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Modal Split in European Freight Transport

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Abstract: Modal split in freight transport has become a major issue in the last decade. Whereas transports account for an increasing part of energy consumed in Europe, the growth of freight carried in the European Union has been more important than its economic growth. Hence, considering that modes of transport display different costs for the society, it is essential not only to understand what repercussions the use of modes generate, but also what factors determine their respective shares of modal split. Here, national dissimilarities in 30 European countries are analysed to inquire inland modal split. The results are then compared with policies in the European Union and Germany to adapt this modal split to its specific issues.

Key words: Modal split, freight, European transports

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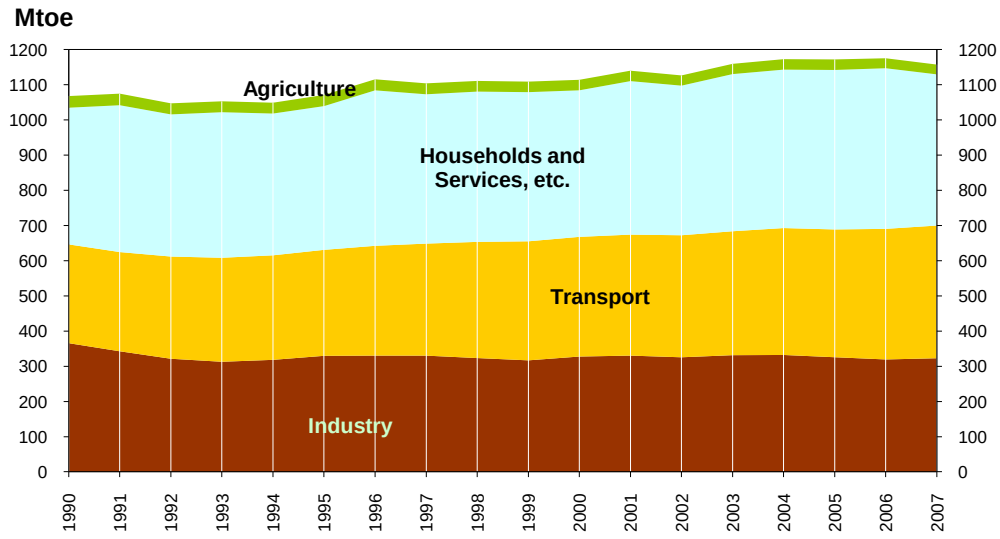
Introduction and methods

Sign of the European market integration as well as globalization, an increasing amount of goods and materials are carried every year across Europe by road, rail, ship or airplane. In fact, between 1995 and 2007 the average yearly growth rate of freight transport in tonne-kilometre has been of 2.7% in the EU27 (27 member countries European Union) whereas the GDP grew at a slightly lower pace of 2.5%. Since a comparable phenomenon occurred for passenger transport, the share of energy consumed by transportation in total energy used in Europe has been gradually rising as can be seen in graph 1. Whereas transports represented 24% of energy used in the EU in 1991, it consumed 29% of the total energy in 2006[1]. Considering that transportation is still almost entirely dependent on oil products – 96.7% in the EU in 2006[2] – and that these products are almost entirely imported, the energy intensity of this sector is a key issue which has a great impact both on the environment and the European energy dependency.

Chart 1: Final energy consumption - EU27 by sector (Mtoe)



Source: Eurostat 2009

[1] Eurostat, *Panorama of Energy*, Statistical books, European Commission, 2009
[2] Eurostat, *Panorama of Transport*, Statistical books, European Commission, 2009

Although the two components of the transportation sector both raise important energy issues, we will focus here on goods transport for several reasons. Firstly, passenger and freight transport have different characteristics and trends and it would be problematic to handle both of them at the same time. Secondly, goods transport is realised by firms whereas passenger transports are very heterogenic since they are an aggregate not only of different means of transports but also of very different forms of activity. From privately own cars to public transports, passenger transport seems to be a too disparate category to be judiciously mixed up with goods transport in this case.

Choosing to focus on Europe doesn't offer unambiguous geographical limits since Europe doesn't appear to be a clear economical or political entity. Whereas the European Union has continuously extended since the birth of the common market in 1957, other European countries which are well integrated in the European economy are not part of the main political institutions so far. A large part of our analysis will be focused on the EU since it is a wide political entity where important decisions are taken concerning transports and energy, but a large part of the EU27 countries were not members of the union during most of the period studied. This is the case for the ten entrants of 2004 and the two last countries to join in 2007 – Romania and Bulgaria. However, we will also largely include European countries which haven't joined the EU so far since they are also a non-negligible part of Europe and can give us a larger perspective of national dissimilarities in terms of freight transport. Thus, data for European countries such as Iceland, Norway and Turkey will be treated as well. Unfortunately, Switzerland's modal characteristics will not be mentioned for data reasons. This work aims at understanding the forces behind freight modal split in the light of its negative implications for the society such as carbon and energy intensity of the sector. Since ten of these countries witnessed an economic transition from planned to market economy in the

1990s[3], it would be a too ambitious task to conduct an analysis on European countries over a period larger than fifteen years.

Energy efficiency of modes are rightfully considered as a main determinant of the aggregated energy intensity of transports, nevertheless we are going to see in the first part of this work that modal split also has a strong impact on the energy intensity of the sector. Modal split is the proportion of different transport means which are used in an area during a certain period of time, it is usually measured in tonne-kilometres. The evolution of modal shares is closely examined by numbers of institutions. In particular the European Commission and to a lower extent the European Environmental Agency publish reports on the question since it is of major importance for transport and environment policies. Using data from Eurostat on modal split of inland freight transport in thirty European countries, we are going to analyse the national dissimilarities in order to find out factors behind them. In particular European countries have different histories and geographical situations which reflect on their transport infrastructures, we are going to identify potential factors and try to determine if they are correlated to the differences observed in relative performances of inland waterways, roads and railways. To do so, we will try as much as possible to use linear regressions calculated on Microsoft Excel to tests our hypothesis.

Geographical characteristics of countries will be the first factors treated, in particular physical connections to the rest of the continent and population density will be inquired. Eastern European countries which joined the EU in the last decades have witnessed a transition from planned economy to market economy, so it seems relevant to put countries' political backgrounds to a test as well. Since there are significant differences across Europe in terms of income level, we will also attempt to find a correlation between GDP per capita and modal split. We will try as much as possible to clarify the reasons for these correlations or absence of correlations between

[3] We could have added East Germany which was not a properly speaking a country anymore but which also was on economic transition.

modal splits and potential factors. Finally, it is necessary to compare our findings before concluding what factors we can consider as playing a role and to what extent they determined modal split.

In the last part of this work, we will review attempts by European policy makers to influence inland modal split. These policies will be presented by using official documents published by authorities. The aim is to evaluate their impact but simply to compare our findings with what is undertaken by governmental organisations. We will start with the largest European political level since we will review EU transport policies aiming at improving freight flows and diminishing their external costs for the society. Transportation has become an important part of the European common policy; for example to develop infrastructures the EU has launched in Essen in 1994 the so-called Trans-European Transport Network which aims at removing bottlenecks of the European network.

Nevertheless transport policy doesn't only take place at the EU level, not only are three of the thirty countries analysed not part of the Union but even for members a large part of the decisions concerning transports are taken at the national level. A complete review of all national policies would be a too ambitious task; so in order to highlight the national transport policies Germany will be used as an example since it is not only the biggest European Country in terms of population and industry but also a land in the middle of Europe where a massive quantity of freight is carried through. In particular, some particular policies will be explored, For example, in order to reduce the environmental impact of heavy-duty vehicles on its territory, the German government introduced recently a new Toll Collect system for heavy duty vehicles, this seems to be an interesting initiative which can have an impact on modal shares and as such requires some attention.

1. Stakes of freight modal split

Freight transport increased clearly in terms of performance in the EU over the last decades, this growth has not been proportional for all modes of transport. Hence, as we are going to see, some modes increased their shares to the detriment of others. This is not without consequences in terms of energy intensity and CO2 emissions. All means of transports having different energy and carbon intensities, this mechanism impact the total energy and carbon intensity of freight transport. Hence, in the case of energy consumption, we can consider energy intensity of freight to be a weighted average of energy intensities of modes, that is to say that both the weight given to modes and their respective energy intensities play a role in the determination of overall energy intensity of the sector.

By studying modal split, we can compare the situation of different countries in terms of energy consumption. Remarkably, in a 1996 study named *Energy trends in the Japanese transportation sector*, Nancy Kiang and Lee Schipper highlight the reasons for the particularly low energy intensity of Nippon passengers transports compared with the United States. They find out that the energy intensities of means of transport in Japan cannot explain this gap and, according to this study, it is the structure of transport modes which is responsible for the Japanese low energy intensity. Using data from the Japanese Ministry of Transports they establish that the high share of rail for passenger transportation determine the low total energy intensity for passenger transports. On the other hand road transports being much more common for freight transportation the energy intensity of goods transport doesn't display a comparable gap with the US freight transport as is it the case for passenger transports. They recall in their introduction that three elements determine the energy consumption of transports:

(1) ' *Activity – volume of transportation measured in passenger-kilometers (pkm) and tonne-kilometers (tkm);*

(2) Structure – modal shares in total activity;

(3) Intensity – energy use per loaded transport activity volume'.[4]

Note that *tonne-kilometre* is usually used to study the relation between energy and transport performance, since it is in fact a relevant indicator when it comes to energy consumption. Still, this unit only represent a part of the transportation service and we will see that it might hide some other aspects relevant to compare modal performances.

As we have seen there are two distinct mechanisms which have an impact on the energy intensity of freight transport. Nevertheless, before we try to determine what the explanations for the variations in modal shares are, we need to be able to compare the costs of these modes in terms of energy and CO2 emissions.

1.1. Modal differences in energy and carbon intensities

As we have seen the various means of transport which can be used to carry goods all have their characteristics in terms of energy and carbon intensity. These differences, together with their respective market shares, determine the carbon and energy intensity of the entire sector, impacting it with two distinct mechanisms: *structural* and *technological*.

Firstly, variations of energy intensity in any transport modes impact the overall energy intensity since the technical effect varies with technology and organisation of transports. For example if a new technology reduces the energy input required for trucks to carry their load, then the energy intensity of road transport might diminish reducing at the same time the overall energy intensity in proportions depending on the share of road transport in freight transport. Secondly, variations in the repartition of modes also change the energy intensity of freight transport. Air transport is particularly energy intensive but it only represents a small share of freight transport

[4] Kiang Nancy and Schipper Lee, 1996, 'Energy trends in the Japanese transportation sector', *Elsevier Science Ltd*, Transport Policy, Vol. 3, No. l/2, p. 22

performances, if it happens to increase its share then the energy intensity of freight transport would increase all things being equal.

In order to adapt the definition given to energy intensity for a cross-sectors analysis to a more appropriate one for modes of transport within one sector, we could paraphrase Ang and Zhang (2000) and adopt the following definition: "[Modal] *energy intensity ... is the amount of energy consumption that is required to yield a given level of output at the* [modal] *level."*[5] To measure how energy intensity has been influenced by technology and structural change in transportation, a decomposition of these underlying trends over the last decades would be of great help.

Modes of transport have different energy intensity, although it is commonly admitted that rail and water transport are the least energy intensive modes whereas road and – to a bigger extent – air transport are the most energy intensive modes, it is delicate to compare between modes since energy intensity varies grandly with factors such as load, technology and infrastructures. Still, estimations of energy and carbon intensity can be found for different geographic area. Here we can compare modes using the outcome of two studies on the modal impact of freight transport. The first one comes from Giannouli et al. (2005) and provides us with estimations of carbon intensities of freight per tonne-kilometre in the EU15 (table 1). As we can see rail, sea and inland waterways (IWW) clearly emit less carbon dioxide than road per tonne-kilometre. Road transport is divided in two categories and show the carbon intensity of heavy duty vehicles compared with light duty vehicles, the second category regrouping small trucks being much more polluting than the other one.

[5] Ang B.W. and Zhang F.Q., 2000, 'A survey of index decomposition analysis in energy and environmental studies', Energy, 25(12), p. 1150

Table 1: Estimated CO_2 emissions of freight per tonne-km in the EU15 from 1990 to 2004

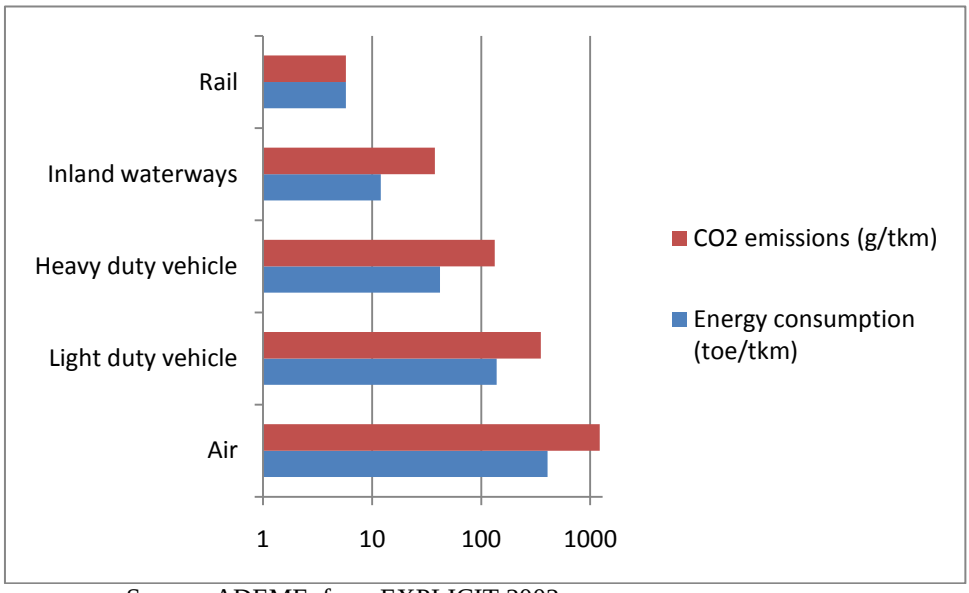
Freight transport	IWW	Maritime	Rail	Road	Heavy Duty Vehicles	Light Duty Vehicles
1990	30.9	13.5	24.0	120.0	90.6	406.8
1991	30.9	13.5	22.6	120.0	90.6	406.8
1992	30.9	13.7	22.6	120.0	90.6	406.9
1993	30.9	13.7	23.2	120.0	90.6	406.2
1994	30.9	13.7	23.1	120.0	90.6	407.0
1995	30.9	13.7	23.0	120.0	90.6	406.7
1996	30.9	13.8	22.7	120.0	90.6	406.5
1997	30.9	13.8	22.7	119.9	90.6	406.2
1998	30.9	13.8	22.6	119.9	90.6	405.9
1999	30.9	13.8	22.9	119.9	90.6	405.6
2000	30.9	13.9	22.8	119.9	90.6	405.4
2001	30.9	13.8	22.9	119.8	90.7	405.1
2002	30.9	13.9	22.8	119.8	90.7	404.8
2003	30.9	13.9	22.8	119.8	90.7	404.5
2004	30.9	13.9	22.7	119.7	90.7	404.1

Source: TRENDS (Giannouli et al., 2005) [6]

Because transportation is almost entirely dependent on oil products – 96.7% in the EU in 2006 – modal energy intensities ranking is similar to carbon intensities. Another study gives us estimations of both CO2 emissions (gram/tonne-kilometre) and energy consumption (tonne-oil-equivalent/tonne-kilometre) of freight for rail, inland waterways, road and air transport in the case of France (table xx). Note that the presence of air transport requires the use of a logarithmic scale. As we can see carbon and energy intensities seem almost proportional as expected. Rail and inland navigation are much less energy consuming than air and road. Here again, heavy duty vehicles are less polluting than light duty vehicles.

[6] From EEA32 – Overall energy efficiency and specific CO2 emissions for passenger and freight transport
The classification in *least* and *most energy intensive* at the top of the table has been added by the author of this work to clarify the lecture of the table.

Chart 2: Energy consumption and CO2 emissions of goods transport in France in 2002 by mode, logarithmic scale



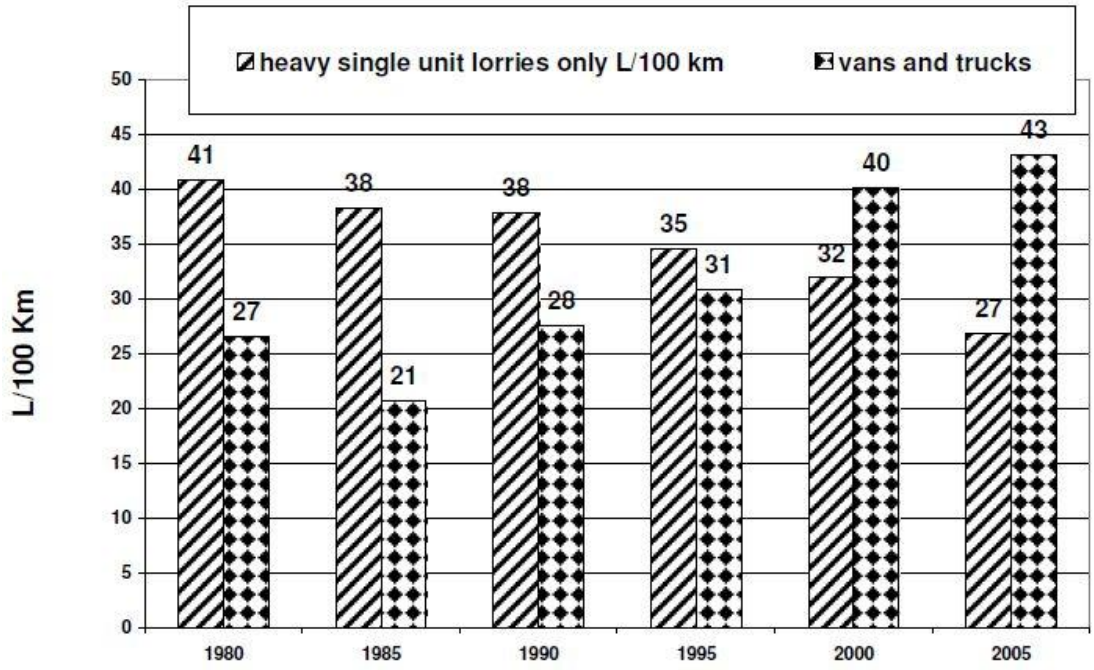
Source: ADEME, from EXPLICIT 2002

Although this only represents the French situation, it seems fair to allow ourselves to generalise this ranking to the rest of Europe since it displays comparable results to the study for the EU15. European countries have similar situations in terms of technologies and the inherent characteristics of these modes of transport tend to let their carbon and energy intensities evolve parallel to one another. Still, several factors determine changes in modal efficiency the most obvious one being technology.

Even though we can broadly compare modes, it would be delicate to maintain exactly how much energy intensive they comparatively are. These categories include many different technical realities. Not only can the technology vary, but the energy intensity with a given technology also depends on other technical factors, e.g. load. A very energy efficient truck can happen to be more energy intensive than a less energy efficient one if it is only half loaded.

As we have said, the energy intensity of each mode varies with time. We might expect the fuel efficiency of means of transport to improve over time; nevertheless, it is not always the case. The following chart displays energy efficiency of different vehicles of road freight transport in Denmark, it comes from an article in progress made by Bonilla and Salling and available on the internet (see link below). We see that whereas heavy single unit lorries saw their energy efficiency improving gradually in Denmark over the period, it became worst in the case of vans and trucks between 1985 and 2005. Nevertheless, we should be careful before drawing any conclusions as we have here energy intensity in terms of litre per 100 kilometres and we don't know about the capacity of these vans and trucks. For example if they had become bigger, then their energy intensity would have increased for a certain distance but probably not when comparing to their load.

Chart 3: Average truck fuel economy L/100 km in Denmark from 1980 to 2005



Source: D. Bonilla and K. Salling from Statistics Denmark[7]

[7] Bonilla and Salling, *Energy Consumption And Truck Freight Transport Demand: Is Denmark a special case?*, work in progress available online (Mai 2010) http://www.tsu.ox.ac.uk/events/nectar/bonilla_salling_paper.pdf

Despite the fact that carbon dioxide emissions are the most famous kind of pollution for its impact on the climate, it is not the only negative impact of transport. Many of these impacts (noise, congestion, pollution…) are not integrated in the finale price of transport; hence they are a cost to the society but not to the final transport consumer and are therefore called external costs. According to K. S. Eriksen (1999), Senior Research Economist Institute of Transport Economics of Oslo, Norway, "Transport activities are known to have substantial negative external effects. One of the reasons for trying to value these effects is that the cost to society of using a specific transport mode should be reflected in the price that is paid by the transport user and thus form the basis for a transport tax policy."[8] Theoretically, making the most polluting modes of transport more expansive should help developing a more environmental freight sector, as it is put by Jourquin et al. (1999) "One way to partly shift transport demand on trains and barges is to introduce a pricing/taxation policy which takes into account these external costs for the different modes." Even though internalisation of costs might play in favour of some of the less polluting modes, its impact of modal split might be limited by the features of transport means. They have inherent characteristics others than their energy intensities and these partly determine modal split. In particular they have different costs characteristics and different degrees of flexibility which make them imperfect substitutes to one another. For example, pipelines can only be used for liquids and gas and they are fixed infrastructures, so they have a very limited substitutability with other modes.

1.2. Trends in the European Union's freight modal split between 1990 and 2005

We have seen so far that transportation uses an increasing amount of energy both in absolute and relative terms and that the energy used by transports

[8] Eriksen, K. S., Calculating External Costs of Transportation in Norway, Principles and Results, NECTAR Conference in Delft, October 1999

varies with two mechanisms: technical – which impact modal energy intensity – and structural, that is to say changes in modal split. We are now going to see what trends are to be observed in the freight modal split of the EU since the early 1990s before we start analysing national differences in inland modal split.

Table 2 is from Panorama of Transport, a statistical book edited by Eurostat. It displays the performance of goods transport by mode between 1995 and 2006 in the EU27. We observe that all modes of transport saw their performance increased at the end of the period, but they did not increase in the same proportions. Hence, some modes of transport – air and road – have increased their share to the detriment of others. If it wasn't for its high average annual growth rate (AAGR) of 3.8% over the period, air transport wouldn't call our attention considering that it only represents a very small share of the total performance over the period – 0.07% in 1995 and 0.072% in 2006.

Table 2: Goods transport performance, by mode, EU-27, 1995 to 2006 (billion tkm)[9]

Mode	Road	Air	Rail	Oil Pipelines	Inland Waterways	Sea	Total
Modal Share 2006	45.57%	0.072%	10.50%	3.26%	3.33%	37.29%	100%
2006	1 888	3.0	435	135	138	1 545	4 143
2005	1 800	2.9	413	136	138	1 530	4 020
2004	1 747	2.8	413	131	136	1 488	3 918
2003	1 625	2.6	391	130	123	1 445	3 717
2000	1 519	2.7	401	126	133	1 348	3 529
1995	1 289	2.0	386	115	121	1 150	3 062
Modal Share	42.10%	0.07%	12.61%	3.76%	3.95%	37.56%	100%
AAGR 1995 to 2006	3.53%	3.75%	1.09%	1.47%	1.20%	2.72%	2.79%

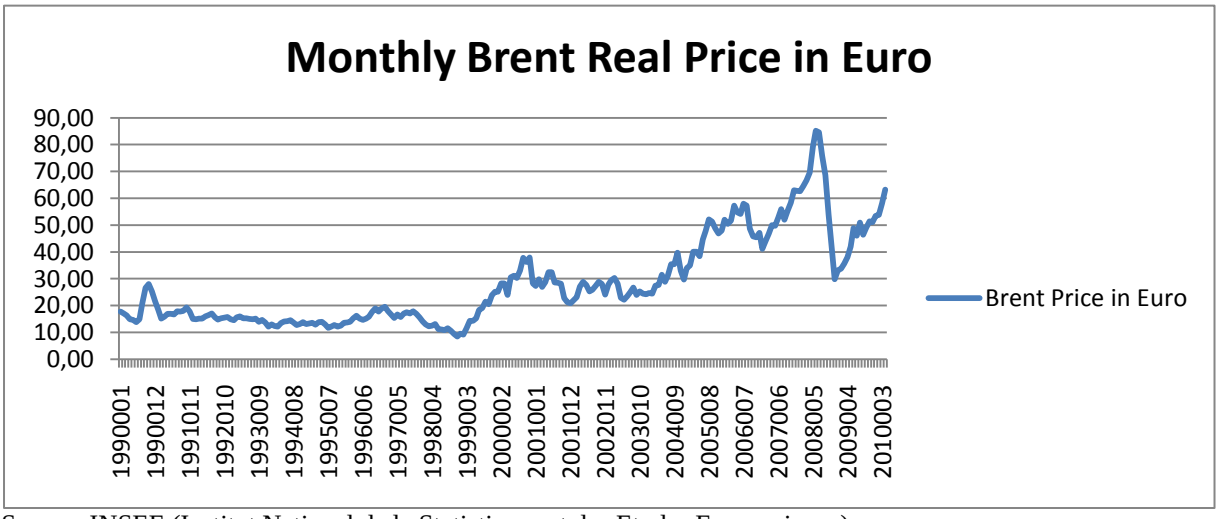
Road: national and international haulage by vehicles registered in the EU-27
Air & Sea: only domestic and intra-EU27 transport; provisional estimates
Source: DG Energy and Transport

[9] Eurostat, *Panorama of Transport*, Statistical books, European Commission, 2009, p. 57
The modal shares were recalculated by the author for 2006 in order to display figures with two decimals and no 0% figure for air transport as it is in the original document. The modal shares for 1995 were also calculated for the sake of comparison with those for 2006.

First mean of transport in terms of modal share, road transport benefit from the second highest increase with an AAGR of 3.5%. Thus, its already high modal share increased from 42.1% to 45.57%. Rail, oil pipelines and inland waterways lost importance in relative terms with AAGR of respectively 1.1%, 1.5% and 1.2% largely under the 2.8% AAGR of total performance of goods transport. Finally, sea transport is the closest to the average growth rate and only saw its share slightly declining.

We could expect energy prices to be a main determinant of modal shares since we have seen that energy intensity can vary grandly across modes. Hence, a consequent rise of energy prices might encourage companies to go for the relatively less energy consuming means of transport which – all other things held constant – would become comparatively cheaper. Nevertheless, it appears that air and road, the most energy intensive modes of transport, have increased their market shares in the last years whereas oil prices have increased regularly till the 2008 financial crisis (see graph below). It seems then that other factors might have a greater influence on modal share than energy prices since their negative expect energy prices to have a negative impact on the most energy intensive modes if any.

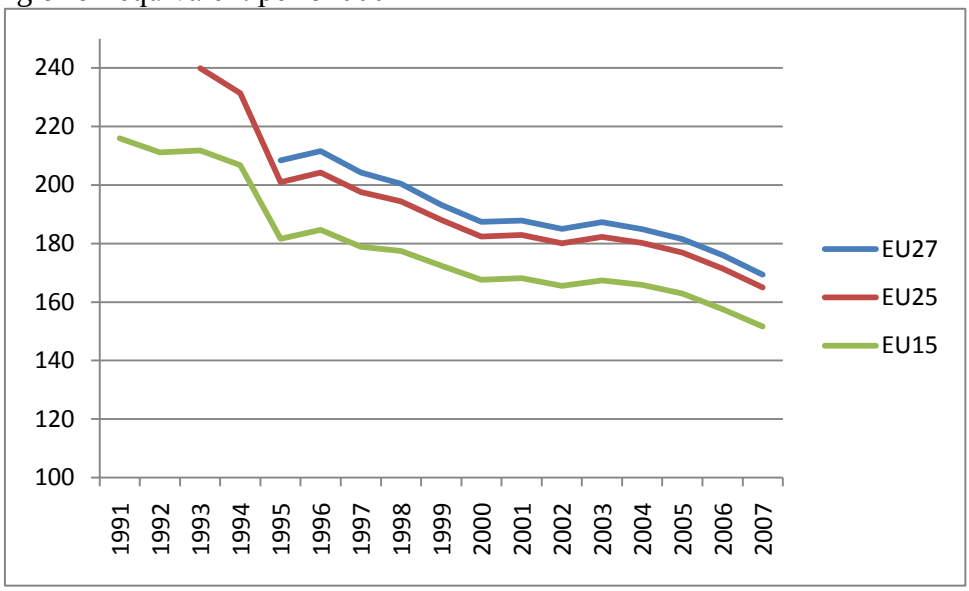
Chart 4: Monthly Brent real price in Euro from January 1990 to March 2010



Source: INSEE (Institut National de la Statistiques et des Etudes Economiques)

In the graph bellow we see that the energy intensity of the EU economy decreased grandly during the same period, so we might wonder why the energy prices have had such an impact on the economy but not in the freight sector. Note that the energy intensity of the economy was calculated on Kg of TOE per €1000 of value added, whereas our performances in transportation are presented in tonne-kilometre. This makes in fact a big difference since tonne-kilometre only take a part of the transport service into account. Transport activities are not only about moving a certain weight on a certain distance, many other elements compose value added of the sector.

Chart 5: Energy intensity in the European Union between 1991 and 2007 in Kg of oil equivalent per €1000



Source: Eurostat

Although tonne-kilometre is a widely used unit to measure freight transport quantity, it has some clear limitations which we must be aware of. For instance speed is not taken into account. If time were to be measured, it should be taken into account in a negative way, that is to say that the faster the transportation the higher the performance and the slower the journey the smaller performance a mode would produce since speed is a valuable

criterion. Flexibility is another element, a 2009 study from the Australian Bureau of Infrastructure, Transport and Regional Economics points out that "road can provide a single-mode door-to-door service, whereas conveying non-bulk goods by rail typically involves transhipment between road and rail, adding to total freight costs and transit times."[10] This holds for Europe as well.

Hence, it seems reasonable to asses that the performance of road, and to a larger extent air transport, might be more important than it appears with tonne-kilometre data. On the other hand, inland water transport, rail and sea transport, being slower, might see their performance share reduced. Having still the same amount of energy used, the energy intensity of what first seemed to be very energy intensive modes might be reduced if speed was taken into account in the performance ratio. The same effect would thus increase energy intensity of what is considered the least energy intensive modes such as rail.

A European Commission staff working document stresses that "the transport industry is not a homogenous economic sector but composed of modal industries that are in different economic situation".[11] Hence, it would be interesting to compare tonne-kilometre modal performances with the economic value produced by mode since we could expect price to reflect the value of all aspects of a transport service. Unfortunately, we didn't find any statistics decomposing the freight transport sector by mode. Nevertheless, we can still try to have an idea of the differences in services across modes. Notably, data are available on the value of goods carried through the EU borders since they are recorded by European customs. In table 3 below, the total value and total weight of goods exported and imported in the EU in 2007 are displayed, a third column gives us the value of one tonne hauled.

[10] Australian Government, Department of Infrastructure, Tranport, Regional Development and Local Government, Bureau of Infrastructure, Transport and Regional Economics, *Road and rail freight: competitors or complements?*, Information sheet 34, 2009, p. 7
[11] European Commission, Commission Staff Working Paper, *Impact Assessment of the Communication "Keep Europe Moving" Sustainable mobility for our continent. Mid-term review of the European Commission's 2001 Transport White Paper*, 2006, p. 23

In 2007 export by inland waterway had a total value of €4.9 billion for a total weight of 8.8 million tonnes, the same year air exports amounted to €321.1 billion for a weight of 11.5 billion tonnes. This gives us averages of €27 921.7 per tonne carried by air and €556.8 per tonne hauled on inland waterways. In this case goods exported by air were 50 times more expansive than those carried by inland navigation. Taking these two extremes of the modal spectrum gives us a gap in term of value carried and this is even more apparent for importations as the same calculations gives us an average value of one tonne carried by air 273 times greater than for inland navigation. This is not surprising considering the particularities of these modes. Firstly, air transport is particularly costly for heavy objects in terms of energy so air transportation tends to be used for rather light goods. Secondly, the time lost transporting goods as a financial cost in itself for firms and the more valuable a good is, the more costly it is for them to wait till the good is delivered. These two effects explain why air transport – being the fastest mode – is better suited for expansive light goods whereas inland waterways is more adapted to heavy material requiring little attention. As the EU working document concludes, "the transport of light and high-value freight over longer distances will remain the predominant natural market segments for air transport also in the longer run."[12]

[12] Ibid.

Table 3: EU external trade by mode of transport in 2007 presented value and weight

	Exports			Imports		
	Value in billion €	Weight in million tonnes	Value (€) / Weight (tonne)	Value in billion €	Weight in million tonnes	Value (€) / Weight (tonne)
Sea	560.2	373.0	**1 501.9**	736.9	1275.1	**577.9**
Road	281.2	83.8	**3 355.6**	181.8	60.1	**3 025.0**
Rail	21.6	23.7	**911.4**	18.4	78.1	**235.6**
IWW	4.9	8.8	**556.8**	4.0	17.0	**235.3**
Pipeline	3.5	3.8	**921.1**	87.4	269.2	**324.7**
Air	321.1	11.5	**27 921.7**	262.9	4.1	**64 122.0**
Other or unknown	49.1	7.6	6 460.5	142.5	96.8	1 472.1
Total	1 241.4	512.3	2 423.2	1 433.8	1 800.4	796.4

Source: European Commission[13]

Concerning other modes, we should mention that the average tonne of merchandise to have crossed the border by road is more valuable than for rail – 3.7 times for exports and 12.8 times for imports. Although this enlighten us about modal characteristics and has some potential for generalisation to intra-European transportation, we should still be aware that those figures hold for EU external trade. We observe some clear value differences between imports and exports so we should expect intra-EU freight to have at least comparable amplitudes in variations of tonne value

[13] European Commission, *EU energy and transport in figures*, Statistical Pocketbook 2009, p. 104
In the original document value and weight are displayed in two distinct tables, for the sake of comparison they are presented together here, value/weight was calculated by the author.

per mode. Still, if we were to rank modes from the one carrying the most valuable goods to the least expensive merchandise, the same classification would appear for imports and exports: first air, then road, sea, pipelines, rail and finally inland navigation. The American Bureau of Transport Statistics shed light on respective advantages of modes and confirms our interpretation. On the one hand the US BTS stresses that "as the value per ton of a shipment rises, the cost of having a valuable cargo tied up in transit increases, so shippers are likely to shift more of their shipments to faster, more expensive modes like truck and air", but on the other hand "as the length of haul (miles per ton travelled) increases, causing the line-haul transportation cost to become a larger portion of the total, shippers are more likely to shift to lower cost modes like rail and water"[14]

Although modes of transports are complementary and thus have to some extent their respective markets – such as transport of light valuable goods for air – they are also in some occasions substitutable to one another, which means that they are "often competing with each other"[15] and that there is some potential to shift freight from one mode to another. As we are about to see, rail, road and inland navigation are partly competing for inland transportation. We have focused in this section in transport statistics aggregated at the EU level, but European nations have themselves different modal splits that we should analyse to understand this potential for modal shift.

[14] US Bureau of Transport Statistics, Economic Impact of Shipment Choices, Web site, 2010, http://www.bts.gov/programs/freight_transportation/html/shipment_choices.html
[15] European Commission, Commission Staff Working Paper, *Impact Assessment of the Communication "Keep Europe Moving" Sustainable mobility for our continent. Mid-term review of the European Commission's 2001 Transport White Paper*, 2006, p. 23

2. National disparities in modal split in Europe

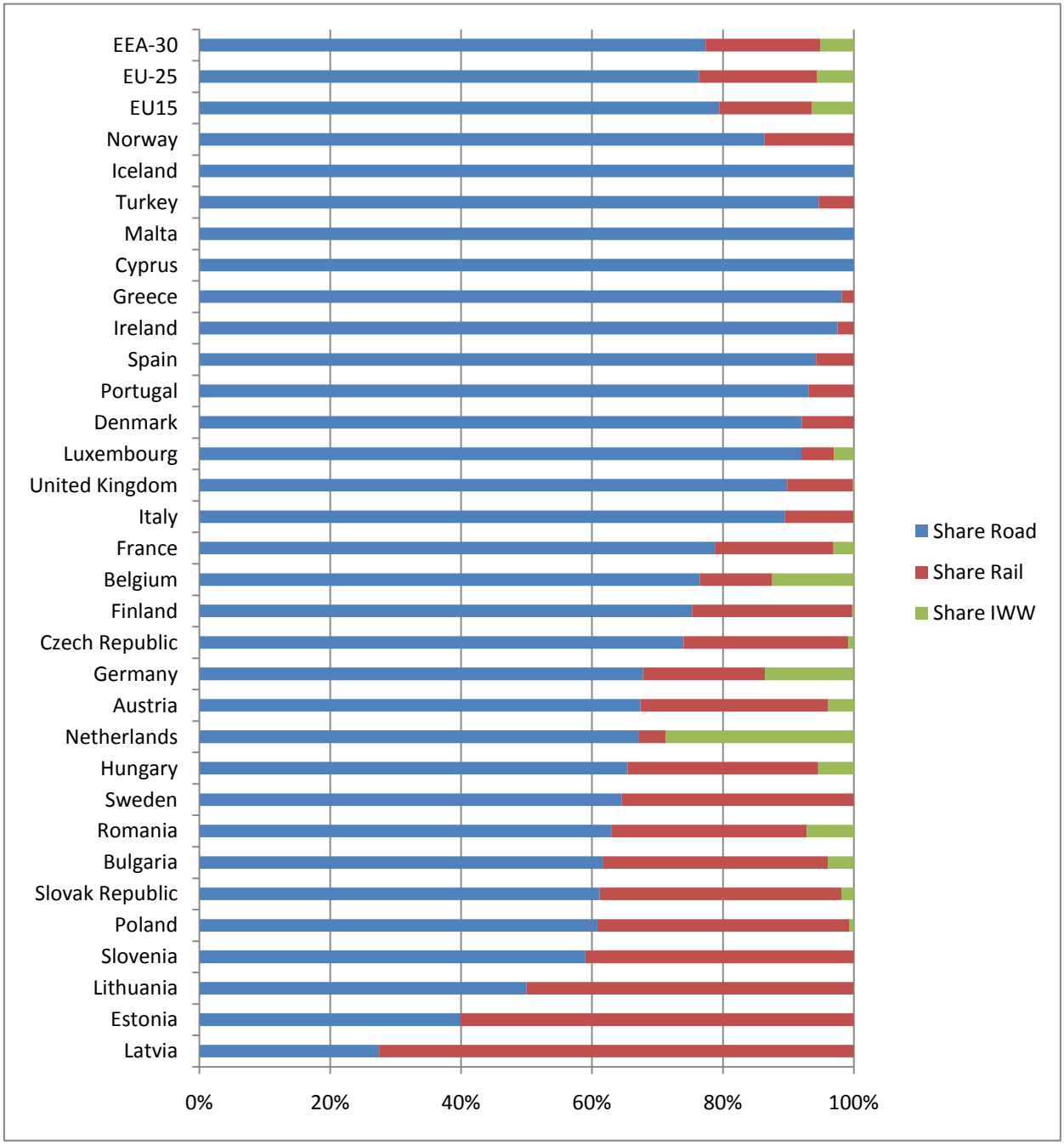
Behind these European statistics, individual countries have very different realities which we must be aware of. We must nevertheless be careful since Eurostat specify that "the data concerning different geographical entities are not fully comparable."[16] Still, we can distinguish some broad patterns. To simplify this analysis, we are going to use cross-sectional data showing us modal splits for only one period of time (2003). This should nevertheless be enough to have a broad idea of the dissimilarities between European countries. Here we choose to include countries which are not part of the EU in order to widen our sample. Hence Iceland, Norway and Turkey will also be part of this analysis since the EEA also provide data for these countries. This sections aims at observing the situations of countries and emit hypothesises which we will try to test in the next section. The graph below from the European Environmental Agency displays modal split of freight transport for inland transport except pipelines in 2003. The three modes displayed – road, rail and inland waterways – are partially substitutable which is so much the case for pipelines which can only transport liquids and gas. Note that considering the importance of sea and oceans costs in the European geography, sea transport is also a competitor to those modes. In particular – as the European Commission stresses in a document addressed to the European Parliament and Council – "the maritime sector is proving to be a valuable alternative to land transport"[17]. Nevertheless, we lack data for the so-called short sea shipping – the part of maritime transport which competes with inland modes in Europe. This is probably due to its legal framework which does not offer the opportunity to distinguish between short sea shipping and longer maritime transport between continents. Here the EU executive branch mentions that "there is as yet no seamless internal

[16] Eurostat, *Panorama of Transport*, Statistical books, European Commission, 2009, p. 58
[17] Commission of European Communities, Communication from the Commission to the Council and the European Parliament Keep Europe moving - Sustainable mobility for our continent, *Mid-term review of the European Commission's 2001 Transport White Paper*, 2006, p.11

shipping market: sea journeys from one Member State to another are considered external due to international regulations."[18]

2.1. Rail and road shares of inland freight

Graph 6: Inland freight transport's modal split in the members of the EU27 in 2003



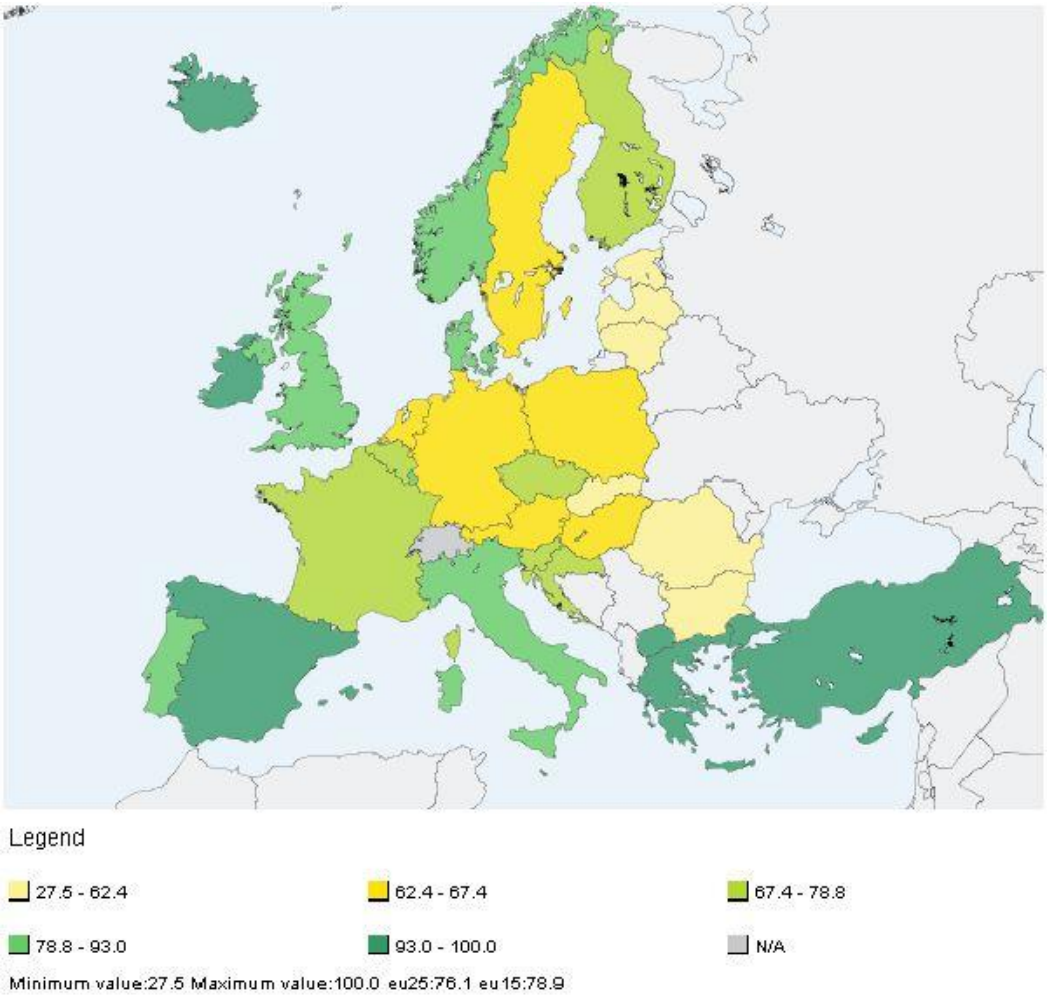
Source: EEA

[18] Ibid.

Geographic situation

The importance of road transport is obvious at first sight on the graph above. It is the main inland mode for almost all countries except Latvia (27%) and Estonia (40%). Lithuania appears to have its inland freight transport equally divided between rail and road. This mode also has a monopole or a quasi-monopole in many countries: Malta (100%), Cyprus (100%), Iceland (100%), Greece (98%), Ireland (98%), Turkey (95%), Spain (94%), Portugal (93%), Denmark (92%), Luxemburg (92%), the United Kingdom (90%) and Italy (90%). These countries present some common characteristics; many of them are relatively small countries. There seem to be geographically isolated countries having a large access to the sea – except for Luxemburg. Still, not all of these countries are islands and some of them also have most of their territory on peninsulas (Spain, Portugal, Italy, Greece) which are isolated from the rest of the continent by mountains ranges: the Pyrenees for Spain and Portugal, the Alps for Italy, Gramos and Rhodope Mountains for Greece, and the Scandinavian Mountains for Norway. Hence, the first hypothesis to be tested will be the following: the share of road transport in inland freight transport increases with the geographical isolation of countries from the rest of the continent by natural obstacles such as sea and mountains. We notice that rail and road are the two main inland modes in all countries except the Netherlands and Belgium where inland waterways come second after road transport. Hence, we are going first to focus on road and rail shares and come back to inland waterways later.

Map 1: Share of road in inland freight transport in tonne-kilometres in Europe in 2003



Source: Eurostat

In order to test this hypothesis, let's classify European countries with the following dummy variable: 1 for countries which can be considered as geographically isolated, this is the case for countries being mainly islands or peninsulas, and 0 for countries mainly integrated to the continent. This leaves us with some debatable cases, for example, should Sweden and Finland be included in the rather isolated or in the countries rather close to the continent? The map above show us that Sweden and Finland have a modal split rather in favour of rail transport if compared to other countries, so it would be tempting to put them in the less isolated countries. Still, it would be doubtful not to consider them as rather isolated since the Baltic

Sea is clearly an obstacle between them and the rest of the European continent. Out of carefulness, we will then put them into the isolated category to see if we come out with significant results anyway.

Table 4: Classification of European Countries by geographical proximity to the core of the continent

Category	Value	Countries
Isolated	1	Cyprus, Denmark, Finland, Greece, Iceland, Ireland, Italy, Malta, Norway, Portugal, Spain, Sweden, Turkey and the United Kingdom
Continental	0	Austria, Belgium, Bulgaria, Czech Republic, Estonia, France, Germany, Hungary, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Slovakia and Slovenia

A linear regression was conducted on this basis to see if the respective shares of road match our geographical ranking. The following tables display significant results.

Table 5: Summary output of linear regression with road shares of inland freight transport in 2003 and a variable representing isolation from the European continent

Regression Statistics	
Multiple R	0,739868
R Square	0,547405
Adjusted R Square	**0,531241**
Standard Error	0,130705
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,578551	0,578551	33,86545	**2,98E-06**
Residual	28	0,478347	0,017084		
Total	29	1,056898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,632554	0,032676	19,35822	9,53E-18
Isolation	**0,27836**	0,047833	5,819403	**2,98E-06**

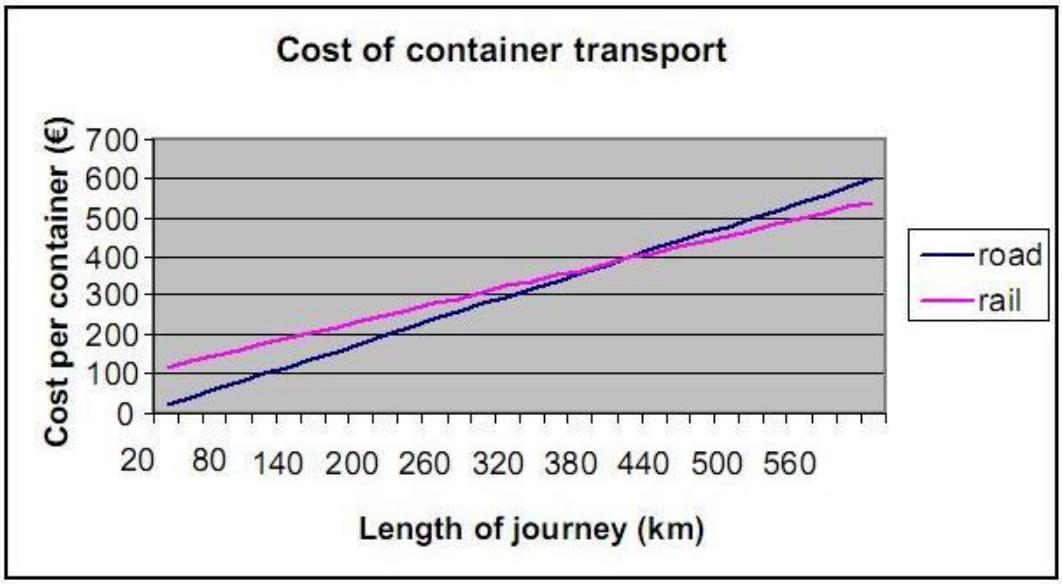
Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,56562	0,699489	0,56562	0,699489
0,180379	0,376342	0,180379	0,376342

As we can see in the summary output of the linear regression, there is a highly significant correlation between our variables which allows us to reject the null hypothesis. There is apparently in the case of Europe a correlation between the geographical situation of a country and its share of road transport in inland freight transport, but this fact still remains to be explained.

Road and rail are dominants means of transport but they are nevertheless imperfect substitutes. A study focused on Scandinavia was made by Danish researchers to estimate structural inelasticities of modal substitution in freight transport (Rich et al. 2009). According to this study, it is becomes less possible to substitute rail to road for distances smaller than 500 kilometres, this is partly due to infrastructures but also to the fact that the flexibility of road transport makes it an unavoidable mode for the first and last part of a journey. Hence, the shorter the journey the more expansive it becomes to shift goods from road to rail and then back to road. That's why it is normally less costly to carry goods only on road for relatively short journeys. The British engineering consultancy Atkins estimated for the EU the costs of container transport as a function of the length of journey, the graph below illustrate their conclusions. Here, in the case of containers, rail becomes profitable compared with road for journeys longer than 440 kilometres, this is not far from the 500 kilometres mentioned by Rich et al. In a working document, the European Commission confirms that road "can provide flexible services regarding departure time and destination, and it is the fastest transport mode for distances up to about 500 km."[19]

[19] European Commission, *Impact Assessment of the Communication "Keep Europe Moving" Sustainable mobility for our continent. Mid-term review of the European Commission's 2001 Transport White Paper*, 2006, p. 22

Chart 7: Cost of container transport



Source : Impact assessment, Atkins

In order to compare this study with actual data, we can examine the average distance for which means of transport were used. In table 6 below, average kilometre was calculated by dividing performances in tonne-kilometres by performances in tonnes for each mode in the case of France. This gives us an idea of the average journey distance each mode has been used for in 2003. Although the average distance for rail (355 km) is shorter than the figures mentioned before, it is clear that rail was used for much longer distances than for road (89 km). This difference with Rich et al. and Atkins' study can be explained by the specificities of countries in terms of infrastructures, taxes and subsidies as well as data collection.

Table 6: French modal split for inland freight transport in 2003[20]

	Tonnes (thousands)	Tkm (millions)	Average km
Rail	78 261	27 795	355.16
Inland waterways	27 230	4 021	147.67
Road	1 914 142	1 71 157	89.42
Total France (metropole)	2 019 633	202 973	100.50

Source France: SOeS, SitraM

[20] Data available online: http://www.statistiques.developpement-durable.gouv.fr/rubrique.php3?id_rubrique=223

This gives an interesting light to our previous empirical findings. It is no coincidence that small islands display the largest road shares; remember that Iceland, Malta and Cyprus have 100% of their inland freight transport on road whereas it is of 98% in the Irish case. Since no inland mode can be used to carry freight from and to places outside of the country, there can be no long distance transactions made only with an inland mode. Hence, inland journeys take place on short distances where road would be less profitable than rail even if there would be the appropriate rail infrastructures. To have an idea of the distances involved on these islands, consider that the distance between Dublin and Cork, the second biggest city in the Irish Republic, is only of 250 kilometres, the distance from Dublin to Belfast is even shorter with less than 200 kilometres.[21] This is far below the point where rail becomes clearly profitable and explains the competitiveness of road on the green island (98% of inland tonne-kilometres). Moreover, if goods were to be carried from outside of the island shipping would have to be the first mode involved and since cities tend to be situated along the coast line (as for Dublin, Belfast and Cork in the case of Ireland) there would be no economic incentives to combine sea transport with rail since it is too costly on short distances and cannot offer the necessary last kilometres service. Malta, Cyprus and Iceland are comparable or smaller islands and they display a complete road monopole (100% of inland tonne-kilometres), but what about a bigger island like Britain?

As we have seen, the United Kingdom has a rather small, but still non negligible share of freight transport taking place on rail (10% against 90% for road transport). This is compatible with our explanation considering first that Britain is a much bigger island – London is 450 kilometres distant to Newcastle and 640 kilometres to Edinburgh – and secondly that it is nowadays connected to the continent by the Channel Tunnel which makes rail journeys with other countries possible. Still, Britain remains an island and as such has a very large share of road transport.

[21] Calculated with Google Maps

It seems that the same mechanisms play for countries being mainly on peninsulas but to a lower extent. As our hypothesis suggests, the relative geographical isolation of countries from the rest of the continent by natural obstacle to inland transport such as sea and mountains plays in favour of road. We observe it in the case of Portugal, Spain, Denmark, Norway, Greece, Turkey and Italy, but not in the case of Sweden and Finland which both have high shares of rail transport. Nevertheless, these two Scandinavian countries appear first not to be as isolated as others, and secondly they have rather large superficies and no major islands. Hence, we may also wonder if population density plays a role here as well by increasing the length of potential freight journeys.

Population density

Following our previous analysis, if population density plays a role in modal split, we would expect road shares to be negatively correlated to population density whereas rail shares would have a positive correlation. Table 7 on next page displays population densities in most European countries in 2003, we are now going to use them to see if there is a correlation between population density and modal split in Europe.

Table 7: Population density and modal split of inland freight transport in Europe in 2003

	Inhabitant/km²	Road	Rail	IWW		Inhabitant/km²	Road	Rail	IWW
Austria	98,5	67%	29%	4%	Latvia	37,3	27%	73%	0%
Belgium	342,1	77%	11%	12%	Lithuania	55,1	50%	50%	0%
Bulgaria	70,5	62%	34%	4%	Luxembourg	174,6	92%	5%	3%
Cyprus	78,1	100%	0%	0%	Malta	1263	100%	0%	0%
Czech Republic	132,1	74%	25%	1%	Netherlands	480,3	67%	4%	29%
Denmark	125,1	92%	8%	0%	Norway	14,9	86%	14%	0%
Estonia	31,2	40%	60%	0%	Poland	122,2	61%	39%	1%
Finland	17,1	75%	24%	0%	Portugal	113,6	93%	7%	0%
France	98,1	79%	18%	3%	Romania	94,5	63%	30%	7%
Germany	231,2	68%	19%	14%	Slovakia	109,7	61%	37%	2%
Greece	84,3	98%	2%	0%	Slovenia	99,1	59%	41%	0%
Hungary	108,9	65%	29%	5%	Spain	83	94%	6%	0%
Iceland	2,9	100%	0%	0%	Sweden	21,8	65%	35%	0%
Ireland	58,4	98%	2%	0%	Turkey	91,3	95%	5%	0%
Italy	195,2	90%	10%	0%	United Kingdom	244,3	90%	10%	0%

Source: Eurostat

By using population density – expressed in inhabitant per square kilometre – as an independent variable, and road share as a dependent variable, we obtain the following table. As we can see the correlation is in the way we expected it: we have a positive correlation between population density and road share in inland freight transport. However, this correlation is weak (0.000195) and is far from being significant (0.21).

Table 8: Summary output of linear regression with national road shares and population densities in Europe in 2003

Regression Statistics	
Multiple R	0,236463
R Square	**0,055915**
Adjusted R Square	0,022197
Standard Error	0,188774
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,059096	0,059096	1,658338	**0,20837**
Residual	28	0,997802	0,035636		
Total	29	1,056898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,732115	0,041749	17,53606	1,24E-16
Pop Density	**0,000195**	0,000151	1,287765	**0,20837**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,646595	0,817634	0,646595	0,817634
-0,00011	0,000504	-0,00011	0,000504

Because the shares express the modal split between three modes of transport, the correlation between road shares and an independent variable should be the opposite of a correlation between rail and inland waterways added together. But before drawing conclusions concerning population density, let's see if we can find a significant correlation with rail shares only.

Table 9: Summary output of linear regression with national rail shares and population densities in Europe in 2003

Regression Statistics	
Multiple R	0,325214
R Square	0,105764
Adjusted R Square	**0,073827**
Standard Error	0,182449
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,110238	0,110238	3,311659	**0,079498**
Residual	28	0,932057	0,033288		
Total	29	1,042294			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,25061	0,04035	6,210859	1,04E-06
Pop. Density	**-0,00027**	0,000146	-1,8198	**0,079498**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,167956	0,333263	0,167956	0,333263
-0,00056	3,34E-05	-0,00056	3,34E-05

Not surprisingly, we find this time a weak negative correlation (-0.00027) which was of the kind expected and corresponds to our last linear regression. Although we have less insignificant results as before, we can only reject the null hypothesis at the 90% level so we will consider this correlation as not significant. Hence we have to reject the hypothesis that population density plays a role in modal split of freight transport, at least on the national level. This is not necessarily contradictory with our previous explanation because population density is only a national average which can hide very different realities. For example, climatic reasons might influence the repartition of a country's population such as it could be composed of regions with a high population density and still be almost empty in some other areas. Freight transport in those later parts of the country would then be quasi-inexistent and freight transport figures would only reflect the situation of a part of the national territory. Economic activity tends to concentrate on certain areas for local businesses to improve their competitively by benefiting from clusters' effects such as positive externalities (Porter 1990). In our case that means that what really counts is probably not so much the overall population density of a country, but the transportation links clusters have with other area of intensive economic activity in the same country and the rest of the continent.

Political background

Differences in the development of infrastructures might also influence modal split dissimilarities. Although infrastructures are constructed to match a demand, authorities can be in favour of certain kind of infrastructures rather than others. In fact, if priority is given to one type of infrastructures to the detriment of others, modal split would be impacted on the medium and long run. We noticed already that Baltic countries had very large shares of rail freight transport, so we could wonder if the soviet past of these three republics could be responsible for this particularity. If we want to test this statistically, we are going to need an independent variable which reflects economic policies differences in several European regions since political traditions in other countries could also have played a role in their infrastructure. To do so, let's classify our 30 countries depending on their economic policy traditions by using a self made simple variable similar to a so-called dummy variable. The idea is to give higher values to countries which economic policy have been characterised by strong state intervention in the national economy, and lower values to traditionally more *laissez-faire* government. By doing so, we will only take into account economic policies in the half century following World War II; this includes the reconstruction following the destructions of the conflict. It is thus not only the most recent half century but also a period having had a great impact on today's infrastructures. Hence, former soviet republics will be attributed the higher value, other formerly planned economies will come second, then market economies with a strong tradition of government intervention in the economy, and finally the most economically liberal countries. The distinction between the two last categories is somewhat arbitrary; countries of Western Europe clearly have different political background, but it is delicate to draw a line to separate them in two distinct categories.

Table 10: Classification of countries by political background for linear regression

Category	Value	Countries
Former Soviet Republic	3	Estonia, Latvia, Lithuania
Other formerly planned economies	2	Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovenia, Slovakia
Market economies with rather interventionist states	1	Belgium, Austria, Denmark, Finland, France, Germany, Iceland, Italy, Luxembourg, Norway, Netherlands, Sweden
Market economies with less political intervention	0	Cyprus, Greece, Ireland, Malta, Portugal, Spain, United Kingdom, Turkey

Using the classification above, we can calculate a linear regression with road shares as a dependent variable. As you can see below, this gives us a highly significant negative correlation.

Table 11: Summary output of linear regression with rail shares of inland freight modal split in 2003 and a variable for economic policy traditions of 30 European countries

Regression Statistics	
Multiple R	0,891622
R Square	0,79499
Adjusted R Square	**0,787668**
Standard Error	0,087968
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,840224	0,840224	108,5788211	**3,85E-11**
Residual	28	0,216674	0,007738		
Total	29	1,056898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,971515	0,0257	37,80265	1,41262E-25
Eco policy	**-0,17919**	0,017197	-10,4201	**3,85023E-11**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,918872	1,024159	0,918872	1,024159

-0,21442	-0,14397	-0,21442	-0,14397

Railways require a larger involvement from the state, not only to realise the investment in infrastructures needed but also to organise their management. Concerning infrastructures, the larger role governments play in the economy, the more incline they are to invest in public transportation infrastructures such as railways. A 1997 report from the OECD on liberalisation and structural reforms in the freight transport sector in Europe mentions that "until 1989, the transport markets in the central and eastern Europe states were governed by a rigid regime of central planning, including five year plans and large scale public ownership of the freight transport companies." This doesn't mean that there were no investments in roads, but that the political will to develop a railways network must have been stronger on these economies, hence, "the high market shares held by railways were a result of public planning and design rather than the economic efficiency of the railway companies."[22] Moreover, concerning freight transport, we can postulate that in formerly planned economies where rail usually has a very high share of inland freight transport, the economic model based on much lower productivity incentives probably didn't encourage the development of the somewhat more flexible road transportation. If this is the case we could expect formerly planned economies to have witnessed a relative decrease in rail in the decades following their transition to free market economies. By using once again a dummy variable with 1 for transition economies and 0 to other European countries, we can calculate a correlation using their slope of rail share as a dependent variable. The slope was only calculated for the period running from 2000 to 2008 because data were not available for too many countries for a larger period; still we had to reduce our sample to 26 for the same reasons.

[22] Organisation for Economic Co-operation and Development, *Liberalisation and structural reforms in the freight transport sector in Europe*, Paris, 1997, p. 20

Table 12: Summary output of linear regression with rail slope and transition

Regression Statistics	
Multiple R	0,808979
R Square	**0,654447**
Adjusted R Square	0,640049
Standard Error	0,710154
Observations	26

ANOVA

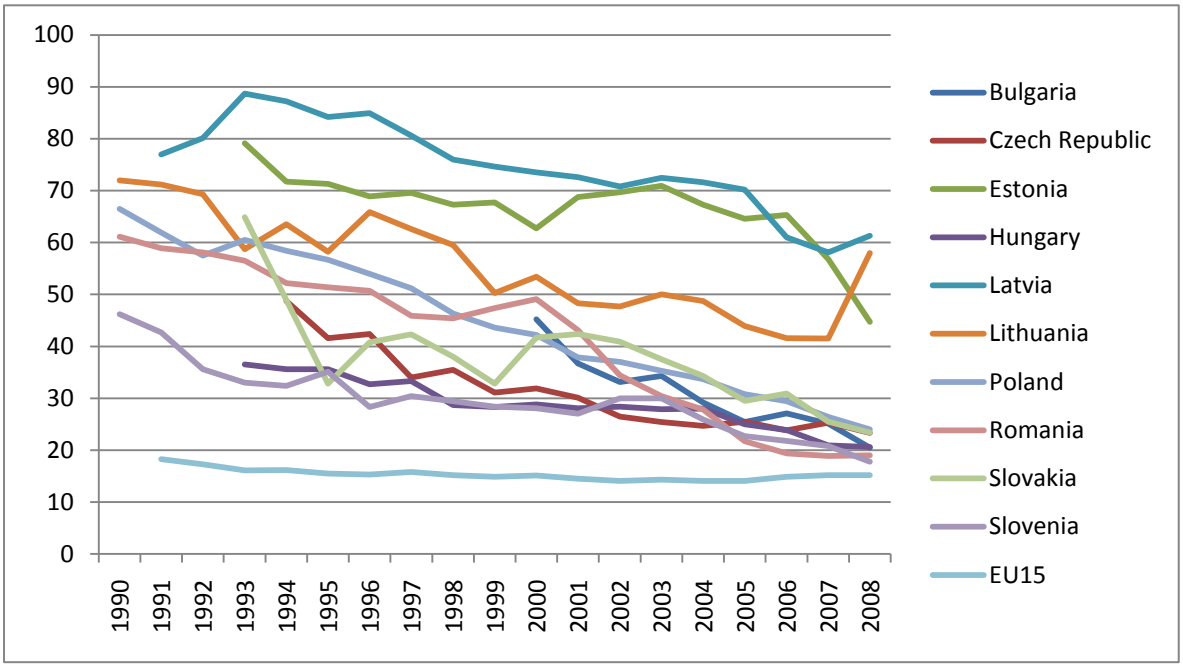
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	22,92324	22,92324	45,45387	**5,66E-07**
Residual	24	12,10365	0,504319		
Total	25	35,02689			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,052366	0,177539	0,294956	0,770564
Transition Eco	**-1,93003**	0,286272	-6,74195	**5,66E-07**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
-0,31406	0,418788	-0,31406	0,418788
-2,52087	-1,3392	-2,52087	-1,3392

There is a highly significant correlation between the slope of rail share between 2000 and 2008 and our dummy variable for transition economies. This correlation is negative meaning that formerly planned economies tend to have seen their shares of rail diminish in inland transport more than others. This confirms our previous idea that planned economies played in favour of rail rather than road transport. It seems that the two decades following the end of the so-called iron curtain have witnessed a convergence of these countries with the EU15 in terms of modal split. This phenomenon is obvious on the following chart, especially for non-Baltic countries which seem to converge to the EU15 rail share.

Graph 8: Rail shares in inland freight transport for European transition economies compared to the EU15 between 1990 and 2008



Source: Eurostat

The transition that east European countries have experienced from a planned to a market economy seems to have leaded them to converge to the west European modal split. These economies have been engaged in a catching up process since the 1990 and are converging with the Western Europe in terms of income as well. Hence, we may wonder if modal split does not also have a link with income level.

Income level

Considering the European dissimilarities in terms of GDP per capita there might be a correlation between modal split and income level. Table 13 displays relative GDP per capita of 30 European countries in 2003 with the EU27 as an index basis. Not surprisingly the countries which were to join the EU in the following years had the lower income level. Romania and Bulgaria had around one third of the EU27 average. The Baltic countries and Poland were close to half of this level. Luxembourg and Norway have

the highest GDP per capita. Countries for which data on modal split are not available such as Switzerland were not shown in this table.

Table 13: index GDP per capita in Europe in 2003 (EU27=100)

Country	GDP/capita	Country	GDP/capita
Austria	126,8	Lithuania	49,1
Belgium	123,3	Luxembourg	247,6
Bulgaria	32,5	Malta	78,3
Cyprus	88,9	Netherlands	129,3
Czech Republic	73,4	Norway	156,2
Denmark	124,1	Poland	48,9
Estonia	54,5	Portugal	76,6
Finland	112,5	Romania	31,3
France	111,8	Slovakia	55,4
Germany	116,5	Slovenia	83,4
Greece	92,6	Spain	100,9
Hungary	62,8	Sweden	124,1
Iceland	125,5	Turkey	35,9
Ireland	140,6	United Kingdom	121,7
Italy	110,7	**EU27**	**100**
Latvia	43,3		

Source: Eurostat

A linear regression calculated with income level as an independent variable and national road shares for a dependent variable gives us significant results at the 95% level (1.1% probability of null hypothesis, see table 14). We have a slightly positive correlation between income level and road shares (0.12%), which means that the higher income a country have the higher share road transport tends to have in inland freight transport.

Table 14: Summary output of linear regression between road shares of inland freight modal split and relative income level of 30 European countries in 2003.

Regression Statistics	
Multiple R	0,459805
R Square	0,211421
Adjusted R Square	**0,183257**
Standard Error	0,172528
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,22345	0,22345	7,506903	**0,010575**
Residual	28	0,833448	0,029766		
Total	29	1,056898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,578225	0,074253	7,787234	1,75E-08
Income level	**0,00192**	0,000701	2,739873	**0,010575**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,426125	0,730325	0,426125	0,730325
0,000485	0,003356	0,000485	0,003356

Once again, let's not forget that since we have three inland modes we need one more linear regression before being able to draw conclusions for rail freight. Below are the results for rail share as a dependent variable. We have a more significant correlation since we can now reject the null hypothesis at a 99% level, as we might have expected from our previous results, the correlation between rail shares and income level is negative. That means that in 2003 richer countries relied less on rail than others.

Table 15: Summary output of linear regression with rail shares of inland freight modal split and relative income level of 30 European countries in 2003

Regression Statistics	
Multiple R	0,510194
R Square	0,260298
Adjusted R Square	0,23388
Standard Error	0,165938
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,271307	0,271307	9,853081	**0,003972**
Residual	28	0,770987	0,027535		
Total	29	1,042294			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,412173	0,071416	5,771398	3,39E-06
Income level	**-0,00212**	0,000674	-3,13896	**0,003972**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,265883	0,558463	0,265883	0,558463
-0,0035	-0,00074	-0,0035	-0,00074

Although this is in itself an interesting finding, we don't know yet if rail shares decrease with income level rising or if countries having larger rail shares tend to be less rich for some reasons. Using the slope of rail share as a dependent variable and the average annual growth rate of GDP per capita as an independent variable (table 16), we can try to see if economic development is synonym with a reduction of rail share as we might expect in view of our last findings. Here we will only use data for countries where there could be an evolution over time, which excludes countries with no rail shares such as Iceland, Cyprus, Greece and Malta.

Table 16: Average annual growth rate of GDP per capita and slope of rail shares in inland freight transport in Europe between 2000 and 2008

Countries	AAGR of GDP/capita	Slope of rail share	Countries	AAGR of GDP/capita	Slope of rail share
Austria	3,50%	0,931667	Lithuania	14,23%	-0,33833
Belgium	3,66%	0,635	Luxembourg	6,42%	-0,59333
Bulgaria	12,98%	-2,575	Netherlands	4,48%	0,278333
Czech Republic	11,11%	-0,90167	Norway	7,62%	-0,12333
Denmark	3,65%	0,041667	Poland	9,79%	-2,11667
Estonia	13,30%	-2,05167	Portugal	3,82%	-0,25
Finland	4,33%	0,351667	Slovakia	14,31%	-2,53167
France	3,30%	-0,62333	Slovenia	6,54%	-1,39167
Germany	2,43%	0,463333	Spain	5,71%	-0,4
Hungary	9,87%	-1,105	Sweden	3,11%	0,001667
Ireland	6,05%	-0,44833	Turkey	7,34%	0,00119
Italy	3,16%	0,18	United Kingdom	2,36%	0,391667
Latvia	15,00%	-1,90333			

Source: Eurostat

There is a strong and very significant correlation between the evolution of rail shares and GDP per capita. This means that European countries having the fastest economic growth tended to rely less and less on rail transport during the last decade.

Table 17: Summary output of linear regression between rail slopes and average annual growth rates of GDP per capita in Europe between 2000 and 2008

Regression Statistics	
Multiple R	0,806058
R Square	0,649729
Adjusted R Square	**0,6345**
Standard Error	0,611637
Observations	25

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	15,96043	15,96043	42,6635	**1,15E-06**
Residual	23	8,604308	0,3741		
Total	24	24,56474			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,81641	0,244068	3,345014	0,002808
AAGR	**-19,3661**	2,964924	-6,53173	1,15E-06

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
0,311518	1,321303	0,311518	1,321303
-25,4995	-13,2327	-25,4995	-13,2327

We have seen previously that formerly planned economies tend to converge with the rest of Europe in terms both of income per capita and modal split. Thus, we could be suspicious concerning this correlation since perhaps it is mostly due to these countries that we find correlation. To make sure this phenomenon is also a western phenomenon, we calculated the same linear regression but excluded this time formerly planned economies. The outcome does not allow us this time to reject the null hypothesis at the 99% level, not even at the 95% level but only at the 90% level. This shouldn't necessarily lead us to the conclusion that the correlation we found previously was only due to eastern countries. Significance tends to be reduced when the sample is smaller and we must keep in mind that in this case we almost have a significant correlation although we have a much smaller sample. This phenomenon is mostly due to Eastern countries but we can postulate that it also operated to a lower extent in the rest of Europe.

Table 18: Summary output from a linear regression with average annual growth rate and slope of rail share in inland freight between 2000 and 2008 for Western European countries

Regression Statistics	
Multiple R	0,472948
R Square	0,22368
Adjusted R Square	**0,168229**
Standard Error	0,408546
Observations	16

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,67328	0,67328	4,0338	**0,064291**
Residual	14	2,336735	0,16691		
Total	15	3,010015			

	Coefficients	*Standard Error*	*t Stat*	*P-value*

Intercept	0,611934	0,296741	2,062185	0,05826
AAGR	**-12,6201**	6,28357	-2,00843	**0,064291**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
-0,02451	1,24838	-0,02451	1,24838
-26,097	0,856792	-26,097	0,856792

To sum up our findings regarding income level and modal split we could say that we observed first that better off countries usually have smaller shares of freight on rails and larger on roads, second that countries with faster growth have seen their rail transport shares diminishing more than others. This phenomenon seems to be mostly due to transition economies in Eastern and Central Europe, but there are signs that it could also play a role in Western Europe. Carefulness doesn't allow us to be affirmative in the case of Western Europe, but we can still try to identify mechanisms behind this correlation in favour of road transport. The last two decades have witnessed the development of new ways of organising business activities. More competitive methods of production have spread throughout the developed countries, notably *just-in-time* and outsourcing have been the core of these changes in management. The requirements of lean production, by aiming at avoiding downtimes and delays, are probably more compatible with the flexibility of road transport. Hence, we could wonder if rail freight loses of markets shares is due to recent organisational trends. Since rail freight reduced its share and not its absolute performance maybe high economic growth led additional freight to be carried by road rather than rail because rail infrastructures were not evolving at the same pace. In particular, the higher level of organisation required for rail combined with the inherited system of public national rail companies was maybe not appropriate to carry additional amount of goods across borders. In fact, in a 2001 White Paper on transport the European Commission deplores "the lack of infrastructure suitable for modern transport and of interoperability between networks and systems" of European railways. This question would require a deeper analysis to be answered accurately; it is

delicate to draw conclusions on a correlation based on such a limited sample.

Conclusions on modal split rail/road

Geographical situation, income level and political background gave us significant results to different extent and are all plausible explanations for the European dissimilarities in modal split. Still, since they partly match each others' ranking, we may wonder if one of these factors is predominant. Maybe comparing Europe with countries from other continents could help us clarify the European situation.

Table 19 depicts modal split in five main world economies; here we do not only have road, rail and inland waterways, but also domestic sea shipping and oil pipelines. Oil pipelines being used for only one kind of good, we can see that only the United States and Russia – two major oil producers have consequential pipelines shares. Concerning other inland modes, we notice that rail is predominant in the USA, China and Russia, whereas road is more important in Europe and Japan. Inland waterways have a low share of freight transport on average, except in China where it represents 15% of the total tonne-kilometres.

Table 19: Comparative goods transport performance: EU27, USA, Japan, China and Russia, 2006 (billion tkm and %)

	EU27		USA		Japan		China		Russia	
Road	1 888	46%	1 890	30%	347	60%	975	11%	201	4%
Rail	435	10%	2 705	43%	23	4%	2 195	25%	1 951	41%
Oil pipeline	135	3%	854	14%	:	0%	166	2%	2 499	53%
Inland Waterways	138	3%	486	8%	:	0%	1 291	15%	58	1%
Sea (domestic/ intra-EU27)	1 545	37%	332	5%	208	36%	4 258	48%	48	1%
Total 5 modes	4 140	100%	6 266	100%	578	100%	8 886	100%	4 757	100%

Source: DG Energy and Transport, Eurostat, US Bureau of Transportation Statistics, Japan Statistics Bureau, National Bureau of Statistics of China, Goskom STAT (Russia), International Transport Forum, from Panorama of Transport 2009, p. 57

What do these data tell us about our factors? In order to have a clearer idea of what this modal split means concerning our three inland modes, here is another table made from the data of the one above.

Table 20: Comparative goods inland transport performance: EU27, USA, Japan, China and Russia, 2006 (billion tkm and %)

	EU27		USA		Japan		China		Russia	
Road	1 888	77 %	1 890	37%	347	94%	975	22%	201	9%
Rail	435	18 %	2 705	53%	23	6%	2 195	49%	1 951	88%
Inland waterways	138	6%	486	10%	:	0%	1 291	29%	58	3%
Total 3 modes	2 461	100%	5 081	100%	370	100%	4 461	100%	2 210	100%

Source: DG Energy and Transport, Eurostat, US Bureau of Transportation Statistics, Japan Statistics Bureau, National Bureau of Statistics of China, Goskom STAT (Russia), International Transport Forum, from Panorama of Transport 2009, p. 57

Firstly, the very high share of road transport in Japan seems to corroborate the idea that insularity plays in favour of road transport. Regarding economic policy consideration, the high shares of rail transport in Russia (88%) and China (49%) tend to confirm the idea that a strong state has a positive influence on rail freight. Nevertheless, the United States also have an important share of rail transport (53%) which can hardly be explained by the role of the state neither by income level since they benefit from one of the highest GDP per capita in the world. What China, Russia and the United States have in common, however, is their tremendous area. We have seen before that rail transport is usually less profitable than road for short journeys, but – in the case of Europe – density of population didn't give us significant results. Considering that, despite the effect of globalisation, most economic transactions still take place inside national borders and that economic activity tends to concentrate in big cities which can be far from each others in the case of a large country, the size of a

country could matter whatever its population density. In the United States distances between the most important economic centres – such as New York or California – are measured in thousands of kilometres rather than hundreds of kilometres. If rail is more profitable than road for short distances – we have seen that it was the case in Europe – then it seems fair to assess that geographical characteristics of countries matter more in inland modal split than income level or economic policy. In fact, the American Bureau of Transportation Statistics confirms that "in general, trucking dominated shipment distances of less than 500 miles[23] while rail dominated the longer distance shipments."[24] It seems then that geographical characteristics of countries play a role in modal split. Finally, remembering that we have found strong signs in favour of political factors, especially in the case of transition economies, we will accept the hypothesis that the political past of European nations impacted their modal share, but to a lower extent than geography. However, there is still one mean of transport to which we did not give so much attention so far because of its small importance in terms of total freight performance.

2.2. Inland Waterways

Despite the predominant place that inland navigation have had in history, this mode only represented around 5% of inland freight performance in the European Economic Area 30 in 2003. Still, this mode is not without advantages, as stressed in a 2001 European Commission White Paper on transports, "Nowadays, despite a slight revival, water transport is the poor relation even though it is a mode which is not expensive and does less damage to the environment than road transport."[25] Hence, even though it only has a small importance at the European level, it is interesting to grant

[23] 500 miles is equivalent to 800 kilometres
[24] US Bureau of Transportation Statistics, Website, Modal Shares, 2010, http://www.bts.gov/programs/freight_transportation/html/dominant_mode.html
[25] Commission of the European Communities, *WHITE PAPER European transport policy for 2010: time to decide*, Brussels, 2001, p. 41

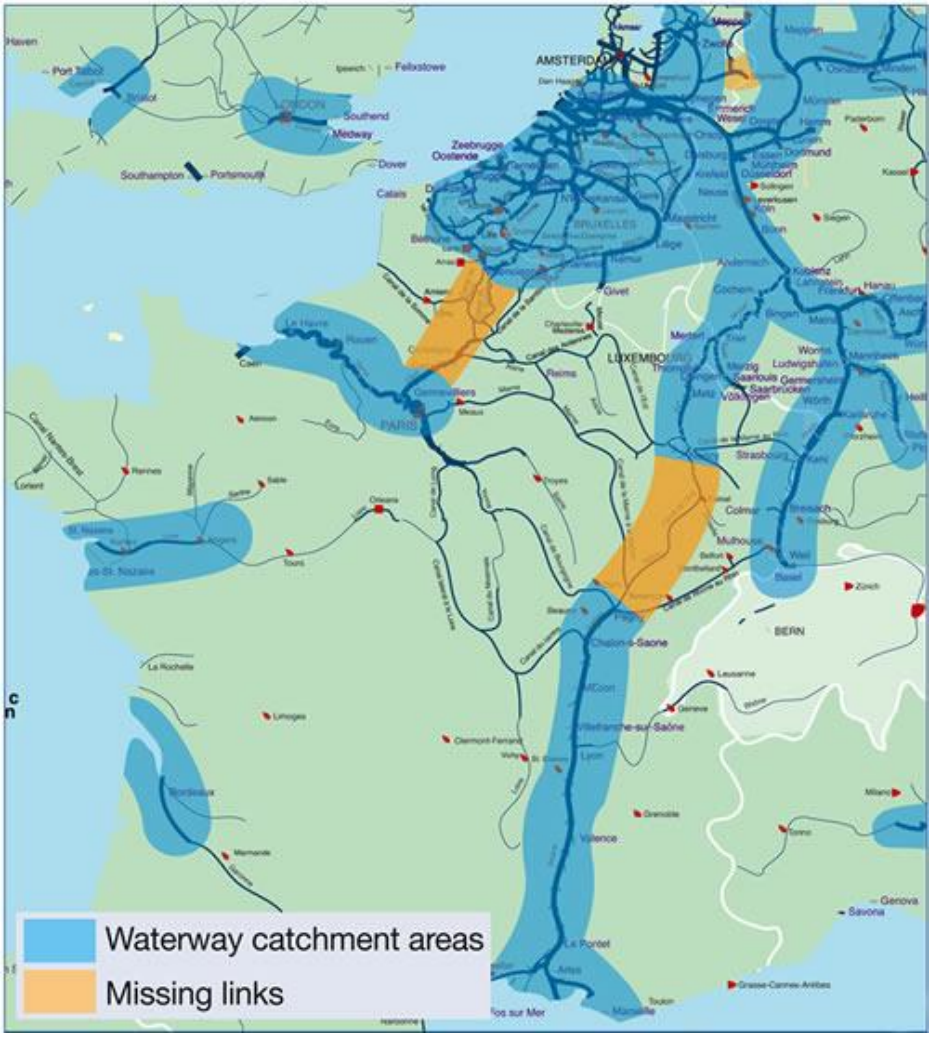
inland waterways a part of our modal split analysis since it can actually be highly competitive in specific conditions, for example the European Commission stresses that "on certain corridors their [rivers'] share exceeds 40%"[26] of modal share.

A short observation of the European modal split by countries tells us that the Netherlands clearly have the biggest share of inland waterways with 29% of all inland freight transport taking place on water. This was clearly made possible by the geographical situation of the Low Countries and their well developed canal infrastructures connected to the Rhine River. As the Dutch Ministry of Transport, Public Works and Water Management puts it on its website, "The Netherlands is strategically situated on the Rhine Delta and therefore has good connections with the large European hinterland. This favourable position makes the Dutch inland shipping fleet the most important carrier of goods on the inland waterways of Europe."[27] It is interesting to note that the two Dutch neighbours, Germany and Belgium, have respectively the second and third largest share of inland waterways in Europe – respectively 14% and 12%. Two other EU members having access to the River Rhine – France and Luxemburg – have a small but still significant share of freight transport on inland waterways (3%). Nevertheless, in the case of France other major navigable rivers, such as the Seine or the Rhone, and canals might also play an important role as we can see on the map below.

[26] Commission of European Communities, Communication from the Commission to the Council and the European Parliament Keep Europe moving - Sustainable mobility for our continent, *Mid-term review of the European Commission's 2001 Transport White Paper*, 2006, p.12

[27] Dutch Ministry of Transport, Public Works and Water Management, website, http://www.verkeerenwaterstaat.nl/english/topics/freight_transportation/inland_shipping_and_waterways/index.aspx

Map 2: inland waterway network western of the River Rhine.



Source: Inland Navigation Europe

Moreover, we notice that all other countries having shares of freight transport on inland waterways large enough to appear on the graph page 18 benefit from an access to the River Danube except Czech Republic. This is the case for Hungary, Romania, Bulgaria and Austria, but also Germany which has access to both the River Danube and the River Rhine. These two major European rivers are linked for fluvial navigation use by the River Main and the Main-Danube canal. Hence, added together they form the most important European inland waterway network which is navigable for some of the biggest barges and is accessible both from the North Sea and the Black Sea. Inland waterways were classified in 1992 by the European

Conference of Ministers of Transport in seven categories depending on the size of ships and convoys they were able to carry. This gave a ranking from 0 for only leisure ships to VII for the biggest push convoys.[28] Considering the importance of this network accessible to class V ships (class V corresponds to Rhine barges), we can hypothesise that access to this network plays a great role in the inland waterway share of European countries. To make sure this holds, we are going to conduct a linear regression using a dummy variable: the value 0 will be given to countries having no inland waterway access of class V or more to this network, countries integrated to it will be given the value 1 (table 21).[29]

Table 21: Classification of European countries by their access to the inland waterway network

	Value	Countries
Access	1	Belgium, Bulgaria, Austria, Czech Republic, France, Germany, Hungary, Luxembourg, Netherlands, Romania, Slovakia
No Access	0	Cyprus, Denmark, Estonia, Finland, Greece, Iceland, Italy, Norway, Ireland, Latvia, Lithuania, Malta, Poland, Portugal, Turkey, Slovenia, Spain, Sweden, United Kingdom

As expected we find that our variable has a positive and significant correlation with inland waterways shares in Europe (table 22). This confirms the idea of the importance of the Rivers Rhine and Danube in European inland navigation, not only are they accessible to relatively large

[28] Inland Navigation Europe, website, Fact and Figures, http://www.inlandnavigation.org/en/factsandfigures/fleet2/class_categories.html

[29] This classification was made using a map of European inland waterways available in German online, http://www.inlandnavigation.org/documents/Facts%20Figures/Network/Map_Waterways_Europe.jpg

inland navigation ships, but they also connect regions which are far from the sea and, as such, rely quasi-entirely on inland transport.

Table 22: Summary output linear regression with inland waterways shares of freight and a dummy variable representing access to the River Danube – River Rhine navigation network in 2003.

Regression Statistics	
Multiple R	0,615838
R Square	**0,379256**
Adjusted R Square	0,357087
Standard Error	0,048416
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,040101	0,040101	17,10717	**0,000291**
Residual	28	0,065636	0,002344		
Total	29	0,105737			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,000555	0,011107	0,050009	0,960471
Rhine - Danube	**0,07587**	0,018343	4,136081	**0,000291**

Lower 95%	*Upper 95%*	*Lower 95%*	*Upper 95%*
-0,0222	0,023308	-0,0222	0,023308
0,038295	0,113444	0,038295	0,113444

From this brief analysis we can conclude that geographical circumstances play again a great role in determining the share of freight which is hauled on inland waterways. Although canals also play a role, rivers represent the core of the European inland navigation network. In particular, the River Danube and the River Rhine appear to be the two major European navigation axes.

3. European transport policies on freight modal split

Major public challenges such as climate change and dependency to oil imports have generated concerns about energy efficiency in the economy. Whereas the transport sector is booming both for passengers and freight, the question of energy intensity in this key sector has become increasingly important. When it comes to freight we notice that Europe hasn't witnessed appropriate trends so far. ODYSEE-MURE, a project aiming at evaluating energy efficiency progress in Europe, notice that "in most countries the share of efficient transport modes (rail and water) is decreasing; in other words, the trend is moving in the direction opposite to the direction in which policy makers plan for it to move."[30] Hence, several policy tools have been developed at different level, we are going first to focus on the EU and then concentrate on Germany, a rather successful example of national policy.

3.1. Policies at the EU level

The organisation of goods transport in Europe confronts the European Union with several challenges. First of all it is important to remember that opening trade between nations has historically been the major task of the Union. Thus, working at enhancing goods transport links between European nations could be considered as one of its natural ambitions. One should notice that the EU being the main international organisation in Europe has inherently a role to play in the organisation of a trans-European network, in fact "since freight transport is so often a cross-border activity, concerted action at European level will obviously greatly increase the chances of success."[31] The European ambition of opening trade was not only based on the claim of guaranteeing peace, but also on the economic belief that more competition should benefit to national economies and that to create growth a developed infrastructure network is required. Accordingly, the European Commission is prompt to mention that "freight transport is essential to

[30] Energy Efficiency Trends and Policies in the Transport Sector in the EU, September 2009, ADEME Editions, Paris, p. 58
[31] European Commission, Directorate - General for Energy and Transport, Logistics: keeping freight moving, 2006, p. 2

maintain economic growth and competitiveness."[32] Last but not least, a new aspect of transport policy has come to be debated with the emergence of environmental concerns. Hence, nowadays European policy makers mention that "a modern transport system must be sustainable from an economic and social as well as an environmental viewpoint."[33] In order to achieve these objectives, several levers are used by the EU institutions and we are going to focus on the main programs which have been developed. Firstly, fiscal policies aiming at integrating external costs are being encouraged so that the price of transports reflect their real cost to the society. Secondly, the development of new European transport infrastructures is designed in cooperation with local institutions, the so-called Trans-European Transport Network (TEN-T) ambition to improve transport connections and the European level. Thirdly, the Marco Polo projects finance private organisations ambitioning to shift freight from road to more environmental friendly modes. Finally, the adjustment of transport market regulations, notably in the rail freight sector, can help putting rail freight back on tracks by improving its competitiveness.

Integrating external costs

One of the main modal split issues is that goods transportation generates external costs to the society. For example pollution, noise, congestion or the use of infrastructures are costs to the society which are often not part of the transports' costs as they are paid by the final consumer. By using fiscal tools, authorities can attempt to reintegrate these costs in the final price so that modes which are the most costly to the society such as road freight (congestion of roads, noise, accidents, CO2 emissions...) do not benefit anymore from the externality of a part of their costs. The sum of private and external costs can be called *socialcosts*. Hence, theoretically if external costs were to be integrated in modes' prices, this would balance modal competition in favour of the least costly modes, all costs taken into account.

[32] Ibid., p. 1
[33] European Commission, *WHITE PAPER European transport policy for 2010: time to decide*, Brussels, 2001, p. 6

As a booming mode with important negative aspects, road freight was the first target of the European Union in 1990s when the EU institutions were contemplating a directive constraining EU members to adopt specific taxes for heavy duty vehicles. A facultative harmonised toll system – the so-called Eurovignette – was adopted by Belgium, Denmark, Germany, Luxemburg and Sweden[34] but Germany withdrew from it a few years later (more on this in the next section). The European legislation was modified several times during the last decade in order to adapt to the concept of external costs. Even though Eurovignette is not present in most EU members, there is a European legislation setting minimum national tax rates to heavy goods vehicles.[35] Still, the Eurovignette is not properly speaking based on road's external costs and the Commission is now working on making the incorporation of internal costs to the Eurovignette more flexible. Hence, the EU institutions claim that "the amendment of the "Eurovignette" Directive should allow Member States to internalise the costs related to pollution and congestion caused by heavy goods vehicles (external costs)."[36]

It goes without saying that other modes also have internal costs. In July 2008 a document titled *Strategy for the internalisation of external costs* was passed by the executive organ, the Commission, on other European institutions such as the Parliament, the Council and the Committee of Regions. This document stresses that modal external costs should be gradually integrated to user price, in particular air and sea transport should be integrated into the Emission Trading System from 2012. Rail also has noticeable external costs in terms of noise which should be

[34] Eurovignette, Wesite, Home, https://www.eurovignettes.eu/web20portal/en/welcome
[35] Europa Website, Summaries of EU legislations, *Externalisation of external transport costs,* 2010, http://europa.eu/legislation_summaries/transport/transport_energy_environment/tr0007_en.htm
[36] Europa Website, Summaries of EU legislations, http://europa.eu/legislation_summaries/internal_market/single_market_for_goods/motor_vehicles/interactions_industry_policies/l24045b_en.htm

taken into account in rail legislation. Finally, it was envisaged to integrate all external costs of inland waterways in 2013.

Integrating external costs is a substantial step further in the adaptation of transport to the society's need, but one must keep in mind that it cannot alone have an efficient impact on modal split. In fact, in the same document it is stressed that "in order to reduce the external costs, we therefore need a strategy that includes various other elements in addition to internalisation, elements such as providing infrastructure, encouraging technological innovation, competition policy, legislation and setting standards."[37] This consideration was also developed in a 2009 paper by Rich et al. titled *On structural inelasticities of modal substitutions in freight transport* – already referred to on page 22 of this work. In this academic work, on modal substitutions in the Scandinavian region, the authors conclude that "increased prices will be passed onto end consumers rather than affect modal substitution." because of structural inelasticities. Hence, this kind of policies requires being combined with the development of infrastructures and intermodality.

Trans-European Transport Network

Two years after the Maastricht treaty, the resolution was reached in Essen, Germany, by the European Council to enhance transport connections between national networks,[38] this was to be followed in 1996 by a legal framework voted in the Parliament to establish "Community guidelines for the development of the trans-European transport network"[39]. The TEN-T main task is to strengthen cross-border connections of all modes of transport for both passengers and goods in Europe by supervising and financing public projects. Against the tremendous progression of road transport and

[37] Commission of European Communities, Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, Strategy for the internalisation of external costs, 2008, p. 3
[38] European Parliament, Definition of trans-European networks, European Parliament Fact Sheets, Website, 2010, http://www.europarl.europa.eu/factsheets/4_6_1_en.htm
[39] Decision No 1692-96-EC of the European Parliament and of the Council of 23 July 1996 on community guidelines for the development of the trans-European transport network, p.1

given the magnitude of the task, the program was developed a decade later: its budget was doubled and an executive agency was established and put in charge of "managing the technical and financial implementation of the TEN-T programme."[40] Even though it also ambitions to improve logistics in Europe and implements intelligent transport systems such as the global navigation satellite system Galileo, a clear priority is given to the development of rail networks, among the €6,699.4 million contributions of the European Commission for the period from 2007 to 2013, €4,311.5 million were allocated to railways projects which is 65.4% of total budget. Already in the previous budget period from 1996 to 2006 were rail assigned more than half of a much smaller total budget (€641.7 million). [41]

We have seen in our analysis of national dissimilarities in Europe that geographically isolated regions such as islands and peninsula tended to have much lower shares of rail transport. In fact, it is interesting to see that among priorities identified in the 1996 legal framework defining guidelines for the development of the TEN-T network stands the "establishment and development of infrastructure which promotes the interconnection of national networks in order to facilitate the linkage of islands, or areas similar to islands, and landlocked, peripheral and outermost regions on the one hand and the central regions of the Community on the other".[42] In order to improve international railways linkage on the Old Continent, it is also among the legal priority to undertake "the necessary measures for the gradual achievement of an interoperable rail network, including, where feasible, routes adapted for freight transport".

Many of the priority projects aim at developing connections of territories with limited links of inland modes with the continent. This is the

[40] The Trans-European Transport Network Executive Agency, *TEN-T Projects in Figures*, 2010, p.2
[41] Ibid., p. 1
[42] European Communities, Decision No 1692/96/EC of the European Parliament and of the Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network *OJ L 228, 9.9.1996, p. 1–104*

case for projects which are already been completed like the Öresund fixed link which was achieved in 2000 (number 11 priority), and should be completed by the Fehrmarn Belt railway axis between Denmark and Germany (number 20 priority). But above all it is the case for other projects still on progress such as the multimodal axis designed to connect the Iberian Peninsula to the rest of the continent and notably to develop rail connections between both sides of the Pyrenees – ranked as number 8 priority. Numerous railway axes were also designed to improve trans-European railways. We can cite the top priority projects which should create an enhanced rail section from Berlin to Palermo in Sicily. This would contribute to open up Italy to the rest of the continent, since it is rather isolated by the Alps, and create a fixed link between Sicily and the Italian Peninsula. Some of these projects are specifically conceived for freight, for example the freight railway axis Sines/Algericas-Madrid-Paris (number 16 priority).

Concerning inland waterways, we noticed earlier that countries' connections to the Rhine-Danube network was highly correlated with their shares of inland navigation freight. The two only TEN-T projects concerning inland navigation aim at extending this network. The first one between the Netherlands and Germany is the called Betuwe line, the second one is planned to open up to freight the canal between the River Seine in France and the Belgian inland waterways, both appear as *missing links* on the map from page 39.

Marco Polo Projects

As a part of the European Commission, the Executive Agency for Competitiveness and Innovation (EACI) assigns grants to private projects which can help at moving goods transport from roads to other modes. In a brochure made available by the EACI, the European Commission presents the concept of the Marco Polo projects. Although this document was only published to praise this European project and hence present it in a favourable way, its approach is promoted in the introduction and it is

obvious that the Marco Polo program concerns directly our subject since it is supposed to "help reduce traffic congestion on Europe's crowded roads and promotes environment friendly means of transport. Its strategy is simple: shift as much freight traffic as possible from roads to other modes of transport. While roads are overused, rail, sea and inland waterways often have spare capacity. They also pollute less. A Marco Polo grant can make the difference between launching a modal-shift project or not."[43] Numerous projects using all kinds of modes were co-financed by the EU, for example the so-called Scandinavian Shuttle by the Swedish firm UBQ AB was granted €2.5 million to organise a reliable rail freight service between Germany, Denmark and Sweden in prevision of the opening of the Copenhagen-Malmö fixed link in 2000.[44]

Integrating the European rail market

From the end of the Second World War onwards, the European rail market belonged exclusively to national public companies, this absence of competition hasn't only be source of inefficiency which came to favour other modes, but it is also a brake to international rail trade since this mode requires a larger degree of organisation than road transport and these are among others the reasons of rail's relative decline in freight transport. Therefore, opening national rail freight market to new operators was adopted as a part of European transport policy.

Generally speaking, opening national markets to competition is the core of the EU economic policy. In the case of transport the Commission stresses in its official communication to the Parliament and the Council that "the process of liberalisation of the internal market stimulates innovation and investment to bring better service at a lower cost". Concerns about the decline of rail in Europe appeared in the 1990s, a 1996 European Commission's White Paper point out that "a rail transport service is generally the sum of national services … this segmentation is particularly

[43] European Commission, *Lightening the Load, Marco Polo leads the Way*, 2009, p. 2
[44] Ibid., p. 14

serious in the case of freight, as the market increasingly demands seamless transport with full logistic support. Other modes can offer it; rail cannot."[45] Therefore, several directives have been designed in the last decade to "*introduce market forces into rail*".

In 1991 the European Community failed to impose an opening of the rail market, but the directive 91/440 paved the way to the reforms to come by making the distinction between rail network management and train operations obligatory to all members (Bowers 1996). It is only four years later that another directive was introduced to partially open national rail markets. It gave two years to EU members to adapt their legislation so that any "*railway undertaking*" meeting the security standards would be guarantee a license to operate its rail transport activities, but with some specific limitations.[46] Although this first step was followed in 2001 by a *first railway package*, it is only in 2008 that the European railways sector was completely open to competition.[47] EU members adopted the European legislation at their own pace, so there are clear differences in the situation of rail freight throughout the EU. Nevertheless, it has been noticed that in the first countries to open their railway market, rail has already begun to gain market shares. In particular, this is the case for Germany as we are going to see in the next section.

Although policies have been undertaken by the EU, the impact on modal split has mostly been limited at the continental level. In particular, the restructuration of the formally planned economies has largely played in favour of road. This has led the ODYSSE-MURE to conclude in its study (already mentioned page 8) that "modal shift measures are still scarce, especially with regard to freight transport, and only very limited results have

[45] Commission of European Communities, White Paper, A strategy to revitalising the community railways, 1996, p. 14
[46] European Communities, **Council Directive 95/18/EC of 19 June 1995 on the licensing of railway undertakings,** *OJ L 143 , 27/06/1995 P. 0070 – 0074*
[47] Commission of European Communities, WHITE PAPER European transport policy for 2010: time to decide, 2001

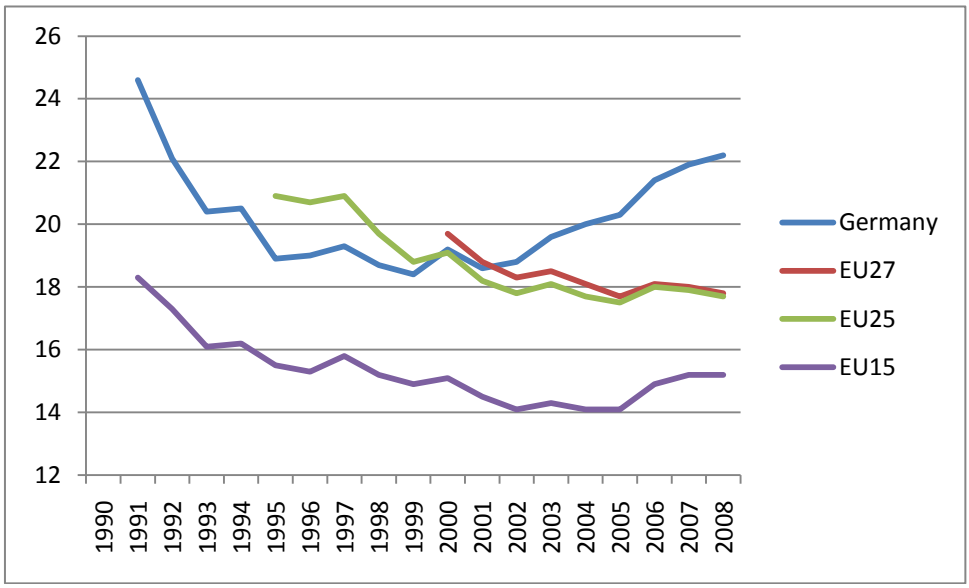
been achieved in that area. "[48] But the EU's decisions only represent a small part of transport policies in Europe, not only because there are European countries which are not members, but also because the national level is still the main level of decision.

3.2. An example of national transport policy: Germany

First European country in terms of inhabitants, industrial production and largest economy on the Old Continent, Germany occupies also a central position in the middle of Europe between West and East. All these elements explain why Germany has the largest freight performance in terms of tonne-kilometres with more than 20% of the total EU27 performance in 2003. Not only is Germany remarkable for its size, but one should also be aware that it is one of the few European countries which rail share increased in the 2000s. As we can see on the chart below, the German share of rail in inland freight decreased from the beginning of the 1990s till the turn of the century and then increased again leaving its curve with a U-shape. If we compare it with the European Union, we see that the same phenomenon does not appear at the EU level, the slight uptrend noticeable at the end of the period for the EU15 being probably due to Germany's weight in the total EU15 freight performance. In fact, this is the result of successful German transport policies. In particular, two aspects of this policy need to be considered and both of them are interrelated with EU policies. Firstly, Germany's rail freight market was one of the first to be opened to competition in Europe. Secondly, the German government displayed from the 1990s a strong political will to establish a toll for heavy duty vehicles on its roads.

[48] Energy Efficiency Trends and Policies in the Transport Sector in the EU, September 2009, ADEME Editions, Paris, p. 68, http://www.odyssee-indicators.org/publications/PDF/brochures/transport.pdf

Chart 9: Share of rail in inland freight modal split for Germany compared with the EU between 1990 and 2008



Railway Reform

Together with the United Kingdom, Germany was first in Europe at opening its rail market to new operators. This early timing is partly due to the 1990 German reunification which put the socialist Deutsche Reichbahn, the East German railway public company, into the hand of the Federal Government. Previously, a commission had been created to support the German institutions in this challenge. As a result, most of the propositions of the *Regierungskommission Bundesbahn* were adopted in 1993. The West German Deutsche Bahn, which hadn't been so efficient either and was crumbling into debt, was reformed to become more market oriented and was merged with the Deutsche Reichbahn. Following the EU directive, the rail sector was divided with infrastructure being kept by the Federal Government and the train activity. The former was sub-divided in three parts, local passengers, freight and intercity (Bowers 1996). Last but not least, the market was opened to any company interested in offering rail services. It seems that this set of reforms was rather successful, as the European Commission stressed in 2006 "in the United Kingdom and in Germany where the market was opened up in 1995, the growth of rail

freight during this period was respectively + 70% and of + 24% in 2004 in relation to 1995."[49] This phenomenon is obvious on the previous chart where the railways share of inland modal split display a distinctive U-shape. Seeing that competitiveness is a relative measure, a mode's competitiveness can not only improve by reducing its own costs but it might also improve when its competitors see their costs rising. Hence, this increase in railways' modal share might also be due to an increase in road transportation costs.

The German Toll Collect system

The Federal Government also had ambitious plans for road transport in the early 1990s, but ironically, because the first German project of truck toll was not compatible with the European Community's legal framework, a decision from European Court of Justice had it abolished in 1990 only a few weeks after the law took effect. Nevertheless, the EU legislation was modified and in accordance with a European directive, the so-called *Eurovignette* was set up a few years later in several European countries including Germany. This was only to last a few years since the German government, seeking to develop the concept, created a new Toll Collect system (LKW-Maut) which – not being compatible with the European Eurovignette – made Germany withdraw from it.[50] Despite its tormented birth, the system is considered nowadays as appropriately ambitious, as a document published by the French public agency ADEME puts it: "The most innovative country is Germany with its Toll Collect system, aimed both at raising the efficiency of trucks and moving part of the road traffic to rail and water transport."[51] The particularity of this system is that heavy duty vehicles are followed by GPS which enables the toll to be collected

[49] European Commission, *Impact Assessment of the Communication "Keep Europe Moving" Sustainable mobility for our continent. Mid-term review of the European Commission's 2001 Transport White Paper*, 2006, p. 23

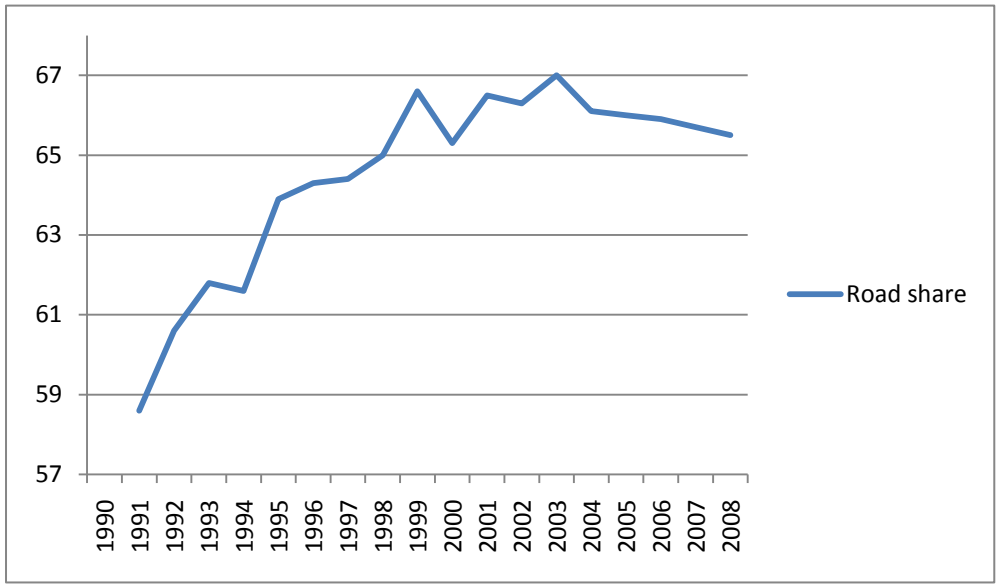
[50] German Federal Ministry of Transport, Building and Urban Development, website, 2010, http://www.bmvbs.de/Verkehr/Gueterverkehr-Logistik/Lkw-Maut-,1436.22466/Weitere-Informationen-zur-Lkw-.htm

[51] Energy Efficiency Trends and Policies in the Transport Sector in the EU, September 2009, ADEME Editions, Paris, p. 58, http://www.odyssee-indicators.org/publications/PDF/brochures/transport.pdf

electronically without the traffic congestion generated by tollbooths. Note that incomes from the toll are to be invested in transport infrastructures, mostly roads but also railways and inland waterways.[52] Concerning modal split we see on the chart next page the expected consequences of the rail's share increase and here we have a curve looking like an inverted U-shape although it may be too early to conclude on the long term effects of all those measures.

But one of the toll's objectives is to improve modal carbon and energy efficiency of road since the price of the toll depends on the emissions class of the vehicle. It is planned to extend this system to all German major roads and to include light duty vehicles before 2020.[53]

Chart 10: German road share in inland freight transport between 1991 and 2008



Source: Eurostat

Even if this concept is generally praised, some reserves were expressed specific points. First of all, it has been pointed out that

[52] German Federal Ministry of Transport, Building and Urban Development, website, 2010, http://www.bmvbs.de/Verkehr/Gueterverkehr-Logistik/Lkw-Maut-,1436.22466/Weitere-Informationen-zur-Lkw-.htm

[53] Energy Efficiency Trends and Policies in the Transport Sector in the EU, September 2009, ADEME Editions, Paris, p. 59, http://www.odyssee-indicators.org/publications/PDF/brochures/transport.pdf

investments in infrastructures were not as large as expected.[54] Secondly, governmental projects of increasing the toll met some opposition and a debate is taking place in Germany on the soundness of further increase of the toll price. For example, the Bavarian minister Emilia Müller stressed in 2008 the difficulty for small and medium-sized enterprises to face a new cost increase at a time when the recession was hitting the transportation sector.[55]

In the 1990s, the German Federal Government showed its will to reform freight transportation. On the one hand major railway reforms have revolutionised the German rail system by introducing competition into this traditionally protected sector and railways have become more competitive than before, having thus already regained a significant share of modal split. On the other hand, an innovative toll system was introduced on German roads to internalise external costs and improve heavy duty vehicles' energy efficiency. We can postulate that the instauration of the Eurovignette and later of the Toll Collect system although improved railways' competitiveness by increasing costs of its first modal competitor.

Conclusions

Goods transportation has intensified in Europe in the last decades and all modes of transport have increased their absolute performances at different paces which have modified modal split of freight. In particular, road freight has increased almost constantly in most European countries. Transportation is a polluting activity and modes of transport generate external costs to the society in terms notably of CO2 emissions, noise and congestion, but they have dissimilar external costs and some modes are more advantageous to the society than others. In particular, the tremendous development of road

[54] Ibid.
[55] Ifo Schnelldienst 19/2008, *Fur und Wider: die Diskussion um die Mauterhohung*, 2008, p. 5

transport is considered to be inappropriate because it is energy intense and is responsible for numerous external costs such as pollution, noise, accidents and road congestion.

European countries are not equal when it comes to modal split and huge dissimilarities in inland freight transport can be observed. Our regression analysis based on 2003 national modal splits helped us to understand these dissimilarities. Geographic situations of countries seem to be responsible for a large part of the differences, countries which are isolated from the rest of continent such as islands and peninsulas tend to have a much larger share of inland transport on road. This seems to be because road is the less costly mode for short distances which means that it is massively used in these countries and that non inland modes are largely used to link these countries with the rest of the continent, road being the predominant option for the last kilometres of these international journeys. Still, all divergences from the European average cannot be explained by geography and we have found that other elements play a noticeable role. Modal split can also be subject to economic policies and we obtained significant results by inquiring political background of nations. It seems that the more a country's state has been involved in the economy of a country historically, the highest share of rail transport this country is likely to have. This is obvious for formerly planned economies which have a high rail share, although there is a convergence with the EU 15 and road has become increasingly important in goods transport. Despite some significant results concerning income levels, it is delicate to conclude whether we can accept it as a factor impacting modal split for the results are highly influenced by transition economies still catching up both in terms of income and modal split. A rather minor mode in term of European relative performance, inland waterways are important in some specific areas such as the Netherlands and the River Rhine's corridor. There is an extensive navigable network joining the Rivers Rhine and Danube and only countries connected by substantially large links to this network have sizeable inland navigation shares.

Conscious of the issues around freight modal split, the EU has launched several projects in order to stop road transport's growth and shift freight to more environmental friendly modes such as rail, sea and inland waterways. Important infrastructure projects are undertaken under the Trans-European Transport Network Agency to link somewhat isolated regions of Europe to the rest of the continent and promote less polluting modes. Another aspect of the EU policy is the Marco Polo projects which offer grants to private enterprises designed to shift freight out of roads. But the EU policy does not only consist on subsidies and regulations have been introduced to adapt modal split: directives from the European institutions have opened national rail markets to competition and roads' taxations from national states are subject to minimal tolls. Some countries have a common toll system called Eurovignette, this was originally the case for Belgium, Denmark, Sweden, Luxemburg and Germany but the later introduced in 2005 an innovative Toll Collect system based on satellite localisation of vehicles. Germany's railways sector is also interesting since it was the first country with the United Kingdom to open rail to competition. Empirical data show that these measures must have been rather successful since road has lost market shares in favour of rail since the end of the 1990s.

Subject to unavoidable geographical factors and economic particularities, the European modal split of freight transport is characterised by large amplitude of variation in inland modal shares. Still, considering the impact of some modes to the environment and the society it is important that authorities undertake the necessary policies to permit a harmonious development of freight. Development of infrastructures, market regulations and taxations are three pillars which European governments can use to achieve this goal.

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