0047**
14	**0.90**	**0.0001**	**0.90**	**0.0001**
15	**0.98**	**0.0000**	**0.98**	**0.0000**
16	**0.38**	**0.0751**	**0.43**	**0.0568**
17	0.31	0.1169	0.31	0.1195
18	0.23	0.1925	0.27	0.1526
19	0.16	0.2810	0.16	0.2810
20	**0.89**	**0.0001**	**0.91**	**0.0001**
21	**0.83**	**0.0007**	**0.83**	**0.0007**
22	**0.61**	**0.0132**	**0.61**	**0.0132**
23	**0.38**	**0.0788**	**0.38**	**0.0762**
24	**0.79**	**0.0015**	**0.88**	**0.0002**

2.3 Conclusion and selected methodology

In the first part of this chapter, a methodology to develop an economic indicator as a representative variable for the economic activity is explained. However, some uncertainties exist regarding the bridge matrix and the allocation of products to commodities. To prove the stability of the bridge matrix and the leverage effect of the β-factors, a sensitivity-test is done. Two alternative bridge matrices are contrasted with the original one from the Austrian approach. On the one hand, a modified Austrian bridge matrix is built and on the other hand a radically changed bridge matrix is calculated. Afterwards, for both approaches the commodity-based economic indicators are computed and then the regression analyses are done.

With regard to all three approaches, it is apparent that the results do not differ as much as expected due to the partly very different β-factors. Thus, it can be concluded that the impact of the bridge matrix on the results of the regression analysis, more precise on the coefficient of determination and the significance, is low. The comparison of the approaches shows that the β-factor in general is not the decisive input parameter in the whole proceeding. The leverage effect regarding the final results is marginal. Altogether, the bridge matrix can be characterized as invariant. This leads to the conclusion that the preluding presented Austrian approach can be maintained. Although the determination of the β-factors for commodity NST/R-24 is not transparent and comprehensible, the values, however, are more plausible than the β-factors calculated in the second sensitivity-test.

For every country a bridge matrix on the basis of the specific freight volume and another based on ton kilometres is constructed. These individual matrices show little differences for the β-factors, which have no remarkable influence on the results as the sensitivity-tests showed. However, taking the specific national transportation data for the construction of the bridge matrix into account is sensible, as opposed to using one matrix for all countries. The bridge matrices for all countries beyond Germany are displayed in the annex.

3. Preparation of the data for the analysis

Data used in the methodology explained before concern economy and transportation, more precise supply and use tables (SUT) plus gross value added (GVA) as well as the tonnage and ton kilometres of freight transport. The analysis based on these data has to be prepared carefully with regard to their availability, selection and, if necessary, interpolation.

This chapter starts with an overview about data handling in the European Union. Thereby the several classification systems play an important role regarding availability and compatibility of different data needed in the methodology. Out of it some limitations result, and hence a selection of the comprehensive volume of economic and transport data has to be done. In some cases of data gaps, however, interpolation of data is necessary.

3.1 Availability and origin of necessary data

An important advantage of the developed methodology is that it is solely based on publically available statistics. Thus, it does not require expensive or scarce data sources, such as regional input/output tables or commodity flow data. Moreover, this kind of data are normally not collected in a standardized manner, or at the desired level of detail. So, a wide range of researchers dealing with freight modelling and without access to these important data can benefit from this approach.

All data used in this thesis are taken by statistics published by the European Union (EU), more precisely, by their statistical office Eurostat. Originally founded in 1953 for the purposes of the European Coal and Steel Community (ECSC), in its contemporary setting, Eurostat offers much more than industrial data. The broad spectrum covers diverse economic information about services, trade, or finance, as well as social and environmental themes. Eurostat is allocated to the European Commission for Employment, Social Affairs, Skills and Labour Mobility, and operates pursuant to Regulation (EC) No 223/2009 (8). The central mission of Eurostat is to provide high quality statistics on Europe at a standard level that makes comparisons between member states possible. Purchasers of the statistics are adjacent to governments, businesses, journalists, scientists, etc. Because all statistics are offered for free, the public can access the data, which in a large part enables this thesis. Over the decades more and more countries joined the community of states, so the amount of member states increased from six founding members of the former European Economic Community (EEC) to now 28 members of the EU.

3.2 Classifications and their relationship

In this thesis a lot of data from several European countries are used. The European-wide standardized classifications enables uniform evaluation and analyses for every county. Moreover, a transnational comparability of national data would not be possible without a standardised collection and representation of these data. Also, the comparison of data in variation in time requires a comparable base; such comparisons become impossible if changes in the classification system interrupt the time series.

Revisions of classifications, however, are ordinary, as changing circumstances in the economy consequently have an effect to the classification systems, hence why it is necessary to revise them from time to time. As a consequence of such revisions, individual elements as well as the hierarchical structure could be affected. By way of example, new activities arise or existing ones disappear, respectively, and are replaced because of technological developments. The challenge is to find the reasonable point in time for the next update. There is a trade-off between continuity of the time series data and when it is necessary to revise the classification. If the period of time between two versions is too long, the up-to-dateness and the explanatory power diminishes with time. On the other hand, if the interval is too short, data are only comparable for short time series. The conventional practice should be to revise a classification only when absolutely necessary (14, 9)

In the following sections, the classification systems needed in this thesis and their historic development will be described. All three classifications are European-wide, legally binding, and founded on European Union law.

- Statistical classification of **economic activities** in the European Community (NACE)
- Statistical classification of **products** by activity (CPA)
- Standard **goods** classification for transport statistics (NST)

In annex Section 1 the classifications used for the data analysis are offered. Due to lucidity reasons, only the upper levels of the hierarchies are provided.

3.2.1 Statistical classification of economic activities in the European Community (NACE)

The *Statistical classification of economic activities in the European Community (NACE)* is the European standard classification of productive economic activities. The history of the classification of economic activities in Europe began in the early nineteen-sixties; in this decade several statistical nomenclatures are provided for the first time. In the beginning, each of them comprises only parts of the economy, such as commercial activities or agriculture. In 1970, they were combined to form the first comprehensive *NACE*, which covered all sectors of the economy, but this primary version was not comparable to other international classifications of economic activities. Furthermore, a legal liability was missing, so data were still collected according to national statistics and afterwards transformed into the NACE. Because of these reasons, an alignment with the *International Standard Industrial Classification (ISIC)* of the United Nations was made. This alignment led to the first revision called NACE Rev. 1, which was derived from ISIC and established by the European Council in October 1990. Since then, both statistics have the same items at the highest level. In the proceeding levels of classification the NACE is more detailed. (14) Twelve years later, in 2002, a further minor revision (NACE Rev. 1.1) was published. This version respects some new items because of new activities (e. g. call centres) and changes in some titles. A more comprehensive revision was enacted in 2006, resulting in the currently valid version, NACE Rev. 2. The driving reason behind this revision was a necessary adaption to the altered world economy. (14)

Currently, the individual European countries use national versions of the NACE additionally. In Germany, this classification is called "Klassifikation der Wirtschaftszweige" (WZ). The newest version was published in 2008 (WZ 2008) and is built on the European system. It considers specific characteristics of the German economy and the categorisation in proceeding levels of classification is suitably adjusted. (58)

3.2.2 Statistical Classification of Products by Activity in the European Economic Community (CPA)

In October 1993, the European Council elaborated, for the first time, a regulation concerning classifications of products called *Statistical Classification of Products by Activity in the European Economic Community (CPA)*. Products incorporate physical goods as well as services. To ensure comparability on a global level, the structure refers to the *Central Product Classification (CPC)* of the United Nations. In contrast to the CPC, the CPA is legally binding in the European Union. An essential purpose of this classification is the interconnection between products and industries. In this way each CPA classified product is related to one single NACE classified economic activity by using the same hierarchical structure up to the fourth level.

In 1996 and 2002 the CPA was updated. The latter update became necessary because of the implementation of the NACE Rev. 1.1. A more comprehensive revision took place in 2008, respondent to the new NACE Rev. 2. The CPA 2008 experienced a change in structure and an increase in details in every level. (9)

National versions of the CPA exist just as there are national versions of NACE. In Germany the corresponding classification is called *"Güterverzeichnis für Produktionsstatistiken" (GP)* and the actual version was implemented in January 2009. (57)

3.2.3 Standard Goods Classification for Transport Statistics (NST)

Goods transported by the four modes of transport – road haulage, railways, inland waterways, and maritime transport – are collected into the *Standard goods Classification for Transport Statistics (NST)*[4]. This classification originated in the early 1960s. In 1961 the first version was implemented and in 1967 it already required revision. The new formulation NST/R was valid for a period of four decades until 2007. Meanwhile, a related version was established, the so called NST/R-24, which serves to transfer European-wide consistent data to the Statistical Office of the European Communities (Eurostat).

The NST 2007 replaced the former versions and is mandatory for all countries reporting data to Eurostat. The substantial advantage is owing to the closer coherence to other statistical nomenclatures, such as NACE and CPA. While the categorization of the NST/R was related to the physical nature of the goods, the categorization of the actual transport statistic is based on the economic activities from which the goods originate. What results is a complete compatibility to CPA. A few classes were further added because of their relevance in terms of transport activities. (60, 38) In addition to the universally accepted NST, no national version of goods classifications

[4] The abbreviation NST derives from the French title "*Nomenclature Uniforme de Marchandises pour les Statistiques de Transport*"

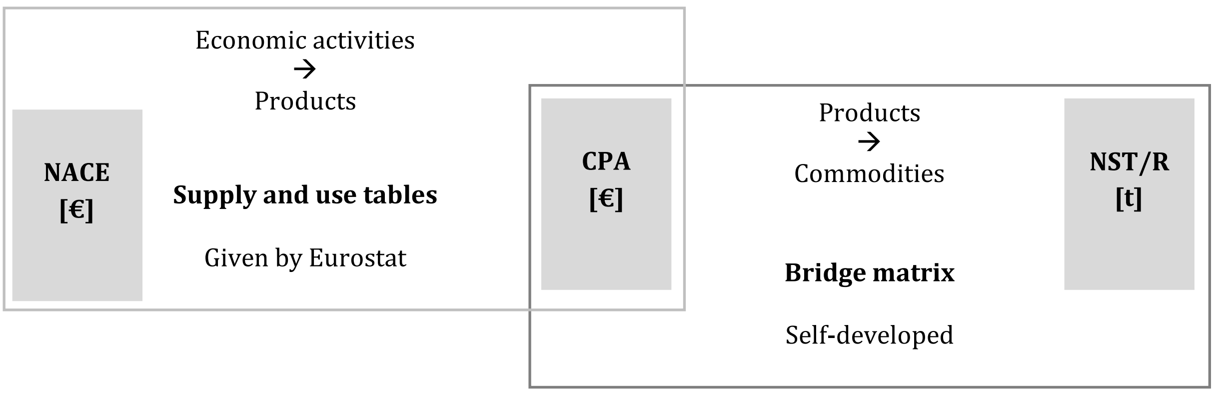
for transport statistics is needed. Thus, in Germany the NST 2007 is at the basis of this statistical nomenclature.

3.2.4 Relationship of the classification

Closing the classification topic, a short overview about the relationships of the classification systems used in this thesis is given, so that the transitions along the methodology are comprehensible. The relation between products and economic branches is derivable from supply and use tables (SUT). These tables show how products and services (CPA-classified) are related to industries (NACE-classified) supplying and using them. SUT are part of the national account systems, which describes all internal (domestic economy) and external (exports and imports) interactions of a national economy and thus portrays the general structure of it at a glance. A supply table gives an impression about the production structure of an economy and reports the value of domestically produced goods and services complemented by imports. Use tables, on the contrary, represent the intermediate consumption of products and services by industries accompanied by exports. (32) For the analysis in this thesis, only domestic supply and usage of products are relevant. The SUT's information about services as well as imports and exports will not be considered. With a view to the table section presenting the domestic production and consumption, it is evident that the supply of a specific product is mostly dominated by a single industry producing or manufacturing it. In contrast to this, the usage of products through economic branches is more widely spread.

The economic sectors for which the gross value added (GVA) is shown are also classified with NACE. As mentioned above, supply and use tables reveal the interrelations between products and economic sectors. Thus, up to the development of the economic indicator based on CPA-classified products, the methodology is built on transferable relations and this fosters preciseness in the calculation. It must be noted, however, that ultimately the economic indicator should be available for each commodity and not for products and as mentioned in chapter 2, this allocation is not possible with the used classifications. For this reason the so-called bridge matrix explained in the previous chapter has to be constructed for the allocation of products to commodities. Finally, commodity-based economic indicators result. The following Figure 2 depicts the relationship of the classification systems and the transitions between them.

Figure 2: Relationship of the classification systems used in the methodology (own representation)



3.2 Limitations in data availability make selections necessary

For regression analysis, comprehensive amounts of data are desirable to receive robust results due to sufficient data points. However, several limitations constrain the usage of the vast volume of data.

Primary limitations are owing to the frequent changes in the classification systems, which have prevented comparisons over long time periods. For instance, the revisions of CPA and NACE are necessary because as the relevance of products and economies develop, production processes change and new products appear.(32) This problem will be less relevant in the future when increasing harmonization of the statistics helps improve compatibility. However, until then, every change towards a revised classification sets a dividing line for time series. The aim of the entire data preparation procedure is to receive a set of data, which is comprehensive as well as consistent, and requires as little interpolation of data gaps as possible.

As mentioned above, since 2008 the transportation data are classified according to NST 2007. The newest data in these statistics are from 2013, hence, a period covering six years results.[5] To obtain more data points for the time series regression, the former classification NST/R will be used. The data collection started in 1999, thus the longest available time span lasts from 1999 to 2007 and comprises data from nine consecutive years. Vassallo et al used exactly the same period of time for their analysis referring to the road haulage demand in the United Kingdom and Spain and assessed it as “sufficiently representative” (1). Furthermore, Vassallo et al point out the advantage of avoiding the impact of the economic recession in Europe in the end of the decade, which could distort the results of the analysis.

Another limitation concerns the selection of countries that can be considered for the analysis. In principle, the availability of data from Eurostat for a certain country depends on the duration of its membership to the European Union. Therefore, the comparability of statistics from two or more countries is generally only given for the time span in which these states both belong to the EU. In conjunction with the limited period of time due to the classification method, this durational consideration issue prompts the decision to choose those EU member states which acceded to the union before 1999. This selection ensures that these states offered the required data within the chosen time span to Eurostat. The last accessions before the beginning of the analysis period occurred in 1995, when Austria, Finland and Sweden expanded the EU to 15 members. The so called EU-15-countries and their abbreviation code used in the thesis are listed in Table 15.

Table 15: Member states of the EU-15

Country	Code	Year of accession	Country	Code	Year of accession
Austria	AT	1995	Italy	IT	1958
Belgium	BE	1958	Luxembourg	LU	1958
Denmark	DK	1973	Portugal	PT	1986
Finland	FI	1995	Spain	ES	1986
France	FR	1958	Sweden	SE	1995
Germany	DE	1958	The Netherlands	NL	1958
Greece	GR	1981	United Kingdom	UK	1973
Ireland	IE	1973			

[5] Last data and statistic check on 07th of July 2015

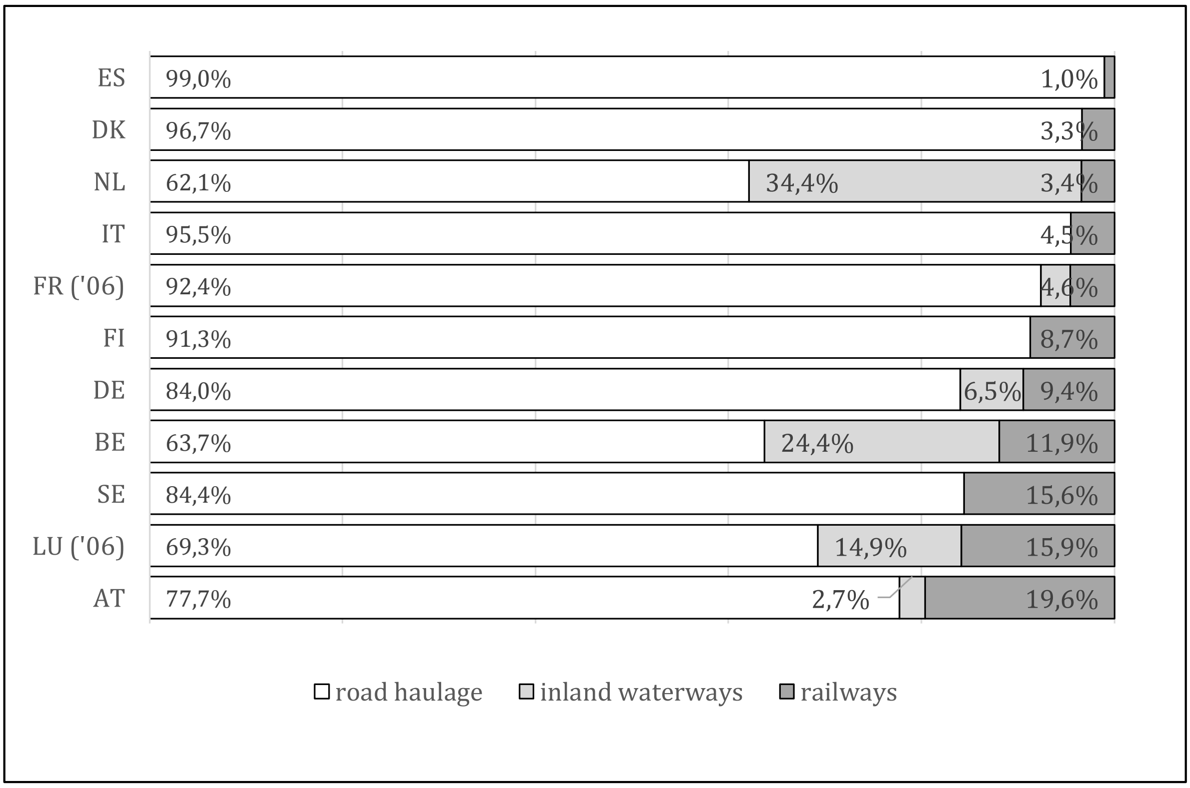
3.2.1 Transportation Data

In this thesis the transport data for each country on a national level is of interest. The share of freight transported via pipelines or by airplanes is negligible due to their very low quantity compared with the three paramount modes: road haulage, railways, and inland waterways. Eurostat offers statistics with diverse designs focussing on particular parameters for each. Due to the fact that the regression analysis is done separately for each commodity, statistics which present the data differentiated by type of good as well are needed (17, 33, 34).

In the case of the railway statistics for all chosen countries, except for Sweden, no data are given for 2002 and foregoing years. For this reason, railway data will not be considered in the linear regression analysis. Although railways holds a considerable share of the modal split in some countries (Figure 3), the purpose of this thesis is to achieve a consistent set of data for the sake of comparability.

With regard to the information about the transport by inland waterways, it must be noted that data are only given if the annual quantity of goods exceeds one million tonnes (36). Thus, only 7 out of the EU-15 countries exhibit transported tonnes and ton kilometres by inland waterway, namely: Belgium, Germany, France, Luxembourg, the Netherlands, Austria, and the United Kingdom. In consequence of the limited availability of railway and inland waterways statistics for several countries, only the road haulage data are used. Compared with other great national economies, such as the United States, China, or Russia, in the EU road haulage is more significant and relevant (50). This fact is emphasized in Figure 3 and is mainly due to the smaller size of the European countries compared to the large countries mentioned above, where railway transport across great distances is more dominant than within the EU.

Figure 3: Modal share of transported tonnes in selected European Countries in 2007



In the case of Greece, neither road haulage nor railway data are stated in the statistics, thus Greece cannot be taken into consideration for the analysis. For all other 14 countries, the data for road haulage and inland waterways – applicable between 1999 and 2007 and distinguished by type of commodity – are given with the exception of a few gaps in some statistics. Two kinds of missing data occur: either single gaps occur in an at large complete statistic, or the total amount of the freight volume in ton kilometres is given for only one year. The latter case mostly concerns data from 2007 and in such cases the total sum given is distributed to the 24 commodities according to the relative shares of the previous year, 2006. This analogous allocation is acceptable, because no remarkable changes of the shares from one year to another are observed in the statistics. This kind of interpolation was necessary in the inland waterways statistics of Belgium, Germany, France, Luxembourg, and the Netherlands, which shares are low in comparison with the road haulage, as well as in the road haulage statistics of Sweden for the year 1999. In the case of Sweden, the distribution is done according to the data of the year 2000. Single gaps often concern commodities, the quantity of which for the other years is very low or even nil, therefore, the missing data are complemented with null as well. The following Table 16 gives an expression of both kinds of interpolation in the case of the inland waterways data set of France.

Table 16: Interpolation of inland waterways data set in the case of France [1,000 t]

	Year	2007	2006	2005	2004	2003	2002	2001	2000	1999
NST/R										
1		9,720	9,137	8,893	8,182	7,929	7,990	7,949	8,786	8,237
2		0	0	0	0	0	0	0	2	55
3		0	0	0	0	1	0	0	1	0
4		20	19	25	35	211	105	312	556	21
5		11	10	10	20	13	19	8	6	3
6		1,662	1,562	1,768	1,694	1,597	1,265	1,391	1,578	1,529
7		2,013	1,892	1,518	1,632	1,456	1,556	1,489	1,827	1,631
8		6,611	6,215	6,110	6,405	5,078	5,914	4,922	5,792	5,313
9		649	610	557	458	156	0	6	4	0
10		9,296	8,739	9,157	8,782	9,201	9,552	10,533	9,982	9,915
11		2,460	2,313	1,891	2,124	2,034	2,053	2,392	1,859	2,122
12		518	487	620	654	559	836	838	639	662
13		3,464	3,256	2,831	2,916	2,700	3,167	3,663	3,975	3,245
14		763	717	679	661	552	590	590	612	560
15		29,042	27,301	25,246	25,047	24,606	27,032	27,191	28,354	26,615
16		1,413	1,328	1,455	1,331	1,150	1,051	1,085	1,131	1,144
17		604	568	698	842	1,008	939	919	818	645
18		1,790	1,683	1,499	1,628	1,081	1,129	1,170	1,244	1,000
19		777	730	779	737	691	633	740	712	713
20		160	150	149	189	209	214	258	189	238
21		27	25	15	19	16	15	34	21	32
22		29	27	34	59	61	147	114	110	105
23		15	14	17	14	20	15	25	134	123
24		4,961	4,664	4,398	3,896	3,341	2,868	2,782	2,338	1,602
total		76,004	71,448	68,347	67,325	63,670	67,092	68,408	70,669	65,508

Legend:	Data completely given		Data interpolated	

3.2.2 Economic Data

The statistics referring the national accounts, supply, and use tables are available for each of the EU-15 countries[6]. However, for Portugal, Ireland, and Greece, some limitations affect either the year 1999 or the year 2007, for which no supply and use tables are given. Qualitative interpolation of the data is not necessary; however, some adoptions to transfer the data into a format which can be processed in the calculation tool are done for all tables. Furthermore, the tables depicting the gross value added exhibit larger gaps and make their usage in the case of four countries infeasible. While, for the United Kingdom and Ireland, no information is available at all, and in the cases of Portugal and Greece, the quantity of missing data is too extensive to remedy it with help of interpolation.

[6] Eurostat31; Eurostat30; Eurostat29; Eurostat28; Eurostat27; Eurostat26; Eurostat25; Eurostat24; Eurostat23; Eurostat22; Eurostat21; Eurostat20; Eurostat19; Eurostat18

3.2.3 Summary of available data for the analysis

Altogether, in spite of limitations, a broad amount of data in the form of a panel data set is available, structurally depicted in Table 17. The two-dimensional data set allows analysis relating to either the temporal dimension or the dimension of countries. Taking the explained and explanatory variables for one single country over a time interval into account enables linear regression analysis of time series (columns in Table 17). Otherwise, if the data for the countries are analysed at one specific point or period in time, so called cross-sectional regression analysis are possible (rows in Table 17).

Table 17 Structure of the available panel data set

Dimension of countries	**AT**	**BE**	**DE**	**DK**	**ES**	**FI**	**FR**	**IT**	**LU**	**NL**	**SE**
Temporal dimension		Linear Regression									
1999	...		...	...	...	...	...	...	...	...	...
2000	...		...	...	...	...	...	...	...	...	...
2001	...		...	...	...	...	...	...	...	...	...
2002	...		...	...	...	...	...	...	...	...	...
2003	...		...	...	...	...	...	...	...	...	...
2004	...		...	...	...	...	...	...	...	...	...
2005	...			Cross-sectional regression							
2006	...		...	...	...	...	...	...	...	...	...
2007	...		...	...	...	...	...	...	...	...	...

Countries in which statistics about the gross value added or transportation are not at all or very fragmentarily available cannot take part in the analysis. As a consequence, Greece, Ireland, the United Kingdom, and Portugal are ruled out and 11 out of 15 European countries remain for the calculation of the economic indicator.

Summarising for the selected countries, the supply and use tables, as well as the gross value added needed to generate the economic indicator, are given completely. With a view to the transportation data, Table 18 depicts on overview of the road haulage and inland waterway data taken into account in the main analysis.

Table 18: Availability of transportation data for the selected countries

	AT	**BE**	**DE**	**FR**	**LU**	**NL**	**DK**	**ES**	**FI**	**IT**	**SE**
Road haulage					17	1	1	5	9		25
Inland waterways	33	28	24	37	62	24					

Legend:	Data completely given		Data interpolated (in x of 216 cases)	Data not available

4. Analysis and representation of the results

The introductory chapters covering the elaborations about the methodology (chapter 2) and the available data volume (chapter 3) are concluded. The foundation has been laid out and now the focal point can be expounded on from here. The emphasis of the thesis is the analysis of the relation between freight volumes or transport performance on the one hand, and the economic indicator on the other hand, differentiated for commodities. This chapter focuses on the calculation and the representation of the results of the correlation analysis, which strength is expressed through the coefficient of determination. The analyses are done for altogether eleven countries and 24 kinds of goods each; however, the detailed descriptions represent the case example – Germany – while the outcomes of the other analysed countries are given in the annex.

The chapter starts with an explanation of the technical implementation of the methodology, then the results of the linear regression analysis for Germany are elaborated in detail. For the case examples of Germany a further analysis case is performed, wherein the railway transportation data are additionally taken into account. Subsequently, further analysis to test the stationarity of the used data series in the case of Germany and a cross-sectional regression analysis are presented. After this, the results of the regression analysis for all considered countries are summarised. In the last subchapter, some explanations about cross-sectional regression analysis are carried out. It has to be taken into account that the content related interpretation of the results, as well as the transnational comparisons, are the main focus in the following chapter.

4.1 Technical implementation of the methodology

Up until this point, the calculation of the economic indicator, which is the independent variable in the regression analysis, is only described theoretically. The technical implementation of the methodology occurs by using the object-relational database management system PostgreSQL. To operate the database the open source software pgAdmin is used. Most of the source code for the method was already developed by Müller and Wolfermann; however, adaptions for the utilization beyond the national application were necessary.

During the whole calculation procedure one has to take care to use the correct data formats and the right data for each country, as well as what concerns the bridge matrices and the GVA-tables and supply and use tables. Therefore, for each computation, the source code has to be adjusted precisely whereby the individual codes representing the analysed countries help to distinguish the data files and tables.

If one has calculated the economic indicators, they must be brought together with the transportation data to realize the regression analysis. At this point it should be reiterated that the calculations of the indicators – the independent variable – originate from the supply and use tables and are either based on the bridge matrices computed with the tonnage or on the ton kilometres. Accordingly, the dependent variable of the regression analysis is either the tonnage or the ton kilometres. The regression analysis, which finally is expressed in the coefficients of determination "R^2" and the calculation of their significance, is done with Microsoft Excel. The usage of a widely accessible software can pave the way for subsequent research as well as the free accessible data mentioned in the chapter before.

4.2 Results of the linear regression analysis for Germany

In this section, the correlation procedure in the case of Germany based on supply and use tables is represented in detail. Thereby the correlation of the transported tonnes and respectively the economic indicators are considered as an example. In the end, all outcomes are summarised in a so-called “result fact sheet,” which represents the results per country at a glance. The technical procedure with regard to the ton kilometres is analogously, but in the case of Germany the result fact sheet is offered into the annex Section 4. The result fact sheets of the other ten considered European countries are given in the annex Section 4 as well.

To start the regression analysis the economic indicators calculated in chapter 2 are taken up. The values for Germany based on use and supply tables are given in Table 19 and Table 20. Furthermore, the equivalent transportation data as dependent variables are needed. The freight volume transported in Germany on road haulage and inland waterways between 1999 and 2007 is presented in Table 21. The calculation of the coefficients of determination and the significances is achieved through the use of Microsoft Excel.

Table 19: Economic indicator based on use tables for Germany (bridge matrix based on tonnes) [million €]

NST/R \ Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	10,416.26	11,104.06	10,483.84	10,954.40	11,731.02	11,626.96	11,605.43	11,892.87	11,577.93
2	10,274.93	10,953.40	10,341.59	10,805.77	11,571.86	11,469.20	11,447.97	11,731.50	11,420.84
3	19,796.56	20,683.19	19,636.14	20,334.78	21,836.05	21,680.30	22,282.19	22,592.04	22,278.00
4	61,465.85	62,048.66	59,815.78	57,313.07	55,180.57	54,762.51	49,850.87	51,121.25	49,827.88
5	8,240.49	8,525.92	8,604.90	8,775.70	9,576.64	8,928.32	8,948.48	9,177.24	9,238.42
6	41,368.20	42,467.54	41,862.70	43,490.32	43,900.51	45,099.27	46,156.23	45,721.04	46,410.11
7	22,514.49	23,522.84	22,332.04	23,126.60	24,833.99	24,656.85	25,341.40	25,693.77	25,336.63
8	27,585.33	29,108.58	24,315.36	26,196.81	26,256.99	30,960.07	31,539.83	31,824.14	37,485.49
9	181.13	168.18	176.68	168.04	168.09	163.87	163.93	177.23	174.36
10	69,483.14	64,516.69	67,778.39	64,464.22	64,483.17	62,861.52	62,884.35	67,989.89	66,886.43
11	26,662.57	24,515.76	26,882.08	26,498.12	25,914.34	25,960.71	27,663.27	31,398.54	31,599.70
12	3,895.76	3,582.05	3,927.82	3,871.72	3,786.40	3,793.17	4,041.96	4,587.77	4,617.14
13	47,781.54	48,937.84	49,450.31	48,604.40	49,976.43	50,420.42	50,557.69	54,183.93	56,845.52
14	59,134.75	56,794.53	53,166.86	51,419.68	50,560.25	49,540.36	47,672.19	48,370.64	49,119.46
15	52,512.30	45,899.55	42,662.57	40,301.63	40,415.69	38,941.55	38,193.66	38,814.10	39,125.84
16	8,918.59	8,950.10	8,960.91	9,153.22	9,378.96	9,537.79	9,493.85	9,860.04	10,376.95
17	934.40	937.67	938.78	958.86	982.51	999.10	994.49	1,032.83	1,087.03
18	66,484.79	66,719.60	66,800.16	68,233.56	69,916.40	71,100.32	70,772.77	73,502.49	77,355.97
19	29,092.75	27,516.96	28,077.79	28,178.56	28,727.73	29,236.17	29,670.76	29,675.51	29,776.31
20	183,308.57	203,331.38	209,399.67	216,908.44	221,836.73	225,857.59	229,966.44	234,242.85	249,268.08
21	21,600.89	22,123.63	22,355.30	21,972.89	22,593.15	22,793.87	22,855.92	24,495.26	25,698.50
22	6,616.67	6,354.82	5,948.91	5,753.42	5,657.26	5,543.14	5,334.11	5,412.26	5,496.04
23	71,879.45	74,365.25	75,054.03	76,543.78	83,529.30	77,874.81	78,050.87	80,046.25	80,579.64
24	299,415.76	293,774.98	294,094.32	302,749.49	312,283.20	313,232.39	314,564.79	325,422.36	334,411.62

Table 20: Economic indicator based on supply tables for Germany (bridge matrix based on tonnes) [million €]

NST/R \ Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	6,434.03	5,369.46	6,089.39	5,985.77	5,132.21	6,086.66	4,671.35	4,038.69	4,049.60
2	6,346.73	5,296.61	6,006.77	5,904.55	5,062.58	6,004.08	4,607.97	3,983.89	3,994.65
3	4,028.65	3,386.13	3,802.40	3,742.45	3,259.04	3,826.92	2,942.11	2,571.99	2,582.44
4	11,809.99	12,557.25	11,210.08	10,953.92	10,320.21	11,193.42	10,211.91	10,400.88	10,066.57
5	2,127.24	2,019.62	1,994.17	2,045.59	2,057.13	2,188.94	2,176.08	2,242.38	2,214.87
6	31,496.15	33,656.57	30,847.99	31,770.03	33,711.25	33,746.61	34,206.46	33,292.55	31,957.14
7	4,581.52	3,850.83	4,324.21	4,256.04	3,706.29	4,352.10	3,345.86	2,924.95	2,936.84
8	4,639.28	6,195.08	5,088.53	4,980.00	3,890.80	4,178.27	3,326.26	4,187.73	4,968.13
9	19.42	24.21	28.07	21.61	16.22	19.02	16.86	21.37	17.88
10	7,450.36	9,289.24	10,767.36	8,288.81	6,222.19	7,297.07	6,467.64	8,199.04	6,860.82
11	68,883.51	4,294.49	4,863.68	4,835.60	4,530.46	4,527.71	4,988.58	5,905.94	5,795.59
12	10,065.82	627.34	710.49	706.39	661.81	661.41	728.74	862.74	846.62
13	31,880.39	32,879.84	33,397.29	32,314.93	32,909.82	33,470.18	34,101.16	39,664.80	39,590.36
14	16,439.09	16,353.55	15,012.58	13,875.07	13,660.98	13,147.80	13,147.58	14,101.99	13,916.60
15	8,850.98	7,436.60	6,973.90	5,795.55	6,776.40	6,108.56	7,121.66	7,506.42	7,830.85
16	5,952.76	6,280.49	6,344.49	6,577.87	6,625.15	6,934.66	7,090.29	7,324.74	7,579.16
17	623.00	657.30	663.95	688.38	693.32	725.74	742.01	766.56	793.17
18	44,374.18	46,817.22	47,294.17	49,033.91	49,386.29	51,693.61	52,853.67	54,601.34	56,497.87
19	8,017.08	7,799.53	8,019.94	8,633.29	8,796.48	9,011.78	8,775.64	8,796.19	8,514.21
20	132,841.14	144,398.20	151,559.48	150,004.11	157,792.75	161,497.67	165,899.21	177,468.13	192,101.39
21	14,412.40	14,864.25	15,098.16	14,608.85	14,877.80	15,131.13	15,416.37	17,931.56	17,897.91
22	1,839.39	1,829.82	1,679.78	1,552.50	1,528.55	1,471.13	1,471.10	1,577.89	1,557.15
23	18,553.36	17,614.37	17,392.45	17,841.75	17,942.32	19,092.59	18,980.68	19,558.41	19,318.87
24	110,094.41	122,809.32	119,805.90	116,821.55	118,560.22	121,265.86	125,957.41	131,567.89	137,195.89

Table 21 Transported freight via road haulage and inland waterways in Germany between 1999 and 2007 [1,000 tonnes]

NST/R \ Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	39,873	41,131	39,957	39,606	34,677	33,996	39,237	37,319	36,437
2	29,856	43,174	34,555	32,475	32,002	34,127	34,117	34,829	35,953
3	16,482	17,829	15,155	17,597	18,163	18,959	20,112	15,956	22,402
4	68,953	74,517	70,464	63,951	62,375	66,416	74,396	81,206	89,018
5	16,984	24,737	20,057	19,239	15,572	17,72	17,262	17,499	20,267
6	321,883	334,208	333,889	335,307	348,179	357,986	369,303	373,662	388,643
7	14,494	13,985	16,039	15,921	16,827	18,289	20,738	22,048	25,476
8	46,431	46,349	44,677	45,23	43,268	49,536	45,791	49,327	52,575
9	1,286	1,041	1,439	1,096	638	628	723	469	413
10	177,83	163,993	172,877	150,045	150,452	153,095	155,366	162,899	156,229
11	65,612	73,529	63,706	62,694	56,686	62,306	58,691	66,032	67,33
12	10,772	14,358	12,074	9,61	7,87	7,958	8,109	8,836	9,842
13	104,582	96,623	105,996	95,13	95,238	102,847	99,928	112,04	121,231
14	248,348	236,103	221,659	196,95	198,413	204,269	191,407	199,027	185,863
15	1,642,338	1,422,038	1,340,384	1,256,428	1,223,475	1,195,089	1,161,098	1,216,032	1,244,395
16	27,796	29,568	26,494	26,283	26,333	27,949	26,784	29,224	31,34
17	3,308	2,82	2,386	2,982	3,108	2,894	3,292	3,6	3,285
18	226,32	221,241	203,302	193,896	207,022	211,386	211,884	222,305	233,672
19	31,238	32,959	34,194	31,168	32,164	33,585	33,134	34,393	35,542
20	95,522	102,772	110,053	107,457	111,267	120,57	125,647	135,324	141,659
21	36,245	41,973	45,707	45,21	42,544	44,669	44,049	50,936	54,81
22	24,695	22,670	20,322	22,509	21,141	20,871	20,578	21,727	20,794
23	141,555	137,921	139,028	142,37	147,926	157,835	157,408	163,76	176,822
24	185,343	218,280	221,900	209,448	225,55	237,918	267,636	288,248	306,683
total	3.577.745	3.413.818	3.296.315	3.122.603	3.120.887	3.180.897	3.186.689	3.346.697	3.460.682

On the basis of commodity NST/R-15 the calculated correlations between the economic indicator and the transport variable are presented. The commodity NST/R-15 "Crude and manufactured minerals" is taken as an example, because its quantity is about one third of the total freight amount and the coefficients of determination based on supply and use tables reveal significant results each, even though the coefficients have greatly different values. The regression analysis is presented graphically to show that the correlations between the economic indicators and the transported tonnes could be observed clearly (Figure 4 and Figure 5). Below the graphs the corresponding data of the economic indicators and the freight volume are given (Table 22).

Figure 4 Regression analysis of NST/R-15 based on use tables in the case of Germany

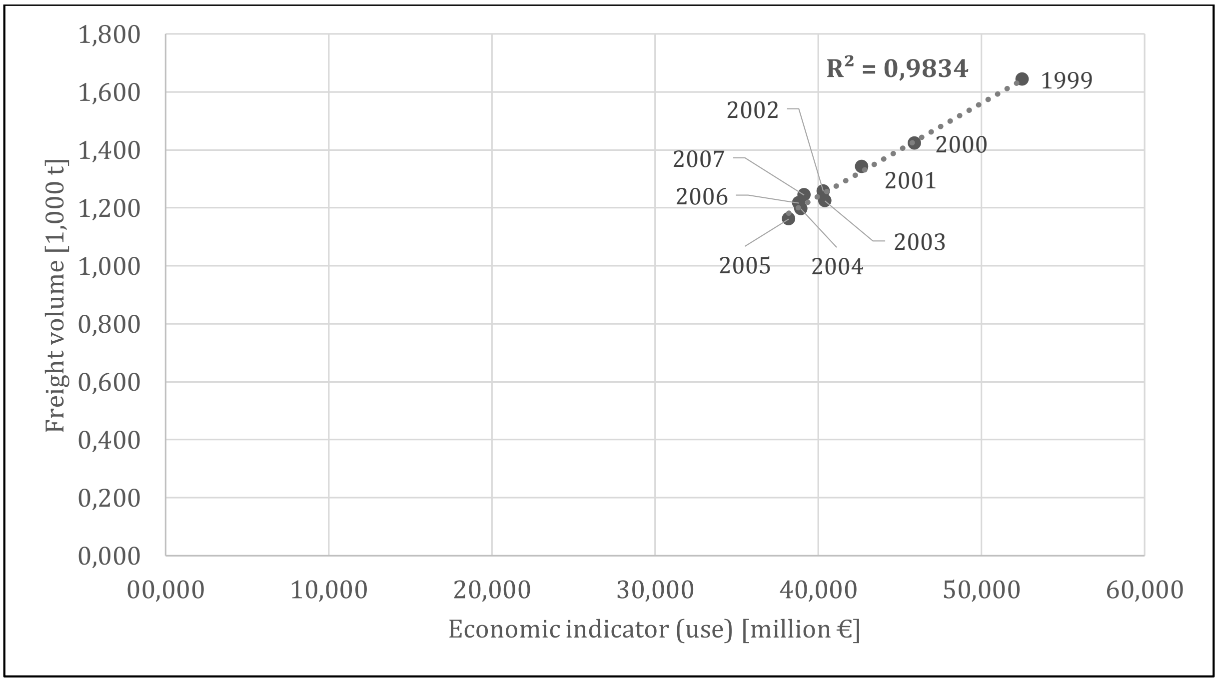


Figure 5 Regression analysis of NST/R-15 based on supply tables in the case of Germany

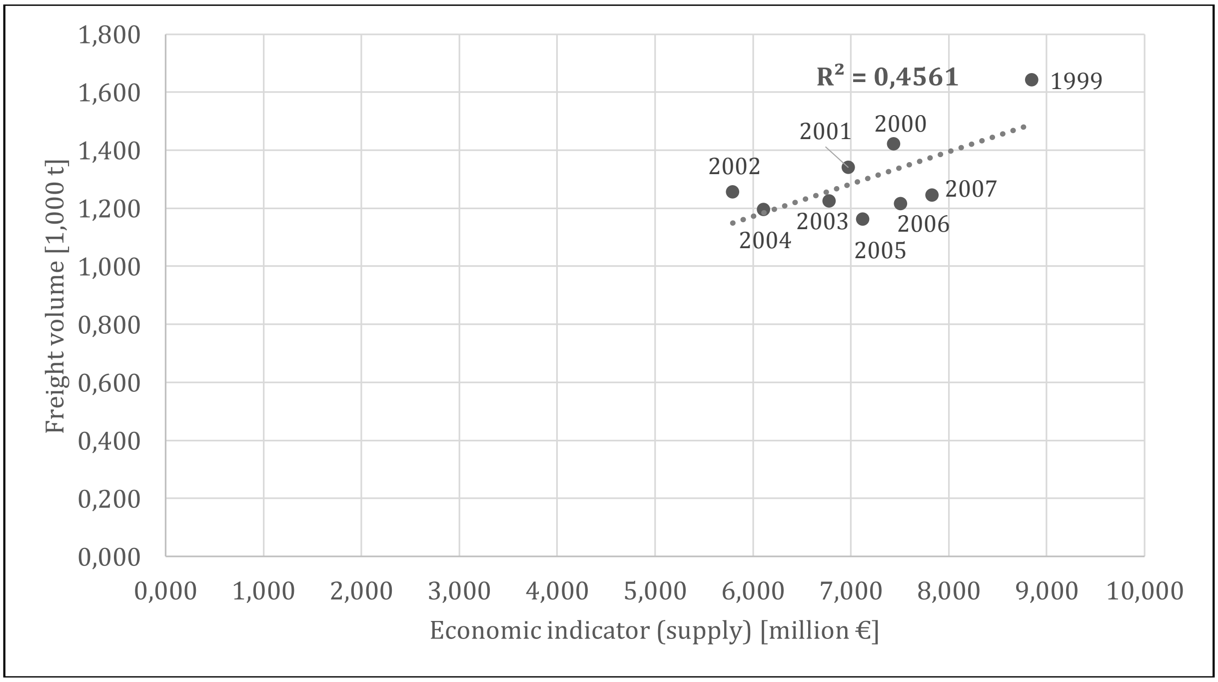


Table 22 Data of the regression analysis of NST/R-15 in the case of Germany

Year	Economic indicator (supply) [million €]	Economic indicator (use) [million €]	Freight volume [t]
1999	8,850.98	52,512.30	1,642,338.00
2000	7,436.60	45,899.55	1,422,038.00
2001	6,973.90	42,662.57	1,340,384.00
2002	5,795.55	40,301.63	1,256,428.00
2003	6,776.40	40,415.69	1,223,475.00
2004	6,108.56	38,941.55	1,195,089.00
2005	7,121.66	38,193.66	1,161,098.00
2006	7,506.42	38,814.10	1,216,032.00
2007	7,830.85	39,125.84	1,244,395.02

After the calculation of the coefficients of determination, their significances are determined. First, the significance level is defined with α = 0.05, which is a common assumption in overall work with statistics in research. Then, so-called p-values are calculated with help from the t-test. If a p-value is equal to or smaller than the significance level α, then the result of a coefficients of determination is declared as statistically significant, which connotes that the likelihood of these results emerging by chance is lower than 5%. The results of the regression analysis, as well as the results of the t-test to define the significance level, are presented in the following result fact sheet for Germany (Table 23). At this point it should be remarked that within the context of this thesis, a result is named significant when the value of a coefficients of determination as result of the correlation analysis is statistically significant due to the t-test.

All in all, for every country, 48 coefficients of determination – in short R^2 (two per commodity) – and as much values of their significances are calculated on base of tonnes and ton kilometres each. With regard to the results based on the calculation with tonnes 22 out of 48 R^2 are significant with a significance level lower than α= 0.05 (marked bold in Table 23). The 22 significant results are spread over 14 commodities, whereby ten of the significant values are based on supply tables and a majority of 12 significant values are based on use tables. For eight commodities, both values are significant. The use-based results for 8 out of 14 commodities offer better explanatory power with higher significances as well as higher R^2. These improved results are accentuated in Table 23. NST/R 9 "Crude petroleum" is the only commodity significantly explained by the supply-based tables and not by the use-based tables, while all other significant supply-results are also significantly explained by the use-based tables. However, the share of "Crude petroleum" on the total freight volume transported in Germany in 2007 is much lower than one percent, thus it is negligible. Altogether the 14 significantly explained commodities comprises 84.1 % of the total freight volume. A result, which is achieved by taking solely the use-based values into account. The quantity significantly explained by the supply-based tables is about two thirds (65.8 %).

In addition to the results based on transported tonnes, now the outcomes of the same procedure based on ton kilometres are depicted (Table 24). In this case 27 out of 48 R^2 are meaningful with a significance level lower than α= 0.05 (marked bold). In the aggregate, 16 commodities exhibit significant R^2 values and again a majority of 11 commodities reveals significant results by the regression based on use as well as on supply tables. While the correlation based on supply tables leads to significant R^2 for 14 out of 24 commodities, in the case of use tables, one commodity less is significantly explained. However, these 13 commodities represent 85.0 % of the total ton kilometres in Germany in 2007 in contrast to 79.3 % through the supply-based outcome. All in all, more than nine out of ten ton kilometres (91.6 %) are explained as statistically significant. Summarising, it can be said, that the correlation of the economic indicator with the ton kilometres in the case of Germany shows more significant results and a higher share of the total freight amount.

Table 23 Result fact sheet for the regression analysis based on tonnes in the case of Germany

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage and inland waterways in 2007
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0.06	**0.47**	0.5319	**0.0416**	**1.1%**
2	0.09	0.02	0.4431	0.7090	1.0%
3	0.23	0.34	0.1912	0.1006	0.6%
4	0.08	0.26	0.4545	0.1623	2.6%
5	0.15	0.17	0.2952	0.2734	0.6%
6	0.14	**0.92**	0.3151	**0.0001**	**11.2%**
7	**0.69**	**0.64**	**0.0056**	**0.0097**	**0.7%**
8	0.00	**0.79**	0.8594	**0.0014**	**1.5%**
9	**0.45**	0.10	**0.0477**	0.4124	**0.0%**
10	0.29	**0.62**	0.1316	**0.0122**	**4.5%**
11	0.01	0.00	0.7581	0.8605	1.9%
12	0.02	0.10	0.7243	0.4031	0.3%
13	**0.71**	**0.70**	**0.0045**	**0.0047**	**3.5%**
14	**0.84**	**0.90**	**0.0005**	**0.0001**	**5.4%**
15	**0.46**	**0.98**	**0.0459**	**0.0000**	**36.0%**
16	0.23	0.38	0.1867	0.0751	0.9%
17	0.25	**0.31**	0.1749	**0.1169**	**0.1%**
18	0.09	0.23	0.4454	0.1925	6.8%
19	0.02	0.16	0.7526	0.2810	1.0%
20	**0.97**	**0.89**	**0.0000**	**0.0001**	**4.1%**
21	**0.78**	**0.83**	**0.0017**	**0.0007**	**1.6%**
22	**0.51**	**0.61**	**0.0304**	**0.0132**	**0.6%**
23	**0.75**	0.38	**0.0024**	0.0788	**5.1%**
24	**0.94**	**0.79**	**0.0000**	**0.0015**	**8.9%**
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			**65.8%**	**84.1%**	**84.1%**
Amount of commodities explained significantly			**10**	**12**	**14**

Table 24 Result fact sheet for the regression analysis based on ton kilometres in the case of Germany

NST/R	**Coefficient of determination R^2 value**		**Significance test p-value**		**Share of total ton kilometres transported via road haulage and inland waterways in 2007**
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	**0.47**	0.03	**0.0407**	0.6677	2.1%
2	**0.53**	0.24	**0.0261**	0.1764	1.9%
3	**0.59**	**0.62**	**0.0161**	**0.0114**	0.6%
4	0.08	0.22	0.4741	0.2063	2.7%
5	0.11	0.17	0.3839	0.2636	0.7%
6	0.13	**0.94**	0.3328	**0.0000**	14.6%
7	**0.73**	**0.71**	**0.0031**	**0.0041**	1.5%
8	0.06	0.15	0.5112	0.2969	2.6%
9	0.35	0.08	0.0911	0.4542	0.0%
10	**0.65**	0.36	**0.0089**	0.0900	4.7%
11	0.01	0.02	0.7975	0.6876	2.2%
12	0.05	0.09	0.5480	0.4413	0.3%
13	**0.58**	**0.62**	**0.0171**	**0.0123**	5.9%
14	**0.82**	**0.74**	**0.0008**	**0.0030**	5.1%
15	**0.64**	**0.66**	**0.0092**	**0.0077**	11.7%
16	0.16	0.07	0.2912	0.4781	1.2%
17	**0.84**	**0.77**	**0.0005**	**0.0020**	0.2%
18	**0.86**	**0.85**	**0.0003**	**0.0004**	7.9%
19	0.30	**0.71**	0.1284	**0.0046**	1.2%
20	**0.98**	**0.94**	**0.0000**	**0.0000**	7.3%
21	**0.78**	**0.81**	**0.0015**	**0.0010**	2.2%
22	0.00	0.01	0.9902	0.7711	1.1%
23	**0.67**	**0.51**	**0.0068**	**0.0315**	9.5%
24	**0.91**	**0.78**	**0.0001**	**0.0015**	12.9%
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			**79.3%**	**85.0%**	**91.6%**
Amount of commodities explained significantly			**14**	**13**	**16**

4.2.1 Specific case of regression analysis: Correlation with included railway data and comparison of the results in the case of Germany

As explained in chapter 3, railway data are not considered in the analysis due to insufficient data availability. However, in contrast, Müller et al used freight data of all three paramount transport modes – road haulage, inland waterway, and railway – in their preceding research. As elaborated in chapter 2, the transportation data are used twice in the procedure. On the one hand, they are used directly in the correlation analysis as dependent variables, and on the other hand, they are decisive for the generation of the bridge matrix. In this section a closer look into the impacts of taking the railway data into account, specifically in the case of Germany, is offered.

The complete freight data sets, inclusive tonnes transported by railways are taken over from a publication of Müller and Klauenberg and are depicted in Table 26 (51). The railway data are given in several tables offered by the German Federal Statistical Office Destatis and have to be matched so that they are available in the required configuration: tonnes per commodity per year.

Table 25 gives an impression of the importance of considering goods transported with railways. Exemplary for Germany in year 2007, the absolute amount and the relative share of the total freight volume are depicted. Altogether, 9.4% of all transported goods have been moved by railways. The different proportions across the 24 commodities are immense and range from 0.1%, in the case of NST/R-3 "Live animals, sugar beet," up to 68.9%, in the case of NST/R-9 "Crude petroleum." For one third of the commodities, the percentage of transports via railways is higher than 10%, thus the contribution to the total freight volume is remarkable. In these eight cases, differences regarding the bridge matrix and the final results of the analysis are most likely.

Table 25 Absolute and relative quantity of transported freight via railways per commodity in Germany in 2007

NST/R	Freight transported by railways (1,000 t)	Share of the total freight volume
1	2,872	7.3%
2	140	0.4%
3	16	0.1%
4	8,922	9.1%
5	185	0.9%
6	2,238	0.6%
7	1,267	4.7%
8	51,355	49.4%
9	875	68.0%
10	33,915	17.8%
11	30,928	31.5%
12	273	2.7%
13	61,453	33.6%
14	8766	4.5%
15	32,193	2.5%
16	7,875	20.1%
17	1,013	23.6%
18	23,308	9.1%
19	2,440	6.4%
20	11,419	7.5%
21	2,020	3.6%
22	136	0.6%
23	9,100	4.9%
24	68,407	18.2%
total	**361,116**	**9.4%**

Table 26 Transported freight via road haulage, inland waterways, and railways in Germany between 1999 and 2007 [1,000 tonnes]

NST/R \ Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	41,639	43,424	41,210	40,711	35,825	34,453	40,930	39,969	39,309
2	30,418	43,711	35,025	32,902	32,275	34,359	34,308	35,020	36,093
3	16,495	17,854	15,163	17,612	18,185	18,971	20,141	15,978	22,418
4	74,146	81,702	75,938	68,958	66,411	72,076	80,760	88,860	97,940
5	17,226	24,958	20,259	19,379	15,716	17,875	17,432	17,676	20,452
6	325,180	337,310	336,953	337,692	350,715	360,428	371,603	375,967	390,881
7	14,782	14,363	16,259	16,082	17,012	18,488	20,987	22,722	26,743
8	103,520	104,727	99,007	98,062	99,826	102,576	95,339	100,639	103,930
9	2,091	1,857	2,108	1,652	1,510	1,432	1,734	1,376	1,288
10	200,885	187,886	197,611	176,074	178,611	184,701	190,171	198,824	190,144
11	93,579	103,144	91,824	89,896	84,530	91,824	87,013	97,141	98,258
12	11,476	14,931	12,618	10,197	8,486	8,313	8,516	9,190	10,115
13	153,967	150,479	160,020	148,537	148,769	158,734	150,849	171,428	182,684
14	255,411	241,917	227,601	202,186	204,309	211,719	198,255	207,097	194,629
15	1,673,506	1,448,918	1,369,343	1,285,500	1,249,811	1,224,658	1,190,481	1,247,546	1,276,588
16	35,242	36,989	33,552	33,637	33,995	35,539	34,260	36,949	39,215
17	3,882	3,555	3,058	3,671	3,823	3,546	4,068	4,509	4,298
18	243,928	239,406	221,310	213,079	226,677	233,575	234,360	243,762	256,980
19	33,910	35,737	36,731	33,908	34,956	36,439	35,803	36,957	37,982
20	107,225	114,580	123,745	118,624	122,117	131,651	136,294	146,764	153,078
21	38,289	43,986	47,669	47,155	44,458	46,516	46,015	53,039	56,830
22	25,125	23,137	20,775	22,816	21,424	21,138	20,809	21,922	20,930
23	148,768	145,166	145,870	148,999	155,305	165,473	165,492	172,589	185,922
24	214,405	248,249	250,911	240,629	263,069	276,675	318,362	346,893	375,090
total	3,865,095	3,707,986	3,584,560	3,407,958	3,417,815	3,491,159	3,503,982	3,692,817	3,821,797

Owing to the methodology, the quantity of the 24 commodities influences the proportions of the bridge matrix. However, the β-factors associated with commodity 24 are fixed and in consequence the factors of many product-commodity-pairs are independent of the underlying freight data. Table 27 contrasts the variable β-factors resulting from the freight data and exclusive and inclusive railway data respectively. As expected, the relative differences between both kinds of β-factors are largest for those commodities which exhibit a high share of transported goods by railways: e. g. NST/R-9 or NST/R-13. Nevertheless, the absolute differences of the both kinds of β-factors are not that noteworthy and the testing of the sensitivity of the bridge matrix in chapter 2 revealed that the leverage effect of the bridge matrix on the final results is limited.

Table 27 Variable β-factors depending on the consideration of railway data in bridge matrix-construction

NST/R	**CPA 2002**	**β-factor resulting from data**		**NST/R**	**CPA 2002**	**β-factor resulting from data**	
		exclusive railway	**inclusive railway**			**exclusive railway**	**inclusive railway**
1	1	0.2727	0.2840	12	27	0.0369	0.0276
2	1	0.2690	0.2608	13	27	0.4548	0.4989
3	1	0.1676	0.1620	13	28	0.6198	0.6865
3	5	0.3743	0.3648	14	26	0.8544	0.8578
5	17	0.0720	0.0694	16	24	0.1110	0.1240
5	18	0.0720	0.0694	16	25	0.0771	0.0861
5	19	0.0720	0.0694	17	24	0.0116	0.0136
5	36	0.0679	0.0643	17	25	0.0081	0.0094
5	37	0.0771	0.0743	18	24	0.8274	0.8124
7	1	0.1906	0.1932	18	25	0.5748	0.5644
7	5	0.4257	0.4352	21	27	0.2056	0.1552
9	11	0.0026	0.0067	21	28	0.2802	0.2135
9	23	0.0026	0.0067	22	26	0.0956	0.0922
10	11	0.9974	0.9933	23	17	0.6280	0.6306
10	23	0.9974	0.9933	23	18	0.6280	0.6306
11	13	0.8725	0.9067	23	19	0.6280	0.6306
11	27	0.2526	0.2683	23	36	0.5921	0.5946
12	13	0.1275	0.0933	23	37	0.6729	0.6757

The fact sheet of the results is given in Table 28. Altogether, 20 (22)[7] out of 48 R^2 values are of note, with a significance level lower than $\alpha=0.05$ (marked bold in the table). These 20 significant results are spread over 13 (14) commodities, whereby eight (10) of the significant values are based on supply tables and a majority of 12 (12) significant values are based on use tables. For 7 (8) commodities both values are significant. The explanatory power of the use-based results in 8 out of 13 commodities show higher significance and R^2 values. These superior results are highlighted in Table 28. NST/R-16 "Natural and chemical fertilizers" is the only commodity that is significantly explained by the supply-based tables and not by the use-based tables, while all other noteworthy supply-results have significant correlations by both the supply based and use based tables. However, the share of "Natural and chemical fertilizers" on the total freight volume transported in Germany in 2007 is exactly one percent, thus, it is negligible. Altogether, the 13

[7] The outcomes resulting from the analysis exclusive to the railways data are given in brackets for comparative purposes.

significantly explained commodities comprises 78.4% (84.1%) of the total freight volume. Taking solely the commodities with significant correlations due to use-based analyses into account, 77.4% (84.1%) of total freight amount are significant, while the significant quantity due to the supply-based tables is 64.9% (65.8%).

Table 28 Result fact sheet for the regression analysis based on tonnes inclusive railway data in the case of Germany

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage, inland waterways and railways in 2007
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0.18	0.28	0.2538	0.1393	1.0%
2	0.14	0.00	0.3141	0.9486	0.9%
3	0.25	0.21	0.1704	0.2099	0.6%
4	0.31	**0.49**	0.1175	**0.0351**	**2.6%**
5	0.07	0.01	0.4838	0.7793	0.5%
6	**0.84**	**0.95**	**0.0005**	**0.0000**	**10.2%**
7	0.00	0.41	0.9167	0.0634	0.7%
8	0.08	0.00	0.4633	0.9824	2.7%
9	0.27	**0.74**	0.1499	**0.0027**	**0.0%**
10	0.04	0.02	0.6093	0.6936	5.0%
11	0.12	0.04	0.3526	0.5912	2.6%
12	0.13	0.13	0.3484	0.3319	0.3%
13	**0.70**	**0.64**	**0.0048**	**0.0100**	**4.8%**
14	0.38	**0.53**	0.0746	**0.0267**	**5.1%**
15	**0.61**	**0.46**	**0.0126**	**0.0441**	**33.4%**
16	**0.47**	0.23	**0.0412**	0.1953	**1.0%**
17	**0.47**	**0.49**	**0.0400**	**0.0366**	**0.1%**
18	0.35	0.17	0.0937	0.2721	6.7%
19	0.07	**0.54**	0.5026	**0.0245**	**1.0%**
20	**0.95**	**0.77**	**0.0000**	**0.0018**	**4.0%**
21	**0.80**	**0.73**	**0.0011**	**0.0033**	**1.5%**
22	0.35	0.29	0.0961	0.1376	0.5%
23	0.21	**0.86**	0.2185	**0.0003**	**4.9%**
24	**0.89**	**0.97**	**0.0001**	**0.0000**	**9.8%**
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			**64.9%**	**77.4%**	**78.4%**
Amount of commodities explained significantly			**8**	**12**	**13**

4.3 Stationarity of time series analysis

Stationarity is a significant assumption for regression and time series analyses. A time series of observed data points is characterized stationary if its statistical attributes, for instance expectation value or variance, are constant over time. In the case of regression analysis, both variables, predict and predicted, must meet the requirement of stationarity. However, for economic time series, this requirement is typically not fulfilled; on the contrary, often a trend is apparent(43). In this thesis economic data, represented as gross value added or supply and use tables, portray several consecutive years which are used in the methodology. Additionally, the amount of transported tonnes and the transport performance measured in ton kilometres are used. The problem of using non-stationary time series in correlation analysis is that spurious relationships occur easily. Spurious relationships display a correlation between variables, although no causal relation underlies. Furthermore, the spuriously identified relation is reduced to a common trend of the variables. (40, 41)

Accepting that a correlation analysis performed in this thesis reveals an economic indicator, for which a strong relation to the equivalent freight variable is found, such an indicator seems useful for forecasts of future freight volume or ton kilometres, which can be derived from it. For such statistical predictions, time series models are needed and those must also fulfil the stationarity-requirement. Hence, stationarity is an important requirement in two respects. One the one hand, in the course of correlation analysis as focus of this thesis, and on the other hand, with regard to forecasting models.

The characteristics of a mathematical function or process can be verified with the help of appropriate tests. Tests with the objective to check the statistical attributes of a process in the course of time are called stationarity tests. In other words, these tests show how time-independent a data series is. One of the most popular methods is the so-called Dickey-Fuller-Test (DF-Test); a unit root test, developed in the 1970s by David Dickey and Wayne Fuller (6). The null hypothesis, which is to be verified with the test, implies the existence of a unit root and thus the process is non-stationary and a stochastic trend exists. According to this, the alternative hypothesis is that no unit root exists and hence the process is stationary and has no stochastic trend. A stationary time series is also called integrated of order nil (I[0]). If the null hypothesis is confirmed by the test and no stationarity of the original data is given, then the differences of the data of the time series can be generated (see Table 19). The adjusted process is named a differentiated time series in order 1 (I[1]) and can be tested on stationarity as well. This procedure can be reiterated until a stationary process results. The original time series is called "integrated process in order d", whereby "d" is the number of necessary differentiations. (40, 55)

Table 29: Proceeding of testing the stationarity for a time series

<table>
<tr><td colspan="3">Test of the stationarity
(here with help of the DF-Test)</td></tr>
<tr><td rowspan="5">Process is stationary
➔ Execution of the correlation analysis</td><td colspan="2">Process is non-stationary
➔ Risk of spurious correlations</td></tr>
<tr><td colspan="2">Differentiating: Generation of the first difference</td></tr>
<tr><td colspan="2">Test of the stationarity
(here with help of the DF-Test)</td></tr>
<tr><td rowspan="2">Process is stationary
➔ Execution of the correlation analysis</td><td>Process is non-stationary
➔ Risk of spurious correlations</td></tr>
<tr><td>Generation of the second difference of the process
…
Repetition until a stationary differentiated process in order “d” results</td></tr>
</table>

4.3.1 Concrete cases of the application of the stationarity-test

The data set in this thesis, analysed in terms of correlations, is very comprehensive and for this reason not every data series can be tested for stationarity. The tests are carried out for the three countries with the highest amount of commodities, which exhibit significant results in the correlation analyses. Taking the freight volume into account, the countries are Spain, Germany, and the Netherlands which are analysed, and with respect to the ton kilometres, Spain, France and Germany are analysed. The stationarity is tested for each freight volume or ton kilometres and the both economic indicators based on either supply or use tables. Due to 24 commodities and three stationary-tests each, altogether 72 tests per country result.

The Dickey-Fuller-Test is carried out with the statistic-tool “xlSTAT”, which can be implemented in Microsoft Excel. One exemplary depiction of the outcome for NST/R-15 “Crude and manufactured minerals” in the case of Germany is presented in Table 30. All other results of the stationary-tests for the six relevant countries are depicted in the annex Section 5. In the upper section of Table 30, the data of the time series are given, below which the results of the DF-Test are presented. The findings are to be interpreted this way: the null hypothesis is fulfilled if the p-value is greater than the significance level α=0.05 (5%). Thus, the time series has a unit root and is not stationary. In the example of NST/R-15, this is the case for the freight volume and the supply-based economic indicator. In the case of the use-based economic indicator, the p-value is smaller than the significance level and thus the null hypothesis must be rejected. Consequently, the alternative Hypothesis is accepted and the stationarity of the time series is proven. The risk of rejecting the null Hypothesis, although it is true, is quantified through the p-value, so it is 0.4%.

Table 30: Results of the Dickey-Fuller-Test in the case of Germany for commodity NST/R-15 "Crude and manufactured minerals" (tonnes)

Year	**Freight volume [t]**	**EI_supply [million €]**	**EI_use [million €]**
1999	1,642,338.00	8,850.98	52,512.30
2000	1,422,038.00	7,436.60	45,899.55
2001	1,340,384.00	6,973.90	42,662.57
2002	1,256,428.00	5,795.55	40,301.63
2003	1,223,475.00	6,776.40	40,415.69
2004	1,195,089.00	6,108.56	38,941.55
2005	1,161,098.00	7,121.66	38,193.66
2006	1,216,032.00	7,506.42	38,814.10
2007	1,244,395.02	7830.85	39,125.84
p-value (single-sided)	0.877	0.593	0.004
Significance level α	0.05	0.05	0.05
Conclusion of the DF-Test	non-stationary	non-stationary	stationary

However, with regard to the tests of the time series used in this thesis, it is an exception that the null hypothesis of the DF-Test is rejected and stationarity of a time series is revealed. For Germany on the whole, only three out of 72 time series are stationary; in the case of Spain and Netherlands, just three or four time series are stationary (Table 31). Taking the findings for the stationarity tests related to the correlation analyses with ton kilometres into account, on average, only three time series per country are stationary as well (Table 32). The comparison of the results for Spain and Germany, tested for tonnes as well as for ton kilometres, shows that time series often reveal stationarity in both cases.

Table 31: Summarised results of the Dickey-Fuller-Test for Spain, Germany and Netherlands (tonnes)

	Spain	Germany	Netherlands
Number of stationary variables	3	3	4
List of stationary time series	NST/R-16 EI_supply NST/R-17 EI_supply NST/R-18 EI_supply	NST/R-15 EI_supply NST/R-19 EI_supply NST/R-24 EI_use	NST/R-1 EI_use NST/R-2 EI_use NST/R-6 freight volume NST/R-8 freight volume

Table 32: Summarised results of the Dickey-Fuller-Test for Spain, Germany and France (ton kilometres)

	Spain	Germany	France
Number of stationary variables	3	4	2
List of stationary time series	NST/R-16 EI_supply NST/R-17 EI_supply NST/R-18 EI_supply	NST/R-6 freight volume NST/R-15 EI_supply NST/R-19 EI_supply NST/R-24 EI_use	NST/R-1 freight volume NST/R-16 freight volume

After performing the test, only few data are stationary, and hence, for the majority of the data, the stationary-test indicates the risk of spurious correlations. If the unit root test reveals that a time series is non-stationary and has a stochastic trend, it is possible to reach stationarity by differentiating the process. Therefore, the differences between two consecutive data points are computed and these values build a new process for which the criteria of stationarity can be checked afterwards. However, in the adjusted process one data point less is available and thus the explanatory power decreases, particularly as the extent of maximal nine individual data points within the original time series is already small. Furthermore, due to the differentiation, the information about the level of the original data gets lost. In the example in Table 33, the original data points range between about 7,500 million and 11,000 million ton kilometres, but after differentiating the series, only the differences remain.

Table 33: Results of computing the differences for commodity NST/R-4 "Wood and cork" in the case of Germany (ton kilometres)

Year	**Transport performance** [million tkm] **Original time series**	**Transport performance** [million tkm] **first differences**	**Transport performance** [million tkm] **second differences**
1999	8,721.00		
		185.00	
2000	8,906.00		- 249.00
		- 64.00	
2001	8,842.00		- 693.00
		- 757.00	
2002	8,085.00		271.00
		- 486.00	
2003	7,599.00		1,029.00
		543.00	
2004	8,142.00		414.00
		957.00	
2005	9,099.00		- 317.00
		640.00	
2006	9,739.00		263.35
		903.35	
2007	10,642.35		
p-value (single-sided)	0.999	**0.026**	**0.008**
Significance level α	0.05	0.05	0.05
Conclusion of the DF-Test	non-stationary	**stationary**	**stationary**

Considering the example of NST/R-4, it is shown that the differentiation leads to stationary processes in the first and second difference. However, altogether the differentiation of the time series only in exceptional cases results in stationarity, as Table 34 and Table 35show. In the case of Germany, the stationarity-test in first or even second differences raises the number of stationary variables from 3 up to 14, with regard to tonnes, and from 4 to 14 with regard to ton kilometres. That is still not particularly much with respect to 72 data series in the aggregate.

Table 34: Summarised results of the Dickey-Fuller-Test in differences for Spain, Germany, and the Netherlands (tonnes)

	Spain	Germany	Netherlands
Original time series			
Number of stationary time series	3	3	4
First differences			
Cumulated number of stationary time series	5	5	6
List of added stationary time series	NST/R-1 freight volume NST/R-7 freight volume	NST/R-9 freight volume NST/R-19 freight volume	NST/R-15 freight volume NST/R-22 freight volume
Second differences			
Cumulated number of stationary time series	5	13	12
List of added stationary time series		NST/R-1 EI_supply NST/R-1 EI_use NST/R-2 EI_supply NST/R-2 EI_use NST/R-3 EI_supply NST/R-5 EI_supply NST/R-7 EI_supply NST/R-23 EI_supply	NST/R-1 freight volume NST/R-5 freight volume NST/R-1 EI_use NST/R-15 EI_supply NST/R-20 freight volume NST/R-23 EI_use

Table 35: Summarised results of the Dickey-Fuller-Test in differences for Spain, Germany, and France (ton kilometres)

	Spain	Germany	France
Original time series			
Number of stationary time series	3	4	2
First differences			
Cumulated number of stationary time series	4	7	5
List of added stationary time series	NST/R-8 freight volume	NST/R-4 freight volume NST/R-9 freight volume NST/R-13 freight volume	NST/R-9 EI_use NST/R-10 EI_use NST/R-15 freight volume
Second differences			
Cumulated number of stationary time series	13	14	5
List of added stationary time series	NST/R-22 freight volume NST/R-22 EI_supply NST/R-22 EI_use NST/R-23 freight volume NST/R-23 EI_supply NST/R-23 EI_use NST/R-24 freight volume NST/R-24 EI_supply NST/R-24 EI_use	NST/R-1 EI_supply NST/R-1 EI_use NST/R-2 EI_supply NST/R-2 EI_use NST/R-5 EI_supply NST/R-23 EI_supply NST/R-24 freight volume	

4.3.2 Opportunity of co-integration of non-stationary variables

It was previously stated that the correlation of two non-stationary time series usually implies the problem of spurious regressions. However, situations can occur which counter this problem. This is the case if non-stationary economic variables are co-integrated so that a long-term equilibrium relationship exists. Supplementary to the stationarity-topic, the possibility to reveal such relations in the case of considering non-stationary processes should be indicated in this section in short without performing any statistical test.

The underlying idea of the concept is that the correlation between variables within a certain period is not statistically verifiable, and thus the time series are detected as non-stationary, although a relationship in a larger time frame is observable. There exists a deviation from the equilibrium in the short term, but at least one variable adjusts in the course of time so that the long-term equilibrium is reconstituted. Co-integrated variables do not have independent trends, but are driven through a common stochastic trend. While the regression of differences of the concerning time series only gives information about the short-term relation, the co-integration enables evidence about long-term equilibrium relationship. (43, 40)

In principle, two non-stationary variables only can be co-integrated, if they are integrated processes in the same order d. With help of the mentioned Dickey-Fuller-Test, the degree of integration can be determined. Accepting that the degree of integration is equal, then subsequently a test of co-integration can be added. A popular example for a co-integration test is the Engle-Granger-Method. The assumption of the method is, if two variables are identified as co-integrated, then their linear combination must be stationary.

4.3.3 Conclusion

The detection of correlation between the transported tonnes or ton kilometres and an economic indicator is the main purpose of this thesis. Whenever a relationship is revealed, the explanatory variable is worth considering for forecasts with help of time series models. However, for both kind of analyses – regression analysis as well as time series analysis – stationarity of the variables is a fundamental condition.

The tests in terms of stationarity is done with the Dickey-Fuller-Test for selected countries and a large majority of analysed time series do not reveal stationarity. The tests were done for Spain, Germany and the Netherlands, with regard to tonnes and for Spain, Germany and France, in view of ton kilometres. The building of the first or even second differences and the repeated stationary-test result only in little improvements. Consequently, for large parts of the data set, the correlation of the data series, the tonnes or ton kilometres of the commodities as well as the corresponding economic indicators that are either based on supply or on use tables, holds the danger of spurious regressions. In other words, the occurrence of incorrectly identified relations must be considered as very likely. This means that further consideration must be given to unconsidered und unknown factors which would affect the determined correlation between the freight variable and the economic indicator. For projections, time series models are used and in these analysis the variable, which has to be estimated, must be stationary. With regard to freight transport modelling, for instance, the freight volume is the variable to be explained.

4.4 Summarised results of the regression analysis for European countries

In this section the results of the linear regression analysis in the European context are presented. At this point the outcomes of the R^2 and the respective significances are given aggregated for all countries at a glance. The result fact sheets with the concrete values for each country can be found in the annex.

First, the results of the regression analysis of the economic indicator with the transport volume are considered. The bar chart in Figure 6 depicts the amount of commodities, which reveal significant results at a significance level of 10% or even 5%. The bar chart below (Figure 7) shows how large the corresponding share of tonnes are. A first look reveals that the findings for the eleven European countries are considerably different. Taking the 5% significance level as a threshold, a wide range from 20 commodities in the case of Spain to just 2 commodities in the case of Sweden is observable. In this context, the German result can be better evaluated and the comparison shows that 14 commodities with a 5% significance rating are the second best value. On an average, the transported tonnes of narrowly 10 out of 24 kinds of goods (9.9/24.0) per country correlate significant with the economic indicator. If the significance level is increased to 10% in most of the countries – except for France – one, two, or even three additional commodities exhibit significant results. The average value increases up to 11.7 kinds of goods, thus in total almost half of all commodities in these countries show significant values (129 out of 264; 48.9%). While Spain exhibits by far the highest amount (20 commodities), on the other side of the chart, Luxembourg (5), Finland (3) and Sweden (2) stand in contrast to Spain on the low end of the spectrum. Among the extremes the values of a majority of seven countries are rather close together (9 up to 14 commodities).

With regard to the share of the tonnes associated with the amount of commodities, some remarkable differences come to light. In Figure 7, the shares corresponding to the 5% significance level are arranged from the highest to the lowest. The order of the countries compared to the sorting on base of the absolute kind of goods varies, but no country changes its rank more than two positions. Across all eleven countries, on an average 50.7% of the total freight volume of a country correlate significantly under usage of the economic indicator. However, the shares of the separate countries diverge immensely, thus a classification of the countries is not perfectly possible. Spain is still at the top of the ranking (99.2%), with a substantial gap to the second-best result, which belongs to Germany (84.1%). At the end of the spectrum, Sweden (17.6%) and Finland (3.9%) switch their positions and in a broader scope both of these countries can be pooled in with Denmark, Belgium, and Luxembourg, because their shares are by far lower than the next higher value of Austria. Following this categorization, the remaining countries can be subdivided again into two groups. In the cases of Germany, Italy, and France, which are some of the biggest European national economies, the significant results comprise more than three quarters of the total freight volume. Taking the lower significance level amounting to 10% into account leads to two different effects. For a majority of eight out of eleven countries, the results just increase slightly by around one percent. However, in the cases of Belgium (+12.3%), Denmark (+19.5%), and especially Luxembourg (+35.2%), the significant tonnes increases greatly. These few but high increases lift up the average value from 7.0% up to 57.7%.

Figure 6 Summarised presentation of the significantly explained amount of commodities for all considered countries (tonnes)

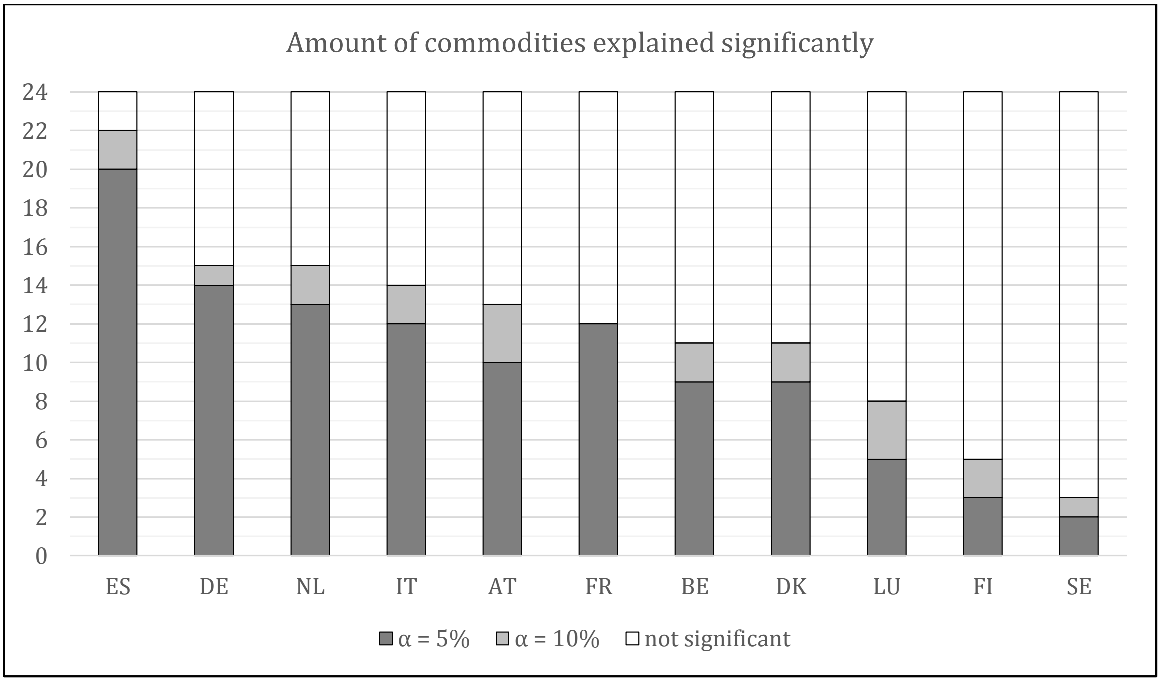
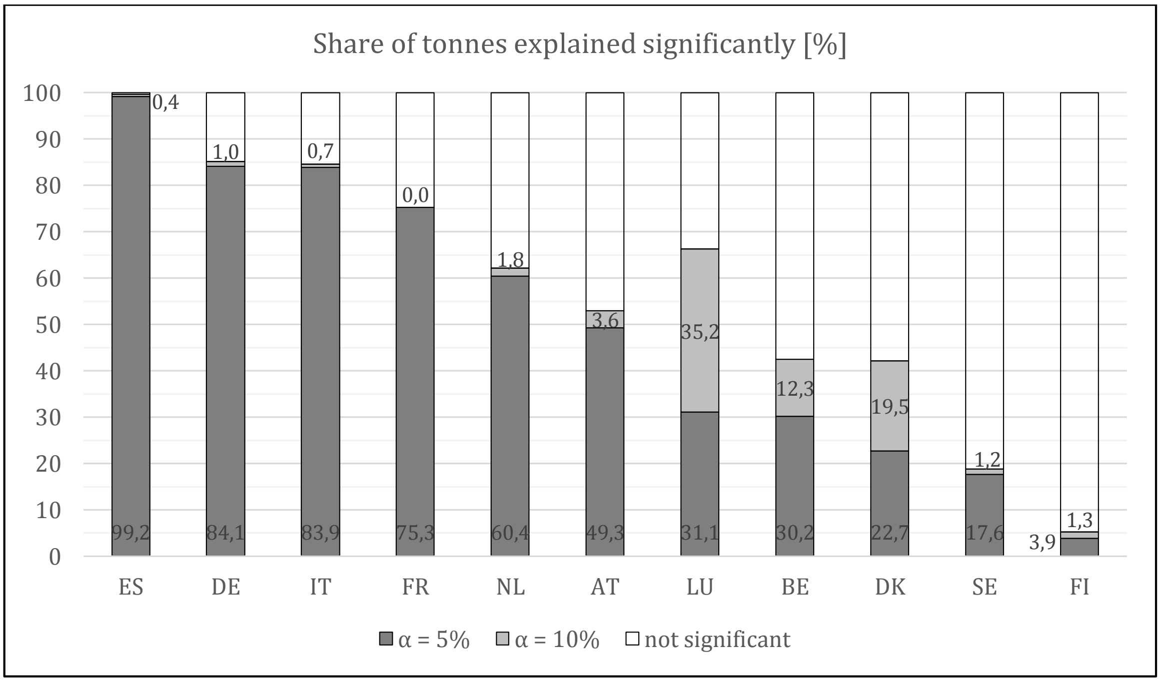


Figure 7 Summarised presentation of the significantly explained share of tonnes for all considered countries (tonnes)



Now, the results of the regression analysis of the economic indicator with the ton kilometres are considered. Equivalent to the elaborations above, the bar chart in Figure 8 Summarised presentation of the significantly explained amount of commodities for all considered countries (ton kilometres) depicts the amount of commodities that show significant results at a significance level of 10% or even of 5%. The bar chart below Figure 9 depicts how large the corresponding share of ton kilometres are. Also, for the regression analysis of the economic indicator with the transport performance, the outcomes for the eleven European countries are considerably different, but not as much as for the correlation with the transport volume. Taking the 5% significance level as a threshold, a range from 18 commodities in the case of Spain to 3 commodities in the case of Finland is reached. The German result in the amount of 16 commodities with 5%-significance rating are the second best value again. On an average, the ton kilometres of 9.2 out of 24 kinds of goods per country correlate significantly with the economic indicator. If the significance level is 10%, up to four additional commodities per country exhibit significant results. The average amount increases up to exactly the same value as for the analysis with tonnes: 11.7 commodities. A clustering of the results in respective countries is hardly sensible, because the intervals between the several values are evenly distributed. What is likely to be most useful is a rough differentiation into two groups. In the case of six countries, maximally 7 kind of goods (9, if the significance level of 10% is taken into account) reveal significant results of the regression analysis. Compared with this, the other five countries have at least 9 (12) significant commodities.

In Figure 9 the shares of the 5% significance level are arranged from the highest to the lowest value. In doing so, the two-part subdivision of the eleven countries can be transferred to this chart representing the share of tonnes as well, because no country switches into the upper or lower division. However, a few rank interchanges happened. Over all eleven countries an average 45.3% of the total ton kilometres of a country correlate significantly with the economic indicator, more than 5% less compared to the correlation with tonnes. With regard to the individual countries, it is remarkable that Spain, France, and Germany reach shares in the amount of more than 90%. With Austria ranking in fourth with 53.6%. The high ranking of this top-three trio is attributed to the fact that the transport performance in these countries is consequently higher. If the significance level of 10% is taken as a threshold, it leads to partly immense increases. In the case of the Netherland (22.9%), Belgium (26.5%), and especially Luxembourg (36.1%), the significantly explainable ton kilometres rises greatly. Moreover, in the case of Sweden (8.0%), Austria (8.9%), and Denmark (12.8%), the increase is around 10%. Altogether, the average value for the 10% significance level is 56.7% and thus, the value of the correlation with tonnes is almost reached.

Figure 8 Summarised presentation of the significantly explained amount of commodities for all considered countries (ton kilometres)

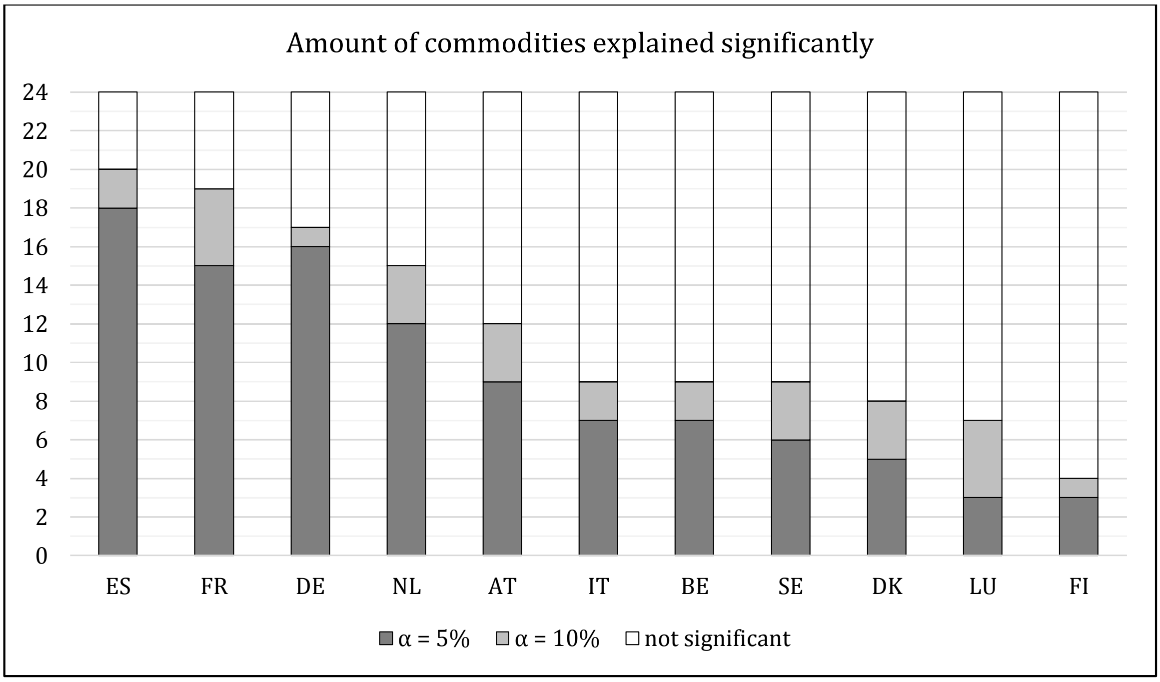
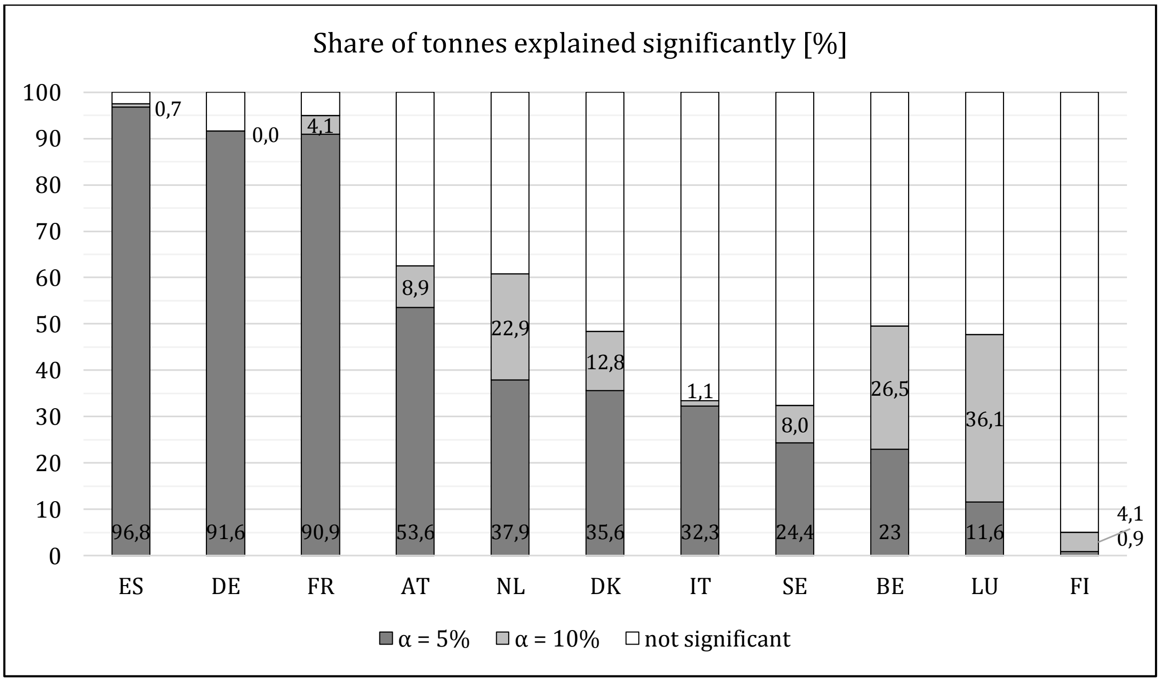


Figure 9 Summarised presentation of the significantly explained share of tonnes for all considered countries (ton kilometres)



4.5 Cross-sectional regression analysis

As already mentioned in chapter 2, one basic assumption for the regression analysis is that the individual observed data points are independent of each other. However, the used data are very likely subject to time-dependency, because a concrete data point is influenced by the value on an earlier point in time. For the analysis a comprehensive set of data in the form of a panel data is available. These two-dimensional data sets comprise numerous observations for the 11 selected countries within a time period of 9 years between 1999 and 2007. Dependent on which dimension is considered, different analyses can be performed. The relation between freight transport and economy is investigated so that ultimately findings regarding freight transport modelling can be gained. Thereby, forecasting is of particular interest and for this reason extensive time series regressions are carried out in this thesis to analyse the development of freight variables as well as economic parameters and especially their relation over time.

In this section, the other dimension of the data set will be the basis for the regression analysis to exclude time-dependency of the used variables. In terms of a cross-sectional analysis, the observations of the several countries in one particular point in time are taken into account. More precisely, the observed data points of the economic indicator and freight volume are used for the selected countries represented in the span of one year. In Table 36, the results of the cross-sectional analysis for the year 2007 are depicted. The findings for the foregoing years till 1999 are presented in the annex Section 7.

The outcomes of the cross-sectional analysis for the year 2007 show that the coefficient of determination R^2 for 15 or 22 out of 24 commodities reveal significant results on a 5% level. Similar to the results of the linear regression, the usage of the economic indicator derived from use tables leads to more significant results than the usage of the supply based ones. It is apparent that the two commodities NST/R-4 and -8, which show no significant result in terms of a regression with the use-based indicator, also do not reveal significant results under usage of the supply-based economic indicator.

As the other fact sheets in the annex present, in other years many similar significant correlations are observed. In the annex Section 7 the outcomes for all nine years within the considered time span are juxtaposed. Each table cell represents a combination of one commodity and a particular year (commodity-year-pair), so that line-by-line the correlations of economic indicator and freight variable for one kind of good across the years is presented.

Altogether, in both tables a vast majority of the findings have significant results on at least a 10% level (highlighted light in the tables) and most of the R^2 values display a significance on a 5% level (highlighted dark in the tables). In the case of supply-based findings, only 43 out of 216 R^2 values are not significant (19.9%), and in the case of use-based results, only 12 R^2 values are not significant (5.6%). Coefficients of determination with a value greater than $R^2>0.80$ are marked bold in the tables and it can be stated that large parts of the R^2 values exceed this threshold. Similar to the results for the year 2007 in Table 36 all commodity-year-pairs, which are not explained significantly through the use-based economic indicator, show also no significant correlation due to the indicator derived from supply tables. In other words, the outcomes for both kind of indicators are congruent and the use-based cross-sectional regression reveals additional significant results in the cases of 31 commodity-year-pairs. With regard to the non-significant values, it is obvious that a few commodities are affected with non-significant results in multiple or even all years within the considered time span. The good NST/R-4 “Wood and cork” do not show any significant R^2 value for either the supply- or the use-based correlation within the nine years. With respect to the supply-based cross-sectional regression NST/R-8 “Solid mineral fuels” and NST/R-23 “Leather, textile, clothing, other manufactured articles,” also do not reveal any significant result. In the case of NST/R-5, -10, -11 and -9, no significant results in up to six years are given. Latter commodities also affect the use-based cross-sectional regression.

Table 36 Result fact sheet for the cross-sectional regression analysis based on tonnes for the year 2007

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**
1	**0,53**	**0,58**	**0,0258**	**0,0176**
2	**0,42**	**0,48**	**0,0599**	**0,0398**
3	**0,61**	**0,67**	**0,0134**	**0,0072**
4	0,08	0,14	0,4755	0,3237
5	**0,28**	**0,67**	**0,1392**	**0,0071**
6	**0,60**	**0,80**	**0,0143**	**0,0012**
7	**0,70**	**0,72**	**0,0048**	**0,0037**
8	0,01	**0,40**	0,8180	**0,0684**
9	**0,58**	**0,96**	**0,0167**	**0,0000**
10	0,18	**0,67**	0,2507	**0,0067**
11	**0,42**	**0,84**	**0,0611**	**0,0006**
12	**0,47**	**0,64**	**0,0413**	**0,0096**
13	**0,77**	**0,96**	**0,0018**	**0,0000**
14	**0,61**	**0,92**	**0,0135**	**0,0001**
15	**0,40**	**0,85**	**0,0686**	**0,0004**
16	**0,83**	**0,74**	**0,0006**	**0,0028**
17	**0,99**	**0,97**	**0,0000**	**0,0000**
18	**0,91**	**0,89**	**0,0001**	**0,0001**
19	**0,51**	**0,65**	**0,0303**	**0,0087**
20	**0,76**	**0,86**	**0,0023**	**0,0003**
21	**0,92**	**0,91**	**0,0000**	**0,0001**
22	**0,87**	**0,92**	**0,0002**	**0,0000**
23	0,19	**0,69**	0,2422	**0,0054**
24	**0,56**	**0,93**	**0,0212**	**0,0000**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			15	22

5. Interpretation of the results

In the previous chapter, the regression analyses were carried out with help of the developed methodology, which brings the economic indicator and the freight volume or transport performance together. The representation of the outcomes for each country individually was paramount, and coefficients of determination and their significances were presented in terms of fact sheets. This kind of representation depicts the findings, especially those of the significant commodities and the aggregated shares, for each country at a glance. The results displayed obvious disparities between the several countries.

This chapter focusses on the comparison of the results across countries. Because the purpose of this thesis is to identify goods whose volume is strong and significantly correlated to the economic indicator, special consideration is paid to the 24 commodities previously discussed. Strong correlating goods could be estimated well, and thus can contribute to a more precise freight generation in transport modelling. Furthermore, this consideration offers answers to the debate about coupling and decoupling of transportation and economic activities differentiated according to commodity classes. For this purpose, the absolute number and kind of goods with significant results should be emphasized in the interpretation opposite to the relative distribution and aggregated proportions. The interpretation of relative results is of secondary importance, as the varying shares of a commodity for different countries often renders the comparison deceptive (see annex Section 6). Classifying a result as significant presupposes a significance level of 10%.

In the first part of the chapter, the significant results for all analysed countries are represented in “result matrices”. The three matrices for the regression analyses with the freight volume and ton kilometres are each given. One matrix shows the outcomes for the analyses with the economic indicator derived from supply tables and another matrix shows the results for the usage of the use-based indicator. These matrices show, at a glance, whether the correlation between an economic indicator and a freight variable for a certain commodity and country (further referred to as a country-commodity-pair) reveals or does not reveal a significant result. In a third aggregated matrix supply and use-based result matrices are brought together and if a country-commodity-pair has two significant outcomes, then the more significant one is depicted.

In this context, an important remark about the mode of expression in the following of the thesis must be stated. If the correlation between the freight volume or ton kilometres of a particular commodity and the according economic indicator reveal a significant coefficient of determination, then the country-commodity-pair is shortly called *significant*. If a commodity shows quite a few significant results for several countries, then it is called *often significant*. In contrast, *rarely significant* kinds of goods are those which only reveal significant results in exceptional cases.

In contrast to this more general representation and interpretation, in the next part of the chapter selected results are considered in detail. Due to the enormous set of data and results, the commodities are classified into two “focus groups” for the regression analyses with the freight volume and ton kilometres. The classification is first explained and then the findings are interpreted.

5.1 Summarised representation of the significant results

After considering the results of the correlation analysis individually for each analysed country, the results for each country will be compared between each other. The comparison focuses on the significance level of the correlations. Therefore, a matrix representation is chosen in which each country is represented in a single column and the several commodities are depicted in single lines. Eleven Countries and 24 commodities lead to a maximum of 264 country-commodity-pairs for which the significance is determined. However, for a few country-commodity-pairs, no result could be calculated due to their economic indicators with a value of nil. Those cells are marked gray in the following tables and are identical for both freight variables tonnes and ton kilometres. An economic indicator can accept the value nil if either the gross value added of a relevant industry is nil or a particular value in a supply or use table is nil. An economic indicator is not available for commodity NST/R-9 "Crude petroleum" in the case of Spain, Finland and Luxembourg. With regard to Luxembourg, it must be mentioned that several indicators are not computable. For altogether 12 commodities, no economic variable could be derived from the statistics. A detailed insight in the supply and use tables reveal that the absence of the supply of products is responsible for the non-existent indicators. In particular, supply-based indicators cannot be generated because no supply of products is shown.

If the relationship of the economic indicator and the transport variable for a certain commodity in a specific country exceeds the defined significance level, then the country-commodity-pairs are highlighted in colour. Furthermore, the significance levels are distinguished through colour as well; if they are higher than 10% the colour of the cells are bright and if they exceed 5% the colour of the cells are dark.

With regard to freight generation modelling, the applied methodology aims at ascertaining commodities, which relation to the developed economic indicator is showing significant results. Gaining knowledge about the number and the kind of commodities revealing significant results due to the methodology for a certain country is of predominant interest. The determination of the share of tonnes or ton kilometres that consequently can be significantly explained by using the methodology is of second priority, because the relative proportions vary between countries. The main focus is on identifying commodities, which reveal often significant correlations in a transnational context and not to predict the greatest share of transported freight within a country.

5.1.1 Result matrix tonnes

First, the outcomes of the correlation of the economic indicators with the transported tonnes are mentioned. While Table 37 gives an overview for the significant results of the regression analysis with the economic indicators based on supply tables, the results referring to the analysis with the use-based indicators are presented in Table 38.

In the case of supply-based results, altogether roughly one third of the calculable country-commodity-pairs are significant of at least 10% (87 of 252 pairs, 34.5%). A great majority of more than 80% of these results (70 pairs) have a significance level of 5% and lower. With regard to the use-based findings, it is evident that the majority of the results are significant. Exactly 108 of 259 (41.7%) country-commodity-pairs are significant of at least 10%, which is on an average approximately two commodities more per country. Here again, a bit more than 80% of the significant results are significant of a 5% significance level (88 pairs).

For nine of the eleven analysed countries, the regression with the use-based economic indicator leads to a higher amount of significantly explainable commodities than the regression with the supply-based indicator. For some countries as Germany, the Netherlands, and Belgium the regression analysis using the economic indicators derived from use tables reveal four correlations more compared to the supply-based indicator. However, the two exceptions are the Scandinavian countries Finland and Denmark. In the case of Finland, a relation for three kinds of goods is observed for each of the indicators, and in the case of Denmark, twice as many commodities correlate significantly with the supply-based indicator than with the use-based one.

Furthermore, the matrices display obvious differences in the findings for these countries. To receive a better overview about the findings, the countries are arranged with regard to the amount of commodities that are significantly explained. As the comparison between Table 37 and Table 38 shows, the rankings of the countries are, for the most part, similar.

In the case of Spain, the most significant correlations are found for 19 supply-based and 20 use-based relations between indicator and freight volumes. At the end of the ranking for Sweden or Finland, only maximum three significant relations are identified. Besides Spain, the other notable national economies are Germany, Italy, France, the Netherlands, and Austria, which reveal the most commodities explained significantly. On average, 7.9 commodities per country in the supply result matrix and 9.8 commodities per country in the use result matrix have significant results.

In Table 39 Summarised result matrix for the outcomes of the regression between the economic indicator and tonnes the outcomes of both analyses are brought together. If a country-commodity-pair exhibits significant results for the supply-based regression as well as for the use-based analysis, then the result with the higher significance level is depicted. In the aggregate for nearly half of all the country-commodity-pairs that could be found display significant results of 10% (129 of 259, 49.8%). A majority of more than 85% of the results display a significance level of 5% (110 pairs). This value is remarkably higher compared to the findings of either the supply-based regression or the use-based one, because in the aggregation the more significant values assert. The correlation between freight volume and economic indicator for 47 country-commodity-pairs (36.4%) can be reduced to the usage of the supply-based indicator, while the usage of the use-based indicator reveals significant results for 82 country-commodity-pairs (63.6%). Consequently, the conclusion following to the separate assessment of the results based on supply or use tables is emphasized with regard to the aggregated consideration: the regression analysis with the economic indicator derived from use tables leads to much more significant correlations than the usage of the supply-based indicator. This is also valid in particular cases for each country, except for Denmark, where the usage of the supply-based indicator leads to more significant results. As an example to interpret the summarising Table 39 Summarised result matrix for the outcomes of the regression between the economic indicator and tonnes in the right way: in the case of Germany, a significant relation between the freight volumes of altogether 15 out of 24 commodities with an economic indicator is calculated. Nine commodities exhibit a significant relation with regard to the use-based indicator; accordingly the remaining six kinds of goods are related to the supply-based indicator.

Moving forward, the perspective of the interpretation shifts in focus from the countries to a view of the commodities themselves. In short, both the supply-based as well as the use-based regression analyses reveal at least one significant result for every commodity. On average, 3.6 commodities per country have significant results if the supply-based indicator is taken into account (Table 37).Using the indicator derived from the use tables leads roughly to one additional significantly explained commodity per country (4.5) (Table 38). With regard to the supply-based result matrix, it is evident that 14 commodities have significant results in one to three countries and ten commodities show significant results in four or more countries. On the other hand, when taking into account the use-based indicators, a majority of 17 commodities have significant results in at least four countries. Six kinds of goods are explained significantly in more than half of the countries. Considering the commodities that are explained at least four times, the following eight kinds of goods are identified in both results matrices: NST/R-8, -13, -14, -15, -20, -21, -23 and -24.

Considering the aggregated results of the supply-based and use-based analyses in Table 39, each commodity is explained through two countries. Here, almost half of the commodities, namely eleven, are explained significantly in more than half of the countries. On average, 5.4 commodities per country show significant results.

Table 37 Result matrix for the outcomes of the regression between the supply-based economic indicator and tonnes

	Country	**ES**	**NL**	**AT**	**DE**	**IT**	**DK**	**FR**	**BE**	**LU**	**FI**	**SE**	
NST/R													
1		x					x				x		3
2		x					x						2
3		x					x						2
4			x	x				x					3
5		x		x						x			3
6		x		x		x	x						4
7		x			x				x				3
8		x	x	x			x				x		5
9			x		x								2
10		x	x										2
11			x	x					x				3
12			x										1
13		x	x	x	x	x							5
14		x		x	x	x		x		x			6
15		x	x		x	x		x		x			6
16		x						x	x				3
17		x						x			x		3
18		x	x				x		x	x			5
19		x				x	x						3
20		x	x	x	x	x							5
21		x		x	x	x		x					5
22					x								1
23		x	x		x	x	x						5
24		x		x	x	x		x	x			x	7
		19	11	10	10	9	8	7	5	4	3	1	Amount of sign. commodities

<u>Legend</u>

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Grey cell represent non-calculable values.

Table 38 Result matrix for the outcomes of the regression between the use-based economic indicator and tonnes

	Country	ES	NL	DE	AT	IT	FR	BE	LU	DK	SE	FI	
NST/R													
1		x	x	x		x			x		x		6
2		x			x		x					x	4
3		x	x			x	x	x					5
4		x	x		x				x				4
5					x								1
6		x		x	x								3
7		x	x	x		x				x			5
8			x	x		x						x	4
9			x				x						2
10		x	x	x			x		x				5
11		x	x		x			x				x	5
12		x	x			x							3
13		x	x	x	x	x							5
14		x		x	x		x	x	x				6
15		x	x	x		x	x						5
16		x		x			x	x			x		5
17		x					x			x			3
18		x	x						x				3
19		x			x	x	x	x		x			6
20		x	x	x	x	x		x					6
21		x		x	x	x		x					5
22			x	x									2
23		x	x	x	x	x		x					6
24		x		x	x	x	x	x	x	x	x		9
		20	15	14	12	12	10	9	6	4	3	3	Amount of sign. commodities

<u>Legend</u>

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Grey cell represent non-calculable values.

Table 39 Summarised result matrix for the outcomes of the regression between the economic indicator and tonnes

	Country	ES	DE	NL	IT	AT	FR	DK	BE	LU	FI	SE	
NST/R													
1		x	x	x	x			x		x	x	x	8
2		x				x	x	x			x		5
3		x		x	x		x	x	x				6
4		x		x		x	x			x			5
5		x				x				x			3
6		x	x		x	x		x					5
7		x	x	x	x			x	x				6
8		x	x	x	x	x		x			x		7
9			x	x			x						3
10		x	x	x			x			x			5
11		x		x		x			x		x		5
12		x		x	x								3
13		x	x	x	x	x							5
14		x	x		x	x	x		x	x			7
15		x	x	x	x		x			x			6
16		x	x				x		x				4
17		x					x	x			x	x	5
18		x		x				x	x	x			5
19		x			x	x	x	x	x				6
20		x	x	x	x	x			x				6
21		x	x		x	x	x		x				6
22			x	x									2
23		x	x	x	x	x		x	x				7
24		x	x		x	x	x	x	x	x		x	9
		22	15	15	14	13	12	11	11	8	5	3	Amount of sign. commodities

<u>Legend</u>

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Grey cell represent non-calculable values.

5.1.2 Result matrix ton kilometres

The results of the correlation of the economic indicators with the rendered ton kilometres are now mentioned. While Table 40 gives an overview for the significant results of the regression analysis with the economic indicators based on supply tables, the results referring to the analysis with the use-based indicators are presented in Table 40. In the case of supply-based results, altogether 36.5% of the calculable country-commodity-pairs are significant on at least a 10% level (92 of 252 pairs). A majority of goods, specifically 70% of these results (65 pairs), have a significance level of 5% or lower. With regard to the use-based findings, an increase in 20 more significant results is evident. 112 of 259 (43.2%) country-commodity-pairs are significant on at least a 10% level. In this case, roughly three quarters of the results are significant on a 5% level (83 pairs).

For nine of the eleven analysed countries, the regression with the use-based economic indicator leads to a higher amount of explainable commodities than the regression with the supply-based indicator. For France and Sweden, the regression analysis using the economic indicators derived from use tables reveal four to five correlations more compared to the supply-based indicator. However, Germany and Spain are exceptions. In the case of Germany, one commodity less correlates significantly with the use-based indicator than with the supply-based one, and in the case of Spain, a relation for 18 kinds of goods is observed for each of the two indicators.

As the comparison between Table 40 and Table 41Table 38 shows, the rankings of the countries are, for the most part, similar. Spain again leads the ranking, with Luxembourg and Finland ranking at the end, whereby for Luxembourg several results are once more not computable. Besides Spain, the other notable national economies are Germany, France, the Netherlands, and Austria, which contribute to the leading group in both the supply and the use matrices. On average, 8.4 commodities per country in the supply result matrix and 10.2 commodities per country in the use result matrix have significant results.

In the aggregate presented in Table 42, for nearly half of all the country-commodity-pairs, significant results of at least a 10% level could be found (129 of 259, 49.8%). A majority of close to 80% of the results displayed significance levels of 5% (101 pairs). The correlation between ton kilometres and the economic indicator for 49 country-commodity-pairs (38.0%) can be reduced to the usage of the supply-based indicator, while the usage of the use-based indicator reveals significant results for 80 country-commodity-pairs (62.0%). Consequently, the conclusion following to the separate assessment of the results based on supply or use tables is emphasized with regard to the aggregated consideration: the regression analyses with the economic indicator derived from use tables lead to greater significant correlations than the usage of the supply-based indicator. This is the case for each country, apart from two exceptions. Once more, in the case of Denmark, the usage of the supply-based indicator leads to more significant results and this time also for Germany, wherein six use-based explained commodities are accompanied by eleven kinds of goods with significant results of the supply-based analysis.

Emphasizing now the interpretation of the findings towards the commodities, it can be stated that also with the transport performance as dependent variable for every commodity, at least one significant result is revealed. On average, 3.8 commodities per country have significant results if the supply-based indicator is taken into account (Table 40). Using the indicator derived from the use tables leads roughly to one additional significantly explained commodity per country (4.7)

(Table 41). With regard to the supply-based result matrix, it can be stated that 14 commodities have significant results in one to three countries and ten commodities show significant results in four or more countries. On the other hand, when considering the use-based indicators, a majority of 16 commodities have significant results in at least four countries. One third of the 24 commodities are explained significantly in more than half of the countries. Considering the commodities that are explained at least four times, the following nine kinds of goods are identified in both result matrices: NST/R-7, -8, -10, -14, -15, -18, -21, -23 and -24.

Considering the aggregated results of the supply-based and use-based analyses Table 42 ten commodities are explained significantly in more than half of the countries. On average, 5.4 commodities per country show significant results.

Table 40 Result matrix for the outcomes of the regression between the supply-based economic indicator and ton kilometres

	Country	**ES**	**DE**	**FR**	**NL**	**AT**	**IT**	**DK**	**BE**	**SE**	**LU**	**FI**	
NST/R													
1		x	x	x									3
2		x	x										2
3		x	x										2
4				x		x							2
5		x		x		x	x				x		5
6		x		x						x			3
7		x	x					x	x				4
8		x		x	x	x			x	x			6
9			x		x		x						3
10		x	x	x	x	x							5
11					x				x				2
12					x							x	2
13		x	x		x								3
14		x	x	x			x	x					5
15		x	x	x	x	x		x	x		x		8
16					x	x							2
17		x	x	x									3
18		x	x	x	x	x	x	x			x		8
19		x			x			x					3
20		x	x								x		3
21		x	x		x	x	x					x	6
22						x							1
23		x	x	x				x		x			5
24		x	x	x			x		x	x			6
		18	15	12	11	9	6	6	5	4	4	2	Amount of sign. commodities

Table 41 Result matrix for the outcomes of the regression between the use-based economic indicator and ton kilometres

	Country	**ES**	**FR**	**DE**	**NL**	**AT**	**SE**	**IT**	**DK**	**BE**	**LU**	**FI**	
NST/R													
1		x			x			x					3
2		x	x			x							3
3			x	x	x		x						4
4						x							1
5			x					x					2
6		x	x	x		x	x						5
7		x	x	x	x	x	x		x		x	x	9
8		x			x		x	x		x			5
9			x		x								2
10		x	x	x	x	x					x		6
11		x			x			x	x	x			5
12		x			x								2
13		x	x	x	x				x				5
14		x	x	x				x	x		x		6
15		x	x	x	x	x			x		x		7
16					x	x				x			3
17		x	x	x			x						4
18		x	x	x	x	x	x	x	x		x		9
19		x	x	x					x	x			5
20		x	x	x	x						x		5
21		x		x	x	x	x	x		x		x	8
22						x							1
23		x	x	x			x			x		x	6
24		x	x	x			x	x		x			6
		18	16	14	14	10	9	8	7	7	6	3	Amount of sign. commodities

<u>Legend</u>

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Grey cell represent non-calculable values.

Table 42 Summarised result matrix for the outcomes of the regression between the economic indicator and ton kilometres

	Country	ES	FR	DE	NL	AT	IT	SE	BE	DK	LU	FI	
NST/R													
1		x	x	x	x		x						5
2		x	x	x		x							4
3		x	x	x	x			x					5
4			x			x							2
5		x	x			x	x				x		5
6		x	x	x		x		x					5
7		x	x	x	x	x		x	x	x	x	x	10
8		x	x		x	x	x	x	x				7
9			x	x	x		x						4
10		x	x	x	x	x					x		6
11		x			x		x		x	x			5
12		x			x							x	3
13		x	x	x	x					x			5
14		x	x	x			x			x	x		6
15		x	x	x	x	x			x	x	x		8
16					x	x			x				3
17		x	x	x				x					4
18		x	x	x	x	x	x	x		x	x		9
19		x	x	x	x				x	x			6
20		x	x	x	x						x		5
21		x		x	x	x	x	x	x			x	8
22						x							1
23		x	x	x				x	x	x		x	7
24		x	x	x			x	x	x				6
		20	19	17	15	12	9	9	9	8	7	4	Amount of sign. commodities

<u>Legend</u>

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Grey cell represent non-calculable values.

5.1.3 Result matrices – summarising comparison

The interpretation of the result matrices is finished with a short comparison of the outcomes of the regression analysis, either based on the freight volume or on the transport performance. Thereby, the quantity of commodities obtaining significant results is the basis for the description. A comparison of significantly explained proportions is not possible, because the share of one commodity often is very different with regard to either the transported tonnes or the ton kilometres. For example, bulk commodities like petroleum, metals, or ores (NST/R-8, -10, -12 and -13) are heavy and therefore transported via inland waterway vessels and railways across long distances.

In the aggregate for both kinds of transportation variables – freight volume as well as ton kilometres – the regression analysis leads to exactly the same amount of significant results on a 10% level from 129 of 259 country-commodity-pairs. In other words, every second possible value achieves a significant result under usage of the applied methodology. However, the results are highly differentiated over the considered countries and commodities, which consequently could be split into two groups: one for often significant and another for rarely significant countries and respectively commodities. Another similarity is that the correlation with the economic indicators derived from use-tables leads to grater significant results in both matrices for tonnes (21 more) as well as ton kilometres (20 more). However, the analysis with the transport performance as dependent variable reveals more significant values. More precisely, in the case of supply-based correlations, five more results are given and in the case of use-based correlations, four more results are given. In the aggregate, however, the sums of results are equal to what has been previously mentioned. Thus, nine more country-commodity-pairs have two significant outcomes, both for regressions with supply-based and use-based indicators.

Altogether six commodities are identified for which the regression analyses with tonnes and ton kilometres both result in at least four significant findings per matrix. These commodities are:

- NST/R-8 Solid mineral fuels
- NST/R-14 Cement, lime, manufactured building materials
- NST/R-15 Crude and manufactured minerals
- NST/R-21 Manufactures of metal”
- NST/R-23 Leather, textile, clothing, other manufactured articles
- NST/R-24 Miscellaneous articles

On the other hand, the following three commodities do not reveal more than three significant results in any analyses, also keeping in mind that the correlations for NST/R-9 are not entirely computable.

- NST/R-9 Crude petroleum
- NST/R-12 Non-ferrous ores and waste
- NST/R-22 Glass, glassware, ceramic products

By answering the question of which freight variable has to be used to receive more significant results, it is possible to draw the conclusion that the regression analysis with the freight volume works better for most countries. Only in the cases of Germany, Sweden, and France does the usage of the transport performance as a variable reveal more results. While the improvement in the case of Germany amounts for just two commodities, in the case of Sweden, six more commodities accrue significant results, and in the case of France, seven more commodities accrue significant results, which is a prominent shift towards a better explanatory.

5.2 Detailed interpretation of selected significant results

As the results have been outlined and elaborated on with the use of result matrices, now a more detailed interpretation of the findings of the regression analyses will follow. This interpretation focuses on a determined set of countries chosen for analysis – a focus group – with discussion of countries external to this focus group remaining on the periphery.

Before the definition of the focus groups is justified, explanations for the subsequent interpretations are given. In principle, the interpretations and conclusions concern the countries of the focus groups. However, at certain points, comparisons to the results of the whole set of analysed countries are taken into account to confirm or disprove a statement. Often average values of the focus groups are mentioned to give a rough impression of certain information. The following interpretation focusses in particular on the polar extreme gradients of significant commodities.

5.2.1 Definition of two focus groups

The detailed interpretation is distinguished regarding the two freight variables used in the regression analysis; tonnes and ton kilometres. The determining factor to establish the two focus groups is the number of commodities which reveal significant results. An amount of twelve or more kinds of goods, thus at least half of the commodity's categorization NST/R, is defined as a threshold to determine the inclusion of a country into a focus group. The figures from the previous chapter illustrate the choosing of the focus group of countries and are for this reason displayed again. The focus groups are from here out differentiated as marked in Figure 10Figure 6 and Figure 11. The countries chosen are listed in the following Table 43.

Table 43 List of the focus groups

"focus group tonnes"	**"focus group ton kilometres"**
Spain (ES)	Spain (ES)
Germany (DE)	Germany (DE)
Netherlands (NL)	Netherlands (NL)
Italy (IT)	Austria (AT)
Austria (AT)	France (FR)
France (FR)	

In the case of the analyses with the freight volume as representative transportation variable six countries and in the other analysis case five countries meet the criteria. It is interesting that the "focus group ton kilometres" is congruent to the "focus group tonnes", wherein Italy as sixth country completes the sample. Similar focus groups enable possible comparisons between them over the course of the interpretation, but especially one important conclusion can be drawn: the same countries have a considerable amount of significant explained commodities.

With Germany, France, Spain, and the Netherlands – in “focus group ton kilometres” also Italy – the national economies with the greatest gross domestic product (GDP) and gross value added (GVA) are part of the selections (see Figure 12 and Figure 13). Complementing, the Figure 7 and

Figure 9 in chapter 4 depict the shares of tonnes and ton kilometres respectively of the significantly explained kinds of goods. It is also evident that the countries of the two focus groups attain the highest values compared to the rest of the previously considered countries outside of the representative sample. The only exception is Luxembourg, if the relative freight volume is considered, but this country maintains a special exception status, as several results are not computable due to non-existent supply and use of those products. Hence, comparisons with the other countries have been taken out of consideration in order to be able to work with a compatible representative sample.

Figure 10 Summarised presentation of the significantly explained amount of commodities for all considered countries (tonnes); focus group marked

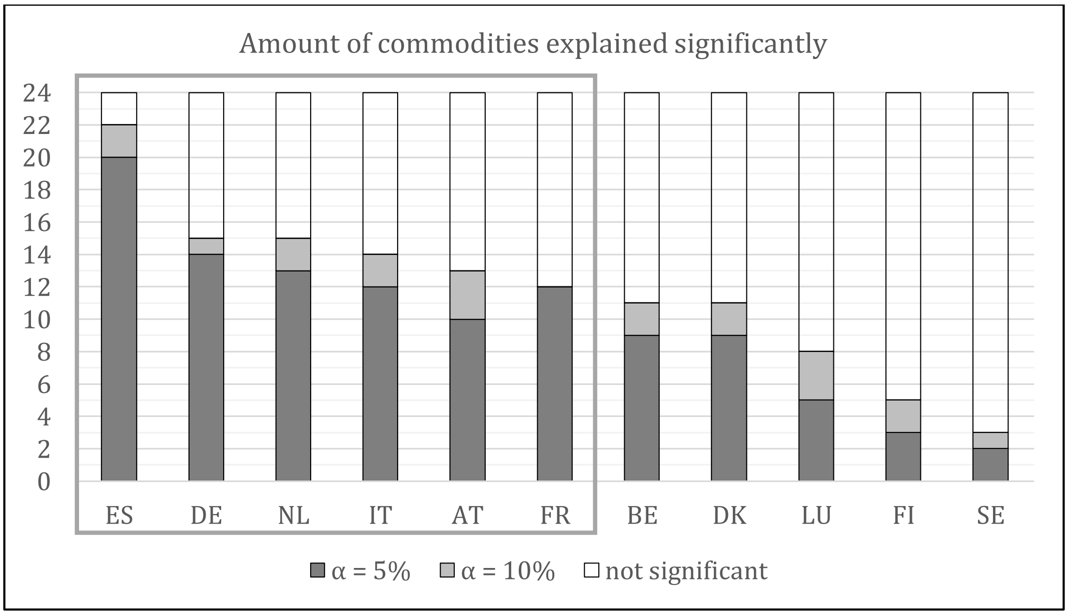
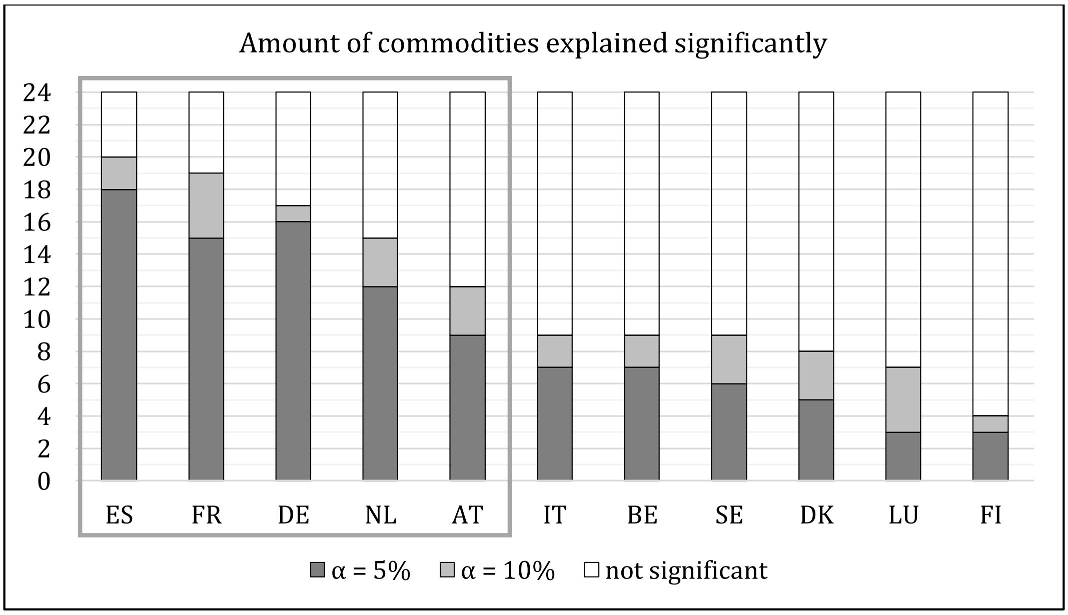


Figure 11 Summarised presentation of the significantly explained amount of commodities for all considered countries (ton kilometres); focus group marked



5.2.2 Interpretation of the countries' characteristics

As representative expressions for the power of the national economies, in Figure 12 the gross domestic product as well as the gross value added are displayed, and in Figure 13 the exports and imports of goods and products are displayed. The focus groups are framed, and thus it is clearly visible that the countries of the focus groups exhibit the highest amount of significant results. Austria also maintains a status of special exception, because the GDP, GVA, and trading operations are to the same scale as in the cases of Belgium, Denmark, or Sweden; however, Austria has remarkably more significant results.

At this point, a particularity in the case of Spain should be mentioned. With regard to the results of the economic indicators, it is obvious that the values for the year 2007 are remarkably smaller compared to the previous years, while the value for the freight volume is within the range of the previous years. For identifying such enormous statistical outliers, which distort the subsequent regression analysis, a ratio of the freight data and the indicators derived from supply and use tables is computed. In Table 44, the quotients for commodity NST/R-1 are given and the statistical outliers are marked. This phenomena is also observed for most of the other commodities and consequently the data for the year 2007 are excluded from the regression analysis. The same analysis is done for all other countries, but no further exclusions are necessary.

Figure 12 Gross domestic product and gross value added of the selected countries in billion Euro (2007) (10)

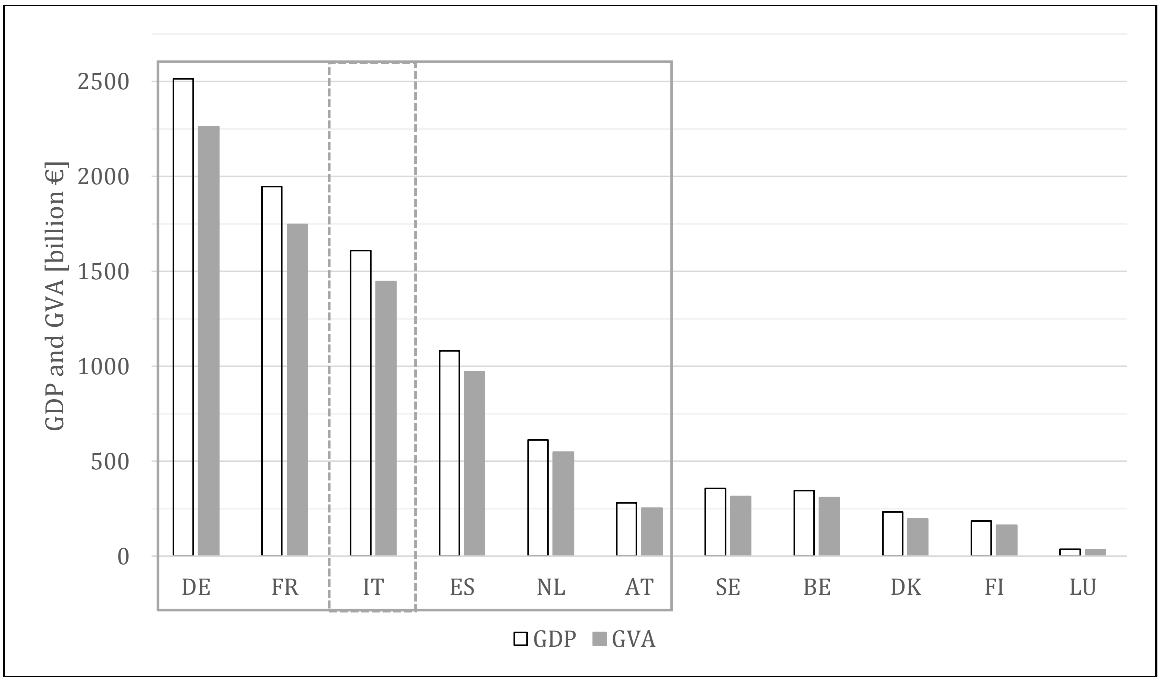


Figure 13 Export and import of goods and products of the selected countries in billion Euro (2007) (11)

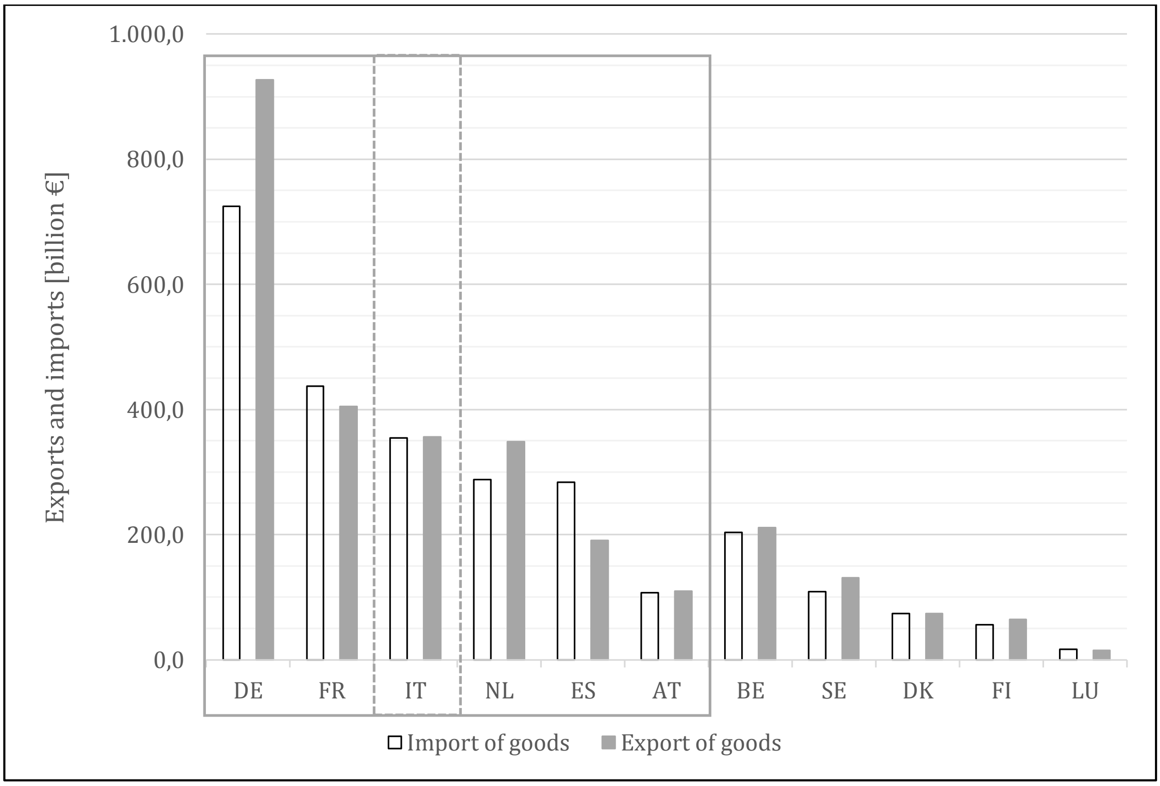


Table 44 Identification of statistical outliers before performing the regression analysis for NST/R-1 in the case of Spain

Year	Freight volume [1,000 t]	EI_use [€]	Freight volume/ EI_use	EI_supply [€]	Freight volume/ EI_supply
1999	25,603	4,471.58	5.7	6,068.10	4.2
2000	27,352	4,824.16	5.7	6,499.68	4.2
2001	27,461	4,890.47	5.6	6,285.21	4.4
2002	34,617	5,161.87	6.7	6,838.00	5.1
2003	37,623	5,541.24	6.8	6,839.24	5.5
2004	31,116	5,702.58	5.5	7,024.62	4.4
2005	32,654	5,914.47	5.5	6,431.03	5.1
2006	37,687	6,091.91	6.2	7,062.11	5.3
2007	35,416	1,093.11	**32.4**	47.59	**744.2**

Since the construction of the bridge matrix, and the correlation depend on whether transportation data of road haulage and inland waterways is considered or solely the data of road haulage, no explicit statement regarding the involvement of a country in a focus group is derivable. Both kinds of underlying transportation data occur in the focus group (see Figure 14).

Furthermore, the amount of freight transport via inland waterways is differentially high and important and for a few countries not available at all. In contrast, railway transport occurs in all countries, but is not taken into consideration due to insufficient data. However, Figure 14 and Figure 15 show that the six countries of the focus group exhibit very different modal splits and this is true for the remaining countries as well. This leads to the conclusion that the modal split is not an indication of whether a country reveals more or less significant commodities. A tendency seems to be that high freight volumes reveal many significant results, which is true for Spain, Germany, and France. Conversely, Austria has by far the smallest freight volume of all of the countries in the focus group, even smaller than the amount of Belgium. However, Austria has more significant results than Italy, despite the fact that Italy's quantity of transported tonnes is more than threefold that of Austria (Table 45 and Table 46).

Figure 14 Modal split of the freight volume for the countries of the focus group

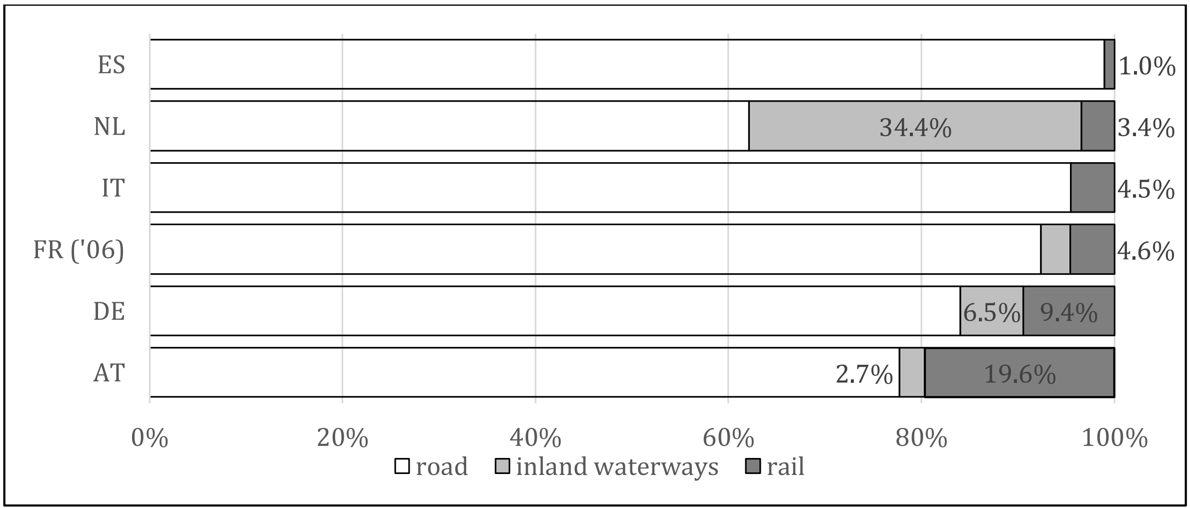


Table 45 Values of the modal split of the freight volume for the countries of the focus group

	Road haulage [1,000 t]	Railways [1,000 t]	Inland waterways [1,000 t]	Total [1,000 t]
ES	2,408,984	67,809	-	2,476,793
NL	636,170	34,867	352,615	1,023,652
IT	1,496,878	70,761	-	1,567,639
FR	2,181,715	108,333	71,448	2,361,496
DE	3,211,716	361,116	248,966	3,821,798
AT	354,338	89,522	12,107	455,967

Figure 15 Modal split of the freight volume for the remaining countries

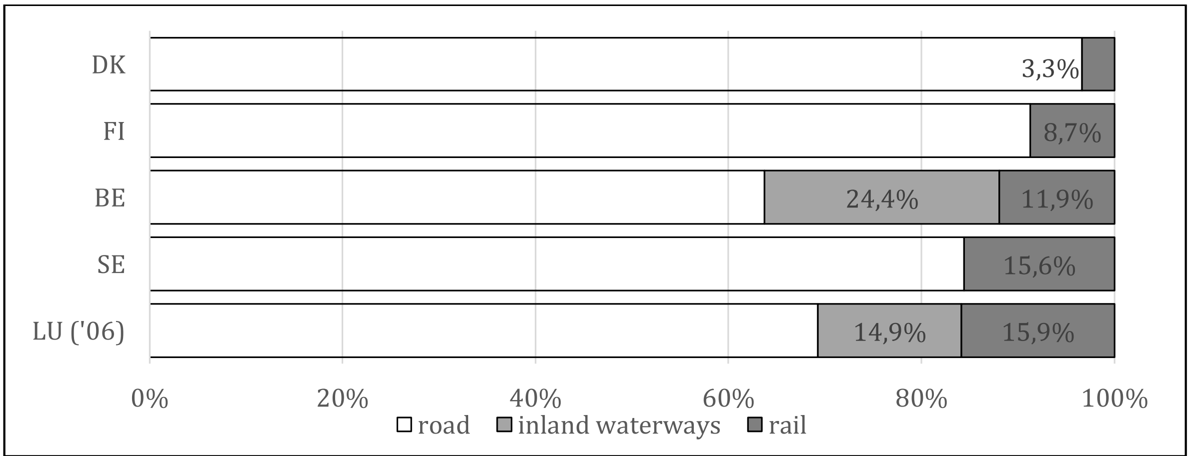


Table 46 Values of the modal split of the freight volume for the remaining countries

	Road haulage [1,000 t]	Railways [1,000 t]	Inland waterways [1,000 t]	Total [1,000 t]
DK	197,919	6,849	-	204,768
FI	422,161	40,288	-	462,449
BE	352,202	65,774	134,647	552,623
SE	367,283	67,809	-	435,092
LU	53,016	12,133	11,395	76,544

Also, the size and geographical location of the countries is very different from each other. These realities affect the usage of different modes of transport, in particular railways and inland waterways, which require expensive infrastructure. Moreover, the transport performance data of the modes tend to be higher for long-distance transport if a country is larger.

The size of the country does not entirely explain whether the number of commodities reveal correlations due to the applied methodology (Table 47). However, taking additional information about the boundary lines into account, a more expressive image arises. With regard to Table 48, it can be stated that the countries of the focus group – with exception of the Netherlands – have the most borderlands within the 11 analysed countries. It can be surmised that a high volume of transit transports characterize countries for which the methodology identifies many correlations. Transit transports occur especially in connection with seaports and hinterland transports. In particular in the Netherlands, where the largest European seaport Rotterdam is located, these hinterland transports play an important role, as do further seaports in the rankings belonging to countries of the focus group: Antwerp (BE), Hamburg (DE), Amsterdam (NL), Marseille (FR), Algeciras (ES) and Le Havre (FR) (35). The only exception in this list is Antwerp; however, Belgium is the country with the best results outside of the focus group. All in all, seaports are of particular interest because of their function to generate a lot of traffic at a single point.

Summarising the previous data and characteristics of the countries, it can be stated that the six countries, which reveal the most significant results, are quite heterogeneous. Generally speaking, it can be stated, that countries with large gross domestic product, large gross value added, and extensive exports and imports tend to have many significant correlations between the freight variable and the economic indicator. In contrast, neither the analyses considering freight data nor the modal split of a country give an impression or even allow for a conclusion to be formed, if a country will reveal rather more or less significant correlations. While the size of a country do not provide an explanation for the frequency of correlations, diverse connection to neighbouring countries due to the geographical location as well as the existence of larger seaports can be an indication for a good explanatory power of the methodology.

Table 47 Country sizes (2)

	Country size focus group		**Country size remaining countries**
ES	498,980.00 km²	**BE**	30,278.00 km²
DE	348,672.00 km²	**LU**	2,586.00 km²
FR	549,970.00 km²	**DK**	42,394.00 km²
NL	33,893.00 km²	**FI**	303,815.00 km²
AT	82,445.00 km²	**SE**	410,335.00 km²
IT	294,140.00 km²		

Table 48 Information about the boundary lines of the countries (3)

	Length of the border	Number of borderlands	Length of coastline		Length of the border	Number of borderlands	Length of coastline
	Focus group				**Remaining countries**		
ES	1,917.8 km	4	4,964.0 km	BE	1,385.0 km	4	66.5 km
DE	3,621.0 km	9	2,389.0 km	LU	359.0 km	3	0.0 km
FR	2,889.0 km	8	4,853.0 km	DK	68.0 km	1	7,314.0 km
NL	1,027.0 km	2	451.0 km	FI	2,681.0 km	3	1,250.0 km
AT	2,562.0 km	8	0.0 km	SE	2,233.0 km	2	3,218.0 km
IT	1,932.2 km	6	7,600.0 km				

5.2.3 Interpretation of "focus group tonnes"

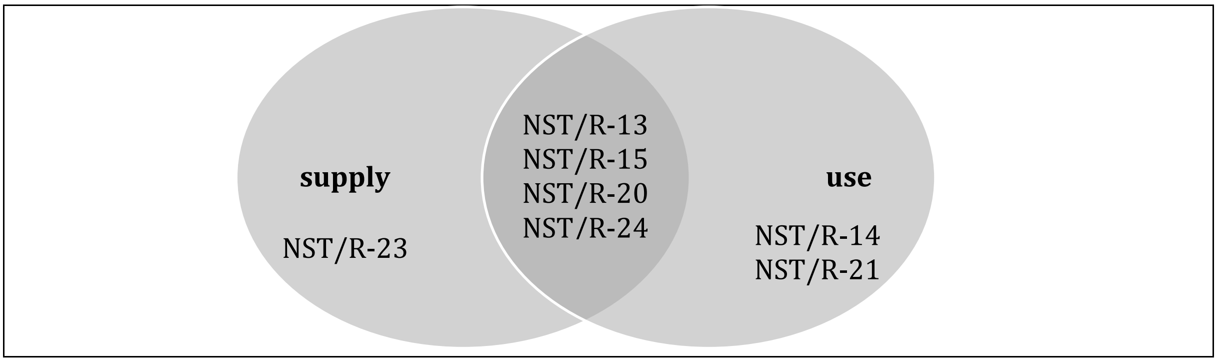
The following detailed consideration and interpretation comprises Spain, Germany, the Netherlands, Italy, Austria, and France. First, it is conspicuous that the correlation with the economic indicator derived from use tables leads to appreciably more significant results. In the use-based analysis, far more than half of the computable country-commodity-pairs reveal significant results (57.6%, 83 of 144), while in the case of supply-based analysis, just 45.8% of the results are significant (66 of 144). Bringing both indicators together and giving priority to the more significant results, altogether 63.6% of the computable country-commodity-pairs have significant results (91 of 143).

Figure 16 depicts such commodities at a glance, which reveal a significant correlation between the freight amount and an economic indicator in five of six countries. The graph shows that three commodities (NST/R-14, -21, -23) are significant in five separate instances if the analysis indicator is based either on supply or use tables. Special attention should be given to four kinds of goods (NST/R-13, -15, -20, -24), which have five significant results for each of the two indicators. On average for the six countries, these four commodities alone represent more than half of the total freight transports (52.4%) (Table 49).

Table 49 Proportions of the four often significant commodities

Commodity	Title of divisions	ES	DE	NL	IT	AT	FR	Average
NST/R-13	Metal products	2,7%	3,5%	3,5%	7,6%	2,8%	1,3%	
NST/R-15	Crude and manufactured minerals	44,4%	36,0%	19,5%	35,2%	39,6%	36,9%	
NST/R-20	Transport equipment, machinery, apparatus, engines [...]	2,7%	4,1%	3,9%	2,1%	1,8%	2,6%	
NST/R-24	Miscellaneous articles	4,8%	8,9%	13,8%	10,1%	11,7%	15,1%	
sum		54,7%	52,4%	40,7%	55,0%	55,9%	55,9%	52.4%

Figure 16 Graphical representation of most significant commodities in the case of regression analysis with the freight volume



As mentioned before, the commodities NST/R-14, -21, -23 are rendered significant in five separate instances, through either the supply or the use-based indicator. Taking the other economic indicator into account, the commodities reveal still four significant results. In general, it can be concluded that the most significant commodities exhibit a high concordance independent of which indicator is applied.

- NST/R-14 Cement, lime, manufactured building materials
- NST/R-21 Manufactures of metal
- NST/R-23 Leather, textile, clothing, other manufactured articles

Solely in the case of these three kinds of goods does the supply-based economic indicator reveal the most significant correlations. This is correct for NST/R-5, -14 and -21, which are exactly one time more significant compared to the use-based indicator. In contrast, for eleven commodities, the use-based indicator leads to more correlations. The significantly explained amount of following listed commodities is also clearly higher if the use-based indicator is used as explanatory variable.

- NST/R-1 Cereals
- NST/R-3 live animals, sugar beet
- NST/R-7 Oil seeds and oleaginous fruit and fats
- NST/R-10 Petroleum products
- NST/R-19 Paper pulp and waste paper

These commodities reveal four significant results with regard to the use-based indicator and only one or two with respect to the supply-based indicator. However, on average the aggregated proportion of this quintet on the total freight volume is about 8.2%, and accordingly the advantage of the use-based regression analysis, with regard to the number of results, does not reflect a considerable surplus with respect to the relative distribution.

In a broader context, the first three kinds of goods have to do with agriculture. By taking a closer look at the results, and curtailing the findings for Spain where these three kinds of goods correlate significantly, an interesting fact is noticeable. While for the supply-based regression analysis only in one single case is a significant result identified (NST/R-7 in Germany), there are, however, six significant results for Germany, France and Italy due to use-based regression analyses. Consequently, it can be summarised that the commodities in an agricultural context are more often significant due to the indicator derived from use tables. The few quantitative results of further commodities comprising agricultural and food products as well as animal fodder (NST/R-2 and -6) support this conclusion.

Now those commodities which reveal merely a few significant results are considered. Considering the outcomes from supply and use tables in the aggregate, the following four kinds of goods are maximally significant in two countries, one consistently being Spain in three out of four cases.

- NST/R-5 Textiles, textile articles and man-made fibres
- NST/R-17 Coal chemicals, tar
- NST/R-18 Chemicals other than coal chemicals and tar
- NST/R-22 Glass, glassware, ceramic products

The average share of the rarely significant commodities for the countries of the focus group is only 5.7%, with a range from 2.0% (AT) to 12.2% (NL). It is striking to note that both commodity groups, including chemical products, belong to the group of rarely significant commodities.

Expanding the focus for consideration to compare the results for all 11 countries, it can be stated that these four commodities still belong to the last third of commodities which have the fewest significant outcomes. However, NST/R-17 and -18 exhibit significant results in Denmark, Belgium, and Luxembourg. This is possibly due to their location at coastal areas and the existence of maritime ports, where such commodities are loaded and unloaded from sea-going vessels. The continental transport in countries where significant correlations are found is done primarily with inland waterway vessels. In the cases of Belgium and the Netherlands, where data are available, the share of transports of NST/R-17 and -18 by inland waterways have a significantly higher share compared to other countries as Table 50 depicts. While NST/R-17 accounts for on average 0.4% of the total freight amount of a country, NST/R-18 comprises a considerable proportion of 3.6% and is of particular interest, because it is a comparatively high share (see annex Section 6).

Table 50 Transports of NST/R-17 and 18 by inland waterways in selected countries

Share of transports by inland waterways	NST/R-17	NST/R-18
NL	79.9%	24.1%
BE	73.4%	31.3%
LU	no data	0.1%
DK	no data	no data
Average of „focus group“	48.1%	8.7%

Now the relevance of the transport mode for the commodities is taken into account to interpret the results of the regression analysis. This concerns the questions of how goods are transported and what kind of modal split a commodity has. The investigation focusses on the often and rarely significant commodities, the proportions of which are depicted in the left side of Table 51 and Table 52. With regard to the average shares applied, only the data of countries with significant results are used to compute them. In the right side of the tables, the average values of the opposite countries are given, which explain (Table 52) or do not explain (Table 51) the commodities significantly. Table 51 shows that some of the four kinds of goods have a considerably high share of railway transports, although freight transported by railways is not considered in the analysis due to a lack of data. On the contrary, Table 52 shows that the represented commodities reveal less significant results, although the shares of transports by railways are low. The findings in both tables are partly opposing and consequently it cannot be concluded that the missing data of railways effects the results of the regression analyses in a similar way. Commodities in both tables – the more often significant kinds of goods as well as the rarely significant – have a considerably high or low share of railway transports. As examples, the goods NST/R-13 and -15 are mentioned in Table 51 and the goods NSR/R-22 and -17 are mentioned in Table 52.

Even if the railway transports are not solely taken into account, but the modal split of the individual commodities as well, there still remains no visible scheme for an explanation. The findings do not reveal any consistent relationship between the frequency of the significant correlations for a commodity and their modal split. This is true for the more frequently explained kinds of goods as well as for those which have less significant results, as the following example referring road haulage shows. The average share of the significantly explained countries compared to the other countries is either markedly higher (e.g. NST/R-13 and -17) or lower (e.g. NST/R-20), and in other cases rather equal (e.g. NST/R-15 and -22).

Table 51 Modal split of often significant commodities

NST/R	Road haulage	Inland waterways	Railways		NST/R	Road haulage	Inland waterways	Railways
13	70.4%	16.7%	17.4%		13	52.9%	10.4%	41.0%
15	89.4%	15.6%	1.2%		15	89.9%	16.0%	2.1%
20	81.9%	1.8%	14.2%		20	92.3%	0.1%	7.6%
24	84.8%	1.7%	14.1%		24	78.9%	35.5%	3.4%

Table 52 Modal split of rarely significant commodities

NST/R	Road haulage	Inland waterways	Railways		NST/R	Road haulage	Inland waterways	Railways
5	93.8%	5.9%	3.3%		5	97.9%	2.3%	1.3%
17	64.9%	49.6%	29.3%		17	47.9%	54.1%	8.8%
18	86.3%	24.1%	1.7%		18	77.1%	3.5%	21.2%
22	95.7%	3.8%	0.5%		22	97.0%	1.5%	2.3%

5.2.4 Interpretation of “focus group ton kilometres”

The detailed interpretation of the “focus group ton kilometre” comprises Spain, Germany, the Netherlands, Austria, and France, which are all part of the “focus group tonnes” as well.

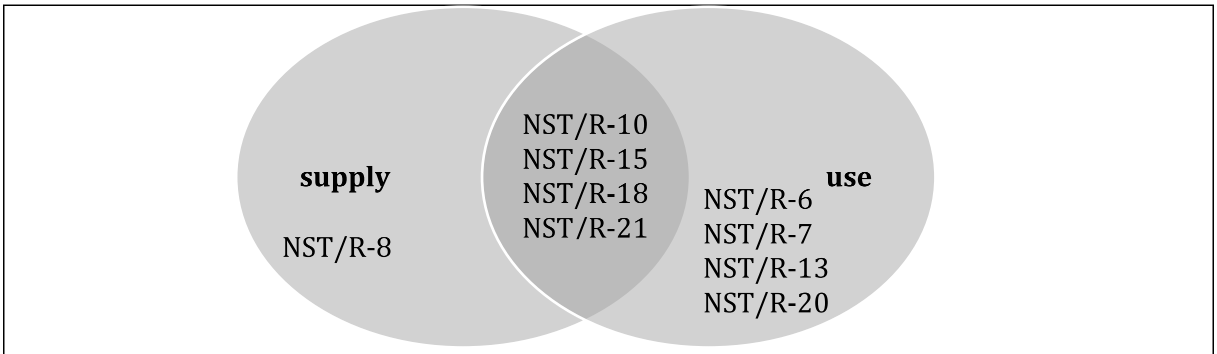
First, it is evident that the correlation with the use-based economic indicator leads to more significant results. In the use-based analysis, about 60 percent of the computable country-commodity-pairs reveal significant results (60.5%, 72 of 119), while in the case of supply-based analysis, 54.6% of the results are significant (65 of 119). Bringing both indicators together and giving priority to the more significant results, narrowly 70% of the computable country-commodity-pairs have significant results (69.7%, 83 of 119).

In Figure 17, commodities are presented that reveal a significant correlation between the ton kilometres and an economic indicator in at least four of five countries. The chart shows that five commodities (NST/R-6, -7, -8, -13 and -20) are significant in four or five separate instances if the analysis indicator is based either on supply or use tables. Special attention should be given to four kinds of goods (NST/R-10, -15, -18 and -21), which have four, or in the case of the former three commodities even five significant results, for each of the two indicators. On average for the group, these four most significant commodities represent 22.9% of the total ton kilometres (Table 49 and Table 53).

Table 53 Proportions of the four most significant commodities

Commodity	Title of divisions	ES	DE	FR	NL	AT	Average
NST/R-10	Petroleum products	2.4%	4.7%	3.9%	7.4%	4.3%	
NST/R-15	Crude and manufactured minerals	12.4%	11.7%	12.3%	10.4%	10.3%	
NST/R-18	Chemicals other than coal chemicals and tar	4.7%	7.9%	3.8%	9.7%	2.4%	
NST/R-21	Manufactures of metal	0.8%	2.2%	1.3%	1.1%	0.8%	
Sum		20.3%	26.6%	21.3%	28.6%	17.8%	22.9%

Figure 17 Graphical representation of most significant commodities in the case of regression analysis with the transport performance



As mentioned before, the commodities NST/R-6, -7, -8, -13 and -20 are rendered significant in four or five separate instances through either the supply or the use-based indicator. However, considering the other economic indicator in each case, the commodities are less frequently significant. Consequently, the often significant commodities can be separated into two groups: while three of the most often significant kinds of goods reveal significant correlations in all countries of the focus group, most of the remaining kinds of goods reveal much more significant results by using a particular indicator for the regression analysis.

- NST/R-6 Foodstuffs and animal fodder
- NST/R-7 Oil seeds and oleaginous fruit and fats
- NST/R-8 Solid mineral fuels
- NST/R-13 Metal products
- NST/R-20 Transport equipment, machinery, apparatus, engines, whether or not assembled, and parts thereof

In the case of four kinds of goods, the supply-based economic indicator reveals the most significant correlations. This is correct for NST/R-1, -4, -5 and -8, which are one or two times more significant compared to the use-based indicator. In contrast, for a majority of nine commodities, the use-based indicator leads to more significant correlations. Especially, the significant amount of NST/R-6 "Foodstuffs and animal fodder" and NST/R-7 "Oil seeds and oleaginous fruit and fats" is clearly higher if the use-based indicator, instead of the supply-based one, is used as an explanatory variable. These two commodities reveal four respectively five significant results with regard to the use-based indicator and only two with respect to the supply-based indicator. On average, the aggregated proportion of the two kinds of goods on the total transport performance is about 14.6%. Accordingly, the advantage of the use-based regression analysis, with regard to the number of results, does reflect a considerable surplus with respect to the relative distribution. Both kinds of goods have to do with agriculture and by taking a closer look at the results, a conclusion already mentioned in the "focus group tonnes" is supported: commodities in an agricultural context are more often significant due to the indicator derived from use tables than due to the supply-based indicator.

Now those commodities which reveal merely a few significant results are considered. Considering the outcomes from supply and use tables in the aggregate, the following five commodities are maximally significant in two countries, one consistently being Austria in three out of five cases.

- NST/R-4 Wood and cork
- NST/R-11 Iron ore, iron and steel waste and blast furnace dust
- NST/R-12 Non-ferrous ores and waste
- NST/R-16 Natural and chemical fertilizers
- NST/R-22 Glass, glassware, ceramic products

The average share of the rarely significant commodities for the countries of the focus group is solely 7.7%, with a range from 5.2% (ES) to 11.0% (AT). It is again striking to note that both commodity groups, including ores, belong to the group of less significant commodities.

Expanding the focus of the interpretation to the results of all 11 countries, it can be seen that the four least significant commodities are those which are also identified if only the countries of the focus group are considered (NST/R-4, -12, -16 and -22).

Finally, again the relevance of the transport mode for the commodities is taken into account to interpret the results of the regression analysis. The investigation focusses on the often and rarely significant commodities, which proportions are depicted in the left side of the Table 54 and Table 55. The depicted average shares refer to values of those countries, which have significant results.

In the right side of the tables, the average values of the opposite countries are given, which explain (Table 52 and Table 55) or do not explain (Table 54) the commodities significantly. In both groups commodities exist which have a considerably high or low share of railway transports. Almost all commodities in Table 54 and Table 55 can be mentioned as examples. Even if the railway transports are not solely taken into account, but the modal split of the individual commodities as well, there still remains no visible scheme for an explanation. The findings do not reveal any consistent relationship between the frequency of the significant correlations for a commodity and their modal split. This is true for the more frequently significant kinds of goods as well as for those which have less significant results, as the following example referring to road haulage shows. The average share of the significantly explained countries compared to the other countries is either higher (e.g. NST/R-18 and -4), lower (e.g. NST/R-12), or rather equal (e.g. NST/R-10 and -22).

Table 54 Modal split of often significant commodities

NST/R	Road haulage	Inland waterways	Railways		NST/R	Road haulage	Inland waterways	Railways
10	33.5%	32.4%	40.8%		10	36.6%	4.4%	61.9%
15	58.8%	23.6%	22.3%		15	52.9%	10.1%	43.7%
18	56.2%	10.5%	35.3%		18	45.2%	1.9%	54.2%
21	69.7%	2.2%	28.6%		21	63.8%	0.6%	35.9%

Table 55 Modal split of rarely significant commodities

NST/R	Road haulage	Inland waterways	Railways		NST/R	Road haulage	Inland waterways	Railways
4	68.5%	0.2%	31.2%		4	57.8%	1.5%	41.6%
11	27.1%	22.9%	61.4%		11	19.8%	11.0%	74.1%
12	44.9%	96.6%	6.8%		12	54.9%	10.3%	39.4%
16	29.3%	26.8%	43.9%		16	48.0%	14.0%	45.7%
22	82.5%	1.2%	16.3%		22	87.1%	1.8%	29.1%

5.3 Interpretation of the remaining countries

The interpretation of the findings of the remaining countries outside of the defined focus group is limited to only a few statements. First of all, the special case of Luxembourg is called back into consideration. In the small Western European country several correlations cannot be computed to generate the economic indicators for various commodities due to missing data. Nonetheless, despite these limitations, for altogether 8 (tonnes, see Table 39) respectively 7 (ton kilometres, see Table 42 commodities, which represent a remarkable share of two third (66.3%, tonnes) respectively narrowly half of the total (47.7%, ton kilometres), display significant correlations result.

In the following, the kinds of goods are named that reveal the most significant results outside of both focus groups when the findings for correlation are either based on supply or use tables, which are interpreted in the aggregate. In terms of the regression analysis with the freight volume as the dependent variable the commodities NST/R-1, -17, -18 and -24 exhibit at least three significant coefficients of determination in five countries.

- NST/R-1 Cereals
- NST/R-17 Coal chemicals, tar
- NST/R-18 Chemicals other than coal chemicals and tar
- **NST/R-24 Miscellaneous articles**

With regard to the regression analysis between the transport performance and the economic indicators, the commodities NST/R-7, -18, -21 and -23 have the most significant results. More precisely, three kinds of goods are four-times and in the case of NST/R-7 even five-times significant in the six countries outside of the focus group.

- NST/R-7 Oil seeds and oleaginous fruit and fats
- **NST/R-18 Chemicals other than coal chemicals and tar**
- **NST/R-21 Manufactures of metal**
- NST/R-23 Leather, textile, clothing, other manufactured articles

The comparison shows, that different commodities reveal significant results, if either the tonnes or the ton kilometres are used for the regression analysis. Solely NST/R-18 “Chemicals other than coal chemicals and tar” shows significant outcomes for both kinds of analysis.

5.4 Summarising of the interpretations of the regression analysis

The interpretation of the results of the regression analysis concludes with a summary. Thereby the findings of the correlation between the economic indicator and freight volume are confronted with the outcomes of the correlation between the indicator and the transport performance.

In the summary, the results for the focus groups are emphasized. The focus groups comprise countries in which the application of the regression analysis leads to correlations with a significant coefficient of determination in at least 12 out of 24 commodities. Spain, France, Germany, the Netherlands, and Austria are part of both focus groups – regarding the analysis with the freight volume as well as the one with ton kilometres – and the former is completed by Italy.

The following statements concerning economical and geographical characteristics are valid for the majority of the countries of the focus groups; however, in many cases, Austria is an exception. A tendency seems to be that large freight volumes and transport performances lead to many significant results. Both transport parameters are significantly higher for the focus groups than for the remaining analysed countries. In addition to the impact of the freight volume, it can be surmised that transit transports and diverse connections to neighbouring countries can be an indication for a good explanatory power of the methodology. In this context, particular attentions should be paid to seaports because of their function to generate and attract a lot of traffic and impact hinterland transports. The individual modal splits of all 11 analysed countries are very heterogeneous, so that no indication, regardless of whether a country reveals more or less significant correlations, can be derived from these proportions. Moreover, the constrained waiver of transportation data from railways due to insufficient data availability does not consequently preclude the identification of correlations for commodities, which are railways-affine. With respect to the transportation via inland waterways, it can be stated that countries with inland waterway freight transportation, as well as without, are part of the focus groups. In short, no evident relationship between the used transport modes as well as the modal splits and the frequency of significant kinds of goods is identifiable.

Taking into account economic indicators as the gross domestic product and the gross value added or the trading in terms of export and import of products and goods, allows for the conclusion to be drawn that countries with a larger GDP and GVA, as well as extensive trade activities, exhibit more significant correlations between the freight variable and the economic indicator.

With respect to the concrete findings of the regression analyses, it can be stated that in terms of the correlation with tonnes as well as with ton kilometres, the usage of the economic indicator derived from use tables reveals more significant country-commodity-pairs than the usage of supply-based indicators. For the analyses with the freight volume as well as the ton kilometres, roughly 60 percent of the computed correlations have significant coefficients of determination (Table 56). Furthermore, the explanatory power of the analysis with ton kilometres exceeds the analysis with tonnes.

Table 56 Summarised percentages of significant correlations

	Supply-based indicator	**Use-based indicator**	**Both indicators in the aggregate**
Tonnes	45.8%	57.6%	63.6%
Ton kilometres	54.6%	60.5%	69.7%

Most of the country-commodity-pairs, which correlate significantly due to a supply-based indicator, are also significant if the analysis is done with a use-based economic indicator. The opposite case occurs infrequently and if both indicators show a significant result for a particular country-commodity-pairs, then mostly the use-based one reveals the higher significance. The advantage of use-based indicators for regression analysis could derive from the structure of the use tables, where the computation of the indicator originates from. The usage or consumption of a product through different industries is much more varied compared to its production. Hence, the consumption functions are more multi-part and complex than the production functions. By all means it can be concluded that the demand for products drives transportation.

For both analysis-cases, it holds true that the often significant commodities represent a clearly larger share of the total amount than the commodities for which fewer correlations are found. The four kinds of goods with the best results represent more than half (52.4%, tonnes) respectively more than 20 percent (22.9% ton kilometres) of the total freight amount. In contrast, the four respectively five scarcest significant kinds of goods solely represent 5.7% and 7.7% of the total. Moreover, it is evident that the most often significant commodities in both kinds of analysis exhibit significant results for applying the supply as well as use-based economic indicator. If the group of often significant commodities (marked bold in Table 57) is expanded through such kinds of goods, which reveal a lot of significant results for only one of the two indicators, then the overlap of similar findings for correlations with tonnes and ton kilometres increases (highlighted grey in

Table 57). Among other things, NST/R-13 “Metal products” and NST/R-21 “Manufactures of metal” could be found for both analysis-cases.

Table 57 Comparison of most often significant commodities for both analysis-cases

Tonnes		**Ton kilometres**	
NST/R-13	Metal products	**NST/R-10**	Petroleum products
NST/R-15	Crude and manufactured minerals	**NST/R-15**	Crude and manufactured minerals
NST/R-20	Transport equipment, machinery, apparatus, engines [...]	**NST/R-18**	Chemicals other than coal chemicals and tar
NST/R-24	Miscellaneous articles	**NST/R-21**	Manufactures of metal
NST/R-14	Cement, lime, manufactured building materials	NST/R-6	Foodstuffs and animal fodder
NST/R-21	Manufactures of metal	NST/R-7	Oil seeds and oleaginous fruit and fats
NST/R-23	Leather, textile, clothing, other manufactured articles	NST/R-8	Solid mineral fuels
		NST/R-13	Metal products
		NST/R-20	Transport equipment, machinery, apparatus, engines [...]

It is also helpful to identify the commodities which reveal the fewest significant correlations and to explore the cases for which the methodology does not work. In Table 58 the commodities with rarely significant results are depicted. For the regression analysis with tonnes as well as ton kilometres, the commodity-groups including chemical goods (NST/R-16, -17 and -18) and the commodity NST/R-22 are rarely significant.

Table 58 Comparison of scarcest significant commodities for both analysis-cases

Tonnes		**Ton kilometres**	
NST/R-5	Textiles, textile articles and man-made fibres	NST/R-4	Wood and cork
NST/R-17	Coal chemicals, tar	NST/R-11	Iron ore, iron and steel waste and blast furnace dust
NST/R-18	Chemicals other than coal chemicals and tar	NST/R-12	Non-ferrous ores and waste
NST/R-22	Glass, glassware, ceramic products	NST/R-16	Natural and chemical fertilizers
		NST/R-22	Glass, glassware, ceramic products

Taking into account the findings of the remaining countries beyond the focus group, it is evident that the significantly explained kinds of goods are partly identical. Those commodities which reveal most often significant results for the countries of a focus group and the remaining ones are:

- NST/R-24 Miscellaneous articles (t)
- NST/R-18 Chemicals other than coal chemicals and tar (tkm)
- NST/R-21 Manufactures of metal (tkm)

5.5 Interpretation of the cross-sectional analysis for tonnes

This subchapter is concerned with the interpretation of the results of the cross-sectional analysis. The representation of the results in chapter 4 shows that a majority of the outcomes are significant and that a lot of coefficients of determination indicate strong correlations. Commodities with non-significant commodity-year-pairs were already identified in chapter 4 and will not be reconsidered here as for these kinds of goods no dependency between the economic indicator and freight volume over the time span is found.

For the significantly explained commodities, an average value of the national R^2 values and the according standard deviation are presented in Table 59. Due to the fact that almost all commodities have continuously significant results, the quality of the correlation is evaluated with help of the standard deviation of the R^2 values. The standard deviation describes the average value of the differences between the mean value of a data series and its individual data points. This value has the same dimension as the data of the observed series, and the smaller the standard deviation is, the more invariable is the data series. A significant conclusion can be made that a consistent R^2 value on a high level over the course of time proves a stable and reliable correlation between the economic indicator and the tonnes or ton kilometres. This statement is supported by the findings presented in Table 59, wherein it is evident that in general the lower R^2 values have the larger standard deviations and vice versa.

In Figure 18, all commodities with R^2 values greater than 0.80 are presented. For both cross-sectional regression analyses, based either on supply or on use tables, 9 out of 24 commodities reveal an R^2 value in the amount of at least 0.80, and six kinds of goods exhibit these strong correlation for both kinds of analysis.

- NST/R-6 Foodstuffs and animal fodder
- NST/R-13 Metal products
- NST/R-17 Coal chemicals, tar
- NST/R-18 Chemicals other than coal chemicals and tar
- NST/R-20 Transport equipment, machinery, apparatus, engines […]
- NST/R-21 Manufactures of metal

Additionally, the following kinds of goods show correlations with an R^2 value greater than 0.80 in the case of supply-based cross-sectional regression analysis:

- NST/R-3 Life animals, sugar beet

- NST/R-7 Oil seeds and oleaginous fruit and fats
- NST/R-16 Natural and chemical fertilizers
- NST/R-22 Glass, glassware, ceramic products

Finally, the following commodities exhibit correlations with an R^2 value greater than 0.80 in the case of use-based cross-sectional regression analysis:

- NST/R-10 Petroleum products
- NST/R-14 Cement, lime, manufactured building materials
- NST/R-15 Crude and manufactured minerals
- NST/R-24 Miscellaneous articles

It is evident that commodities in an agricultural context (NST/R-3, -6 and -7) reveal significant results primarily if the supply-based economic indicator is applied in the analysis. This is also true for commodities in connection with the chemical industry (NST/R-16, -17 and -18). On the other hand, the use-based analysis leads to remarkably higher coefficients of determination for dry and liquid bulk commodities as NST/R-10, -14 and -15.

Figure 18 Graphical representation of most significant commodities in the case of cross-sectional regression analysis with the freight volume

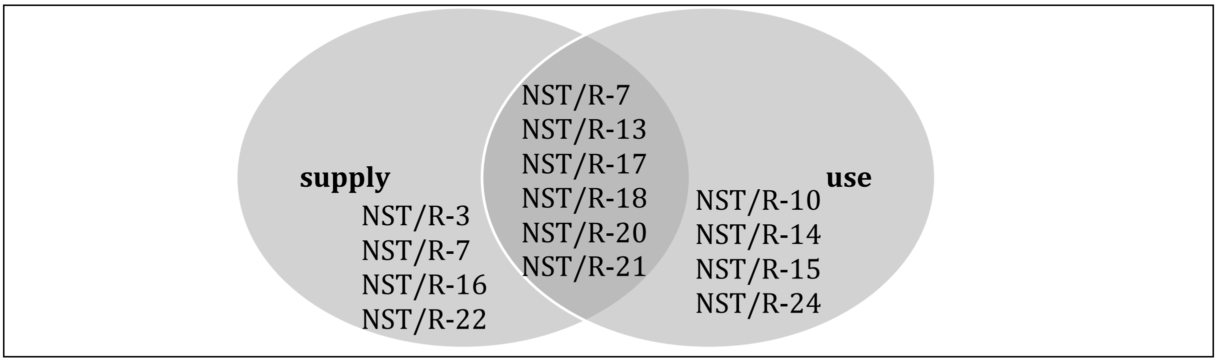


Table 59 Coefficients of determination and standard deviation of the cross-sectional analysis

	Supply-based Cross-sectional analysis		**Use-based Cross-sectional analysis**	
NST/R	**Coefficient of determination**	**Standard deviation**	**Coefficient of determination**	**Standard deviation**
1	0.77	0.09	0.78	0.10
2	0.70	0.11	0.72	0.10
3	**0.82**	0.08	0.71	**0.04**
4	-	-	-	-
5	-	-	0.73	**0.06**
6	**0.85**	0.09	**0.83**	**0.02**
7	**0.81**	**0.06**	0.74	**0.05**
8	-	-	0.46	0.10
9	-	-	-	-
10	-	-	**0.83**	**0.07**
11	-	-	0.78	0.11
12	0.67	0.15	0.75	0.10
13	**0.94**	**0.06**	**0.95**	**0.01**
14	0.75	0.15	**0.92**	**0.02**
15	0.57	0.16	**0.87**	**0.02**
16	**0.82**	0.09	0.75	0.10
17	**0.96**	**0.01**	**0.96**	**0.01**
18	**0.92**	**0.02**	**0.90**	**0.03**
19	0.56	**0.06**	0.79	**0.07**
20	**0.88**	**0.06**	**0.92**	**0.03**
21	**0.84**	0.10	**0.83**	0.08
22	**0.83**	**0.04**	0.78	**0.06**
23	-	-	0.77	**0.04**
24	0.59	**0.05**	**0.83**	0.08

**R^2 values greater than 0.80 and standard deviations smaller than 0.08 are marked bold*

In Table 59, the standard deviations smaller than 0.08 (10% of the determined R^2threshold 0.80) are marked bold. As the data suggests, the strength of the correlations obviously do not vary greatly over time for those kinds of goods. For most commodities, both R^2 values show amounts on a similarly high level. However, the R^2 values of the use-based cross-sectional regression analyses are in two out of three cases higher than the supply-based analyses, and especially for the commodities NST/R-14, -15, -19 and -24 where the R^2 values of the use-based analysis clearly exceed the supply-based ones. Furthermore, for a few kinds of goods, the continuous computation of correlations with a supply-based indicator is not possible at all.

Comparing the outcomes of the cross-sectional regression analysis with those of the linear regression analysis reveals that the findings do not correspond to each other for large parts of the results. Taking into account the most often significant commodities as a result of performing the regression analysis, for some kinds of goods both kinds of analysis reveal high and significant correlations and for other kinds of goods only one of both analyses do. Examples for commodities, which are several times significant due to cross-sectional as well as linear regression analyses, are: NST/R-13, -20 and -21, including metals, manufactures of metals, and various machinery. In contrast, for NST/R-17 and -18 – comprising in particular chemicals – completely different results under usage of the kinds of analysis are identified. While these kinds of goods reveal high correlations in the linear regression analysis, they do not show the same high correlations if the cross-sectional regression analysis is applied.

5.6 Interdependency of a commodities' weight and value

The value and the weight or density are basic characteristics of products and commodities. If value and weight are related to each other in terms of a ratio, than a more meaningful comparability of different kinds of products and goods is possible. As a consequence, a value-weight-ratio is a measure of the monetary value of a product or commodity per unit of weight.

For the shippers in the transport sector, this ratio is one of the most important factors to determine how a product will be transported to markets and consumers (39). Furthermore, this factor expressing the relation between a goods monetary value and its physical quantity is also of interest for the theoretical mode choice in freight transport modelling. Besides the fundamental 4-step modelling approach, de Jong et al argue that a number of additional transformations are required within a comprehensive freight transport model(5). As an example for a transformation, the conversion of trade flows in terms of money into physical commodity flows in tonnes is pointed out. Input-output models and special variations as the multi-region input-output models (MRIO) are commonly applied in freight transport modelling. To determine produced and attracted tonnes in freight generation models, or to produce commodity flows in freight distribution models, those weight-to-value-ratios are needed. According to de Jong et al, this required conversion from values to tonnes is a major disadvantage of input-output models(5).

At this point, the methodology applied in this thesis can offer a potential solution. The purpose of this thesis is to investigate the relation between the amount of a commodity expressed in tonnes and an economic indicator essentially based on the gross value added. With help of the regression analysis, the relation between both variables is computed in the form of a linear curve progression ($y = a * x + t$), which is a simplifying assumption to delimit complexity. In this formula the parameter "a" is the gradient of the function, whereby the gradient represents the ratio of the delta values of the freight variable on the y-axis and the economic indicator on the x-axis. Consequently, the gradient of the linear trend can be interpreted as the ratio between the weight of a commodity in tonnes and a monetary expression, what is an inverse formulation compared to the so far mentioned value-weight-ratio.

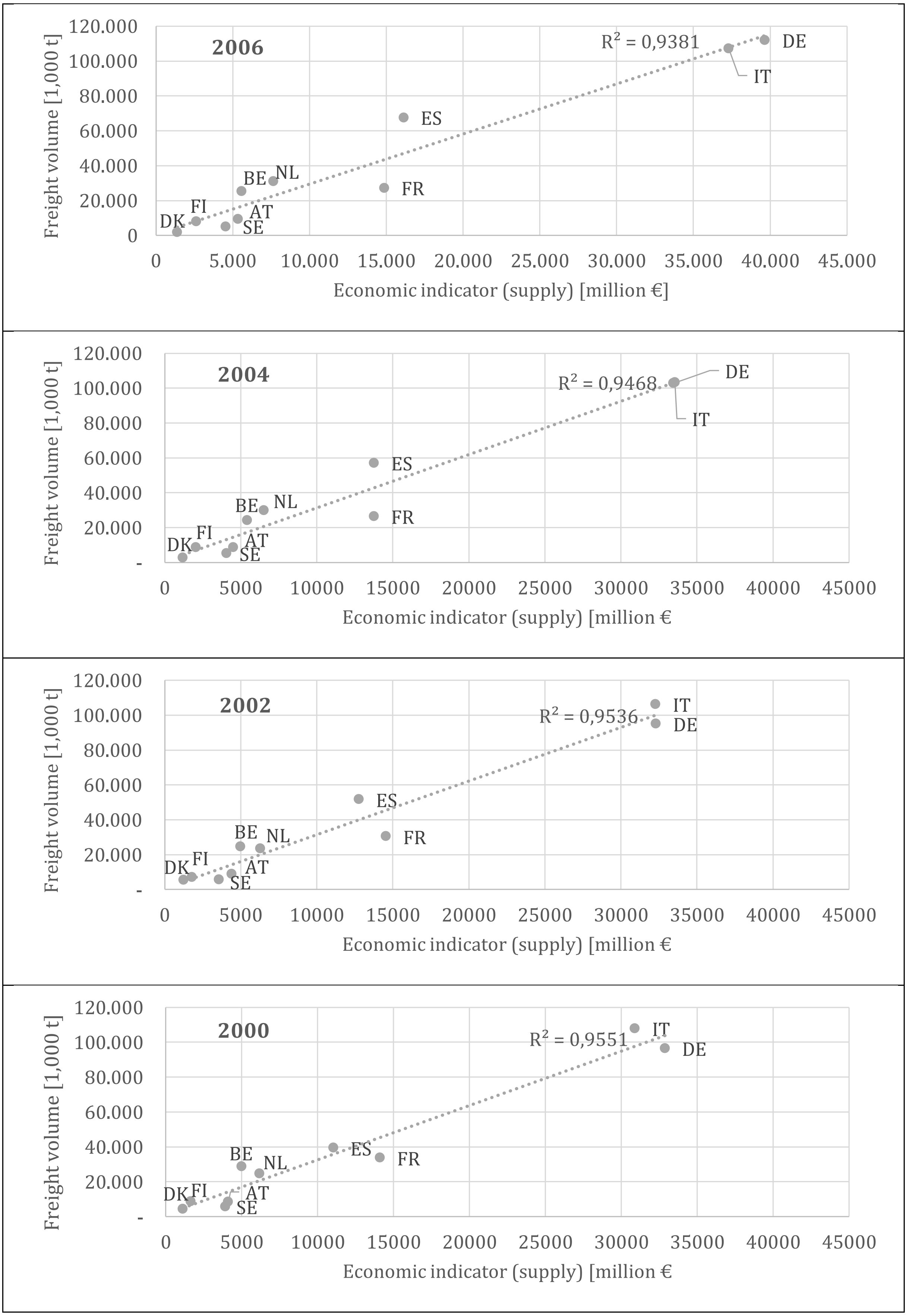
Taking into account the cross-sectional regression analyses elaborated in chapter 4, it is evident that for most commodities the strength of the correlation in the form of R^2 values is rather constant over the course of time, which is statistically expressed by a low standard deviation. The cross-sectional regression analyses is used to eliminate the temporal dimension from the regression analysis. The exemplary representation of the results of the supply-based regression analysis for NST/R-13 “Metal products” shows that for the individual countries, the data of the freight volume and the economic indicator and consequently corresponding ratios that are constant over time (Figure 19 and Table 60).

Finally, it can be concluded, that it is possible to derive individual weight-value-ratios (WVR) for altogether 24 kinds of goods from the regression analysis. Performing cross-section regression analysis allows for a transnational ratio to be determined, which is constituted by the individual WVR of the considered countries for a particular year. With help of a weight-value-ratio, the monetary data of commodities from a statistic can be transferred into tonnes.

Table 60 Weight-value-ratios for NST/R-13 in selected years

	Freight volume 2006 [1,000 t]	**Supply-based EI 2006 [million €]**	**WVR 2006**	**WVR 2004**	**WVR 2002**	**WVR 2000**
AT	9,597	5,354	1.8	1.9	2.0	2.1
BE	25,476	5,596	4.6	4.5	4.9	5.8
DE	112,040	39,665	2.8	3.1	2.9	2.9
DK	2,011	1,400	1.4	2.4	4.3	4.0
ES	67,775	16,143	4.2	4.1	4.0	3.6
FI	8,213	2,635	3.1	4.2	3.8	5.3
FR	27,419	14,877	1.8	1.9	2.1	2.4
IT	107,353	37,296	2.9	3.1	3.3	3.5
NL	31,148	7,652	4.1	4.6	3.7	4.0
SE	5,311	4,554	1.2	1.3	1.6	1.5

Figure 19 Graphical presentation of the supply-based cross-sectional regression analysis for NST/R-13 in selected years



6. Implications and outlook for freight transport modelling

In this chapter, the central conclusion of the thesis and consequences for freight transport modelling are summarised. The initial posing of the scientific question is taken up and at certain points an outlook in terms of providing proposals for further research is presented.

In the previous chapters of the thesis, the methodology was explained and then applied to a comprehensive set of data including transport and economic data for 11 countries and 24 kinds of goods. Furthermore, stationarity tests were carried out and cross-sectional regression analyses and linear regression analyses were also done. The outcome of this is a plethora of results, which can be investigated from several different perspectives, which was completed in the last chapter. Now, in this chapter, the essential conclusions of the analyses and the interpretations are drawn. The chapter concludes with the insights that are gained in regard to freight transport modelling and the possible consequences that may follow.

One important and fundamental measure mentioned at the beginning of this project was to advance the methodology to a general approach in order to make transnational applications possible. This thesis has shown that the development of the economic indicator based on a consistent set of data is feasible for several European countries. Particular attention was given to the bridge matrix, which allocates CPA-classified products to NST/R-classified commodities, because no adequate allocation for the versions CPA-2002 and NST/R-24 is available so far. An approach from the Austrian Institute of Economic Research (WIFO) was adopted and sensitivity tests were performed which revealed that the leverage effect of the bridge matrix in general, or the individual factors on the results of the regression analysis, were negligibly low. Conversely, variations of the economic indicator result due to changes of the product-based economic indicator, which as is well known, is computed with the weights of the supply and use tables and the gross value added. While the weights create the assignment between industries and products in terms of production and consumption functions, the gross value added determines the dimension of the indicators, and thus exerts influence on the final economic indicator.

Besides a general methodology, there was no way around using a consistent set of data to be able to perform a uniform analyse and interpretation, which afterwards enabled comparisons of the findings. The more extensive the selection of considered countries, the more difficult was the generation of a homogenous set of data. Due to this, in the end the choice comprised 11 European countries, whereby considerably much data, – as the railway transportation data – could not be taken into account. With regard to statistical analysis in general, it can be stated, that for the purpose of considering and comparing numerous objects (e. g. countries, commodities or transportation modes) within one analysis, a consistent data set is absolutely crucial, and thus, accepting that some data must be waived is necessary.

The relationship between freight volume and the economic indicator was investigated with help of the regression analysis. In order to be able to perform such analyses, the available data had to be checked in reference to the following two fundamental conditions: the time series used in the execution of regression analyses, which had to be stationary, and the individually observed data points of a time series, which had to be independent of each other. It is important to reiterate here that the stationarity is an important condition to exclude spurious correlation between two variables and is also a criteria to permit time series analyses with the aim to predict future values and developments. The test of a time series' stationarity can be performed by various investigative methods, the one implemented in this thesis is the Dickey-Fuller-test. Time-independency of data points was achieved by performing cross-sectional regression analysis instead of linear regression analysis. The advantage of this kind of analysis is that the data for certain objects – here the 11 countries – were considered at one particular point of time – here for one specific year. Thus the individual observed data points are time-independent of each other, which is a crucial condition for performing regression analysis.

The stationarity-tests revealed that for almost all data series the condition of stationarity is not fulfilled. This means that the observed correlations are very likely spurious correlations and effected through external, non-considered parameters. Additionally, further tests revealed that the differentiating of the series do not lead to stationarity as well.

Against the background of these findings, the handling with statistical analyses in the research pertaining to the interrelationship between economic activities and freight transportation should be revised. It must be critically stated that within the scope of this thesis, research does not reveal a discussion about the technical suitability or unsuitability of the regression analysis in the course of the coupling/decoupling discussion. However, this discussion should be conduct in the future to underline the credibility of computed results. A systematic collection, preparation, and processing of the data analysis must become standard. Otherwise, the coupling/decoupling discussion runs the risk of being subject to the same subjective oversights.

In connection with differentiating the time series, another problem became apparent: the data series are too short for meaningful findings. With each built difference, one data point gets lost, and, the original series cover maximal nine values within a time span from 1999 to 2007 at all. Furthermore, the explanatory power of the correlation analysis, the usage for reliable projections and the co-integration of non-stationary variables, are restricted due to the small amount of data. Consequently, for statistical analyses, more long-term data series with as many data points as possible should be used to obtain reliable results about relations or projections.

With regard to the assumptions preceding the introductory research question, a two-part assessment can be given. The first assumption, that a transnational application can be developed, is met, because economic indicators can be calculated for different countries and commodities with a consistent methodology. However, as mentioned above, the second assumption concerning the stationarity of the data is not fulfilled.

Nevertheless, the correlation analysis was carried out, but against this background of an insufficient framework of conditions. Consequently, the answer to the research question must be given with reservations and results and interpretations must be considered carefully and critically. The answer and conclusions should be understood in a general sense pointing out tendencies and trends; however, a comparison of the findings can be permitted, because all the results are computed through the same methodology – which admittedly does not fulfil all of the necessary conditions.

Finally, the answer to the research question could be formulated as follows: the developed economic indicator and applied methodology is not the encompassing solution to verify a coupling between economic activity and freight transportation in general, but it offers helpful explanations for the few analysed countries and commodities. However, especially for commodities which do not reveal significant correlations, other approaches than the presented one are required to explain the freight generation of those kinds of goods.

It is evident that the methodology works best for economically strong countries with a large domestic economy and manifold trade relationships. The thesis proved numerous correlations between economic indicators and tonnes or ton kilometres beyond Germany for countries such as France, Spain, the Netherlands, and Italy. An implication of this finding is that the economic power of a national economy, as well as its role within an economic community, is important to consider and decisive for the way of describing the coupling or decoupling of economic activity and freight transportation. It appears that countries which are smaller in size and economic power require more individual and adjusted approaches to achieve a better understanding of the relationship between economy and transportation. It is possible that the specification and pronounced economic key areas characterise a smaller national economy more than a bigger national economy, and thus, models focussing on these particular characteristics expand the knowledge.

In the regression analyses, two indicators were used: one derived from supply tables and another from use tables of national accounts. Müller et al already found out that the use-based analyses reveal considerably more significant results than the supply based analyses, and in this thesis, the statement could be confirmed in a European context with respect to linear regression analysis done for other countries, and also in regard to the cross-sectional regression analysis. Economic activities on the consumption side, which include intermediate as well as finished products, explain the freight generation better than the production side. According to these findings, further investigation into the pattern of demand should be performed in freight generation modelling. For this purpose, economic industries as well as geographic regions with a high demand for products should be particularly taken into consideration.

The stationary-tests indicated a high probability of the existence of impact factors on the correlation, which are not part of the economic indicator containing the gross value added. An advantage of the gross value added is that it is collected and available for each economic sector. In principle, it would seem an exception that one single parameter is an appropriate explanatory variable among all industries, because investigations of individual industries need more specialised variables. This thesis cannot answer the question – what the concrete, additional parameters beyond the indictor are – however, it gives some suggestions to advance future research.

An interim conclusion is that the relationship between economic activities and freight transportation can hardly be described by one single variable representing the economic side of the relation. As already stated in the introduction of the thesis, particular caution is needed in the usage of aggregated parameters (e. g. GDP) as single explanatory variables. The approach elaborated in this thesis heads in the right direction, because the indicators are created for each commodity and take into account various industries by usage of supply and use tables as well as sector-specific gross value added. However, in the end, the methodology primarily considered one single factor – the economic indicator – so the results of the regression analysis is narrowly focused. In further research, multivariate regression analyses could be a suitable alternative.

When talking about impact factors on freight transport generation, transportation logistics is a central issue, and increasingly more attention is given to it.(45, 61) Of particular interest is the decision making of the players to achieve a better understanding of the way a product or commodity is transported (mode choice), and especially of the freight handling within the transport chain.(50) As is well known, transported freight was considered in this thesis of interest as an output factor in freight generation models, but there is a clear difference to the amount of originally produced or demanded products and commodities. The transported freight volume ends up factoring at a higher level than the produced volume, because during the value-added process, as well as within the transportation and logistics system, a tonne of freight is handled several times, and as a result the same tonne of freight is collected several times in statistics. Additionally, it is worth restating that a factor representing the transhipment of goods is the handling factor which converts the physical weight of goods into freight tonnes lifted. (4, 53, 49)

Within the scope of this thesis, research could not reveal concrete examples for handling factors. In any case, it is necessary to take a closer look at the logistics systems in the countries. It can be assumed that those systems are differently structured and complex, because the economies and the transportation systems of the countries are different as well. For instance, countries with a high domestic demand for consumer products – as Germany, France or Spain – have comprehensive trade structures and different transport chains compared to countries with a pronounced primary sector that produces or mines a lot of raw materials. In the context of trading and goods handling, sea ports and continental places of transhipment play an important role as single traffic-attracting points.

An involvement of added parameters, as well as insights in certain areas of the transportation system, requires more comprehensive data collection, because at present detailed information and data are often unknown. In respect thereof, the data procurement in the form of statistical surveys or census in passenger transport is considerably advanced compared to that of freight transport.(44)

As shown at the end of the previous chapter, a ratio between the weight and the value of products and commodities proved to be an effective way to derive freight volumes from economic statistics. In most countries, economic activities are documented in more detail than transportation, and in those cases a value-weight-ratio can be helpful to compute missing data. It was shown that value-weight-ratios can be derived from the regression analyses performed in this thesis distinguished for 24 kinds of goods.

Originally, in the research from Müller et al, the analyses of the interdependency of economic activities and transportation under usage of the developed methodology was solely done for the single case of Germany. If only one country is taken into consideration with data from different years, solely time series regression analyses can be executed. In this thesis, the set of data was extended by information about ten other European countries, on which the same analytical approach was applied. For all these countries, linear time series regression analyses were executed as well; however, performing cross-sectional regression analyses proves to be more meaningful. This kind of analysis has two major advantages: first, data describing the relationship between economic activity and freight transportation for various countries are considered in one pooled analysis, and second, these data pairs are time-independent, because they are all considered for one single point of time. With that, the above mentioned condition of time-independency for data used in regression analyses is fulfilled. For this reason, cross-sectional analyses are preferable in future correlation analyses and a greater emphasis should be given to them.

The intensive discussion about relationships and correlation analysis aims to produce predictive models in order to forecast future transportation. Economic indicators or parameters, for which a connection to freight transportation can be identified, are suited for the projection of future freight developments. For the estimation of future values, linear regression models can be applied; however, more exact results provide econometric time series models, because they do not postulate a linear correlation. Before a model is applied, the functional form of a correlation has to be verified, whereby several kinds can occur, e. g. linear, logarithmic, or quadratic curve progressions. In any case, the central data series for the estimation models is the freight volume, which should be projected, and most of the models require stationarity to exclude spurious correlation.

A research in connection with this thesis demonstrates that a lot of econometric time series models are discussed, which emphasises the assumption that customized solutions are in demand (5, 56). Each of them has its advantages and disadvantages, and most models are specialised on a particular field of application, which means that no single model outperforms the others. The models are different with regard to the range of the forecasts: short, medium, and long-term projections are differentiated from each other. Latter models are needed if statements in the more distant future are to be achieved, possibly to gain knowledge for the development of strategies and dimensioning of infrastructure. As examples for long-term econometric models, the "Partial Adjustment (PAM) Model" and the "Reduced Autoregressive Distributed Lag Model (ReADLM)" are named.

Concluding the context of the time series analyses, the occurrence of structural breaks is mentioned. Such breaks in time series occur due to striking events which contradict a general development. Mathematically expressed, a structural break is a change of the level or of the gradient of a curves progression, or even a change of both parameters. A concrete example for a structural break is the financial and economic crisis started in 2007, which caused decreases in economy and freight transportation. In those cases, the econometric time series models have to be adjusted with help of appropriate auxiliary-models. (48)

Finally, it can be stated that the developed methodology works and reveals correlations for several countries beyond Germany. However, the used time series for the linear regression analysis does not fulfil the condition of stationarity. This leads to two consequences: first, a discussion about the technical preconditions for the performance of regression analysis and in the course of the coupling/decoupling discussion is necessary. Practically speaking, performing cross-section regression analysis would be more preferable. Thereby, sufficient data must be taken into account to obtain meaningful results. Furthermore, it is evident that a comparative analysis of several objectives generally is at the expense of a specific analysis of one individually. For the purpose of more precise investigation in further research, the commodities which revealed the most significant results in the analyses and the topic of transportation logistics are suggested.

7. Summary

In this chapter, the contents of this master thesis are summarised first in English and afterwards in German. Apart from the summary, the thesis is structured into six chapters. It is also followed by a comprehensive annex which provides further explanatory material coinciding with data and information discussed in the chapters. The introductory chapter establishes this thesis with the previous scholarship in this research field. The second and third chapters lie down the foundation for the analyses presented in chapter 4. First, the methodology is explained critically and in detail (chapter 2), afterwards a suitable data set is prepared (chapter 3). Chapter 5 gives extensive insight into the findings from the performed analysis and offers interpretations. Finally, the sixth chapter derives implications for future freight generation modelling.

The thesis contributes to the discussion about the coupling or decoupling of transport and economy. For this purpose, a methodology developed by Stephan Müller, Jens Klauenberg, and Axel Wolfermann from the Institute of Transport Research at the German Aerospace Center (DLR) (51, 52) is taken up, developed, and applied in a broader European context. The methodology contributes to freight generation modelling as first step of the 4-step modelling approach, which comprises furthermore freight distribution, choice of mode, and assignment. In short, the methodology provides a way to build an economic indicator, which when used alongside the freight variable – transported tonnes or ton kilometres – allows for correlation analysis to be devised, through which relationships are established. The indicator, as well as the freight volume or transport performance, are considered on the level of commodities and are classified according to NST/R. This disaggregated approach is an important advance compared to aggregated models, wherein, for example, the gross domestic product alone is used to derive freight data as input for transport models. Consequently, the findings of this thesis serve as input data for freight generation models as well as a comparison for models that have their own freight generation modules. Furthermore, it represents quantitative evidences to the coupling/decoupling discussion and enables the projection of future transport volumes.

The following research question with two preliminary assumptions leads through this thesis:

Assuming that, first, the economic indicator is calculated using the same method that was used in the case of Germany, and, second, the underlying data set fulfils the statistical test: ***Does the economic indicator also show for other European countries such a high coupling between economic activity and freight transportation?***

The relationship between economic activities on sectoral levels and transported commodities should be ascertained with help of linear the regression analysis. Therefore, chapter 2 offers a two-part methodology to determine the economic indicator. First, information about supply and use tables (SUT), which are part of national accounts, and the gross value added (GVA) as the prominent descriptive factor for economic development, are used to generate a product-based indicator. The second step is its transformation to a commodity-based indicator with help of an additional parameter, the β-factor. The SUT lists the production and consumption of products and services (CPA-classified) through economic sectors (NACE-classified), and in this way they give an impression about supply and demand within a national economy. Thereby, services can be neglected in the analysis, because they do not trigger physical transportation. On the basis of the SUT, two contribution functions are built: the supply tables are used to derive a weighted function for the production, and the use tables are utilized to extract a weighted consumption-function. The individual product-industry-weights are multiplied with the industry-specific GVA and afterwards the sums are built for each of the 31 products. However, for the correlation, an indicator for commodities is necessary and for this reason a transformation of economic products to transported commodities is done next. This is quite a challenge, because no explicit allocation in the form of tables is available for the used versions of the classifications CPA-2002 and NST/R. Therefore, an approach of the Austrian Institute of Economic Research (WIFO) is taken up to allocate 31 products to 24 kinds of goods. (46, 7) The transformation comes about in two-parts: first, it must be determined which products are associated to which commodities. These product-commodity-combinations represent a qualitative allocation. Second, the several combinations have to be weighed against each other to obtain concrete values representing the relative shares. This is the quantitative part of the allocation. The whole allocation table is called the bridge matrix and the individual values of the product-commodity-pairs are called β-factors. An exceptional position holds the commodity NST/R-24 “Miscellaneous articles”, which primarily consists of transport containers wherein the exact contents are unknown. Due to this uncertainty, a majority of 24 out of 31 products are allocated to NST/R-24 with determined β-factors. The weighing of the remaining β-factors is done on the basis of the specific tonnes or ton kilometres of the commodities related to the sum over all 24 kinds of goods. To ensure that the approach in general, and the determination of the fixed β-factors for NST/R-24, can be used beyond Austria and Germany, sensitivity tests are performed to prove its stability. This is done by varying the β-factors, especially those which are referred to NST/R-24, and comparing the consequent outcomes of the regression analysis with those resulting from the original bridge matrix. In the final analysis, it can be concluded that the impact of the bridge matrix on the results of the regression analysis is low. The comparisons show that the β-factor in general is not the decisive input parameter in the whole proceeding and its leverage effect regarding the final results is marginal, so that the bridge matrix can be characterized as invariant.

Furthermore, in this second chapter, some general criticism of the execution of the regression analysis in the case of Germany done by Müller et al is stated. This concerns two conditions in the context of performing statistical analyses. On the one hand, the data series must be stationary to exclude spurious correlation between the two variables considered in the regression analysis. On the other hand, the individual observed data points of a time series must be independent of each other, so that a data point is not influenced by the value on an earlier point in time. This criticism is responded to in the fourth chapter of the thesis, where stationarity test and cross-sectional regression analysis are presented.

Before the regression analyses can be carried out to investigate coupling or decoupling of the economic indicator and freight variable, chapter 3 outlines the data situation and the selection of countries taken into consideration. As already mentioned, the methodology, as well as the regression analysis itself, requires data about economy and transportation, more precise SUT und GVA on the one side and freight volume and transport performance on the other side. To make comparisons beyond single countries possible, a consistent set of data is necessary, and for this reason, statistics from Europe’s statistical office Eurostat are used. Classifications are subject to change, thus often revisions consequently result and make a mutual reference, as what was needed in the bridge matrix to allocate CPA-classified products to NACE-classified commodities, difficult to ascertain. In light of this problem, the available data comprises a time span of nine consecutive years between 1999 and 2007. Out of it, the sample of possible countries is limited as well, because only those countries which were acceded to the European Union before 1999 could be chosen. The statistics depicting the GVA exhibit large gaps in the case of 4 out of altogether 15 possible member states. Consequently, the following 11 countries are part of the thesis' analyses: Germany, France, Spain, Italy, the Netherlands, Austria, Belgium, Luxembourg, Denmark, Sweden, and Finland.

Also, with regard to the transport statistics, lack of data also poses a difficulty. Information about the transported volumes of the several commodities by railways are first given in 2003, thus data are only available for five years, which is too little for a correlation analysis. As a consequence, railway transportation data must be collectively waived. As a comparison of the modal shares of the transported tonnes in the countries shows, the proportion of the railway-transports in total range from 1.0% in the case of Spain up to just shy of 20% in the case of Austria. In respect to the statistics about road haulage, no restrictions are to be lamented. Furthermore, as data of inland waterways are generally only collected if the annual quantity exceeds one million tonnes, thus in 6 out of 11 countries[8] these freight volumes are considered additionally to the road haulage.

With the methodology explained and the required data prepared, the performance of the linear regression analysis can be done. Chapter 4 comprises the description of the analyses, wherein the freight volumes or transport performance and the supply-based or use-based economic indicator are differentiated by commodities and brought together. The results of the regression analyses are expressed in the coefficients of determination (R^2 value). Altogether, for every country 96 R^2 values are generated, half of them based on tonnes or ton kilometres, as well as half of them with supply-based or use-based indicators. Additionally, the significance of all the findings in the term of a p-value is computed with help from t-tests, whereby the level of significance is determined with $\alpha = 0.05$. The detailed representation of the regression analysis and results within the chapter is done for the case of Germany, while the outcomes for the further countries are depicted in the form of *result fact sheets* in the annex Section 4.

Considering the concrete results of the linear regression analyses, for those with tonnes as a dependent variable as well as those with ton kilometres, similar statements can be summarised. With regard to the amount of commodities which reveal significant correlations, the findings for all eleven countries are considerably different. However, if the countries are arranged from the highest to the lowest amount or share of significant correlated commodities, then the order of the countries is very similar. Taking the 5% significance level as a threshold, a wide range from 20 commodities for Spain to only 2 commodities for Sweden is observable in the regression analysis between indicator and freight volume. In the case of Germany, significant correlations for 14 out of 24 commodities are found. On an average, narrowly 10 out of 24 kinds of goods (9.9/24.0) per country reveal significant results. Transfer the absolute number of commodities to the corresponding share, across all eleven countries, on an average half of the total freight volume of a country correlate significantly (50.7%). Spain is still at the top of the ranking (99.2%), with a

[8] Germany, France, the Netherlands, Austria, Belgium and Luxembourg

substantial gap to the second-best result, which belongs to Germany (84.1%), and at the end of the spectrum are Sweden (17.6%) and Finland (3.9%). For comparison, the linear regression analysis between the economic indicator and ton kilometres lead to a range from 18 commodities for Spain to 3 kinds of goods for Finland. Thus, on average, fewer commodities per country exhibit significant results, numerically 9.2 out of 24 commodities. Likewise, the proportions, since on average 45.3% of the total tons kilometres of a country correlate significantly with the indicator, achieve similar results. While the share exceeds 90% in the case of Spain, France, and Germany, it is below 25% for Sweden, Belgium, Luxembourg and Finland.

For the case examples of Germany, a specific analysis case is performed additionally to examine the effect of taking railway transports into consideration. The transported tonnes by railways are taken into account beside the data of road haulage and inland waterways. This is possible with the help of data from the German Federal Statistical Office Destatis, because data from Eurostat are not available, as was previously mentioned. Altogether, 13 commodities, one less compared to the analysis without railway data, representing a share of 78.4% reveal significant results.

Picking up on the criticism in chapter 2, particular attention is given to the condition of stationarity in the context of regression analysis. The time series used in the analysis are checked regarding stationarity with help of a Dickey-Fuller-Test. The tests are done for those countries which exhibit the most significant results, because the whole data set is too comprehensive. With regard to the freight volume, Spain, Germany, and the Netherlands are analysed, and with respect to the ton kilometres, Spain, France, and Germany are analysed. However, the tests show that most of the time series are not stationary, and thus, the risk of spurious correlations is indicated. On average of all the tests, solely 3 out of 72 time series reveal stationarity. In the case of non-stationarity, it is possible to reach stationarity by differentiating the process. Hence, the first and second differences were computed; however, stationarity was only additionally indicated very few times. Finally, it can be stated, that for large parts of the data set, the correlation of the data series holds the danger of spurious regressions. For this reason, further consideration must be given to unconsidered und unknown factors which would affect the determined correlation between the freight variable and the economic indicator.

Another criticism directs to the independency of the individually observed data points of a time series. Concerning this matter, an answer is given through the performance of cross-sectional regression analysis with the freight volume as an explained variable. While in linear regression analysis, data from several years for one particular country are used, in cross-sectional regression analysis, data from the considered countries at one particular point in time are used. The findings show that a majority of the 24 commodities reveal significant correlations over the whole period of time from 1999 to 2007. Most of the significant outcomes exhibit strong correlations expressed through high R^2 values. Similar to the linear regression analysis, correlations with the economic indicator derived from use tables lead to more significant results than correlations with the supply-based indicator.

In chapter 5, the perspective on the outcomes of the regression analysis is changed for the purpose of interpretations. Up to now, the results are presented in fact sheets for every country; however, now the focus is on the comparison of the results for the 24 commodities across individual countries, because the identification of commodities, which can be explained with the methodology, is of particular interest in the context of this thesis and freight generation modelling on the whole.

In the first instance, all the outcomes are represented at a glance in the form of *result matrices*, wherein the correlation for a certain commodity in a country is marked significant or not. For the regression analyses with tonnes and ton kilometres, and in each case three matrices are given, which depict the results for the usage of the supply-based and the use-based indicator. In the third matrix, the more significant result of both is shown.

Considering first the matrices for the correlation with tonnes, it can be stated that in the case of supply-based results, altogether roughly one third of the country-commodity-pairs are significant of on at least a 10%-level (87 of 252 pairs, 34.5%) (Table 61). With regard to the use-based findings, 7% more country-commodity-pairs (108 of 259 pairs, 41.7%) are significant. On average, 7.9 commodities per country in the supply result matrix and 9.8 commodities per country in the use result matrix have significant results.

The result matrix, wherein the outcomes of both analyses are brought together, shows that half of all regression analyses reveal significant correlations (129 of 259, 49.8%) (Table 61). The exactly same result was found for the correlation with ton kilometres. Another similarity is that the regression analysis with the economic indicator derived from use tables leads to much more significant correlations than the usage of the supply-based indicator.

Within the supply-based regression analyses in the case of ton kilometres, it is true that altogether 36.5% of the calculable country-commodity-pairs are significant on at least a 10%-level (92 of 252 pairs). In the case of the use-based findings, 112 out of 259 (43.2%) country-commodity-pairs have significant R^2 values. On average, 8.4 commodities per country in the supply result matrix and 10.2 commodities per country in the use result matrix have significant results.

Table 61 Summarized percentages of significant correlations for all countries

	Supply-based indicator	Use-based indicator	Both indicators in the aggregate
Tonnes	34.5%	41.7%	49.8%
Ton kilometres	36.5%	43.2%	49.8%

Summarising the consideration of the result matrices, it can be noticed that the significant results are highly differentiated over the countries and commodities, which consequently could be split into two groups: one for often significant and another for rarely significant countries and respectively commodities. Moreover, altogether the analysis with the transport performance as the dependent variable reveals more significant values compared to the freight volume. However, with respect to the separate countries, for most of them the regression analysis with the freight volume leads to more significant correlation.

In the aggregate, six commodities are identified for which the regression analyses with tonnes and ton kilometres both result in at least four significant findings per matrix. These commodities are:

- NST/R-8 Solid mineral fuels
- NST/R-14 Cement, lime, manufactured building materials
- NST/R-15 Crude and manufactured minerals
- NST/R-21 Manufactures of metal

- NST/R-23 Leather, textile, clothing, other manufactured articles
- NST/R-24 Miscellaneous articles

On the other hand, the following three commodities do not reveal more than three significant results in any analyses – it should be kept in mind that the correlations for NST/R-9 are not entirely computable.

- NST/R-9 Crude petroleum
- NST/R-12 Non-ferrous ores and waste
- NST/R-22 Glass, glassware, ceramic products

More detailed interpretations of the findings of the regression analyses are focused on determined focus groups within which all these countries are allocated, and for which at least half of the commodities reveal significant results. The focus group tonnes comprises six countries, which are Spain, Germany, the Netherlands, Italy, Austria, and France, and the focus group ton kilometres is the same except for the inclusion of Italy. Due to the similarity, one important conclusion can be drawn: the same countries have a considerable amount of significantly correlated results. Furthermore, with regard to the statistics, it is evident that most of the countries of the focus groups tend to have large gross domestic product, large gross value added, and extensive exports and imports. In contrast, the freight data and the modal splits of the countries, as well as their geographic size, are very heterogeneous and do not give an impression of whether a country will reveal more or less significant correlations. However, a diverse connection to neighbouring countries due to the geographical location, as well as the existence of larger seaports, can be an indication for proving the methodology.

With respect to the concrete findings of the regression analyses, it is conspicuous that in the terms of the correlation with tonnes, as well as with ton kilometres, the usage of the economic indicator derived from use tables reveals more significant results than the usage of supply-based indicators. Furthermore, it is proven that most of the country-commodity-pairs, which correlate significantly due to a supply-based indicator, are also significant if the analysis is done with a use-based economic indicator. In short, it can be concluded that the demand for products drives transportation.

All in all, for the analyses with the freight volume, as well as the ton kilometres, roughly 60 percent of the computed correlations for the countries of the focus group have significant coefficients of determination (Table 62Table 56). Furthermore, the explanatory power of the analysis with ton kilometres exceeds the analysis with tonnes.

Table 62 Summarized percentages of significant correlations for the focus group

	Supply-based indicator	**Use-based indicator**	**Both indicators in the aggregate**
Tonnes	45.8%	57.6%	63.6%
Ton kilometres	54.6%	60.5%	69.7%

With respect to the focus group tonnes, special attention should be given to the four commodities (NST/R-13, -15, -20, -24) which have five significant results out of six considered countries for each of the two indicators. On average, for the six countries, these commodities alone represent more than half of the total freight transports (52.4%)

- NST/R-13 Metal products
- NST/R-15 Crude and manufactured minerals
- NST/R-20 Transport equipment, machinery, apparatus, engines […]
- NST/R-24 Miscellaneous articles

Interpretations on a broader context reveal that commodities within an agricultural framework have more often significant results through the indicator derived from use tables.

In contrast, it is striking to note that commodities, including chemical products, show rarely significant results. Altogether, four kinds of goods have significant results in maximally two countries, one consistently being Spain in three out of four cases. However, the average share of the rarely significant commodities for the countries of the focus group is only 5.7%.

- NST/R-5 Textiles, textile articles and man-made fibres
- NST/R-17 Coal chemicals, tar
- NST/R-18 Chemicals other than coal chemicals and tar
- NST/R-22 Glass, glassware, ceramic products

In the case of ton kilometres, NST/R-10, -15, -18 and -21 should be taken into special consideration, because they exhibit significant results for both economic indicators in four or even all five countries of the focus group. In contrast to the focus group tonnes, these most frequently significant commodities on average represent solely 22.9% of the total ton kilometres.

- NST/R-10 Petroleum products
- NST/R-15 Coal chemicals, tar
- NST/R-18 Chemicals other than coal chemicals and tar
- NST/R-21 Manufactures of metal

Considering the outcomes from supply and use tables in the aggregate, the following five commodities have maximally two significant correlations in two countries:

- NST/R-4 Wood and cork
- NST/R-11 Iron ore, iron and steel waste and blast furnace dust
- NST/R-12 Non-ferrous ores and waste
- NST/R-16 Natural and chemical fertilizers
- NST/R-22 Glass, glassware, ceramic products

The average share of the rarely significant commodities for the countries of the focus group is 7.7% and it is striking to note that both commodity groups, including ores, belong to the group of rarely significant commodities.

Paying particular attention to the relevance of the transport mode for a commodity to interpret the results of the regression analysis, it can be surmised that the findings do not reveal any consistent relationship between the frequency of significant correlations for a commodity and their modal split. This evidence is true for the more frequently significant kinds of goods as well as for those which have rarely significant results, and independent of either tonnes or ton kilometres, are used as freight variable.

Besides the explanations about the linear regression analysis, the chapter also interprets the findings of the cross-section regression analysis. It was shown that a majority of the correlations are significant and, due to this fact, the quality of the correlation is evaluated with help of the standard deviation of the R^2 values.

A significant conclusion can be made that a consistent R^2 value on a high level over the course of time proves a stable and reliable correlation between the economic indicator and the tonnes or ton kilometres.

For both cross-sectional regression analyses, based either on supply or on use tables, one quarter of the commodities (6 out of 24) reveal a strong correlation expressed by an R^2 value in the amount of 0.80 and higher.

- NST/R-6 Foodstuffs and animal fodder
- NST/R-13 Metal products
- NST/R-17 Coal chemicals, tar
- NST/R-18 Chemicals other than coal chemicals and tar
- NST/R-20 Transport equipment, machinery, apparatus, engines [...]
- NST/R-21 Manufactures of metal

The strength of the correlations do not vary greatly over time for those kinds of goods, which standard deviations are constantly below a value of 0.08 (10% of the determined R^2 threshold 0.80). For most commodities, both R^2 values reveal results on a similarly high level. However, the R^2 values of the use-based cross-sectional regression analyses are in two out of three cases higher than the supply-based analyses. Comparing the outcomes of the cross-sectional regression analysis with those of the linear regression analysis, shows that the outcomes do not correspond to each other in overall results.

Finally, the chapter discusses in detail the value-weight-ratios. These parameters combine two of the basic characteristics of a product or commodity by building its ratio. With the help of value-weight-ratios, monetary data of commodities from a statistic can be transferred into tonnes. The cross-sectional analyses performed in this thesis offer a possibility to derive individual weight-value-ratios (WVR) for altogether 24 kinds of goods.

In chapter 6, the final chapter aside from the summary, implications for future freight generation modelling are derived from the research work of this thesis. Concluding, it can be stated that the methodology originally developed for the case of Germany within this thesis was expanded to a general method based on a consistent set of data. The application for other countries was performed and the regression analyses reveal correlations for several countries beyond Germany. However, the used time series for the linear regression analysis did not fulfil the condition of stationarity. Thus, in the future, a discussion about the technical preconditions for the performance of regression analysis and in the course of the coupling/decoupling discussion is necessary, and in the implementation, cross-section regression analysis should be performed over linear regression analysis. Thereby, sufficient data points must be taken into account to obtain meaningful results.

Moreover, the need for detailed data procurement and taking multivariate into consideration was emphasised. The issue of value-weight-ratios was addressed as well, and it was mentioned that such ratios proved to be an effective way to derive freight volumes from economic statistics. The regression analyses carried out in the thesis can be utilised to derive value-weight-ratios. For more precise investigation in further research, those commodities which revealed the most significant results in the analyses, and the topic of transportation logistics are suggested.

Zusammenfassung

Diese Masterarbeit beschäftigt sich im weiteren Sinne mit dem Zusammenhang zwischen Ökonomie und Güterverkehr und der damit einhergehenden Diskussion um die Kopplung bzw. Entkopplung von beidem. Die Arbeit trägt ihren Beitrag zu der Diskussion bei, indem sie eine Methode erläutert, die zur Entwicklung eines Wirtschaftsindikators führt, der anschließend in Regressionsanalysen verwendet werden kann. Für den Anwendungsfall Deutschland wurde die Methode von Stephan Müller, Jens Klauenberg und Axel Wolfermann am Institut für Verkehrsforschung des Deutschen Zentrums für Luft- und Raumfahrt (DLR) entwickelt und dahingehend erfolgreich angewendet, dass für über 90 % des Frachtaufkommens im Jahr 2007 ein Zusammenhang zu dem Wirtschaftsindikators identifiziert werden konnte (51, 52). Im Rahmen dieser Arbeit wird die Methode nun verallgemeinert und auf eine einheitliche Datenbasis gestellt, dass sie auf weitere europäische Länder angewendet werden kann.

Diese Arbeit trägt zum besseren Verständnis der Entstehung von Frachtaufkommen bei und adressiert damit die erste und grundlegende Stufe der Modellierung von Gütertransporten. Die an die Frachterzeugung anschließenden weiteren Arbeitsschritte des vierstufigen Modellierungskonzeptes sind die Frachtverteilung, die Transportmittelwahl sowie die abschließende Umlegung der Fahrten auf das Infrastrukturnetz.

Die Regressionsanalysen werden auf Ebene von Transportgutarten entsprechend der Klassifizierung nach NST/R-24 durchgeführt. Dementsprechend müssen das Transportaufkommen in Tonnen bzw. die Transportleistung in Tonnenkilometern sowie die Wirtschaftsindikatoren disaggregiert je Gutart vorliegen. Die Betrachtung des Zusammenhangs zwischen Ökonomie und Güterverkehr auf Ebene von einzelnen Gutarten stellt einen Fortschritt gegenüber aggregierten Methoden dar, in denen beispielsweise allein aus dem Bruttoinlandsprodukt einer Volkswirtschaft auf deren gesamtes Transportaufkommen geschlossen wird.

Noch immer stellt die Ableitung von Frachtaufkommen aus ökonomischen Aktivitäten eine Herausforderung dar und deshalb sind die Erkenntnisse, die durch diese Masterarbeit gewonnen werden, von großer Relevanz und kommen verschiedensten Anwendungsbereichen zugute. Mithilfe der entwickelten Methode können Frachtaufkommen zum einen als Inputparameter für Frachterzeugungsmodelle bestimmt werden und zum anderen den Ergebnissen anderer Erzeugungsmodelle gegenübergestellt werden. Des Weiteren werden belastbare Daten für die Diskussion um die Kopplung bzw. Entkopplung von Ökonomie und Güterverkehr geliefert und auf Grundlage der Ergebnisse können Prognosen zukünftiger Frachtaufkommen erstellt werden.

Die Forschungsfrage, der zwei wichtige Annahmen vorausgehen, lautet:

Angenommen, dass zum einen die Wirtschaftsindikatoren unter Verwendung der für den Fall Deutschland angewandten Methode generiert werden, und zum anderen, dass das der Analyse zugrunde liegende Datenmaterial statistische Voraussetzungen erfüllt: **Lässt sich mit Hilfe des Wirtschaftsindikators auch für andere europäische Länder eine hohe Kopplung von Ökonomie und Güterverkehr feststellen?**

Anschließend an das einleitende Kapitel, dessen Inhalte bis hierher zusammengefasst wurden, umfasst die Masterarbeit sechs weitere Kapitel – wovon das letzte die Zusammenfassung enthält – sowie einen sehr umfassenden Anhang, der die Ausführungen mit Ergebnisdarstellungen und Statistiken untermauert. In Kapitel 2 wird die bereits im Kurzen angeführte Methode detailliert und kritisch erläutert. Kapitel 3 enthält die Ausführungen zu allen Statistiken und Daten, die für die Analysen benötigt werden. Dazu wird die Auswahl der für die Analyse ausgewählten Länder hergeleitet. Durch diese beiden Kapitel ist die Grundlage für die umfangreichen Analysen gelegt, die in Kapitel 4 beschrieben werden. Des Weiteren wird auf die Kritik der Methode aus Kapitel 2 Bezug genommen und es werden weiterführende Untersuchungen angestellt. Das Kapitel 5 legt die Interpretation der zuvor ermittelten Ergebnisse der Regressionsanalysen dar und in dem abschließenden Kapitel 6 werden wichtige Schlussfolgerungen für die Frachtmodellierung erörtert sowie an gegebener Stelle auf Vorschläge für weitere Forschungen hingewiesen.

Der Zusammenhang zwischen Ökonomie und Güterverkehr soll mit Hilfe von linearen Regressionsanalysen untersucht werden. Während sich das Transportaufkommen direkt aus Statistiken entnehmen lässt, muss der Wirtschaftsindikator zuvor berechnet werden. Die dafür angewandte Methode wird in Kapitel 2 ausführlich erläutert. Die beschreibenden Faktoren, die in die Berechnung des Indikators eingehen, sind Daten aus Aufkommens- und Verwendungstabellen, sowie die Bruttowertschöpfung. Aufkommens- und Verwendungstabellen sind Bestandteil der Volkswirtschaftlichen Gesamtrechnung und geben Auskunft darüber, durch welche Wirtschaftszweige (NACE-klassifiziert) bestimmte Produkte (CPA-klassifiziert) produziert und verwendet werden. Zunächst erhält man somit zwei Indikatoren für jedes der 31 Produkte. Der eine Indikator wird aus den Aufkommenstabellen abgeleitet und der anderen aus den Verwendungstabellen. Da letztlich jedoch ein Indikator je Transportgutart (NST/R-klassifiziert) benötigt wird, ist im abschließenden Schritt eine Zuordnung von Produkten zu Gutarten notwendig. Da es dazu keine standardisierten Übertragungstabellen gibt, wird auf einen Ansatz des Österreichischen Instituts für Wirtschaftsforschung (WIFO) zurückgegriffen (46, 7). Da die Dokumentation der Annahmen dieses Ansatzes nicht lückenlos gegeben ist und auch um seine Anwendung über Österreich hinaus zu legitimieren werden Sensitivitätsanalysen durchgeführt, um aufzuzeigen, wie sich die Ergebnisse der Regressionsanalysen in Abhängigkeit von den Zuordnungsfaktoren verhalten.

Des Weiteren wird in dem Kapitel in zweifacher Hinsicht Kritik an dem bisherigen Vorgehen geübt. Zum einen wurden die für die Analysen im Fall Deutschland verwendeten Datenreihen bislang nicht auf Stationarität getestet, um das Auftreten von Scheinkorrelationen auszuschließen und zum anderen muss gewährleistet sein, dass die einzelnen Datenpunkte unabhängig voneinander sind. Diese Kritik wird in Kapitel 4 aufgegriffen, indem Stationaritätstests und Querschnittsregressionen durchgeführt werden.

Nachdem die Methode zur Entwicklung des Wirtschaftsindikators vorgestellt wurde, wird in Kapitel 3 der gesamte Datenbestand, der für die Analysen nötig ist, aufbereitet. Die Vergleichbarkeit der Ergebnisse für verschiedene Länder ist ein wichtiges Ziel dieser Arbeit und daher muss den Analysen ein konsistenter Datensatz zugrunde liegen. Die Daten zum Transportaufkommen in Form von transportierten Tonnen und Transportkilometern sowie die Aufkommens- und Verwendungstabellen und die Bruttowertschöpfung werden durch das europäische Statistikamt Eurostat frei zugänglich zur Verfügung gestellt. Mangelnde

Verfügbarkeit von Daten und Wechsel von Klassifikationssystemen sind wesentliche Restriktionen, die den für die Analysen verfügbare Datensatz einschränken. Der Analysezeitraum fällt auf die 1999 bis 2007 und innerhalb dieses Zeitraums stehen ausreichend Daten für 11 Mitgliedsstaaten der Europäischen Union zur Verfügung. Neben Deutschland sind dies: Frankreich, Spanien, Italien, die Niederlande, Österreich, Belgien, Luxemburg, Dänemark, Schweden und Finnland. Bezüglich des Transportaufkommens können die Transporte im Straßengüterverkehr sowie die der Binnenschifffahrt berücksichtigt werden, wohingegen Transporte mit der Eisenbahn aufgrund fehlender Daten nicht berücksichtigt werden können.

In Kapitel 4 kann nun die Zusammenhangsanalyse zwischen Wirtschaftsindikator und Frachtvariable durchgeführt werden. Der Indikator basierend auf den Aufkommens- oder Verwendungstabellen als erklärende Variable und die Tonnen oder Tonnenkilometer als zu erklärende Variable werden in linearen Regressionsanalysen zusammengebracht. Die Stärke eines Zusammenhangs wird durch das Bestimmtheitsmaß R^2 ausgedrückt. Zusätzlich wird die Signifikanz der Ergebnisse in Form des p-Werts durch t-Tests bestimmt. Die Durchführung der Zusammenhangsanalyse und die Ergebnisse werden für den Fall Deutschland ausführlich dargelegt. Die Resultate der weiteren untersuchten Länder befinden sich im Anhang Teil 4.

Die Ergebnisse für die 11 Länder sind sehr unterschiedlich, wobei für die einzelnen Länder hinsichtlich der Regression mit Tonnen oder Tonnenkilometern recht ähnliche Resultate erzielt werden. Während im Fall von Spanien für 20 der insgesamt 24 Gutarten eine signifikante Korrelation ermittelt wird – bei einem Signifikanzlevel von 5 % – so weist Schweden nur im Fall von 2 Gutarten einen Zusammenhang zwischen Indikator und Transportaufkommen auf. Im Durchschnitt aller betrachteten Länder erzielen rund 10 Gutarten signifikante Ergebnisse und Deutschland schneidet mit 14 korrelierenden Gutarten deutlich überdurchschnittlich ab. Diese Gutarten repräsentieren 84,1 % der 2007 in Deutschland per Lkw und Binnenschiff transportierten Güter. Im Mittel wird gut die Hälfte der Transportaufkommen aller Länder durch diese Methode signifikant erklärt (50,7 %), wohingegen in Bezug auf die Transportleistung durchschnittlich ungefähr 9 Gutarten mit einem Anteil von 45,3 % signifikante Ergebnisse erzielen.

Für Deutschland wird zusätzlich ein besonderer Analysefall dargestellt. Dabei wird in der Regressionsanalyse unter Zuhilfenahme von Daten des Statistischen Bundesamtes Destatis der Gütertransport mit Eisenbahnen berücksichtigt. In diesem Fall werden für 13 Gutarten signifikante Bestimmtheitsmaße ermittelt und es lassen sich 78,4 % des Transportaufkommens signifikant ableiten.

Die Kritik des zweiten Kapitels aufgreifend, wird der Durchführung von Tests zur Stationarität von Zeitreihen eine besondere Aufmerksamkeit gewidmet. Dies geschieht mit Hilfe des sogenannten Dickey-Fuller-Tests, der exemplarisch für die Länder ausgeführt wird, die die meisten signifikant korrelierenden Gutarten aufweisen. In Bezug auf das Transportaufkommen sind dies Spanien, Deutschland und die Niederlande, sowie bei der Transportleistung Spanien, Deutschland und Frankreich. Die Tests zeigen, dass die Stationarität einer Zeitreihe nur in Ausnahmefälle nachgewiesen wird und somit ist es sehr wahrscheinlich, dass die nachgewiesenen Zusammenhänge auf weitere, in der Analyse nicht berücksichtige Einflussfaktoren zurückzuführen sind.

Auf den zweiten Kritikpunkt wird geantwortet, indem neben den linearen Regressionsanalysen nun auch Querschnittsregressionen durchgeführt werden. Das bedeutet, dass die Datenpunkte alle Länder zu einem bestimmten Zeitpunkt analysiert werden. Diese Analysen zeigen, dass für eine große Mehrheit der Gutarten länderübergreifend ein Zusammenhand identifiziert wird. Auch bei dieser Form der Zusammenhangsanalyse führt die Verwendung von Indikatoren, die von den Verwendungstabellen abgeleitet werden, zu mehr signifikanten Ergebnissen, als die Verwendung von aufkommens-basierten Indikatoren.

Die Interpretation der Ergebnisse in Kapitel 5 lenkt den Blick von der Betrachtung der einzelnen Länder weg und richtet ihn auf die verschiedenen Transportgutarten. Diese stehen fortan im Fokus, da die Methode im Sinne eines Betrages zur Modellierung der Frachterzeugung solche Gutarten identifizieren soll, deren Aufkommen mit Hilfe des Indikators abgeleitet werden kann. Zunächst werden in sogenannten Ergebnismatrizen die Ergebnisse für alle Länder und Gutarten in einer Übersicht dargestellt. In diesen Tabellen werden solle Länder-Gutarten-Kombinationen gekennzeichnet, die einen signifikanten Zusammenhang aufweisen. Wie Tabelle 1 zeigt, erzielen in Bezug auf das Transportaufkommen gut ein Drittel der Kombinationen signifikante Resultate, wenn der Indikator auf Aufkommenstabellen basiert. Im Fall von Verwendungstabellen sind gut 40 % der Länder-Gutarten-Kombinationen signifikant und werden beide Indikatoren überlagert betrachtet, so ist rund die Hälfte der Werte signifikant. In Bezug auf die Transportleistung wird in der Aggregation beider Indikatoren exakt dasselbe Resultat erziel und auch hier für die Korrelation mit auf Verwendungstabellen basierenden Indikatoren zu mehr signifikanten Ergebnissen.

Tabelle 1: Zusammengefasste Anteile der signifikanten Korrelationen für alle Länder

	Indikator basiert auf Aufkommenstabellen	**Indikator basiert auf Verwendungstabellen**	**Beide Indikatoren**
Tonnen	34,5 %	41, 7 %	49, 8 %
Tonnenkilometer	36,5 %	43, 2 %	49, 8 %

Insgesamt betrachtet weisen folgende Gutarten sowohl bei der Betrachtung des Transportaufkommens als auch der Transportleistung für alle Länder die meisten signifikanten Zusammenhänge auf:

- NST/R-8 Feste mineralische Brennstoffe
- NST/R-14 Zement, Kalk, verarbeitete Baustoffe
- NST/R-15 Steine und Erden
- NST/R-21 Metallwaren, einschließlich EBM-Waren
- NST/R-23 Leder, Textilien, Bekleidung, sonstige Halb- und Fertigwaren
- NST/R-24 Sonstige Waren

Dem gegenüber gibt es für folgende Gutarten nicht mehr als drei signifikante Ergebnisse:

- NST/R-9 Rohes Erdöl
- NST/R-12 NE-Metallerze und Abfälle von NE-Metallen
- NST/R-22 Glas, Glaswaren, keramische und andere mineralische Erzeugnisse

Alles in allem zeigen die Ergebnisse über die verschiedenen Länder hinweg ein sehr differenziertes Bild. Aus diesem Grund wird für eine zielgerichtete Interpretation eine Auswahl von Ländern getroffen, die im Detail untersucht wird. Zu der sogenannten Fokusgruppe, die jeweils für Korrelationen mit Tonnen und Tonnenkilometern gebildet wird, gehören Länder, für die mindestens 12 der 24 Gutarten signifikante Bestimmtheitsmaße aufweisen. Die Fokusgruppe Tonnen beinhaltet Spanien, Deutschland, die Niederlande, Österreich, Frankreich sowie Italien und die Fokusgruppe Tonnenkilometer umfasst abgesehen von Italien dieselben Länder. Aus dieser Deckungsgleichheit lässt sich bereits die Schlussfolgerung ziehen, dass die Methode für dieselben Länder viele Korrelationen ermittelt. Des Weiteren charakterisiert die Auswahl, dass es sich um große Volkswirtschaften handelt, die im Vergleich aller betrachteten Länder die größten Bruttosozialprodukte, Bruttowertschöpfung sowie Ex- und Importe erzielen. Allerdings sind die Frachtaufkommen und die Modal Splits der sechs bzw. fünf Länder sehr verschieden, so dass diese Eigenschaften keinen Schluss darauf zulassen, ob für ein Land durch die Methode mehr oder weniger Korrelationen nachgewiesen werden.

Werden in Analogie zur obigen Tabelle nun nur die Resultate für die Länder der Fokusgruppen betrachtet, so lässt sich eine deutliche Steigerung der erklärten Länder-Gutarten-Kombinationen konstatieren (Tabelle 2).

Tabelle 2: Zusammengefasste Anteile der signifikanten Korrelationen für die Länder der Fokusgruppe

	Indikator basiert auf Aufkommenstabellen	Indikator basiert auf Verwendungstabellen	Beide Indikatoren
Tonnen	45,8 %	57,6 %	63,6 %
Tonnenkilometer	54,6 %	60,5 %	69,7 %

In der Fokusgruppe Tonnen erzielen folgende vier Gutarten in mindestens fünf der sechs Länder signifikante Ergebnisse und repräsentieren dabei im Durchschnitt mehr als die Hälfte der Transportaufkommen in den Ländern (52, 4 %):

- NST/R-13 Eisen, Stahl und NE-Metalle (einschließlich Halbzeug)
- NST/R-15 Steine und Erden
- NST/R-20 Fahrzeuge und Beförderungsmittel, Maschinen, Motoren, auch zerlegt und Einzelteile
- NST/R-24 Sonstige Waren

Wird die Ergebnisanalyse etwas weiter gefasst, so kann festgehalten werden, dass Gutarten im Zusammenhang mit Landwirtschaft deutlich mehr Korrelationen aufweisen, wenn die Indikatoren auf Grundlage der Verwendungstabellen verwendet werden.

Dem gegenüber fällt auf, dass Gutarten im Kontext chemischer Erzeugnisse nur selten signifikante Ergebnisse zeigen. Die insgesamt vier Gutarten mit den wenigsten signifikanten Korrelationen machen in Summe jedoch nur 5,7 % des gesamten Aufkommens der Länder der Fokusgruppe aus.

- NST/R-5 Spinnstoffe und Textilabfälle, andere pflanzliche, tierische und verwandte Rohstoffe
- NST/R-17 Grundstoffe der Kohle- und Petrochemie, Teere
- NST/R-18 Chemische Erzeugnisse, ausgenommen Grundstoffe der Kohle- und Petrochemie sowie Teere
- NST/R-22 Glas, Glaswaren, keramische und andere mineralische Erzeugnisse

Mit Blick auf die Transportleistung stehen die vier Gutarten mit den häufigsten Korrelationen nur für knapp ein Viertel (22,9 %) der gesamten Transportleistung eines Landes.

- NST/R-10 Mineralölerzeugnisse
- NST/R-15 Steine und Erden
- NST/R-18 Chemische Erzeugnisse, ausgenommen Grundstoffe der Kohle- und Petrochemie sowie Teere
- NST/R-21 Metallwaren, einschließlich EBM-Waren

Maximal in zwei der fünf Länder erzielen folgende Gutarten signifikante Ergebnisse:

- NST/R-4 Holz und Kork
- NST/R-11 Eisenerze, Eisen- und Stahlabfälle und -schrott, Hochofenstaub, Schwefelkiesabbrände
- NST/R-12 NE-Metallerze und Abfälle von NE-Metallen
- NST/R-16 Natürliche oder chemische Düngemittel
- NST/R-22 Glas, Glaswaren, keramische und andere mineralische Erzeugnisse

Wie bereits gesagt wurde sind die Ergebnisse der Querschnittsregression bis auf wenige Ausnahmen signifikant. Deshalb spielt zur qualitativen Bewertung auch die Höhe des Bestimmtheitsmaßes und dessen Standardabweichung eine größere Rolle als bei der linearen Regression zuvor. Ein über den Analysezeitraum hinweg konstant hohes Bestimmtheitsmaß zeugt von einem starken Zusammenhang zwischen Indikator und Frachtvariable. Für ein Viertel der Gutarten lässt sich für beide Arten der Indikatoren eine Korrelation mit einem R^2-Wert größer 0,80 feststellen.

- NST/R-6 Andere Nahrungs- und Futtermittel
- NST/R-13 Eisen, Stahl und NE-Metalle (einschließlich Halbzeug)
- NST/R-17 Grundstoffe der Kohle- und Petrochemie, Teere
- NST/R-18 Chemische Erzeugnisse, ausgenommen Grundstoffe der Kohle- und Petrochemie sowie Teere

- NST/R-20 Fahrzeuge und Beförderungsmittel, Maschinen, Motoren, auch zerlegt und Einzelteile
- NST/R-21 Metallwaren, einschließlich EBM-Waren

Abschließend wird in dem Kapitel auf das Verhältnis von Gewicht und Wert als wesentliche Charakteristika eines Produkts oder einer Transportgutart eingegangen. Die Idee ist, dass mit Hilfe von Wert-Gewicht-Verhältnissen die Transportaufkommen aus Wirtschaftsstatistiken, die monetäre Informationen beinhalten, abgeleitet werden können. Die Querschnittsregressionen stellen solche Verhältnisse für die insgesamt 24 Gutarten zur Verfügung.

In Kapitel 6 werden Schlussfolgerungen aus den Erkenntnissen, die durch diese Masterarbeit gewonnen wurden, gezogen und ein Ausblick auf weiteren Forschungsbedarf gegeben. Zunächst ist festzuhalten, dass es gelungen ist die Methode auf Grundlage eines einheitlichen Datensatzes für verschiedene europäische Länder anzuwenden. Die Verwendung des durch die Methode entwickelten Wirtschaftsindikators erzielt auch über Deutschland hinaus in einigen Ländern viele signifikante Ergebnisse. Jedoch muss einschränkend deutlich gemacht werden, dass die Daten grundlegende statistische Voraussetzungen für die Durchführung von Zusammenhangsanalysen nicht erfüllen, wie anhand der Tests der Stationarität aufgezeigt wurde. Recherchen belegen zusätzlich, dass zukünftig im Kontext von Zusammenhangsanalysen eine stärkere Auseinandersetzung mit statistischen Erfordernissen notwendig ist, damit aussagekräftige Ergebnisse in die Diskussion um die Kopplung bzw. Entkopplung von Ökonomie und Güterverkehr eingebracht werden.

Generell sind Querschnittsregressionen bevorzugt zu verwenden, da dabei eine zeitliche Unabhängig der Datenpunkte gewährleistet ist. In jedem Fall sind ausreichend Daten für die Analysen zu verwenden.

Zudem ist deutlich geworden, dass es weitere, in der Methode nicht berücksichtige Einflussfaktoren für den Zusammenhang zwischen dem Wirtschaftsindikator, der im Wesentlichen auf die Bruttowertschöpfung gestützt ist, und den Transportvariablen gibt. Insbesondere bezüglich des Themas der Transportlogistik bedarf es eines besseren Verständnisses.

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Annex

Section 1: Classifications

Classification of commodities according to NST/R

NST/R	Titles of Divisions
1	Cereals
2	Potatoes, other fresh or frozen fruit and vegetables
3	Life animals, sugar beet
4	Wood and cork
5	Textiles, textile articles and man-made fibres, other raw animal and vegetable materials
6	Foodstuffs and animal fodder
7	Oil seeds and oleaginous fruit and fats
8	Solid mineral fuels
9	Crude petroleum
10	Petroleum products
11	Iron ore, iron and steel waste and blast furnace dust
12	Non-ferrous ores and waste
13	Metal products
14	Cement, lime, manufactured building materials
15	Crude and manufactured minerals
16	Natural and chemical fertilizers
17	Coal chemicals, tar
18	Chemicals other than coal chemicals and tar
19	Paper pulp and waste paper
20	Transport equipment, machinery, apparatus, engines, whether or not assembled, and parts thereof
21	Manufactures of metal
22	Glass, glassware, ceramic products
23	Leather, textile, clothing, other manufactured articles
24	Miscellaneous articles

Classification of products according to CPA 2002

CPA 2002	Titles of Divisions
AA 01	Products of agriculture, hunting and related services
AA 02	Products of forestry, logging and related services
BA 05	Fish and other fishing products; services incidental of fishing
CA 10	Coal and lignite; peat
CA 11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying
CA 12	Uranium and thorium ores
CB 13	Metal ores
CB 14	Other mining and quarrying products
DA 15	Food products and beverages
DA 16	Tobacco products
DB 17	Textiles
DB 18	Wearing apparel; furs
DC 19	Leather and leather products
DD 20	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials
DE 21	Pulp, paper and paper products
DE 22	Printed matter and recorded media
DF 23	Coke, refined petroleum products and nuclear fuels
DG 24	Chemicals, chemical products and man-made fibres
DH 25	Rubber and plastic products
DI 26	Other non-metallic mineral products
DJ 27	Basic metals
DJ 28	Fabricated metal products, except machinery and equipment
DK 29	Machinery and equipment n.e.c.
DL 30	Office machinery and computers
DL 31	Electrical machinery and apparatus n.e.c.
DL 32	Radio, television and communication equipment and apparatus
DL 33	Medical, precision and optical instruments, watches and clocks
DM 34	Motor vehicles, trailers and semi-trailers
DM 35	Other transport equipment
DN 36	Furniture; other manufactured goods n.e.c.
DN 37	Secondary raw materials

Classification of commodities according to NACE Rev. 1

NACE	Titles of Divisions
01	Agriculture, hunting and related service activities
02	Forestry, logging and related service activities
05	Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing
10	Mining of coal and lignite; extraction of peat
11	Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying
12	Mining of uranium and thorium ores
13	Mining of metal ores
14	Other mining and quarrying
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of pulp, paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuels
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastic products
26	Manufacture of other non-metallic mineral products
27	Manufacture of basic metals
28	Manufacture of fabricated metal products, except machinery and equipment
29	Manufacture of machinery and equipment n.e.c.
30	Manufacture of office machinery and computers
31	Manufacture of electrical machinery and apparatus n.e.c.
32	Manufacture of radio, television and communication equipment and apparatus
33	Manufacture of medical, precision and optical instruments, watches and clocks
34	Manufacture of motor vehicles, trailers and semi-trailers
35	Manufacture of other transport equipment
36	Manufacture of furniture; manufacturing n.e.c.
37	Recycling

40	Electricity, gas, steam and hot water supply
41	Collection, purification and distribution of water
45	Construction
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale services of automotive fuel
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
55	Hotels and restaurants
60	Land transport; transport via pipelines
61	Water transport
62	Air transport
63	Supporting and auxiliary transport activities; activities of travel agencies
64	Post and telecommunications
65	Financial intermediation, except insurance and pension funding
66	Insurance and pension funding, except compulsory social security
67	Activities auxiliary to financial intermediation
70	Real estate activities
71	Renting of machinery and equipment without operator and of personal and household goods
72	Computer and related activities
73	Research and development
74	Other business activities
75	Public administration and defence; compulsory social security
80	Education
85	Health and social work
90	Sewage and refuse disposal, sanitation and similar activities
91	Activities of membership organisation n.e.c.
92	Recreational, cultural and sporting activities
93	Other service activities
95	Private households with employed persons

Section 2: Bridge matrices

Bridge matrices (BM) allocate products (CPA-classified) to commodities (NST/R-classified)

Germany: BM based on ton kilometres (2007)

Commodity *k* NST/R	**Product *i* CPA 2002**	**Factor $\beta_{i,k}$**	***k***	***i***	**$\beta_{i,k}$**	***k***	***i***	**$\beta_{i,k}$**
1	01	0.3095	13	28	0.6537	24	01	0.1000
2	01	0.2800	14	26	0.7850	24	05	0.2000
3	01	0.0850	15	14	1.000	24	12	1.000
3	05	0.2190	16	24	0.1198	24	15	0.1000
4	02	1.000	16	25	0.0833	24	16	0.8000
4	20	1.000	17	24	0.0174	24	17	0.3000
5	17	0.0496	17	25	0.0121	24	18	0.3000
5	18	0.0496	18	24	0.8128	24	19	0.3000
5	19	0.0496	18	25	0.5647	24	21	0.2000
5	36	0.0467	19	21	0.8000	24	22	1.000
5	37	0.0531	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.2254	20	32	0.3300	24	27	0.0500
7	05	0.5810	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0033	20	35	0.9000	24	30	0.6700
9	23	0.0033	21	27	0.1986	24	31	0.3000
10	11	0.9967	21	28	0.2463	24	32	0.6700
10	23	0.9967	22	26	0.1650	24	33	0.6700
11	13	0.8635	23	17	0.6504	24	34	0.1000
11	27	0.1937	23	18	0.6504	24	35	0.1000
12	13	0.1365	23	19	0.6504	24	36	0.3400
12	27	0.0306	23	36	0.6133	24	37	0.2500
13	27	0.5271	23	37	0.6969			

Austria: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3109	13	28	0.7688	24	01	0.1000
2	01	0.3537	14	26	0.9128	24	05	0.2000
3	01	0.1545	15	14	1.000	24	12	1.000
3	05	0.5252	16	24	0.2784	24	15	0.1000
4	02	1.000	16	25	0.1934	24	16	0.8000
4	20	1.000	17	24	0.1878	24	17	0.3000
5	17	0.0524	17	25	0.1305	24	18	0.3000
5	18	0.0524	18	24	0.4837	24	19	0.3000
5	19	0.0524	18	25	0.3361	24	21	0.2000
5	36	0.0494	19	21	0.8000	24	22	1.000
5	37	0.0562	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0808	20	32	0.3300	24	27	0.0500
7	05	0.2748	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0024	20	35	0.9000	24	30	0.6700
9	23	0.0024	21	27	0.0939	24	31	0.3000
10	11	0.9976	21	28	0.1312	24	32	0.6700
10	23	0.9976	22	26	0.0372	24	33	0.6700
11	13	0.9518	23	17	0.6476	24	34	0.1000
11	27	0.2915	23	18	0.6476	24	35	0.1000
12	13	0.0482	23	19	0.6476	24	36	0.3400
12	27	0.0148	23	36	0.6106	24	37	0.2500
13	27	0.5499	23	37	0.6938			

Austria: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3485	13	28	0.8219	24	01	0.1000
2	01	0.3924	14	26	0.8074	24	05	0.2000
3	01	0.0394	15	14	1.000	24	12	1.000
3	05	0.1983	16	24	0.2430	24	15	0.1000
4	02	1.000	16	25	0.1688	24	16	0.8000
4	20	1.000	17	24	0.0359	24	17	0.3000
5	17	0.0556	17	25	0.0250	24	18	0.3000
5	18	0.0556	18	24	0.6711	24	19	0.3000
5	19	0.0556	18	25	0.4662	24	21	0.2000
5	36	0.0525	19	21	0.8000	24	22	1.000
5	37	0.0596	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1196	20	32	0.3300	24	27	0.0500
7	05	0.6017	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0026	20	35	0.9000	24	30	0.6700
9	23	0.0026	21	27	0.0629	24	31	0.3000
10	11	0.9974	21	28	0.0781	24	32	0.6700
10	23	0.9974	22	26	0.1426	24	33	0.6700
11	13	0.9561	23	17	0.6444	24	34	0.1000
11	27	0.2152	23	18	0.6444	24	35	0.1000
12	13	0.0439	23	19	0.6444	24	36	0.3400
12	27	0.0099	23	36	0.6075	24	37	0.2500
13	27	0.6620	23	37	0.6904			

Belgium: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2836	13	28	0.8144	24	01	0.1000
2	01	0.2931	14	26	0.8737	24	05	0.2000
3	01	0.1663	15	14	1.000	24	12	1.000
3	05	0.4114	16	24	0.1880	24	15	0.1000
4	02	1.000	16	25	0.1306	24	16	0.8000
4	20	1.000	17	24	0.0125	24	17	0.3000
5	17	0.1208	17	25	0.0087	24	18	0.3000
5	18	0.1208	18	24	0.7495	24	19	0.3000
5	19	0.1208	18	25	0.5207	24	21	0.2000
5	36	0.1139	19	21	0.8000	24	22	1.000
5	37	0.1295	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1570	20	32	0.3300	24	27	0.0500
7	05	0.3886	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0019	20	35	0.9000	24	30	0.6700
9	23	0.0019	21	27	0.0658	24	31	0.3000
10	11	0.9981	21	28	0.0856	24	32	0.6700
10	23	0.9981	22	26	0.0763	24	33	0.6700
11	13	0.6899	23	17	0.5792	24	34	0.1000
11	27	0.1780	23	18	0.5792	24	35	0.1000
12	13	0.3101	23	19	0.5792	24	36	0.3400
12	27	0.0800	23	36	0.5461	24	37	0.2500
13	27	0.6262	23	37	0.6205			

Belgium: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2779	13	28	0.8162	24	01	0.1000
2	01	0.3704	14	26	0.7742	24	05	0.2000
3	01	0.1049	15	14	1.000	24	12	1.000
3	05	0.3335	16	24	0.1433	24	15	0.1000
4	02	1.000	16	25	0.0996	24	16	0.8000
4	20	1.000	17	24	0.0084	24	17	0.3000
5	17	0.1167	17	25	0.0058	24	18	0.3000
5	18	0.1167	18	24	0.7983	24	19	0.3000
5	19	0.1167	18	25	0.5546	24	21	0.2000
5	36	0.1100	19	21	0.8000	24	22	1.000
5	37	0.1250	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1468	20	32	0.3300	24	27	0.0500
7	05	0.4665	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0047	20	35	0.9000	24	30	0.6700
9	23	0.0047	21	27	0.0727	24	31	0.3000
10	11	0.9953	21	28	0.0838	24	32	0.6700
10	23	0.9953	22	26	0.1758	24	33	0.6700
11	13	0.8644	23	17	0.5833	24	34	0.1000
11	27	0.1464	23	18	0.5833	24	35	0.1000
12	13	0.1356	23	19	0.5833	24	36	0.3400
12	27	0.0230	23	36	0.5500	24	37	0.2500
13	27	0.7080	23	37	0.6250			

Denmark: BM based on tonnes for (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2904	13	28	0.3832	24	01	0.1000
2	01	0.2295	14	26	0.9044	24	05	0.2000
3	01	0.3084	15	14	1.000	24	12	1.000
3	05	0.6491	16	24	0.5410	24	15	0.1000
4	02	1.000	16	25	0.3758	24	16	0.8000
4	20	1.000	17	24	0.2028	24	17	0.3000
5	17	0.0319	17	25	0.1409	24	18	0.3000
5	18	0.0319	18	24	0.2063	24	19	0.3000
5	19	0.0319	18	25	0.1433	24	21	0.2000
5	36	0.0301	19	21	0.8000	24	22	1.000
5	37	0.0342	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0717	20	32	0.3300	24	27	0.0500
7	05	0.1509	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0066	20	35	0.9000	24	30	0.6700
9	23	0.0066	21	27	0.4062	24	31	0.3000
10	11	0.9934	21	28	0.5168	24	32	0.6700
10	23	0.9934	22	26	0.0456	24	33	0.6700
11	13	0.8147	23	17	0.6681	24	34	0.1000
11	27	0.1977	23	18	0.6681	24	35	0.1000
12	13	0.1853	23	19	0.6681	24	36	0.3400
12	27	0.0450	23	36	0.6299	24	37	0.2500
13	27	0.3012	23	37	0.7158			

Denmark: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.1948	13	28	0.4313	24	01	0.1000
2	01	0.3806	14	26	0.8491	24	05	0.2000
3	01	0.2160	15	14	1.000	24	12	1.000
3	05	0.5325	16	24	0.2849	24	15	0.1000
4	02	1.000	16	25	0.1979	24	16	0.8000
4	20	1.000	17	24	0.1530	24	17	0.3000
5	17	0.0195	17	25	0.1063	24	18	0.3000
5	18	0.0195	18	24	0.5121	24	19	0.3000
5	19	0.0195	18	25	0.3558	24	21	0.2000
5	36	0.0184	19	21	0.8000	24	22	1.000
5	37	0.0209	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1085	20	32	0.3300	24	27	0.0500
7	05	0.2675	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0269	20	35	0.9000	24	30	0.6700
9	23	0.0269	21	27	0.3997	24	31	0.3000
10	11	0.9731	21	28	0.4687	24	32	0.6700
10	23	0.9731	22	26	0.1009	24	33	0.6700
11	13	0.7055	23	17	0.6805	24	34	0.1000
11	27	0.1288	23	18	0.6805	24	35	0.1000
12	13	0.2945	23	19	0.6805	24	36	0.3400
12	27	0.0538	23	36	0.6416	24	37	0.2500
13	27	0.3678	23	37	0.7291			

Finland: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.5158	13	28	0.6205	24	01	0.1000
2	01	0.1708	14	26	0.9222	24	05	0.2000
3	01	0.1889	15	14	1.000	24	12	1.000
3	05	0.7081	16	24	0.2097	24	15	0.1000
4	02	1.000	16	25	0.1457	24	16	0.8000
4	20	1.000	17	24	0.1026	24	17	0.3000
5	17	0.0278	17	25	0.0713	24	18	0.3000
5	18	0.0278	18	24	0.6377	24	19	0.3000
5	19	0.0278	18	25	0.4430	24	21	0.2000
5	36	0.0262	19	21	0.8000	24	22	1.000
5	37	0.0298	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0245	20	32	0.3300	24	27	0.0500
7	05	0.09191	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0000	20	35	0.9000	24	30	0.6700
9	23	0.0000	21	27	0.2009	24	31	0.3000
10	11	1.000	21	28	0.2795	24	32	0.6700
10	23	1.000	22	26	0.0278	24	33	0.6700
11	13	0.8530	23	17	0.6722	24	34	0.1000
11	27	0.2586	23	18	0.6722	24	35	0.1000
12	13	0.1470	23	19	0.6722	24	36	0.3400
12	27	0.0446	23	36	0.6338	24	37	0.2500
13	27	0.4460	23	37	0.7202			

Finland: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3161	13	28	0.6689	24	01	0.1000
2	01	0.3663	14	26	0.9248	24	05	0.2000
3	01	0.2048	15	14	1.000	24	12	1.000
3	05	0.7529	16	24	0.1272	24	15	0.1000
4	02	1.000	16	25	0.0884	24	16	0.8000
4	20	1.000	17	24	0.0818	24	17	0.3000
5	17	0.0408	17	25	0.0568	24	18	0.3000
5	18	0.0408	18	24	0.7410	24	19	0.3000
5	19	0.0408	18	25	0.5148	24	21	0.2000
5	36	0.0384	19	21	0.8000	24	22	1.000
5	37	0.0437	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0128	20	32	0.3300	24	27	0.0500
7	05	0.0471	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0000	20	35	0.9000	24	30	0.6700
9	23	0.0000	21	27	0.1919	24	31	0.3000
10	11	1.000	21	28	0.2311	24	32	0.6700
10	23	1.000	22	26	0.0252	24	33	0.6700
11	13	0.8292	23	17	0.6592	24	34	0.1000
11	27	0.1681	23	18	0.6592	24	35	0.1000
12	13	0.1708	23	19	0.6592	24	36	0.3400
12	27	0.0346	23	36	0.6216	24	37	0.2500
13	27	0.5554	23	37	0.7063			

France: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3597	13	28	0.5434	24	01	0.1000
2	01	0.3689	14	26	0.9082	24	05	0.2000
3	01	0.1146	15	14	1.000	24	12	1.000
3	05	0.5350	16	24	0.4796	24	15	0.1000
4	02	1.000	16	25	0.3332	24	16	0.8000
4	20	1.000	17	24	0.0126	24	17	0.3000
5	17	0.1310	17	25	0.0087	24	18	0.3000
5	18	0.1310	18	24	0.4578	24	19	0.3000
5	19	0.1310	18	25	0.3180	24	21	0.2000
5	36	0.1235	19	21	0.8000	24	22	1.000
5	37	0.1404	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0568	20	32	0.3300	24	27	0.0500
7	05	0.2650	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0166	20	35	0.9000	24	30	0.6700
9	23	0.0166	21	27	0.1983	24	31	0.3000
10	11	0.9834	21	28	0.3566	24	32	0.6700
10	23	0.9834	22	26	0.0418	24	33	0.6700
11	13	0.5049	23	17	0.5690	24	34	0.1000
11	27	0.2270	23	18	0.5690	24	35	0.1000
12	13	0.4951	23	19	0.5690	24	36	0.3400
12	27	0.2226	23	36	0.5365	24	37	0.2500
13	27	0.3021	23	37	0.6096			

France: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2392	13	28	0.6114	24	01	0.1000
2	01	0.5293	14	26	0.8224	24	05	0.2000
3	01	0.0617	15	14	1.000	24	12	1.000
3	05	0.3752	16	24	0.2791	24	15	0.1000
4	02	1.000	16	25	0.1939	24	16	0.8000
4	20	1.000	17	24	0.0105	24	17	0.3000
5	17	0.0702	17	25	0.0073	24	18	0.3000
5	18	0.0702	18	24	0.6604	24	19	0.3000
5	19	0.0702	18	25	0.4588	24	21	0.2000
5	36	0.0662	19	21	0.8000	24	22	1.000
5	37	0.0752	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0698	20	32	0.3300	24	27	0.0500
7	05	0.4248	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0218	20	35	0.9000	24	30	0.6700
9	23	0.0218	21	27	0.2200	24	31	0.3000
10	11	0.9782	21	28	0.2886	24	32	0.6700
10	23	0.9782	22	26	0.1276	24	33	0.6700
11	13	0.6499	23	17	0.6298	24	34	0.1000
11	27	0.1715	23	18	0.6298	24	35	0.1000
12	13	0.3501	23	19	0.6298	24	36	0.3400
12	27	0.0924	23	36	0.5938	24	37	0.2500
13	27	0.4661	23	37	0.6748			

Italy: BM based on tonnes for (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3915	13	28	0.8397	24	01	0.1000
2	01	0.3812	14	26	0.8920	24	05	0.2000
3	01	0.0718	15	14	1.000	24	12	1.000
3	05	0.4516	16	24	0.0903	24	15	0.1000
4	02	1.000	16	25	0.0628	24	16	0.8000
4	20	1.000	17	24	0.2968	24	17	0.3000
5	17	0.1711	17	25	0.2062	24	18	0.3000
5	18	0.1711	18	24	0.5629	24	19	0.3000
5	19	0.1711	18	25	0.3910	24	21	0.2000
5	36	0.1613	19	21	0.8000	24	22	1.000
5	37	0.1833	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0554	20	32	0.3300	24	27	0.0500
7	05	0.3484	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0062	20	35	0.9000	24	30	0.6700
9	23	0.0062	21	27	0.0553	24	31	0.3000
10	11	0.9938	21	28	0.0603	24	32	0.6700
10	23	0.9938	22	26	0.0580	24	33	0.6700
11	13	0.8413	23	17	0.5289	24	34	0.1000
11	27	0.1048	23	18	0.5289	24	35	0.1000
12	13	0.1587	23	19	0.5289	24	36	0.3400
12	27	0.0198	23	36	0.4987	24	37	0.2500
13	27	0.7701	23	37	0.5667			

Italy: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3055	13	28	0.8346	24	01	0.1000
2	01	0.4656	14	26	0.8067	24	05	0.2000
3	01	0.0624	15	14	1.000	24	12	1.000
3	05	0.3876	16	24	0.0789	24	15	0.1000
4	02	1.000	16	25	0.0548	24	16	0.8000
4	20	1.000	17	24	0.1648	24	17	0.3000
5	17	0.1493	17	25	0.1145	24	18	0.3000
5	18	0.1493	18	24	0.7063	24	19	0.3000
5	19	0.1493	18	25	0.4907	24	21	0.2000
5	36	0.1408	19	21	0.8000	24	22	1.000
5	37	0.1600	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0664	20	32	0.3300	24	27	0.0500
7	05	0.4124	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0091	20	35	0.9000	24	30	0.6700
9	23	0.0091	21	27	0.0614	24	31	0.3000
10	11	0.9909	21	28	0.0654	24	32	0.6700
10	23	0.9909	22	26	0.1433	24	33	0.6700
11	13	0.8136	23	17	0.5507	24	34	0.1000
11	27	0.0857	23	18	0.5507	24	35	0.1000
12	13	0.1864	23	19	0.5507	24	36	0.3400
12	27	0.0196	23	36	0.5192	24	37	0.2500
13	27	0.7833	23	37	0.5900			

Luxembourg: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.4577	13	28	0.8835	24	01	0.1000
2	01	0.2149	14	26	0.7415	24	05	0.2000
3	01	0.0122	15	14	1.000	24	12	1.000
3	05	0.0428	16	24	0.2179	24	15	0.1000
4	02	1.000	16	25	0.1514	24	16	0.8000
4	20	1.000	17	24	0.0000	24	17	0.3000
5	17	0.0161	17	25	0.0000	24	18	0.3000
5	18	0.0161	18	24	0.7321	24	19	0.3000
5	19	0.0161	18	25	0.5086	24	21	0.2000
5	36	0.0152	19	21	0.8000	24	22	1.000
5	37	0.0173	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.2152	20	32	0.3300	24	27	0.0500
7	05	0.7572	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0000	20	35	0.9000	24	30	0.6700
9	23	0.0000	21	27	0.0131	24	31	0.3000
10	11	1.000	21	28	0.0165	24	32	0.6700
10	23	1.000	22	26	0.2085	24	33	0.6700
11	13	0.9991	23	17	0.6839	24	34	0.1000
11	27	0.2358	23	18	0.6839	24	35	0.1000
12	13	0.0009	23	19	0.6839	24	36	0.3400
12	27	0.0002	23	36	0.6448	24	37	0.2500
13	27	0.7009	23	37	0.7327			

Luxembourg: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2183	13	28	0.8820	24	01	0.1000
2	01	0.5670	14	26	0.3635	24	05	0.2000
3	01	0.0077	15	14	1.000	24	12	1.000
3	05	0.0539	16	24	0.0834	24	15	0.1000
4	02	1.000	16	25	0.0579	24	16	0.8000
4	20	1.000	17	24	0.0000	24	17	0.3000
5	17	0.0269	17	25	0.0000	24	18	0.3000
5	18	0.0269	18	24	0.8666	24	19	0.3000
5	19	0.0269	18	25	0.6021	24	21	0.2000
5	36	0.0254	19	21	0.8000	24	22	1.000
5	37	0.0289	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1070	20	32	0.3300	24	27	0.0500
7	05	0.7461	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0000	20	35	0.9000	24	30	0.6700
9	23	0.0000	21	27	0.0176	24	31	0.3000
10	11	1.000	21	28	0.0180	24	32	0.6700
10	23	1.000	22	26	0.5865	24	33	0.6700
11	13	1.000	23	17	0.6731	24	34	0.1000
11	27	0.0684	23	18	0.6731	24	35	0.1000
12	13	0.0000	23	19	0.6731	24	36	0.3400
12	27	0.0000	23	36	0.6346	24	37	0.2500
13	27	0.8640	23	37	0.7211			

Netherlands: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.1469	13	28	0.6818	24	01	0.1000
2	01	0.4176	14	26	0.8501	24	05	0.2000
3	01	0.1225	15	14	1.000	24	12	1.000
3	05	0.2922	16	24	0.1742	24	15	0.1000
4	02	1.000	16	25	0.1210	24	16	0.8000
4	20	1.000	17	24	0.0091	24	17	0.3000
5	17	0.1897	17	25	0.0063	24	18	0.3000
5	18	0.1897	18	24	0.7667	24	19	0.3000
5	19	0.1897	18	25	0.5327	24	21	0.2000
5	36	0.1789	19	21	0.8000	24	22	1.000
5	37	0.2033	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.2130	20	32	0.3300	24	27	0.0500
7	05	0.5078	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0035	20	35	0.9000	24	30	0.6700
9	23	0.0035	21	27	0.1127	24	31	0.3000
10	11	0.9965	21	28	0.2182	24	32	0.6700
10	23	0.9965	22	26	0.0999	24	33	0.6700
11	13	0.2296	23	17	0.5103	24	34	0.1000
11	27	0.1113	23	18	0.5103	24	35	0.1000
12	13	0.7704	23	19	0.5103	24	36	0.3400
12	27	0.3736	23	36	0.4811	24	37	0.2500
13	27	0.3523	23	37	0.5467			

Netherlands: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.1327	13	28	0.7351	24	01	0.1000
2	01	0.4696	14	26	0.8233	24	05	0.2000
3	01	0.0978	15	14	1.000	24	12	1.000
3	05	0.2627	16	24	0.1496	24	15	0.1000
4	02	1.000	16	25	0.1039	24	16	0.8000
4	20	1.000	17	24	0.0116	24	17	0.3000
5	17	0.2045	17	25	0.0081	24	18	0.3000
5	18	0.2045	18	24	0.7888	24	19	0.3000
5	19	0.2045	18	25	0.5480	24	21	0.2000
5	36	0.1928	19	21	0.8000	24	22	1.000
5	37	0.2191	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1999	20	32	0.3300	24	27	0.0500
7	05	0.5373	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0028	20	35	0.9000	24	30	0.6700
9	23	0.0028	21	27	0.0957	24	31	0.3000
10	11	0.9972	21	28	0.1649	24	32	0.6700
10	23	0.9972	22	26	0.1267	24	33	0.6700
11	13	0.1926	23	17	0.4955	24	34	0.1000
11	27	0.0824	23	18	0.4955	24	35	0.1000
12	13	0.8074	23	19	0.4955	24	36	0.3400
12	27	0.3453	23	36	0.4672	24	37	0.2500
13	27	0.4266	23	37	0.5309			

Spain: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.2903	13	28	0.7953	24	01	0.1000
2	01	0.4400	14	26	0.9317	24	05	0.2000
3	01	0.1076	15	14	1.000	24	12	1.000
3	05	0.5074	16	24	0.3399	24	15	0.1000
4	02	1.000	16	25	0.2362	24	16	0.8000
4	20	1.000	17	24	0.0297	24	17	0.3000
5	17	0.0630	17	25	0.0206	24	18	0.3000
5	18	0.0630	18	24	0.5804	24	19	0.3000
5	19	0.0630	18	25	0.4032	24	21	0.2000
5	36	0.0594	19	21	0.8000	24	22	1.000
5	37	0.0675	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0621	20	32	0.3300	24	27	0.0500
7	05	0.2926	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0000	20	35	0.9000	24	30	0.6700
9	23	0.0000	21	27	0.0794	24	31	0.3000
10	11	1.000	21	28	0.1047	24	32	0.6700
10	23	1.000	22	26	0.0183	24	33	0.6700
11	13	0.8650	23	17	0.6370	24	34	0.1000
11	27	0.2312	23	18	0.6370	24	35	0.1000
12	13	0.1350	23	19	0.6370	24	36	0.3400
12	27	0.0361	23	36	0.6006	24	37	0.2500
13	27	0.6033	23	37	0.6825			

Spain: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.1390	13	28	0.8030	24	01	0.1000
2	01	0.6446	14	26	0.8528	24	05	0.2000
3	01	0.0492	15	14	1.000	24	12	1.000
3	05	0.3384	16	24	0.1814	24	15	0.1000
4	02	1.000	16	25	0.1260	24	16	0.8000
4	20	1.000	17	24	0.0236	24	17	0.3000
5	17	0.0432	17	25	0.0164	24	18	0.3000
5	18	0.0432	18	24	0.7450	24	19	0.3000
5	19	0.0432	18	25	0.5176	24	21	0.2000
5	36	0.0407	19	21	0.8000	24	22	1.000
5	37	0.0463	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0672	20	32	0.3300	24	27	0.0500
7	05	0.4616	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0000	20	35	0.9000	24	30	0.6700
9	23	0.0000	21	27	0.0836	24	31	0.3000
10	11	1.000	21	28	0.0970	24	32	0.6700
10	23	1.000	22	26	0.0972	24	33	0.6700
11	13	0.8255	23	17	0.6568	24	34	0.1000
11	27	0.1437	23	18	0.6568	24	35	0.1000
12	13	0.1745	23	19	0.6568	24	36	0.3400
12	27	0.0304	23	36	0.6193	24	37	0.2500
13	27	0.6923	23	37	0.7037			

Sweden: BM based on tonnes (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3997	13	28	0.6447	24	01	0.1000
2	01	0.2000	14	26	0.8805	24	05	0.2000
3	01	0.2452	15	14	1.000	24	12	1.000
3	05	0.6531	16	24	0.1382	24	15	0.1000
4	02	1.000	16	25	0.0960	24	16	0.8000
4	20	1.000	17	24	0.0370	24	17	0.3000
5	17	0.0482	17	25	0.0257	24	18	0.3000
5	18	0.0482	18	24	0.7748	24	19	0.3000
5	19	0.0482	18	25	0.5383	24	21	0.2000
5	36	0.0454	19	21	0.8000	24	22	1.000
5	37	0.0516	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.0551	20	32	0.3300	24	27	0.0500
7	05	0.1469	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0015	20	35	0.9000	24	30	0.6700
9	23	0.0015	21	27	0.1649	24	31	0.3000
10	11	0.9985	21	28	0.2553	24	32	0.6700
10	23	0.9985	22	26	0.0695	24	33	0.6700
11	13	0.7115	23	17	0.6518	24	34	0.1000
11	27	0.2623	23	18	0.6518	24	35	0.1000
12	13	0.2885	23	19	0.6518	24	36	0.3400
12	27	0.1063	23	36	0.6146	24	37	0.2500
13	27	0.4164	23	37	0.6984			

Sweden: BM based on ton kilometres (2007)

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.3405	13	28	0.6471	24	01	0.1000
2	01	0.3081	14	26	0.7930	24	05	0.2000
3	01	0.1432	15	14	1.000	24	12	1.000
3	05	0.4554	16	24	0.0950	24	15	0.1000
4	02	1.000	16	25	0.0660	24	16	0.8000
4	20	1.000	17	24	0.0319	24	17	0.3000
5	17	0.0471	17	25	0.0222	24	18	0.3000
5	18	0.0471	18	24	0.8231	24	19	0.3000
5	19	0.0471	18	25	0.5718	24	21	0.2000
5	36	0.0444	19	21	0.8000	24	22	1.000
5	37	0.0504	20	29	0.8000	24	24	0.0500
6	15	0.9000	20	30	0.3300	24	25	0.3400
6	16	0.2000	20	31	0.7000	24	26	0.0500
7	01	0.1083	20	32	0.3300	24	27	0.0500
7	05	0.3446	20	33	0.3300	24	28	0.1000
8	10	1.000	20	34	0.9000	24	29	0.2000
9	11	0.0028	20	35	0.9000	24	30	0.6700
9	23	0.0028	21	27	0.1973	24	31	0.3000
10	11	0.9972	21	28	0.2529	24	32	0.6700
10	23	0.9972	22	26	0.1570	24	33	0.6700
11	13	0.7707	23	17	0.6520	24	34	0.1000
11	27	0.1910	23	18	0.6529	24	35	0.1000
12	13	0.2293	23	19	0.6529	24	36	0.3400
12	27	0.0568	23	36	0.6156	24	37	0.2500
13	27	0.5049	23	37	0.6996			

Section 3: Sensitivity tests

Approach 1

Sensitivity test for the five highest use-based economic indicators (EI)

Original and modified β-factors in the case of Germany (use-based EI)

$\beta_{i,k}$	Original values	Modified values
β_22,24	1.000	1.000
β_25,16	0.0771	0.0692
β_25,17	0.0081	0.0072
β_25,18	0.5748	0.5156
β_25,24	0.3400	0.4080
β_29,20	0.8000	0.7600
β_29,24	0.2000	0.2400
β_33,20	0.3300	0.1960
β_33,24	0.6700	0.8040
β_34,20	0.9000	0.8800
β_34,24	0.1000	0.1200

Original and modified β-factors in the case of Germany (use-based EI)

$\beta_{i,k}$	Original values	Modified values
β_15,6	0.9000	0.8800
β_15,24	0.1000	0.1200
β_22,24	1.000	1.000
β_26,14	0.9128	0.9032
β_26,22	0.0372	0.0368
β_26,24	0.0500	0.0600
β_30,20	0.3300	0.1960
β_30,24	0.6700	0.8040
β_33,20	0.3300	0.1960
β_33,24	0.6700	0.8040

Sensitivity test for the five lowest supply- and use-based economic indicators (EI)

Product-based EI for Germany and Austria in 2007 (five lowest values are marked)

Product *i* CPA 2002	**Commodities *k*, to those a product is allocated**	**EI Germany**		**EI Austria**	
		EI_i_supply [€]	**EI_i_use [€]**	**EI_i_supply [€]**	**EI_i_use [€]**
1		14,850.00	42,456.66	2,848.00	5,000.29
2		2,310.00	7,386.30	1,259.36	2,040.30
5	3; 7; 24	**250.00**	40,508.33	**10.00**	7,235.03
10		4,968.13	37,485.49	1,051.00	3,096.84
11		2,098.40	20,533.25	1,006.16	2,380.98
12		0.00	0.00	0.00	0.00
13		0.00	23,131.60	0.00	0.00
14		7,830.85	39,125.84	2,129.34	9,076.68
15		35,210.15	50,609.94	5,285.09	7,889.85
16	6; 24	**1,340.00**	**4,305.81**	**119.00**	**119.00**
17	5; 23; 24	6,656.37	**27,823.46**	**969.64**	4,759.81
18	5; 23; 24	**2,874.11**	**22,758.63**	1,053.60	7,684.31
19	5; 23; 24	**1,620.49**	**17,047.13**	**774.17**	**3,733.51**
20		7,756.57	42,441.58	2,622.60	7,640.27
21		10,642.77	37,220.39	1,800.24	4,161.25
22		21,709.40	78,504.69	3,054.34	9,694.78
23		4,780.30	46,527.54	680.05	7,318.23
24		50,205.17	51,329.21	3,929.06	5,824.19
25		26,023.16	60,692.74	2,020.25	7,263.78
26		16,288.16	57,490.01	3,018.14	12,206.64
27		22,943.75	45,199.44	3,698.21	5,107.09
28		47,040.24	58,549.23	4,956.55	7,426.63
29		77,972.45	68,258.23	6,946.40	7,247.05
30		20,640.52	48,334.43	1,316.03	8,099.31
31		35,327.25	57,381.64	3,465.05	6,475.98
32	20; 24	19,060.45	36,222.94	1,838.80	**3,720.45**
33		26,098.27	81,787.82	2,289.34	8,549.59
34	20; 24	78,730.90	75,927.29	3,306.55	**3,578.66**
35		13,803.11	34,739.87	1,488.31	4,337.33
36		14,610.84	46,553.26	2,753.15	5,240.43
37	5; 23; 24	**5,446.56**	**15,669.95**	**513.73**	**3,623.84**

Original and modified β-factors in the case of Germany (supply-based EI)

$\beta_{i,k}$	Original values	Modified values
β_5,3	0.3743	0.3556
β_5,7	0.4257	0.4044
β_5,24	0.2000	0.2400
β_16,6	0.2000	0.0400
β_16,24	0.8000	0.9600
β_18,5	0.0720	0.0658
β_18,23	0.6280	0.5742
β_18,24	0.3000	0.3600
β_19,5	0.0720	0.0658
β_19,23	0.6280	0.5742
β_19,24	0.3000	0.3600
β_37,5	0.0771	0.0720
β_37,23	0.6729	0.6280
β_37,24	0.2500	0.3000

Original and modified β-factors in the case of Germany (use-based EI)

$\beta_{i,k}$	Original values	Modified values
β_16,6	0.2000	0.0400
β_16,24	0.8000	0.9600
β_17,5	0.0720	0.0658
β_17,23	0.6280	0.5742
β_17,24	0.3000	0.3600
β_18,5	0.0720	0.0658
β_18,23	0.6280	0.5742
β_18,24	0.3000	0.3600
β_19,5	0.0720	0.0658
β_19,23	0.6280	0.5742
β_19,24	0.3000	0.3600
β_37,5	0.0771	0.0720
β_37,23	0.6729	0.6280
β_37,24	0.2500	0.3000

Original and modified β-factors in the case of Austria (supply -based EI)

$\beta_{i,k}$	Original values	Modified values
β_5,3	0.5252	0.4990
β_5,7	0.2748	0.2610
β_5,24	0.2000	0.2400
β_16,6	0.2000	0.0400
β_16,24	0.8000	0.9600
β_17,5	0.0524	0.0479
β_17,23	0.6476	0.5921
β_17,24	0.3000	0.3600
β_19,5	0.0524	0.0479
β_19,23	0.6476	0.5921
β_19,24	0.3000	0.3600
β_37,5	0.0562	0.0524
β_37,23	0.6938	0.6476
β_37,24	0.2500	0.3000

Original and modified β-factors in the case of Austria (use-based EI)

$\beta_{i,k}$	Original values	Modified values
β_16,6	0.2000	0.0400
β_16,24	0.8000	0.9600
β_19,5	0.0524	0.0479
β_19,23	0.6476	0.5921
β_19,24	0.3000	0.3600
β_32,20	0.3300	0.1960
β_32,24	0.6700	0.8040
β_34,20	0.9000	0.8800
β_34,24	0.1000	0.1200
β_37,5	0.0562	0.0524
β_37,23	0.6938	0.6476
β_37,24	0.2500	0.3000

Comparative results of the regression analysis (coefficient of determination and significance) with original and modified β-factors in the case of Germany

Supply-based regression analysis…	… with original β-factors ("Austrian BM")		… with modified β-factors ("Modified Austrian BM")	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
3	0,23	0,1912	0,23	0,1910
5	0,15	0,2952	0,15	0,3059
6	0,14	0,3151	0,17	0,2693
7	**0,69**	**0,0056**	**0,69**	**0,0056**
23	**0,75**	**0,0024**	**0,76**	**0,0023**
24	**0,94**	**0,0000**	**0,94**	**0,0000**

Use-based regression analysis…	… with original β-factors ("Austrian BM")		… with modified β-factors ("Modified Austrian BM")	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
5	0,17	0,2734	0,18	0,2580
6	**0,92**	**0,0001**	**0,85**	**0,0004**
23	0,38	0,0788	0,41	0,0630
24	**0,79**	**0,0015**	**0,76**	**0,0021**

Comparative results of the regression analysis (coefficient of determination and significance) with original and modified β-factors in the case of Austria

Supply-based regression analysis…	… with original β-factors ("Austrian BM")		… with modified β-factors ("Modified Austrian BM")	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
3	0,09	0,4343	0,09	0,4340
5	**0,42**	**0,0584**	**0,42**	**0,0593**
6	**0,80**	**0,0011**	**0,80**	**0,0011**
7	0,01	0,7777	0,01	0,7805
23	0,27	0,1493	0,26	0,1562
24	**0,63**	**0,0103**	**0,63**	**0,0102**

Use-based regression analysis…	… with original β-factors ("Austrian BM")		… with modified β-factors ("Modified Austrian BM")	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
5	**0,47**	**0,0416**	**0,47**	**0,0402**
6	**0,86**	**0,0003**	**0,86**	**0,0003**
20	**0,74**	**0,0030**	**0,74**	**0,0030**
23	**0,72**	**0,0037**	**0,73**	**0,0034**
24	**0,73**	**0,0033**	**0,73**	**0,0034**

Approach 2

BM for Austria 2007 approach 2

Commodity *k* NST/R	Product *i* CPA 2002	Factor $\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$	*k*	*i*	$\beta_{i,k}$
1	01	0.0614	13	28	0.1842	24	01	0.8223
2	01	0.0698	14	26	0.4705	24	05	0.9465
3	01	0.0305	15	14	1.000	24	12	1.000
3	05	0.0351	16	24	0.0338	24	15	0.6159
4	02	1.000	16	25	0.0338	24	16	0.6159
4	20	1.000	17	24	0.0228	24	17	0.6373
5	17	0.0272	17	25	0.0228	24	18	0.6373
5	18	0.0272	18	24	0.0586	24	19	0.6373
5	19	0.0272	18	25	0.0586	24	21	0.9149
5	36	0.0272	19	21	0.0851	24	22	1.000
5	37	0.0272	20	29	0.1325	24	24	0.8848
6	15	0.3841	20	30	0.1325	24	25	0.8848
6	16	0.3841	20	31	0.1325	24	26	0.5104
7	01	0.0160	20	32	0.1325	24	27	0.7114
7	05	0.0184	20	33	0.1325	24	28	0.7844
8	10	1.000	20	34	0.1325	24	29	0.8675
9	11	0.0024	20	35	0.1325	24	30	0.8675
9	23	0.0024	21	27	0.0285	24	31	0.8675
10	11	0.9976	21	28	0.0314	24	32	0.8675
10	23	0.9976	22	26	0.0192	24	33	0.8675
11	13	0.9518	23	17	0.3355	24	34	0.8675
11	27	0.0885	23	18	0.3355	24	35	0.8675
12	13	0.0482	23	19	0.3355	24	36	0.6373
12	27	0.0045	23	36	0.3355	24	37	0.6373
13	27	0.1670	23	37	0.3355			

Comparative results of the supply-based regression analysis (coefficient of determination and significance) with original and new-calculated β-factors in the case of Austria.

Supply-based regression analysis…	… with original β-factors (“Austrian BM”)		… with modified β-factors (“Radically changed BM”)	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
1	0,06	0,5407	0,06	0,5407
2	0,11	0,3788	0,11	0,3788
3	0,09	0,4343	0,09	0,4311
4	**0,78**	**0,0017**	**0,78**	**0,0017**
5	**0,42**	**0,0584**	**0,42**	**0,0582**
6	**0,80**	**0,0011**	**0,80**	**0,0011**
7	0,01	0,7777	0,01	0,8173
8	**0,85**	**0,0004**	**0,85**	**0,0004**
9	0,01	0,7744	-*	-*

10	0,14	0,3287	0,14	0,3287
11	**0,42**	**0,0608**	**0,42**	**0,0608**
12	0,00	0,8707	-*	-*
13	**0,47**	**0,0407**	**0,47**	**0,0422**
14	**0,58**	**0,0173**	**0,58**	**0,0173**
15	0,30	0,1240	0,30	0,1240
16	0,19	0,2374	0,19	0,2418
17	0,02	0,6938	0,03	0,6735
18	0,10	0,3974	0,09	0,4210
19	0,00	0,8937	0,00	0,8937
20	**0,83**	**0,0006**	**0,84**	**0,0005**
21	**0,82**	**0,0007**	**0,82**	**0,0008**
22	0,17	0,2650	0,17	0,2650
23	0,27	0,1493	0,26	0,1607
24	**0,63**	**0,0103**	**0,64**	**0,0095**

**No result, because the value of the economic indicator is nil.*

Comparative results of the use-based regression analysis (coefficient of determination and significance) with original and new-calculated β-factors in the case of Austria.

Use-based regression analysis…	… with original β-factors (“Austrian BM”)		… with modified β-factors (“Radically changed BM”)	
NST/R	**R^2 value**	**p-value**	**R^2**	**p-Wert**
1	0,23	0,1864	0,23	0,1864
2	**0,36**	**0,0856**	**0,36**	**0,0856**
3	0,04	0,6233	0,03	0,6446
4	**0,84**	**0,0005**	**0,84**	**0,0005**
5	**0,47**	**0,0416**	**0,48**	**0,0398**
6	**0,86**	**0,0003**	**0,86**	**0,0003**
7	0,28	0,1429	0,31	0,1216
8	0,00	0,8655	0,00	0,8655
9	0,13	0,3366	-*	-*
10	0,17	0,2723	0,17	0,2723
11	**0,37**	**0,0797**	**0,37**	**0,0797**
12	0,00	0,8617	-*	-*
13	**0,37**	**0,0841**	**0,37**	**0,0834**
14	**0,52**	**0,0273**	**0,52**	**0,0273**
15	0,20	0,2254	0,20	0,2254
16	0,28	0,1412	0,28	0,1445
17	0,03	0,6573	0,04	0,6167
18	0,02	0,6951	0,02	0,7175
19	**0,40**	**0,0694**	**0,40**	**0,0694**
20	**0,74**	**0,0030**	**0,77**	**0,0017**
21	**0,77**	**0,0018**	**0,77**	**0,0018**
22	0,24	0,1847	0,24	0,1847
23	**0,72**	**0,0037**	**0,73**	**0,0035**
24	**0,73**	**0,0033**	**0,71**	**0,0042**

**No result, because the value of the economic indicator is nil.*

Section 4: Result fact sheets

Commodities with a significant R^2 value on a 5% level are marked.

Sweden: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0.00	0.39	0.9192	0.0715	1.2%
2	0.16	0.16	0.2871	0.2801	0.6%
3	0.01	0.13	0.8232	0.3488	0.8%
4	0.04	0.22	0.5838	0.2074	22.0%
5	0.06	0.00	0.5128	0.8629	0.3%
6	0.27	0.18	0.1529	0.2514	7.3%
7	0.00	0.05	0.9170	0.5441	0.2%
8	0.14	0.07	0.3233	0.4862	0.6%
9	0.00	0.01	0.9834	0.8505	0.0%
10	0.18	0.25	0.2499	0.1668	4.0%
11	0.01	0.00	0.7772	0.8688	1.0%
12	0.06	0.05	0.5123	0.5472	0.4%
13	0.00	0.05	0.9258	0.5525	1.6%
14	0.05	0.02	0.5465	0.7152	4.0%
15	-*	-*!	-*	-*	27.4%
16	0.00	0.00	0.9740	0.9671	0.3%
17	0.30	**0.60**	0.1307	**0.0140**	**0.1%**
18	0.01	0.00	0.8294	0.9918	1.8%
19	0.24	0.11	0.1757	0.3743	1.4%
20	0.11	0.00	0.3933	0.9926	3.1%
21	0.01	0.00	0.8350	0.9385	0.6%
22	0.05	0.04	0.5715	0.5892	0.3%
23	0.00	0.02	0.9193	0.7085	3.7%
24	**0.79**	**0.78**	**0.0012**	**0.0017**	**17.5%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	17.5%	17.6%	17.6%
Amount of commodities explained significantly	1	2	2

**No result, because the value of the economic indicator is nil.*

France: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage and inland waterways in 2007
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0.02	0.26	0.7001	0.1593	3.3%
2	0.00	**0.81**	0.9261	**0.0010**	**3.3%**
3	0.00	**0.79**	0.9536	**0.0014**	**1.0%**
4	**0.67**	0.10	**0.0073**	0.4128	**1.8%**
5	0.09	0.03	0.4430	0.6541	0.7%
6	0.29	0.23	0.1337	0.1919	8.8%
7	0.00	0.09	0.9787	0.4371	0.5%
8	0.01	0.03	0.7791	0.6802	0.6%
9	0.00	**0.92**	0.9225	**0.0000**	**0.1%**
10	0.16	**0.46**	0.2940	**0.0435**	**3.8%**
11	0.02	0.30	0.7193	0.1302	1.0%
12	0.22	0.04	0.2004	0.5972	0.9%
13	0.13	0.22	0.3382	0.2038	1.3%
14	**0.51**	**0.91**	**0.0309**	**0.0001**	**10.2%**
15	**0.93**	**0.88**	**0.0000**	**0.0002**	**36.9%**
16	**0.46**	0.43	**0.0442**	0.0552	**1.8%**
17	0.35	**0.58**	0.0910	**0.0166**	**0.0%**
18	0.01	0.15	0.8441	0.3002	1.7%
19	0.02	**0.45**	0.6894	**0.0487**	**0.4%**
20	0.09	0.26	0.4303	0.1640	2.6%
21	**0.50**	0.07	**0.0320**	0.4910	**0.8%**
22	0.22	0.34	0.1997	0.1004	0.5%
23	0.09	0.15	0.4221	0.2986	2.9%
24	**0.60**	**0.81**	**0.0147**	**0.0010**	**15.1%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	66.6%	70.9%	75.3%
Amount of commodities explained significantly	**6**	**9**	**12**

Italy: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0.00	**0.74**	0.9991	**0.0028**	**1.7%**
2	0.21	0.03	0.2150	0.6738	1.7%
3	0.01	**0.58**	0.7611	**0.0174**	**0.3%**
4	0.00	0.22	0.9196	0.2053	1.5%
5	0.06	0.08	0.5405	0.4673	0.8%
6	**0.45**	0.20	**0.0469**	0.2279	**7.2%**
7	0.09	0.37	0.4268	0.0823	0.2%
8	0.16	**0.76**	0.2884	**0.0022**	**0.4%**
9	0.31	0.01	0.1197	0.8294	0.0%
10	0.23	0.00	0.1872	0.9113	4.1%
11	0.07	0.04	0.5045	0.6096	1.0%
12	0.05	**0.67**	0.5752	**0.0067**	**0.2%**
13	**0.55**	0.44	**0.0217**	0.0507	**7.6%**
14	**0.53**	0.32	**0.0265**	0.1131	**15.7%**
15	**0.86**	**0.91**	**0.0003**	**0.0001**	**35.2%**
16	0.00	0.00	0.9519	0.9607	0.5%
17	0.06	0.14	0.5409	0.3285	1.6%
18	0.00	0.00	0.9073	0.8605	3.1%
19	**0.47**	**0.57**	**0.0415**	**0.0180**	**1.0%**
20	**0.48**	**0.73**	**0.0388**	**0.0035**	**2.1%**
21	0.43	0.38	0.0542	0.0785	0.5%
22	0.06	0.06	0.5085	0.5121	1.0%
23	**0.54**	**0.45**	**0.0234**	**0.0491**	**2.4%**
24	**0.83**	**0.90**	**0.0007**	**0.0001**	**10.1%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	81.3%	53.3%	83.9%
Amount of commodities explained significantly	8	9	12

Netherlands: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage and inland waterways in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0.02	0.34	0.7444	0.0964	1.0%
2	0.09	0.06	0.4299	0.5417	2.8%
3	0.03	0.41	0.6580	0.0635	0.8%
4	0.41	**0.74**	0.0619	**0.0028**	**1.3%**
5	0.00	0.00	0.8606	0.9968	1.4%
6	0.01	0.02	0.8401	0.7370	10.6%
7	0.01	**0.53**	0.7634	**0.0256**	**1.4%**
8	0.36	**0.57**	0.0871	**0.0190**	**3.4%**
9	0.43	**0.64**	0.0550	**0.0093**	**0.0%**
10	**0.67**	**0.73**	**0.0068**	**0.0033**	**8.2%**
11	**0.58**	**0.50**	**0.0177**	**0.0330**	**1.1%**
12	**0.60**	**0.51**	**0.0147**	**0.0302**	**3.7%**
13	**0.75**	**0.71**	**0.0027**	**0.0041**	**3.5%**
14	0.02	0.17	0.7523	0.2684	4.8%
15	0.38	**0.51**	0.0773	**0.0296**	**19.5%**
16	0.25	0.25	0.1675	0.1726	2.3%
17	0.00	0.01	0.8885	0.7574	0.1%
18	**0.88**	**0.90**	**0.0002**	**0.0001**	**10.1%**
19	0.00	0.05	0.9488	0.5681	0.9%
20	**0.61**	**0.83**	**0.0126**	**0.0006**	**3.9%**
21	0.29	0.33	0.1330	0.1072	1.1%
22	0.22	**0.48**	0.2067	**0.0373**	**0.6%**
23	**0.46**	0.44	**0.0457**	0.0529	**3.8%**
24	0.05	0.01	0.5438	0.7805	13.8%
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	34.2%	56.6%	60.4%
Amount of commodities explained significantly	7	12	13

Denmark: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	**0.48**	0.15	**0.0387**	0.2999	**2.7%**
2	**0.61**	0.00	**0.0134**	0.9753	**2.1%**
3	0.36	0.16	0.0889	0.2848	2.8%
4	0.00	0.00	0.8607	0.8852	4.1%
5	0.23	0.05	0.1931	0.5826	0.1%
6	0.35	0.29	0.0911	0.1320	16.7%
7	0.02	**0.53**	0.7115	**0.0258**	**0.7%**
8	**0.62**	0.08	**0.0115**	0.4654	**0.2%**
9	0.10	0.09	0.4096	0.4223	0.0%
10	0.04	0.07	0.6249	0.4836	2.0%
11	0.04	0.02	0.5883	0.7140	1.0%
12	0.04	0.03	0.6014	0.6551	0.2%
13	0.09	0.31	0.4404	0.1161	1.5%
14	0.07	0.01	0.5047	0.8172	10.3%
15	0.00	0.02	0.8585	0.7234	30.7%
16	0.21	0.06	0.2206	0.5153	2.8%
17	0.19	**0.56**	0.2368	**0.0211**	**1.1%**
18	**0.46**	0.22	**0.0449**	0.2015	**1.1%**
19	**0.48**	**0.48**	**0.0376**	**0.0394**	**0.4%**
20	0.00	0.13	0.9534	0.3410	2.6%
21	0.03	0.16	0.6565	0.2873	2.0%
22	0.14	0.00	0.3186	0.8796	0.5%
23	**0.62**	0.00	**0.0118**	0.9977	**2.8%**
24	0.22	**0.61**	0.2069	**0.0128**	**11.8%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	9.2%	13.9%	22.7%
Amount of commodities explained significantly	6	4	9

Austria: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage in 2007
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0.06	0.23	0.5407	0.1864	0.9%
2	0.11	0.36	0.3788	0.0856	1.0%
3	0.09	0.04	0.4343	0.6233	0.4%
4	**0.78**	**0.84**	**0.0017**	**0.0005**	**7.6%**
5	0.42	**0.47**	0.0584	**0.0416**	**0.5%**
6	**0.80**	**0.86**	**0.0011**	**0.0003**	**7.3%**
7	0.01	0.28	0.7777	0.1429	0.2%
8	**0.85**	0.00	**0.0004**	0.8655	**0.1%**
9	0.01	0.13	0.7744	0.3366	0.0%
10	0.14	0.17	0.3287	0.2723	3.9%
11	0.42	0.37	0.0608	0.0797	1.5%
12	0.00	0.00	0.8707	0.8617	0.1%
13	**0.47**	0.37	**0.0407**	0.0841	**2.8%**
14	**0.58**	**0.52**	**0.0173**	**0.0273**	**10.8%**
15	0.30	0.20	0.1240	0.2254	39.6%
16	0.19	0.28	0.2374	0.1412	0.4%
17	0.02	0.03	0.6938	0.6573	0.3%
18	0.10	0.02	0.3974	0.6951	0.8%
19	0.00	0.40	0.8937	0.0694	1.1%
20	**0.83**	**0.74**	**0.0006**	**0.0030**	**1.8%**
21	**0.82**	**0.77**	**0.0007**	**0.0018**	**0.5%**
22	0.17	0.24	0.2650	0.1847	0.4%
23	0.27	**0.72**	0.1493	**0.0037**	**6.2%**
24	**0.63**	**0.73**	**0.0103**	**0.0033**	**11.7%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	42.7%	46.5%	49.3%
Amount of commodities explained significantly	8	8	10

Belgium: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage and inland waterways in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0.10	0.09	0.4149	0.4199	1.5%
2	0.13	0.25	0.3335	0.1753	1.5%
3	0.15	**0.49**	0.3082	**0.0356**	**0.9%**
4	0.04	0.03	0.5851	0.6564	1.7%
5	0.08	0.04	0.4705	0.6028	0.7%
6	0.01	0.11	0.7757	0.3887	10.3%
7	**0.53**	0.05	**0.0269**	0.5601	**0.8%**
8	0.33	0.02	0.1038	0.7116	2.5%
9	0.01	0.01	0.8413	0.8411	0.0%
10	0.32	0.29	0.1146	0.1326	6.9%
11	0.38	**0.48**	0.0754	**0.0399**	**1.4%**
12	0.17	0.11	0.2649	0.3752	0.6%
13	0.01	0.11	0.8027	0.3944	4.9%
14	0.34	**0.56**	0.1001	**0.0197**	**8.2%**
15	0.16	0.05	0.2781	0.5707	26.0%
16	**0.46**	**0.81**	**0.0447**	**0.0010**	**2.1%**
17	0.12	0.08	0.3629	0.4736	0.1%
18	0.40	0.17	0.0698	0.2762	8.5%
19	0.17	**0.70**	0.2744	**0.0048**	**0.4%**
20	0.16	0.35	0.2920	0.0942	3.8%
21	0.25	**0.54**	0.1691	**0.0245**	**0.5%**
22	0.11	0.09	0.3810	0.4414	0.7%
23	0.15	**0.78**	0.3056	**0.0017**	**3.6%**
24	**0.58**	**0.69**	**0.0164**	**0.0054**	**12.2%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	15.1%	29.3%	30.2%
Amount of commodities explained significantly	3	8	9

Spain: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	**0.63**	**0.62**	**0.0107**	**0.0113**	**1.5%**
2	0.49	**0.95**	0.0352	**0.0000**	**2.2%**
3	**0.58**	0.38	**0.0173**	0.0757	**0.5%**
4	0.09	**0.86**	0.4352	**0.0003**	**1.1%**
5	0.39	0.27	0.0742	0.1480	0.2%
6	**0.88**	**0.93**	**0.0002**	**0.0000**	**7.9%**
7	**0.73**	**0.82**	**0.0036**	**0.0008**	**0.3%**
8	**0.92**	0.33	**0.0000**	0.1059	**1.1%**
9	-*	-*	-*	-*	0.0%
10	**0.73**	**0.86**	**0.0032**	**0.0003**	**3.5%**
11	0.01	**0.83**	0.7579	**0.0006**	**1.0%**
12	0.05	0.37	0.5591	0.0836	0.2%
13	**0.95**	**0.94**	**0.0000**	**0.0000**	**2.7%**
14	**0.91**	**0.95**	**0.0001**	**0.0000**	**19.2%**
15	**0.90**	**0.91**	**0.0001**	**0.0001**	**44.4%**
16	**0.79**	**0.87**	**0.0014**	**0.0003**	**1.0%**
17	**0.79**	**0.82**	**0.0013**	**0.0008**	**0.1%**
18	**0.82**	**0.91**	**0.0008**	**0.0001**	**1.7%**
19	**0.74**	**0.81**	**0.0029**	**0.0009**	**0.4%**
20	**0.91**	**0.95**	**0.0001**	**0.0000**	**2.7%**
21	**0.71**	**0.61**	**0.0043**	**0.0131**	**0.4%**
22	0.07	0.10	0.4762	0.3998	0.4%
23	**0.82**	**0.82**	**0.0008**	**0.0008**	**2.5%**
24	**0.51**	**0.61**	**0.0306**	**0.0130**	**4.8%**
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			97.1%	97.6%	99.2%
Amount of commodities explained significantly			18	18	20

**No result, because the value of the economic indicator is nil.*

Finland: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage in 2007
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	**0.59**	0.02	**0.0163**	0.7078	**1.1%**
2	0.00	**0.79**	0.8653	**0.0012**	**0.3%**
3	0.07	0.33	0.4787	0.1074	0.4%
4	0.10	0.19	0.4078	0.2447	13.7%
5	0.01	0.00	0.7902	0.8837	0.2%
6	0.08	0.05	0.4611	0.5572	6.1%
7	0.24	0.05	0.1766	0.5554	0.1%
8	0.44	**0.47**	0.0512	**0.0420**	**2.5%**
9	-*	-*	-*	-*	0.0%
10	0.17	0.03	0.2754	0.6340	3.3%
11	0.16	0.38	0.2812	0.0751	0.9%
12	0.34	0.13	0.1012	0.3316	0.2%
13	0.03	0.01	0.6354	0.7717	1.6%
14	0.14	0.24	0.3160	0.1762	4.5%
15	0.13	0.07	0.3500	0.4789	45.6%
16	0.24	0.01	0.1792	0.8387	0.6%
17	0.35	0.12	0.0961	0.3557	0.3%
18	0.12	0.05	0.3716	0.5732	2.0%
19	0.01	0.16	0.8299	0.2854	0.9%
20	0.09	0.02	0.4299	0.7012	2.3%
21	0.23	0.23	0.1868	0.1923	0.7%
22	0.01	0.02	0.7656	0.7366	0.1%
23	0.04	0.18	0.5861	0.2607	4.0%
24	0.00	0.04	0.8957	0.6119	8.7%
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			1.1%	2.9%	3.9%
Amount of commodities explained significantly			1	2	3

**No result, because the value of the economic indicator is nil.*

Luxembourg: Result fact sheet for the regression analysis based on tonnes

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total tonnes transported via road haulage and inland waterways in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0.00	0.39	0.8869	0.0713	2.9%
2	0.19	0.01	0.2388	0.7536	1.3%
3	0.05	0.07	0.5646	0.4950	0.1%
4	0.06	**0.55**	0.5095	**0.0221**	**3.5%**
5	0.35	0.18	0.0942	0.2617	0.1%
6	-*	0.15	-*	0.3039	5.1%
7	0.00	0.01	0.9352	0.7884	1.3%
8	-*	0.03	-*	0.6727	5.4%
9	-*	-*	-*	-*	0.0%
10	-*	**0.93**	-*	**0.0000**	**4.9%**
11	-*	0.22	-*	0.2017	2.8%
12	-*	0.11	-*	0.3838	0.0%
13	-*	0.15	-*	0.3118	8.5%
14	**0.47**	**0.56**	**0.0410**	**0.0205**	**5.4%**
15	0.36	0.00	0.0851	0.8774	32.2%
16	0.17	0.15	0.2672	0.3115	0.6%
17	-*	-*	-*	-*	0.0%
18	**0.55**	0.41	**0.0216**	0.0611	**2.2%**
19	-*	0.08	-*	0.4471	0.1%
20	0.03	0.00	0.6361	0.9443	1.5%
21	-*	0.29	-*	0.1347	0.2%
22	0.12	0.00	0.3535	0.8578	1.5%
23	0.03	0.00	0.6370	0.8586	5.2%
24	0.16	**0.81**	0.2865	**0.0009**	**15.1%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	7.6%	28.9%	31.1%
Amount of commodities explained significantly	2	4	5

**No result, because the value of the economic indicator is nil.*

Sweden: Result fact sheet for the regression analysis based on ton kilometres

NST/R	**Coefficient of determination R^2 value**		**Significance test p-value**		**Share of total ton kilometres transported via road haulage in 2007**
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0,20	0,15	0,2307	0,3028	1,2%
2	0,32	0,34	0,1110	0,1018	0,6%
3	0,29	**0,61**	0,1375	**0,0129**	**0,8%**
4	0,07	0,28	0,4890	0,1424	22,0%
5	0,02	0,04	0,6982	0,6167	0,3%
6	0,41	0,39	0,0617	0,0737	7,3%
7	0,09	0,40	0,4460	0,0663	0,2%
8	0,34	**0,83**	0,0984	**0,0006**	**0,6%**
9	0,01	0,02	0,7969	0,7328	0,0%
10	0,13	0,22	0,3482	0,2023	4,0%
11	0,01	0,04	0,7759	0,6046	1,0%
12	0,01	0,00	0,8047	0,9863	0,4%
13	0,08	0,13	0,4627	0,3347	1,6%
14	0,28	0,32	0,1422	0,1122	4,0%
15	-*	-*	-*	-*	27,4%
16	0,06	0,03	0,5121	0,6386	0,3%
17	0,32	**0,52**	0,1145	**0,0293**	**0,1%**
18	0,19	**0,53**	0,2355	**0,0268**	**1,8%**
19	0,26	0,20	0,1581	0,2256	1,4%
20	0,01	0,08	0,8135	0,4751	3,1%
21	0,24	0,44	0,1814	0,0516	0,6%
22	0,20	0,26	0,2220	0,1633	0,3%
23	0,42	**0,68**	0,0574	**0,0064**	**3,7%**
24	**0,60**	**0,55**	**0,0145**	**0,0221**	**17,5%**
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			17.5%	24.4%	24.4%
Amount of commodities explained significantly			1	6	6

**No result, because the value of the economic indicator is nil.*

France: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage and inland waterways in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	**0,49**	0,15	**0,0370**	0,3024	**3,3%**
2	0,02	**0,86**	0,7103	**0,0003**	**3,3%**
3	0,03	**0,85**	0,6696	**0,0004**	**1,0%**
4	0,44	0,00	0,0521	0,9086	1,8%
5	**0,59**	**0,46**	**0,0157**	**0,0457**	**0,7%**
6	**0,69**	**0,77**	**0,0053**	**0,0018**	**8,8%**
7	0,02	0,37	0,7235	0,0796	0,5%
8	0,36	0,04	0,0853	0,6196	0,6%
9	0,01	**0,91**	0,7869	**0,0001**	**0,1%**
10	0,38	**0,57**	0,0784	**0,0183**	**3,8%**
11	0,03	0,06	0,6340	0,5421	1,0%
12	0,00	0,03	0,9169	0,6457	0,9%
13	0,01	0,42	0,7698	0,0587	1,3%
14	**0,66**	**0,92**	**0,0078**	**0,0001**	**10,2%**
15	**0,86**	**0,92**	**0,0003**	**0,0000**	**36,9%**
16	0,18	0,10	0,2567	0,4116	1,8%
17	**0,77**	**0,78**	**0,0020**	**0,0016**	**0,0%**
18	0,43	**0,91**	0,0545	**0,0001**	**1,7%**
19	0,00	**0,45**	0,9615	**0,0475**	**0,4%**
20	0,17	**0,66**	0,2631	**0,0081**	**2,6%**
21	0,10	0,16	0,4131	0,2788	0,8%
22	0,24	0,12	0,1808	0,3711	0,5%
23	**0,64**	0,40	**0,0099**	0,0698	**2,9%**
24	**0,57**	**0,88**	**0,0184**	**0,0002**	**15,1%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	77.9%	84.7%	90.9%
Amount of commodities explained significantly	8	13	15

Italy: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0,03	**0,67**	0,6640	**0,0074**	**1,7%**
2	0,09	0,24	0,4436	0,1850	1,7%
3	0,04	0,31	0,5951	0,1225	0,3%
4	0,00	0,21	0,9907	0,2159	1,5%
5	**0,50**	**0,70**	**0,0343**	**0,0049**	**0,8%**
6	0,14	0,04	0,3250	0,5957	7,2%
7	0,02	0,04	0,6908	0,5858	0,2%
8	0,16	**0,72**	0,2835	**0,0039**	**0,4%**
9	0,39	0,01	0,0711	0,7730	0,0%
10	0,02	0,00	0,7313	0,9468	4,1%
11	0,00	0,39	0,8900	0,0746	1,0%
12	0,05	0,20	0,5540	0,2280	0,2%
13	0,00	0,00	0,9687	0,8759	7,6%
14	0,44	**0,72**	0,0522	**0,0036**	**15,7%**
15	0,21	0,31	0,2151	0,1187	35,2%
16	0,01	0,08	0,8107	0,4693	0,5%
17	0,05	0,07	0,5813	0,4887	1,6%
18	**0,52**	**0,88**	**0,0294**	**0,0002**	**3,1%**
19	0,28	0,33	0,1388	0,1088	1,0%
20	0,03	0,01	0,6767	0,8250	2,1%
21	**0,58**	**0,54**	**0,0166**	**0,0234**	**0,5%**
22	0,01	0,05	0,7605	0,5746	1,0%
23	0,24	0,14	0,1798	0,3301	2,4%
24	0,44	**0,54**	0,0519	**0,0243**	**10,1%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	4.4%	32.3%	32.3%
Amount of commodities explained significantly	3	7	7

Netherlands: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage and inland waterways in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0,04	**0,55**	0,6166	**0,0222**	**1,0%**
2	0,01	0,00	0,7918	0,9045	2,8%
3	0,00	**0,46**	0,8777	**0,0438**	**0,8%**
4	0,13	0,16	0,3310	0,2898	1,3%
5	0,06	0,04	0,5318	0,6090	1,4%
6	0,00	0,01	0,9628	0,8375	10,6%
7	0,01	**0,79**	0,8299	**0,0013**	**1,4%**
8	0,34	**0,53**	0,0970	**0,0257**	**3,4%**
9	**0,49**	**0,68**	**0,0352**	**0,0061**	**0,0%**
10	**0,70**	**0,81**	**0,0050**	**0,0010**	**8,2%**
11	**0,56**	**0,50**	**0,0211**	**0,0340**	**1,1%**
12	**0,60**	**0,54**	**0,0138**	**0,0242**	**3,7%**
13	**0,48**	**0,45**	**0,0375**	**0,0480**	**3,5%**
14	0,00	0,07	0,9054	0,4819	4,8%
15	0,37	0,43	0,0842	0,0551	19,5%
16	0,42	0,43	0,0588	0,0563	2,3%
17	0,19	0,23	0,2346	0,1920	0,1%
18	**0,51**	**0,52**	**0,0305**	**0,0293**	**10,1%**
19	**0,52**	0,33	**0,0287**	0,1085	**0,9%**
20	0,27	**0,47**	0,1488	**0,0421**	**3,9%**
21	0,36	0,40	0,0851	0,0675	1,1%
22	0,01	0,11	0,7994	0,3765	0,6%
23	0,09	0,08	0,4348	0,4694	3,8%
24	0,00	0,00	0,9781	0,9909	13,8%
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			27.4%	37.1%	37.9%
Amount of commodities explained significantly			7	11	12

Denmark: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0,14	0,00	0,3205	0,9437	2,7%
2	0,33	0,33	0,1038	0,1071	2,1%
3	0,24	0,03	0,1823	0,6501	2,8%
4	0,09	0,04	0,4447	0,5983	4,1%
5	0,00	0,31	0,9113	0,1225	0,1%
6	0,06	0,29	0,5423	0,1340	16,7%
7	**0,74**	0,36	**0,0030**	0,0866	**0,7%**
8	0,03	0,01	0,6351	0,8176	0,2%
9	0,06	0,01	0,5311	0,8186	0,0%
10	0,00	0,02	0,8597	0,7417	2,0%
11	0,00	0,39	0,9804	0,0737	1,0%
12	0,01	0,05	0,7994	0,5580	0,2%
13	0,26	0,41	0,1637	0,0626	1,5%
14	0,36	0,37	0,0902	0,0810	10,3%
15	**0,46**	0,38	**0,0444**	0,0781	**30,7%**
16	0,04	0,07	0,6207	0,4974	2,8%
17	0,03	0,06	0,6787	0,5355	1,1%
18	**0,66**	**0,51**	**0,0078**	**0,0306**	**1,1%**
19	**0,82**	**0,56**	**0,0007**	**0,0207**	**0,4%**
20	0,03	0,21	0,6302	0,2151	2,6%
21	0,01	0,10	0,7847	0,3990	2,0%
22	0,19	0,15	0,2476	0,3027	0,5%
23	**0,51**	0,23	**0,0316**	0,1958	**2,8%**
24	0,02	0,01	0,7338	0,8401	11,8%
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	35.6%	1.5%	35.6%
Amount of commodities explained significantly	5	2	5

Austria: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0,01	0,26	0,8270	0,1609	0,9%
2	0,01	0,40	0,7923	0,0654	1,0%
3	0,01	0,28	0,8428	0,1412	0,4%
4	**0,78**	**0,53**	**0,0015**	**0,0261**	**7,6%**
5	0,36	0,05	0,0869	0,5641	0,5%
6	0,27	0,38	0,1523	0,0790	7,3%
7	0,01	**0,46**	0,7772	**0,0447**	**0,2%**
8	**0,73**	0,13	**0,0034**	0,3313	**0,1%**
9	0,03	0,17	0,6379	0,2629	0,0%
10	**0,46**	0,38	**0,0438**	0,0781	**3,9%**
11	0,22	0,13	0,2043	0,3338	1,5%
12	0,12	0,26	0,3685	0,1577	0,1%
13	0,01	0,00	0,7608	0,9089	2,8%
14	0,21	0,10	0,2092	0,4045	10,8%
15	**0,50**	0,44	**0,0329**	0,0533	**39,6%**
16	0,39	**0,54**	0,0711	**0,0244**	**0,4%**
17	0,15	0,12	0,3052	0,3619	0,3%
18	**0,70**	0,40	**0,0052**	0,0678	**0,8%**
19	0,01	0,17	0,7828	0,2651	1,1%
20	0,23	0,11	0,1933	0,3878	1,8%
21	**0,53**	0,43	**0,0259**	0,0544	**0,5%**
22	**0,68**	**0,66**	**0,0065**	**0,0078**	**0,4%**
23	0,01	0,01	0,7917	0,7617	6,2%
24	0,21	0,33	0,2147	0,1060	11,7%
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	53.0%	8.7%	53.6%
Amount of commodities explained significantly	7	4	9

Belgium: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage and inland waterways in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0,07	0,06	0,4818	0,5305	1,5%
2	0,20	0,03	0,2235	0,6721	1,5%
3	0,00	0,13	0,9092	0,3465	0,9%
4	0,32	0,12	0,1129	0,3543	1,7%
5	0,32	0,00	0,1126	0,9653	0,7%
6	0,04	0,13	0,6027	0,3366	10,3%
7	**0,79**	0,34	**0,0014**	0,1015	**0,8%**
8	**0,72**	**0,54**	**0,0037**	**0,0251**	**2,5%**
9	0,00	0,00	0,9857	0,9874	0,0%
10	0,15	0,16	0,3017	0,2797	6,9%
11	0,38	**0,57**	0,0777	**0,0180**	**1,4%**
12	0,22	0,27	0,2012	0,1546	0,6%
13	0,11	0,01	0,3846	0,7697	4,9%
14	0,02	0,00	0,7455	0,9160	8,2%
15	0,39	0,06	0,0714	0,5407	26,0%
16	0,21	**0,59**	0,2116	**0,0163**	**2,1%**
17	0,04	0,00	0,6245	0,8677	0,1%
18	0,00	0,14	0,9925	0,3247	8,5%
19	0,02	**0,52**	0,6970	**0,0289**	**0,4%**
20	0,15	0,00	0,3087	0,9544	3,8%
21	0,23	0,41	0,1952	0,0612	0,5%
22	0,18	0,08	0,2551	0,4595	0,7%
23	0,19	**0,78**	0,2362	**0,0016**	**3,6%**
24	**0,56**	**0,75**	**0,0210**	**0,0025**	**12,2%**
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	15.5%	22.2%	23.0%
Amount of commodities explained significantly	3	6	7

Spain: Result fact sheet for the regression analysis based on ton kilometres

NST/R	**Coefficient of determination R^2 value**		**Significance test p-value**		**Share of total ton kilometres transported via road haulage in 2007**
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0,34	**0,52**	0,0979	**0,0280**	**1,5%**
2	**0,56**	**0,90**	**0,0212**	**0,0001**	**2,2%**
3	0,43	0,29	0,0535	0,1331	0,5%
4	0,01	0,04	0,7749	0,5966	1,1%
5	**0,57**	0,31	**0,0193**	0,1201	**0,2%**
6	**0,92**	**0,92**	**0,0001**	**0,0000**	**7,9%**
7	**0,62**	**0,66**	**0,0118**	**0,0076**	**0,3%**
8	**0,51**	**0,74**	**0,0308**	**0,0029**	**1,1%**
9	-*	-*	-*	-*	0,0%
10	**0,60**	**0,67**	**0,0149**	**0,0071**	**3,5%**
11	0,01	**0,81**	0,7674	**0,0009**	**1,0%**
12	0,08	0,41	0,4529	0,0624	0,2%
13	**0,94**	**0,91**	**0,0000**	**0,0001**	**2,7%**
14	**0,97**	**0,98**	**0,0000**	**0,0000**	**19,2%**
15	**0,96**	**0,97**	**0,0000**	**0,0000**	**44,4%**
16	0,11	0,14	0,3851	0,3126	1,0%
17	0,42	**0,48**	0,0572	**0,0388**	**0,1%**
18	**0,77**	**0,85**	**0,0020**	**0,0004**	**1,7%**
19	**0,52**	0,38	**0,0294**	0,0763	**0,4%**
20	**0,83**	**0,91**	**0,0006**	**0,0001**	**2,7%**
21	**0,78**	**0,68**	**0,0015**	**0,0060**	**0,4%**
22	0,13	0,15	0,3411	0,3052	0,4%
23	**0,83**	**0,87**	**0,0006**	**0,0003**	**2,5%**
24	**0,56**	**0,66**	**0,0208**	**0,0075**	**4,8%**
					100 %
Significance level below 5%			Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly			94.2%	96.2%	96.8%
Amount of commodities explained significantly			15	16	18

**No result, because the value of the economic indicator is nil.*

Finland: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage in 2007
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**	
1	0,18	0,15	0,2560	0,3090	1,1%
2	0,25	0,29	0,1670	0,1314	0,3%
3	0,10	0,15	0,4074	0,2983	0,4%
4	0,29	0,09	0,1315	0,4404	13,7%
5	0,00	0,05	0,9935	0,5547	0,2%
6	0,00	0,02	0,8649	0,6913	6,1%
7	0,18	**0,50**	0,2526	**0,0322**	**0,1%**
8	0,23	0,27	0,1959	0,1491	2,5%
9	-*	-*	-*	-*	0,0%
10	0,22	0,15	0,2010	0,3017	3,3%
11	0,01	0,02	0,8375	0,7257	0,9%
12	**0,47**	0,22	**0,0430**	0,1994	**0,2%**
13	0,00	0,01	0,9413	0,8319	1,6%
14	0,21	0,27	0,2113	0,1561	4,5%
15	0,06	0,18	0,5149	0,2543	45,6%
16	0,00	0,02	0,8834	0,7533	0,6%
17	0,09	0,01	0,4311	0,7543	0,3%
18	0,02	0,10	0,7425	0,4021	2,0%
19	0,31	0,11	0,1188	0,3871	0,9%
20	0,07	0,04	0,4787	0,5967	2,3%
21	**0,66**	**0,68**	**0,0080**	**0,0061**	**0,7%**
22	0,17	0,16	0,2746	0,2836	0,1%
23	0,14	0,38	0,3150	0,0771	4,0%
24	0,19	0,07	0,2462	0,4923	8,7%
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	0.9%	0.8%	0.9%
Amount of commodities explained significantly	2	2	3

**No result, because the value of the economic indicator is nil.*

Luxembourg: Result fact sheet for the regression analysis based on ton kilometres

NST/R	Coefficient of determination R^2 value		Significance test p-value		Share of total ton kilometres transported via road haulage in 2007
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression	
1	0,11	0,00	0,3948	0,9499	2,9%
2	0,09	0,00	0,4348	0,9352	1,3%
3	0,02	0,01	0,7045	0,8437	0,1%
4	0,05	0,28	0,5579	0,1449	3,5%
5	0,41	0,31	0,0649	0,1208	0,1%
6	-*	0,18	-*	0,2601	5,1%
7	0,15	**0,46**	0,2960	**0,0460**	**1,3%**
8	-*	0,01	-*	0,8471	5,4%
9	-*	-*	-*	-*	0,0%
10	-*	**0,87**	-*	**0,0003**	**4,9%**
11	-*	0,24	-*	0,1829	2,8%
12	-*	-*	-*	-*	0,0%
13	-*	0,24	-*	0,1798	8,5%
14	0,16	**0,50**	0,2903	**0,0333**	**5,4%**
15	0,36	0,35	0,0879	0,0941	32,2%
16	0,18	0,14	0,2588	0,3291	0,6%
17	-*	-*	-*	-*	0,0%
18	0,44	0,35	0,0520	0,0925	2,2%
19	-*	0,01	-*	0,7612	0,1%
20	0,37	0,40	0,0799	0,0696	1,5%
21	-*	0,04	-*	0,6023	0,2%
22	0,25	0,09	0,1693	0,4385	1,5%
23	0,08	0,06	0,4467	0,5405	5,2%
24	0,00	0,15	0,9235	0,3083	15,1%
					100 %

Significance level below 5%	Supply-based regression	Use-based regression	Aggregated results
Share of tonnes explained significantly	0.0%	11.6%	11.6%
Amount of commodities explained significantly	0	3	3

**No result, because the value of the economic indicator is nil.*

Section 5: Stationarity

The significance level is α = 0.05 and stationary results are highlighted.

Results of the Dickey-Fuller-Test for Germany (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,650	0,999	0,973	13	0,952	0,979	0,889
2	0,213	0,999	0,973	14	0,297	0,838	0,879
3	0,552	0,825	0,961	15	0,877	0,593	**0,004**
4	0,443	0,375	0,305	16	0,815	0,688	0,807
5	0,743	0,693	0,696	17	0,246	0,689	0,807
6	0,134	0,732	0,874	18	0,097	0,688	0,807
7	0,891	0,825	0,961	19	0,313	0,396	**0,002**
8	0,696	0,557	0,970	20	0,621	0,930	0,976
9	0,857	0,721	0,514	21	0,709	0,979	0,889
10	0,387	0,721	0,514	22	0,741	0,838	0,879
11	0,730	0,271	0,284	23	0,311	0,693	0,696
12	0,368	0,271	0,284	24	0,229	**0,001**	0,207

Results of the Dickey-Fuller-Test in first differences for Germany (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,406	0,066	0,065	13	0,071	0,477	0,654
2	0,620	0,066	0,065	14	0,591	0,199	0,130
3	0,439	0,257	0,083	15	0,393	0,563	0,651
4	0,147	0,521	0,606	16	0,414	0,224	0,494
5	0,362	0,385	0,625	17	0,075	0,222	0,494
6	0,366	0,607	0,264	18	0,207	0,224	0,494
7	0,369	0,257	0,083	19	**0,013**	0,702	0,109
8	0,287	0,541	0,742	20	0,126	0,994	0,479
9	**0,027**	0,494	0,316	21	0,723	0,477	0,654
10	0,345	0,494	0,316	22	0,122	0,199	0,130
11	0,128	0,416	0,555	23	0,439	0,385	0,624
12	0,583	0,416	0,555	24	0,235	0,083	0,290

Results of the Dickey-Fuller-Test in second differences for Germany (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,373	**0,040**	**0,021**	13	0,118	0,057	0,243
2	0,632	**0,040**	**0,021**	14	0,279	0,494	0,416
3	0,218	0,200	**0,046**	15	0,555	0,715	0,096
4	0,450	0,511	0,595	16	0,587	0,681	0,646
5	0,626	0,507	**0,000**	17	0,063	0,678	0,646
6	0,427	0,135	0,310	18	0,134	0,681	0,646
7	0,555	0,200	**0,046**	19	0,051	0,454	0,226
8	0,466	0,718	0,530	20	0,423	0,834	0,132
9	0,206	0,184	0,744	21	0,646	0,057	0,243
10	0,457	0,184	0,744	22	0,429	0,494	0,416
11	0,419	0,999	0,972	23	0,121	0,507	**0,000**
12	0,459	0,999	0,972	24	0,106	0,137	0,074

Results of the Dickey-Fuller-Test for Spain (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,387	0,354	0,870	13	0,744	0,770	0,452
2	0,109	0,354	0,870	14	0,392	0,985	0,104
3	0,083	0,815	0,884	15	0,593	0,442	0,928
4	0,310	0,143	0,997	16	0,354	0,396	**0,047**
5	0,946	0,552	0,122	17	0,494	0,395	**0,047**
6	0,888	0,063	0,968	18	0,363	0,396	**0,047**
7	0,100	0,815	0,884	19	0,765	0,621	0,294
8	0,627	0,683	0,243	20	0,388	0,354	0,203
9	0,243	0,243	0,243	21	0,676	0,770	0,452
10	0,364	0,608	0,211	22	0,114	0,985	0,104
11	0,436	0,555	0,598	23	0,301	0,552	0,122
12	0,331	0,555	0,597	24	0,901	0,502	0,988

Results of the Dickey-Fuller-Test in first differences for Spain (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	**0,045**	0,358	0,637	13	0,677	0,319	0,996
2	0,122	0,358	0,637	14	0,224	0,095	0,334
3	0,665	0,162	0,742	15	0,166	0,796	0,851
4	0,485	0,363	0,827	16	0,838	0,822	0,528
5	0,357	0,570	0,607	17	0,614	0,822	0,528
6	0,777	0,379	0,137	18	0,502	0,822	0,528
7	**0,005**	0,162	0,742	19	0,588	0,729	0,145
8	0,283	0,174	0,947	20	0,997	0,921	0,400
9	0,947	0,947	0,947	21	0,163	0,319	0,996
10	0,494	0,496	1,000	22	0,107	0,095	0,334
11	0,077	0,929	0,501	23	0,473	0,570	0,607
12	0,208	0,929	0,501	24	0,668	0,277	0,914

Results of the Dickey-Fuller-Test in second differences for Spain (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,996	0,996	0,996	13	0,996	0,996	0,996
2	0,996	0,996	0,996	14	0,996	0,996	0,996
3	0,996	0,996	0,996	15	0,996	0,996	0,996
4	0,996	0,996	0,996	16	0,996	0,996	0,996
5	0,996	0,996	0,996	17	0,996	0,996	0,996
6	0,996	0,996	0,996	18	0,996	0,996	0,996
7	0,996	0,996	0,996	19	0,996	0,996	0,996
8	0,996	0,996	0,996	20	0,996	0,996	0,996
9	0,996	0,996	0,996	21	0,996	0,996	0,996
10	0,996	0,996	0,996	22	0,996	0,996	0,996
11	0,996	0,996	0,996	23	0,996	0,996	0,996
12	0,996	0,996	0,996	24	0,996	0,996	0,996

Results of the Dickey-Fuller-Test for the Netherlands (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,755	**0,006**	0,480	13	0,140	0,208	0,278
2	0,634	**0,006**	0,480	14	0,400	0,599	0,896
3	0,501	0,472	0,473	15	0,882	0,578	0,939
4	0,192	0,780	0,435	16	0,426	0,677	0,712
5	0,692	0,997	0,081	17	0,562	0,676	0,711
6	0,736	0,019	0,470	18	0,316	0,677	0,712
7	0,950	0,472	0,473	19	0,230	0,723	0,757
8	**0,015**	0,071	0,449	20	0,300	0,585	0,737
9	0,150	0,645	0,622	21	0,607	0,208	0,279
10	0,697	0,645	0,622	22	0,522	0,599	0,896
11	0,236	0,699	0,803	23	0,157	0,997	0,081
12	0,120	0,699	0,803	24	0,169	0,418	0,874

Results of the Dickey-Fuller-Test in first differences for the Netherlands (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,324	0,138	0,516	13	0,677	0,381	0,470
2	0,324	0,138	0,516	14	0,118	0,894	0,563
3	0,705	0,078	0,516	15	**0,015**	0,862	0,616
4	0,199	0,529	0,467	16	0,582	0,897	0,379
5	0,311	0,133	0,223	17	0,553	0,897	0,379
6	0,400	0,252	0,633	18	0,402	0,897	0,379
7	0,177	0,078	0,516	19	0,552	0,080	0,352
8	0,106	0,424	0,581	20	0,426	0,791	0,361
9	0,526	0,132	0,679	21	0,490	0,381	0,471
10	0,306	0,132	0,679	22	**0,041**	0,894	0,563
11	0,457	0,256	0,236	23	0,903	0,133	0,223
12	0,359	0,256	0,237	24	0,270	0,708	0,454

Results of the Dickey-Fuller-Test in second differences for the Netherlands (tonnes)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	**0,003**	0,694	0,957	13	0,543	0,900	0,998
2	0,273	0,694	0,957	14	0,198	0,143	0,589
3	0,591	0,759	0,948	15	0,115	0,196	**0,025**
4	0,199	0,487	0,977	16	0,391	0,453	0,223
5	**0,043**	**0,037**	0,246	17	0,661	0,453	0,223
6	0,557	0,880	0,098	18	0,307	0,453	0,223
7	0,242	0,759	0,948	19	0,971	0,538	0,484
8	0,082	0,856	0,564	20	**0,048**	0,710	0,577
9	0,336	0,362	0,059	21	0,491	0,900	0,998
10	0,587	0,362	0,059	22	0,131	0,143	0,589
11	0,244	0,777	0,753	23	0,814	**0,037**	0,246
12	0,063	0,777	0,753	24	0,256	0,585	0,799

Results of the Dickey-Fuller-Test for Germany (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,723	0,999	0,973	13	0,077	0,981	0,878
2	0,188	0,999	0,973	14	0,139	0,838	0,879
3	0,188	0,999	0,973	15	0,910	0,593	**0,004**
4	0,999	0,375	0,305	16	0,443	0,688	0,807
5	0,684	0,693	0,696	17	0,632	0,688	0,807
6	**0,041**	0,732	0,874	18	0,359	0,688	0,807
7	0,589	0,811	0,959	19	0,118	0,396	**0,002**
8	0,683	0,557	0,970	20	0,879	0,930	0,976
9	0,342	0,721	0,514	21	0,485	0,981	0,878
10	0,604	0,721	0,514	22	0,656	0,838	0,879
11	0,318	0,266	0,283	23	0,642	0,693	0,696
12	0,512	0,266	0,283	24	0,180	**0,001**	0,207

Results of the Dickey-Fuller-Test in first differences for Germany (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,354	0,066	0,065	13	**0,045**	0,488	0,692
2	0,466	0,066	0,065	14	0,798	0,199	0,130
3	0,313	0,273	0,086	15	0,390	0,563	0,651
4	**0,026**	0,521	0,606	16	0,442	0,223	0,494
5	0,457	0,385	0,624	17	0,927	0,223	0,494
6	0,770	0,607	0,264	18	0,764	0,224	0,494
7	0,318	0,273	0,086	19	0,613	0,702	0,109
8	0,392	0,541	0,742	20	0,431	0,994	0,479
9	**0,018**	0,494	0,316	21	0,598	0,488	0,692
10	0,095	0,494	0,316	22	0,370	0,199	0,130
11	0,634	0,403	0,557	23	0,392	0,385	0,624
12	0,441	0,403	0,557	24	0,228	0,083	0,290

Results of the Dickey-Fuller-Test in second differences for Germany (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,071	**0,040**	**0,021**	13	**0,004**	0,074	0,207
2	0,480	**0,040**	**0,021**	14	0,373	0,494	0,416
3	0,271	0,205	0,050	15	0,379	0,715	0,096
4	**0,008**	0,511	0,595	16	0,775	0,681	0,646
5	0,645	0,507	**0,001**	17	0,287	0,680	0,646
6	0,584	0,135	0,310	18	0,335	0,681	0,646
7	0,714	0,205	0,050	19	0,396	0,454	0,226
8	0,457	0,718	0,530	20	0,258	0,834	0,132
9	0,058	0,184	0,744	21	0,724	0,074	0,207
10	0,435	0,184	0,744	22	0,657	0,494	0,416
11	0,584	0,994	0,972	23	0,468	0,507	**0,000**
12	0,748	0,994	0,972	24	**0,022**	0,137	0,074

Results of the Dickey-Fuller-Test for Spain (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,440	0,354	0,870	13	0,058	0,763	0,453
2	0,440	0,354	0,870	14	0,663	0,985	0,104
3	0,251	0,813	0,831	15	0,373	0,442	0,928
4	0,198	0,143	0,997	16	0,494	0,396	**0,047**
5	0,429	0,552	0,123	17	0,810	0,396	**0,047**
6	0,948	0,063	0,968	18	0,447	0,396	**0,047**
7	0,598	0,813	0,831	19	0,968	0,621	0,294
8	0,371	0,683	0,243	20	0,269	0,354	0,203
9	0,243	0,243	0,243	21	0,588	0,763	0,453
10	0,834	0,608	0,211	22	0,387	0,985	0,104
11	0,427	0,530	0,623	23	0,507	0,552	0,122
12	0,341	0,530	0,623	24	0,974	0,502	0,988

Results of the Dickey-Fuller-Test in first differences for Spain (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,226	0,358	0,637	13	0,092	0,335	0,992
2	0,561	0,358	0,637	14	0,458	0,095	0,334
3	0,168	0,169	0,714	15	0,233	0,796	0,851
4	0,385	0,363	0,827	16	0,763	0,822	0,528
5	0,714	0,570	0,607	17	0,730	0,822	0,528
6	0,541	0,379	0,137	18	0,547	0,822	0,528
7	0,470	0,169	0,715	19	0,656	0,729	0,145
8	**0,036**	0,174	0,947	20	0,688	0,921	0,400
9	0,947	0,947	0,947	21	0,135	0,335	0,992
10	0,352	0,496	1,000	22	0,461	0,095	0,334
11	0,653	0,930	0,474	23	0,655	0,570	0,607
12	0,430	0,930	0,474	24	0,816	0,277	0,914

Results of the Dickey-Fuller-Test in second differences for Spain (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,996	0,996	0,996	13	0,996	0,996	0,996
2	0,996	0,996	0,996	14	0,996	0,996	0,996
3	0,996	0,996	0,996	15	0,996	0,996	0,996
4	0,996	0,996	0,996	16	0,996	0,996	0,996
5	0,996	0,996	0,996	17	0,996	0,996	0,996
6	0,996	0,996	0,996	18	0,996	0,996	0,996
7	0,996	0,996	0,996	19	0,996	0,996	0,996
8	0,996	0,996	0,996	20	0,996	0,996	0,996
9	0,996	0,996	0,996	21	0,996	0,996	0,996
10	0,996	0,996	0,996	22	**0,006**	**0,006**	**0,006**
11	0,996	0,996	0,996	23	**0,006**	**0,006**	**0,006**
12	0,996	0,996	0,996	24	**0,006**	**0,006**	**0,006**

Results of the Dickey-Fuller-Test for France (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	**0,012**	0,862	0,674	13	0,977	0,995	0,302
2	0,625	0,862	0,674	14	0,941	0,998	0,287
3	0,130	0,754	0,771	15	0,832	0,996	0,968
4	0,655	0,997	0,538	16	**0,025**	0,400	0,703
5	0,264	0,570	0,539	17	0,586	0,399	0,703
6	0,301	0,562	0,772	18	0,365	0,400	0,703
7	0,587	0,754	0,771	19	0,287	0,733	0,722
8	0,687	0,339	0,125	20	0,470	0,192	0,816
9	0,482	0,603	0,227	21	0,737	0,995	0,302
10	0,652	0,603	0,227	22	0,469	0,998	0,287
11	0,187	0,815	0,714	23	0,240	0,570	0,539
12	0,327	0,815	0,714	24	0,185	0,334	0,392

Results of the Dickey-Fuller-Test in first differences for France (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	**0,014**	0,660	0,472	13	0,126	0,913	0,409
2	0,132	0,660	0,472	14	0,605	0,539	0,466
3	0,623	0,226	0,476	15	**0,032**	0,658	0,905
4	0,331	0,929	0,565	16	0,224	0,919	0,514
5	0,305	0,218	0,330	17	0,730	0,919	0,514
6	0,439	0,978	0,243	18	0,497	0,919	0,514
7	0,569	0,226	0,476	19	0,369	0,559	0,396
8	0,673	0,653	0,177	20	0,439	0,476	0,595
9	0,657	**0,043**	0,936	21	0,340	0,913	0,409
10	0,205	**0,043**	0,936	22	0,839	0,539	0,466
11	0,179	0,446	0,756	23	0,709	0,218	0,330
12	0,308	0,446	0,756	24	0,376	0,838	0,473

Results of the Dickey-Fuller-Test in second differences for France (ton kilometres)

NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**	NST/R	p-value (single-sided) **Freight volume**	p-value (single-sided) **EI_use**	p-value (single-sided) **EI_supply**
1	0,996	0,996	0,996	13	0,996	0,996	0,996
2	0,996	0,996	0,996	14	0,996	0,996	0,996
3	0,996	0,996	0,996	15	0,996	0,996	0,996
4	0,996	0,996	0,996	16	0,996	0,996	0,996
5	0,996	0,996	0,996	17	0,996	0,996	0,996
6	0,996	0,996	0,996	18	0,996	0,996	0,996
7	0,996	0,996	0,996	19	0,996	0,996	0,996
8	0,996	0,996	0,996	20	0,996	0,996	0,996
9	0,996	0,996	0,996	21	0,996	0,996	0,996
10	0,996	0,996	0,996	22	0,996	0,996	0,996
11	0,996	0,996	0,996	23	0,996	0,996	0,996
12	0,996	0,996	0,996	24	0,996	0,996	0,996

Section 6: Interpretation

Proportional distribution of commodities (tonnes)

NST/R	ES	NL	AT	DE	IT	FR	Average focus group		DK	BE	SE	FI	LU	Average of all countries
1	1.5%	1.0%	0.9%	1.1%	1.7%	3.3%	1.6%		2.7%	1.5%	1.2%	1.1%	2.9%	1.7%
2	2.2%	2.8%	1.0%	1.0%	1.7%	3.3%	2.0%		2.1%	1.5%	0.6%	0.3%	1.3%	1.6%
3	0.5%	0.8%	0.4%	0.6%	0.3%	1.0%	0.6%		2.8%	0.9%	0.8%	0.4%	0.1%	0.8%
4	1.1%	1.3%	7.6%	2.6%	1.5%	1.8%	2.6%		4.1%	1.7%	22.0%	13.7%	3.5%	5.5%
5	0.2%	1.4%	0.5%	0.6%	0.8%	0.7%	0.7%		0.1%	0.7%	0.3%	0.2%	0.1%	0.5%
6	7.9%	10.6%	7.3%	11.2%	7.2%	8.8%	8.8%		16.7%	10.3%	7.3%	6.1%	5.1%	8.9%
7	0.3%	1.4%	0.2%	0.7%	0.2%	0.5%	0.6%		0.7%	0.8%	0.2%	0.1%	1.3%	0.6%
8	1.1%	3.4%	0.1%	1.5%	0.4%	0.6%	1.2%		0.2%	2.5%	0.6%	2.5%	5.4%	1.7%
9	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	3.5%	8.2%	3.9%	4.5%	4.1%	3.8%	4.7%		2.0%	6.9%	4.0%	3.3%	4.9%	4.5%
11	1.0%	1.1%	1.5%	1.9%	1.0%	1.0%	1.3%		1.0%	1.4%	1.0%	0.9%	2.8%	1.3%
12	0.2%	3.7%	0.1%	0.3%	0.2%	0.9%	0.9%		0.2%	0.6%	0.4%	0.2%	0.0%	0.6%
13	2.7%	3.5%	2.8%	3.5%	7.6%	1.3%	3.6%		1.5%	4.9%	1.6%	1.6%	8.5%	3.6%
14	19.2%	4.8%	10.8%	5.4%	15.7%	10.2%	11.0%		10.3%	8.2%	4.0%	4.5%	5.4%	9.0%
15	44.4%	19.5%	39.6%	36.0%	35.2%	36.9%	35.3%		30.7%	26.0%	27.4%	45.6%	32.2%	34.0%
16	1.0%	2.3%	0.4%	0.9%	0.5%	1.8%	1.2%		2.8%	2.1%	0.3%	0.6%	0.6%	1.2%
17	0.1%	0.1%	0.3%	0.1%	1.6%	0.0%	0.4%		1.1%	0.1%	0.1%	0.3%	0.0%	0.4%
18	1.7%	10.1%	0.8%	6.8%	3.1%	1.7%	4.0%		1.1%	8.5%	1.8%	2.0%	2.2%	3.6%
19	0.4%	0.9%	1.1%	1.0%	1.0%	0.4%	0.8%		0.4%	0.4%	1.4%	0.9%	0.1%	0.7%
20	2.7%	3.9%	1.8%	4.1%	2.1%	2.6%	2.9%		2.6%	3.8%	3.1%	2.3%	1.5%	2.8%
21	0.4%	1.1%	0.5%	1.6%	0.5%	0.8%	0.8%		2.0%	0.5%	0.6%	0.7%	0.2%	0.8%
22	0.4%	0.6%	0.4%	0.6%	1.0%	0.5%	0.6%		0.5%	0.7%	0.3%	0.1%	1.5%	0.6%
23	2.5%	3.8%	6.2%	5.1%	2.4%	2.9%	3.8%		2.8%	3.6%	3.7%	4.0%	5.2%	3.8%
24	11.8%	15.1%	8.7%	17.5%	12.2%	11.8%	10.7%		15.1%	10.1%	8.9%	11.7%	13.8%	4.8%

Proportional distribution of commodities (ton kilometres)

NST/R	ES	NL	AT	DE	FR	Average focus group		IT	DK	BE	SE	FI	LU	Average of all countries
1	2,0%	1,1%	1,2%	2,1%	2,9%	1,9%		2,5%	1,8%	1,7%	1,5%	1,1%	0,9%	1,7%
2	9,4%	4,0%	2,5%	1,9%	6,3%	4,8%		3,8%	3,6%	2,3%	1,4%	1,2%	2,2%	3,5%
3	0,7%	0,8%	0,2%	0,6%	0,7%	0,6%		0,5%	2,0%	0,6%	0,6%	0,7%	0,0%	0,7%
4	1,3%	1,4%	8,9%	2,7%	2,2%	3,3%		2,4%	5,3%	2,1%	20,7	19,2	3,7%	6,3%
5	0,5%	2,2%	1,0%	0,7%	0,7%	1,0%		1,4%	0,1%	1,3%	0,4%	0,5%	0,4%	0,8%
6	16,0	11,4	11,7	14,6	13,4	13,4%		13,2	20,9	15,0	11,5	12,6	8,9%	13,6%
7	1,0%	1,7%	0,5%	1,5%	0,8%	1,1%		0,5%	1,0%	0,9%	0,5%	0,0%	0,4%	0,8%
8	0,7%	3,8%	0,1%	2,6%	0,6%	1,6%		0,5%	0,2%	1,9%	0,6%	2,7%	1,7%	1,4%
9	0,0%	0,0%	0,0%	0,0%	0,1%	0,0%		0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
10	2,4%	7,4%	4,3%	4,7%	3,9%	4,6%		4,3%	1,7%	4,1%	2,9%	3,6%	3,5%	3,9%
11	1,4%	0,9%	0,7%	2,2%	1,0%	1,2%		1,3%	0,9%	1,4%	1,2%	1,4%	1,2%	1,2%
12	0,3%	3,9%	0,1%	0,3%	0,5%	1,0%		0,3%	0,4%	0,2%	0,4%	0,3%	0,0%	0,6%
13	6,7%	4,8%	7,6%	5,9%	2,7%	5,5%		12,2	2,6%	6,8%	3,3%	4,8%	14,9	6,6%
14	9,8%	4,4%	5,4%	5,1%	6,4%	6,2%		10,1	7,8%	6,5%	3,8%	6,5%	2,5%	6,2%
15	12,4	10,4	10,3	11,7	12,3	11,4%		11,4	10,2	13,1	6,4%	10,9	7,4%	10,6%
16	1,1%	1,8%	0,3%	1,2%	1,6%	1,2%		0,6%	1,2%	2,0%	0,4%	0,9%	0,6%	1,1%
17	0,1%	0,1%	0,1%	0,2%	0,1%	0,1%		1,3%	0,6%	0,1%	0,1%	0,6%	0,0%	0,3%
18	4,7%	9,7%	2,4%	7,9%	3,8%	5,7%		5,7%	2,1%	11,3	3,2%	5,5%	5,8%	5,6%
19	0,7%	0,8%	2,9%	1,2%	0,5%	1,2%		2,0%	0,5%	0,4%	1,3%	1,5%	0,0%	1,1%
20	8,2%	3,9%	3,2%	7,3%	4,7%	5,5%		3,7%	4,7%	4,7%	5,0%	4,5%	3,3%	4,8%
21	0,8%	1,1%	0,8%	2,2%	1,3%	1,2%		1,0%	2,9%	0,7%	1,3%	1,7%	0,3%	1,3%
22	1,1%	0,7%	1,0%	1,1%	1,0%	1,0%		1,8%	0,9%	1,5%	0,7%	0,2%	4,0%	1,3%
23	8,2%	5,4%	12,2	9,5%	6,0%	8,3%		5,2%	4,7%	6,5%	5,8%	8,1%	10,1	7,4%
24	10,4	18,0	22,6	12,9	26,5	18,1%		14,1	23,7	14,8	27,2	11,4	28,2	19,1%

Modal split of the freight volume (tonnes) for the countries of the focus group

Spain (2007) and Germany (2006)

ES	road haulage	railways
1	97.3%	2.7%
2	100.0%	0.0%
3	100.0%	0.0%
4	98.4%	1.6%
5	97.7%	2.3%
6	99.9%	0.1%
7	99.3%	0.7%
8	89.0%	11.0%
9	-	-
10	98.4%	1.6%
11	84.0%	16.0%
12	93.3%	6.7%
13	100.0%	0.0%
14	99.1%	0.9%
15	100.0%	0.0%
16	99.3%	0.7%
17	88.2%	11.8%
18	99.4%	0.6%
19	95.0%	5.0%
20	97.2%	2.8%
21	100.0%	0.0%
22	100.0%	0.0%
23	100.0%	0.0%
24	95.1%	4.9%
total	99.0%	1.0%

DE	road haulage	railways	inland waterways
1	68.9%	6.6%	24.4%
2	99.4%	0.5%	0.0%
3	99.7%	0.1%	0.1%
4	90.3%	8.6%	1.1%
5	98.9%	1.0%	0.1%
6	97.6%	0.6%	1.8%
7	62.6%	3.0%	34.5%
8	13.2%	51.0%	35.8%
9	22.7%	65.9%	11.4%
10	62.3%	18.1%	19.6%
11	32.6%	32.0%	35.4%
12	79.1%	3.9%	17.0%
13	57.3%	34.6%	8.1%
14	94.9%	3.9%	1.2%
15	93.7%	2.5%	3.8%
16	63.5%	20.9%	15.6%
17	17.5%	20.2%	62.4%
18	85.1%	8.8%	6.1%
19	86.8%	6.9%	6.3%
20	91.1%	7.8%	1.1%
21	95.8%	4.0%	0.3%
22	98.1%	0.9%	1.0%
23	93.7%	5.1%	1.2%
24	79.2%	16.9%	3.9%
total	84.0%	9.4%	6.6%

France (2006) and Italy (2007)

FR	road haulage	railways	inland waterways
1	79.1%	10.1%	10.9%
2	99.8%	0.2%	0.0%
3	100.0%	0.0%	0.0%
4	98.4%	1.5%	0.0%
5	99.9%	0.0%	0.1%
6	96.1%	3.1%	0.7%
7	74.1%	11.8%	14.0%
8	37.9%	25.7%	36.4%
9	58.2%	0.9%	40.9%
10	84.4%	6.4%	9.2%
11	68.2%	23.9%	7.9%
12	92.3%	5.6%	2.1%
13	53.2%	40.2%	6.6%
14	98.4%	1.4%	0.3%
15	94.8%	2.1%	3.1%
16	91.0%	5.9%	3.0%
17	41.5%	8.9%	49.6%
18	82.0%	14.4%	3.7%
19	85.6%	6.0%	8.4%
20	93.9%	5.8%	0.2%
21	99.6%	0.3%	0.1%
22	98.1%	1.6%	0.2%
23	97.9%	2.1%	0.0%
24	94.7%	4.1%	1.3%
total	92.6%	4.4%	2.9%

IT	road haulage	railways
1	94.6%	5.4%
2	99.9%	0.1%
3	100.0%	0.0%
4	89.1%	10.9%
5	99.9%	0.1%
6	98.4%	1.6%
7	99.0%	1.0%
8	96.2%	3.8%
9	100.0%	0.0%
10	96.9%	3.1%
11	79.5%	20.5%
12	98.1%	1.9%
13	89.7%	10.3%
14	99.5%	0.5%
15	99.2%	0.8%
16	95.5%	4.5%
17	99.5%	0.5%
18	97.1%	2.9%
19	97.2%	2.8%
20	93.1%	6.9%
21	98.8%	1.2%
22	99.6%	0.4%
23	97.3%	2.7%
24	81.6%	18.4%
total	95.5%	4.5%

The Netherlands (2006) and Austria (2007)

NL	road haulage	railways	inland waterways
1	20.9%	3.6%	75.6%
2	99.9%	0.0%	0.1%
3	96.6%	0.0%	3.4%
4	97.0%	0.4%	2.6%
5	95.9%	0.3%	3.7%
6	90.3%	0.4%	9.3%
7	30.9%	0.4%	68.7%
8	5.5%	15.1%	79.4%
9	2.6%	22.4%	74.9%
10	24.1%	0.8%	75.1%
11	37.5%	37.8%	24.7%
12	2.5%	0.0%	97.5%
13	56.1%	9.0%	34.8%
14	88.4%	0.3%	11.3%
15	59.4%	0.8%	39.8%
16	74.6%	0.5%	24.9%
17	17.2%	2.9%	79.9%
18	73.1%	2.8%	24.1%
19	66.9%	7.6%	25.5%
20	96.2%	1.2%	2.5%
21	94.7%	1.0%	4.3%
22	93.4%	0.2%	6.5%
23	98.5%	0.5%	1.0%
24	57.8%	6.7%	35.5%
total	63.8%	3.2%	33.0%

AT	road haulage	railways	inland waterways
1	51.9%	21.5%	26.6%
2	98.0%	2.0%	0.0%
3	54.8%	45.2%	0.0%
4	72.0%	27.5%	0.5%
5	89.8%	4.3%	5.9%
6	93.3%	4.0%	2.6%
7	57.2%	19.9%	22.9%
8	3.4%	91.3%	5.3%
9	22.0%	78.0%	0.0%
10	61.5%	26.1%	12.5%
11	13.4%	62.8%	23.8%
12	78.3%	18.4%	3.3%
13	49.1%	43.6%	7.3%
14	96.7%	3.2%	0.1%
15	94.9%	4.5%	0.6%
16	31.9%	27.3%	40.9%
17	81.0%	18.4%	0.6%
18	40.1%	59.2%	0.7%
19	67.0%	32.9%	0.2%
20	31.8%	66.5%	1.6%
21	87.4%	11.6%	1.0%
22	90.1%	9.1%	0.8%
23	83.7%	16.2%	0.1%
24	73.6%	26.3%	0.1%
total	77.7%	19.6%	2.7%

Modal split of the freight volume (tonnes) for the remaining countries

Belgium (2006) and Denmark (2007)

BE	road haulage	railways	inland waterways
1	35.0%	9.8%	55.2%
2	99.2%	0.6%	0.3%
3	96.5%	3.4%	0.1%
4	94.5%	1.4%	4.1%
5	95.7%	1.3%	3.0%
6	91.4%	2.8%	5.8%
7	32.8%	3.5%	63.6%
8	6.9%	18.0%	75.1%
9	35.0%	31.7%	33.3%
10	28.3%	5.7%	66.1%
11	24.8%	32.7%	42.5%
12	9.9%	22.5%	67.5%
13	31.1%	48.3%	20.6%
14	90.1%	1.3%	8.7%
15	65.5%	3.0%	31.5%
16	49.2%	2.7%	48.2%
17	24.4%	2.2%	73.4%
18	60.7%	7.9%	31.3%
19	50.0%	16.1%	33.9%
20	75.5%	9.0%	15.5%
21	84.8%	5.4%	9.8%
22	94.9%	0.2%	4.9%
23	95.5%	3.8%	0.7%
24	46.5%	23.4%	30.1%
total	59.8%	11.8%	28.4%

DK	road haulage	railways
1	100.0%	0.0%
2	99.9%	0.1%
3	100.0%	0.0%
4	98.0%	2.0%
5	100.0%	0.0%
6	94.2%	5.8%
7	92.3%	7.7%
8	100.0%	0.0%
9	100.0%	0.0%
10	100.0%	0.0%
11	100.0%	0.0%
12	100.0%	0.0%
13	71.9%	28.1%
14	99.7%	0.3%
15	99.8%	0.2%
16	97.4%	2.6%
17	99.8%	0.2%
18	90.5%	9.5%
19	61.0%	39.0%
20	94.3%	5.7%
21	99.5%	0.5%
22	97.2%	2.8%
23	99.9%	0.1%
24	92.1%	7.9%
total	96.7%	3.3%

Finland (2007) and Sweden (2007)

FI	road haulage	railways
1	99.3%	0.7%
2	100.0%	0.0%
3	100.0%	0.0%
4	79.1%	20.9%
5	92.9%	7.1%
6	99.6%	0.4%
7	98.6%	1.4%
8	99.6%	0.4%
9	0.0%	100.0%
10	90.7%	9.3%
11	61.2%	38.8%
12	45.0%	55.0%
13	73.1%	26.9%
14	99.5%	0.5%
15	99.4%	0.6%
16	86.3%	13.7%
17	96.2%	3.8%
18	69.4%	30.6%
19	66.8%	33.2%
20	91.5%	8.5%
21	99.6%	0.4%
22	96.0%	4.0%
23	67.4%	32.6%
24	100.0%	0.0%
total	91.3%	8.7%

SE	road haulage	railways
1	99.5%	0.5%
2	97.8%	2.2%
3	100.0%	0.0%
4	90.5%	9.5%
5	99.7%	0.3%
6	98.4%	1.6%
7	97.2%	2.8%
8	85.4%	14.6%
9	100.0%	0.0%
10	90.7%	9.3%
11	10.7%	89.3%
12	84.5%	15.5%
13	43.2%	56.8%
14	97.5%	2.5%
15	99.1%	0.9%
16	89.9%	10.1%
17	97.2%	2.8%
18	88.8%	11.2%
19	72.8%	27.2%
20	91.7%	8.3%
21	96.4%	3.6%
22	97.4%	2.6%
23	68.3%	31.7%
24	90.2%	9.8%
total	84.4%	15.6%

Luxembourg

LU	road haulage	railways	inland waterways
1	6.7%	0.6%	92.7%
2	100.0%	0.0%	0.0%
3	84.2%	0.0%	15.8%
4	99.8%	0.1%	0.1%
5	93.9%	1.5%	4.5%
6	97.6%	1.6%	0.8%
7	0.0%	0.0%	100.0%
8	1.3%	0.5%	98.3%
9	-	-	-
10	69.9%	17.7%	12.4%
11	2.3%	53.5%	44.2%
12	0.0%	0.0%	100.0%
13	44.8%	45.6%	9.5%
14	85.9%	12.9%	1.2%
15	91.7%	3.7%	4.6%
16	50.1%	0.0%	49.9%
17	-	-	-
18	85.6%	14.3%	0.1%
19	0.0%	39.1%	60.9%
20	90.2%	9.8%	0.0%
21	75.0%	23.4%	1.6%
22	100.0%	0.0%	0.0%
23	96.8%	3.2%	0.0%
24	81.9%	18.1%	0.1%
total	69.3%	15.9%	14.9%

Average modal split of the freight volume (tonnes)

Focus group and all considered countries

Focus group	road haulage	railways	inland waterways
1	68.8%	34.4%	8.3%
2	99.5%	0.0%	0.5%
3	91.9%	0.9%	7.5%
4	90.9%	1.1%	8.4%
5	97.0%	2.5%	1.3%
6	95.9%	3.6%	1.7%
7	70.5%	35.0%	6.1%
8	40.9%	39.2%	33.0%
9	34.3%	31.8%	27.9%
10	71.3%	29.1%	9.3%
11	52.5%	22.9%	32.2%
12	73.9%	30.0%	6.1%
13	67.6%	14.2%	23.0%
14	96.2%	3.2%	1.7%
15	90.3%	11.8%	1.8%
16	76.0%	21.1%	10.0%
17	57.5%	48.1%	10.5%
18	79.5%	8.7%	14.8%
19	83.1%	10.1%	10.2%
20	83.9%	1.4%	15.2%
21	96.1%	1.4%	3.0%
22	96.5%	2.1%	2.0%
23	95.2%	0.6%	4.5%
24	80.3%	10.2%	12.9%
total	85.4%	11.3%	7.0%

All 11 countries	road haulage	railways	inland waterways
1	68.5%	47.6%	5.6%
2	99.4%	0.1%	0.5%
3	93.8%	3.2%	4.4%
4	91.5%	1.4%	7.7%
5	96.8%	2.9%	1.6%
6	96.1%	3.5%	2.0%
7	67.6%	50.6%	4.8%
8	49.0%	55.0%	21.0%
9	44.0%	32.1%	29.9%
10	73.4%	32.5%	8.9%
11	46.7%	29.8%	37.0%
12	62.1%	47.9%	11.8%
13	60.9%	14.5%	31.2%
14	95.4%	3.8%	2.5%
15	90.7%	13.9%	1.7%
16	75.3%	30.4%	8.1%
17	66.2%	53.2%	7.2%
18	79.2%	11.0%	14.7%
19	68.1%	22.5%	19.6%
20	86.1%	3.5%	12.0%
21	93.8%	2.8%	4.7%
22	96.8%	2.3%	2.0%
23	90.8%	0.5%	8.9%
24	81.1%	11.8%	12.4%
total	83.1%	14.7%	8.9%

Modal split of the transport performance (ton kilometres) for the countries of the focus group

Spain (2007) and Germany (2006)

ES	road haulage	railways
1	73.8%	26.2%
2	99.6%	0.4%
3	99.7%	0.3%
4	44.3%	55.7%
5	93.9%	6.1%
6	97.3%	2.7%
7	85.1%	14.9%
8	19.5%	80.5%
9	0.0%	100.0%
10	37.8%	62.2%
11	30.9%	69.1%
12	86.3%	13.7%
13	53.9%	46.1%
14	92.9%	7.1%
15	81.9%	18.1%
16	57.1%	42.9%
17	49.1%	50.9%
18	59.5%	40.5%
19	54.1%	45.9%
20	79.6%	20.4%
21	70.9%	29.1%
22	97.7%	2.3%
23	82.0%	18.0%
24	44.5%	55.5%
total	69.3%	30.7%

DE	road haulage	railways	inland waterways
1	34.9%	15.0%	50.0%
2	98.4%	1.6%	0.0%
3	98.8%	0.5%	0.7%
4	71.8%	26.0%	2.2%
5	95.7%	3.8%	0.5%
6	93.5%	2.1%	4.4%
7	49.5%	4.8%	45.7%
8	7.7%	43.4%	48.9%
9	17.7%	67.7%	14.6%
10	29.0%	35.5%	35.5%
11	15.6%	49.2%	35.3%
12	71.3%	8.4%	20.3%
13	49.3%	39.6%	11.1%
14	88.8%	6.9%	4.3%
15	67.0%	13.3%	19.8%
16	28.1%	34.5%	37.4%
17	11.1%	33.1%	55.7%
18	70.6%	19.3%	10.1%
19	63.6%	25.4%	11.0%
20	82.0%	16.7%	1.4%
21	90.3%	9.2%	0.5%
22	96.6%	2.2%	1.2%
23	87.3%	11.4%	1.3%
24	58.0%	36.6%	5.3%
total	65.3%	21.7%	13.0%

The Netherlands (2006) and Austria (2007)

NL	road haulage	railways	
1	24.0%	1.1%	74.9%
2	99.9%	0.0%	0.1%
3	95.0%	0.0%	5.0%
4	96.9%	0.4%	2.8%
5	97.5%	0.1%	2.4%
6	90.0%	0.4%	9.6%
7	38.1%	0.4%	61.5%
8	5.0%	17.2%	77.8%
9	0.0%	51.0%	49.0%
10	15.8%	1.1%	83.2%
11	23.3%	53.8%	22.9%
12	3.4%	0.0%	96.6%
13	59.1%	7.6%	33.3%
14	85.2%	0.4%	14.4%
15	32.7%	2.2%	65.1%
16	53.9%	0.1%	46.0%
17	24.6%	3.9%	71.5%
18	67.7%	3.6%	28.8%
19	48.3%	11.9%	39.9%
20	96.2%	1.1%	2.7%
21	93.3%	1.3%	5.4%
22	94.4%	0.0%	5.6%
23	98.9%	0.3%	0.7%
24	67.6%	6.8%	25.5%
total	63.6%	4.1%	32.3%

AT	road haulage	railways	inland waterways
1	16.4%	70.5%	13.0%
2	90.2%	9.8%	0.0%
3	93.6%	6.4%	0.0%
4	43.5%	56.1%	0.4%
5	72.7%	19.4%	7.9%
6	75.9%	21.0%	3.1%
7	26.3%	62.4%	11.3%
8	0.3%	99.0%	0.7%
9	4.3%	95.7%	0.0%
10	12.5%	84.5%	3.0%
11	2.8%	89.1%	8.2%
12	26.7%	72.7%	0.6%
13	15.2%	83.0%	1.8%
14	49.9%	49.8%	0.3%
15	33.9%	65.1%	1.0%
16	4.8%	87.6%	7.5%
17	9.7%	89.6%	0.7%
18	9.3%	90.5%	0.1%
19	42.0%	57.9%	0.1%
20	17.0%	81.4%	1.7%
21	24.5%	74.9%	0.6%
22	82.5%	16.3%	1.2%
23	48.3%	51.6%	0.1%
24	19.4%	80.6%	0.0%
total	23.4%	74.9%	1.7%

France (2006)

FR	road haulage	railways	inland waterways
1	50.9%	32.7%	16.5%
2	98.9%	1.1%	0.0%
3	100.0%	0.0%	0.0%
4	93.5%	6.4%	0.1%
5	99.5%	0.3%	0.1%
6	89.7%	9.6%	0.6%
7	61.4%	26.9%	11.8%
8	22.5%	42.1%	35.3%
9	17.1%	2.9%	80.0%
10	71.3%	20.6%	8.1%
11	48.5%	46.9%	4.6%
12	83.9%	10.3%	5.9%
13	42.7%	53.2%	4.1%
14	92.3%	6.7%	1.0%
15	78.5%	12.9%	8.5%
16	78.3%	17.2%	4.4%
17	41.5%	14.2%	44.3%
18	74.1%	22.8%	3.1%
19	78.0%	16.0%	6.1%
20	82.5%	17.3%	0.2%
21	98.5%	1.3%	0.2%
22	96.6%	3.2%	0.2%
23	94.6%	5.4%	0.0%
24	84.2%	14.6%	1.2%
total	80.9%	15.7%	3.4%

Modal split of the transport performance (ton kilometres) for the remaining countries

Belgium (2006) and Denmark (2007)

BE	road haulage	railways	inland waterways
1	22.3%	59.1%	18.6%
2	92.4%	7.5%	0.1%
3	97.8%	2.2%	0.0%
4	27.8%	71.3%	0.9%
5	87.2%	11.7%	1.1%
6	85.4%	12.9%	1.7%
7	41.8%	40.4%	17.8%
8	2.4%	87.5%	10.1%
9	7.3%	89.5%	3.2%
10	9.6%	81.7%	8.8%
11	2.7%	91.2%	6.2%
12	29.7%	45.4%	24.9%
13	17.2%	79.2%	3.6%
14	64.7%	30.2%	5.1%
15	30.2%	50.0%	19.8%
16	22.2%	64.1%	13.7%
17	5.8%	87.5%	6.8%
18	40.5%	55.6%	3.9%
19	11.1%	86.3%	2.6%
20	31.2%	66.3%	2.5%
21	31.4%	67.0%	1.7%
22	84.9%	13.3%	1.8%
23	48.0%	51.9%	0.0%
24	22.0%	76.7%	1.3%
total	29.2%	65.3%	5.4%

DK	road haulage	railways
1	51.3%	48.7%
2	97.9%	2.1%
3	100.0%	0.0%
4	53.5%	46.5%
5	90.3%	9.7%
6	77.4%	22.6%
7	87.4%	12.6%
8	22.3%	77.7%
9	100.0%	0.0%
10	34.1%	65.9%
11	19.8%	80.2%
12	89.0%	11.0%
13	14.1%	85.9%
14	81.9%	18.1%
15	65.3%	34.7%
16	68.9%	31.1%
17	77.4%	22.6%
18	43.6%	56.4%
19	47.6%	52.4%
20	51.9%	48.1%
21	92.9%	7.1%
22	87.7%	12.3%
23	71.3%	28.7%
24	33.6%	66.4%
total	49.7%	50.3%

Finland (2007) and Sweden (2007)

FI	road haulage	railways
1	14.7%	85.3%
2	79.7%	20.3%
3	97.2%	2.8%
4	58.4%	41.6%
5	62.1%	37.9%
6	76.4%	23.6%
7	2.8%	97.2%
8	9.4%	90.6%
9	0.0%	100.0%
10	9.4%	90.6%
11	5.1%	94.9%
12	42.6%	57.4%
13	8.8%	91.2%
14	50.1%	49.9%
15	31.4%	68.6%
16	11.4%	88.6%
17	31.5%	68.5%
18	16.7%	83.3%
19	23.3%	76.7%
20	19.8%	80.2%
21	36.6%	63.4%
22	44.2%	55.8%
23	34.0%	66.0%
24	9.2%	90.8%
total	20.6%	79.4%

SE	road haulage	railways
1	98.2%	1.8%
2	95.2%	4.8%
3	100.0%	0.0%
4	75.5%	24.5%
5	96.8%	3.2%
6	94.4%	5.6%
7	91.1%	8.9%
8	52.2%	47.8%
9	100.0%	0.0%
10	72.1%	27.9%
11	8.3%	91.7%
12	52.5%	47.5%
13	19.7%	80.3%
14	88.2%	11.8%
15	88.9%	11.1%
16	72.9%	27.1%
17	88.5%	11.5%
18	71.1%	28.9%
19	32.6%	67.4%
20	76.8%	23.2%
21	89.1%	10.9%
22	93.2%	6.8%
23	41.0%	59.0%
24	70.5%	29.5%
total	61.2%	38.8%

Luxembourg (2006) and Italy (2007)

LU	road haulage	railways	inland waterways
1	1.3%	93.8%	4.9%
2	61.8%	38.2%	0.0%
3	10.0%	90.0%	0.0%
4	9.9%	90.1%	0.0%
5	15.8%	84.2%	0.0%
6	36.7%	63.2%	0.1%
7	0.0%	88.4%	11.6%
8	0.2%	97.9%	1.9%
9	0.0%	100.0%	0.0%
10	3.0%	96.9%	0.0%
11	0.2%	99.3%	0.6%
12	0.0%	100.0%	0.0%
13	7.9%	91.9%	0.2%
14	12.0%	88.0%	0.1%
15	7.1%	92.6%	0.3%
16	2.1%	97.6%	0.3%
17	0.0%	100.0%	0.0%
18	4.5%	95.5%	0.0%
19	0.0%	99.8%	0.2%
20	5.2%	94.8%	0.0%
21	0.8%	99.2%	0.0%
22	76.8%	23.2%	0.0%
23	10.9%	89.1%	0.0%
24	11.1%	88.9%	0.0%
total	7.6%	92.1%	0.3%

IT	road haulage	railways
1	92.5%	7.5%
2	99.8%	0.2%
3	100.0%	0.0%
4	82.0%	18.0%
5	99.9%	0.1%
6	94.9%	5.1%
7	96.9%	3.1%
8	88.3%	11.7%
9	100.0%	0.0%
10	91.6%	8.4%
11	75.3%	24.7%
12	98.2%	1.8%
13	86.7%	13.3%
14	98.1%	1.9%
15	94.7%	5.3%
16	91.3%	8.7%
17	98.4%	1.6%
18	94.8%	5.2%
19	96.7%	3.3%
20	87.8%	12.2%
21	97.4%	2.6%
22	99.2%	0.8%
23	95.9%	4.1%
24	72.0%	28.0%
total	89.4%	10.6%

Average modal split of the transport performance (ton kilometres)

Focus group and all considered countries

Focus group	road haulage	railways	inland waterways
1	40.0%	29.1%	38.6%
2	97.4%	2.6%	0.0%
3	97.4%	1.4%	1.4%
4	70.0%	28.9%	1.4%
5	91.9%	5.9%	2.7%
6	89.3%	7.2%	4.4%
7	52.1%	21.9%	32.6%
8	11.0%	56.4%	40.7%
9	7.8%	63.5%	35.9%
10	33.3%	40.8%	32.4%
11	24.2%	61.6%	17.7%
12	54.3%	21.0%	30.8%
13	44.0%	45.9%	12.6%
14	81.8%	14.2%	5.0%
15	58.8%	22.3%	23.6%
16	44.4%	36.5%	23.9%
17	27.2%	38.4%	43.1%
18	56.2%	35.3%	10.5%
19	57.2%	31.4%	14.3%
20	71.4%	27.4%	1.5%
21	75.5%	23.2%	1.7%
22	93.6%	4.8%	2.1%
23	82.2%	17.4%	0.5%
24	54.8%	38.8%	8.0%
total	60.5%	29.4%	12.6%

All 11 countries	road haulage	railways	inland waterways
1	43.7%	29.7%	40.1%
2	92.2%	0.0%	7.8%
3	90.2%	0.9%	9.3%
4	59.7%	1.1%	39.7%
5	82.9%	2.0%	16.1%
6	82.9%	3.2%	15.4%
7	52.8%	26.6%	32.7%
8	20.9%	29.1%	63.2%
9	31.5%	24.5%	55.2%
10	35.1%	23.1%	52.3%
11	21.1%	13.0%	71.8%
12	53.1%	24.7%	33.5%
13	34.1%	9.0%	61.0%
14	73.1%	4.2%	24.6%
15	55.6%	19.1%	34.0%
16	44.6%	18.2%	45.4%
17	39.8%	29.8%	44.0%
18	50.2%	7.7%	45.6%
19	45.2%	10.0%	49.4%
20	57.3%	1.4%	42.0%
21	66.0%	1.4%	33.3%
22	86.7%	1.7%	12.4%
23	64.8%	0.4%	35.1%
24	44.7%	5.6%	52.2%
total	50.9%	9.4%	44.0%

Section 7: Cross-sectional analysis

Result fact sheet based on tonnes for the year 2006

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression
1	**0.77**	**0.73**	**0.0020**	**0.0033**
2	**0.75**	**0.71**	**0.0027**	**0.0044**
3	**0.83**	**0.71**	**0.0007**	**0.0043**
4	0.10	0.15	0.4060	0.3047
5	**0.50**	**0.85**	**0.0338**	**0.0004**
6	**0.86**	**0.81**	**0.0003**	**0.0009**
7	**0.76**	**0.77**	**0.0022**	**0.0020**
8	0.00	**0.49**	0.8906	**0.0356**
9	**0.81**	**0.81**	**0.0010**	**0.0009**
10	0.27	**0.79**	0.1497	**0.0014**
11	**0.60**	**0.93**	**0.0146**	**0.0000**
12	**0.51**	**0.71**	**0.0319**	**0.0046**
13	**0.94**	**0.95**	**0.0000**	**0.0000**
14	**0.57**	**0.92**	**0.0186**	**0.0000**
15	**0.60**	**0.87**	**0.0137**	**0.0002**
16	**0.86**	**0.80**	**0.0003**	**0.0012**
17	**0.97**	**0.96**	**0.0000**	**0.0000**
18	**0.89**	**0.86**	**0.0001**	**0.0003**
19	**0.59**	**0.75**	**0.0149**	**0.0024**
20	**0.85**	**0.91**	**0.0004**	**0.0001**
21	**0.94**	**0.90**	**0.0000**	**0.0001**
22	**0.83**	**0.82**	**0.0006**	**0.0007**
23	0.26	**0.72**	0.1628	**0.0037**
24	**0.64**	**0.89**	**0.0092**	**0.0001**

Significance level below 5%	Supply-based regression	Use-based regression
Amount of commodities explained significantly	20	23

Result fact sheet based on tonnes for the year 2005

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**
1	**0.70**	**0.75**	**0.0047**	**0.0027**
2	**0.74**	**0.73**	**0.0031**	**0.0034**
3	**0.84**	**0.73**	**0.0005**	**0.0032**
4	0.08	0.10	0.4593	0.4103
5	0.34	**0.75**	0.0998	**0.0026**
6	**0.88**	**0.83**	**0.0002**	**0.0007**
7	**0.78**	**0.73**	**0.0017**	**0.0034**
8	0.01	0.44	0.7834	0.0509
9	**0.60**	**0.65**	**0.0142**	**0.0088**
10	0.29	**0.80**	0.1310	**0.0011**
11	**0.50**	**0.93**	**0.0342**	**0.0000**
12	**0.54**	**0.71**	**0.0248**	**0.0045**
13	**0.94**	**0.92**	**0.0000**	**0.0000**
14	**0.63**	**0.91**	**0.0105**	**0.0001**
15	**0.63**	**0.87**	**0.0102**	**0.0002**
16	**0.86**	**0.83**	**0.0003**	**0.0006**
17	**0.97**	**0.96**	**0.0000**	**0.0000**
18	**0.89**	**0.87**	**0.0001**	**0.0003**
19	**0.62**	**0.72**	**0.0120**	**0.0036**
20	**0.86**	**0.92**	**0.0003**	**0.0001**
21	**0.93**	**0.91**	**0.0000**	**0.0001**
22	**0.81**	**0.75**	**0.0009**	**0.0026**
23	0.33	**0.76**	0.1064	**0.0023**
24	**0.66**	**0.94**	**0.0075**	**0.0000**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			19	22

Result fact sheet based on tonnes for the year 2004

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**
1	**0.79**	**0.75**	**0.0014**	**0.0024**
2	**0.75**	**0.71**	**0.0025**	**0.0041**
3	**0.85**	**0.68**	**0.0004**	**0.0064**
4	0.06	0.17	0.5261	0.2695
5	0.32	**0.74**	0.1104	**0.0029**
6	**0.88**	**0.84**	**0.0002**	**0.0005**
7	**0.81**	**0.74**	**0.0010**	**0.0029**
8	0.00	0.41	0.8643	0.0643
9	**0.54**	**0.82**	**0.0251**	**0.0007**
10	0.25	**0.82**	0.1682	**0.0007**
11	**0.64**	**0.90**	**0.0098**	**0.0001**
12	**0.69**	**0.74**	**0.0057**	**0.0028**
13	**0.95**	**0.95**	**0.0000**	**0.0000**
14	**0.66**	**0.92**	**0.0081**	**0.0001**
15	**0.54**	**0.89**	**0.0250**	**0.0001**
16	**0.84**	**0.80**	**0.0005**	**0.0011**
17	**0.97**	**0.96**	**0.0000**	**0.0000**
18	**0.90**	**0.87**	**0.0001**	**0.0002**
19	**0.56**	**0.78**	**0.0204**	**0.0016**
20	**0.84**	**0.90**	**0.0005**	**0.0001**
21	**0.93**	**0.91**	**0.0000**	**0.0001**
22	**0.90**	**0.79**	**0.0001**	**0.0014**
23	0.31	**0.77**	0.1200	**0.0020**
24	**0.59**	**0.86**	**0.0157**	**0.0003**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			19	22

Result fact sheet based on tonnes for the year 2003

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression
1	**0.77**	**0.75**	**0.0019**	**0.0027**
2	**0.70**	**0.72**	**0.0052**	**0.0038**
3	**0.85**	**0.73**	**0.0004**	**0.0035**
4	0.05	0.15	0.5757	0.3016
5	0.29	**0.75**	0.1342	**0.0024**
6	**0.90**	**0.85**	**0.0001**	**0.0004**
7	**0.87**	**0.79**	**0.0002**	**0.0014**
8	0.00	0.35	0.8913	0.0914
9	**0.50**	**0.65**	**0.0325**	**0.0087**
10	0.29	**0.89**	0.1360	**0.0002**
11	0.30	**0.78**	0.1268	**0.0016**
12	**0.77**	**0.92**	**0.0019**	**0.0000**
13	**0.96**	**0.95**	**0.0000**	**0.0000**
14	**0.73**	**0.90**	**0.0036**	**0.0001**
15	**0.56**	**0.87**	**0.0198**	**0.0003**
16	**0.89**	**0.83**	**0.0001**	**0.0006**
17	**0.94**	**0.93**	**0.0000**	**0.0000**
18	**0.92**	**0.90**	**0.0001**	**0.0001**
19	**0.53**	**0.78**	**0.0262**	**0.0015**
20	**0.88**	**0.93**	**0.0002**	**0.0000**
21	**0.90**	**0.90**	**0.0001**	**0.0001**
22	**0.87**	**0.79**	**0.0003**	**0.0015**
23	**0.24**	**0.81**	**0.1848**	**0.0009**
24	**0.55**	**0.82**	**0.0226**	**0.0008**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			19	22

Result fact sheet based on tonnes for the year 2002

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**
1	**0.86**	**0.82**	**0.0003**	**0.0008**
2	**0.82**	**0.76**	**0.0008**	**0.0020**
3	**0.91**	**0.76**	**0.0001**	**0.0022**
4	0.05	0.16	0.5814	0.2893
5	0.28	**0.71**	0.1389	**0.0044**
6	**0.90**	**0.86**	**0.0001**	**0.0003**
7	**0.88**	**0.73**	**0.0002**	**0.0034**
8	0.00	0.37	0.9487	0.0835
9	0.23	0.22	0.1967	0.1984
10	0.34	**0.85**	0.1007	**0.0004**
11	0.27	**0.66**	0.1534	**0.0077**
12	**0.84**	**0.86**	**0.0006**	**0.0003**
13	**0.96**	**0.95**	**0.0000**	**0.0000**
14	**0.74**	**0.86**	**0.0031**	**0.0003**
15	0.34	**0.86**	0.0986	**0.0003**
16	**0.85**	**0.79**	**0.0004**	**0.0014**
17	**0.97**	**0.97**	**0.0000**	**0.0000**
18	**0.92**	**0.91**	**0.0000**	**0.0001**
19	**0.60**	**0.79**	**0.0149**	**0.0013**
20	**0.89**	**0.94**	**0.0001**	**0.0000**
21	**0.72**	**0.74**	**0.0038**	**0.0029**
22	**0.79**	**0.74**	**0.0015**	**0.0031**
23	0.26	**0.79**	0.1562	**0.0013**
24	**0.51**	**0.75**	**0.0313**	**0.0025**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			16	21

Result fact sheet based on tonnes for the year 2001

NST/R	**Coefficient of determination R^2 value**		**Significance test p-value**	
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**
1	**0.83**	**0.84**	**0.0006**	**0.0005**
2	**0.78**	**0.81**	**0.0016**	**0.0010**
3	**0.88**	**0.74**	**0.0002**	**0.0028**
4	0.14	0.28	0.3262	0.1431
5	0.31	**0.72**	0.1214	**0.0040**
6	**0.88**	**0.83**	**0.0002**	**0.0006**
7	**0.80**	**0.67**	**0.0011**	**0.0070**
8	0.00	0.38	0.9950	0.0764
9	0.19	0.20	0.2447	0.2239
10	**0.61**	**0.85**	**0.0135**	**0.0004**
11	0.08	**0.66**	0.4608	**0.0077**
12	**0.71**	**0.82**	**0.0045**	**0.0007**
13	**0.97**	**0.96**	**0.0000**	**0.0000**
14	**0.89**	**0.94**	**0.0001**	**0.0000**
15	**0.49**	**0.84**	**0.0370**	**0.0005**
16	**0.82**	**0.75**	**0.0008**	**0.0027**
17	**0.96**	**0.96**	**0.0000**	**0.0000**
18	**0.92**	**0.91**	**0.0000**	**0.0001**
19	0.44	**0.80**	0.0524	**0.0012**
20	**0.91**	**0.94**	**0.0001**	**0.0000**
21	**0.70**	**0.72**	**0.0049**	**0.0039**
22	**0.77**	**0.72**	**0.0019**	**0.0037**
23	0.25	**0.79**	0.1737	**0.0014**
24	**0.58**	**0.79**	**0.0173**	**0.0013**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			17	21

Result fact sheet based on tonnes for the year 2000

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	Use-based regression	Supply-based regression	Use-based regression
1	**0.84**	**0.84**	**0.0005**	**0.0006**
2	**0.72**	**0.87**	**0.0036**	**0.0002**
3	**0.79**	**0.63**	**0.0013**	**0.0105**
4	0.12	0.23	0.3591	0.1934
5	0.29	**0.63**	0.1367	**0.0103**
6	**0.89**	**0.83**	**0.0002**	**0.0006**
7	**0.82**	**0.67**	**0.0008**	**0.0069**
8	0.07	**0.65**	0.4867	**0.0091**
9	0.27	0.11	0.1550	0.3813
10	**0.66**	**0.89**	**0.0076**	**0.0001**
11	0.13	**0.70**	0.3416	**0.0048**
12	**0.58**	**0.75**	**0.0169**	**0.0026**
13	**0.96**	**0.93**	**0.0000**	**0.0000**
14	**0.94**	**0.94**	**0.0000**	**0.0000**
15	**0.69**	**0.87**	**0.0058**	**0.0002**
16	**0.83**	**0.77**	**0.0007**	**0.0018**
17	**0.95**	**0.96**	**0.0000**	**0.0000**
18	**0.94**	**0.93**	**0.0000**	**0.0000**
19	**0.62**	**0.87**	**0.0118**	**0.0002**
20	**0.94**	**0.96**	**0.0000**	**0.0000**
21	**0.73**	**0.74**	**0.0033**	**0.0031**
22	**0.79**	**0.75**	**0.0013**	**0.0025**
23	0.28	**0.79**	0.1388	**0.0013**
24	**0.58**	**0.76**	**0.0172**	**0.0023**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			18	22

Result fact sheet based on tonnes for the year 1999

NST/R	Coefficient of determination R^2 value		Significance test p-value	
	Supply-based regression	**Use-based regression**	**Supply-based regression**	**Use-based regression**
1	**0.80**	**0.94**	**0.0010**	**0.0000**
2	**0.63**	**0.72**	**0.0103**	**0.0036**
3	**0.80**	**0.76**	**0.0012**	**0.0023**
4	0.06	0.20	0.5410	0.2329
5	0.43	**0.76**	0.0549	**0.0023**
6	**0.86**	**0.81**	**0.0003**	**0.0009**
7	**0.90**	**0.82**	**0.0001**	**0.0008**
8	0.33	**0.63**	0.1090	**0.0107**
9	0.30	**0.49**	0.1278	**0.0362**
10	**0.46**	**0.89**	**0.0456**	**0.0001**
11	**0.72**	**0.65**	**0.0038**	**0.0087**
12	**0.93**	**0.58**	**0.0000**	**0.0174**
13	**0.99**	**0.96**	**0.0000**	**0.0000**
14	**0.99**	**0.94**	**0.0000**	**0.0000**
15	**0.91**	**0.90**	**0.0001**	**0.0001**
16	**0.58**	**0.48**	**0.0173**	**0.0376**
17	**0.94**	**0.95**	**0.0000**	**0.0000**
18	**0.96**	**0.97**	**0.0000**	**0.0000**
19	**0.55**	**0.92**	**0.0224**	**0.0000**
20	**0.96**	**0.94**	**0.0000**	**0.0000**
21	**0.79**	**0.78**	**0.0014**	**0.0017**
22	**0.88**	**0.76**	**0.0002**	**0.0021**
23	0.30	**0.80**	0.1298	**0.0011**
24	**0.62**	**0.71**	**0.0122**	**0.0045**
Significance level below 5%			Supply-based regression	Use-based regression
Amount of commodities explained significantly			19	23

Result matrix for the supply-based cross-sectional regression analysis based on tonnes

NST/R	2007	2006	2005	2004	2003	2002	2001	2000	1999
1	0,53	0,77	0,70	0,79	0,77	**0,86**	**0,83**	**0,84**	**0,80**
2	0,42	0,75	0,74	0,75	0,70	**0,82**	0,78	0,72	0,63
3	0,61	**0,83**	**0,84**	**0,85**	**0,85**	**0,91**	**0,88**	0,79	**0,80**
4	0,08	0,10	0,08	0,06	0,05	0,05	0,14	0,12	0,06
5	0,28	0,50	0,34	0,32	0,29	0,28	0,31	0,29	0,43
6	0,60	**0,86**	**0,88**	**0,88**	**0,90**	**0,90**	**0,88**	**0,89**	**0,86**
7	0,70	0,76	0,78	**0,81**	**0,87**	**0,88**	**0,80**	**0,82**	**0,90**
8	0,01	0,00	0,01	0,00	0,00	0,00	0,00	0,07	0,33
9	0,58	**0,81**	0,60	0,54	0,50	0,23	0,19	0,27	0,30
10	0,18	0,27	0,29	0,25	0,29	0,34	0,61	0,66	0,46
11	0,42	0,60	0,50	0,64	0,30	0,27	0,08	0,13	0,72
12	0,47	0,51	0,54	0,69	0,77	**0,84**	0,71	0,58	**0,93**
13	0,77	**0,94**	**0,94**	**0,95**	**0,96**	**0,96**	**0,97**	**0,96**	**0,99**
14	0,61	0,57	0,63	0,66	0,73	0,74	**0,89**	**0,94**	**0,99**
15	0,40	0,60	0,63	0,54	0,56	0,34	0,49	0,69	**0,91**
16	**0,83**	**0,86**	**0,86**	**0,84**	**0,89**	**0,85**	**0,82**	**0,83**	0,58
17	**0,99**	**0,97**	**0,97**	**0,97**	**0,94**	**0,97**	**0,96**	**0,95**	**0,94**
18	**0,91**	**0,89**	**0,89**	**0,90**	**0,92**	**0,92**	**0,92**	**0,94**	**0,96**
19	0,51	0,59	0,62	0,56	0,53	0,60	0,44	0,62	0,55
20	0,76	**0,85**	**0,86**	**0,84**	**0,88**	**0,89**	**0,91**	**0,94**	**0,96**
21	**0,92**	**0,94**	**0,93**	**0,93**	**0,90**	0,72	0,70	0,73	0,79
22	**0,87**	**0,83**	**0,81**	**0,90**	**0,87**	0,79	0,77	0,79	**0,88**
23	0,19	0,26	0,33	0,31	0,24	0,26	0,25	0,28	0,30
24	0,56	0,64	0,66	0,59	0,55	0,51	0,58	0,58	0,62

Legend

Bold marked values represent R^2 values greater than 0.80.

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Result matrix for the use-based cross-sectional regression analysis based on tonnes

NST/R	2007	2006	2005	2004	2003	2002	2001	2000	1999
1	0,58	0,73	0,75	0,75	0,75	**0,82**	**0,84**	**0,84**	**0,94**
2	0,48	0,71	0,73	0,71	0,72	0,76	**0,81**	**0,87**	0,72
3	0,67	0,71	0,73	0,68	0,73	0,76	0,74	0,63	0,76
4	0,14	0,15	0,10	0,17	0,15	0,16	0,28	0,23	0,20
5	0,67	**0,85**	0,75	0,74	0,75	0,71	0,72	0,63	0,76
6	**0,80**	**0,81**	**0,83**	**0,84**	**0,85**	**0,86**	**0,83**	**0,83**	**0,81**
7	0,72	0,77	0,73	0,74	0,79	0,73	0,67	0,67	**0,82**
8	0,40	0,49	0,44	0,41	0,35	0,37	0,38	0,65	0,63
9	**0,96**	**0,81**	0,65	**0,82**	0,65	0,22	0,20	0,11	0,49
10	0,67	0,79	**0,80**	**0,82**	**0,89**	**0,85**	**0,85**	**0,89**	**0,89**
11	**0,84**	**0,93**	**0,93**	**0,90**	0,78	0,66	0,66	0,70	0,65
12	0,64	0,71	0,71	0,74	**0,92**	**0,86**	**0,82**	**0,75**	0,58
13	**0,96**	**0,95**	**0,92**	**0,95**	**0,95**	**0,95**	**0,96**	**0,93**	**0,96**
14	**0,92**	**0,92**	**0,91**	**0,92**	**0,90**	**0,86**	**0,94**	**0,94**	**0,94**
15	**0,85**	**0,87**	**0,87**	**0,89**	**0,87**	**0,86**	**0,84**	**0,87**	**0,90**
16	0,74	**0,80**	**0,83**	**0,80**	**0,83**	0,79	0,75	0,77	0,48
17	**0,97**	**0,96**	**0,96**	**0,96**	**0,93**	**0,97**	**0,96**	**0,96**	**0,95**
18	**0,89**	**0,86**	**0,87**	**0,87**	**0,90**	**0,91**	**0,91**	**0,93**	**0,97**
19	0,65	0,75	0,72	0,78	0,78	0,79	**0,80**	**0,87**	**0,92**
20	**0,86**	**0,91**	**0,92**	**0,90**	**0,93**	**0,94**	**0,94**	**0,96**	**0,94**
21	**0,91**	**0,90**	**0,91**	**0,91**	**0,90**	0,74	0,72	0,74	0,78
22	**0,92**	**0,82**	0,75	0,79	0,79	0,74	0,72	0,75	0,76
23	0,69	0,72	0,76	0,77	**0,81**	0,79	0,79	0,79	**0,80**
24	**0,93**	**0,89**	**0,94**	**0,86**	**0,82**	0,75	0,79	0,76	0,71

Legend

Bold marked values represent R^2 values greater than 0.80.

Light highlighted values are significant on at least 10%.

Dark highlighted values are significant on at least 5%.

Eidesstattliche Erklärung

Die selbständige und eigenhändige Anfertigung
versichere ich, Daniel Windmüller, an Eides statt.

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Datum / Unterschrift

Statutory Declaration

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