European Freight Transport Statistics:

Limitations, Misinterpretations and Aspirations

Professor Alan McKinnon

Logistics Research Centre,
Heriot-Watt University,
Edinburgh, UK

A C E A

ACEA 15th SAG MEETING

Prof. Alan McKinnon	*Heriot-Watt University, Edinburgh*
Dr Jacques Leonardi	*University of Westminster*
Anders Lundström	*Chairman SAG, SCANIA*
Marco Sorgetti	*CLECAT*
Michael Nielsen	*IRU*
Monika Wrzesinska	*EUROSTAT*
Pawel Stelmasczyk	*DG MOVE, European Commission*
Andreas Nägele	*DG MOVE, European Commission*
Manfred Buck	*DAIMLER*
Stefan Klatt	*MAN*
Michel Potvin	*RENAULT*
Erik Dahlberg	*SCANIA*
Ulf Ceder	*SCANIA*
Ulf Ehrning	*VOLVO*
Michael Niedenthal	*VDA*
Fuensanta Martínez Sans	*ACEA*
Stefan Larsson	*ACEA*
Alessandro Coda	*EUCAR*

Introduction

Statistics are often derided as being boring, inaccurate and misleading. Lloyd George's famous statement about 'lies, damned lies and statistics' is often quoted to emphasise the point. It is only through the collection, analysis and interpretation of statistics that we can build up an understanding of socio-economic phenomena. Such an understanding is fundamental to government policy-making and the formulation of business strategy. This is well illustrated by the freight transport sector. Within Europe it is a highly fragmented sector composed of hundreds of thousands of businesses, varying enormously in size and each year moving billions of consignments of widely varying sizes and weights on a myriad of possible routes. Given the scale and complexity of the freight transport system, it is impossible to analyse and understand it in the absence of large statistical databases.

The European Union is well-endowed with freight transport statistics by comparison with most other parts of the world. Most national governments and Eurostat have elaborate systems in place to collect and process freight data for all the main transport modes. These systems are far from perfect, however, and as a result tables of published statistics contain gaps and apparent inconsistencies. The choice of metrics and data collection methods is also open to criticism. It is often, however, at the interpretation stage that problems arise, when statistics are misunderstood or deliberately manipulated to give a misleading impression of a freight trend or performance level.

This paper provides a critique of the compilation and interpretation of official freight transport statistics in Europe. It is based on a review of relevant literature, discussions with many users of these statistics and long personal experience of using them in the course of academic research and consultancy. It begins with a review of the types of freight data required to inform public policy making. It then presents a detailed assessment of the freight data currently available, highlighting statistical gaps, biases and anomalies. As climate change is likely to become a much more important transport policy issue, the movement of goods will have to be more closely monitored to help governments and businesses develop and implement decarbonisation strategies for the freight transport sector. A later section of the paper explores the implications for the collection of freight data, particularly if governments are to set carbon reduction targets for this sector.

1 The Need for Freight Transport Data

This paper will focus on four of the main questions that transport policy-makers typically ask and which can only be answered statistically:

How much freight is being moved?

It is important to know the answer to this question for several reasons. First, policy-makers and planners need to know how much transport infrastructure capacity to provide for the movement of freight. Second, they must also assess the demands for other resources by the freight sector, primarily energy, vehicles and labour. Third, the amount of freight movement is considered quite an accurate barometer of the level of activity in a national economy and thus an indicator used in general economic planning. Traditionally it has correlated closely with gross domestic product (GDP), though in some countries tonne-km and GDP trends have begun to decouple over the past decade (Tapio, 2005; McKinnon, 2007). Fourth, one must have some indication of the quantity of freight being moved to assess the scale of the related externalities.

Which transport modes are being used?

As transport modes have different infrastructures, capacity planning requires freight data disaggregated by mode. This disaggregation is also required because modes differ in their resource costs and environmental impacts per unit transported. It is largely because of these differences that modal shift, from road to rail and water-borne modes, has been the central tenet of freight transport policy for several decades at national and EU levels. Governments require accurate freight modal split data to monitor the effectiveness of their modal shift policies.

How efficiently is the freight being transported?

Governments and businesses have a strong interest in minimising the resource costs and environmental impacts of freight transport. They need, therefore, to measure the efficiency with which the freight transport sector uses a range of inputs, including infrastructural capacity, energy, vehicle space and labour. The efficiency of a country's freight transport system is also an important determinant of its overall international competitiveness. Governments can influence the efficiency of freight transport through their fiscal and regulatory policies. Legal restrictions on truck size and weight, for example, have a direct bearing on road freight efficiency. Efficiency data is therefore required to help formulate a range of freight policies and monitor their impacts.

How much road traffic is generated by the movement of freight?

Road is by far the dominant mode of freight transport in all European countries and trucks and vans account for a significant proportion of total traffic on the road network. Planners and policy-makers therefore have a particular interest in understanding the dynamics of road freight traffic. Data on truck- and van-kms is required to analyse the relationship between the total volume of freight movement and the amount of vehicle traffic required to carry it and the contribution that this traffic makes to congestion and environmental degradation.

In the next section, we consider how well these questions can be answered on the basis of currently available data.

② Freight Transport Data in Europe: a statistical critique

Amount of freight movement

The standard measure of freight movement is the tonne-km, defined as the movement of one tonne of product over one kilometre. The tonne-km permeates all freight transport research and policy-making. It is the universal measure of freight transport activity (or 'performance'). It is also widely used as the freight variable in ratio measures such as freight transport intensity (tonne-kms to GDP), average payload weight (tonne-km to vehicle-kms), productivity (tonne-kms per vehicle or driver), energy efficiency (fuel consumed per tonne-km) and carbon efficiency (gCO_2 per tonne-km).

Despite its generality, the tonne-km statistic has several shortcomings:

① ▶ It measures only the weight (or mass) of the freight and takes no account of its volume. It is not surprising that the quantity of freight is expressed mainly in weight terms, because weight is much easier to measure than volume, particularly as consignments can have irregular shapes. Weight-based measures also correlate more closely with energy use and 'wear-and-tear' on transport infrastructure. Volumetric measurement of freight, on the other hand, gives an indication of the amount of vehicle and container space required and provides greater insight into the utilisation of vehicle capacity, as discussed below. If the average density of freight were constant through time, then changes in tonne-kms could be translated into variations in cubic metre-kms using a standard ratio. Anecdotal evidence within the logistics industry suggests, however, that this is not the case. The average density of freight consignments appears to be declining mainly as a result of the substitution of lighter materials (such as plastics) for heavier ones

(such as metal and wood) and the increasing use of packaging material. It would therefore be beneficial to separately monitor trends in the cubic volume of freight being moved if an acceptable means could be found of doing so.

② ▶ There are inconsistencies in the measurement of the weight. The main distinction is between net and gross tonne-kms. The net figure comprises solely the freight, whereas the gross estimate includes the weight of the vehicle. Ideally, it should always be the net weight of freight that is recorded. Even the definition of net tonne-kms can vary depending on whether the weight of handing equipment (or the 'unit load device' ULD) is included in the calculation. Including the weight of 20ft and 40ft ISO containers, for instance, adds, respectively 2.4 tonnes and 4 tonnes to the total weight of a consignment. It is also debatable whether the weight of pallets, roll cages, stillages and dollies be included in the weight of the freight consignment, though they normally are.

③ ▶ The measurement of distance should, in theory, be quite straight-forward. Complications arise, however, when calculating tonne-km values for multiple-drop and collection rounds. To facilitate data collection, official surveys often allow carriers to average the weight of loads collected or delivered across all the stops on a round, thus approximating the actual distance travelled by each consignment. Accurate measurement of the length of haul is important, however, as it sheds light on the geographical processes that traditionally have been major drivers of freight traffic growth (McKinnon and Woodburn, 1996). It also exerts a strong influence on the choice of transport mode and potential for freight to be transferred between modes.
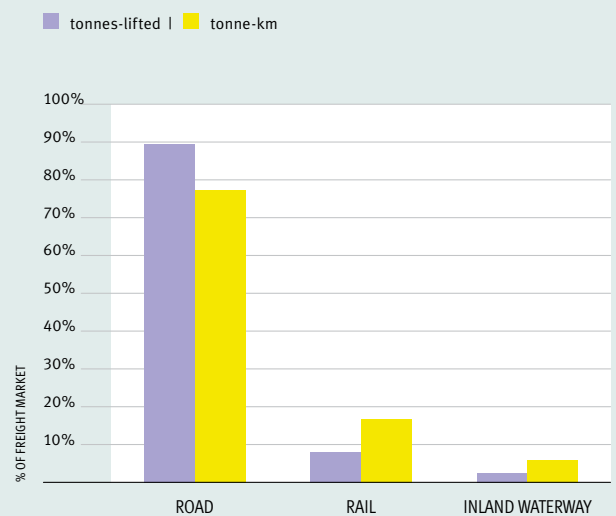
Freight Modal Split

The division of freight traffic between modes has been the dominant issue in freight transport policy for many decades. It was been a widely-held view among politicians, planners and policy-makers that shifting freight from road to rail or water-borne modes represents a panacea to freight transport problems. There has, therefore, been great interest in statistics showing the relative use of different transport modes.

The freight modal split can be measured in different ways, each giving a differing impression of a mode's relative importance. If, for example, the modal split is expressed in terms of tonne-kms, the rail and waterborne-modes appear to command a larger share of the freight market than if tonnes-lifted statistics are used (Figure 1) (Eurostat, 2009). This is because they are essentially long haul modes with a comparative advantage in moving freight over longer distances and substantially greater average lengths of haul (Savy, 2010). On the other hand, if one were to express modal split in terms of the value of the freight carried by the various modes, road's share would substantially exceed that calculated on a tonne-km basis. No European data have been found to compare the average value-density[1] of freight carried by different modes, however, this information is collected in the United States in the course of the periodic Commodity Flow Studies (US Census Bureau, 2004). Figure 2 shows how road (and multi-modal transport) carry freight with a much higher average value (in $) per ton than rail or waterborne modes. It should be noted too that the vertical axis on this graph has a logarithmic scale. So judgements about the relative importance of particular transport modes depend very much on the choice of metric.

1. Value density is the ratio of a product's value to its weight.

FIGURE 1: FREIGHT MODAL SPLIT IN THE EU27: MEASURED BY TONNES-LIFTED AND TONNE-KM

SOURCE Eurostat – 2009

FIGURE 2: AVERAGE VALUE OF SHIPMENTS CARRIED BY DIFFERENT FREIGHT MODES UNITED STATES – 2007
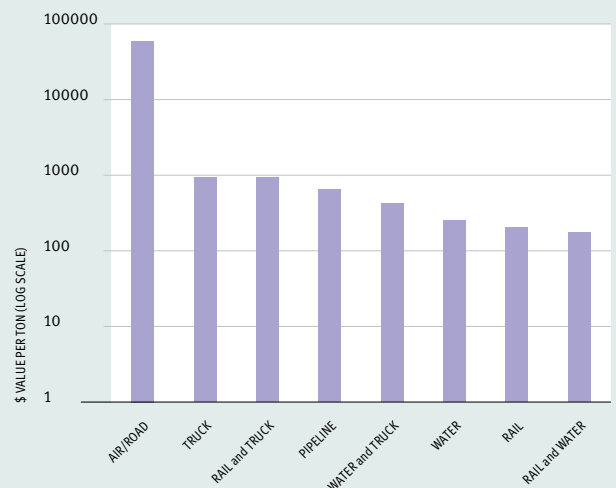
SOURCE US Census Bureau – 2008

TABLE 1: EFFECT OF FREIGHT MARKET DEFINITION ON THE ROAD / RAIL MODAL SPLIT - UK 2006

DATA SOURCE *Department for Transport – 2007*

DEFINITION OF SURFACE FREIGHT MARKET	% OF TOTAL TONNE-KMS	
All rail freight tonne-kms plus tonne-kms moved by:	ROAD	RAIL
all trucks over 3.5 tonnes	88%	12%
all articulated trucks	85%	15%
all articulated trucks with gross weights over 33 tonnes haul length > 100 km	82%	18%
all articulated trucks with gross weights over 33 tonnes haul length > 200 km	74%	26%
all articulated trucks with gross weights over 33 tonnes haul length > 300 km	58%	42%

The freight modal split can also be distorted by other factors:

① ▶ Definition of the freight market

Some types of freight have characteristics that make them 'captive' to particular modes. It is sometimes argued that such freight should be excluded from the assessment of freight modal split and traffic shares calculated with reference to the smaller 'contestable' market. As road transport has a much larger share of this 'captive' traffic, this approach tends to inflate the share of the freight market held by rail and waterborne transport. Table 1 illustrates the effects on modal split of changes in the definition of the UK freight market.

② ▶ Measurement of weight

This is particularly relevant to the analysis of freight modal split. Companies or trade bodies representing a particular transport mode can give an exaggerated impression of the amount of traffic handled by expressing it in gross tonne-kms. Today within the EU, however, the normal practice across all the main modes is for tonne-kms to be quoted on a net basis, except in the movement of containerised goods where the tare (i.e. unladen) weight of the container is usually included. If containerised flows represent a larger share of a particular mode's traffic, this practice tends to exaggerate its share of total tonnes-lifted and tonne-kms.

③ ▶ Density of the commodities carried

Modes tend to specialise in the movement of particularly types of product. Rail and waterborne modes carry a preponderance of primary commodities, such as coal, aggregates, cement, steel, oil and chemicals, characterised by high density. These product groups represent a much smaller proportion of the freight moved by road. This fundamental difference in the density profiles of the freight carried by the different modes is reflected in their shares of tonne-kms. Weight-based measurement of modal split intrinsically favours modes carrying denser product. If it were expressed in terms of the cubic metres of freight moved, road would account for a significantly larger share of the market.

④ ▶ Directness of the route

Where the split is calculated with respect to tonne-kms, modal differences in the journey length between given origins and destinations can distort the results. As the rail and waterway networks are much less dense than the road network, freight consignments generally follow more circuitous routes. The additional distance travelled by freight on the rail network, and hence tonne-kms, can be further inflated by restrictions on the movement of particular types of trains on particular routes. Woodburn (2007), for example, quotes examples of rail distances for freight trains being increased by, respectively, 9% and 15% to release capacity on trunk lines for passenger trains

and to route trains with larger deep-sea containers via lines with higher loading gauge[2] clearances. The EcoTransit (2010) online tool for comparing the environmental impact of different transport modes on user-specified routes can be used to compare distances travelled on different modal networks between the same origin and destination. It indicates, for example, in the case of a haul between Rotterdam and Prague, the truck distance would be 922 kms whereas the rail distance would be 1041kms, 13% greater. Differences in the directness of routing across the road, rail and waterway networks introduces a systematic bias in the measurement of distance travelled and hence tonne-kms.

⑤ ▶ **Treatment of intermodal traffic**
Official freight statistics do not differentiate intermodal traffic (i.e. a rail or waterborne trunk haul with road feeder movements at either end). The tonne-kms generated on the various journey legs are simply subsumed within the general figures for each mode and no attempt made to define the nature of the interconnection between the modes on particular door-to-door hauls. IURR, the main organisation representing intermodal operators publish consignment and tonne-km statistics for these co-modal services (IURR, 2009), though do not release figures on the relative proportions of tonne-kms 'clocked-up' on road feeders and rail / water trunk-hauls. In the absence of published data on the relative lengths of road feeder movements and trunk-hauls, it is not possible to assess the extent to which the routing of consignments via intermodal terminals inflates tonne-kms. The EcoTransit tool indicates, for specific door-to-door movements, the relative lengths of direct road and intermodal journeys (EcoTransit, 2010). Across a sample of eight such journeys criss-crossing mainland Europe, the intermodal distance was roughly 8% greater, with the intermodal distance increment ranging from -1% to 18% (Table 2). The extra tonne-kms associated with this intermodal deviation from the direct road route needs to be considered when setting tonne-km targets for the growth of intermodal traffic in Europe and also assessing the net environmental benefits of a shift from road to intermodal services.

TABLE 2: DIFFERENCES IN ROAD AND INTERMODAL DISTANCES BETWEEN EUROPEAN CITIES

			ROAD (KM)	INTERMODAL (KM)	EXTRA INTERMODAL DISTANCE (KM)	%
Paris	▶	Hamburg	887	914	27	3%
Amsterdam	▶	Milan	1032	1125	93	9%
Copenhagen	▶	Zurich	1337	1416	79	6%
Brussels	▶	Prague	901	1059	158	18%
Rome	▶	Warsaw	1847	1827	-20	-1%
Marseilles	▶	Cologne	1020	1087	67	7%
Vienna	▶	Madrid	2387	2635	248	10%
Budapest	▶	Bordeaux	1933	2163	230	12%
	TOTAL KM		**11344**	**12226**	**882**	**8%**

2. The loading gauge measures the maximum clearance around a vehicle travelling on the rail or road networks. In the case of rail it is determined by the height of tunnels and bridges and distance between station platforms.

Freight Transport Efficiency

At a company level, the operational efficiency of freight transport can be measured in many different ways, using a range of utilisation and productivity measures (Caplice and Sheffi, 1994). Attempts to measure the efficiency of freight transport at a macro (or national) level are frustrated, however, by a lack of official data and concern about the consistency of some of the statistics that are available. Using government data it is only possible to assess the efficiency of road freight transport. No general statistics are compiled on the efficiency of freight movement by rail or water-borne transport. This is a serious anomaly given the strenuous efforts of governments and the EU to transfer large amounts of freight from road to rail, primarily for environmental reasons. In the absence of data on load factors and energy efficiency on the rail freight and waterway systems, it is not possible to compare the environmental performance of the different modes on a consistent basis. Some of the available data on the utilisation of intermodal road-rail freight services, however, suggests that capacity could be much more effectively used. In a survey of over 550 container trains in the UK Woodburn (2010, p.17) found that *'if all existing services were fully loaded, there would be a 38% increase in TEU carried by rail and if all were operated with 24 fully loaded standard wagons… the growth would be 65%'.* The greater statistical transparency of the road freight sector places it at a relative disadvantage in public debates over vehicle loading as capacity utilisation on competing modes is not subject to the same degree of scrutiny.

Given data limitations, attention here will focus on the accuracy and validity of currently available measures of the efficiency of road freight operations.

The main efficiency measure in this context is vehicle utilisation, which can be defined as the ratio of the actual capacity used to the total capacity available. In the case of a truck, five utilisation measures can be applied:

① ▶ *Level of empty running:* the proportion of truck-kms run empty.

② ▶ *Weight-based loading factor:* the ratio of the actual weight of goods carried to the maximum weight that could have been carried on a laden trip.

③ ▶ *Tonne-km loading factor:* the ratio of the actual tonne-kms moved to the maximum tonne-kms that could have been moved if the vehicle had been travelling at its maximum legal weight. Unlike the first measure which assumes that the loading factor is constant on a particular trip, this measure allows for weight-based loading to vary during the journey, as consignments are delivered or collected.

④ ▶ *Volumetric loading factor:* the proportion of cubic space in the vehicle occupied by a load. It is a 3-dimensional view of vehicle fill.

⑤ ▶ *Deck-area coverage (or 'load area length'):* the proportion of the vehicle floor (or deck) area covered by a load, representing a 2-dimensional view of vehicle loading. Where the height to which products can be stacked is tightly constrained, loading is usually limited more by the available deck-area than by the cubic capacity.

Government road freight surveys in some European countries permit the calculation of the first three measures, though one must exercise caution in interpreting the results.

① ▶ *Empty running:* Figure 3 presents data from Eurostat on the average level of empty running by trucks in EU countries. The variation among these countries seems exceptionally large and raises doubts about the accuracy and consistency of the national surveys on which the estimates are based. Some of the Eurostat figures actually differ significantly from the numbers published in the corresponding national government tables. For example, Eurostat quotes an empty running % for the UK of 22% for 2006, whereas the corresponding figure in the UK statistical publication is 27% (Department for Transport, 2007). Pasi (2009, p.7) acknowledges that, *'At the European level, common aggregation procedures have been used that might diverge from national practices. Therefore differences might occur between the figures in this publication and national values'.* Some of the international differences in average empty running figures may also be attributable to differences in the minimum weight of trucks included in the national surveys. EU statistical directives give national governments some discretion in setting this minimum value within the range 3.5 tonnes – 6 tonnes (Eurostat, 2008a). It is also likely that the definition of 'empty' varies both within and between countries, as often this is not exactly specified in the questionnaires. Operators are sometimes unsure whether to classify as 'empty' vehicles returning various types of handling equipment. While a truck carrying only enough wooden pallets for the next load may be considered empty, another returning empty roll cages from supermarket to a distribution centre could be considered loaded. One haulier moving an empty ISO container back to a port might consider this to be a load, as they are being paid to move it, while another might, for statistical purposes, record the trip as an empty journey. There is a need for more rigorous definitions of what types of trip should be classified as empty.

FIGURE 3: AVERAGE PERCENTAGE OF TRUCK-KMS RUN EMPTY IN EU COUNTRIES – 2008

SOURCE *Eurostat*
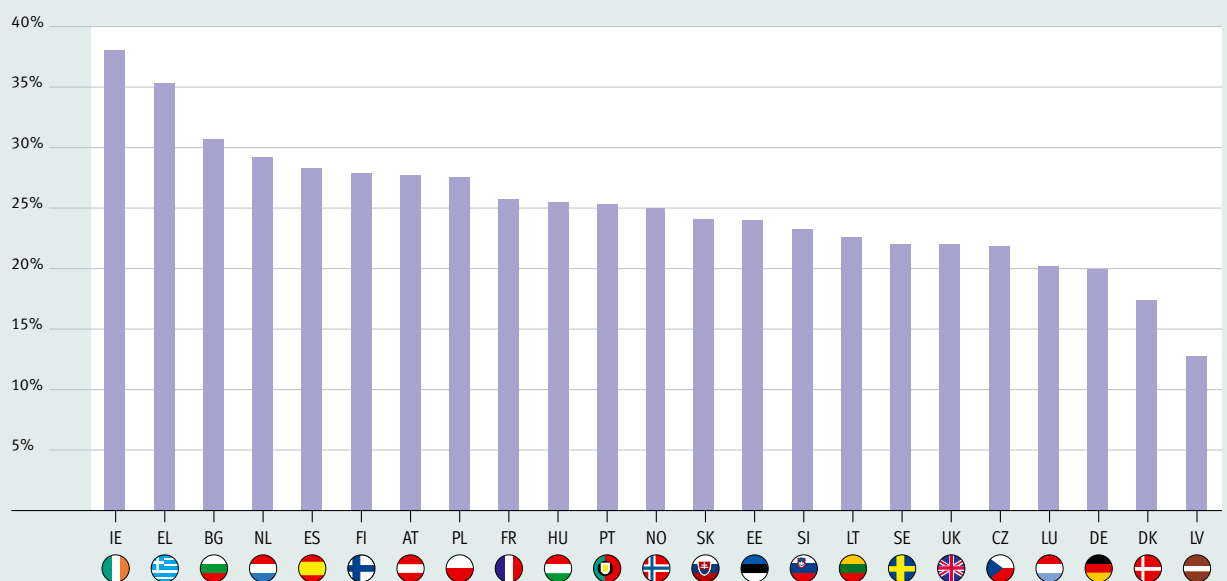
The interpretation of empty running statistics also requires some qualification. There is a common perception that empty running is the result of a prodigal use of transport capacity and clear evidence of inefficiency. In practice, it is often very difficult, if not impossible, to obtain a return load and thus eliminate empty running. Much empty running, for example, is the result of geographical imbalances in freight traffic flows, In many countries it is illegal for companies operating trucks on an 'own account' basis to collect a return load from another company. A retrospective analysis of just under 9000 road deliveries in the British food supply chain over a 48 hour period revealed relatively few opportunities for backloading after allowance was made for a series of operational constraints (McKinnon and Ge, 2006). While it would be unwise to extrapolate this finding to other sectors and countries, it does cast doubt on claims that empty running could be drastically reduced. It would be desirable to distinguish actual empty kilometres from the minimum amount of empty running that could be achieved within different operational and commercial scenarios. This would, however, go well beyond the capabilities of current data collection systems.

② ▶ *Weight-based loading:* Figure 4 shows the wide variation across EU countries in the average payload weight moved by trucks on loaded journeys. It is not known to what extent these variations reflect genuine differences in vehicle loading in these countries as opposed to methodological inconsistencies in the collection and analysis of the survey data. A comparison of the national road freight transport survey methodologies by Eurostat (2008a) reveals marked differences in the weights and ages of trucks included in the surveys, the methods of calculating tonne-kms on multiple stop journeys, the proportion of vehicles sampled, the % response rate and standard error of the estimates. It has not been possible to get EU member states to agree on a consistent method of calculating tonne-kms for multiple drop / collection rounds. Some methods, for example, tend to over-estimate kilometres while others over-estimate tonnage. It is clearly desirable to move to a single, standardised method of calculation which gives the most realistic estimate of tonne-kms moved.

FIGURE 4: AVERAGE PAYLOAD WEIGHT ON LOADED TRUCK JOURNEYS – 2008

SOURCE *European Parliament - 2010; Department for Transport – 2009*
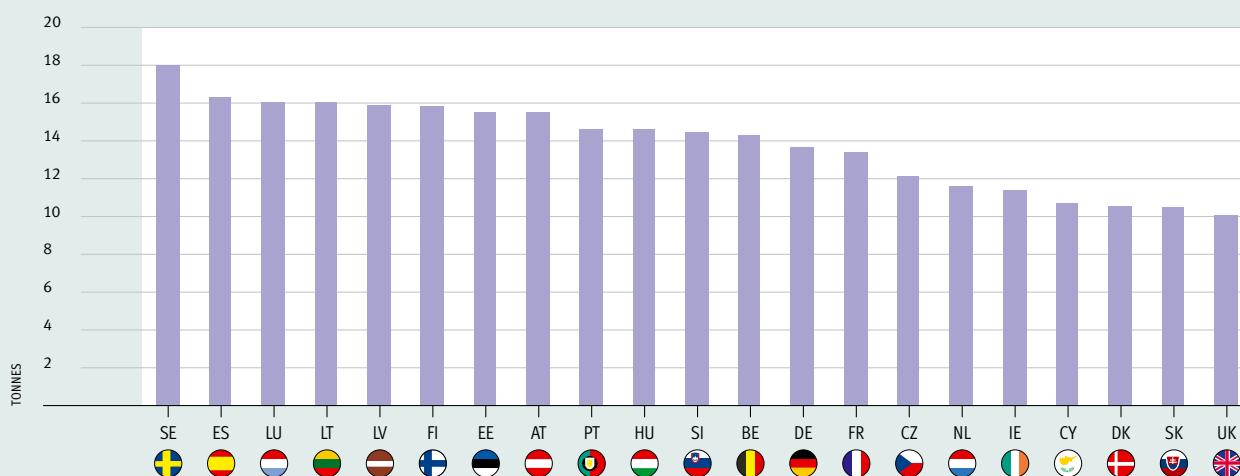
If one wishes to analyse the effects of the weight-based load factor on energy consumption and CO_2 emissions, data is also required on the tare weight of the trucks. Tare weight data is almost entirely absent from official freight statistics, despite the fact that vehicle tare weights can have a significant impact on energy efficiency. Depending on the tractor and trailer configuration, the tare weight of an articulated truck can vary from 12 tonnes (7 tonnes tractor + 5 tonnes trailer) to 20 tonnes (McKinnon and Leonardi, 2010). Research by Coyle (2007) has shown how, at the bottom end of the vehicle weight range, quite small increases in the gross weight of an articulated truck can disproportionately raise its fuel consumption.

It should also be recognised that these weight-based measures present only a partial view of vehicle utilisation as they take no account of the large proportion of loads which 'cube out' or 'floor out' before the maximum vehicle weight is reached. Trucking companies are often criticised for using only around 60% of the available weight carrying capacity of their vehicles. In practice, however, many lightly loaded vehicles are transporting low density products which can actually be filling the available cube or floor area. This was observed in studies of several major European transport companies undertaken by NEA and TFK (Lumsden, 2009). It can also be confirmed by national survey data on the nature of the load constraints on trucks. Since the late 1990s, national surveys of operators in some European countries have asked whether vehicle loads are subject to weight and / or volume constraints. This has revealed

that a much larger proportion of loads are constrained by volume than by weight. Moreover, this proportion has been increasing through time, probably for two reasons:

- increase in the maximum legal weight of trucks in some countries, such as the UK where it was raised from 40/41 tonnes to 44 tonnes in 2001.
- decline in the average density of road freight.

Another useful source of empirical data on the relationship between weight- and volume-based measurement of vehicle utilisation is the series of transport Key Performance Indicator (KPI) surveys commissioned by the UK government since 1997 (McKinnon, 2009; Department for Transport, 2009a). These unique surveys have collected data on a standard set of KPIs across samples of vehicle fleets in particular sectors, such as food and drink, non-food retailing, express parcels, automotive and building supplies. Unlike the main road freight surveys that governments conduct, these KPI surveys have endeavoured to measure the use of vehicle capacity by floor-area coverage and load height as well as by weight. Figure 5 illustrates how, across a sample of 53 fleets in the UK food supply chain, floor (or deck) area coverage was substantially higher than the conventional weight-based loading factor. The results of several of these KPI surveys also confirmed the observation of Samuelson and Tilanus (1997) in a survey of less-than-truckload operations that vehicle floor areas were relatively well covered, but in the vertical dimension much vehicle space above the load was unused.
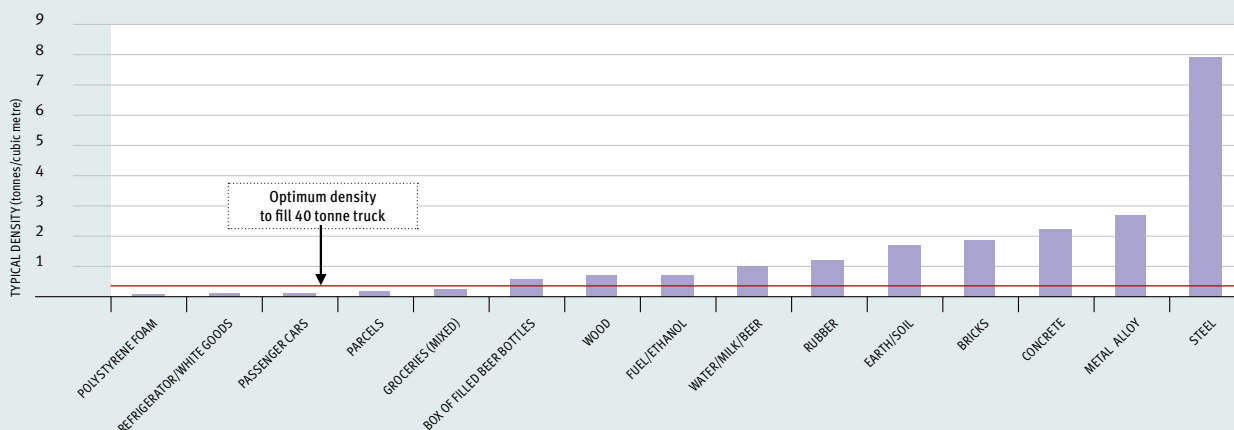
FIGURE 5: VARIATIONS IN WEIGHT AND DECK AREA UTILISATION ACROSS 53 TRUCK FLEETS

■ Deck area utilisation | ■ Weight utilisation | ── Average deck volume utilisation | ── Average weight utilisation

MEAN 69%

MEAN 53%

% OF MAXIMUM UTILISATION

VEHICLE FLEETS

SOURCE *McKinnon and Ge – 2004*

The optimum density of freight moved by a 40 tonne articulated truck with a 13.6 metre trailer 4 metres high, the typical 'workhorse' of the European road freight industry, is around 0.3 tonne/cubic metre. Freight of this density would fill the available space in the trailer and reach the maximum vehicle weight simultaneously. In practice, the actual density of freight varies widely around this benchmark figure (Figure 6).

FIGURE 6: VARIATIONS IN THE AVERAGE PRODUCT DENSITY (ADAPTED FROM GLAESER - 2010)

TYPICAL DENSITY (tonnes/cubic metre)

Optimum density
to fill 40 tonne truck

POLYSTYRENE FOAM | REFRIGERATOR/WHITE GOODS | PASSENGER CARS | PARCELS | GROCERIES (MIXED) | BOX OF FILLED BEER BOTTLES | WOOD | FUEL/ETHANOL | WATER/MILK/BEER | RUBBER | EARTH/SOIL | BRICKS | CONCRETE | METAL ALLOY | STEEL

By pricing their services on the basis of 'chargeable weight', carriers can try to use the price mechanism to attract a mix of traffic that balances weight and volume utilisation of their vehicles. A standard density of 333 kg per cubic metre is typically used in the road freight sector in chargeable weight calculations. The cubic dimensions of the load are divided by 333 kg to calculate the 'chargeable weight'. If this exceeds the actual weight of the load then the freight rate is based on the chargeable weight; if not, it is based on the actual weight. This imposes a higher per kg charge on lower density consignments. This system of charging is widely applied in the airfreight sector to incentivise the efficient use of very expensive aircraft hold capacity. It is used in the LTL / parcels sectors of the road freight market, though less extensively than in the airfreight sector and rarely in the distribution of full truck loads.

The virtual absence of data on utilisation measures 4. and 5., relating to the 2-and 3-dimensional utilisation of vehicle space, is a major statistical gap. The inclusion in some official road freight surveys of a question about whether loads are volume- and/or weight-constrained goes a small way to filling this gap. It sheds some light on volume utilisation, but only at the extreme ends of the load size and weight distributions. No information is available on the **average** volume-utilisation of the truck. Nor are respondents asked to distinguish floor-area from cubic capacity constraints.

The lack of official data on the space utilisation of trucks has in recent years posed a problem for researchers and consultants analysing the costs and benefits of allowing longer and heavier vehicles (LHVs) to operate in more European countries. To quantify the opportunities for consolidating freight in these vehicles, described by a recent OECD / ITF (2010) study as 'high productivity trucks', assumptions have had to be made about the statistical distribution of load dimensions and densities (e.g Knight et al, 2008). In the absence of extensive survey data, it is difficult to judge how realistic these assumptions have been. The main EU-commissioned study on this topic employed the Trans-Tools model to assess the impact of load consolidation in LHVs (TML et al, 2008). This analysis, however, was essentially weight-based and was not able, because of a lack of empirical data, to take adequate account of the cubic volume of freight moved by road. Inadequate measurement of vehicle utilisation may, therefore, be weakening the case for a relaxation of current limits on truck carrying capacity.

Although freight transport researchers bemoan the lack of volumetric data, they generally concede that it would be very difficult in practice to collect it. In many sectors, volumetric data is not routinely recorded and, even where it is, it is not related to the internal cubic capacity of the vehicle. As much road freight is now carried in unitised loads such as pallets, roll cages, dollies and stillages, it should in theory be possible to estimate volume utilisation by dividing the actual number of units carried by the maximum that could have been carried. This assumes, however, that the handling units have similar internal utilisation or, in the case of pallets, that their average stacking height is uniform. Regrettably, at present there is no easy and robust way of measuring the volumetric utilisation of trucks in the course of national road freight surveys, and, as governments are reluctant to impose additional data collection burdens on companies, there is little prospect of this being introduced in the foreseeable future.

Estimates of Road Freight Traffic

Trucks and vans are often blamed for much of the congestion on the road network. Trucks also account for the vast majority of 'wear and tear' to the road pavement reflecting the fact that it increases steeply with axle weight. Furthermore, the impact of road freight transport on externalities such as air pollution, noise irritation and accidents correlates much more closely with the distances trucks travel on the roads (i.e. vehicle-kms or truck-kms) than with tonne-kms and tonnes-lifted. It is important therefore that policy-makers have access to accurate truck-km data. Once more, however, a review of the statistics reveals deficiencies in currently available data.

The distances travelled by trucks on national road networks are usually estimated in two ways: from questionnaire surveys of operators and network-based traffic counts (which can be either manual or based on automatic counters embedded in the road surface). In theory, these different methods should yield the same results. In practice, there is usually a significant difference between these two sets of truck-km estimates. In the UK, for example, the traffic count survey produced a truck-km estimate in 2009 that was 40% higher that the estimate based on the annual survey of the movements of 16,000 trucks. This discrepancy more than doubled between 1996 and 2009. Significant discrepancies have also been reported in Denmark and France.

This has serious implications for the analysis of the road freight system and resulting policy prescriptions because truck-km estimates influence calculations of:

- trucks' share of total traffic and their contributions to traffic congestion, road wear and tear and emissions
- the incidence of truck-related accidents per billion kilometres travelled

- the potential income likely to be raised from road tolling schemes
- composite measures such as tonne-kms, fuel efficiency (vehicle-kms / litre) and average payload weight (tonne-kms / vehicle-kms)

It is important to discover the main causes of the truck-km discrepancy and find a means of determining a single value that commands general support. The discrepancy is generally attributed to three factors (McKinnon and Leonardi, 2010):

- National surveys of road freight operators exclude foreign-registered lorries but their movements are recorded by the network-based counts. Eurostat regularly publishes cabotage statistics (e.g. Wrzesinska, 2010), which can be used to assess the degree of foreign penetration of domestic haulage markets. These statistics suggest, however, that the presence of foreign truck traffic offers only a partial explanation of the difference in truck-km estimates.

- Misclassification of trucks and vans in manual road-side counts: Staff counting vehicles can mistake a large van for a small rigid truck. The fact that these counts tend to exaggerate truck-kms suggests that there is a systematic bias in these classification errors towards trucks.

- Under-reporting by operators of the number and / or length of trips made by the sample of trucks included in the questionnaire survey. A separate analysis of the tachographs of a sample of surveyed vehicles in the UK did show significant under-estimation. There is also evidence of operators claiming that vehicles are temporarily off the road to avoid having to complete the questionnaire when in fact that are actually being used during the survey week.

③ Carbon Footprinting of Freight Transport

The need to improve the range and quality of freight transport data has gained new urgency in recent years as governments have begun to develop carbon reduction policies for transport. The initial requirements have been to estimate the share of total greenhouse gas (GHG) emissions attributable to freight transport and to examine how this has been changing through time. To devise and refine decarbonisation strategies, governments need to supplement these macro-level calculations with disaggregated GHG estimates for specific transport modes, vehicle types and logistics sectors. This has highlighted many of the statistical gaps discussed earlier in this paper.

Macro-level estimation of CO_2 emissions from road transport

Experience in the UK illustrates the problems that can be encountered in trying to estimate CO_2 emissions from road freight transport (McKinnon and Piecyk, 2009). Four approaches can be used to calculate these estimates, each requiring different types of input data. Depending on the approach adopted and nature of the input data, estimates of the total CO_2 emissions from road freight transport in the UK in 2006 varied from 19.5 to 25.8 million tonnes. Most of this variation was attributable to the choice of data source for truck-kms and average fuel efficiency:

Truck-kms: reference was made earlier to the so-called 'truck-km discrepancy' which is particularly pronounced in the UK but also present in other EU countries. Use of the lower truck-km estimate derived from operator surveys, even after correction for foreign-registered vehicles, yielded a significantly lower CO_2 figure than the use of the network-based traffic count estimate of truck-kms.

Fuel efficiency: average fuel efficiency values can come from three sources:
(1) operator surveys
(2) laboratory-based testing of sample vehicles running on various duty cycles
(3) macro-level estimates of fuel purchases and vehicle activity

In the UK, as in many other countries, there is no differentiation of vehicle type at point of fuel purchase. No aggregate records are kept of the amounts of diesel fuel used by trucks. Instead, national consumption of fuel by trucks is estimated retrospectively on a bottom-up basis using data from either (1) or (2). If a means could be found of differentiating vehicle types in the recording of fuel purchases by the transport sector, this fuel supply data could be used to provide an independent check on bottom-up CO_2 estimates for road freight operations.

Research in the UK suggests that, of the two bottom-up methods of calculating fuel efficiency, operator surveys are likely to provide more accurate estimates. Indeed, in 2008 the UK's National Atmospheric Emissions Inventory switched the source of fuel efficiency data from (2) to (1) and, as a consequence, cut the estimated growth in CO_2 emissions from road freight between 1990 and 2005 by a factor of three (McKinnon and Piecyk, 2009). This was only possible, however, because since 1989 the UK government had included a question about fuel consumption in its annual survey of road freight operators.

EU member states are not required to collect data on truck fuel efficiency. Council Regulation 1172/98 relating to 'statistics on the carriage of goods by road' (Eurostat, 2008b) merely states that:
'Other data variables which countries **might find** useful to collect for their own internal uses are:

• *Fuel purchased during survey week:* Very important as it enables estimates of average fuel consumption to be made. Satisfactorily reported, but sometimes omitted'

It is understood that only twelve member states currently collect this data, though others are planning to do so. In the absence of this survey data researchers and government officials have little choice but to use the data derived from laboratory testing in the course of projects such as COPERT and ARTEMIS, which have been shown, at least in the UK, to under-estimate actual truck fuel efficiency.

Relative CO_2-intensity of different transport modes

At the heart of government plans to decarbonise freight transport is the transfer of freight from road to rail and waterborne modes, which emit significantly less CO_2 per tonne-km. To measure the carbon benefits of shifting freight to these modes one needs accurate estimates of their average carbon intensity. Numerous estimates exist in publications and online databases and are often adopted uncritically in modal split studies. Researchers and policy-makers must observe several caveats in using these figures:

① ▶ *Modal CO_2-intensity values are highly sensitive to the utilisation of vehicle capacity.* For example, the carbon intensity of a 40-44 tonne truck fully laden in both directions (with a 29 tonne load) is roughly a third of that a similar vehicle carrying 10 tonnes when laden and running 40% of its kilometres empty. Studies by Marintek et al (2000) and more recently Spielmann et al (2010) have shown how vehicle load factor exerts a strong influence on the energy efficiency of a range of freight transport modes. McKinnon and Piecyk (2010, p.12) also note that *'there has been evidence in the past of modal biases in the assumptions made about vehicle loading,*

with emission factors for some modes based on full loading and for others only on average load factors. It is important that the organisations compiling emission factor datasets make assumptions about vehicle utilisation explicit'.

② ▶ *Modal CO_2-intensity is generally measured with respect to weight rather than volume:* The standard carbon intensity metric is gCO_2/tonne-km. This weight-based definition of CO_2-intensity tends to favour modes and carriers carrying more dense product. Other things being equal, the denser the product, the lower will tend to be the carbon intensity value. As the rail and waterway networks cater mainly for heavier, primary products, this commodity mix tends to depress their average CO_2 emissions per tonne-km.

③ ▶ *Choice of system boundary for the modal comparison of CO_2-intensity.* Almost all the published carbon intensity values relate solely to emissions from the operation of the vehicle. As Backstrom (2009) has pointed out, however, this is only the first of a series of five system boundaries that can be drawn around the modal CO_2 calculation (labelled SB1). The boundary can be extended (through SB2 to SB5) to include GHG emissions from the related energy supply chain, from the maintenance of vehicles and infrastructure, from their construction and disposal and finally from administrative activities associated with freight transport. Some research in Sweden and the US on the carbon footprint of infrastructure construction and maintenance has suggested that enclosing these activities within the system boundary erodes some of the environmental advantage that rail transport commands at the operational, SB1 level. This is significant because a major displacement of freight from road to rail across much of Europe would require the construction of new rail lines.

④ ► *The relative CO_2-intensity of modes varies from country to country:* These variations are most pronounced in the case of rail freight operations, reflecting mainly international differences in the proportions of electrified services and the nature of the energy mix. For example, ADEME (2007), the French government environmental agency advocates an average carbon intensity value of 7.3 gCO_2/tonne-km for French rail freight services, which benefit from heavy dependence on nuclear power, whereas DEFRA (2010) recommends a value of 27 gCO_2/tonne-km for UK rail freight movements, roughly 90% of which are diesel-hauled.

④ Target-setting in the Freight Transport Sector

Politicians and government officials are sometimes reluctant to set quantitative targets for public policies as they make it easier to judge their impact and can be a source of embarrassment when a policy fails. There have, nevertheless, been several high-profile examples of policy targets being set for freight transport at both EU and national levels. For instance, the Marco Polo II programme has had the objective of transferring to rail- and water-based co-modal services the forecast growth in cross-border road tonne-kms between 2007 and 2013. Although superficially this may seem a quantitative target, the fact that it is based on a forecast trend in international tonne-kms makes it fairly notional and difficult to assess retrospectively. Modal split targets set by UK governments, such as the target in its Ten Year Transport Plan to increase rail freight tonne-kms by 80% between 2000 and 2010, have been more specific and verifiable, though still open to criticism. Woodburn (2007), for example, challenges the choice of tonne-kms as the metric for a rail freight target. He argues that *'emphasis on tonnes appears contrary to the likelihood that the majority of potential rail freight growth will come from relatively low weight sectors rather than traditional heavy products'* (p.64). He notes, for example, that *'a coal train operating over the same distance is likely to have a tonne-kilometre weighting around four or five times that of a premium logistics service'.* There is a danger that policy objectives are defined with respect to the statistical data that is available even though they may not be the most appropriate.

This earlier experience of target setting in the freight sector is very pertinent because it is likely that over the next few years sector-level CO_2 reduction targets will be introduced. Ambitious targets have been set at both EU and national levels to cut GHG emissions by 2020 and 2050. To our knowledge, no government has yet published sectoral GHG-emission targets. Targets are likely to vary by sector in relation to the relative cost-effectiveness of GHG abatement, but be generally very challenging.

Users and providers of freight transport services will be able to apply a range of mutually-reinforcing 'decarbonisation' measures to meet any carbon reduction target set for the freight transport sector. Several EU-funded studies have reviewed or are reviewing the range of CO_2-reducing measures for the freight sector, including Freightvision (AustriaTech, 2010), GHG-TransPoRD and Logman. Figure 7 outlines a decarbonisation framework that has been devised for this sector based on six key parameters (McKinnon, 2008).

FIGURE 7: DECARBONISATION FRAMEWORK FOR ROAD FREIGHT TRANSPORT
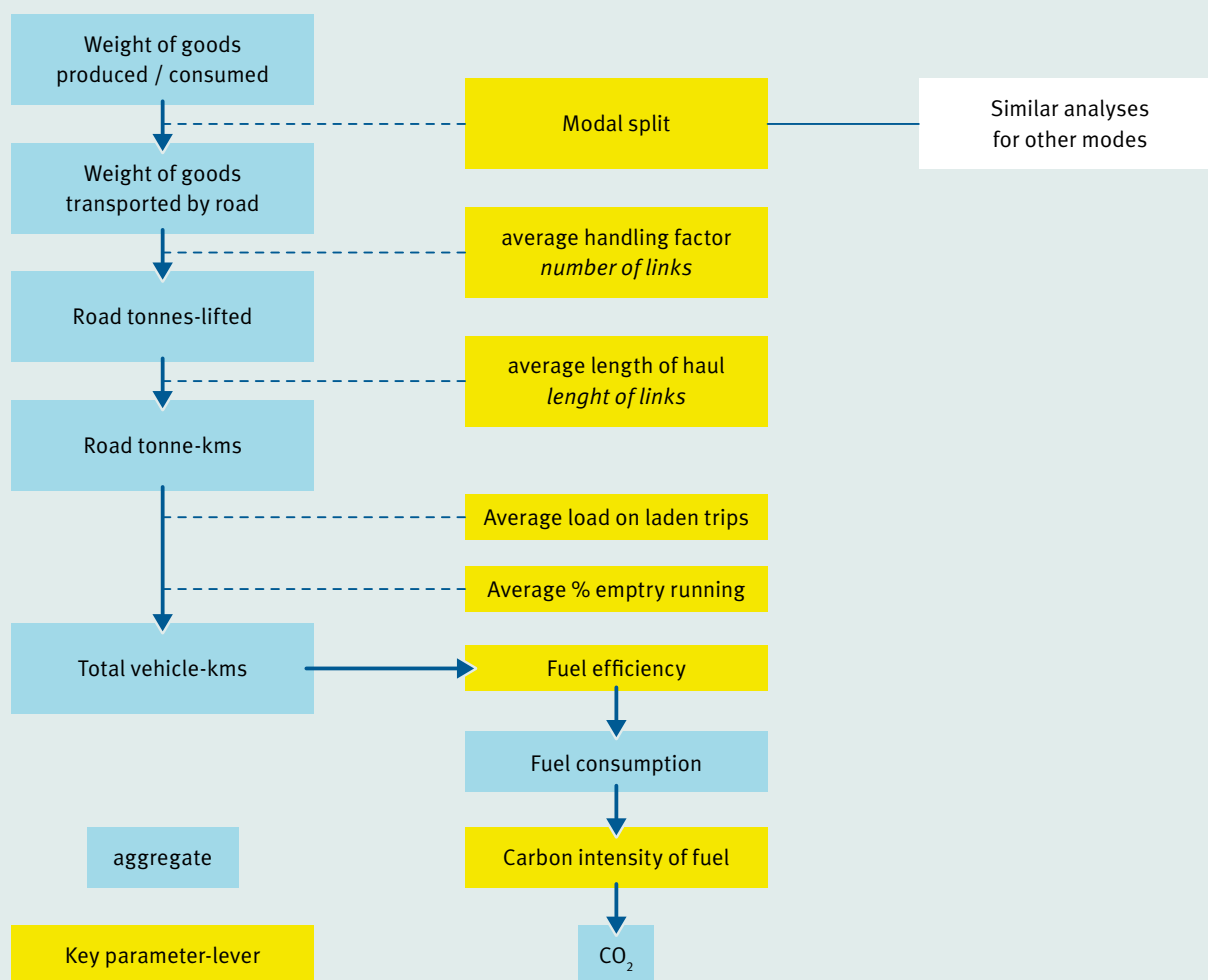
To assess the potential for altering these parameters and to review progress towards decarbonisation it will be necessary to improve statistical reporting of the related metrics. Table 3 lists the indices associated with each of the parameters and classifies them in terms of the current availability of relevant data at a macro-level. At present very few EU countries come close to collecting and publishing the data that will be required to develop, manage and monitor a comprehensive decarbonisation programme for freight transport.

TABLE 3: AVAILABILITY OF DATA REQUIRED TO CALIBRATE FREIGHT DECARBONISATION MODEL

● in some EU countries | ■ for most / all EU countries

	ROAD	RAIL	WATERWAY	INTERMODAL
Tonnes-lifted	■	■	■	
Tonne-kms	■	■	■	
Unit loads				■
Distance travelled	■			
Average payload weight	■			
Vehicle utilisation by weight	●			
Vehicle utilisation by volume				
% of empty running	■			
Fuel efficiency	●			
Carbon intensity of fuel				

Conclusions

Although researchers and policy-makers in Europe have access to a much broader range of freight statistics than their counterparts in many other parts of the world, there are still major gaps and inconsistencies. This paper has examined some of the more serious shortcomings, many of them relating to the utilisation of vehicle capacity.

Eurostat must be commended for its efforts to standardise the collection of transport data across the EU, though this has tended to be at a rather low base-level. All EU countries should be encouraged to adopt the statistical practices of those countries, such as France, Germany and the UK, which have pioneered new forms of data collection and as a result have gained a deeper insight into the efficiency and dynamics of their freight sectors[3]. It can be difficult, however, to get member states to agree to new standardised data collection methods. Indeed this process of statistical enhancement and harmonisation is likely to be inhibited over the next few years by public expenditure cuts by EU member governments and a reluctance to impose a greater data collection burden on businesses during a period of financial austerity. There is a danger too that, as an economy measure, some governments may scale down their freight transport surveys.

On the other hand, advances in information and communication technology (ICT) offer the potential to facilitate freight data collection and cut its cost. It is being deployed in the freight sector primarily to increase the visibility of delivery operations, thereby improving customer service and permitting more effective management of resources. Government statisticians must now find a way of accessing the huge amounts of operational freight data that telematics systems are generating. Questionnaire-based surveys, in which freight operators often grudgingly participate, will eventually become obsolete as information downloads ease the transfer of data into central statistical databases. Given the relatively slow rate of ICT diffusion across the European road freight sector, however, and the time taken to gain approval for new statistical procedures, it is unlikely that this will happen in the near future.

Even the conventional methods of data collection could be more effectively and extensively used to plug the numerous gaps in Table 3. This will require government commitment and resourcing, but also a willingness on the part of industry to invest time and effort in recording and supplying the necessary data. Companies must be convinced, however, that there is a genuine need for the information to support government research and policy-making and that the numbers they provide will be properly interpreted. Above all, they must recognise the value of statistics in improving our understanding of the freight transport system.

---

3. Regrettably the UK has not supplied Eurostat with national road freight statistics since 2007. It is not clear why it has suspended this practice and how long this situation is likely to prevail.

ACEA

References

ADEME (2007) 'Emission Factors Guide: Version 5'

AustriaTech (2010) 'Freightvision: Management Summary IV: Vision and Action Plan' Vienna.

Backstrom, S. (2009) 'Emission allocation methodologies and system boundary setting in transport environmental assessment/foot printing' presentation to NTM workshop, Brussels, June 24.

Caplice, C. and Sheffi, Y. (1994) 'A review and evaluation of logistics metrics' International Journal of Logistics Management, vol.5, no. 2.

Coyle, M. (2007) 'Effects of Payload of the Fuel Efficiency of Trucks' UK Department for Transport, London.

DEFRA (2010) 'Guidance on How to Measure and Report your Greenhouse Gas Emissions' London.

Department for Transport (2007) 'Road Freight Statistics 2006' London

Department for Transport (2009a) 'Road Freight Statistics 2008' London

Department for Transport (2009b) 'Key Performance Indicators for Food and Drink Supply Chains', Freight Best Practice Programme,London.

European Parliament (2010) 'Logistics as an Instrument for Tackling Climate Change' DG Internal Policies, Policy Department B: Structural and Cohesion Policies, Strasbourg.

EcoTransit (2010) http://www.ecotransit.org/

Eurostat (2008a) 'Methodologies Used in Surveys of Road Freight Transport in Member States and Candidate Countries' Luxembourg.

Eurostat (2008b) 'Road Freight Transport Methodology: Reference manual for the Implementation of Council Regulation No. 1172/98 on statistics on the the carriage of goods by road' Luxembourg.

Eurostat (2009) 'Panorama of Transport' Luxembourg.

Glaeser, K-P (2010) 'Performance of Articulated Vehicles and Road Trains regarding Road Damage and Load Capacity' Paper presented to the HVTT11 conference, Melbourne.

IURR (2009) 'Statistics 2009' Brussels.

Knight, I. et al (2008) 'Longer and / or Longer and Heavier Goods Vehicles (LHVs): A study of the likely effects if permitted in the UK: Final Report' TRL, Crowthorne.

Lumsden, K. (2009) 'Truck Masses and Dimensions: Impact on Transport Efficiency' ACEA SAG Discussion Paper, Brussels.

Marintek et al (2000) 'Study of Greenhouse Gas Emissions from Ships' Final report to the International Maritime Organisation.

McKinnon, A.C. (2007) 'The Decoupling of Road Freight Transport and Economic Growth Trends in the UK: An Exploratory Analysis' Transport Reviews, vol. 27, no.1.

McKinnon, A.C. (2008) 'The Potential of Economic Incentives to Reduce CO_2 Emissions from Goods Transport' Paper prepared for the 1st International Transport Forum on 'Transport and Energy: the Challenge of Climate Change' Leipzig.

McKinnon, A.C. (2009) 'Benchmarking Road Freight Transport: Review of a Government-sponsored Programme' Benchmarking: an International Journal, Vol. 16, no.5.

McKinnon, A.C. and Ge, Y. (2004) 'Use of a Synchronised Vehicle Audit to Determine Opportunities for Improving Transport Efficiency in a Supply Chain' International Journal of Logistics: Research and Applications, vol. 7, no.3.

McKinnon, A.C. and Ge, Y. (2006) 'The Potential for Reducing Empty Running by Trucks: A Retrospective Analysis' International Journal of Physical Distribution and Logistics Management, vol 36, no 5.

McKinnon, A.C. and Leonardi, J. (2009) 'The Collection of Long Distance Road Freight Data in Europe' in Bonnel, P., M. Lee-Gosselin, J. Zmud and J.-L. Madre (eds) 'Transport Survey Methods: Keeping up with a Changing World, Emerald, Bingley. pp 295-310.

McKinnon, A.C. and Piecyk, M.I. (2009) ' Measurement of CO2 emissions from road freight transport: A review of UK experience' Energy Policy, vol 37, pp. 3733-3742.

McKinnon, A.C. and Piecyk, M.I. (2010) 'Measuring and Managing CO_2 Emissions of European Chemical Transport' Cefic, Brussels.

McKinnon, A.C. and Woodburn, A. (1996) 'Logistical Restructuring and Freight Traffic Growth: An Empirical Assessment' Transportation, vol. 23, 2, 1996.

OECD / International Transport Forum (2010) 'Moving Freight with Better Trucks: Summary Report' Paris.

Pasi, S. (2009) 'Global Economic Crisis Hits European Road Freight Transport in the Fourth Quarter of 2008: Road Freight Transport in 2008' Statistics in Focus 86/2009, Eurostat, Luxembourg.

Spielmann, M. et al (2010) 'Comparison of Energy Demand and Emissions from Road, Rail and Waterway Transport in Long-Distance Freight Transport' PE International, Leinfelden-Echterdingen.

Samuelsson, A. and Tilanus, B. (1997) 'A Framework Efficiency Model for Goods Transportation, with an Application to Regional Less-than-Truckload Distribution' Transport Logistics, Vol. 1, No. 2, pp.139-151.

Savy, M. (2010) 'Freight Transport Modes: Competition, Co-operation or Areas of Advantage' ACEA, SAG Discussion Paper, Brussels.

Tapio, P. (2005) Towards a theory of decoupling: degrees of decoupling in the EU and the case of road traffic in Finland between 1970 and 2001, Transport Policy, vol 12, no 2, pp.137-151.

TML (2007) 'Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC' European Commission, Brussels.

US Census Bureau (2008) 'Commodity Flow Study, 2008' http://factfinder.census.gov/servlet/IBQTable?_bm=y&-geo_id=&-ds_name=CF0700P1&-_lang=en

Wrzesinska, M. (2010) 'Transport of Goods by Road has Stopped Decreasing in the Second Half of 2009' Statistics in Focus 39/2010, Eurostat, Luxembourg.

Woodburn, A. (2007) 'Appropriate indicators of rail freight activity and market share: A review of UK practice and recommendations for change' Transport Policy, vol.14, no 1, pp. 59-69.

Woodburn, A. (2010) 'Efficiency of Intermodal Port Hinterland Flows: A Case Study of UK Rail Operations' Paper presented to the 12th World Conference on Transport Research, Lisbon, July 11-15.

ACEA

ACEA

**Association des
Constructeurs Européens
d'Automobiles**

*European
Automobile Manufacturers
Association*

Avenue des Nerviens 85

B-1040 Bruxelles

Belgium

TEL +32 2 732 55 50

FAX +32 2 738 73 10

www.acea.be