Economic impact of introducing road charging for Heavy Goods Vehicles

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Abbreviations

ABMG	Autobahnmautgesetz
AEC	Spanish Road Association, Asociación Espanola de la Carretera
ASECAP	Association of European Toll Road Operators
ASETA	Spanish Association of Turnpikes, Tunnels, Bridges and Other Toll Road Concessionaire Companies, now part of SEOPAN
ASFINAG	Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft (motorway and express roads financing society)
ASTRA	ASsessment of TRAnsport Strategies. Integrated assessment model
BAG	German Federal Office for Goods Transport (Bundesamt Für Güterverkehr)
BGL	(also: BGL e.v.): Bundesverband Güterkraftverkehr, Logistik und Entsorgung (federal association for road freight transport logistics and disposal)
BMVI	German Federal Ministry of Transport and Digital Infrastructure (Bundesministerium Für Verkehr Und Digitale Infrastruktur)
CUPID	Co-ordinating Urban Pricing Integrated Demonstrations
dB(A)	Decibel, A-filter
DSVL	Deutscher Speditions- und Logistikverband
DVZ	German Transportation Newspaper (Deutsche Verkehrs-Zeitung)
EC	European Commission
EEA	European Environment Agency
EIB	European Investment Bank
EU	European Union
GDP	Gross Domestic Product
GVA	Gross Value Added
GVW	Gross vehicle weight
HBEFA	Handbook Emission Factors for Road Transport
HGV	Heavy Goods Vehicle (Usually >12 T Gross Weight)
IMPRINT-NET	Implementation Pricing Reforms in Transport – Networking
INE	Spanish National Statistics Institute (Instituto Nacional de Estadística)
IWT	Inland waterway transport
KBA	Federal Motor Transport Authority (Kraftfahrt-Bundesamt)
LGTT	Loan Guarantee Instrument for TEN-T Projects
LGV	Light goods vehicle (<3.5 t vehicle gross weight)
LHV	Longer and heavier vehicle
LPI	Logistics Performance Index

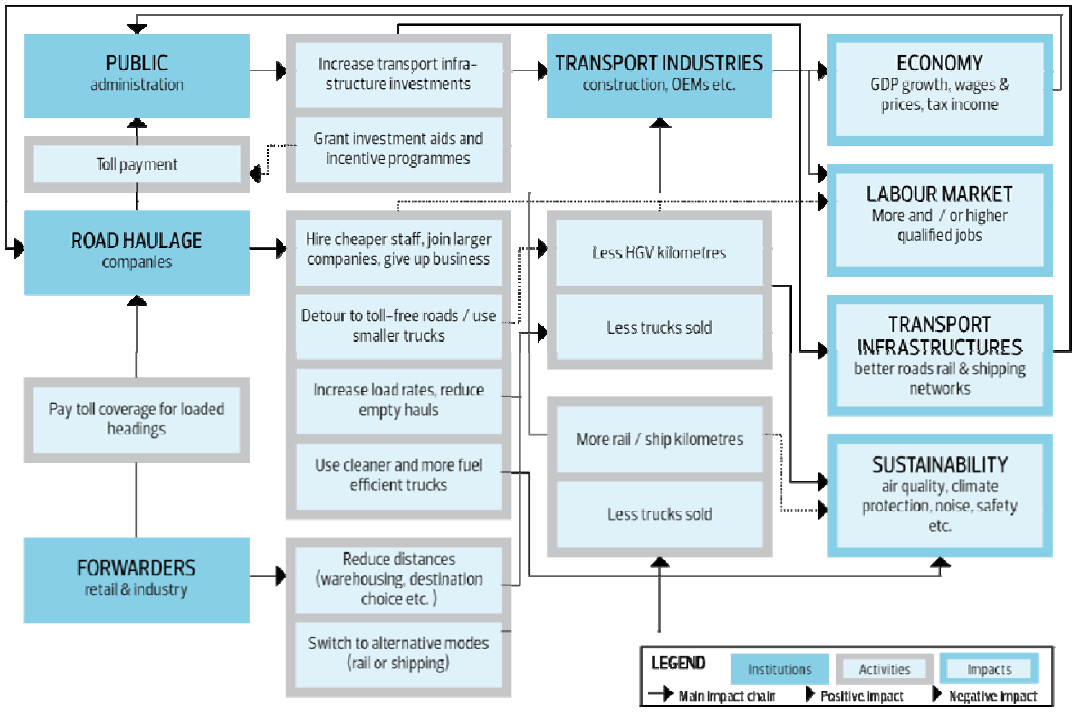
Lkw-Maut	German HGV Motorway Charge
LSVA	Swiss Performance-Related Heavy Vehicle Charge (Leistungsabhängige Schwerverkehrsabgabe)
MAGRAMA	Ministry of Agriculture, Food and and Environmental (Ministerio de Agricultura, Alimentación y Medio Ambiente)
MautHV	Mauthöhenverordnung
META	Modelo Español de Tarifación de Carreteras
MFOM	Ministry of Public Works (Ministerio de Fomento)
OBU	On-board unit (for the German Lkw-Maut)
OTLE	Transport and Logistics Observatory in Spain (Observatorio del Transporte y la Logística en España)
PATS	Pricing Acceptability in the Transport Sector
PEIT	Plan Estrategico de Infraestructuras y Transportes
REVENUE	Revenue Use from Transport Pricing
SEOPAN	Association of Construction Companies of Spain (Asociación de Emrpesas Constructoras y Concesionarias de Infraestructuras)
SME	Small and Medium Sized Enterprise
T&E	Transport and Environment
ToR	Terms of Reference
TRANSyT	Transport Research Centre (Centro de Investigación del Transporte, UPM)
UBA	The Federal Environment Agency (Umweltbundesamt)
UN	United Nations
UNITE	Unification of Accounts and Marginal Costs for Transport Efficiency
UPM	Polytechnic University of Madrid (Universidad Politécnica de Madrid)
VIFG	Verkehrsinfrastrukturfinanzierungs-Gesellschaft

Executive Summary

This report presents the economic and environmental impacts of introducing or expanding road toll systems for heavy goods vehicles (HGVs) in some Spanish regions and their comparison with the impacts of the German toll system. The study was carried out by Fraunhofer ISI in collaboration with the Polytechnic University of Madrid on behalf of Transport & Environment (Brussels) between March and June 2016.

Investigated are potential efficiency gains, business impacts, regional competitiveness and labour market impacts, funding issues, and environmental sustainability. Many of these aspects and the institutions behind them interrelate, which results in a rather complex network of causal relationships as indicated by Figure S-1.

Figure S-1: Schematic illustration of causes and effects of introducing HGV road tolls



Source: Fraunhofer ISI / UPM

We investigate these impacts with a suite of tools: literature review, statistical data analysis, sector interviews, and the application of the ASTRA-EC system dynamics model for transport and economic evolutions.

Main findings

The following eight theses summarise the main findings and recommendations of the study. Where appropriate we provide specific information on the two study regions: Germany and Spain with reference to the provinces of Noreste and Southern Spain.

❶ **Transport efficiency in the road sector can be improved by increasing the cost pressure.** The efficiency of vehicle utilisation, the development of average transport distance and company structures differ widely across Europe, and so does the potential for further efficiency gains. Moreover, after invoicing a share of toll costs to their clients, the remaining cost burden of haulers remains small.

- Since 70% to 80% of tolls for loaded headings have been passed on to forwarders, the cost increase for German truckers is around 2% to 3%. Nevertheless, the introduction of the Lkw-Maut has contributed to further decrease the share of empty headings by 1% to 2%, and to stop the trend of growing average transport distance.
- With 47% of empty headings the overall efficiency of the Spanish trucking sector is far below the German share of 20%, suggesting room for efficiency gains. However, 91% of Spanish haulage companies consist of no more than five employees, indicating a high probability of consolidation among haulage companies when tolls are increased in level and / or geographical scope.

❷ **Transport volumes of rail and shipping grow with higher HGV tolls, but the respective decline in road volumes is marginal.** More expressed mode shift requires high quality and competitive alternatives to road as demonstrated in Switzerland and Austria.

- In Germany, market observations of the ministry for freight traffic diagnosed that mode shift targets of the Lkw-Maut were not met. Transport model applications confirm that an expansion of the Lkw-Maut to all roads would lift rail and shipping volumes by 5% at a 1% decline of road volumes.
- In Spain, the different track gauge to the rest of Europe make shifts to rail more complicated than for Germany. This is confirmed by stakeholder interviews and transport model applications. However, since the market share of the Spanish rail freight sector is currently very low, an extension of the road tolls could lead to a volume increase of up to 12% in some regions

❸ **Profit margins in the transport sector are affected, but to a minor extent only.** Most companies can pass on additional costs to their clients. Only the large number of small transport companies, which have a too weak market position to negotiate for suitable deals, cannot balance additional costs within a larger network.

- In Germany, profit margins are as low as 1% for small hauliers, and these most likely have to face a cost increase due to the Lkw-Maut. In contrast, profit margins reach 6% and more for the big players. For small hauliers toll costs are thus way more threatening than for large companies, who also have more options for logistics optimisation available.
- The commercial road haulage sector in Spain is highly atomised with 91% of companies having no more than five employees. These SMEs are generally in a weak position to pass on tolls and to negotiate higher freight rates.

4 Impacts on economic growth, employment and consumer prices are negligible. Impacts on such indicators will vanish in the fluctuations and longer-term trends of global and national markets. Changes in production costs and product prices estimated by economic models range well below 1%.

- For Germany, studies estimate a share of transport costs at production costs between 2% and 3%. Thus, an increase of toll costs that would lead to an increase of transport costs by 15% would only impact the overall product costs by 0.5% on average.
- Literature for Spain confirms that a rearrangement of prices takes place, but that this would only be noticeable in the first year of the introduction of tolls.

5 Funds for road investment are determined by institutional settings and by earmarking rules. In publically owned and governed systems like the German Lkw-Maut, the allocation of revenues to specific sectors largely depends on political decisions.

- The German Lkw-Maut more or less replaced the existing tax funding of the HGV share of motorway costs upon introduction in 2005. After an initial distribution of revenues to all modes, since 2011 revenues are earmarked to federal roads only. Although the Transport Infrastructure Financing Society in Germany formally uses all Lkw-Maut revenues for road investment, the funding system is not closed as cost share for cars and non-tolled federal roads are decided by the finance minister.
- This household-dependency ensures that the road funding system cannot go bankrupt. On the other hand, Spanish road operators remain more independent of state funding needs and political preferences, but they bear a higher risk because of the lack of flexibility of the contracts.

6 Vignette solutions and tax regimes will cover only a fraction of infrastructure costs and will hardly incentivise a more sustainable purchase and use of vehicles. As their average charge levels are low compared to distance based tolls for commercially used trucks, vignettes will thus only little contribute to logistics efficiency or to the reduction of externalities and congestion. On the other hand, these alternative

funding sources are cheaper to implement and avoid economic burdens on small haulage companies..

- For a central country like Germany with rather high fuel taxes, distance based tolling is the better solution as this allow a fair charging of domestic as well as of foreign trucks using the national road infrastructure. With the high share of transit traffic, funding and acceptability is well manageable.
- Due to little transit traffic, which could be skimmed off, to long distances that Spanish hauliers have to travel to get to the European core markets, and due to the large number of small transport companies the Spanish logistics sector is rather sensitive to tolling. Alternative funding sources, including vignettes, thus deserve consideration. In any case, changes in tolling systems have to be well prepared through stakeholder participation processes and in-depth sector studies.

7 **Reliable road maintenance need closed funding cycles.** These are neither given in Germany nor in Spain. The Austrian system of an autonomous funding and road operation agency may be a good compromise between concession and state owned models.

- In Germany, which is among the richest economies in Europe, the quality indicators for the federal motorway and trunk road network are rapidly deteriorating, despite the Lkw-Maut tariffs having been calculated on the basis of funds required for closing the investment gap.
- The economic crisis caused a major budget shortfall in Spain for maintaining the road infrastructure which has been built over the last two decades. According to the Spanish Road Association, the road maintenance deficit in Spain accounts for €6.6 billion. Interview results for Spain state that less congestion and better pavement conditions for toll roads are expected if tolls are implemented. The concession contracts between the national and regional governments and the concessionaires guarantee for certain quality standards and are thus considered a pre-condition for an effective use of toll revenues..

8 **Intermodal infrastructure needs public funding**. One of the few public models for a large-scale, cross funding of rail infrastructure by road user charges is the Swiss heavy vehicle fee. Its success factor is the country's strong instrument of citizen participation, which cannot be easily transferred to other European countries. Other models like the intermodal, earmarking of the German Lkw-Maut and the planned Eco-Tax in France had to be resigned after strong protests from local policy and the trucking sector. The implementation of road toll systems for cross-funding thus has to be well prepared and communicated before fixing funding rules.

9 HGV toll scenarios impact the external costs of freight transport, but the total effect remains rather limited. Environmental benefits from road tolling arise from efficiency gains in trucking, from mode shift effects and from reduced HGV kilometres. All three effects remain moderate with current charge levels, and so do the economic external costs calculated for these impacts.. Depending on the incentive structure associated with the toll, total savings may range in the order of magnitude of 2% to 5% of total external costs in 2030.

- Resulting from demand growth, from lower emissions and from enhanced safety, average costs in Germany rise by 2% per tkm. In 2030, savings in external costs due to demand changes because of higher toll costs are €38.5 million or 0.5% as compared to a business as usual scenario. Way larger savings can be expected due to toll-driven technical and operational improvements in the road sector.
- Respective figures for Spain are €370 million (0.01%) for Noreste and €1.37 million (0.06%) for Southern Spain. Here, the potential efficiency gains are most likely much more expressed than in Germany.

Final remarks

We can summarise our findings as follows: road toll can be a significant source of government revenues that encourages users to a more rational mobility without having noticeable negative impacts on the logistics sector. As demonstrated in Germany, sustainability benefits can be built in through incentive structures e.g. by tariff differentiation.

The full version of this study contains an elaborated list of recommendations as well as full data and references to the statements made in this summary report.

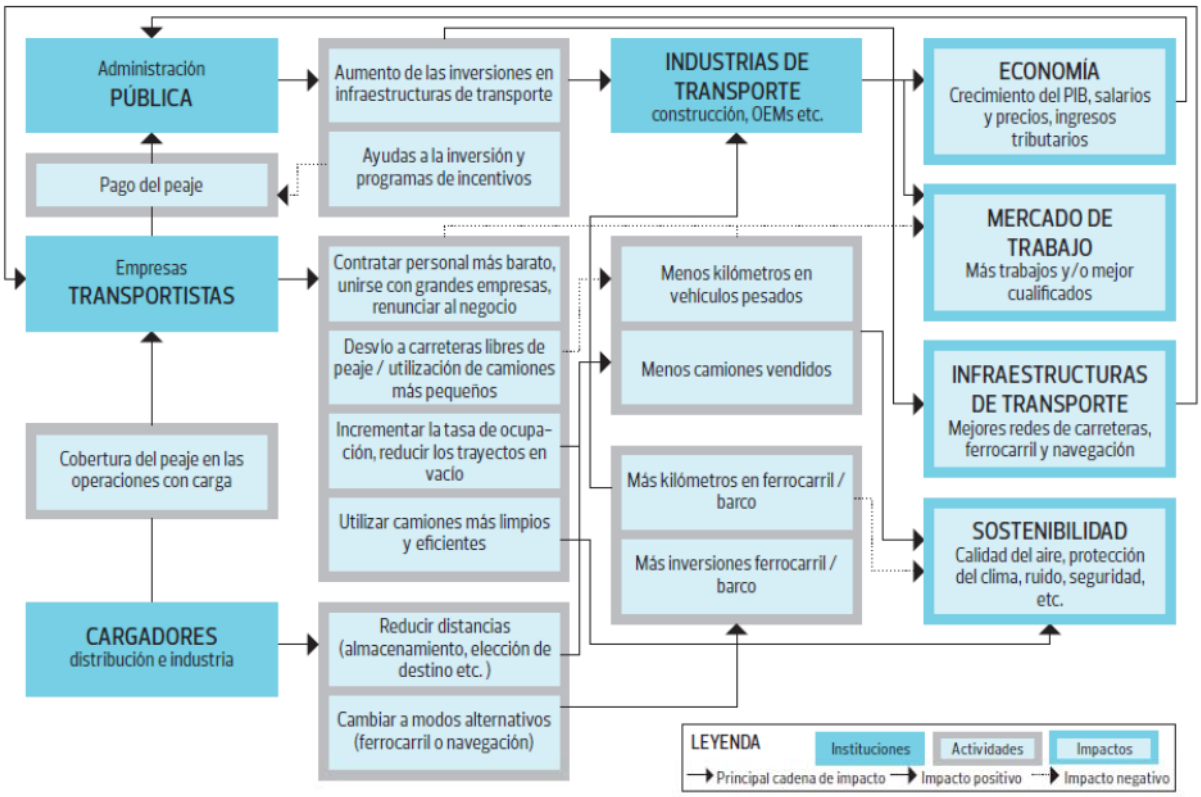
Resumen ejecutivo

Objetivo y enfoque de este informe

Este informe presenta los impactos económicos y ambientales derivados de la introducción o ampliación de los sistemas de tarificación a vehículos pesados de mercancías en ciertas regiones de España y su comparación con los impactos del sistema de peaje alemán. El estudio fue llevado a cabo por Fraunhofer ISI en colaboración con la Universidad Politécnica de Madrid, por encargo de Transport & Environment (Bruselas) entre marzo y junio de 2016.

Se investigan los potenciales aumentos de eficiencia, las repercusiones empresariales, los efectos en la competitividad regional y en el mercado de trabajo, así como cuestiones relativas a la financiación y sostenibilidad medioambiental. Muchos de estos aspectos y las instituciones detrás de ellos están interrelacionados, dando como resultado un conjunto bastante complejo de relaciones causales tal y como se indica en la Figura S-1.

Figura S-1: Ilustración esquemática de las causas y efectos de la introducción de peajes a vehículos pesados



Fuente: Fraunhofer ISI / UPM

Para investigar estos impactos se han adoptado una serie de herramientas: revisión de la literatura, análisis de datos estadísticos, entrevistas del sector y aplicación del modelo de dinámica de sistemas ASTRA-CE a fin de estimar la evolución económica y de los flujos de transporte.

Principales resultados

Las siguientes ocho tesis resumen los principales resultados y recomendaciones del estudio. En su caso, se aporta información específica sobre las dos regiones de estudio: Alemania y España, haciendo especial referencia a las provincias del noreste y sur de España.

1 La eficiencia del transporte en el sector de la carretera se puede mejorar aumentando la presión en los costes. La eficiencia en la utilización del vehículo, la distancia media de transporte y las estructuras empresariales difieren considerablemente a lo largo de Europa, y lo mismo ocurre con el potencial de mejora de la eficiencia. Por otra parte, al trasladar una parte de los costes de peaje a sus clientes, la carga asumida finalmente por los transportistas resulta relativamente pequeña.

- Entre el 70 y el 80% del coste de los peajes cobrados cuando los vehículos van llenos repercute en los cargadores. Esto ha ocasionado que los transportistas alemanes hayan visto incrementados sus costes totales entre un 2 y un 3%. Sin embargo, la introducción del sistema alemán de peaje a vehículos pesados (Lkw-Maut) ha contribuido a disminuir aún más el porcentaje de retornos en vacío –entre un 1 y un 2%–, y a detener la tendencia al crecimiento de la distancia media de transporte.
- Con un 47% de operaciones en vacío en España frente a un 20% en Alemania, se puede afirmar que la eficiencia global del sector de transporte por carretera español es muy inferior al alemán. Por consiguiente, existe en España un amplio margen de mejora en cuanto a ganancias potenciales de eficiencia. Sin embargo, el sector del transporte en España está muy atomizado –el 91% de las empresas de transporte españolas tienen menos de cinco empleados–, lo que indica una alta probabilidad de fusiones e integraciones en el caso de que se incrementen los peajes y/o su alcance geográfico.

2 Los volúmenes de transporte ferroviario y marítimo aumentan cuando se incrementan los peajes a vehículos pesados, pero la respectiva disminución de volumen de transporte por carretera es marginal. Como se ha demostrado en Suiza y Austria, conseguir un cambio más rápido en el reparto modal requiere alternativas de alta calidad y competitivas al transporte de mercancías por carretera.

- En Alemania, datos de tráficos de mercancías del Ministerio dejaron patente que los objetivos de cambio modal al introducir el peaje no se habían cumplido. Los mode-

los de transporte confirman que la ampliación del sistema a todas las carreteras incrementaría los volúmenes de transporte ferroviario y marítimo de mercancías en un 5% mientras que el volumen transportado por carretera sólo disminuiría en un 1%.

- En España, la red ferroviaria tiene un ancho de vía diferente al del resto de Europa, lo que hace que el transvase de la carretera al ferrocarril sea más complicado que en Alemania. Este hecho ha sido confirmado mediante entrevistas con los principales interesados y la calibración de modelos de transporte. No obstante, dado que la cuota de mercado del sector de transporte ferroviario de mercancías español es tan baja, una extensión de los peajes en la red viaria podría elevar los volúmenes actuales hasta un 12% en algunas regiones.

3 Los márgenes de beneficio en el sector del transporte apenas se ven afectados. Las empresas de transporte de mayor tamaño tienen capacidad de trasladar los costes adicionales a sus clientes. No obstante, existe un gran número de empresas de pequeño tamaño que se encuentran en una posición de mercado muy débil a la hora de negociar ofertas adecuadas, siendo incapaces de equilibrar los costes adicionales con sus clientes.

- En Alemania, los márgenes de beneficio de las pequeñas empresas de transporte son del orden del 1%, siendo éstas las que más sufrirían un posible aumento de los peajes. Las grandes empresas, por el contrario, tienen unos márgenes de beneficios del 6% o superiores. En consecuencia, los peajes resultarían una carga mayor para las pequeñas empresas transportistas que para las grandes, quienes a su vez cuentan con más opciones disponibles para optimizar la logística.
- El sector del transporte de mercancías por carretera en España está muy atomizado, contando con un 91% de microempresas que no tienen más de cinco empleados. Estas PYMEs se encuentran por lo general en una posición de debilidad a la hora de trasladar el coste de los peajes y negociar un incremento de los precios de los fletes.

4 Los impactos sobre el crecimiento económico, el empleo y los precios de consumo son insignificantes. Los impactos sobre dichos indicadores tenderán a desaparecer en las fluctuaciones y las tendencias a largo plazo de los mercados nacionales y mundiales. Las variaciones en los costes de producción y los precios de los productos estimados por los modelos económicos están muy por debajo del 1%.

- Para Alemania, algunos estudios estiman que el coste del transporte supone entre el 2 y el 3% del coste de producción. Por tanto, un incremento de los costes de peaje que diera lugar a un incremento de hasta el 15% del coste de transporte tendría una repercusión en los costes globales de producción del 0,5% de media.

- Estudios realizados en España confirman que la tarificación da lugar a un reajuste de los precios sólo apreciable el año de introducción del peaje.

5 Los recursos para la inversión en carreteras vienen determinados por parámetros institucionales y reglas de afectación fiscal. En los sistemas de titularidad y gestión pública como el sistema de peaje alemán, la asignación de los ingresos a sectores específicos depende en gran medida de decisiones políticas.

- El sistema de peaje alemán ha reemplazado más o menos a la financiación presupuestaria en la parte correspondiente a los vehículos pesados desde su introducción en 2005. Tras un periodo inicial en el que los ingresos del sistema fueron distribuidos entre los diferentes modos de transporte –ferrocarril, vías navegables y carretera–; desde 2011 los ingresos se destinan únicamente a la red de carreteras federales. Aunque la Sociedad de Financiación de Infraestructuras de Transporte en Alemania utiliza formalmente todos los ingresos del sistema de peaje para realizar inversiones en carreteras; el sistema de financiación no es cerrado ya que es el ministro de Finanzas quien decide el reparto para vehículos y carreteras federales libres de peaje.
- Esta relación de dependencia evita que el sistema de financiación de carreteras pueda quebrar. Por otra parte, los operadores privados de carreteras en España conservan una mayor independencia de la financiación del Estado así como de decisiones políticas. No obstante asumen un nivel de riesgo mayor debido a la falta de flexibilidad de los contratos.

6 Soluciones como la implementación de viñetas o impuestos afectados cubrirán únicamente un porcentaje del coste de la infraestructura, e incentivarán en menor medida a un comportamiento sostenible en la compra y uso de vehículos. Debido a que, para camiones, los precios de la viñeta son comparativamente menores que los de los peajes asociados a la distancia; éste mecanismos de financiación contribuirá sólo marginalmente a la mejora de la eficiencia logística, y a la reducción de las externalidades y la congestión. Por otra parte, estas fuentes alternativas de financiación son más baratas de implementar y resultan menos gravosas a las pequeñas empresas de transporte.

- Para un país central como Alemania, con impuestos sobre el combustible relativamente altos, la mejor solución son los sistemas de peaje basados en la distancia, ya que permiten la tarificación justa de los vehículos pesados –tanto nacionales como extranjeros– que usan la red de infraestructura. Debido al gran volumen de tráfico de tránsito en Alemania, tanto la financiación como la aceptabilidad de la medida han sido gestionadas correctamente.
- En España, el escaso tráfico de tránsito, las largas distancias que los transportistas españoles tienen que cubrir para llegar a los principales mercados europeos, y la

existencia de un gran número de pequeñas compañías de transporte, hacen que el sector logístico español sea bastante sensible al peaje. Debido a ello, tiene sentido plantearse la posibilidad de utilizar fuentes de financiación alternativas, como las viñetas. No obstante, cualquier cambio a introducir en el sistema de tarificación debe estar adecuadamente preparado y basarse en procesos de participación de las partes interesadas y profundos estudios del sector.

7 Un mantenimiento de carreteras fiable requiere ciclos cerrados de financiación. Estos ciclos no se dan ni en Alemania ni en España. El sistema austriaco, que está basado en un organismo autónomo de financiación y operación de carreteras, podría representar una adecuada solución de compromiso entre el modelo de concesión y el de propiedad estatal.

- En Alemania, una de las economías más ricas de Europa, los indicadores de calidad de la red de autopistas federales se está deteriorando rápidamente a pesar de que las tarifas fueron calculadas en función de los fondos necesarios para solucionar la brecha de financiación existente en las mismas.
- La crisis económica ha llevado consigo una importante reducción de los presupuestos para mantener las carreteras construidas durante años en España. De acuerdo a la Asociación Española de la Carretera, el déficit de mantenimiento en España se cuantifica en 6.600 millones de euros. Los resultados de las entrevistas realizadas muestran que la implementación de sistemas de tarificación en las carreteras conllevaría una menor congestión y una mejora del estado de las carreteras. Los contratos de concesión entre los gobiernos (nacional y regionales) y las concesionarias garantizan determinados estándares de calidad y por lo tanto aseguran un uso eficaz de los ingresos derivados del peaje.

8 La infraestructura intermodal necesita financiación pública. El modelo suizo de tasa por uso de las carreteras es uno de los pocos modelos que permite la financiación cruzada a la infraestructura ferroviaria. El factor de éxito de esta medida recae en el importante instrumento de participación ciudadana del país, que difícilmente puede ser trasladado a otros países europeos. Otros modelos de asignación de recursos a diferentes modos, como el sistema alemán o la prevista ecotasa francesa, tuvieron que ser desestimados debido a fuertes protestas de los responsables políticos locales y del sector de transporte por carretera. Por lo tanto, la implementación de sistemas de tarificación que contemplen la financiación cruzada debe prepararse y comunicarse adecuadamente antes de establecer el marco de financiación.

9 La tarificación de vehículos pesados tiene un impacto positivo pero limitado en la reducción de externalidades del transporte de mercancías. Los beneficios medioambientales de los peajes provienen de las ganancias de eficiencia en el sector

del transporte de mercancías, de la transferencia de cargas a modos más limpios, y de la reducción de los kilómetros hechos por los camiones. Con el nivel actual de peajes estos tres efectos resultan moderados, por lo que también resulta moderada la reducción de costes externos. Dependiendo de la estructura de incentivos asociada al peaje, los ahorros totales se situarían en un orden de magnitud de entre el 2 y el 5% del total de costes externos en el año 2030.

- Debido al crecimiento de la demanda, a las menores emisiones y a la mejora de la seguridad, los costes medios en Alemania se incrementan un 2% por t-km. En 2030, los ahorros en costes externos debidos a los cambios de demanda motivados por los mayores costes de peaje serán de 38,5 millones de euros o de un 0.5% frente al escenario base.
- En el caso de España, en el noreste del país los ahorros serían de 370 millones de euros (0,01% en comparación con el escenario base); y, para el sur, de1.37 millones de euros (0,06%). En este caso, las posibles ganancias de eficiencia se producen más rápidamente que en Alemania.

Observaciones finales

Podemos resumir los resultados de este trabajo de la siguiente manera: los peajes pueden ser una fuente significativa de ingresos para los gobiernos que incentive a los usuarios a una movilidad más racional, sin que tenga impactos negativos importantes en el sector logístico. Tal y como se demostró en Alemania, se pueden lograr beneficios sustanciales mediante estructuras de incentivos como la diferenciación tarifaria.

La versión completa de este estudio contiene una lista de recomendaciones, así como los datos completos y las referencias a los puntos descritos en este resumen.

1 Introduction

1.1 Overview: Freight transport, tolls and the environment

Since the 1990s, the European Union (EU) has promoted a sustainable transport strategy involving the reorganization of freight transport. The transport sector has been the fastest growing energy consumer and therefore a main source of greenhouse gas and air pollutant emissions in the past decades. On the other hand, mobility and in particular, freight transport, drives modern economies and provides a significant number of jobs. In order to preserve the environment and at the same time support economic prosperity, in its 2001 transport White Paper, the EU promoted the full internalization of the external costs of transport and the decoupling of transport from economic growth (EC 2001). Together with the regulation of vehicle emission standards and emission-dependent vehicle taxation, European and national transport policies have managed to curb the environmental burden from transport considerably since the early 1990s. The same holds true for traffic safety, where fatality rates have been halved since then.

Since the 1950s, and in particular after the liberalisation of European freight markets in the early 1990s, road haulage has evolved to become the dominating factor in national and international logistics. Despite major efforts of the EU and some member states to support the railways, the market share of trucks at tons lifted in the EU-28 has stabilized to just below 80% in western Europe, at 95% in Spain and at close to 70% in Germany. In eastern European economies road haulage is still about to gain market shares. This general observation shall, however, not exclude that in specific markets and countries, such as the Alpine and the Baltic states, mode shift policies work and the railways experience high market shares (Doll et al., 2015).

However, it is necessary to bear in mind geographical differences. Germany, representing the core markets of the European Union, is a transit country in the center of Europe. In these economies transport volumes are not necessarily linked to economic activity. In contrast Spain represents the peripheral regions of the EU which do not have significant transit traffic. These countries show a more direct link between economic activity and freight performance on national territory. As an example, in 2014, Germany had 77,123 million tons coming from the EU28 countries; whereas Spain had only 6,301 million tons coming from the EU28 countries, which is equal to 8% of the total for Germany (Eurostat, Online).

Since 1960, the idea of charging transport users has been under debate in the EC for fairness and efficiency objectives based on marginal pricing principles. It has sought to implement policies that aim at better managing road freight transport. The “Eurovi-

gnette Directive" for example, aims at charging Heavy Goods Vehicles (HGVs) for costs of air and noise pollution, along with the economic costs of road construction, maintenance, and operation in order to reduce congestion problems and benefit those companies that invest in efficient logistics, less polluting vehicles and more sustainable transport for the long term (European Commission, 2010). Nevertheless, large differences on its application remain among EU Member States.

Besides moderating the social impacts of transport on our society, transport pricing follows the objective of financing the construction, maintenance and operation of transport networks. This rationale gets ever more important since public funds tend to become more scarce and since the massive investments in particular in road networks of the 1960s to 1980s now slip into major maintenance or renewal phases.

In order to stabilize the financing conditions of the tax funded federal roads and to better manage the traffic of goods on its motorways, Germany implemented the Lkw-Maut in 2005. Having replaced the Eurovignette-System which was in place since 2003, it was designed as a toll for freight vehicles based on the number of kilometers driven, number of axles and the emissions category for heavy trucks, at that time of more than 12 tons. In 2007, it included high level secondary roads and since 2015, trucks heavier than 7.5 tons are charged. Revenues were first used to fund road transport, rail and inland waterways, but since 2010, they are just devoted to roads.

Other countries like Spain and France have started earlier to fund new motorways with concession models and toll systems. Thus, they did not have to implemented new tolling policies in recent years since there were no attempts to internalize transport external costs. In Spain it was back in July 1969, when the first toll motorways officially started operations, and nowadays Spain has more than 3,307 km of tolled motorways, which means approximately 20% of its high capacity road network. It is mainly based on traditional distance-based charges, although some shadow toll roads do exist. (Ministerio de Fomento, 2015). There are some regions in Spain with a high rate of tolls like La Rioja or Catalonia, whereas other regions have very low or even inexistent tolls.

1.2 Mandate and objectives

This report presents the results of a study on the transport sector, economic and environmental impacts of introducing or expanding road toll systems for heavy goods vehicles in Germany and in selected Spanish regions. The study was carried out by the Fraunhofer-Institute for Systems and Innovation Research ISI (Karlsruhe, Germany) in collaboration with the Polytechnic University of Madrid UPM (Spain) on behalf of

Transport & Environment (Brussels) between March and June 2016. This detailed study is accompanied by summary reports in English and Spanish.

The core objective of the study is to shed light on the economic impacts of road tolls on the transport sector as well as on regions and countries. Within four impact areas, the study addresses several research questions. The 13 research questions are listed in the following box. Explicit answers to each of them are provided in the final conclusions (Chapter 8).

Part I: Effects on logistics efficiency:

(1) How is the overall efficiency of the logistics sector affected?

(2) Which impacts on specific groups of actors do occur?

(3) What are potential impacts of extending road charging systems?

(4) Do road charges contribute to a better use of all modes of transport?

Part II: Effects on the economic performance of the sector:

(5) Which direct impacts do hauliers experience?

(6) How are commercial margins and bankruptcies affected?

(7) Are there effects on consumer prices?

(8) Do charges influence the positioning of countries as logistics hubs?

Part III: Effects on budget, revenues and infrastructure:

(9) How do public revenues develop with road charging?

(10) Which impacts can be expected from alternative funding sources?

(11) Which impacts on road maintenance can be observed?

Part IV: Impacts on external costs:

(12) To what extent can air pollution external costs and mortality be avoided?

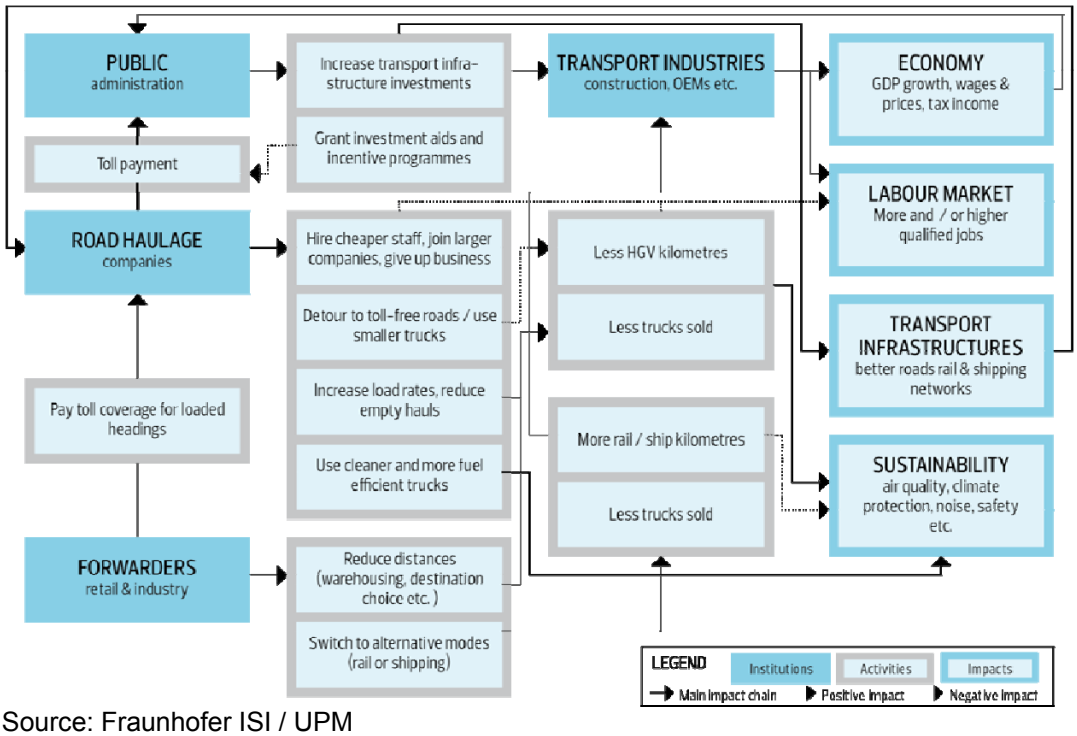
(13) How are greenhouse gas emissions, safety and other externalities affected?

These questions are discussed for three case studies: the HGV charge (Lkw-Maut) in Germany and the two regions of La Rioja in North-Eastern Spain and Jaén in the Southern Spanish region of Andalucía. Wherever possible, the study aims at addressing these questions with a mix of various information sources, including the review of

literature and statistics, the application of a transport and economic simulation model, and the results from a qualitative questionnaire survey and stakeholder interview.

The study deals with several aspects of toll impacts inside and outside the road haulage sectors in Germany and Spain. Investigated are potential efficiency gains, business impacts, regional competitiveness and labour market impacts, funding issues and environmental sustainability. Many of these aspects and the institutions behind them inter-relate, which results in a rather complex network of causal relationships as indicated by figure S1.

Figure S-1: Schematic illustration of causes and effects of introducing HGV road tolls



Source: Fraunhofer ISI / UPM

1.3 Structure of the report

After some introductory remarks upon several aspects of the study, we start with providing an overview of European, German and Spanish HGV charging policies in Chapter 2. Chapter 3 then provides an overview of the methodologies and tools applied to address the research questions of this study.

Chapters 4 to 7 form the main body of the study. According to the above structure of research questions, these deal with the following four topic areas: logistics efficiency (Chapter 4), economic performance (Chapter 5), budgets and revenues (Chapter 6) and finally with external costs (Chapter 7). Within each of the chapters, the report walks

through the related research questions and for each research question, evidence from our methodological toolbox for Germany and for Spain is presented. All of the four chapters end with concluding remarks about the main findings.

Finally, Chapter 8 provides the conclusions across the entire report. In a condensed way, the results and most relevant lines of discussion for each of the research questions are presented here. The annex to the report contains details on the stakeholder questionnaire carried out during the course of the study.

2 HGV tolling in Europe and in the study regions

This section intends to introduce the subject of this study. It starts with a brief history of European initiatives to charge for the use of road infrastructure and turns then to the cases of Germany and Spain.

2.1 European HGV charging policy

After some failed attempts in the late 1960s, the idea of charging transport users for the utilization of infrastructures re-appeared with the Commissions Green Paper on fair and efficient pricing in 1995 and the subsequent white paper on Infrastructure Charging published in 1998. The concepts of the Commission were mainly based on marginal pricing principles, i.e. tariffs which reflect the additional costs which a user is adding to the system and to society while carrying out a certain trip.

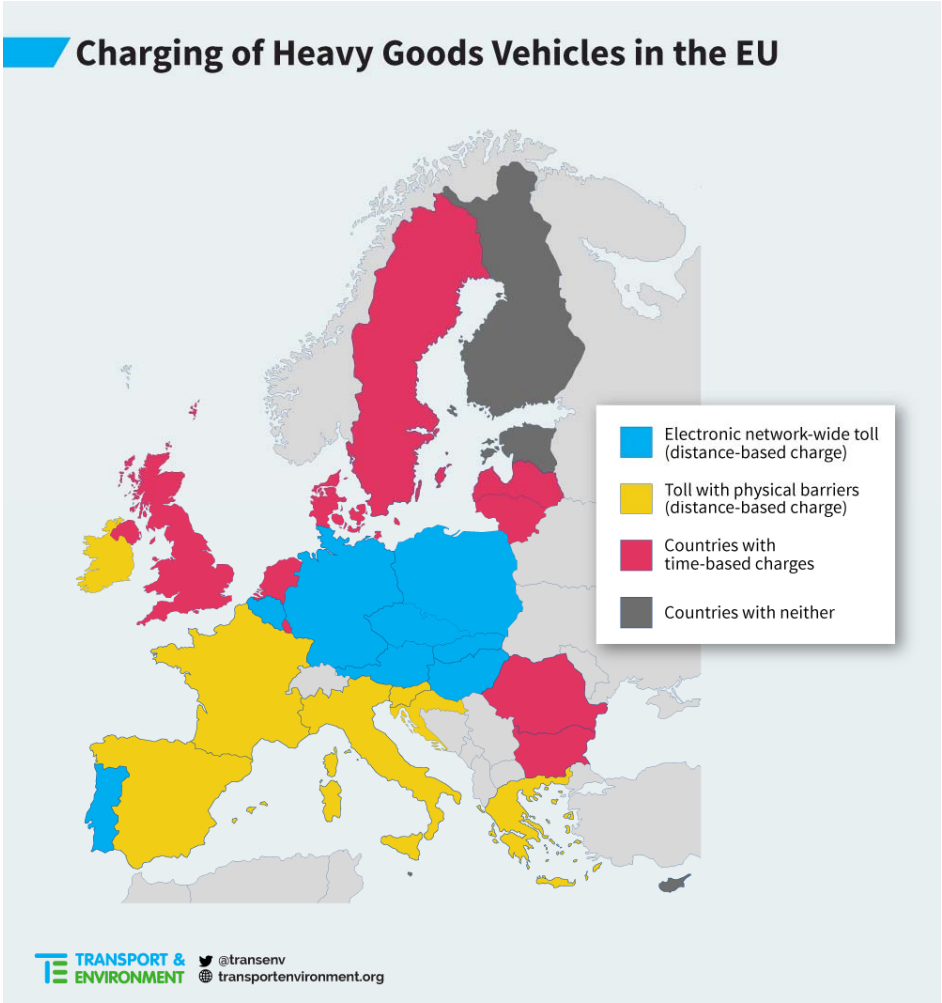
Upon pressure on the Member States of the respective regulation on road charging, the so-called Eurovignette-Directive 1999/62/EC (European Commission, 1999) allowed charges to be based on the total annualised economic costs of road construction, maintenance and operation. With the subsequent directives 2006/38/EC and 2011/76/EC the Commission encourages member states to add environmental and noise costs to the tariffs.

Current road charging systems for trucks in Europe are quite different in terms of objectives, charging technologies and in terms of tariff structures.

- Technologies range from simple toll booth installations to sophisticated satellite based charging systems.
- Tariff structures start from area wide, time-based tariffs (vignette) via simple distance related charges to highly differentiated tariff regimes.

Figure 1 provides an overview of the technical systems prevailing in EU Member States. Switzerland, which has not been included in the exhibit, operates the most sophisticated road charging system in Europe since 2001. In the Swiss heavy vehicle fee, trucks are charged according to their distance travelled, actual weight and their environmental standards, with tariffs greatly exceeding HGV tariffs in the EU Member States. The revenue of the Swiss road charge is to a large extent, used to co-fund the Alpine railway base tunnels through the Lötschberg and the Gotthard.

Figure 1: Road charging systems in the European Union



Source: T&E (2016)

An overview of the impacts of toll systems in Europe was surveyed in a study by RICARDO Energy and Environment and TRT on behalf of the European Commission in 2014 (Gibson et al., 2014). The study finds that harmonization in Europe towards electronic, network-wide tolling is progressing. But there are limits, as some countries, among them Spain, face long concession periods. Countries with network wide tolls are found to be more likely to differentiate tolls according to emission standards. The study assesses the state of knowledge on the likely impacts of various forms of HGV charging systems. Its main conclusion may be summarized as: distance based road charges are only triggering sustainable freight transport if they are applied network wide, with high differentiation according to emission standards. However, their main function is a fair pricing of infrastructure costs to all users.

2.2 The German Lkw-Maut System

2.2.1 History of the Lkw-Maut system

The idea for the German HGV motorway toll (Lkw-Maut), dates back to a report commissioned by the government on transport, infrastructure charges (Pällmann, 2000). By re-organising the tax based funding system of federal roads into a user pays system, the planning bases for extension, maintenance and operation of the road network could be substantially improved. The tariffs thus would reflect the income needed to maintain and renew the network, rather than to re-pay historical investments. In this spirit, the first road infrastructure cost report by Prognos and IWW (2002) followed an entrepreneurial, future oriented accounting principle, which arrived at an average toll rate of 15 Ct./km for HGVs above 12t gross weight on motorways. Given the rate of earmarking on fuel tax payments for diesel, the effective funding needs were estimated at 12.4 Ct./km, which was the average level of the Lkw-Maut upon introduction in 2005.

Besides establishing a fair system for financing German motorways, the Lkw-Maut was designed to give incentives for a more sustainable development of the road freight sector. Targeted impacts were mode shifts to rail, more low emission vehicles and increased efficiency of trucking operations.

The Lkw-Maut should have been introduced in July 2003, but failed due to technical problems in the Toll Collect Consortium, in charge of the concession. According to BAG (2005), after a smooth technical implementation in 2005, expectations of the federal government in terms of revenues were met. Out of 100,000 undertakings, of which 1/3 were extra-territorial were registered and 84% of trips were paid via the electronic on-board unit (OBU) payment system (91% for German hauliers). Around 34% of the projected income of 3.0 billion Euros 2005 came from non-German undertakings.

After a legal dispute between Germany and the EC on a planned toll compensation procedure (see Section 2.2.3), the second infrastructure cost study (Progtrans and IWW, 2007) suggested an average toll level of 16.9 Ct./km, but with a stronger spread of tariffs by environmental standards. This tariff change, which was introduced at the time of the onset of the world economic crisis in 2009, would encourage the use of low emission vehicles. After the successive inclusion of detour-prone federal roads into the tolling systems, from 2012 on all 1100 km of motorway-like federal roads were included in the Toll Collect system (see Figure 2).

Figure 2: Toll road network in Germany as of 1/1/2016

Source: Website of BMVI

2.2.2 Technology and organisation of the Toll Collect system

Due to the high density of exit points and junctions on the German motorway network, a check-in / check-out system with toll booths, as known in France or southern Europe was not considered feasible. A more flexible system based on satellite technology was thus ordered and implemented by the Toll Collect consortium, formed by Siemens and Deutsche Telekom. The system consists of the following elements:

- Registration: vehicles participating in the toll systems have to register at Toll Collect.
- Electronic toll collection via on-board units (OBUs). These have to be built into the vehicles with connections to vehicle electronics and motor controls. The OBU registers the environmental standard of the vehicle, the presence of a trailer and, while driving, the position of the vehicle via GPS. Via the mobile phone network, the OBU

communicates actual toll payments and updates on tolled roads and tariff structures with Toll collect.

- Manual booking: drivers can also book and pay for a trip via the internet or on Toll Collect terminals available in park and rest areas along the motorway.
- Controls of toll payments are done by Toll Collect via camera systems on toll bridges together with the Federal Office for Freight Transport (Bundesamt für Güterverkehr BAG). BAG undertakes manual controls on the roads using control vehicles and mobile road-side devices. For road side control and enforcement BAG employed 775 people in 2012.
- The use of the toll revenues was originally allocated to all modes: 50% to the federal motorways, 38% to rail and 12% to inland waterways. Upon rejection by the federal states, the allocation system was changed in 2009. Since 2015, revenues are entirely spent in the road sector: 83% for infrastructure investments and maintenance, 15% for harmonizing measures supporting the road haulage sector and 2% for other purposes. The investment, planning, and administration of the revenues is done by the Transport Infrastructure Financing Association (Verkehrsinfrastrukturfinanzierungsgesellschaft VIFG).

2.2.3 Tariff levels and tariff structures

The contract with Toll Collect is set for 15 years, i.e. from 2005 to 2020. System costs are around 500 million Euros for the motorways plus an estimated 70 million Euros for the federal road sections added in 2012 (Deutscher Bundestag, 2013).

The revenues and costs of the Toll Collect system are summarised in Table 1 Revenues continuously rose, even through the economic crisis, until 2011, and have been stagnating since then. The system operating costs declined from 20% of revenues when the Toll Collect system was launched to 10.4% in 2011. With the inclusion of trunk roads this cost returned to 15%. The effective average toll paid per HGV kilometre changed from 11 Ct./vkm in 2005 to 17.7 Ct./vkm in 2009/10 and back down to 14.6 Ct./vkm after the toll level revision in 2015.

Charge structures and the use of revenues are regulated by the federal motorways toll act (Autobahnmautgesetz ABMG) of 2003. They have been replaced from 2011 on by the federal trunk roads toll act (Bundesfernstraßenmautgesetz BFStrMG). Toll levels are set by the toll level directive (Mauthöhenverordnung MautHV) of 2003 and its several amendments.

Table 1: Costs and revenues of the German Lkw-Maut 2005 – 2014

Year	Revenues bill. €	System costs bill. €	HGV volume bill. vkm	Average toll € / 100 vkm	Share of System costs
2005	2.59	0.55	24	10.8	21.4%
2006	3.05	0.56	25.8	11.8	18.5%
2007	3.31	0.63	27.4	12.1	18.9%
2008	3.49	0.56	27.6	12.6	16.2%
2009	4.33	0.54	24.4	17.7	12.5%
2010	4.51	0.49	25.7	17.6	10.9%
2011	4.48	0.47	26.7	16.8	10.4%
2012	4.36	0.57	26.6	16.4	13.0%
2013	4.39	0.61	27.2	16.1	14.0%
2014	4.46	0.61	28	15.9	13.8%
2015	4.34	0.54	29.7	14.6	12.4%

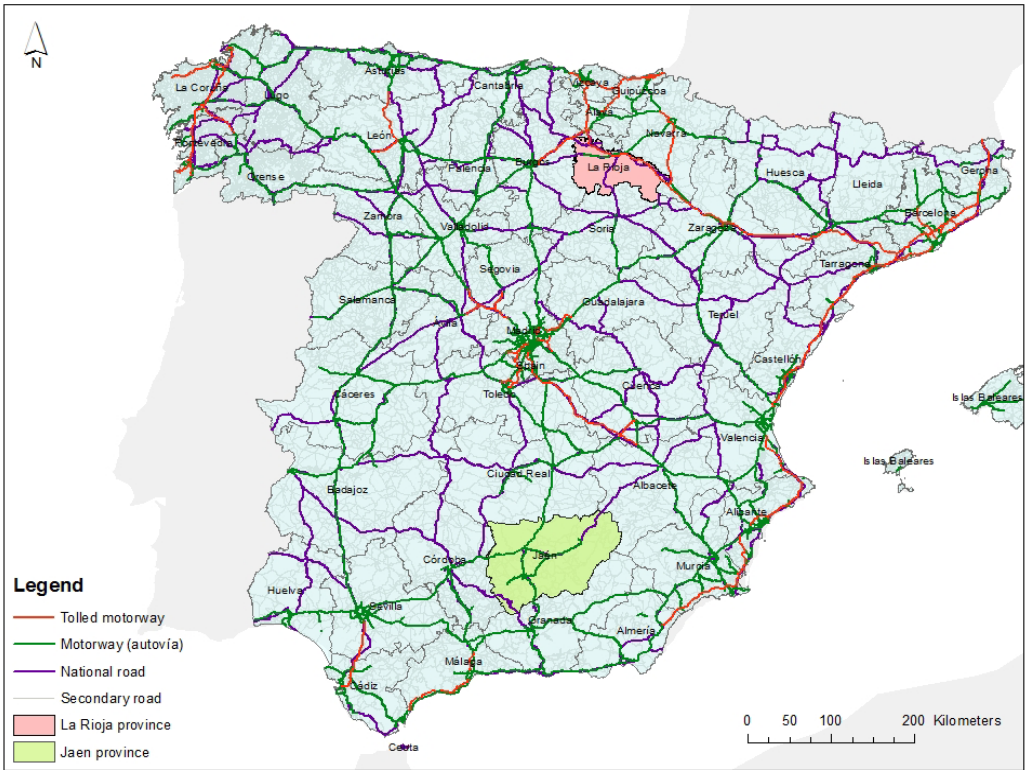
Source: BAG annual toll statistics, Statista.de, VIFG, Deutscher Bundestag (2012)

2.3 The Spanish system of road concessions

2.3.1 Introduction to the Spanish road network

In 2014, the Spanish road network was 166,284 kilometers long, of which 26,124 km were managed by the central government and accounted for 51.2% of total traffic and 62.8% of HGVs. Moreover, there were 71,397 km managed by the Regions (*Comunidades Autónomas*) which received 42.9% of the national traffic. The rest of the 68,763 km were managed by the Spanish Councils (*Diputaciones*) (Ministerio de Fomento, Online). Ninety percent of the high capacity road network in Spain has two lanes per traffic direction (Aparicio, A., et al., 2011). Figure 3 shows the Spanish road map by type of road.

Figure 3: Spanish road map



Source: Fraunhofer ISI with information from the Centro Nacional de Información Geográfica (2015)

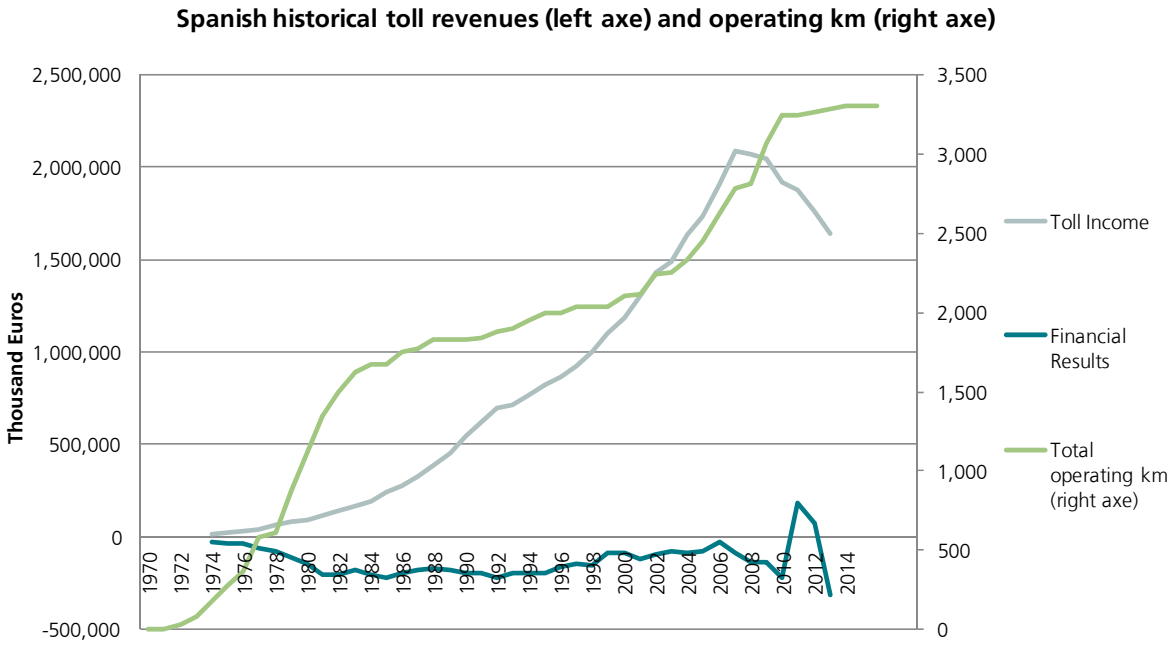
According to Eurostat, there has been a remarkable growth of the Spanish motorway high capacity network. In 2000, the most extensive network within EU15 could be found in Germany, followed by France and Spain; however in 2012, Germany accounted for 12,879 km, France for 11,465 km, and Spain for 14,701 km (Eurostat, 2016).

2.3.2 History of road concessions

The Spanish toll concession system started by the end of the 60's, when almost the entire Spanish road network was composed of single lane roads. In 1977, 1,100 km were built as toll roads. In 1996, it attained 2,000 km and by 2006, 3,000 km were toll roads. Nowadays, there are 3,307 km of tolls and no new toll roads have been planned. When tolls were first implemented, they were a good alternative to conventional roads for users, due to travel time savings. Due to their benefits, social acceptability was very high (Cruz Villalón, 2012). Yet, currently many different opinions arise due to problems related to the bankruptcy rescues of some toll motorways, expansions of the lifetimes of some concessions and its uneven distribution over the country regions (Guzmán Valderrama, 2013). In other cases, additional requirements by the gov-

ernments or events that changed the economic balance of the contract implied contract changes. Recently, there has even been a discussion about the renewal of tolled roads in face of reducing financial losses due to insolvencies of other concessions (Magarino Madrid, 2016; Efe Madrid, 2016). All these issues have increased the concerns with the social acceptability of toll roads in Spain.

Figure 4: Toll motorways' length evolution in Spain and revenues



Source: Fraunhofer ISI with information from Ministerio de Fomento (2015)

Nowadays, the 3,307 km of toll roads are managed by 32 concessionaire companies, shadow tolls included (Ministerio de Fomento, 2015). In 2013, different measures that sought to promote tolled motorways were implemented. These included discounts for passenger vehicles and HGVs, such as the AP-68 (Bilbao-Zaragoza), which crosses the territory of La Rioja.

83.4% of the kilometers of the toll road network are owned by the national government, while the rest are owned by different regional governments (Ministerio de Fomento, 2015). According to the same source, in 2014, the total traffic decreased on average (light and heavy vehicles) by 4.14%, with respect to 2013. This information gives a clear picture on the difficulties to manage roads and concessions along with the current traffic situation.

In 2005, the Strategic Plan on Infrastructures and Transport (Plan Estrategico de Infraestructuras y Transportes, PEIT) established priorities for horizon 2020. This Plan

included shadow toll concessions to upgrade high capacity road sections in order to assure safety, good maintenance, and high quality operation. On the basis of this approach, 1,042 km of roads were awarded to different private consortia (Ministerio de Fomento, 2015). These contracts, with durations of 30 years, pay to the concessionaire on the basis of both traffic and a set of quality indicators. For example, the A-4 section, Puerto Lápice-L.P.Ciudad Real/Jaén (kilometer 184 to kilometer 245) was awarded in this regime.

According to the Ministerio de Fomento (2015), the sector in 2013 employed 3,830 people, of which 588 are related to general service, 2,340 to tolls, and 902 to maintenance.

2.3.3 Tariff levels and tariff structures

Revision of tariff regulations in the National network is regulated by law (14/2000 from December 29th) (Ministerio de Fomento, 2015). Toll implementation is revisited at the beginning of each year.

There are tariff differences depending on the concession and the type of vehicle (Table 2), but there are others which depend on many different aspects, for example, tariff differences may be due to high and low seasons, peak and night or non-peak hours and weekdays, traffic direction, and so on. There are some concessions, like the AP-9 from Pontevedra to Vigo, that have discounts for regular passenger vehicles. Other concessions have applied premiums to certain HGVs (Ministerio de Fomento, 2015). Some of them apply discounts when using electronic toll collection devices.

Table 2: Average prices at 31/12/2013 €/km

Concessions	Pass.veh.	HGV 1[1]	HGV2[2]	Average
AVASA[3]	0.1068	0.1943	0.2254	0.1219
Total National	0.1101	0.1659	0.2035	0.1213
Total Regional	0.1505	0.2381	0.2858	0.1671

Source: Ministerio de Fomento (2015)
Legends: HGV1: trucks and buses of 2 axles with or without trailer (one axle), or buses and trucks of three axles; HGV2: buses and trucks with four or more axles; or 2-axles trucks or buses with trailer of two or more axles; AVASA: Autopista Vasco-Aragonesa, owner of the AP-68 Spanish concession (Bilbao-Zaragoza, which crosses la Rioja)

2.4 Concluding remarks

Tolling road freight transport has a long standing tradition with the European Commission's common transport strategy, as well as in the actual transport policy of some Member States. Supported by several White Papers and Directives, of which the Eurovignette-Directive is most prominent, the EC has developed a sophisticated legal framework for trucks on the Trans-European road network. Nevertheless, the picture in Europe is scattered, as Member States follow different policy philosophies and are subject to varying historical developments.

- Historical difference: while concessions and tolls came along with the construction of new roads since the 1960s in Spain, Germany implemented user charges on an already existing and tax financed road network from 2005 on only.
- Governance: Road tolls in Spain are always associated to concession contracts where private companies are entrusted to build, finance and maintain a certain road stretch on exchange of the right to collect tolls. In contrast, the German Toll Collect consortium is responsible for toll collection only. Ownership of the road network and responsibility for its extension, maintenance and operation remains with the federal government.
- Network and vehicle scope: The Spanish system is comprised of 3 307 km of single, non-connected roads under different ownerships across the country, and around 20% of them are tolled. Germany applies HGV charges to all 12 949 km of motorways and currently 1100 km of federal trunk roads.[1] In terms of vehicles, Spain charges trucks and passenger cars, while Germany started with HGVs above 12t gross weight and currently charges trucks from 7.5t gross weight on.
- Tariff levels and structures: Spanish tariffs in general distinguish only between broad vehicle classes (passenger cars, light trucks and heavy trucks), while German tariffs differentiate by two size classes and Euro exhaust emission standards. Tariff levels are slightly higher in Spain (an average of HGVs of 22.34 €/100 vehicle-km - vkm) in the tolled motorways, than in Germany (14.6 €/100 vkm)
- Toll collection technology: Spain applies traditional toll booths with express lanes for fast payment, while Germany installed a sophisticated satellite and GPRS-based charging and control system.

1 As of 1 June 2016; from 2018 on all 40 000 km of federal trunk roads will be tolled.

3 The Methodological Toolbox

This report covers a desktop study on the impact of the German and the Spanish HGV road toll systems on transport logistics, regional economies and on the environment. As the two systems in Germany and Spain are very different in terms of network coverage and in the strength and dynamics of their underlying national economies, the research questions asked by the Terms of Reference (ToR) and the methodology towards addressing them, slightly differ between the two countries under investigation. But still there remain many similarities between the study regions.

This study has been designed to combine qualitative and quantitative approaches. Following Crang (2002), the dialogue between these two techniques is considered to tackle complex challenges where results are not reachable by either quantitative or qualitative approaches alone. Accordingly, the following sections intend to provide a brief overview of the methodological elements applied to address the research questions formulated in Section 1.2. Details of their application will be discussed in the respective sections in the main body of this study.

3.1 Literature review and Statistic Databases

The impacts of toll systems on transport and economy are complex and in part difficult to monitor with only available statistical sources. An important element of the study, thus, is publications from academics, associations, and the business sector to get a comprehensive overview of the potential consequences of introducing or modifying road charging systems for heavy trucks. In the following sections, we provide a brief overview of the body of knowledge considered for this study. Details on findings are reported in the respective sections in Chapters 4 to 10

3.1.1 International literature on HGV toll impacts

The most recent reports on the impacts of truck tolling systems in Europe have been issued by Transport & Environment (T&E, 2016) and CE Delft (Schroten and Aarnink, 2015 and Schroten, 2016). These reports address the question about whether HGVs in Europe cover the full costs they impose on infrastructure operators, other road users, and the society. Further work on the costs of trucks was carried out by the European Environment Agency (EEA, 2013). A previous study on Understanding the effects of introducing lorry charging in Europe was also carried out by T&E (2010).

Guzman Valderrama (2013) cites different EU projects which have dealt with road charging schemes. For example IMPRINT-NET (Implementation Pricing Reforms in Transport – Networking); UNITE (Unification of Accounts and Marginal Costs for

Transport Efficiency); PATS (Pricing Acceptability in the Transport Sector); REVENUE (Revenue Use from Transport Pricing); and CUPID (Co-ordinating Urban Pricing Integrated Demonstrations). Most of these sources date back to the late 1990s and the early 2000s and build on economic theory by a-priori, assuming that levying cost based charges on transport and other economic activities improves social welfare. Other issues covered by international literature on tolling include: the acceptability of toll systems (Vassallo Magro, 2015), experiences of member states with tolling (Gibson et al., 2014) or the technical and fiscal characteristics of toll systems worldwide (KPMG, 2015).

On the European level, the first address to visit is the Eurostat regional database and the EC pocketbook “Transport in Figures” (latest available version 2015). We supplement this information by data provided by recent studies and by sector institutions and associations. These are the European Environment Agency EEA and Transport and Environment (T&E) for sustainability indicators or the European toll road operators’ association ASECAP for national demand and revenue data.

3.1.2 Main literature and data sources for Germany

The Federal Office for Freight Transport (Bundesamt für Güterverkehr BAG), a subsidiary of the Federal Ministry for Transport and Digital Infrastructures (BMVI), is the entity responsible for the implementation and operation of the German Lkw-Maut. Besides regular logistics market observations, BAG has issued two special reports on toll impacts directly after the introduction of the Lkw-Maut (BAG 2005 and BAG 2006).

The BMVI regularly conducts a review of the traffic impact of the Lkw-Maut (every three years). Past studies were published in 2005/2006, 2009 and 2012/2013 (Deutscher Bundestag, 2013). By the assessment of permanent traffic counting facilities and transport network applications, the reports mainly look at heavy traffic diverging to the secondary road network due to toll impacts and on related safety and noise impacts.

Moreover, infrastructure costs which would need to be allocated to heavy traffic form the basis of the Lkw-Maut tariffs are regularly re-calculated by BMVI. After the initial infrastructure costs study in 2002, updates have been presented in 2007 and 2013; a fourth update study has just been tendered by BMVI[2].

Statistical data on the movement of vehicles on toll roads and toll revenues in Germany is recorded by the Lkw-Maut system operator Toll Collect. Quarterly and annual data

2 The 4th road transport infrastructure study will be performed by Prognos, DLR, Fraunhofer ISI and the Technical University of Berlin.

reports are published by the Federal Office for Freight Transport (BAG). This data is differentiated according to tariff characteristics, i.e. number of axles and emission standard, and by home country of the vehicle. More detailed information, e.g. for specific days or motorway sections, is not available.

More detailed data on vehicle loading and commodities transported is collected for two weeks each year with a sample of 0.5% of registered trucks by the Federal Office for Motor Vehicles (KBA)[3]. This data provides time series on empty headings, kilometres driven etc. for Germany and on a more detailed regional level. For this study, national data is used.

More general data and information on environmental performance in the transport sector is provided by the database “data on environment” by the Federal Environment Agency (UBA). A broader set of transport related data is provided by the statistical compendium “Transport in Figures” (Verkehr in Zahlen) by the Federal Ministry for Transport and Digital Infrastructures (BMVI).

Besides general transport activity data, the Federal Statistical Office (DeStatis) holds data on companies, business structures and business development. Data from trucking associations in Germany, namely BGL and DSLV, are considered where needed. E.g. logistics cost data, including detailed information on European toll tariffs is provided by the Cost Information System KIS of the Federal Association for Trucking, Logistics and Disposal (BGL).

The SCI Logistics Barometer is a poll among 200 representatives from the logistics sector issued each month since June 2003. The barometer asks for medium turn business opportunity expectations and for opinions on topics of specific interest. All monthly issues of commented results are accessible online (SCI, 2016). This continuous information source allows tracking the impact of the Lkw-Maut from its implementation to today.

3.1.3 Main literature and data sources for Spain

Different studies treat in detail the case of the Spanish toll road system and tolling alternatives. The topics under research have been the road pricing schemes and similar

3 The saple is taken by questionnaires on vehicle movements and loadings, to be filled by the vehicle owners over a peripd of two weeks. Results per vehicle segment are published in case the standard error does not exceed 20% and observations are at least 35 vehicles. Less reliable values (standard error 10%-20%, observations 35-50) are highlighted in the reports.

measures to the Eurovignette and its implications; perception, the rise of consumer price index due to HGV toll systems, equity and direct and indirect impacts in different regions. See for example, Aparicio et al., (2011), Asociación Espanola de la Carretera (2012), Condeco-Melhorado et al., (2011); Guzman Valderrama, (2013); Leber and Infras (2006); Vassallo (2012); Vassallo and Lopez (2010); Vassallo (2015) among others.

Moreover, the Ministry of Public Works (Ministerio de Fomento) publishes monthly and annual data regarding traffic in motorways and concessions. Since 2006 they conduct the permanent survey on road freight transport (Ministerio de Fomento, 2015b) and publish annual data on freight traffic (intra- and inter-regional, and international) per regions and among regions. They have also created the Spanish Transport and Logistics Observatory (OTLE, *Observatorio del Transporte y la Logística en Espana*), which provides detailed annual reportsdealing with the transport and logistics sectors (available from 2013 to 2015).

Moreover, the Concessions 2013 report (Ministerio de Fomento, 2015) provides detailed data and other relevant information on traffic volumes by road type in Spain specifically for tolled roads.

Other sources of information are:

- the Agriculture, Food and Ecology Ministry (Ministerio de Agricultura, Alimentación y Medio Ambiente) relative to emissions;
- and regarding demography, enterprises and other socioeconomic characteristics the National Statistics Institute (Instituto Nacional de Estadística, INE) and regional statistics institutes, such as the La Rioja Statistics Institute (Instituto de Estadística de la Rioja) and the Statistics and Cartographic Institute from Andalucia (Instituto de Estadística y Cartografía de Andalucía).

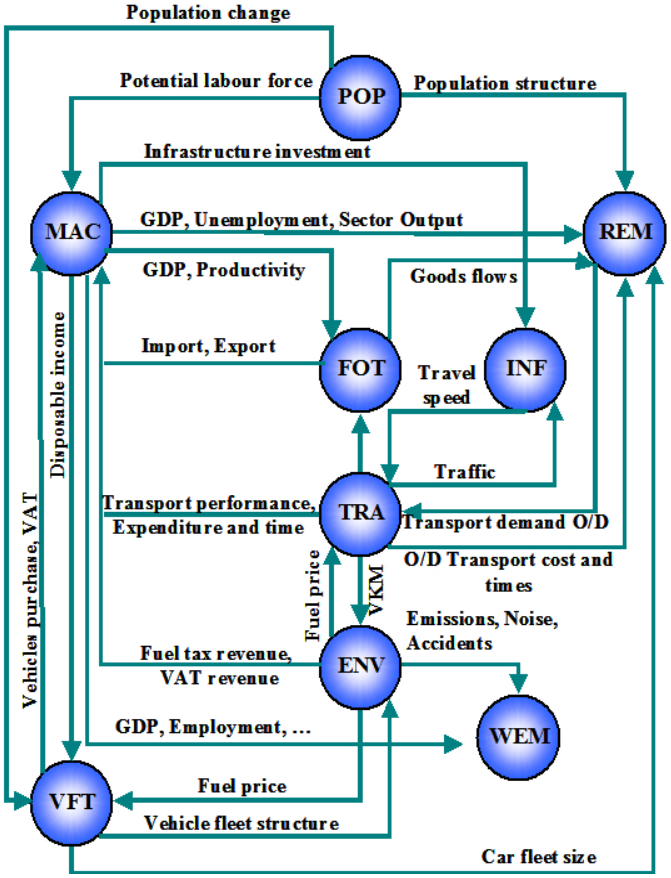
3.2 Application of the ASTRA-EC system dynamics model

The impacts which HGV toll scenarios cause to transport and the economy are presumably so small that statistical evidence cannot be found with sufficient certainty. We thus apply the integrated transport and economic model ASTRA-EC to identify and quantify such impacts.

3.2.1 Model Description

ASTRA (ASsessment of TRAnsport Strategies) is an integrated assessment model applied since more than 10 years ago for strategic policy assessment in the transport and energy field. It covers EU27 Countries plus Norway and Switzerland, and integrates nine modules linked together in manifold ways: a vehicle fleet model, transport model, emission and accident models, population model, foreign trade and economic models with input-output tables, government, employment and investment models. The model is based on the System Dynamics approach and built in Vensim®; it runs until 2050 and provides sophisticated tools for sensitivity analyses. It is developed and maintained by Fraunhofer-ISI (Karlsruhe), TRT (Milan) and M-Five (Karlsruhe).

Figure 5: ASTRA model structure



Source: Fraunhofer ISI

Policy assessment capabilities in ASTRA cover a wide range of policies with flexible timing and levels of the policy implementation. Potential policies include standard setting, infrastructure pricing, fuel taxation, speed limits, carbon taxes, trade policies etc. A strong feature of ASTRA is its ability to simulate and test integrated policy packages and to provide indicators for the indirect effects of transport on the economic system.

ASTRA is able to simulate the impact of macro-economic variables on various policies, like investments in technologies, transport and energy taxation, and fleet renewal incentives. Gross Domestic Product, employment, consumptions and investments are among the main economic outputs provided.

For more information see: http://www.astra-model.eu/.

3.2.2 Scenario definition for Germany and Spain

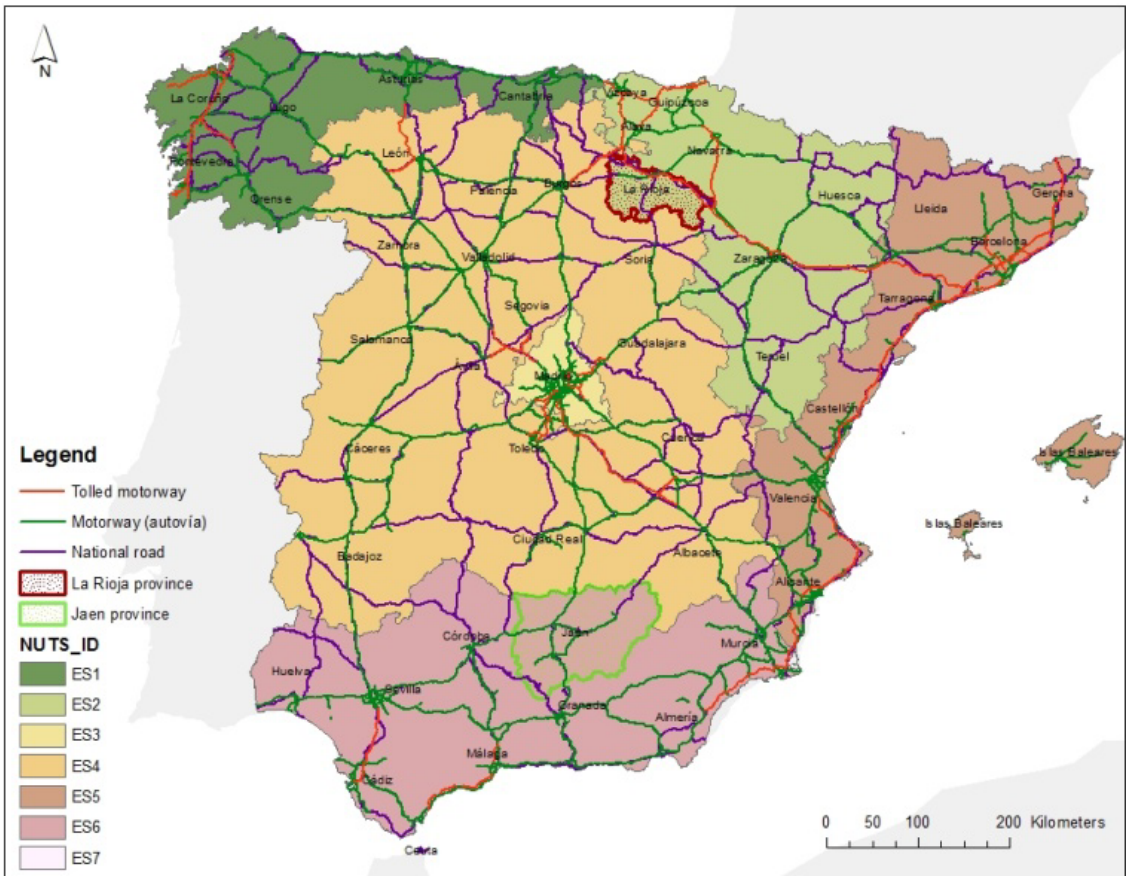
The scenarios in the ASTRA EC model are defined in a rather simple way in order to avoid side assumptions such as the way the revenues are used. Three scenarios are defined for each of the regional entities:

- The Base Case scenario describes the situation of HGV tolls in Europe with regards to past and current developments and to aid in future designs of toll systems. Aside from Germany and the Spanish Regions ES2 and ES6 (see below) the base case contains all European HGV toll systems currently in place.
- The No-Toll scenario describes for all three regional entities a case where all existing tolls, including bridge and tunnel levies, are abolished. This hypothetical case assumes that the abolishment already took place in 1995.
- The High-Toll scenario denotes a condition of extended toll systems in all three areas. For Germany this is the doubling of charge levels plus the extension of the charge to all major federal roads (as planned from 2018 on). For the Spanish regions around La Rioja and Jaén, this is basically the application of a toll similar to the Base Case in Germany with different assumptions on the probability of using toll roads.

The regional resolution of pricing scenarios in the ASTRA-EC model is NUTS-1 or higher. For Germany, these are the 16 federal counties. For Spain, these are six continental provinces plus the Canary Islands (see Figure 6). For the two Spanish regions considered in this study, this rather coarse resolution implies:

- La Rioja is part of the greater region ES2 (North-Eastern Spain) together with the Basque country, Navarre, and Aragon. This region thus covers a large part of the Atlantic corridor coming from France into northern Spain.
- Jaén is part of the NUTS-2 region ES61 (Andalucía). Together with the region of Murcia, Ceuta, and Melilla this forms the NUTS-1 region ES6 (Southern Spain).

Figure 6: NUTS 1 regions in Spain



Source: Fraunhofer ISI using information from the Centro Nacional de Información Geográfica (2015)

The main parameters set for the modelling scenarios are:

- The average toll level on tolled roads. This mean value averages across vehicle size and emission standards. Moreover, it considers potential compensation payments from the state to trucking and forwarding companies.
- The probability of using toll roads. As in all areas not all roads are tolled, this parameter determines which share of the annual mileage of heavy trucks belongs to toll motorways. This parameter also distinguishes between local and regional transport (LRT) and national and border crossing, long distance transport (NAT). The effective burden for these two segments thus is computed by product of toll levels and toll road probabilities.

The scenario assumptions are presented in Table 3.

Table 3: Scenario assumptions for the ASTRA-EC model runs

		Germany - DE0			La Rioja (ES2_NUTS1)		Jaén (ES6_NUTS1)	
		2015	2020	2030	2014	2030	2015	2030
General parameters from ASTRA								
Diesel price	€/l	1.293	1.317	1.365	1,271	1,341	1,271	1,341
Truck costs SRT	€/vkm	1.206	1.206	1.166	1.167	1.106	1.167	1.106
Truck costs INTF	€/vkm	1.307	1.301	1.284	1.196	1.168	1.196	1.168
Current Toll Scenario		Current toll system development; no changes after 2015			Current toll system in La Rioja			
Average toll level	€/vkm	0.160	0.140	0.140	0.105	0.105	0.126	0.126
Use of toll roads SRT		0.730	0.760	0.760	0.200	0.200	0.100	0.100
Use of toll roads NATF		0.910	0.930	0.930	0.560	0.560	0.350	0.350
No Toll Scenario								
Average toll level	€/vkm	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Extended Toll Scenario		Double tariff to base case, all federal roads priced			From 2005 toll system as in DE Base Case		Toll system as in La Rioja, Base Case	
Average toll level	€/vkm	0.250	0.250	0.250	0.140	0.140	0.14	0.14
Use of toll roads SRT		0.750	0.750	0.750	0.730	0.760	0.200	0.200
Use of toll roads NATF		1.000	1.000	1.000	0.910	0.930	0.500	0.500

Source: Fraunhofer ISI

3.2.3 Output indicators

The ASTRA-EC model provides the following output indicators:

- Gross domestic product (GDP) on a national basis
- Employment rate (national)
- Domestic transport flows by three commodity types, modes and NUTS-1 zones for Germany and Spain
- International transport flows between countries affecting Germany and Spain by three commodity types and modes
- Emissions by emission type (GHG-emissions, NOx and particulate matter by mode for Germany and Spain.

As the impacts of road tolls are pretty small compared to other economic and social impacts, e.g. global goods demand or energy prices, model outputs are presented as the difference of the No Toll and High Toll scenarios to the Base Case. The results are shown in the respective chapters below.

3.3 Qualitative analysis Stakeholders' interviews and survey

This study was complemented by the means of semi-structured interviews and a survey questionnaire. This qualitative approach is helpful by providing detail, depth and perspective information while also allowing the testing of different hypotheses (Leech, 2002; Mejia-Dorantes et al. 2014).

Telephone interviews were carried out during the first semester of 2016 and lasted around 30 minutes. They covered various topics. Each participant was free to develop deeper into whichever of the topics below he wanted. The main questions covered were related to:

- Expertise and regional experience
- The current situation of the transport market: national and international market
- The current tolling system and the Eurovignette system
- Point of view of these systems
- Pros and cons
- Other relevant information

The survey was sent to producers and manufacturers, transport operators, logistics companies, experts, public administration, toll operators and infrastructure managers, transport associations. Many of them were reluctant to answer and/or forward this survey, which already explains how the topic of analysis is quite controversial in Spain.

This approach was helpful to understand the particularities of each region, to shed some light on some topics that were necessary to include in the study, and to understand the results.

By telephone interviews and a supporting online questionnaire, expert consultations among Spanish trucking companies, road operators and shippers were conducted. These should enrich the literature and transport model based methodology of this desktop study by collecting recent trend in opinions on road tolling impacts in Spain. In total 12 expert consultations were obtained in the period May to July 2016. Due to the timing close to the summer break and the resources available for the consultation, re-

sponse rates remained low. In particular public administrations were reluctant to contribute to the study. The number of consultations by sector are given in Table 4; the detailed consultation guidelines are provide in the Annex to this study.

Table 4: Profile survey's respondents

Sector	Consultation Count
Producer or Manufacturer	5
Road transport and logistics company	2
Infrastructure manager/toll operator	2
Transport association	1
Other	2
TOTAL	12

The tendency of replies in Spain is discussed in the next chapters. The full (English translated) questionnaire may be found in the Annex.

3.4 Methodology for external costs

Regarding external costs, among the variety of indicator sets which are available for measuring and describing sustainability, we chose external cost indicators. We are aware of the critique towards putting money values on potentially extreme impacts like climate change or death casualties due to road accidents. Nevertheless, the monetization of risks makes them comparable to other costs or benefits that come along with the technology or policy in question.

External costs denote those costs (or monetized impacts) which one individual or party gives to others without compensating for this burden. In other words: external costs express in money values the consumption of common goods, such as clean air and stable climate of safe travel, without paying for it. External costs thus express the absence of functioning markets. According to economic theory, the internalization of external costs would correct for this imperfection and thus improve overall welfare and justice.

Following the logic of the most recent studies on the external costs of transport, we use the following indicators of external costs of transport:

- emissions of air pollutants (environmental sustainability);

- greenhouse gas emissions / climate change potential from the use and the production (upstream) of fuels and electricity (environmental sustainability);
- accident consequences for the victims, their relatives and friends and the society (social sustainability)

With these indicators, we concentrate on the social impacts caused from the use of vehicles, trains or ships, while we exclude all social impacts from the construction and existence of the disposal of infrastructures of vehicles. These might e.g. be separation effects in urban areas, the deterioration of natural habitats or visual intrusion effects.

4 Effects of Road Tolls on Logistics Efficiency

In this section, we look at the effect of tolling scenarios on the logistics efficiency in Germany and Spain. To that end we discuss the impacts that certain groups of actors could face due to logistic movements and how logistic activities could be transferred to other modes.

In this section we will provide the reasons to answer the following questions:

How is the overall efficiency of the logistics sector affected?
Which impacts on specific groups of actors do occur?
What are the likely efficiency impacts of extending road charging systems?
Do road charges contribute to a better use of all modes of transport?

4.1 Impacts on overall transport efficiency

We can measure the efficiency of transport operations in three ways: (i) by the distance travelled per ton of cargo, (ii) by the efficiency in which available load space (vehicle capacity) is utilized and (iii) by cost efficiency of transport operations.

The ratio of ton kilometres by tones provides an idea of the average distance, over which an average ton of goods is shipped. The larger this distance, the more diversified and the less sustainable in environmental and economic terms are logistics networks. As processes are specific to particular logistics segments, indicators of efficiency at least need to distinguish between transport distance classes.

Figure 7 shows the evolution of the average distance travelled per tonne-km for Spain, Germany, France and Italy, i.e for the four large continental economies in Europe, as well as for a weighted average of European countries with full data available. The left side of the figure embraces all distance classes, i.e. local, medium and long distance haulage, while the right side focuses on long distance road freight above 150 km. While for interpreting the impacts of economic factors both sides are telling, for identifying toll impacts figures on long distance haulage are more decisive.

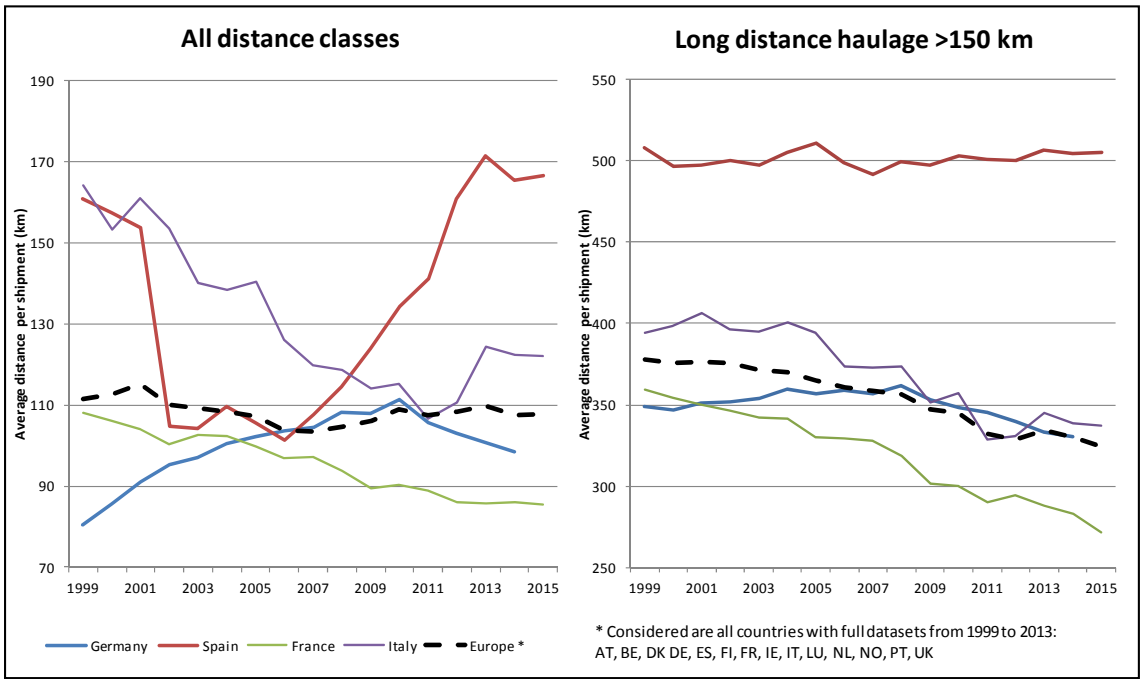
The graph for Germany suggests that distances per tons rose until the introduction of the Lkw-Maut in 2005, then entered a stable state and started to decline after the onset of the world economic crisis in 2009. This impacts is visible for both distance classes, but is way more expressed including local and regional haulage.

France, Italy and the average of European countries specified in Figure 7, where in most cases no change of tolling policy took place, a general trend of declining distances per ton shipped from 1999 to 2015 can be observed. Comparing these coun-

tries to Germany we can suspect that there is some impact of tolls on distances travelled, and thus on logistics efficiency.

The Spanish case is completely contrary. Considering all distance classes, a huge drop and recovery in average distance observed for Spain between 2001 and 2012 is observed, which points on a strong impact of the real estate market crisis in the country. In contrast, long distance haulage is hardly affected, only the absolute value of distances is about 50% above the European average and remains constant.

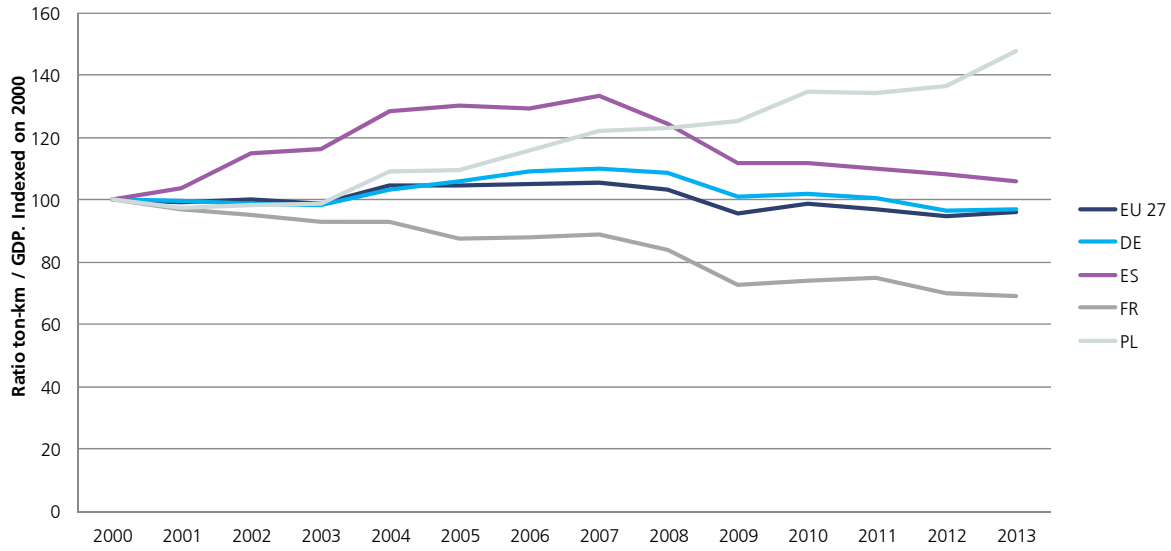
Figure 7: Average distance travelled per tonne transported in Europe's large continental economies by distance classes 1999 to 2015



Source: Fraunhofer ISI

From a national perspective we can link logistics efficiency to freight transport intensiies.This is defined as the measure of the amount of transport activity (tons-kilometres) required to generate one unit of economic output (measured in GDP) of that economy (IPTS, 2003, compare also Section 8.4). Figure 8 presents freight intensities for the EU-28, for Germany,and for Spain as the case study regions in this report, France as an important intermediate country and for Poland, representing the new Member States.

Figure 8: Freight transport performance relative to GDP (Indexed at 2000)



Source: Fraunhofer ISI with data from Eurostat online database

As the cost side in the trucking business is impacted by a multitude of factors such as wages, fuel prices, etc. we use the indicator of vehicle load rates to describe the efficiency of logistics operations under given logistics market structures (i.e. fixed customer networks and shipment distances). Load rates or load factors again are composed of two components:

- the share of empty headings among all trips or vehicle kilometres;
- the volume of weight utilization of loaded trucks;

The load of trucks can be measured in tons or in volume entities, e.g. m³ or palette spaces. As trucks are restricted in weight and volume, both might be a limiting factor. I.e. trucks can be fully stuffed with consumer electronics but do not meet the permissible weight limit, or they may be loaded upon their weight limit with steel products and still have empty space available.

For reasons of simplicity, we use tons per vehicle (tkm) or vehicle per kilometer (vkm) to describe load factors. But bearing the above in mind, this might be misleading. As markets all over Europe change from heavy mass products to lighter consumer goods, ton-based load rates decline over time with all other parameters remaining unchanged.

4.1.1 Germany

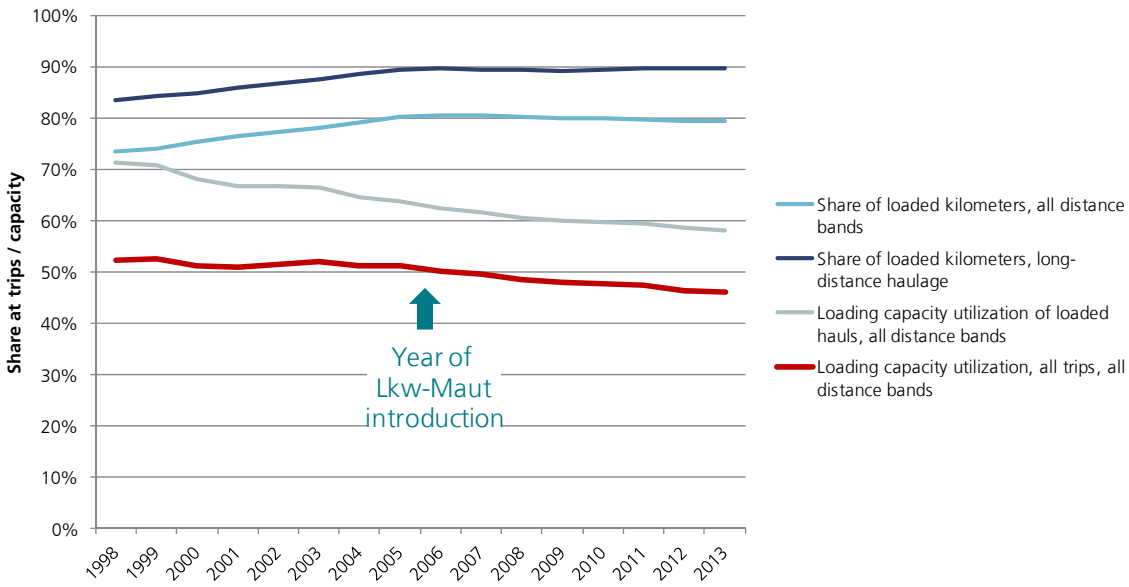
On demand of the European Commission in 1993, the market for road freight transport in Germany was liberalised. Since then, the number of haulage companies has drasti-

cally increased. Together with the fall of the Iron Curtain and the appearance of eastern European low wage trucking companies on the market, price pressure, in particular in international transport, increased. Consequently, efficiency improved, which can be seen in time series on the share of loaded hauls (see Figure 9). The rates show a constant increase of the share of loaded trucks, (i.e. a decline in empty headings) until 2006 and then stay constant in long distance haulage. Due to overcapacities, the share of loaded headings then slightly decreased in local and regional haulage, with the onset of the world economic crisis.

Another issue related to the efficient use of vehicles is the load factor of loaded vehicles. As in the years before, average utility of loaded vehicles fell further even in the first months of 2005 to 58.8% (BGL 2005). The structural effect of the freight market towards more high value / low weight goods and the more rigid availability of delivery time windows and warehousing policies in the production industries are responsible for this trend and cannot be compensated by the hauliers' attempts for higher cost efficiency. Figure 9 shows the ratio between maximum load weight and actual weight[4] of the transported goods, constantly declined in the past decades in Germany. As a net effect, the overall utilization of available truck loads slightly declined between 1998 and 2013. A real impact of the introduction of the Lkw-Maut on this overall measure of logistics efficiency cannot be constituted in aggregate statistics as compiled in Figure 9.

4 Remark: Load space utilization is increasingly more limited by volume of cargo rather than by weight. Thus the presented utilization measure constitutes only a proxi to actual utilization rates.

Figure 9: Share of loaded headings and load capacity utilization by German hauliers



Source: Fraunhofer ISI with data from BGL e.V. and KBA

A detailed look on the logistics sector by the extensive market consultations of BAG (2005 and 2006) leads to the following:

The BAG review acknowledges a further decline in empty headings in the long-distance transport business after toll introduction. In the past years, the share of loaded vehicle kilometres to total vehicle kilometres has risen by around one percent p.a. immediately after the Lkw-Maut introduction.

The Lkw-Maut in addition seems to have a slight impact on the utilization of loaded trucks in long distance haulage. First assessments indicated an increase of even 2.1% to 82.1% (>90% in long-distance haulage, around 65% in regional trucking) (BAG 2005). In the first half of 2006, efficiency could be further increased to 91% in long distance haulage[5].

Measures taken by companies to increase efficiency include the optimization of delivery times, the acquisition of additional return freight via freight exchange platforms and co-operations among undertakings. In other cases, there may be a higher efficiency in

5 This measure refers to utilization considering weight and volume limits; besides the BAG sector consultations, no reliable statistics on the utilization of loaded vehicles specifically for long distance haulage are not available.

administration, the use of cheaper personnel or the optimization of transport operations. In recent years, companies increasingly use software solutions to optimize logistics processes and test different forms of permanent or temporary outsourcing, in particular of border crossing hauls (BAG 2016). However, the BAG consultations reports and well as current statements by transport associations indicate that even under the double burden of high fuel and toll costs, no economically sensible options for a further reduction of empty headings exist. This is confirmed by the trend of stagnating rates for empty headings in Figure 9. It is worth noting that these statements may either be of strategic nature and / or indicate that potentials for improving efficiency on the operations side are exploited to their full extent under given market conditions.

According to expert interviews with the two major trucking associations in Germany[6] the German trucking business is, however, already rather competitive. Further cost savings are considered only possible through the merging of companies. In reality, this means that smaller companies give up their business, which is then taken over by larger entities.

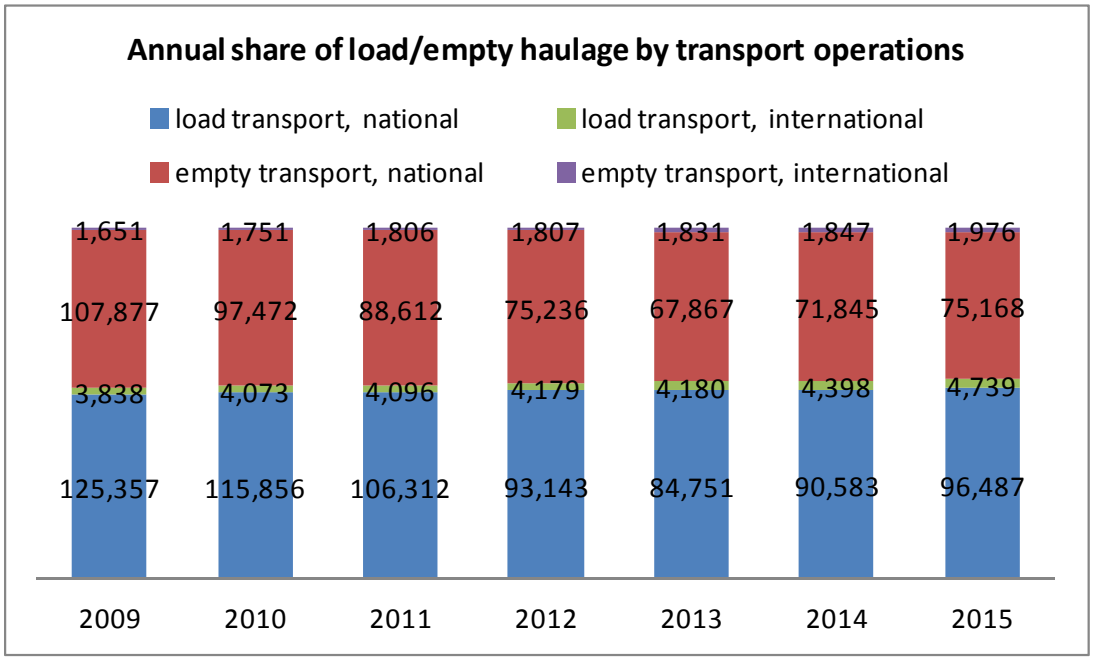
4.1.2 Spain

According to the Ministerio de Fomento (2015b), empty operations have diminished in general terms from 45.88% to 43.25% between 2009 and 2015. In this period, national transport has diminished its empty operations from 46.25% to 43.79%; whereas international transport has diminished its empty operations from 30.08% to 29.42%.

Logically, empty operations are slightly higher when services are made by their own transport services than when the service is subcontracted. It is worth highlighting that around 75% of freight services are made by external operators in Spain, therefore, operations from external operators are more important than own-account services. For example, in 2015 own-account services accounted for 44.80% empty operations at national level and 39.25% at international level, against 43.45% for national and 29.15% for international external transport services. Figure 10 shows the national trend.

6 BGL e.V. and DSVL e.V.

Figure 10: Empty road transport hauls in Spain



Source: Ministerio de Fomento (2015b)

With more than 43%, the share of empty headings in Spain is relatively high. In comparison: all distance classes in Germany have a rate of empty headings of roughly 20%; in long distance haulage these are only a little over 10%.

Nowadays the Spanish trucking sector is mostly made up of many small and medium sized enterprises (SMEs) with considerable headroom for improving vehicle use efficiency. The survey conducted for this paper shows that hauliers think that tolls would slightly impact their fleet and load rates. However it is expected that through better cooperation of these companies, i.e. via freight trading platforms, the competitiveness of the Spanish trucking business could move closer to central European standards.

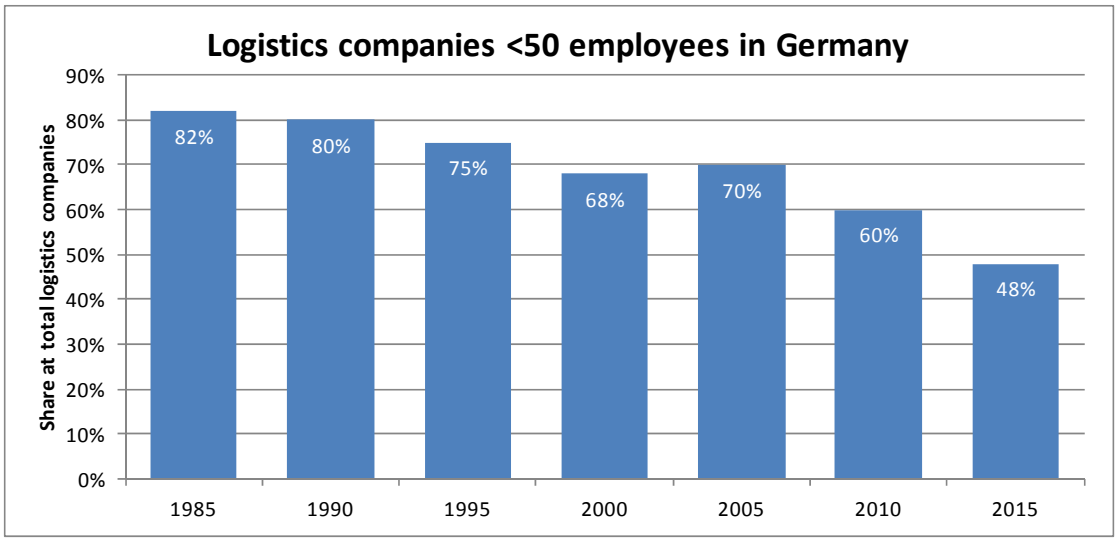
4.2 Toll impacts on specific market players

We can distinguish freight markets by several characteristics: the size of companies, types of services offered and product markets. In the following, we concentrate on company sizes as it can be expected that small and medium sized enterprises are hit harder by cost changes than large entities with more options to balance costs and negotiate with their clients.

4.2.1 Germany

In 2014 over a third (38%) of undertakings had a size between 10 and 50 employees. However, the structure of logistics companies in Germany has drastically changed since the mid 1980s. While 1985 still 82% of undertakings had less than 50 employees, the share of such small and medium sized enterprises (SMEs) dropped to 48% in 2015 (Figure 11). Only in the book year 2005, did the number of SMEs slightly recover, only to then fall even deeper due to the pressure by the EU market liberalisation, the financial and economic crises and potentially by high fuel prices. Statistical evidence does not suggest this development to be closely linked to the Lkw-Maut introduction.

Figure 11: Share of SMEs in the German logistics sector 1985 to 2015



Source: Data from DSLV (2015)

In the study by Euler-Hermes (2015) focusing on the transport sector (i.e. disregarding the warehousing and company logistics services) and taking as a reference the German statistical office, authors state that the German trucking sector is dominated by 68% of so-called micro enterprises with less than 9 employees.

Looking at market segments, a poll by the German Forwarders and Logistics Association (DSVL, 2015) has identified that the largest share (27%) of logistics undertakings see their core business in the retail sector, followed by the automotive industry (17%) and foodstuff, drinks and tobacco products (14%)[7]. The survey reveals that most com-

7 The survey allowed multiple answers, such that totals add up to more than 100%.

panies are active in several markets, such that statements on efficiency impacts of road tolls on specific commodity types will hardly be possible.

The BAG (2005 and 2006) market observations have identified a number of factors for determining the economic impact of the toll on hauliers' business margins. These partly depended on the type of company, market environment, and transport relations they were in. For instance: while the majority of hauliers in domestic transport could pass on direct toll costs for loaded headings to their clients, this was difficult for additional costs (e.g. administration) and for border-crossing trips, and was nearly impossible for empty headings. Forwarders did not suffer from the Lkw-Maut as the additional costs could fully be passed on from the contracted haulier to the final client. It was even observed that in some cases they did not reimburse tolls on empty headings to the hauliers but invoiced them to their clients. The fact that part of the toll costs cannot be passed on is one of the reasons why transport companies look for further efficiency improvements as described above.

Some aspects in detail:

- *Small and medium sized enterprises (SMEs)*. Smaller enterprises are frequently employed as subcontractors of larger transport or forwarding companies. Due to the high level of competition, they are forced to cover parts of the toll costs themselves. SMEs are particularly at risk for economic losses. BAG (2006) found that 10% to 20% of toll costs directly reduce profit margins of small hauliers. However high diesel prices, sharpening social regulations and the EU expansion are much more important factors in the reduction of profit margins.
- *Business structures.* A considerable share of the road freight volume in Germany is moved in inter-company transport, i.e. using company owned truck fleets. Before the introduction of the Lkw-Maut, further pressure on the commercial haulage business by company internal services was apprehended. The first monitoring study (BAG, 2005) did not confirm this, but indicated a tendency for further outsourcing logistics services to commercial companies. Current market reviews reveal that the trend towards outsourcing of logistics services still persists and is particularly strong in the automotive, the food and the consumer goods industry (DVZ, 2015).
- *Types of service*. The Lkw-Maut is imposing a considerable burden on hauliers, while collective consignment services are better able to adjust tariffs to compensate for additional costs. This is because the absolute amount of toll costs in collective consignments is low and cost structures are complex.
- *Contractual arrangements*. Spot markets are particularly price sensitive and contracts only cover distinct transport relations on a short term basis. Here, even the coverage of toll costs for loaded headings by the haulier's client is sometimes difficult; empty headings are not be reimbursed for tolls paid at all. The BAG market reviews emphasise that only in case of established long-term relationships between

forwarders, shippers and hauliers toll payments for empty headings may be covered by the haulier's client.

- *Commodity types.* The burden on forwarding industries depends on their branches. Difficulties arise for low priced food products, building materials and partly the automotive and furniture industry. In general, markets operating in close competition to low wages are problematic, but cases of refusing the coverage of toll costs for loaded headings are even reported with public services as clients (BAG, 2006). In contrast, the coverage of tolls for empty headings is more likely with the use of special purpose vehicles which commonly have comparably low shares of loaded hauls.
- *Geographic structures*. Coverage of toll costs by clients in regional and local transport is often difficult as these propose toll free alternatives even if travel times or distances are longer than on toll roads. In contrast, for shipments to remote areas without a chance for getting a back-load, clients are more likely to cover toll costs for the empty return trip.

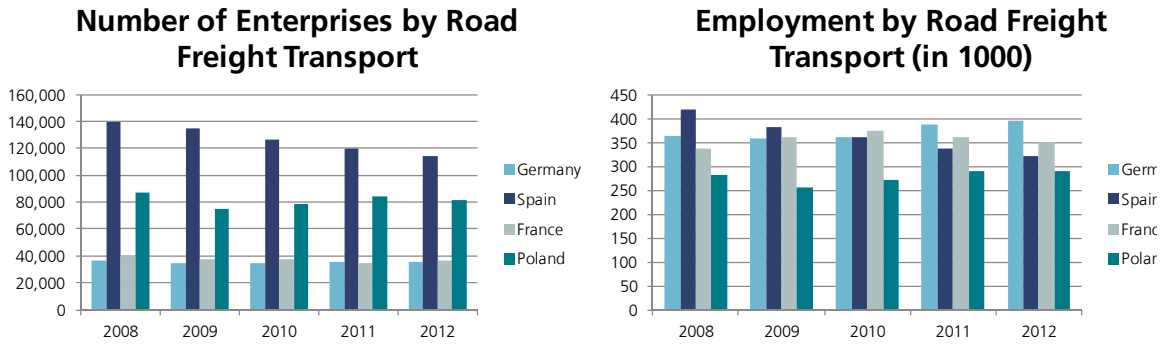
4.2.2 Spain

There is continuous discussion on the structure of transport companies in Spain and its comparison to the rest of Europe. Anibarro García (2016) presents that Spain, in comparison to other countries in Europe, has a higher number of transport companies, whereas the production values and people employed are much lower than the others (compare also SEOPAN 2016). According to Eurostat (online), compared to other EU countries, Spain has a really high number of freight enterprises (much higher than Germany), especially noticeable, when comparing to the level of employment in the sector, which has decreased in the last years.

There is presumably a high number of SMEs in the transport sector compared to other large western European economies (see Figure 13).

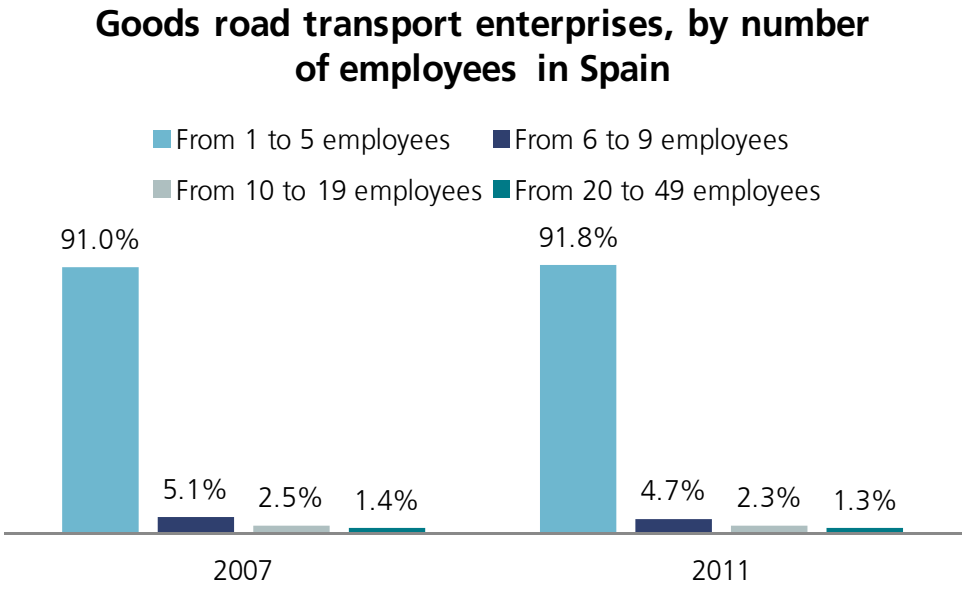
Figure 12 and Figure 13 show the behavior of number of firms and employment over the years. Interestingly, in 2007 there were 138,149 firms in the transport sector, of which, 91% had from 1-5 employees. In 2011, there was a slight increase of firms with 1-5 employees, whereas the rest decreased. It means that during the crisis, they tried to survive by reducing the size of the company. Unfortunately the similar information for Germany is not available.

Figure 12: Number of enterprises and employment in the road freight transport sector



Source: Fraunhofer ISI with data from Eurostat (online)

Figure 13: Company structure in the Spanish road transport sector



Source: Fraunhofer ISI with data from Eurostat (online)

Results from stakeholder consultations

The sample of answers obtained from the stakeholder consultation carried out among Spanish transport companies was too small to draw statistical conclusions.

However, from a qualitative perspective, we see a certain tendency that smaller companies are expecting more severe impacts from changing road toll scenarios than big entities, especially due to the economic constraints of transport companies in Spain

and the atomized market. When respondents were asked about SME transport companies, 5/10 said that SME might be threatened by tolls whereas 4/10 did not find risks or threats for SME.

Moreover, in our interviews, experts affirm that, especially for manufacturers and producers along with SME-transport companies, going to Europe to sell their products will get more complicated since they will need to pay tolls for crossing Spain plus the other tolls in the other different EU countries. This statement is in line with the important increase of international trade in order to overcome the constrained economic situation of the Spanish national market.

4.3 Impacts of toll system extensions on logistics efficiency

The META report (Aparicio et al., 2011) proposes that road pricing effects should be classified as direct, indirect, and distributive. Direct effects are divided into short term, those related to users' behavior; and long term, those related to the location/relocation of economic activities. Indirect effects are linked to the effects that tolls may trigger in other sectors, for example, price increases in many different products until a new price equilibrium takes place. Distributive effects are more related to spillover effects and how they are distributed among the different population groups, they are indeed linked to the equity concept which is one of the premises of tolling systems. Steininger (2002) mentions that as positive effects increase, the transport system may become more efficient, a more balanced modal share may be achieved and the environmental impacts may diminish. According to the literature review by Guzman Valderrama (2013), pricing schemes may lead to reductions in congestion, improvements in environmental quality, better vehicle fleets and more economic resources coming from road transportation. The negative effects are mainly sector specific.

The economic, financial and environmental implications of extending the German and the Spanish toll systems in the two study regions will be investigated further in the respective chapters of this report. Here we will briefly look at the logistics implications of the toll scenarios.

4.3.1 Germany

The performance of the German logistics sector was described in Section 4.1.1. Based on that, for statements on the impact of the Lkw-Maut with regard to the ASTRA-EC model results and the World Bank Logistics Performance Index (LPI) to be introduced in Section 5.4 further down in this study we can conclude the following:

- Logistics performance seems to be dominated by external factors. This is revealed by the World Bank Logistics Performance Index, according to which Germany dropped temporarily from the global pole position (rank 1) to rank 4 shortly after the world economic crises. The efficiency indices of Figure 7 and Figure 8 support this observation.
- The Efficiency of vehicle utilization can be impacted to some extent by higher road charges. A look at past trends of the overall utilization of vehicle load space in Figure 9 suggests only moderate toll impacts. More detailed market observations and ASTRA-EC model results presented further down in this study, however, suggest more flexibility of hauliers in further optimizing operations. The question whether or not to re-consider current organisational forms in the end will be determined by price levels and market structures.

There will be certain tipping points of pricing scenarios, beyond which the road sector will re-organize in order to maintain profitability. Studies on such high toll scenarios for Germany are not available so far. One scenario for this re-organization includes a further wave of bankruptcies of smaller trucking enterprises and mergers of the remaining medium and large sized companies. Looking at the example of Switzerland with currently truck tolls as high as one euro per vehicle kilometre for a full loaded 40t truck, however, shows that high price scenarios do not necessarily imply major market consolidation trends. But the example does indicate that alternative modes can take advantage of a more restrictive treatment of road freight transport.

4.3.2 Spain

With regards to the description of the Spanish logistics sector and the conclusion drawn for Germany we can formulate the following statements:

- With regard to the LPI we see that the Spanish logistics sector is on a positive path towards a serious international hub. With its many seaports to the Atlantic and the Mediterranean Spain. In particular, the larger regions of North-Eastern and Southern Spain take important gateway functions for European global trade. It is unlikely that changes in the charging of trucks in some regions will alter this picture considerably.
- The existing detour traffic in Germany and the stronger impact of road tolls on import-export flow, shows that single regions like the study areas of Jaén and La Rioja are affected by losing transit traffic – and thus income of the motorway concessionaires. However, we do not see major local impacts in the larger regions on traffic flows as reported in Table 6 for North-Eastern and Table 7 for Southern Spain. So the limits shall remain bounded.
- According to the ASTRA-EC model the shipping sectors in both Spanish regions are strong. A change in road volumes will thus have way less impact on the modal share than for Germany. For South-eastern Spain, where the shipping sector is directly

competing with rail, impacts to rail may be as high as +/-12% in domestic and +/-5% in total tonne kilometres.

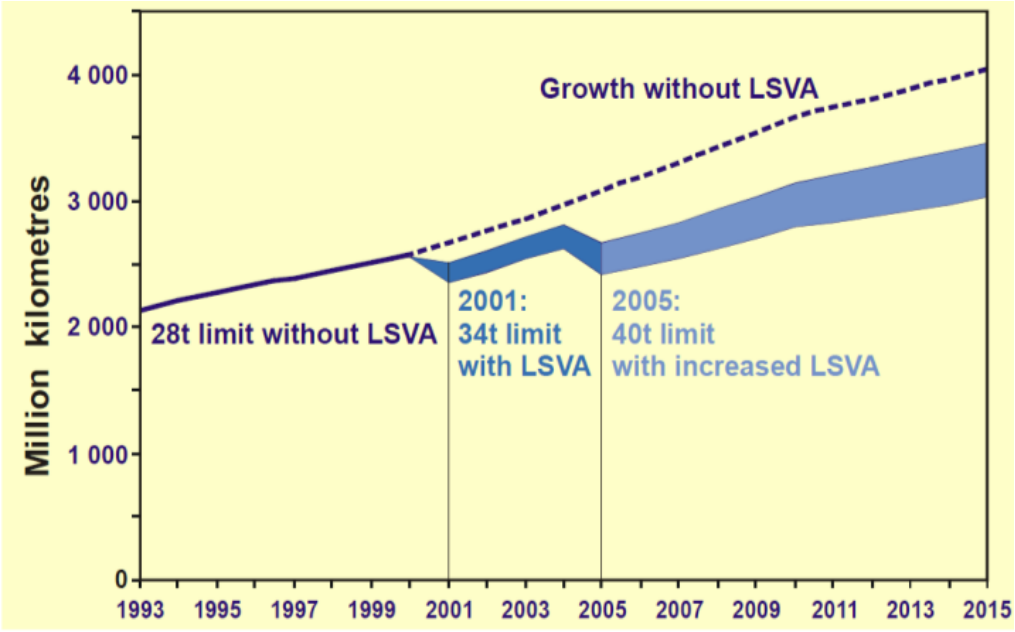
Results from stakeholder consultations

According to the qualitative survey, when respondents were asked about how tolls would impact the performance of their company, the impacts vary notably. For example, production/production costs would be at least somehow affected (6/10). They disagree on the time-costs impacts as many say there would be no impact, or either positive or negative could be expected. Fuel would decrease at least a little (5/10) whereas only 3/10 say that there would not be an impact. Trunk road rates would not be affected (9/10). Moreover, according to their point of view, 5/10 said that employment would not be affected and 7/10 said that wage levels would not be impacted by this measure. There is more disagreement regarding profit margins, as many (4/10) say that there would be at least some reduction on it whereas 3/10 say that there would not be an impact.

4.4 Impacts on the use of alternative modes

Currently, the most advanced road charging system with the explicit goal of incentivizing mode shift and of providing revenues for large-scale railway projects is in place in Switzerland since 2001. According to Vassallo Magro (2015), the Swiss toll system did have an impact on modal shift. Before 2001, the year in which the system was implemented, HGV traffic had an annual increase of 7% whereas after its introduction, there was a notable trend change and after some years it stagnated. The Federal Custom Administration reports that without this system, in 2005 the HGV traffic would have attained 23% more than the current traffic (see figure 21). The cost of it varies between 2.28 and 3.10 cents CHF /ton-km. (Federal Office for Spatial Development, 2015), which makes it more expensive than the German Lkw-Maut. According to the same source, there has been a greater rail share, but not only due to the Swiss toll. As a more important reason it is stated that the ban on driving on Sundays and at night, along with a weight limit restriction of 28 tonnes (until 2001), favored rail.

Figure 14: HGV traffic through the Swiss Alps

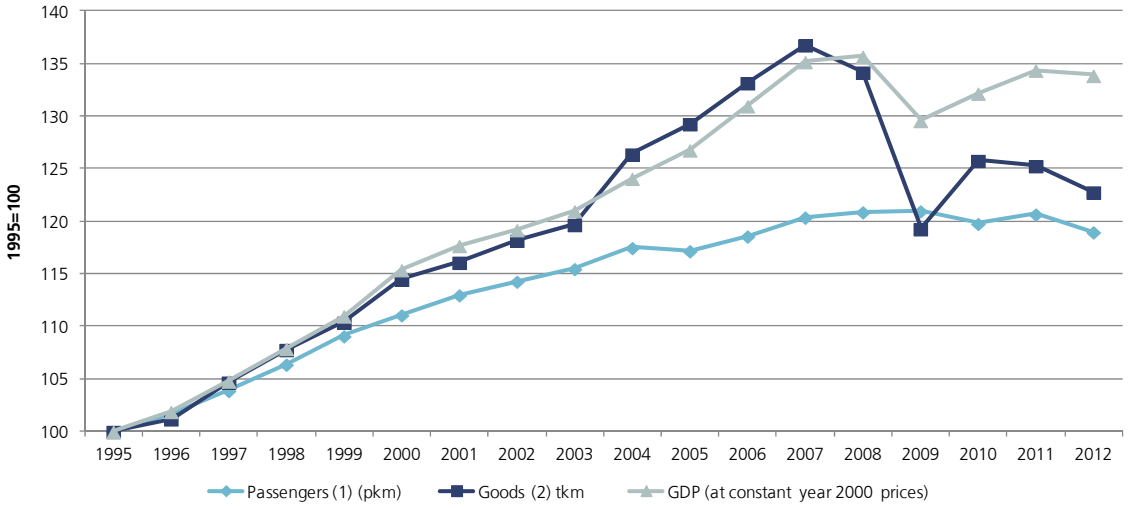


Source: Rapp and Balmer (2003)

Theoretical implications of tolls for mode shift are generally high. With the application of price elasticities found in literature, the LivingRAIL project (Biosca et al., 2014) estimates that the extension of the Swiss heavy vehicle fee, which may costs as much as 1.00 € per vkm with a fully loaded 40t truck to all of Europe, could increase transport volumes of the railways by 20% to 30% - but only by 2050 with the condition that respective infrastructure capacity extensions are implemented. The project finally concludes that a massive shift to rail takes a large variety of measures, covering all fields of railway technology, rail organisation, regional development and policy.

The use of alternative modes is, however, driven by a variety of factors. Besides price, travel time, and quality of the transport modes, the dynamics of regional, national, and global markets take a leading role in transport modes' performance, in particular in freight markets. A quick look across European passenger and freight volumes since 1995 in Figure 15 reveals the over-proportional sensitivity of goods markets to changes in economic performance indicators.

Figure 15: Rail passengers, freight volumes and GDP in the EU



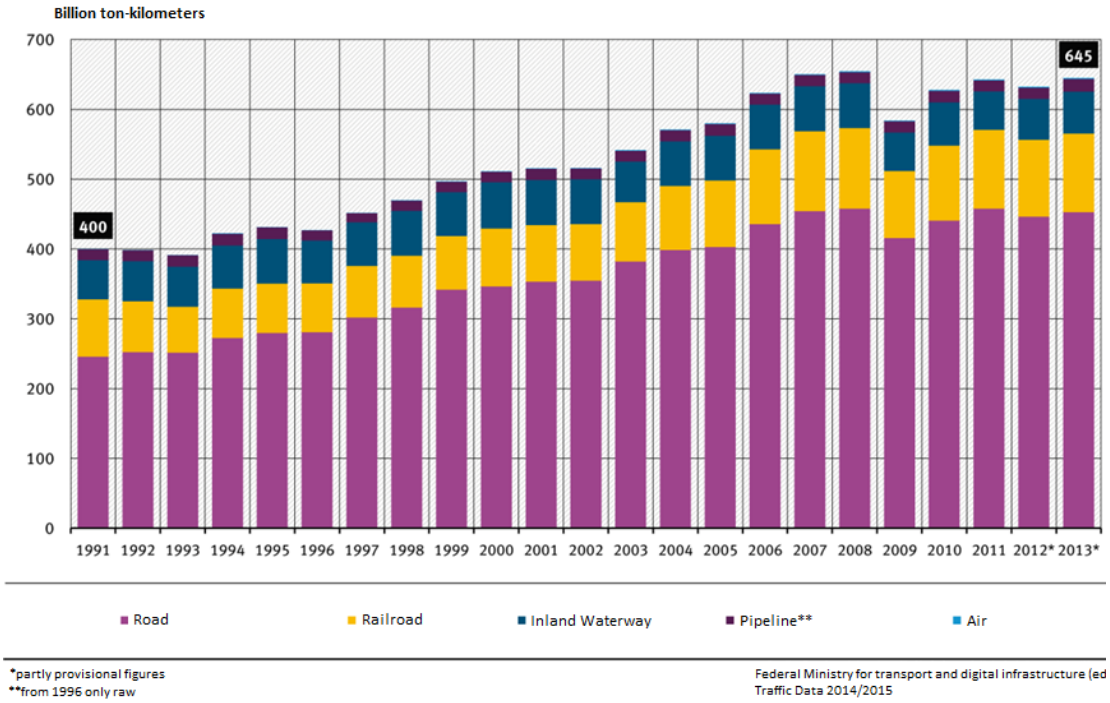
Source: European Commission (2014)

4.4.1 Germany

Back in 1980, the environmentally friendly modes rail and inland waterway transport (IWT) performed half of Germany's transport volume. The high increase in freight demand since then has mostly been absorbed by road haulage, market shares have shrunk to 18% for rail and 9% for IWT (compare Figure 16).

This was, however, mainly driven by the boom in global trade, entailing high demand in port hinterland traffic, high energy prices, scarcity of drivers and capacity constraints in the road network between 2005 and 2007. Logistics and railway bodies interviewed for this study agree that the impact of the Lkw-Maut in that highly dynamic situation was negligible. With the outbreak of the world financial and economic crisis in 2008/2009, rail market shares immediately dropped below the 2005 levels. This extremely sensitive reaction of rail demand to international economic conditions could be observed all across Europe.

Figure 16: Freight transport volumes in tkm in Germany 1991 - 2013 by mode



Source: https://www.umweltbundesamt.de/daten/verkehr/modal-split-des-personen-gueterverkehrs

The BAG market observations (BAG 2006) report a diverging openness of forwarding companies towards alternative modes. While mode shift is extremely difficult for time critical consignments and shipments with long access hauls from and to intermodal terminals, in extreme cases even contractual obligations for using HGVs are reported. In a special report on modal split, BAG (2012) indicates that the field of competition in the freight market is more between rail and inland waterways than between road and rail. This is particularly the case in port hinterland relations and along the Rhine corridor.

Expectations on mode shift impacts before the introduction of the Lkw-Maut differed widely. While policy and environmental stakeholders put much hope in more rail traffic, scientific studies calmed these high expectations. Rothengatter and Doll (2001) for the Federal Environment Agency (UBA) calculated that the level of 12.4 €/100 vkm will have no noticeable impact on freight mode shares. Only a doubling of the charge, its extension to all inter-urban roads and the use of considerable shares of the revenues to improve rail infrastructure would contribute to the declared effects. According to model calculations by Meyer and Lutz (2004) such a scenario would increase the rail share by around 1.8%. Aparicio et al. (2011) also state that for the case of Spain, high

level of road traffic is located mainly in city entrances. Therefore those areas would need to be tolled as well in order to really observe an effect.

The first volume of the BAG (2005) market observations speculates that there seems to be a slight tendency towards less empty headings and a shift towards rail, while detours to the secondary network in most cases were not considered an economic option. In its second review 18 months after the toll introduction, BAG (2006), based on 300 stakeholder consultations, concludes that mode shift goals were not met. The third volume of the federal government's traffic shift observatory due to the Lkw-Maut (Deutscher Bundestag 2013) constitutes that neither the introduction nor the tariff increase of the toll in 2009 showed any impact on rail road competition.

The June 2005 edition of the SCI Logistics Barometer (SCI, 2016) is a bit more positive in this respect. Although respondents agree that still the benefit-cost-ratio for rail is generally worse than for trucking, 25% of respondents (of 200 company decision makers) constitute that the Lkw-Maut has improved the competitiveness of rail.

ASTRA-EC model application

The Application of the ASTRA-EC model confirms the rather cautious conclusion on mode shift potentials. If we take into account the various compensation payments to the logistics sector, the abolishment of the toll would have lead to a 0.8% higher demand for road haulage in domestic transport, and of 1.2% in international transport. Likewise, a doubling of the Lkw-Maut tariffs and its extension to all relevant federal roads would decline road demand by 1.1%. For the rail sector this would imply changes of -2.7% in case of no tolls to +3.4% with double tolls by 2030 (see Table 5). For the intermodal competitiveness situation of road freight transport, these changes would just mean changes in mode share of -0.6% in the No-Toll Scenario to -0.8% in the High Toll Scenario towards 2030.

Table 5: ASTRA-EC results on freight volumes and mode share for Germany

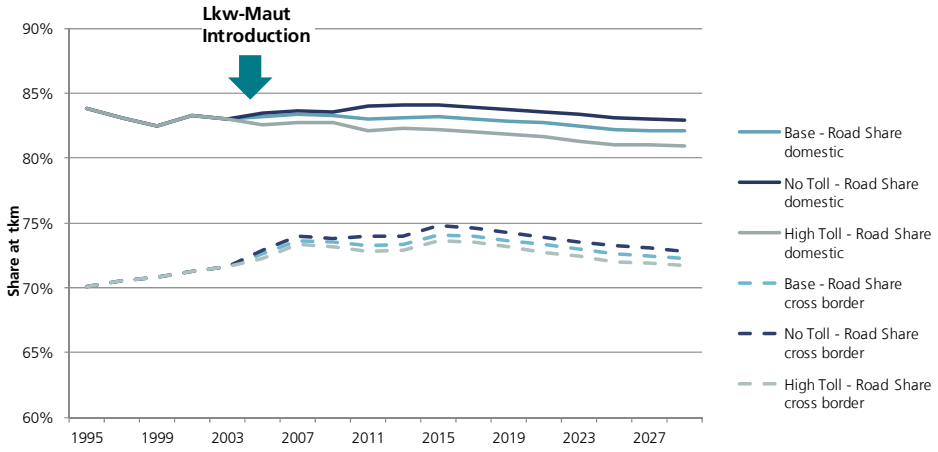
		No Toll to Base Case			High Toll to Base Case		
Mode	Detail	2015	2020	2030	2015	2020	2030
Road tkm	Domestic	+0.85%	+0.82%	+0.82%	-0.85%	-1.03%	-1.13%
	Cross-border	+1.25%	+1.20%	+1.17%	-0.91%	-1.09%	-1.13%
	Total DE	+1.06%	+1.02%	+1.01%	-0.88%	-1.06%	-1.13%
Rail tkm	Domestic	-5.79%	-5.25%	-4.91%	+5.94%	+6.81%	+6.92%
	Cross-border	-2.18%	-1.89%	-1.73%	+1.50%	+1.70%	+1.76%
	Total DE	-3.46%	-3.00%	-2.71%	+3.07%	+3.39%	+3.35%
Ship tkm	Total DE	-2.04%	-1.83%	-1.86%	+2.90%	+3.41%	+3.40%
All modes	Domestic	-0.25%	-0.22%	-0.19%	+0.28%	+0.31%	+0.29%
	Cross-border	+0.36%	+0.37%	+0.36%	-0.28%	-0.35%	-0.32%
	Total DE	+0.08%	+0.12%	+0.13%	-0.02%	-0.06%	-0.07%
Road %	Base Case	78.31%	77.43%	76.36%	78.31%	77.43%	76.36%
	Scenario	79.07%	78.13%	77.03%	77.63%	76.65%	75.55%

5 Source: Fraunhofer ISI, ASTRA-EC model calculations

Figure 17 shows the dynamics of road freight mode shares for the Base Case and the two toll scenarios from 1995 to 2030 as computed by the ASTRA model for domestic haulage and for traffic from and to Germany. Due to the longer distances in international transport, the share of rail and ship in cross border transport is higher than in national transport. Apart from these differences, the ASTRA-EC model expects the dynamics and the scenario impacts to be rather equal between these two market segments. The model calculations also suggest that mode shift impacts may take some time to unfold as shippers need time to re-arrange their business routines.

It should be noted that even the doubling of the German Lkw-Maut as considered in the second scenario just constitutes a third of the tariff level of the Swiss Heavy Vehicle Fee. Moreover, cross funding arrangements from road to rail and a long-lasting policy supporting the rail sector has enabled the current high rail freight market share of close to 50% in Switzerland. To achieve major changes does would require a relaxation of the tariff limits set by the Eurovignette Directive and more proactive national railway policies.

Figure 17: ASTRA-EC results: road mode share Germany



Source: Fraunhofer ISI

5.1.1 Spain

The specific characteristics of rail freight play an important role in the importance of road freight transport in Spain. Rail infrastructure is not completely linked to the rest of Europe due to the geographical barrier of the Pyrenees and due to the Iberian track gauge; therefore, transporting goods by rail to the rest of Europe is a costly task, be-

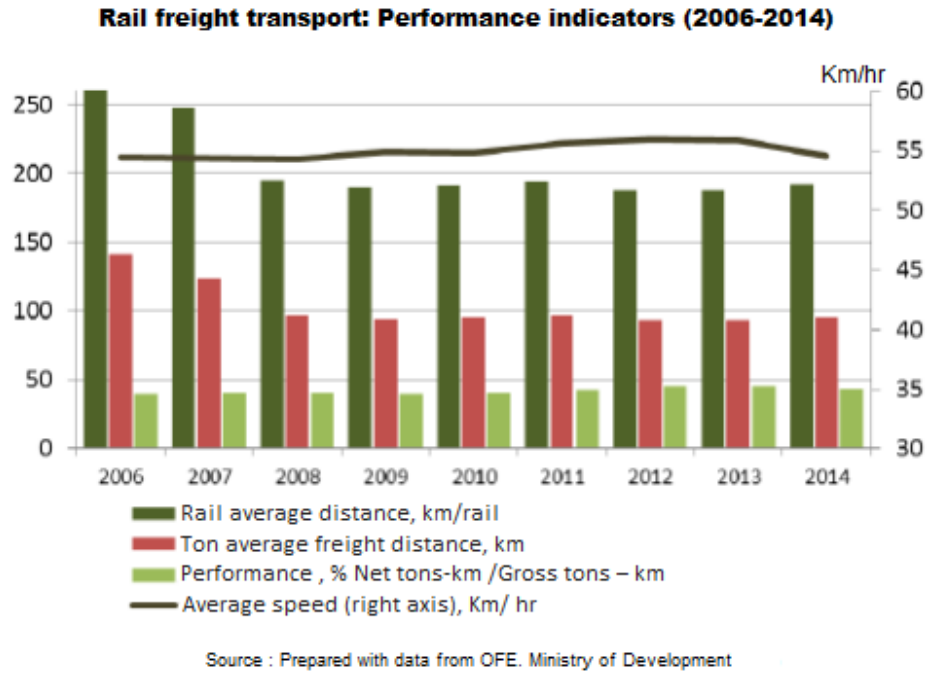
cause containers need to be moved from national to the international standard track gauge. Rail is a freight transport mode very efficient for longer distances, but due to these restrictions, its quotas are very limited. This problem is addressed by the EC's rail freight corridor concept. The Mediterranean and the Atlantic corridors shall connect the Iberian Peninsula to the rest of Europe by high speed for passengers and with standard gauge freight lines with unique technical standards (Doll et al, 2015).

Rail freight transport in Spain is mostly managed by RENFE —the incumbent state-owned rail operator— even though some private operators have been relentlessly increasing their market share over the last few years. Until recently, rail freight in Spain has not been a priority for the government. For example, rail passenger services were prioritized over freight services providing Spain with the second longest high speed rail network in the world. Therefore, it was not always possible to assure delivery dates. Compared to other countries with better rail freight systems, rail infrastructure in Spain for freight has lower standards. As a result, the rail freight share, even if it has never attained important quotas, decreased in the last decades.

Recently, rail liberalization has permitted private enterprises to enter the rail freight business. Private operators attained in 2014 a share of 20% transported tons and 26% of tons-km (OTLE, 2016). The OTLE report shows that in 2014 rail freight notably improved compared to latest years: Transported tons increased by 13% and the tonne-km a 10%. According to this report, this increase is due to the improvement in operation standards.

Even if rail freight had ameliorated its performance in 2014 compared to previous years, it was clear that there is room for improvement. For example, according to the OTLE (2016), in 2014 there was a slight decrease in the leverage of net tons-km / gross tons-km and the average speed of rail freight transport (see Figure 18).

Figure 18: Rail freight transport: Performance indicators (2006-2014)



Source: OTLE (2016)

Regarding other modes, the national air freight transport has decreased between 2005 and 2014 around -45%. According to the OTLE (2016), this trend is minimized by the international freight transport (not EU Schengen countries or emerging markets), which has increased around 72% since 2005. This has to do with the reorientation of the Spanish economy. Regarding maritime transportation, the same source states that after 2008 and 2009, its trend continued to increase, although it should be kept in mind that ships' dimensions have increased in the last years, which allows the transportation of more tons, reducing the unit price of transport rather than a better capacity use.

As stated by the META report (Aparicio et al., 2011), in order for a modal shift to take place,, alternative high quality services and infrastructure are needed. Otherwise, it is impossible that an alternative to road freight services will exist. In section 4,4,2 we already showed how logistic activities are mainly performed by road and that the share of rail is limited. This is in line with the results from the qualitative part of this study.

ASTRA-EC model results for North-Eastern Spain / La Rioja

The ASTRA-EC model has computed tolling impacts on the use of transport modes for the NUTS-2-region of Noth-Eastern Spain. With a transport share of 41.6% of non-road modes in the Base Case 2015, which is by far attributable to shipping, alternative modes are far more developed in Spain than in Germany. This means that changes in

road volumes due to HGV tolling scenarios take less impact on the volumes of alternative modes. Only domestic rail transport is expected to gain up to 5%. Due to the restrictions mentioned above this potential is not expected to unfold in international transport.

The Region of North-Eastern Spain (ES2) contributes about 12% to GDP in Spain. The target region La Rioja (NUTS-3: ES23) contributes 6.4% to the GDP of North-Eastern Spain, i.e. less than one percent to the Spanish economic performance. In front of this background, the results of the ASTRA-EC model shown in Table 6 are less surprising. Neither the internal flows within the NUTS-2 region of North-Eastern Spain nor the incoming and outgoing transport is affected a lot by changing road toll scenarios in La Rioja. Road transport shares change only by -0.32% / +0.33% towards 2030, which is well below any noticeable resolution of regional statistics.

Table 6: ASTRA-EC results : freight volumes and mode share for North-Eastern Spain (ES2)

Indicator		No Toll to Base Case			High Toll to Base Case		
Mode	Detail	2015	2020	2030	2015	2020	2030
Road tkm	Intra-ES2	+0.20%	+0.52%	+0.54%	-0.03%	-0.37%	-0.39%
	To/From ES2	+0.02%	+0.17%	+0.17%	+0.02%	-0.14%	-0.14%
	Total ES2	+0.04%	+0.22%	+0.22%	+0.01%	-0.17%	-0.17%
Rail tkm	Intra-ES2	-1.57%	-4.69%	-4.63%	+1.68%	+4.93%	+4.94%
	To/From ES2	-0.39%	-1.11%	-1.13%	+0.34%	+1.06%	+1.09%
	Total ES2	-0.74%	-2.19%	-2.22%	+0.74%	+2.23%	+2.29%
Ship tkm	Total ES2	+0.31%	-0.09%	+0.92%	+0.37%	-0.01%	+1.02%
All modes	Intra-ES2	+0.09%	+0.32%	+0.33%	+0.25%	+0.49%	0.50%
	To/From ES2	+0.13%	+0.30%	+0.30%	+0.17%	+0.34%	0.35%
	Total ES2	+0.12%	+0.30%	+0.30%	+0.18%	+0.36%	0.37%
Road %	Base Case	58.42%	59.72%	60.49%	58.42%	59.72%	60.49%
	Scenario	58.52%	60.03%	60.81%	58.32%	59.41%	60.16%

6 Source: Fraunhofer ISI, ASTRA-EC model calculations

Table 6 shows two important issues:

- Rail transport demand was 4.6% below the base case in the No-Toll scenario compared to the base case with current tolls. In the extended High Toll scenario it is expected to grow by another 4.9%. This is a considerable change in business volumes as generally, rail markets tend to stagnate or decline.
- Changes in domestic markets are three to five times larger than changes in inbound / outbound flows triggered by alternative toll scenarios. We can thus suspect that, if the model could zoom deeper into the geographical structure, changes for the region of La Rioja would be expressed more than suggested by the ASTRA-EC outputs.

The ASTRA-EC model shows that neither the dynamics nor the slopes of road market shares in the scenarios are considerably affected by the tolling scenarios assumed for the region of La Rioja (implemented for ES2: North-Eastern Spain).

ASTRA-EC model Results for Southern Spain / Jaén

The Region of Jaén (ES616) is part of the NUTS-3 zone of Andalucía. This contributes a major share (82%) of the economic performance to its parent region Southern Spain (ES6), while ES6 again makes up 16% of the Spanish GDP. Jaén makes up 8% of Andalucía's population and 7% of the population of Southern Spain (ES6), which is modelled by the ASTRA-EC model. Its relevance to the region actually considered by the model is thus comparable to the weight of La Rioja for North-Eastern Spain.

Table 7: ASTRA-EC results on freight volumes and mode share for Southern Spain (ES6)

Indicator		No Toll to Base Case			High Toll to Base Case		
Mode	Detail	2015	2020	2030	2015	2020	2030
Road tkm	Intra-ES6	+1.22%	+1.30%	+1.36%	-1.34%	-1.39%	-1.44%
	To/From ES6	+0.30%	+0.30%	+0.30%	-0.34%	-0.33%	-0.33%
	Total ES6	+0.35%	+0.35%	+0.36%	-0.39%	-0.39%	-0.39%
Rail tkm	Intra-ES6	-11.47%	-12.13%	-12.38%	+11.13%	+11.70%	+11.87%
	To/From ES6	-2.07%	-2.05%	-2.08%	+1.89%	+1.86%	+1.87%
	Total ES6	-3.89%	-4.08%	-4.25%	+3.68%	+3.84%	+3.97%
Ship tkm	Total ES6	-1.16%	-1.19%	-1.21%	+0.95%	+0.99%	+0.98%
All modes	Intra-ES6	-1.05%	-1.11%	-1.16%	-0.87%	-0.93%	-0.97%
	To/From ES6	-0.18%	-0.18%	-0.18%	-0.11%	-0.12%	-0.11%
	Total ES6	-0.22%	-0.23%	-0.24%	-0.15%	-0.16%	-0.16%
Road %	Base Case	43.13%	43.43%	43.63%	43.13%	43.43%	43.63%
	Scenario	43.37%	43.69%	43.89%	43.36%	43.67%	43.87%

7 Source: Fraunhofer ISI, ASTRA-EC model calculations

The difference in the regions rather lies in the role of road transport. According to the ASTRA-EC model this makes up only 44% of intra-zonal as well as of incoming and out flowing freight traffic. 47% of domestic transport and 55% of incoming and outgoing shipments are made by ship as the region is framed by the Mediterranean and the Atlantic coast lines. The remaining 9% of domestic and 2% of cross-zonal transport is carried by rail.

The ASTRA-EC results presented in Table 7 show that market impacts are for road somewhat higher than found for North-Eastern Spain. But if we look here, we also uncover some interesting details:

- Impacts for the railways are huge. With an abolishment of existing tolls they would lose 12% of business in domestic transport and 4% in total. With an extension of the toll according to German standards gains in the same order of magnitude are expected. These large changes come from the low market share of the railways: small changes in truck volumes affect them quite considerably.
- Shipping is less affected by changing road toll scenarios. This can be explained by current business volumes and by the missing direct competition between road and waterborne transport as constituted for Germany (BAG, 2006).

The ASTRA-EC model shows that, while in 1995 the model starts with a generally low but higher road share for import-export flows from and to Southern Spain, the position of road haulage rises considerable and equals out for both market segments towards 2007. From this time on, market positions remain stable with a now slightly higher road share in intra-zonal transport.

Results from stakeholder consultations

10 out of 12 responded to the question “Are alternative modes an option?”. 50% of the survey respondents denied this statement, while another 50% respondents agreed to it. Of those who responded which mode would be an option, 3 out of 10 said rail and 1 out of 10 said ship.

When respondents were asked about the challenges of alternative modes, they stated that the use of rail for freight is not really extended and it has difficult access. They also stated that there is a problem with the last mile, and that competing with road in costs, operability and service is a difficult task. Many others agree that security, punctuality, and timeliness of other modes compared to road are still an issue.

Interviewees are somehow reluctant of rail as an alternative mode. It is clear that there is a constraint in the rail system due to the Iberian gauge, which limits the usefulness of

this system. Regarding international freight transport, in which rail systems are more competitive, the movements needed in order to change containers to a European gauge would take time and economic resources. Moreover, not all products are suitable for this type of transport and the flexibility that road transport provides is difficult to beat by alternative modes. Finally, the lack of efficiency in the service has undermined the perception of freight rail by many shippers.

Some opinions regarding the benefits that rail receive (for example, exception of fuel taxes and other types of compensations) were discussed during this interviews.

7.1 Chapter conclusions

Both countries, Germany and Spain, have strong logistics sectors which rank high in international comparison. Both countries show similar transport intensities, i.e. ratio between tkm transported and GDP generated. The differences between the countries lie in their sensitivity towards external drivers of freight transport, company structures, modal shares, and the logistics sector dynamics. While Germany, with dominance of road and rail and a high per capita income, shows a relatively stable development even during the turbulences of the world economic and financial crisis, the Spanish logistic sector still improves in many aspects. Shipping is getting stronger, but with a less developed rail sector and a generally more vulnerable logistics structure in total.

The impact of changing toll scenarios on transport volumes and mode shares in the three regions (Germany, La Rioja and Jaén) provides a diverse picture. While overall transport volumes and transport volumes on road are affected to a minimal extent only in all three regions, rail and shipping may experience a larger impacts on their businesses. In the High Toll scenario rail is expected to gain up to 3.3% in Germany, 2.3% in North-Eastern Spain and 4% in southern Spain by 2030 against the base case. Largest business increases are expected in domestic transport. While for Germany the projected gains for shipping are about equal to rail, the Spanish maritime and short sea sector would just increase by around 1%. This is, however, due to the anyway strong position of the shipping sector in Spain.

But also in the road haulage sector there will be user groups with more or less sensitivity to tolls as it happened in Germany. Trucking companies with high shares of empty headings will be the ones with the highest sensitivity to tolls. The trend of outsourcing of logistics services to self-employed small and medium enterprises, which was observed in Germany from the mid-2000s on, worsens this trend further. So in parts, the impacts of road tolls on the trucking business are profound and need close monitoring before and after major changes in road toll settings are introduced. Required are in-

depth sector analyses as has been performed by the German Office for Freight Transport (BAG) in parallel to the introduction of the Lkw-Maut in 2005.

The above reflections and literature review of different case studies suggest that traditional expectations on mode shift effects from road pricing seem to be overly optimistic. Actual experiences in Germany, findings from literature, transport modelling outputs and stakeholder interviews indicate that at most only some 1% to 2% of road transport demand may be shifted to rail. In single cases this may be more, but only if framework conditions and the offers by the railways meet shippers' needs.

8 Economic Performance

In this chapter we look at the impacts that road toll settings have taken and may take in the future on the planning and decision-making in the road haulage business in Germany and Spain respectively.

In this section we will give the arguments to answer the following questions:

- Which direct and indirect impacts do haulers experience?
- How are commercial margins and bankruptcies affected?
- Are there effects on consumer prices?
- Do charges influence the positioning of countries as logistic hubs?

We start the chapter with a rather broad look on the potential impacts that road tolls take on the logistics sector. Evidence on impacts to the haulage business in particular are added where available.

8.1 Impacts on hauliers and counteractive measures

The scheme of potential impacts of road tolls on the logistics sector has been presented in the introduction to this study. Accordingly, we account for three types of toll impacts:

- The first and most evident impact of tolls on the logistics sector is cost increases. Less evident is the question who bears these additional costs: the hauliers carrying out the shipments, the shippers and forwarders organising logistics flows or the final customer, i.e. production or retail industries?
- Second, impacts are associated with the incentives provided by toll structures. As in the case of Germany tolls can create a pressure towards the use of low emission trucks.
- Third, the revenues of tolls are used to improve transport conditions. These should reduce logistics costs and thus compensate for parts of the logistics costs.

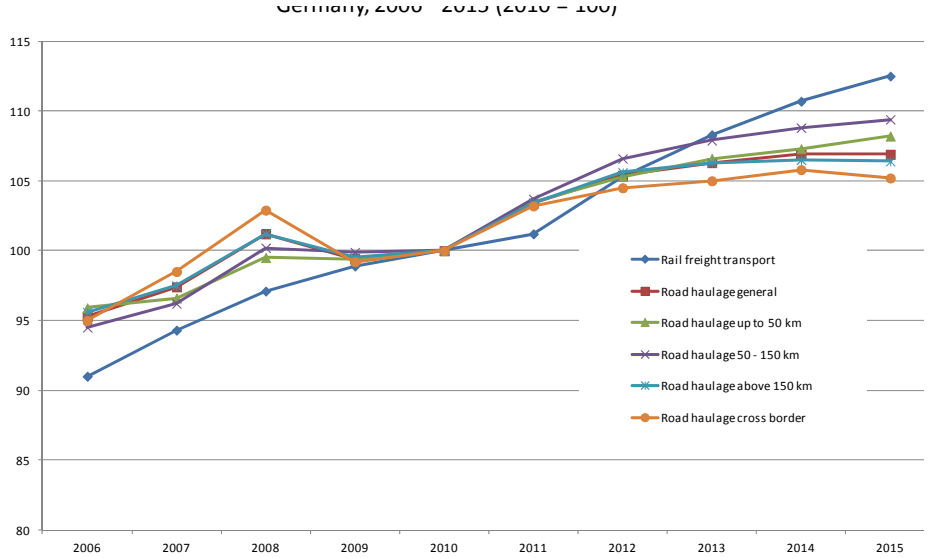
Multiple options for counter-active measures to these impacts are possible: pass on tolls where possible, use cleaner and more fuel efficient vehicles, avoid toll roads, chose less distant destinations where possible, save on personnel and other operating costs, re-locate or merge companies, etc.

8.1.1 Germany

8.1.1.1 Cost increase

Detailed producer price indices by business sectors are available from the Federal Statistical Office (DeStatis) from 2006 on. In the past decade, the producer price index for transport services has increased more for rail (+24%) than for road haulage (+12%). Within road haulage, long distance and cross border transport shows the lowest rate of price increase (11%), as cost pressure on these markets is particularly high and more options than in domestic haulage exist to save costs by employing low wage staff or by optimized fuel purchase (data from DeStatis 2016[8]). According to the Cost Information System (KIS) of the German Trucking Association (BGL) truck operating costs in Germany are around 1 – 1.5 €/km including driver, vehicle and fuel. The Lkw-Maut thus constituted a cost increase of 10% for the trucking business upon introduction in 2005. When assuming that the producer price index already rose at the same pace around 2005, we arrive at a total price increase for road transport service e.g. in the decade 2004 – 2015 of roughly 25%. This is in the same order of magnitude as the rail price index.

Figure 19: Producer price index for transport services in Germany 2005-2016

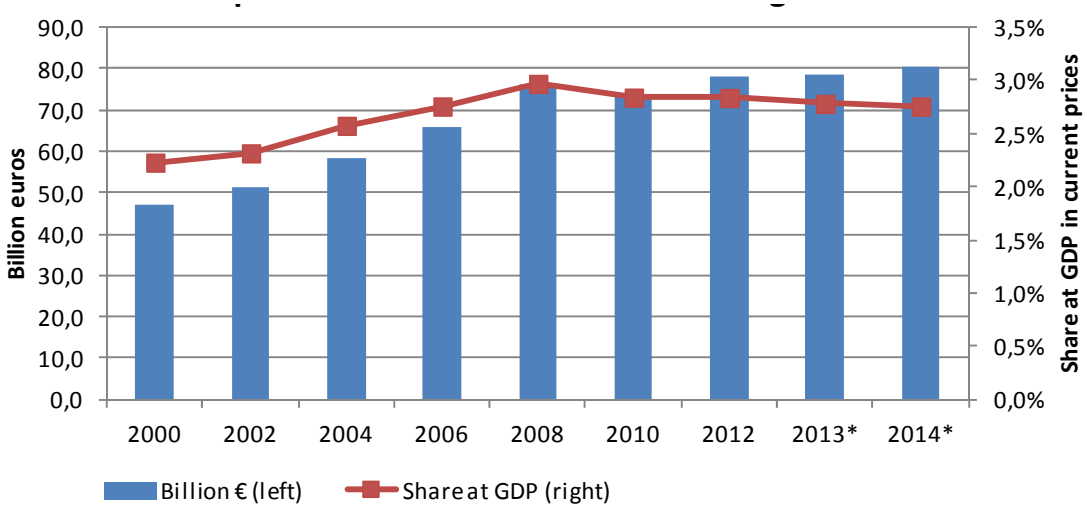


Source: Fraunhofer ISI with data from DeStatis (2016)

8 Respective data from DeStatis is only available from 2005 on.

Statistics reveal that business volumes in the logistics sector grew independent of the introduction of the Lkw-Maut. The turnover of logistics services in Germany has increased from 47.2 bn. Euros in 2000 to an estimated value of 80.4 billion Euros in 2014. Relating this increase of 70% to the growth in GDP (current prices) of 38% in the same period leads to a share of logistics services between 2.2% in 2000 and 2.8% from 2006 to 2014.

Figure 20: Turnover of the logistics industry in Germany, 2000 to 2014



* Preliminary values. Source: data from DSLV (2015) and www.destatis.de

Taking into account that hauliers can pass on the majority of tolls for loaded headings to shippers and forwarders, the resulting cost increase remaining with the trucking business is 2% to 5%. Of course for small enterprises in less favourable competitive positions the cost increase will be closer to 10%. For the forwarding industries transport costs may accounts for an additional 1.4% to 3.6% of production costs (see following sections). Table 8 summarises the values, which provide the basis for assessing potential counter measures in the logistics sector.

Table 8: Share of cost burden through the German Lkw-Maut

Players	**Hauliers**	**Forwarders**
Toll level	0,15 €/HGV-km	
Operating / transport costs	1,00 - 1,50 € / HGV-km	2% - 3% of production costs
Sharing of toll costs	20% - 30%	70% - 80%
Resulting cost increase	2% - 5%	0,14% - 0,36%

Source: Fraunhofer ISI

8.1.1.2 Employment in the logistics sector

In 2014, a total of 532 thousand people were employed in the transport and logistics sector in Germany. Of the roughly 39.5 million employees in Germany, this corresponds to 1.3%. With regards to the 2.8% share of logistics turnover at the national GDP, we can conclude that the labour productivity in logistics was twice as high in the logistics sector than it was on the German economy in total.

Employment effects are considered a measurable indicator to judge the overall impact of road charges on economic activity, and thus on the competitiveness of the region. As for consumer price changes, direct impacts of road toll introduction (or presence) on the number of jobs will not be visible. Thus we relate to model applications:

- Applications of the GWS (2003) model for the doubling of the German HGV toll indicate 27,600 to 108,000 new jobs for Germany and an average increase of GDP per capita between 17 and 34 Euros for Germany.
- Based on 340 expert consultations the BAG report on toll impacts (BAG 2005) constituted, diverging impacts on the business, which are depending on market structures. With regards to the very competitive environment, the main concern was acceptability, whether clients accepted toll-related surcharges on freight rates or not. As indicated above, this concern was partly justified due to the fact that the reimbursement of tolls paid on empty back-hauls by the hauliers' clients is normally problematic.
- Input-Output estimates in Doll and Schaffer (2006) found similar figures, i.e. 36,000 to 39,000 additional jobs (full time equivalents) across all industries. Most of these were expected in construction services (28,500 jobs). Interestingly, road transport takes the last position with only 400 to 450 expected additional jobs. The full range of results by all industries is presented in Table 9.

Table 9: Employment effects estimated for the introduction of the German Lkw-Maut

Industry	Employment effects	
	New jobs with productivity growth of 10%	New jobs without growth of productivity (max)
Construction services	25,200	28,500
Business related services	2,500	2,700
Ceramics and building materials	2,300	2,500
Complementary transport services	1,200	1,300
Wholesale	1,000	1,100
Financing	700	750
Wood and wood products	550	600
Supporting construction services	500	550
Electronics	400	450
Road transport	400	450
Whole economy	36,200	39,000

Source: Doll and Schaffer (2006)

A number of studies show that the re-investment of revenues into the transport sector would create considerable impulses, counter-balancing the direct (negative) impacts of logistics costs increase. Some evidence from core studies and its use in the ASTRA-EC model scenarios is summarized in Table 10.

Table 10: Literature findings: secondary employment effects from road tolls

Study and core statement	No Toll Scenario	High Toll Scenario
Employment in the **rail freight sector**: Sonntag and Liedtke (2015) estimate -150 employees with a 1% reduction of rail volumes.	Up to 0.6% increase in road market share with a 20% rail market share that is a 3% increase in rail demand, i.e. a loss of 400 jobs towards 2015.	Respectively: -1% road market share means +5% rail demand or 740 additional jobs towards 2030.
Sommer and Maibach (2002) estimate for Switzerland the **rail sector** employment increase will lead to roughly 1/3 of road logistics employment drops.	Assuming Swiss and German economic structures are sufficiently similar, an abolishment of the Lkw-Maut would cost 8,000 jobs in the rail sector.	Accordingly, a doubling of the Lkw-Maut would mean another 9,500 jobs in the rail sector.
WIFO (2002) for Austria estimates a **general** increase of employment of +9% with a decrease in transport of -12%.	If assuming equal economic conditions, the +0.05% employment in transport would translate to -0.08% in overall employment.	Similarly, the -0.08% estimate of direct effects would translate to +1.1% in employment overall.

Source: Fraunhofer ISI

The ASTRA system dynamics model predicts a drop in the number of jobs and in GDP across all sectors when considering only the impact of costs increasing in the trucking sector. Based on the literature findings presented above, we assume that second round employment impacts over-compensate the restraining effect of logistics costs increasing by 30%. We thus would have ended up with a positive employment effect of 0.1% against the Base Case with a doubling of the German Lkw-Maut from 2005 on. With a number of 40.4 million employed people in 2015, this corresponds to an additional 40 thousand jobs. Verifying these estimates with actual labour market statistics is not possible as fluctuations in employment due to multiple reasons would outnumber toll effects by far.

Due to a strong demographic change in Germany, i.e. rapid aging and shrinking of the population, employment will most likely not be one of the country's future challenges. Even now, there is a shortage of skilled personnel across all sectors. In the logistics sector, truck drivers being able to cope with demanding modern logistics processes are rare and need to be hired from abroad.

8.1.1.3 Economic performance

Similar to the assessment of employment effects, the ASTRA-EC model estimates the direct impacts of costs increasing in transport and logistics to cause a relative decline in the gross domestic product (GDP) towards 2030 of -0.2%, compared to the Base Scenario. Assuming that all revenues, either through re-investments in the road sector, through compensations or through additional business for the Toll Collect system are fed back into the economy, this effect is neutralised. On top, we can derive a level of second round impacts as investments entail inputs from other sectors of around 40% (compare e.g. Schaffer and Doll, 2006, Kratena and Puwein 2002, Jochem et al, 2008 and Schade, Lüllmann and Beckmann 2008). We thus assume an over-compensation of first round toll impacts of 40%.

The results of the investment impulses on GDP in Germany were modelled with the ASTRA-EC model. If considering the High Toll scenario, i.e. the hypothetical doubling of the Lkw-Maut charges, we see that after the investment impulses manifest, there is an increase in the national GDP by 0.3% for a period of 10 years. This is mainly triggered by the funds invested into the road network and the incentives for truckers to buy new and environmentally friendly vehicles. Finally, the impact fades and even turns negative towards 2030. This is because the average toll level per HGV kilometre, and thus investment activities, stagnates while GDP in other sectors grows.

The overall level of GDP change is well below the expected rate of annual growth and appears to be rather complex and unstable. We can thus neither stipulate a noticeable

positive nor a negative impact of the Lkw-Maut on Germany as a business and logistics location.

8.1.1.4 Other impacts and compensation measures

8.1.1.4.1 Detour traffic

Detouring traffic to the secondary road network (federal and state roads) was one of the major concerns of societal discussions around the Lkw-Maut introduction. Citizen organisations and parts of the policy expected major negative safety, noise and environmental impacts through trucks leaving the motorways to save toll payments. According to the market observations by BAG (2005 and 2006) this should be no major issue as longer travel times seemed to be unacceptable for truckers. For some road links and for a number of foreign motorways in Poland, the Czech Republic and Austria, however, detouring was a problem. Therefore, the federal government demanded regular tri-annual field observation studies on the matter. These were conducted in 2006, 2009 and lastly in 2012/early 2013 (Deutscher Bundestag, 2013).

By combining network model applications and statistical analyses of permanent traffic count facilities, the latest monitoring study concludes that of the roughly 40 000 km of federal roads only 0.6% show additional HGV traffic due to the Lkw-Maut. Reasons for leaving motorways are mainly independent of the Lkw-Maut and affect regional transport far more than long distance haulage. These include: routes via motorways constitute a detour, some federal roads are designed like motorways, secondary roads or toll-free routes in other countries are parallel to tolled motorways, building sites and other obstacles put motorway routes at a greater risk for congestion and during the night time, secondary routes are equally as fast as motorways.

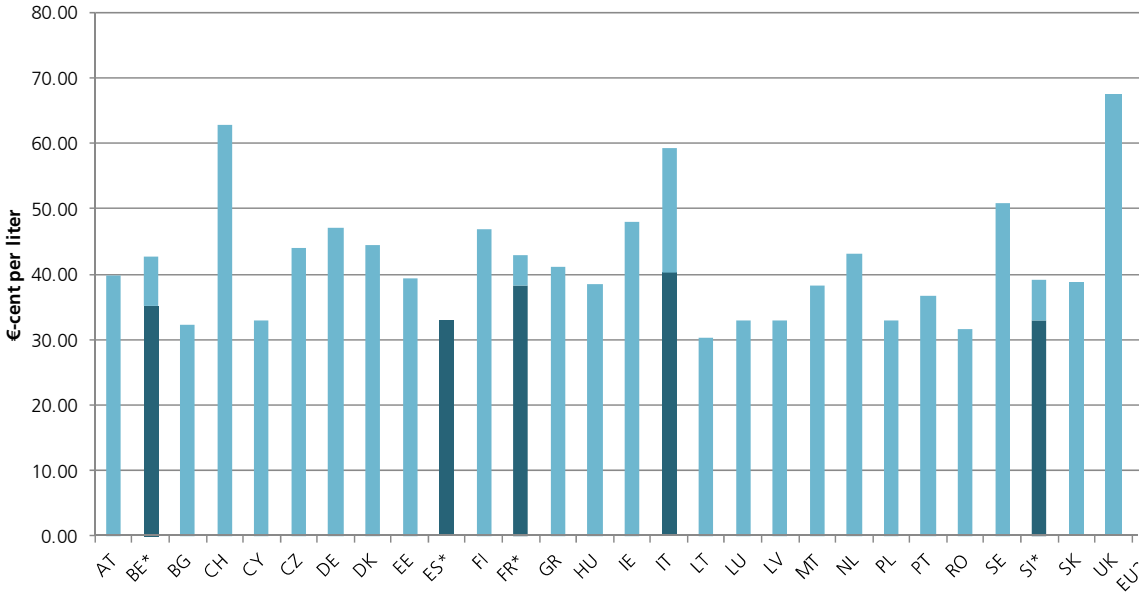
Two counter measures have been implemented to prevent from massive detouring: the closure of detour-prone sections of the secondary road network for heavy trucks and the inclusion of motorway-like sections into the tolling system. Moreover, the motorway A6 in parallel to free French motorways was exempt from the toll. Uncoordinated actions by federal states and the use of some detour routes even before the toll introduction have lead to complaints by the business sector against these measures.

8.1.1.4.2 Fuel issues

According to BAG (2006), German trucking companies compensated the double burden of high energy prices (in the period 2005/2006) and the Lkw-Maut by purchasing diesel in neighbouring European countries with lower prices and fuel tax burdens. Figure 21 indicates that Germany ranges well above the European average in terms of

fuel tax, while some neighbouring countries, all above Poland and Luxembourg, apply – or are close to - the EU minimum rate of 0.33 €/litre. It is expected that this habit will stop only in the case that the planned compensation mechanism of Lkw-Maut reimbursements for fuel tax paid in Germany is implemented.

Figure 21: Fuel tax rates on Diesel in European countries



Highlighted (BE, ES. FR, IT, SI): special rates for commercial use. Source: BGL e.V.

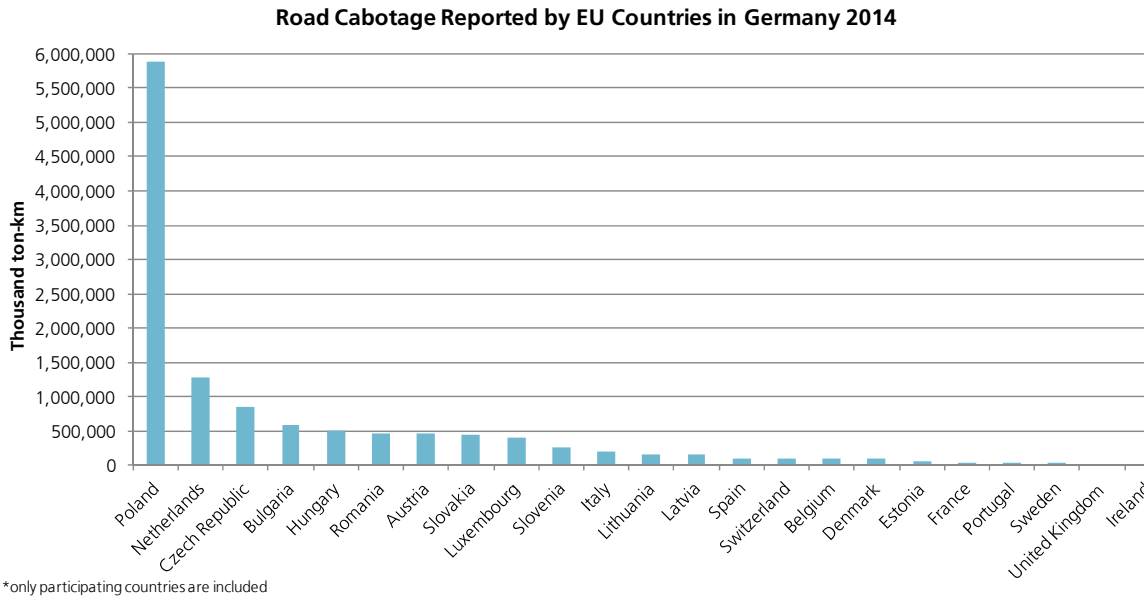
8.1.1.4.3 International competitiveness of national hauliers

The Lkw-Maut was advocated by the improved competitiveness with which German hauliers would take over foreign undertakings, which are performing logistics services within the national territory (cabotage). The line of argumentation says that foreigners have to travel longer distances, while domestic undertakings are already within the market. For roughly 40% of border crossings, road freight transport with heavy trucks is performed by foreign companies. This includes traffic from and to the German market as well as transit traffic.

Since May 2010, Directive 2009/1072/EC sets common rules for providing domestic logistics services by foreign companies (cabotage). Within Germany, cabotage volumes are reported around 12 billion tonne-kilometres by EU sources. Given the broad 450 billion t-km carried by road haulage each year, this corresponds to a share of 4%. Although this figure is still low, sector experts expect it to rise constantly in the future due to high competition in the trucking business.

The vast majority of cabotage traffic, around 50%, is performed by Polish undertakings, followed by Dutch, Czech, Bulgarian and Hungarian companies (Figure 22). Due to the longer access distances which foreign trucks need to take to perform national services, it was hoped that the Lkw-Maut would contribute to minimising cabotage traffic.

Figure 22: Cabotage volumes in Germany by country of the service provider 2014



Source: Eurostat (Online)

According to expert interviews with the two major logistics associations in Germany (BGL e.V. and DSVL e.V.) carried out in the course of this study, the Lkw-Maut has slowed down cabotage traffic. As the real nationality of trucks, however, is not always clear due to the tendency to relocate the headquarters of formerly German companies to low wage countries (out-flagging), the causes and effects in the cabotage market remain somewhat unclear.

8.1.2 Spain

The dominating land freight transport mode in Spain is road, while rail freight plays a marginal role. Different reasons are behind this situation. Road network is radial and much better developed than the rail freight infrastructure, hence, for national transport, road transport costs tend to be lower.

As the annual report from the Spanish Transport and Logistics Observatory (OTLE, 2016) shows, the negative trend in public investment on infrastructure and transport

services by the Ministry of Civil Works (MIFO), government-owned companies, and public administrations is reverted after five years of important decrease due to the economic crisis. Still, these numbers are far from the necessary investment.

Also, according to the OTLE (2016), in 2014 the transport of goods sector increased: the national transport by 5% and the international by another 5%. In 2014 the GDP increased by 1.4%, which would mean that the trend has reverted after the last years. Nevertheless, the use of toll roads remains far below the numbers before the crisis (Munoz, Ramon, 2016b).

According to Aparicio et al. (2011) and Guzmán Valderrama (2013), there are only few studies on road charging indirect impacts, such as GDP or employment, which aim at showing the trade-off between policy and economic impacts. The next paragraphs discuss the main impacts that could take place in the Spanish network.

8.1.2.1 Labour market

As it will be mentioned in section 8.2.2, productivity in activities related to the transport sector has slightly increased over the last few years. It is worth mentioning that economic activities related to storage present a more important productivity increase even though the sector did not destroy employment during the worst years of the crises (OTLE, 2016).

Guzman Valderrama (2013), using input-output tables shows, shows how implementing a distance-based charge to HGVs in Spain, considering 7,053.8 km of highways linking the regional capitals, impacts on the different regions (using the NUTS-2 Spanish regions). According to his analysis, estimated changes of employment and GDP are expected to be notable for some regions, but negligible for others. Macroeconomic indicators are strictly associated with the interregional trade discouraged by the road charging policy. Increases are seen in Navarre, Valencia and Andalucía; whereas reductions are seen in Ceuta and Melilla, Murcia and Extremadura both for GDP and employment. The reason may lay in the fact that regions which have more jobs related to freight transport sectors will lose more jobs and regions with more tertiary employment will have a very slight impact. In the case of Andalucia, it would be expected, from the implementation of a road charging scenario compared to a base case scenario, an increase of 0.13% whereas for La Rioja an increase of 0.10% would be expected. However, an overall decrease of employment in Spain of about -0.02% would be expected from the implementation of a distance based charge to HGVs.

Results also show that benefits of road charging scenarios are located mostly in the richest regions (7 out of 10) whereas only 4 of the poorest regions are benefited. More-

over, the Gini coefficient shows that a great inequality would still exist with the road charging scenario. The benefits of the toll system would be obtained through revenues of the tolling system, which should impact each region. According to his results, annual revenues for the total system would be around 693 M€. Specifically, in the Andalucía region, this would be about 129M€; whereas for La Rioja, they would attain 1.9 M€ only.

ASTRA-EC model results for North-Eastern Spain

The employment impacts for the Spanish region of North-Eastern Spain (ES2) containing La Rioja, range around +/- 0.03% relative to the region's Base Case employment. After temporal positive impulses, particularly in the No Toll Scenario, both scenarios show a negative slope. But the order of magnitude is so small that a real employment impact on the tolling scenarios cannot be derived from the model results. It needs to be repeated here that the small impact of the tolling scenarios considered in this study constitute a problem not only for aggregated statistics, but also for economic models to identify meaningful results.

ASTRA-EC model results for Southern Spain

According to the ASTRA-EC model, the labour market in Southern Spain (ES6) reacts somewhat more dynamically and for both tolling scenarios, positively. But also here, temporal fluctuations are visible and the overall effect is very small. With impacts between 0.01% and 0.05% we cannot acknowledge a significant labour market effect of the selected tolling scenarios.

For the three regions investigated we can conclude that changes in road charging schemes entail employment impacts, but these are complex and small in size. Labour market impacts are naturally of more concern in times of economic stagnation with high unemployment rates. In periods of strong growth, German experiences show that the lack of skilled drivers constitutes a more serious problem for the trucking business.

8.1.2.2 Economic Performance

According to Guzman Valderrama (2013) the GDP results are based on trade patterns which have a direct effect on the total output of sectors and regions. Estimated changes of GDP are expected to be substantial for some regions. For example, in the case of Andalusia (which Jaen is part of) an increase of 0.10% would be expected, from the base-case scenario to the charging scenario. In the case of La Rioja, a more moderate increase of 0.06% would be expected. However, an overall decrease in Spain would be expected, of about -0.007%.

ASTRA-EC model results for North-Eastern Spain

Economic performance indicators, here gross domestic product (GDP), react a bit more intensively on changing toll scenarios according to the ASTRA-EC model findings. This is because revenues re-invested into the economy create direct impulses to the construction and vehicle industry. Counter-balancing factors are slowly declining demand for new vehicles in the high toll scenarios and the losses in the economy due to transaction costs of the toll system payment architecture.

As found for the employment effects, however, the changes are rather small. Following some ups and downs, regional GDP will only decline by -0.3% in 2030. This is well below any annual fluctuation of economic activity and thus not relevant.

ASTRA-EC model results for Southern Spain

As for the case of employment indicators, the results of GDP in Southern Spain (ES6) do not differ substantially from that in North-Eastern Spain (ES2). A long-term decline to -0.3% compared to the Base Case is not of any concern.

For Germany and the two Spanish study regions, we find that impacts of road toll systems on GDP are there, but – as for employment – they partly take counter-intuitive directions and are small in size. The changes against a base case with current road tolling scenarios remaining unchanged until 2030 are too small to be visible among the annual fluctuations of economic performance indicators.

8.1.2.3 Other impacts

8.1.2.3.1 Detour traffic

Results from stakeholder consultations

People that responded to the survey (11 out of 12) already highlighted that the economic crisis modified their decision on taking toll roads. For 36% the crisis modified their decision significantly and for 45% a little.

When respondents were asked if they have perceived more trucks deviating to non-toll roads in Germany, we only received 5 responses, of which 60% agreed on this.

Interviewed experts also agree that this would happen and that it is an important issue, since the wear and tear situation of the non-high capacity network is not in an adequate state. Literature review also sustains this point (See section 2.3.1).

8.1.2.3.2 Fuel issues

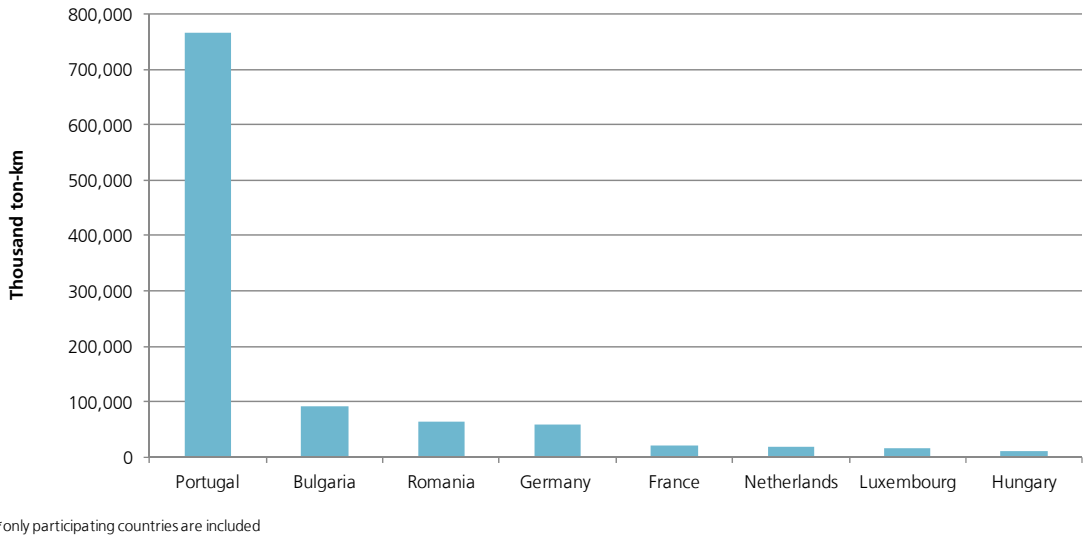
Vassallo and López (2010) highlight that the implementations of HGV toll policies have been controversial for many reasons. For example, fuel taxes are neither homogeneous at the European level, nor at the regional Spanish level. A HGV toll policy is not equitable since it harms in particular, the peripheral regions of Europe. Moreover, road transport companies observe that this policy is not fair because other transport modes (like rail and maritime) are exempt of fuel taxes. However these modes pay fees for using infrastructure and in some cases, such as rail transport, they also pay electricity taxes even though they are not as high as fuel taxes.

8.1.2.3.3 International competitiveness of national hauliers

According to Frisoni et al. (2013), Spain has been an example of linking cabotage and trade activities. In the last decades Spanish hauliers have been very competitive in exploiting the advantages of cross-border trade and cabotage beyond the Pyrenees. They have gained a substantial market out of it.

Recently, the cabotage activity of Polish hauliers has threatened this coupling and outflagging, (which means the licensing of national motor trucks abroad), is seen as another potential risk for the national transport market.

Figure 23: Road cabotage reported by EU Countries in Spain 2014



Source: Eurostat (Online)

Results from stakeholder consultations

One interviewee observed that more attention should be paid in social dumping in the transport sector: “Spanish hauliers are facing a complicated situation and it gets worst when we need to compete with Polish salaries in our own territory”.

8.2 Profit margins and bankruptcies

8.2.1 Germany

8.2.1.1 Profit margins and the toll discount procedure

The German Lkw-Maut was introduced in 2005 during a period of high diesel prices and an increasing international competition after the EU accession of the eastern European countries in January 2004. In that situation, hauliers were concerned about the additional burden of a toll on the practically[9] free German motorways. Cost increases for the logistics sector due to the Lkw-Maut were between 10% and 15%. As stated by the BAG (2005 and 2006) reports and the January 2005 edition of the SCI Logistics Barometer (SCI 2016) these could have been passed on from the hauliers to the forwarders for the roundly 80% of loaded trips. The average cost increase for the haulage sector thus was only in the order of magnitude of 2% to 5% across all types of companies (compare Table 8).

Cost increases particularly hit small and medium sized enterprises (SMEs). According to Euler-Hermes (2015), currently profit margins are as low as 1% for SMEs, while they reach 6% and more for the big players. In 2005 still 70% of hauliers in Germany were SMEs which traditionally have a rather thin capital stock at their disposal. This inequality, which re-appeared in the world economic crisis and nowadays with the minimum wage act and slowly rising energy prices (Euler-Hermes, 2015) caused a number of insolvencies after the introduction of the Lkw-Maut (see later sections).

9 The Lkw-Maut replaced the Eurovignette time based charge of up to 1250 €/vehicle valid until 2003. With a vehicle travel distance of around 100,000 km/a, the Eurovignette was only 1 €/100 km.

Figure 24: Profit margins in the German trucking business 2007 – 2016

f: forecast. Source: Euler-Hermes (2015)

For compensation, the federal government proposed the toll discount procedure (Mautermäßigungsverfahren) of 600 million Euros annually. The first attempt to grant the discount by lowering the tariffs from 15.0 €/100km to 12.4 €/100km upon proof that the respective undertaking paid fuel tax in Germany was rejected by the EC due to concerns about competition. Thus, from 2006 on, the following measures were then formulated in the act on amending motor-vehicle related and Lkw-Maut related regulations (Deutscher Bundestag, 2006 [commented draft] and 2007 [final]):

- Reduction of the annual vehicle tax to the EU minimum: 150 mill. €/a.
- Investment aids for the purchase of environmentally friendly trucks. Volume: 100 mill. €/a.
- Discount on the calculated (cost based) toll of 15.0 €/100km to 13.5 €/100km for all, i.e. national and international users. Volume: 450 mill. €/a.

The practical toll level for German hauliers from 2006 on then fell by 16% from 15.0 to 12.4 €/100 km. If disregarding the additional administrative costs which came along with the compensation programmes, the total cost burden of an average haulier for long-distance travel was lowered by 2.3%.

8.2.1.2 Bankruptcies

Applications and outcomes of insolvency procedures are systematically recorded by the Federal Statistical Agency (DeStatis) by economic sector. These statistics are, however, only available from 2008 on in their current form. The eight year time series in Table 11 indicates that the years directly after the world economic crisis in 2008, the absolute number of insolvency procedures in transport and logistics increased significantly. More or less the same trend was observed for insolvency procedures across all

sectors, such that until 2014 the share of the logistics sector remained between 7.4% and 8.2%. According to BAG (2015) insolvency rates were similar for both types of logistics undertaking: with or without own fleet. We can conclude that the logistics sector is not particularly more vulnerable to changes in economic conditions than other sectors are.

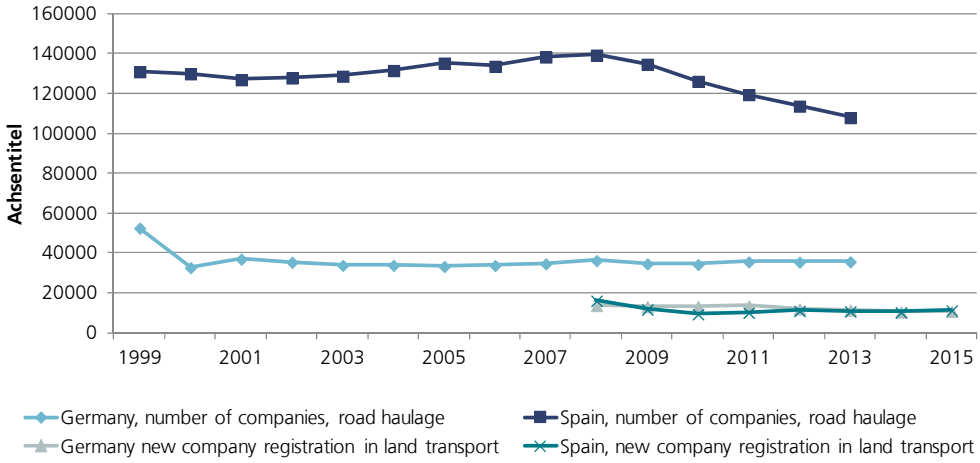
Table 11: Insolvency procedures in logistics, Germany, 2008-2015

Year	2008	2009	2010	2011	2012	2013	2014	2015
Transport and Logistics	1571	1988	1793	1743	1715	1566	1413	1109
Total insolvency proceedings	21359	24315	23531	22393	21311	19488	17877	16979
Share of transport & logistics sector	7.4%	8.2%	7.6%	7.8%	8.0%	8.0%	7.9%	6.5%

Source: GENESIS online database, Federal Statistical Office (DeStatis)

Company start-ups constitute another indicator for the vulnerability of a sector to external conditions (Figure 25). For Germany it was observed by the BAG (2006), that bankruptcy rates have risen in the first half of 2005, but have returned to the level before the toll introduction from mid 2005 on. BAG (2005 and 2006 claims that the number of company start-ups in the logistics sector clearly and constantly declined upon the introduction of the Lkw-Maut in January 2005. The total number of transport companies as shown in Figure 25 shows no significant up or down around the year 2005.

Figure 25: Number of companies and start-ups in land transport in Germany and Spain



Source: Fraunhofer ISI with data from Eurostat (2002 data extrapolated) and EU Transport in Figures 2002 - 2016

For Germany, we can conclude that the sensitivity of businesses in the transport and logistics sector towards external conditions appears to be higher than the average across all sectors. The Lkw-Maut had some impact on business continuity, but this is to a large extent superposed by energy prices and the prevailing global and national economic situation.

8.2.2 Spain

The total working hours in the transport and storage sector is similar to the GDP and Gross value added, although working hours have decreased more than production since 2008 and therefore productivity has recovered and increased with respect to the economy as a whole and the transport sector, after it had stagnated and even shrank between 2000 and 2007 (OTLE, 2016).

8.2.2.1 Toll discount procedure

Results from stakeholder consultations

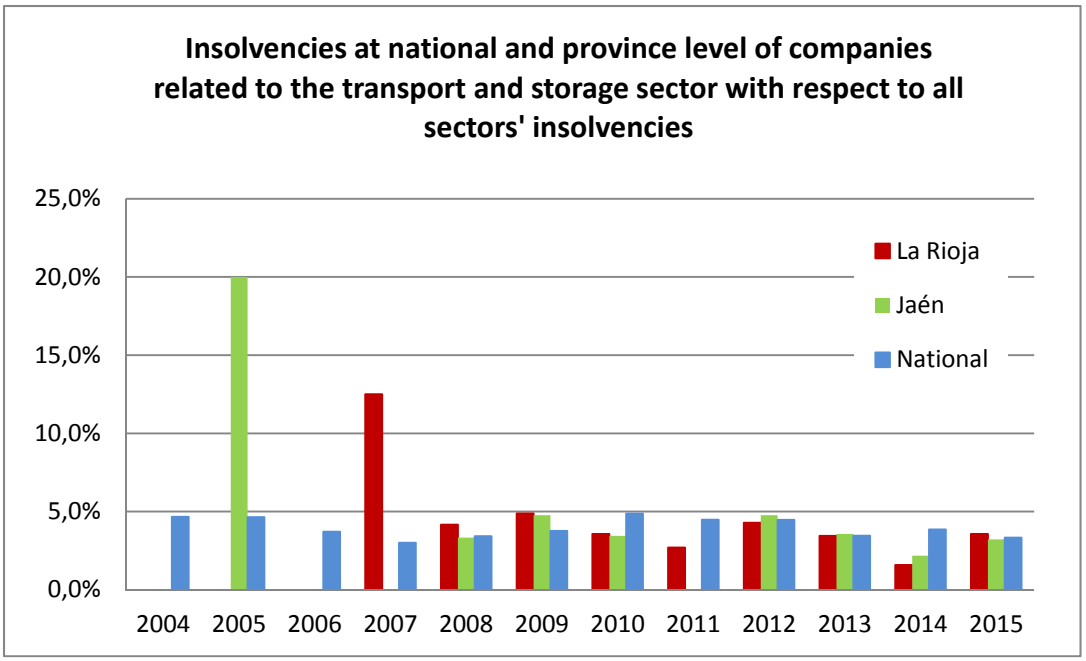
Interviewees understand that there should be compensation to hauliers due to the fact that their competitiveness will be jeopardized. For transporters it is clear that a peripheral country like Spain does not have an important share of foreign companies moving through the territory and therefore the ones paying tolls will be Spanish companies who already pay taxes and fuel, which their objective, among other things, is to maintain transport infrastructures. Some regions in Spain, like Andalucía, will be more impacted, due to the fact that they need to spend more on freight costs than other regions which are already close to the European market (for example, Catalonia).

8.2.2.2 Bankruptcies

The small size of trucking companies in Spain makes that the number of road transport companies as reported by EU Transport in Figures is way higher for Spain than for Germany (Figure 25). The National Statistics Institute (2016) provides information on insolvency procedures from according to companies' main sector of activity. Figure 26 shows how insolvencies have evolved from 2004 to 2015 in the transport and storage sector, compared to the total procedures at a national level and for the provinces of Jaén and La Rioja. It is possible to observe how bankruptcy procedures have evolved during the crisis, but there is no clear tendency of an increased risk for insolvencies in the toll region of La Rioja compared to the national average. Moreover, it is worth highlighting that many companies have just minimized their profits or diminished the level of operations to survive. The characteristics of the sector make the former possible.

Frisoni et al., (2013) observes that, due to the Spanish economic situation, the number of company licenses in 2012 was back to the same levels of 1999, and that in 2010, 8.600 enterprises left the Spanish market. The number of authorizations requested by road hauliers decreased by 11% and cabotage operations have also decreased following the same trend as the national market.

Figure 26: Bankruptcy procedures in Spain for the transport and storage sector



Source: (INE, 2016)

Results from stakeholder consultations

According to the qualitative part of the study, in Spain, one of the impacts that freight forwarders foresee are related to who pays these costs. In an atomized transport sector, such as the Spanish one, hauliers have little power to negotiate prices with shippers so passing the additional toll cost to the producers may be complicated for them unless the government allows including tolls as a separate item within the invoice. This is one of the greater demands from truckers in the survey. Ten respondents reported problems to pass tolls onto the costumer. Those of which gave further comments said that they are able to invoice costs when it is a foreign customer or when transport costs are included in the goods' costs.

According to the survey 4/10 respondents agree at least to some extent that tolls may lead to bankruptcy to transport companies. 6/10 disagree on this point. When respon-

dents were asked about SME transport companies, 5/10 said that SMEs might be threatened by tolls whereas 4/10 did not find risk or threat for SMEs.

8.3 Consumer price impacts

Consumer price indices are confirmed by assessment and monitoring studies for the Austrian Lkw-Maut, introduced in 2004 (Kratena and Puwein, 2002) and the Swiss heavy vehicle fee (Sommer).

8.3.1 Germany

The impact of HGV tolls on production costs is around 10% to 15% in the countries investigated in this study. Given that transport costs commonly range from 1% to 5% of production costs in most industries, the impacts of road tolls on final consumer prices remained below 0.5%. Within common deviations of consumer price indices between zero and 2% p.a., this effect were hardly visible. Exceptions are industries with high transport inputs, such as timber production.

To predict the impacts of the German HGV toll on product prices, Doll and Schaffer (2006) have applied an input-output model for several industry and product classes. The results are presented in Table 12. Considering state aids (harmonization programs, etc.) the several reaction patterns of road hauliers, in particular logistics optimization and the flexible use of different vehicles to avoid toll payments, a road price index between 4.4 and 5.8 was estimated. After direct and indirect impacts and mutual influences, price effects between 0.09 and 0.11% across all industries were found. With up to 2% for wood and wood products, as expected, which show the highest sensitivity.

Table 12: Price effects by selected industries, Germany, 2003

Industry	Price effects	
	Min	Max
Road transport	4.35%	5.77%
Wood and wood products	0.15%	0.20%
Ceramics and building materials	0.13%	0.17%
Tobacco	0.10%	0.13%
Paper and paper products	0.09%	0.12%
Chemical pulp	0.09%	0.12%
Forestry	0.08%	0.11%
Food and animal feed	0.08%	0.10%
Beverages	0.08%	0.10%
Construction services	0.07%	0.09%
Whole economy	0.09%	0.11%

Source: Doll and Schaffer (2006)

Again, the impacts of the toll on actual product prices are so small that aggregated statistics would not show an effect. We thus remain with the model calculations of Table 12.

8.3.2 Spain

Vassallo and López (2010) found, by using Input-Output tables, that the Consumer Price Index (CPI) was expected to increase between 0.14 per cent and 0.21 per cent when charges were set between 0.08 € and 0.12 € /vehicles per kilometer (for HGVs weighing more than 3.5 tons). This would occur only in the year that the charges are established, since from then on prices would remain constant. Lack of disaggregated data is some of the limitations of this study.

Moreover, in the META analysis (Aparicio et al., 2011), it is mentioned that the distribution of the indirect effects between the different regions and groups will influence the redistribution income effect. Applying a similar measure to the Eurovignette, an inflation of around 0.06% would be expected.

8.4 Position of countries as logistics hubs

Road tolls may increase the cost for logistics services and thus make the region in question less attractive as a logistics hub. As logistics, however, is more than just car-

rying products from A to B, and other impacts come into play. These may be productivity gains through increased cost pressure, better infrastructures due to more available funds for maintenance and new constructions, the labour market and the general economic situation. Every second to third year the World Bank issues its Logistics Performance Index LPI. Within six categories (customs, infrastructure, international shipment, logistics competence, tracking & tracing and timeliness) countries are assessed by marks from 1 (excellent) to 5 (poor). This set of indicators forms the basis of the subsequent country assessments.

8.4.1 Germany

In the LPI, Germany constantly takes top positions between 1 (2010 and 2014) and 4 (2012). Highest ratings above 4.3 are given for timeliness and infrastructures in the latest issue of the LPI of 2014. In this issue, the lowest ranking (3.7) was given for international shipments. Table 13 summarizes the results of the LPI for all available past issues.

Table 13: World Bank Logistics Performance Index: Germany 2007-2014

Year	LPI Rank	LPI Score	Customs	Infrastructure	Internat. shipments	Logistics competence	Tracking & tracing	Timeliness
2007	3	4.10	3.88	4.19	3.91	4.21	4.12	4.33
2010	1	4.11	4.00	4.34	3.66	4.14	4.18	4.48
2012	4	4.03	3.87	4.26	3.67	4.09	4.05	4.32
2014	1	4.12	4.10	4.32	3.74	4.12	4.17	4.36
2014-07	+2	+0.02	+0.22	+0.13	-0.17	-0.09	-0.05	+0.03

Source: data from http://lpi.worldbank.org/

According to the consultations with the two major trucking associations BGL e.V. and DSLV e.V. in Germany, the Lkw-Maut did not match expectations in terms of improving road network quality. By providing more stable funds for road construction, the Lkw-Maut should have contributed to make up for the investment and maintenance backlog on German motorways, but that did not happen. In 2015, the quality of the motorway network was worse than in 2005. The facts for 2015:

- A cautious estimate identifies that 5800 (15%) of bridges need immediate rehabilitation or replacement.

- Official numbers from BMVI talk of 2550 bridge segments; another 12 000 bridge segments, however, are considered of satisfactory maintenance condition only [10].

At the time of its introduction, funds from the general budget to the transport ministry were cut. The net impact of the Lkw-Maut on motorway maintenance and its long term impact on the competitiveness of the German logistics sector remains subject to debate.

8.4.2 Spain

According to the World Bank Logistics Performance Index (LPI) the international position of Spain has clearly improved since 2007. Main drivers were better customs procedures, logistics competence in the country and infrastructures (Table 13). The latter may be influenced by road user charges as through private concession models maintenance and investment budgets remained independent of the tightening Spanish public budget after the world economic crises.

The logistic sector has a relatively small dimension in Spain; however its productivity is reported by the OTLE (2016) to be equal to or even bigger than that of other big countries. The reason lays in its structure. 32% of the companies have less than two employees and produce 4% of the total production of the subsector, while companies with more than 99 employees which make only 2% of the subsector but produce 48% of the total.

Table 14: World Bank Logistics Performance Index: Spain 2007-2014

Year	LPI Rank	LPI Score	Customs	Infrastructure	Internat. shipments	Logistics competence	Tracking & tracing	Timeliness
2007	26	3.52	3.17	3.51	3.45	3.55	3.62	3.86
2010	25	3.63	3.47	3.58	3.11	3.62	3.96	4.12
2012	20	3.70	3.40	3.74	3.68	3.69	3.67	4.02
2014	18	3.72	3.63	3.77	3.51	3.83	3.54	4.07
2014-07	+8	+0.20	+0.46	+0.26	+0.06	+0.28	-0.08	+0.21

Source: data from http://lpi.worldbank.org/

It is worth noting that logistic infrastructures have a long term production cycle and therefore, changes are not seen in the short term. Once they are planned and built they

10 Source: focus online http://www.focus.de/immobilien/bauen/es-werden-immer-mehr-das-sind-die-zehn-schlimmsten-broesel-bruecken-in-deutschland_id_4832776.html.

do not change to other places neither are they dismantled. Figure 27 shows how they are distributed in the Spanish territory (Ministerio de Fomento, 2013). It is possible to observe that the provinces of Jaén and La Rioja do not have important road logistic centers. According to the same report, regarding rail logistic centers, the ADIF (Rail Infrastructure Manager, *Administrador de Infraestructuras Ferroviarias*) has one small rail logistic center in Jaen. In the case of La Rioja, there are none, although there are some rail logistic centers in the neighbouring provinces. There are others privately managed, which do have a presence in both provinces, but their activity is mainly related to raw and rail materials and fuels.

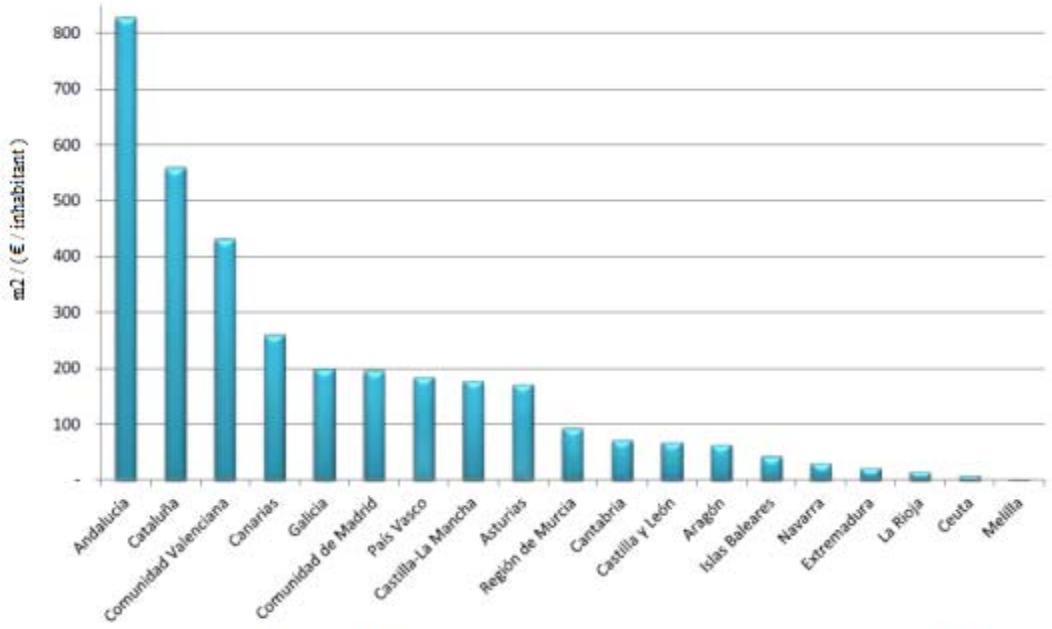
Figure 27: Main road logistic centers in Spain

Source: Ministerio de Fomento (2013)

According to the OTLE (2016), there were 73.7 million m² of logistic facilities in 2014. 51.1% of the logistics area corresponds to the maritime mode, whereas those facilities for road represent 35.2%. Rail facilities have 11% of the total area and for air freight they represent 2.8%. Figure 27 shows how these facilities are distributed all around the Spanish territory. Moreover, Figure 28 analyzes the logistic intensity with respect to the regional GDP (facilities'm² /€/inhab.). In that case, the geographical position plays an

important role along with good national and international connections, ports and population density.

Figure 28: Logistics intensity per Spanish region (m² logistics area/GDP per capita) in 2014

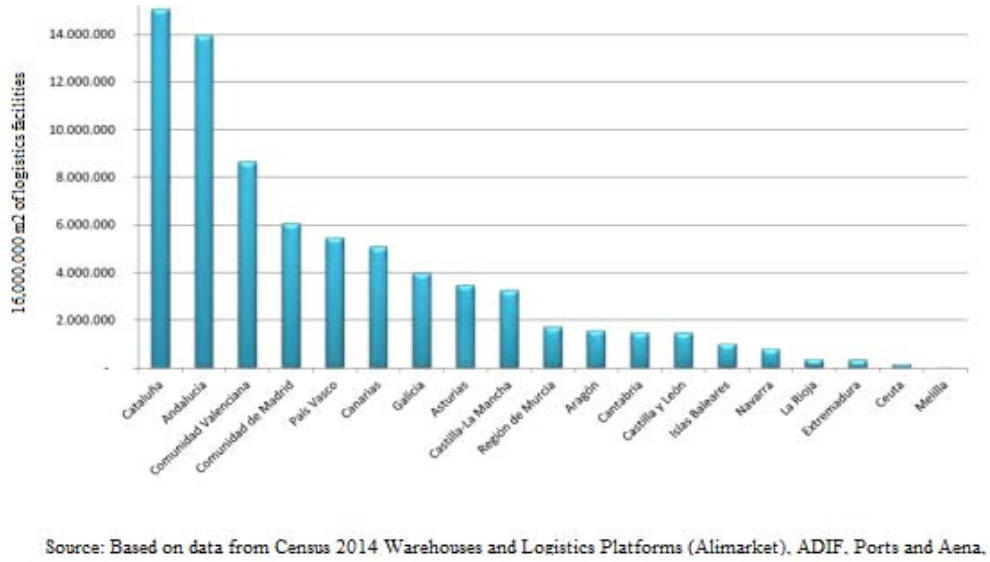


Source: Based on data from Census 2014 Warehouses and Logistics Platforms (Alimarket), Puertos del Estado, ADIF, AENA, S.A. and INE - Padrón Municipal (January 1, 2013)

Source: (OTLE, 2016)

Figure 28 and Figure 29 show the enormous differences of logistics facility availability in the Spanish regions. For the two study areas the differences are striking. While Andalucía takes rank 2 concerning overall logistics area and rank 1 when relating the area per capita, the region of La Rioja takes the 4th and 3rd last ranks.

Figure 29: Logistics facilities area per Spanish region (m2) in 2014



Source: (OTLE, 2016)

The economic weight of the logistic sector in 2013 was equal to 2.9% of the GDP. From 2008-2013, its GDP share was also an average of 2.9% (OTLE, 2016). Moreover, in 2013, people employed in the logistics sector attained 605,000. That year, employment decreased with respect to 2012, about -4.0%, which is a lower value than other previous years. This decrease in the logistics sector was especially important in the subsector road and pipe transport, which represents more than 50% of employment in the logistics sector. Still, the employment rate was higher than the economic weight of the sector. From 2008 to 2013 the average rate of the sector in employment was about 3.67%.

Results from stakeholder consultations

An interviewee commented on the fact that logistic hubs are a major infrastructure that cannot be easily moved to other places. They are there due to many other factors (like accessibility and access to certain markets); therefore, it would not be expected to have major changes due to tolls.

8.5 Concluding remarks

From the information collected above, we receive a mixed picture on the impacts of road tolls on the economy. Those companies directly affected by road user charges, i.e. the logistics sector, have experienced considerable impacts after the introduction of

the German Lkw-Maut, and will most probably do so in case Spain goes for an extension of its system according to the German example.

Even in a period of strong economic growth, which was the case in Germany when the toll was introduced in 2005, and later on, bankruptcies and a trend towards larger companies in the road haulage sector were indicated by the official monitoring studies and more recent statistics. For Spain, which is still struggling to overcome the world financial and economic crisis, these impacts may be even more visible.

On the other hand, economic impacts on consumer prices, GDP, the labour markets and even on logistics competitiveness must be described as marginal. Guzman Valderrama (2013) and the ASTRA-EC transport and economics model show small effects, but these are below the annual fluctuations of respective statistical indicators. For logistics competitiveness, the decisive question eventually is how funds are spent. As long life infrastructures play a crucial part for the productivity and the competitiveness of the logistics sector, funding provided by road tolls should, in theory, support the sector. In practice, however, there is some doubt about the proper use of road tolls.

It is worth mentioning that according to the META report (Aparicio et al., 2011), promoted by the Ministry of Civil Works in Spain (*Ministerio de Fomento)*, the congestion zones in Spain are concentrated in the metropolitan areas, where only some of the motorways of 3+3 lanes and 4+4 lanes show congested parts. In other words, congestion is not an acute problem in the Spanish interurban road networks. This information is linked to the information on the German roads, where there was a minimum impact on the use of alternative modes, and one study stated that this was because entrances to metropolitan areas were not tolled, where heavy traffic exists.

9 Budgets, Revenues & Infrastructures

In this chapter we look at the financial implications of road tolls on public budgets in the case study regions and on their impacts on the quality of road infrastructure availability and maintenance conditions. The latter is of utmost importance as congestion relief and better road quality are two of the corner stone arguments for raising user charges.

Herein, we will answer more specifically the following questions:

How do public revenues develop with road charging?
Which impacts can be expected from alternative funding sources?
Which impacts on road maintenance can be observed?

9.1 Public revenues development due to toll roads

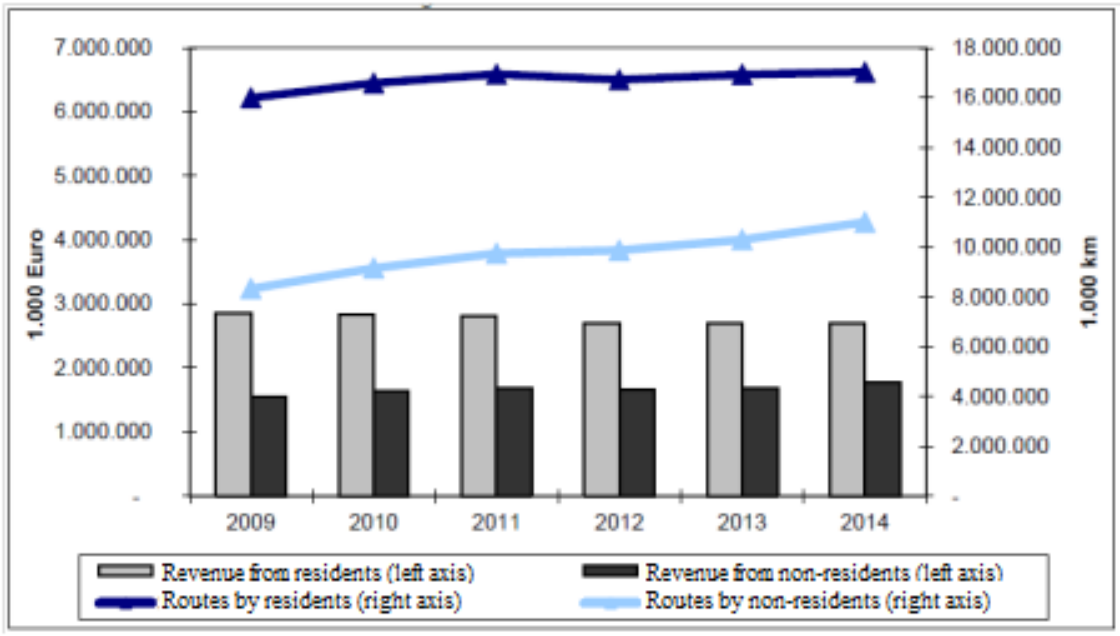
Following the intention of the Eurovignette-Directive (DIR 1999/62/EC and later issues) road user charges are levied in order to create funding for road construction, maintenance, and operation. When earmarked for this purpose or in case concession or similar arrangements prevail, these revenues fall out of public budgets. The levels of revenue flows and their uses will be discussed in the following sections.

9.1.1 Germany

The revenues of the German Lkw-Maut have been steadily increasing in the years after its introduction. Details on revenues are presented in Table 1 in Section 2.2. Due to several impacts, which are the world financial and economic crises from 2008 on and the adaptation of the tariffs to lower public interest rates in 2013, after 2008 the revenues have remained more or less stable at 4.5 billion Euros. Of this, roughly 40% (1.8 billion Euros) is contributed by HGVs registered outside Germany.

The Lkw-Maut income constituted the single most important source of revenues, around 4.34 out of 5.4 billion Euros, for the Federal Ministry for Transport and Digital Infrastructures (Bundesministerium für Verkehr und digitale Infrastruktur, BMVI) in 2014. For comparison: the expenses for the federal road network were 7.3 billion Euros with steadily increasing shares of maintenance against new construction. The expense for the rail network was around 9.7 billion Euros, and for inland waterways, 1.8 billion Euros (Bundesrechnungshof, 2015).

Figure 30: Vehicle kilometres and toll incomes from the German Lkw-Maut 2009-2014



Source: BAG (2015)

The gross revenue from the toll system (4.34 billion Euros) needs to fund the system operation (0.54 billion Euros), harmonisation programmes for hauliers (600 million Euros) and potential losses in income taxes (rough estimate of 170 million Euros). The remaining net revenues are in the order of magnitude of three billion Euros, 2/3 of gross toll income.

Table 15: Gross and net toll revenue 2015 for the Lkw-Maut system

Position	€ Mill. 2015	Comments
Gross toll revenue	4340	
Toll system operation	540	Incl. Toll Collect consortium and BAG control and enforcement activities.
Vehicle tax deduction	150	Includes investment aids and support for education measures; start 2009 after agreement with EC.
Three investment programs	450	
Income tax reductions	170	From reduced profit margins; estimate of 60% national trucks, 20% empty hauls and 30% tax quota = 4% of revenues; other indirect effects neglected.
Net revenues	3040	Rough estimate excluding wider impacts.

Source: Fraunhofer ISI with data from BMVI 11

Of these, the roughly 1.8 billion Euros contributed from non-German hauliers constitute real additional funding sources for the German economy. The remaining revenues constitute transfers between national players, i.e. transport and logistics companies, the rest of the economy, consumers and public entities. The latter of course creates additional income for the road construction sector, but it reduces tax income and purchasing power in the first round. Second round impacts when additional road construction activities enfold will add some additional demand, purchasing power and tax income. In contrast, income from foreign road users directly adds to the national budgets. Accordingly, the overall national budget effect of the road toll is more or less limited to these 40% of non-German toll payments.

On its start, the Lkw-Maut income was earmarked for all three modes of land transport: 50% for federal roads, 38% for railways and 12% for inland waterways. Upon complaints of the trucking businesses and the federal states, since January 2011 all revenues from the Lkw-Maut are used for road projects. This is ensured by the Transport Infrastructure Financing Society VIFG. Revenues are spent for all federal roads, i.e. 12,917 km motorways and 39,387 km federal trunk roads.

Investment impulses of the Lkw-Maut are, however, denied by stakeholders in the trucking business. As soon as the Lkw-Maut was introduced in 2005, the transfer of funds from the Ministry of Finance to the Ministry for Transport (at that time BMVBS) was lowered by a respective amount. Thus, the Lkw-Maut was formally earmarked to

11 http://www.bmvi.de/SharedDocs/DE/Artikel/G/lkw-maut-weitere-informationen.html?nn=35926#doc24830bodyText8 accessed June 2016.

transport and later to road investments. In fact, additional revenues appear in the general budget rather than in transport specific national accounts.

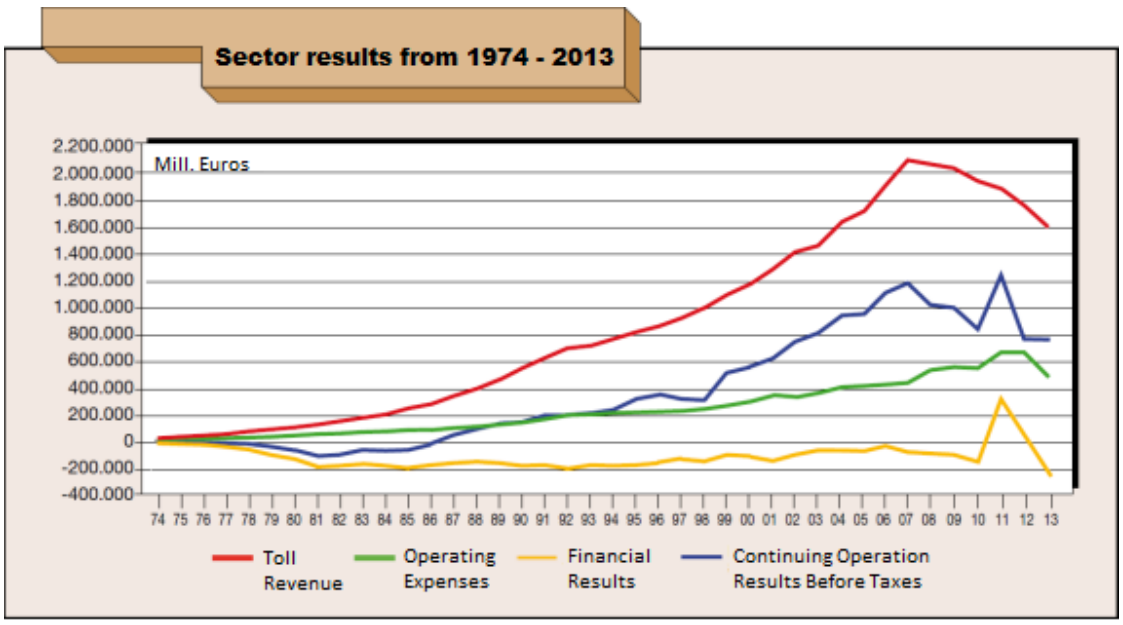
9.1.2 Spain

The financial results for Spanish toll road concessions are provided by the Ministerio de Fomento. A time series dating back to the early 1970s shows revenues growing steadily until the boom years of the global economy in 2005/2006. In 2005, total revenues from cars and trucks arrived at 2.1 billion Euros. After the collapse of the Spanish real estate bubble and the onset of the world economic crises, revenues dropped to 1.6 billion Euros in 2013.

Operational expenses of toll road concessionaires continuously rose to around 700 million Euros in 2010. Financial results after taxes of Spanish road concessions had been below zero between the 1970s and the present. Only in 2011 did a sharp peak create a single year with a positive result. After that, the accumulated results reached an all-time low of -400 million Euros.

The severity of financial problems of some concessionaires is discussed in Spanish media. Besides the economic conditions, the reasons for the failure of some companies are unrealistic traffic forecasts and the availability of free roads all across Spain. The total concessions' financial results are shown in Figure 31.

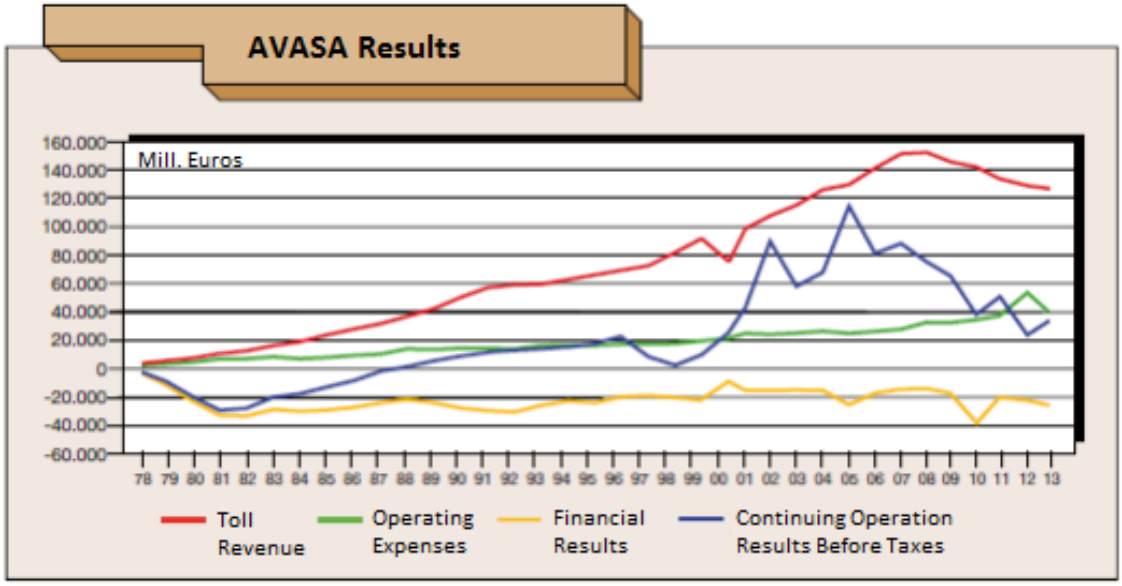
Figure 31: Concessions' financial results (1974-2013)



Source: Ministerio de Fomento (2015)

The AP-68 highway crosses an important part of the territory in la Rioja. The name of the concession is Avasa, managed by Abertis. It was awarded in 1973 and between 1978 and 1980 was put into service (Ministerio de Fomento, 2015). The concession term expires in 2026. Financial results of this concession are shown in Figure 32. They do not differ widely from the general trend identified above.

Figure 32: AVASA financial results



Source: Ministerio de Fomento, (2015)

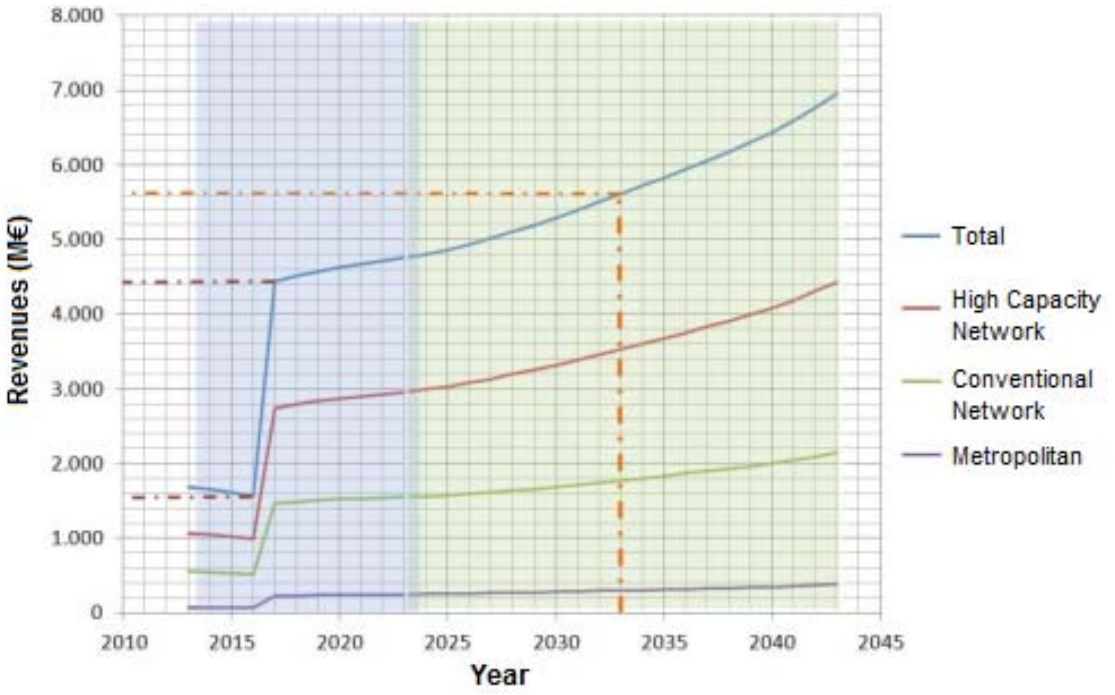
It is important to note that a recent study by the AEC (Spanish Road Association) (Asociación Española de la Carretera, 2015) defines that, in overall, the region of La Rioja as one of the regions where the state of road pavement is in the worst condition (see Figure 36). The study evaluated the situation of non-tolled roads. In La Rioja around 75% of the high capacity roads in La Rioja are tolled.

The AEC (2012) summarizes the possible revenues that could be obtained by a pay per use toll system according to different sources. According to the ASETA association[12], this value is estimated to be around 3,062 million Euros when implemented first for HGVs only (year 2013) and later, around 9,276-14,195 million Euros, when passenger vehicles and HGVs are taxed. The AEC states that discount measures should be

12 Spanish Association of Turnpikes, Tunnels, Bridges and Other Toll Road Concessionaire Companies, now part of SEOPAN.

evaluated in order to establish the revenues. According to Vassallo (2012), the long term value of taxing passenger vehicles and HGVs would increase until 5,610 million Euros by 2033. Figure 33 shows how revenues evolve in the medium to long term according to this last source.

Figure 33: Evolution of revenues (Euros)



Source: Vassallo, (2012)

According to the META study (Aparicio et al., 2011), an approximate income of 400M€ would be expected if the tolling system was only introduced in the TEN-T Spanish network and 6,000M€ if implemented in the whole META network, which is composed by the Spanish TEN-T network and all the high capacity roads in Spain. It is important to highlight that this study was carried out before and at the beginning of the economic crises, therefore its effects were not really noticeable and acceptability was not influenced by a constrained economic situation. For example, in the framework of the study, a survey was carried out, and respondents said that tolls should be applied both to HGV vehicles and LGV passenger vehicles. Moreover, tariffs should vary according to the quality of the highway. There was a huge disagreement between respondents about whether tariffs should vary or not during peak hours and if the toll system should or should not include the whole network. Transport and logistics operators were the most concerned and against a generalized toll system (Di Ciommo et al., 2010). Moreover, the authors of the META report state that the use given to the revenues from the

road charging system is important. Moreover, the distribution of the indirect effects between the different regions and groups will influence the redistribution income effect.

Here, it is important to highlight that the Spanish taxes are hardly ever earmarked. However, the Spanish law does consider other mechanisms to collect funds, such as special contributions fees to capture the added value to the land produced by a new road that may have self-financing purposes (Mejia-Dorantes and Vassallo, 2010; Boletin Oficial del Estado, 2015). This tribute can be charged when the construction or improvement of a road has a direct impact in a property value. Even if special contributions are defined and covered in the legislation; they are often not used because it may take a long time to go through the whole legal process.

The AEC (2012) mentions that if an Eurovignette like system was put into place in Spain, it would be fundamental that the toll collection was carried out by an independent organization in order to directly reinvest the benefits in road infrastructure and road transportation.

Finally, it is worth mentioning that Vassallo (2012) also discusses many equity problems related to road charging. Equity principles need to be taken into account in decision making processes. For example, even if the non-tolled roads do not have an extra charge, they are paid by the Spanish society in general, through taxes. Another issue is equity between national and international users, a point which is really relevant in transit countries like Germany. Regional equity is another issue, among others.

9.2 Hypothetical impacts from alternative funding sources

Road tolling with distance-related tariffs is just one instrument of charging for the use of transport infrastructures. Alternatives would be area charges in the form of the Eurovignette, taxes or public-private partnership solutions.

9.2.1 Tolls and vignettes

This was applied in Germany prior to the introduction of the Lkw-Maut and is still in place in parts of the Benelux countries and Scandinavia. The tariffs of the Eurovignette are raised annually or for shorter periods of time for trucks using the charged road network in the respective country. Tariffs are quite lower than for distance-based motorway tolls, but the collection of the charges is far more cost efficient. An overview of the likely environmental impact of tolls and vignettes is given by Gibson et al. (2015) (see Table 16).

Table 16: Sustainability impacts of tolls and vignettes

Main impact	Mechanism	Vignette	Toll (network wide)	Toll (selected roads)
Air pollution	Greater share of higher Euro class vehicles	Low effectiveness	Potential for a strong effect to increase share of travel carried out by cleaner trucks if differentiated by Euro class Smaller effect on fleet renewal rates	Most trucking firms would have little incentive to modify their vehicle fleets if tolls apply only to selected corridors
Air pollution, congestion	Changes in route to avoid charged areas	No effect	Diversion in cases where alternative non-tolled roads of high quality are available – can be remedied by applying speed restrictions or additional tolls	Diversion in cases where alternative non-tolled roads of high quality are available – can be remedied by applying speed restrictions or additional tolls
Congestion	Changes in travel time to avoid peak periods	Not possible	Some evidence of peak spreading	Some evidence of peak spreading (mostly passenger cars)
Air pollution	Improvement in transport efficiency	No impact expected	Improvements in short-term Long-term effects are uncertain	No impact expected

Source: Gibson et al. (2015)

In the study carried out by Vassallo Magro (2015), they evaluated the amount of a tax similar to the Eurovignette directive of 2011 (2011/76/UE) both for HGV and passenger vehicles, by tolling. Tolling the whole high capacity network and taking into account infrastructure (construction, funding, maintenance, operation and benefits) and external costs (air and noise pollution). It is distance based and takes into account the vehicle category (EURO) and its configuration. There are also discounts during non-peak hours. They state that values obtained in this study are very similar to those of the actual taxes (0.1132 €/veh-km for HGV and 0.0472 €/veh-km for passenger cars) and even lower, especially for HGVs (0.1071€/veh-km for HGVs and 0.0453 €/veh-km for passenger cars). Therefore, they suggest that taxes need to be revisited. In their conclusions they state that in the case that the Eurovignette directive was implemented, fiscal policy would need to be reviewed in order to assure fiscal neutrality and equal charging approaches to other modes; discounts policy; usage of road revenues; invoicing and transition of costs to clients; toll technology systems; incentives to renew vehicles; and finally, harmonization of taxes with other European countries.

Results from stakeholder consultations

When participants in the survey were asked which tolling system would be more appropriate for their region if they had to choose between the traditional (toll concession with free alternative of lower quality), Austrian and German system, only 9 people re-

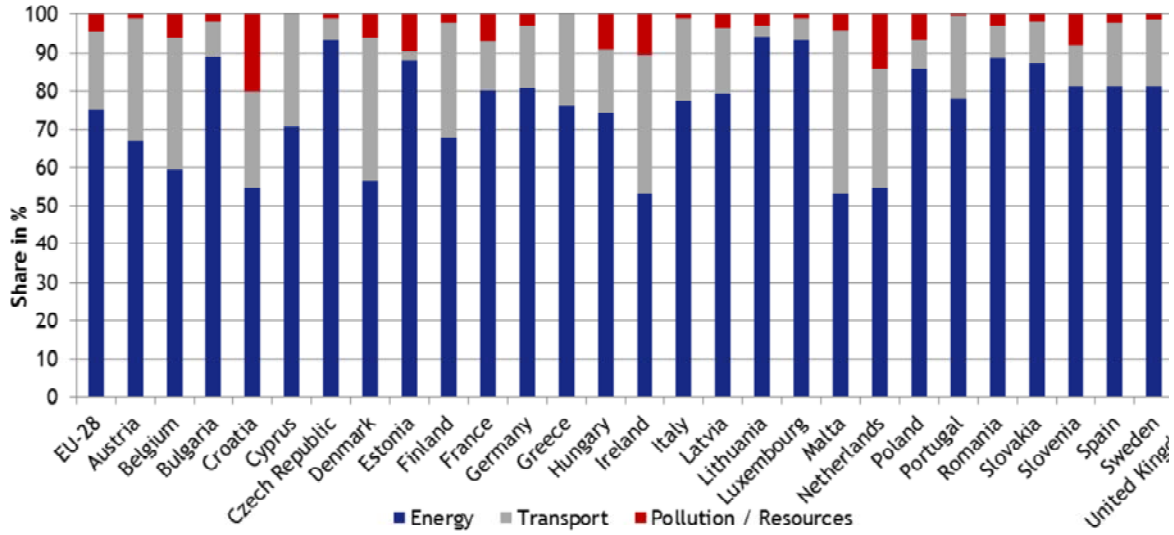
sponded to this part. The participants in the survey still prefer the traditional Spanish toll concession system 8/9. They refer to tolled routes according to the size (HGV1 or HGV2) managed by a private concessionaire in specific high capacity roads. None of them chose the Austrian, and only 1/9 mentioned the German tolling system.

9.2.2 Environmental tax reforms

Another alternative is fuel taxes as already presented in Figure 21. Here, the European Commission has defined a minimum tax rate per litre of diesel in order to prevent extreme forms of tax dumping. Even if fuel taxes cannot be differentiated by emission class, noise or other vehicle characteristics, fuel taxes do price the distance driven and reward fuel efficient vehicles and driving styles. Vehicle registration taxes in contrast, are differentiated by vehicle characteristics, but cannot price for an efficient use. In this respect, vehicle taxes are very similar to area charges (vignettes). However, taxes do have the shortcoming that they do only apply to domestic users or to products (fuel) purchased in the country. On the other hand, European literature on infrastructure financing suggests that tax based forms of funding may be superior to kilometre based charges, as they require fewer transaction costs.

Both forms of taxes can be part of ecological tax reforms. In the first place, we regard all taxes which result in reducing environmental impacts of human activities as environmental taxes. This might be indirect by taxing activities, e.g. energy consumption or transport performance, or direct by relating the tax to emissions. According to Schlegelmich and Joas (2015) in 2012, the EU-28 countries collected 6% of tax revenues through environmental taxes, of which 4% were directly related to CO_2 or air pollutant emissions. Spain (around 4.5% of total revenues) and Germany (around 5.5% of total revenues) both stay below the EU share of environmental tax revenues. Figure 34 shows the share of environmental taxes by EU Member States in 2012.

Figure 34: Share of environmental tax revenues in EU Member States, 2012



Source: Schlegelmilch and Joas (2015) using Eurostat data

The fiscal efficiency of environmental taxes depends on whether we talk about activity based taxes (i.e. with indirect environmental effects) or emission related taxes. Activity based environmental taxes are rather stable in the transport sector as the elasticity of transport demand with tax levels exists, but is rather low.

In contrast, there is some tension between environmental and fiscal efficiency of direct, i.e. emission related, environmental taxes. They aim to reduce the burden from environmental pollution, but it is exactly the environmental burden that forms the basis of tax incomes. As the state of air pollution, global warming, or noise disturbance due to related taxes improves, revenues will decline (compare Schlegelmich and Joas, 2015).

An alternative to that would be a differentiation of a stable tax rate according to environmental criteria, as it is done with most vehicle circulation taxes or the German HGV toll tariffs. To keep revenues stable, the system only has to be adjusted according to the technical improvement of the object in question.

The costs involved with defining and collecting environmental taxes shall be somewhat higher than with plain taxes as vehicle characteristics have to be considered. However, the additional effort is expected to be low. Some wider impacts to business and society can be suspected, as old and high emission vehicles often are operated by less well off companies who have limited options to modernize their fleets to save taxes.

9.2.3 Private capital involvement

The EU Commission, together with the European Investment Bank (EIB), has previously tried to develop additional financial instruments to foster private finance. The Loan Guarantee Instrument for TEN-T Projects (LGTT) aims to reduce the pay-back loads for investors in the ramp-up phase of projects when transport demand has not reached the expected volume. Euro bond finance can be offered to private project companies by attracting liquidity from institutional investors like insurance companies or pension funds.

However, these instruments have not been very successful in previous years. This was initially caused by the low private interest for investment in transport infrastructure after the economic crisis, such that the number of Public-Private Partnerships (PPPs) dropped drastically. A second reason is that transport infrastructure projects often cannot provide a sufficient and stable revenue stream to pay back amortisation and interest. (Doll et al., 2015).

Concessions constitute a specific form of private capital involvement. Also here the sharing of risks has to be agreed on such that the concessionaire maintains quality and availability of the infrastructure without being fully dependent on external development which he does not have control of. The drop in transport demand following the economic crisis constitutes such a case. The AEC suggests that, in the case of Spain, if a specific concession was to manage the toll system, more funds would possibly be available (Asociación Espanola de la Carretera, 2012).

Results from stakeholder consultations

Spanish interviewees stated that raising funds through fuels would be more reasonable since it is a system that already has been proved, less costly, would penalize those vehicles that are not fuel efficient and would compensate for external costs. Valid both for foreign and national transport companies, where national companies could declare their transport costs at the end of the year and finally, associated to less transaction costs.

In the qualitative survey, those which said that they would prefer other sources of funding, they cited: taxes, national and regional budgets, and public-private partnerships.

9.3 Impacts on road maintenance quality

The quality of road infrastructure plays a major role in attracting and maintaining logistics services (BMVI 2014). This quality shall be improved through the creation of stable road financing cycles, e.g. by levying road user charges and feeding the revenues back

into the road sector. It should thus be expected that toll road networks are of better quality than non tolled, tax financed roads. How far this is the case shall be looked at in this section.

9.3.1 Germany

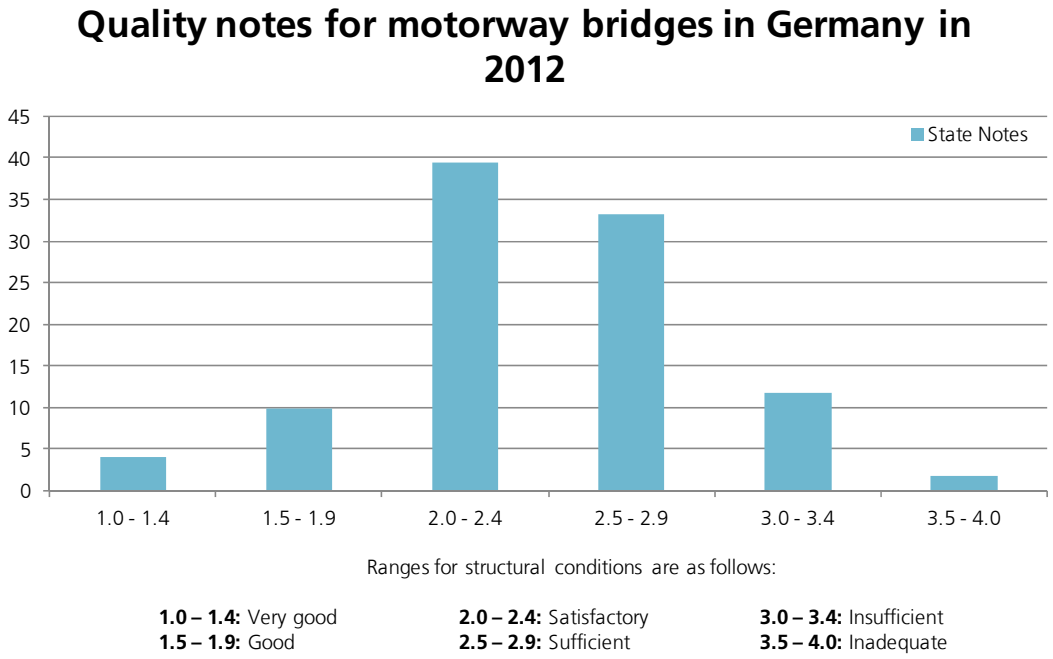
A major argument for the German Lkw-Maut to the logistics sector was the improved maintenance and thus quality of the road network. In the World Bank's Logistics Performance Index (LPI), Germany moved from world rank 3 in 2007 to rank 1 in 2014. On a scale between 1 (very poor) to 5 (excellent), its infrastructures slightly improved 0.13 points to a score of 4.32 (see Table 13 above).

The transport investment report, part C of BMVI (2014)[13] draws a different picture. In recent years, the annual vehicle kilometres on German motorways have been stagnating since 2010 and the average traffic density has even slightly declined from just below 50,000 to 47,100 vehicles in 24 hours (value for 2012). Nevertheless, congestion remains a problem around the major agglomerations and industrial locations in western Germany.

The physical condition of the German federal road network is in parts rather critical. On a scale of 1 to 5, 8.5% of the network is in poor conditions (3.50-4.49) and 8% is subject to immediate action (4.5-5.0). 65% of bridge capacity is foreseen for renewal in the coming years (compare Figure 35). The estimated maintenance budget is above three billion Euros for a total budget of 6.46 billion Euros in road network measures. In contrast: expenditures for renewal in 2012 were only 2.2 billion Euros.

[13] Latest version available for the reporting year 2012.

Figure 35: Quality notes for motorway bridges in Germany in 2012



Source: BMVI (2014)

The alarming condition of some bridges has led to the closure of motorway intersections or links which are critical to logistics services. Associated construction and maintenance work lead to a noticeable increase of motorway congestion and / or detouring times. With current budgets it seems unlikely that the situation will improve substantially as now many of the roads and engineering works built to a large extent in the 1960s and 1970s move towards the end of their designed life span.

Improvements in infrastructure quality after the introduction of the Lkw-Maut are, however, not confirmed by representatives of the trucking industry. The two leading industry associations, DSVL and BGL, complain that the additional income of roughly 4 billion Euros annually (after toll system costs) has been compensated by reducing the budget for the transport ministry upon introduction of the Lkw-Maut.

The reports by Transport & Environment (T&E, 2016) and CE Delft (Schroten and Aarnink, 2015 and Schroten, 2016) address the question about whether HGVs in Europe cover the full costs they impose on infrastructure operators, other road users, and the society. The studies find that this is not the case: only 30% of these costs are covered by taxes and charges from the trucking business.

9.3.2 Spain

The SEOPAN association presented a report in 2014 regarding the implementation of a pay per use road system in Spain (SEOPAN, 2014). They state that it was necessary to implement this system in order to fund maintenance and hence avoid wear and tear of road infrastructure. The report uses an average value of 0.03 €/km for passenger cars and 0.1424 €/km for HGV. It would take into account distance, vehicle type, road type, geographic zone, and time of the day. According to this report, launching an electronic toll collection system would require an investment cost of about 672 million Euros and annual operational costs of 247 million Euros. They estimated an annual income of about 6,828.6 million Euros, and suggested that revenues should be managed by a specific organization in order to use all the resources in funding the road network which should be common in all the Spanish regions.

In order to diminish negative effects and with an equity perspective, the AEC (Asociación Espanola de la Carretera, 2012) proposes that a pay per use tolling system should make use of a “mobility bonus”, where to a certain use, there is a fixed tariff or gratuity, both for private cars and freight transport. When this limited is surpassed then, there is a pay per use charge. They fix this limit in, annually, 15,000 km of passengers and 100,000 km for freight.

However, a recent study from the Spanish Road Association (AEC, *Asociación Espanola de la Carretera*) highlights that, due to the economic crisis, the wear and tear state of roads has been worsening over the last few years because of budget expenditure cuts. The report stipulates that the situation urges that new financial mechanisms are implemented in order to revert this condition. The report by the AEC evaluated the situation of non-tolled roads and it mentions that the road network requires an investment of 6,617 million Euros in order to turn it back to an adequate state. According to this article, if the trend continues in this direction, by 2020 it will be necessary to reconstruct an important part of the network (see Figure 36).

Figure 36: State of pavement in the Spanish road network

Source: Gálvez (2016)

However, if a tolling system was implemented in the high capacity network, or for certain roads only, detouring is quite likely to happen. It would mean that traffic redistribution to national or conventional roads would imply negative effects, such as congestion, worsening of wear and tear, and most importantly, security. The AEC (Asociación Espanola de la Carretera, 2012) suggests tolling alternative routes to reduce the traffic redistribution and its negative impacts as was done in Germany.

Taking into account the importance of road freight in Spain and the wear and tear situation of the Spanish network, more economic resources are urged in order to maintain the Spanish roads as a whole system.

Results from stakeholder consultations

Those who answered the question in the survey “How do toll roads compared to non-toll roads´” acknowledge that tolled roads have less congestion than free roads. Then they agree that the state of the pavement is totally to somehow better and that traffic safety and security is slightly better than free roads. Moreover, when asking about the pros and cons of toll roads respondents agree that the price of it is a negative point. If we analyze the profile of respondents, where more than 40% are producers or manufacturers and we take into account the interviews held and literature review we arrive to further conclusions. For example, that many toll roads have a similar alternative for free which might be only sometimes more congested. However crossing Spain to deliver a

product in Europe increases total transport costs and this situation might impact their decisions. If we take into account the META report (Aparicio et al., 2011) where they state that congestion zones in Spain are concentrated in the metropolitan areas, where only some of the motorways of 3+3 lanes and 4+4 lanes show congested parts, then it is possible to understand that only in some cases forwarders will prefer a toll road.

9.4 Chapter conclusions

Toll revenues may constitute an important part of the transport sector funding. However, we could observe that of course their reliability directly depends on the number of vehicles using the tolled infrastructure. In particular in countries with vulnerable economies and low shares of transit traffic as in the case of Spain the sustainability of the pay-per-use principle for road financing gets under pressure in times of economic downturn.

For state owned infrastructure networks like in Germany the review finds other problems. This is the strong dependency of the money finally left over from road tolling after political decisions on the overall household plan. A look on the World Bank logistics performance index on the other hand shows that infrastructure quality is an important, but not the only element determining the competitiveness of national logistics systems. The example of Spain shows that despite deteriorating road qualities the country managed to climb up in the ranking of the LPI index.

Due to the concession model in Spain, cross-financing of rail or intermodal infrastructure by road charges is legally impossible. Thus changes of toll regimes will not have any impact, other than on the sections of roads they had been raised for. However, the separation of the financing model for the toll motorways from the public budget makes it possible to spend tax money elsewhere.

10 External Costs

One of the corner stone arguments for the introduction of differentiated kilometre-based road user charges is the reduction of environmental impacts from HGV traffic.

Out of the three pillars of sustainability, which are known since the Brundland-Report of the UN's World Commission on Environment and Development in 1987 (WCED 1987), we concentrate on the environmental and social aspects, as funding issues have been discussed earlier in this report. We consider four classes of externalities, which are particularly relevant for these types of adaptive reactions: global warming, air pollution, noise and traffic safety. We use the average cost values per vehicle type and mode of transport as provided by CE Delft et al. (2011), as these directly update the values recommended in the EC handbook on estimating the external costs of transport in 2008[14]. As predicting emission classes towards 2030 would be rather speculative, we compare the external costs for an average tonne of cargo shipped under the various hypothetical scenario assumptions in Germany and the Spanish regions in 2015.

In this section, we look at the impacts of truck charges in Germany and Spain on the sustainability of the freight transport sector. With sustainability, we express the impact which a certain technology or policy takes on the environment and on climate (environmental sustainability), on the well-being of people (social sustainability) and on the financial viability of our communities (economic sustainability). More specifically, herein our aim is to answer the following questions regarding our case studies:

To what extent can air pollution external costs and mortality be avoided?
How are greenhouse gas emissions, safety and other externalities affected?

10.1 Actual environmental performance

Before going into detail with the computation of external costs for the toll scenarios in Germany and Spain we briefly review the performance of the vehicle fleet in the two countries. More precisely: we consider the development of environmental standards and age structures in the German and Spanish truck fleet.

A direct comparison between German and Spanish truck fleets by environmental standards is difficult as neither Eurostat nor EEA collect data on HGV registration or circula-

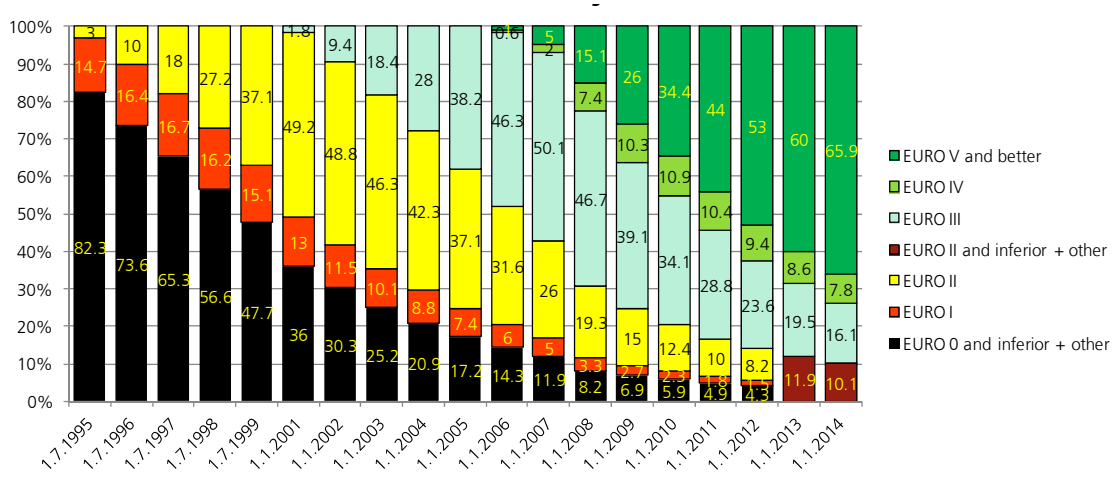
14 We do not use the earlier version of the handbook issued by RICARDO et al., 2008 as the recommendations there are not considered sufficiently comprehensive across modes, vehicle types, countries and cost categories.

tion by Euro emission standards. So we use national statistics on fleet compositions and age structures.

10.1.1 Germany

According to the monitoring report by BAG (2005), the tariff differentiation by environmental standards leads to a preference towards Euro-5 vehicles, while the differentiation by weight and number of axles does not have an impact on investment decisions related to fleet structures. The aggregated statistics on the stock of heavy goods vehicles above 7.5t gross vehicle weight in Germany as depicted in Figure 37 does not directly show the impacts of the Lkw-Maut. But the figure indicates that already in 2006, i.e. one year prior to its compulsory introduction, Euro-V vehicles had been sold.

Figure 37: Share of emission standards at the inventory of HGVs >7.5t in Germany



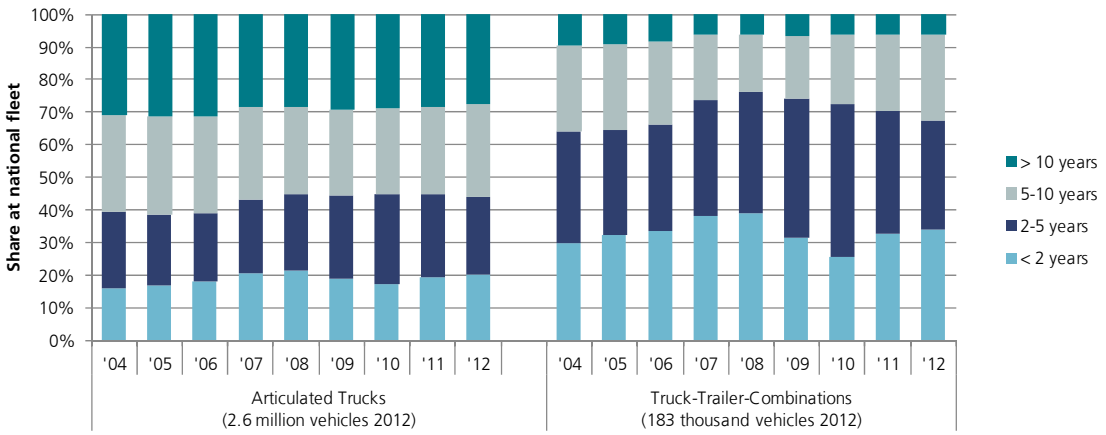
Source: BGL e.V. (downloaded: July 2016)

A clearer indication of the impact of the Lkw-Maut is provided by the age structure of the HGV fleet, which is depicted separately for articulated trucks and for truck-trailer-combinations inFigure 38. In addition to a general trend of a declining share of vehicles older than 10 years, for articulated trucks, a drop from 10% to 6% at vehicle stock shortly after the introduction of the Lkw-Maut can be observed.

The share of Euro-V trucks in Germany appears rather high as only heavy trucks above 7.5 t gross vehicle weight (GVW) are considered. Considering all goods vehicles above 3.5 t GVW the German motor vehicle agency (KBA, 2016) reports a share of Euro-V and Environmentally Enhanced Vehicles (EEV) of 40%. Similar shares are re-

ported by France (Direction des services de transport, 2011). The development of age structures of German trucks by weight class are presented in Figure 38.

Figure 38: Age structure of truck fleet in Germany, 2004 - 2012

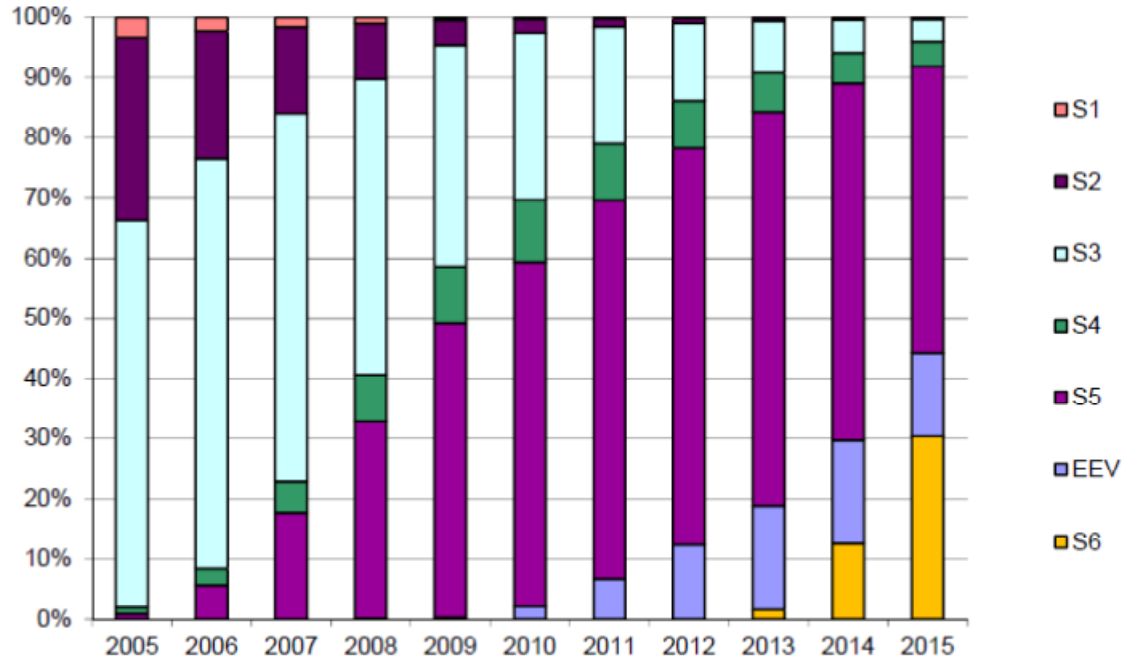


Source: Fraunhofer ISI with data from Eurostat (accessed June 2016)

The environmental performance of road transport is not primarily determined by the vehicle stock, but by their use. This is the main lever of emission-related road charges: wherever hauliers have the choice, they will select the most cost efficient vehicle, i.e. trucks with high emission standards. This can be seen in the toll statistics for Germany during the market decline, following the financial and economic crisis: free capacities allowed the use of an over-proportional share of clean vehicles.

For comparison: TML (2015) provide figures on truck use in Belgium by Euro emission standard for the year 2014. Accordingly, 27.6% of truck kilometres were performed by Euro-V and 16.5% by Euro-VI vehicles. These 44.1% correspond to slightly below 90% of HGV kilometres by Euro-V, Euro-VI and EEV vehicles in Germany as depicted in Figure 39. This indicates a strong impact of the German Lkw-Maut setting on the use of cleaner trucks.

Figure 39: Share of vehicle kilometres on toll roads in Germany by emission standard 2005 - 2015



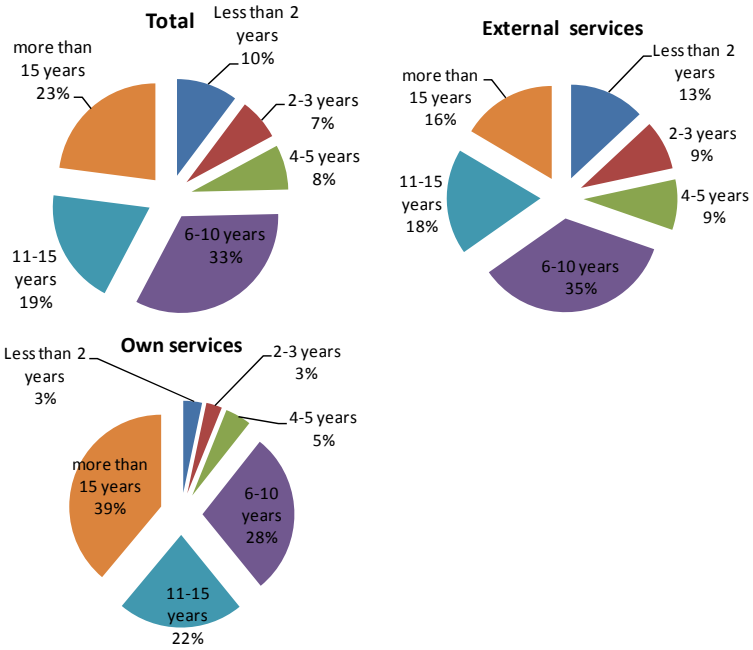
Source: BAG (2016): Toll Statistics 2014/15
Legend: Sn corresponds to Euro-n exhaust emission standard; EEV: energy efficient vehicle.

10.1.2 Spain

For Spain neither figures on the HGV stock nor on vehicle kilometres by environmental standards are available from public statistics. However, statistics allow to separate the fleet age by type of service. Figure 40 shows the freight fleet sorted by age in Spain. The total fleet older than 10 years is about 42% of the total fleet (34% for external services and 61% for own services). The economic crisis is one of the reasons explaining the high age of the Spanish truck fleet.

It is important to highlight that, according to the Ministerio de Fomento (2015b), in 2015, 75.7% of the total freight operations were made by external services, 72.1% at national level and 3.7% at international level, whereas own-services accounted for a total of 24.3%, shared between national transport (24.2%) and international transport (0.1%).

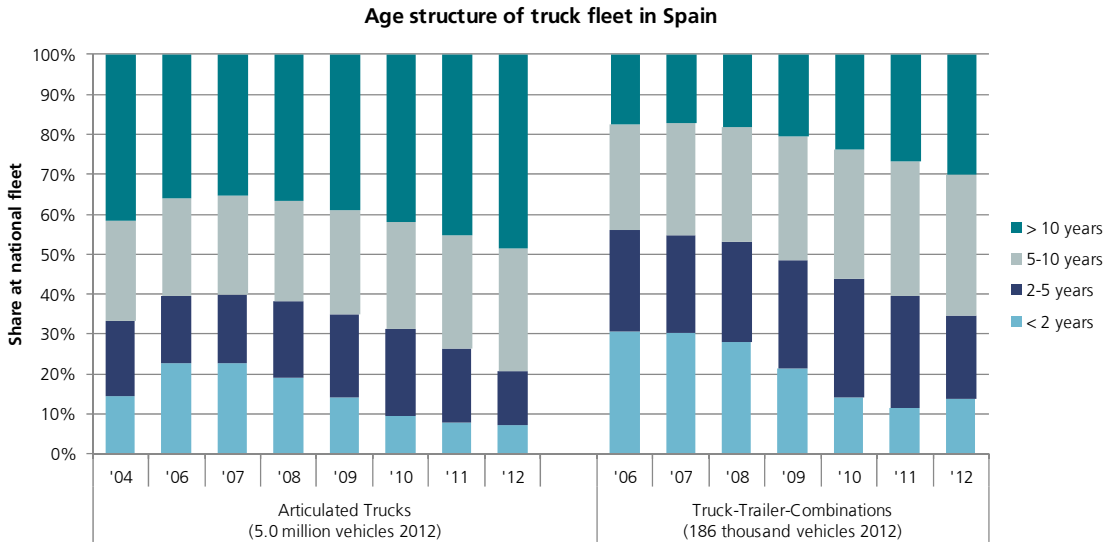
Figure 40: Spanish freight fleet composition 2015



Source: Ministerio de Fomento (2015b)

In contrast to Germany, where the number of old vehicles, in particular in truck-trailer combinations, declined, in Spain the number of old trucks increased drastically over time. The number of vehicles aged more than 10 years increased from 17% to 30% (2012) for truck-trailer units, and from 42% to 48% for articulated goods vehicles. Remarkable is also the difference in the number of vehicles in Spain, which is twice the number of Germany for articulated vehicles and about the same for truck-trailer combinations.

Figure 41: Age structure of truck fleet in Spain, 2004 - 2012



Source: Fraunhofer ISI with data from Eurostat (accessed June 2016)

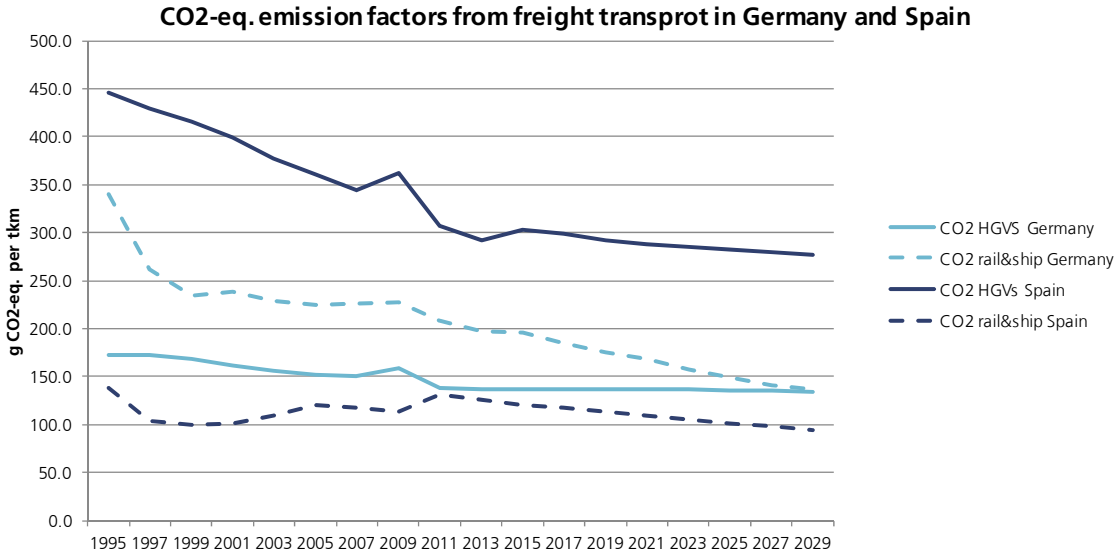
These figures indicate that the strong decline in demand for freight services due to the recent recession in Spain slowed down investment in acquiring new and cleaner vehicles. To counteract this effect, an emission-differentiated charging system could be implemented to stimulate the acquisition on cleaner vehicles hence improving the environmental performance of road transport.

10.2 Methodology by cost category

10.2.1 Climate change costs

The ASTRA-EC model provides total emissions on CO_2-equivalents (CO_2-eq.) and some air pollutants per scenario and for HGVs as well as for the freight sector in total. For CO_2-eq. emissions in Germany, the model provides average emission factors per tonne kilometer (tkm) for Germany and Spain. These depend on technology developments with drive engines and fuels, as well as on load factors, travel patterns and the distribution of goods between vehicle types and modes of transport. The emission factors contained in the ASTRA-EC model are depicted in Figure 42.

Figure 42: CO_2 emission factors per tkm over time for Germany and Spain



Source: Fraunhofer ISI; ASTRA-EC model outputs

Average CO_2-eq. emission factors for trucks are predicted to remain stable in Germany, while they are assumed to decrease for trucks in Spain due to better utilization of loading space and for alternative modes in both countries due to rising shares of renewable energies in rail traction. The reduction rates for 2020 and 2030, related to 2015, are given in Table 17.

Table 17: Relative change of HGV CO_2-eq. emissions per tkm 2020 and 2030 relative to 2013

Market segment	2020/15	2030/15
CO2 HGV Germany	100%	98%
CO2 rail&ship Germany	85%	70%
CO2 HGV Spain	95%	91%
CO2 rail&ship Spain	91%	78%

Source: Fraunhofer ISI, ASTRA-EC model results

Improving efficiency and better engine technologies are counter-balanced by rising CO_2 shadow prices in the future and the high uncertainty in valuing climate change damage and / or mitigation costs. The uncertainty range and the dynamics of CO_2 shadow prices, however, are high. The economic costs of carbon dioxide released into the atmosphere will increase over time as the low hanging fruits of measures to mitigate the consequences of climate change get scarce and as CO_2 and other greenhouse gases cumulate in the atmosphere. Van Essen et al. (2011) suggest an increase of the aver-

age shadow price of 20 Euros per decade. This implies a value range of 50 €/t CO_2-eq. in 1995 to 110 €/t CO_2-eq. in 2030.

With regard to the data above, we compute the external costs of climate change as follows:

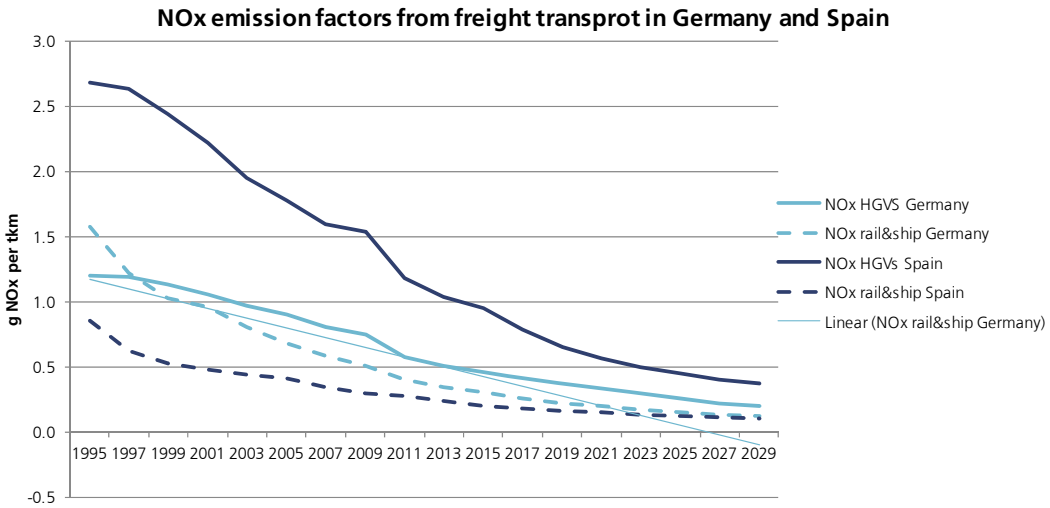
- Average costs per 1000 tkm for HGVs, freight trains and vessels for 2008 (in 2008 prices) are taken from van Essen et al. (2011), including climate change as well as up-and downstream costs, transferred to a shadow price of 80 €/t CO_2-eq. The values are assigned to Germany for their base year 2008. Average costs for Spain are computed according to differences in ASTRA-EC average CO_2 emission rates for 2008.
- 2015 average costs for Germany and Spain per mode (in 2015 prices) are using the relative changes in efficiency from the ASTRA-EC model per mode and country and by applying price indices per country from Eurostat.
- Costs for 2020 and 2030 per 1000 tkm (in 2015 prices) are derived from the 2015 cost values by applying mode-specific efficiency improvements from the ASTRA-EC model and changes of the shadow price of 20 Euros per decade.
- Total changes in external costs in 2015, 2020 and 2030 per mode between the two tolling scenarios and the Base Case are finally computed by applying the average costs per 1000 tkm to the volume changes reported by the ASTRA-EC model.

The same principle of assessing total differences in external costs between the scenarios applies to other cost categories.

10.2.2 Air pollution costs

Air pollution impacts are dominated by two major pollutants: nitrogen oxides (NOx) and particulate matter (PM) of various sizes and thus of various degrees of toxicity. Due to the progressing intensity of Euro exhaust emission standards for new vehicles, emission related vehicle circulation taxes and differentiated motorway charges in some countries, namely Germany and Switzerland, emission factors for air pollutants decline faster than those for greenhouse gases. Figure 43 shows the development for trucks and for their competitors in Germany and Spain between 1995 and 2030, as reported by the ASTRA-EC model.

Figure 43: Nitrogen oxides emission factors per tkm over time for Germany and Spain



Source: Fraunhofer ISI; ASTRA-EC model outputs

The relative development of NOx and PM emission factors in 2020 and 2030 against 2015 are given in Table 18. These show that particulate matter in trucking is expected to be nearly eliminated by 2030, when the Euro-6 emission standard and potential successors show effects.

Table 18: Truck external costs in the EU28 for 2013

Market segment	NOx emission factors		PM emission factors	
	2020/15	2030/15	2020/15	2030/15
HGVs Germany	73%	43%	39%	5%
Rail & ship Germany	63%	39%	79%	75%
HGVs Spain	59%	39%	21%	3%
Rail & ship Spain	72%	51%	73%	59%

Source: Fraunhofer ISI, ASTRA-EC model results

We generate weighted air pollution emission factors by referring the cost values per tonne of pollutant as recommended by van Essen et al. (2011) and by the German Convention on Estimating Environmental Costs (Schwermer, 2012, Annex B). This is around 15 €/t of NOx and 40 €/t PM (precisely: PM_{10} with a particle size of 10µm and less). Contrasting climate cost values, these unit costs are considered constant over

time. The adopted sequence of steps taken to compute total differential external costs of air pollution thus are:

- Transfer of average costs 2008 in 2008 prices from van Essen et al. (2011) for Europe (resp. Germany) to Spain by relative emission standards from ASTRA-EC.
- Transfer from 2008 values to 2015 average costs (in 2015 prices) by Eurostat harmonized consumer price indices and emission standards.
- Transfer of 2015 values to 2020 and 2030 average costs by ASTRA-EC emission standards.

10.2.3 Noise costs

Noise pollution causes several impacts on people affected to it, depending on the level and the duration of exposure. Impacts range from simple nuisance to sleep disturbance, cognitive and psychological impairments to cardio-vascular diseases and even increased risks for heart infarctions and strokes. Noise constitutes a particular problem for rail freight transport and thus may counter-balance some of its environmental and safety advantages.

Since the publication of the Environmental Noise Directive by the European Commission in 2002, member states are obliged to map and monitor noise pollution by 5 dB(A) classes along major roads, railway lines, in large cities and around busy airports by noise source. However, statistically reliable time lines of noise affected citizens are not available yet. Therefore, and because noise constitutes the smallest of all external cost categories (compare Figure 45) we use a simplified estimation procedure for total differential noise costs:

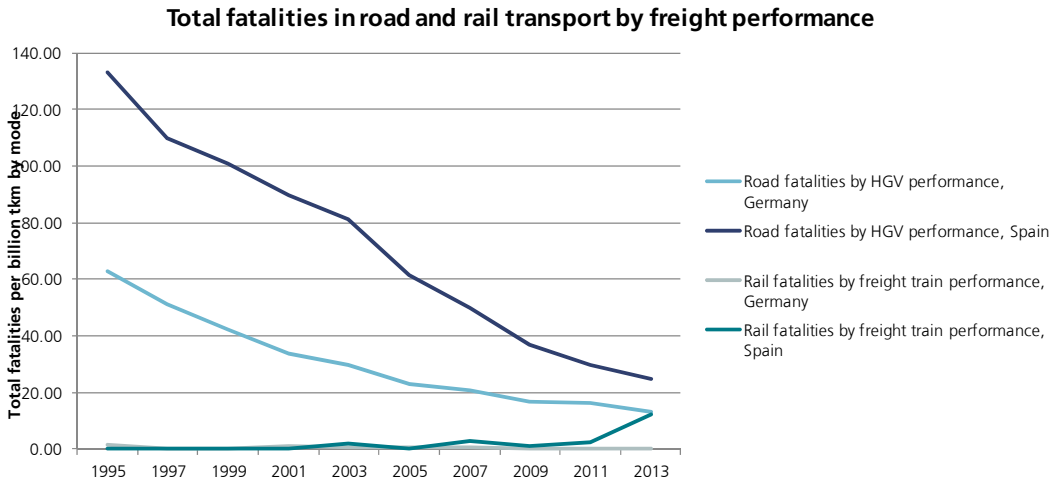
- As for climate change and air pollution impacts, we start from the 2008 values (in 2008 prices) in van Essen et al. (2011) for Germany. The average costs for Spain are estimated with the number of highly affected inhabitants (>70 dB(A)) in Germany (road: 880 000, rail: 205 000) and Spain (road: 1.33 million, rail: 2000).
- These values are inflated to 2015 Eurostat harmonized consumer price indices and then are held constant for 2020 and 2030 for road transport. For rail we assume a reduction of freight noise impacts to 80% by 2020 and to 50% towards 2030 due to the market dispersion of low noise wagons.

10.2.4 Accident costs

Accidents constitute the largest component of the classical external costs, i.e. when excluding congestion and infrastructure damages. Thanks to safety technologies such as safety belts, driver assistance systems, and better driver education (partly even due to denser traffic on European roads), accident rates have come down considerably in

the last decades. Figure 44 shows the development of fatality rates per tkm in Germany and Spain for road and rail transport. The values are composed of death casualties per mode of transport from Eurostat statistics (EC 2015) and of transport performance data from the ASTRA-EC model. Since the past eight years, this measure of accident rates fell by 35% (Germany) and even 50% (Spain) in road transport. In rail transport fatality rates are generally close to zero. For Spain a single major accident, the Santiago di Compostella derailment on July 24, 2013 with 79 death casualties and 140 injured[15] causes the peak in 2013 figures.

Figure 44: Accident rates per billion tkm 1995 – 2013 for Germany and Spain



Source: Fraunhofer ISI with data from EC (2015) and ASTRA-EC model results

Given this development, we assume the following for the average costs of accident externalities:

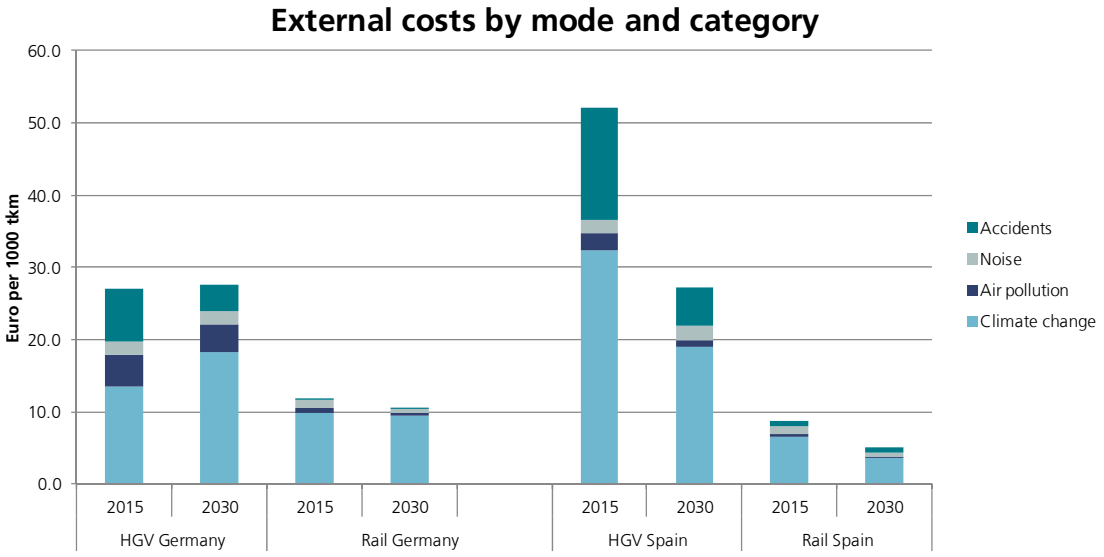
- 2008 values (in 2008 prices) are again taken from van Essen et al. (2011) and are transferred from Germany to Spain using the fatality rates shown in Figure 44.
- Road and rail average cost figures are converted to 2015 prices; road accident costs are adapted to the respective decline in accident rates in the past eight years for which we have data, i.e. the period 2005 to 2013. For all time periods we assume rail accident rates constant and waterborne accident costs as zero.
- For the further development of road haulage accident rates, we assume a further reduction by 35% (50%) from 2015 to 2020 and by 50% (65%) from 2015 to 2030 for Germany (Spain).

15 Compare e.g. https://en.wikipedia.org/wiki/List_of_rail_accidents_in_Spain.

10.2.5 Average external costs

With the above assumptions and methodologies, we receive the average external cost figures as depicted in Figure 45. Interesting is the development of climate change costs found for Germany. Efficiency technologies in trucks as well as electrification and the use of renewable energies in rail seem already too mature to allow for major improvements towards 2030. The rise in CO_2 unit costs then over-compensates the few optimization options remaining. Differently in Spain, safety technologies and fuel efficiency in trucks and freight trains has the potential to bring down external costs considerably.

Figure 45: Compiled average external cost values for Germany and Spain, 2015 and 2030



Source: Fraunhofer ISI

The results of the differential cost calculations between the No Toll and High Toll scenarios for Germany, La Rioja (North-Eastern Spain, ES2) and Jaén (Southern Spain, ES6) are presented in turn.

10.3 Results on total external costs

10.3.1 Germany

The computations in Germany show, that an abolishment of the Lkw-Maut in its current form would lead to an increase in the external costs of transport of 21.5 and 29 billion Euros annually. Or in other words: the Lkw-Maut has saved this amount of social costs. Given the current revenues of the Lkw-Maut of around 4 billion Euros annually, one can

say that the environmental and social costs saved add around 0.6% to the toll systems' surplus.

Going from the current Lkw-Maut setting to the High toll scenario, i.e. doubling revenues by higher tariffs and an extension of the tolled network, would save 23.4 to 38.5 million Euros of environmental and social external costs. While in the road sector savings go up to 76 million Euros in 2030, higher demand on the railways increases their external costs in 2030 by 37.5 million Euros. The results for both scenarios are presented in Table 19.

Table 19: Results: external costs for Germany

Indicator	**Base Case**		**No Toll Scenario**		**High Toll Scenario**	
	2015	**2030**	**2015**	**2030**	**2015**	**2030**
Transport demand (mill. tkm)						
HGV	257 358	245 373	259 557	247 394	255 161	242 604
Rail	50 756	52 093	47 817	49 534	53 770	55 696
Ship	1 337	1 304	1 310	1 279	1 376	1 348
Average costs (€ / 1000 tkm)						
HGV	26.94	27.54	26.94	27.54	26.94	27.54
Rail	11.76	10.41	11.76	10.41	11.76	10.41
Ship	8.83	6.55	8.83	6.55	8.83	6.55
Total costs (mill. €)						
HGV	6 932.3	6 757.9	6 991.6	6 813.5	6 873.2	6 681.6
Rail	596.7	542.1	562.2	515.4	632.2	579.6
Ship	11.8	8.5	11.6	8.4	12.1	8.8
All modes	**7 540.9**	**7 308.5**	**7 565.3**	**7 337.3**	**7 517.5**	**7 270.0**
Diff. to Base Case			**24.4**	**28.9**	**-23.4**	**-38.5**
Total external costs			**0.3%**	**0.4%**	**-0.3%**	**-0.5%**

Source: Fraunhofer ISI

With almost 40 million euros in 2030, the absolute amount of external costs saved constitutes a large number, To generate this saving around 4 billion euros have to be transferred within the tolling system. Doubtless, the primary purpose of tolling systems is funding with the co-benefit of enhanced sustainability of transport. This ratio, however, suggests two conclusions. First, tolling systems need accompanying policy measures to develop into efficient sustainability management tools. Second, simple benefit-cost-figures relating sustainability enhancements to the costs of tolling systems, which commonly amount to 5% to 10% of revenues, do not provide useful information.

10.3.2 Spain

In the following we present the modeling results of external costs for the two Spanish regions of North-Eastern Spain and La Rioja. While the tendency of the results is considered sufficiently robust, the absolute numbers have to be regarded with care as the ASTRA-EC model does not contain digitized transport networks and thus has limited precision in terms of representing transport volumes of transit traffic.

10.3.2.1 Norh-Eastern Spain (ES2) including La Rioja

The changes in external costs we see in the north-Eastern Spanish region of North-Eastern Spain (ES2), which hosts the study region of La Rioja, are minimal. As mode shares do not react much to slight changes in a limited local network, the entailed environmental and social impacts do not either.

The results presented in Table 20 indicate a mixed picture for the case of abolishing the current toll on the motorway AP61 from Bilbao to Zaragoza. Changes in road transport are reported minimal by the ASTRA-EC model. However, rail and to a much higher extent shipping, are affected significantly. This is because both modes, but in particular, coastal shipping, means detours compared to road haulage. As some of these longer transport options shift back to road, external costs in the short run even slightly decline after toll abolishment. In the medium to long term, the higher average costs on roads dominate the picture, leading to an increase in external cost of 1.5 million Euros in 2020 as compared to the base case.

Similarly, when moving the current toll system in place in La Rioja toward something like the current German tolling system, it could decrease impacts by up to 1.6 million Euros in 2020 as compared to the base case. Also here, shipping has a big impact as some in- and outbound flows can change ports to minimize road travel on toll motorways.

In both scenarios, towards 2030 the difference in external costs between the two tolling scenarios and the base case declines. This is because towards 2030, already in the base case, Spanish trucks are assumed to be cleaner and safer to a large degree.

Table 20: Results: external costs for North-Eastern Spain (ES2)

Indicator	Base Case		No Toll Scenario		High Toll Scenario	
	2015	2030	2015	2030	2015	2030
Transport demand (mill. tkm)						
HGV	65 608	74 761	65 603	74 688	65 604	74 686
Rail	6 931	7 896	6 945	7 940	6 943	7 940
Ship	48 513	52 931	48 590	53 134	48 578	53 123
Average costs (€ / 1000 tkm)						
HGV	26.94	27.54	26.94	27.54	26.94	27.54
Rail	11.76	10.41	11.76	10.41	11.76	10.41
Ship	8.83	6.55	8.83	6.55	8.83	6.55
Total costs (mill. €)						
HGV	1 767.2	2 059.0	1 767.1	2 057.0	1 767.1	2 056.9
Rail	81.5	82.2	81.6	82.6	81.6	82.6
Ship	428.4	346.9	429.0	348.2	428.9	348.1
All modes	**2 277.1**	**2 488.1**	**2 277.8**	**2 487.8**	**2 277.7**	**2 487.7**
Diff. to Base Case			**0.72**	**-0.22**	**0.61**	**-0.37**
Total external costs			**0.03%**	**-0.01%**	**0.03%**	**-0.01%**

Source: Fraunhofer ISI

10.3.2.2 Southern Spain (ES6) including Jaén

The results for the region Southern Spain (ES6) hosting Jaén are somewhat more expressed and more stable than the results found for the ES2 region. Shipping is a topic here too, but not so much as in North-Eastern Spain. Although the region of Southern Spain does not consist of as many toll roads as the north-east, a removal of existing tolls shows more profound and stable impacts. External costs increase, despite a significant drop in shipping and rail, by 3.2 million Euros in 2015 and 2.0 million Euros in 2030 compared to the base case.

When introducing a toll system in Southern Spain like the one being used in La Rioja external costs decline by 3.6 million Euros in 2015 and by 2.2 million Euros in 2030 . The reason for these more expressed changes may be the economic importance of the route Seville – Madrid leading through the region, and the limited detour options on that corridor. Results for the two scenarios are presented in Table 21.

The results shown in this section are largely driven by the transport demand figures obtained with the ASTRA-EC system dynamics model. ASTRA-EC does not have a transport network and can thus not model transport flows exactly. Although it contains a calibrated origin-destination matrix which captures most flows, we can for instance

not exactly say what the increase in shipping demand in the Spanish scenarios means in detail.

Table 21: Results: external costs for Southern Spain (ES6)

Indicator	Base Case		No Toll Scenario		High Toll Scenario	
	2015	2030	2015	2030	2015	2030
Transport demand (mill. tkm)						
HGV	65 608	74 761	65 694	74 470	65 697	74 470
Rail	6 931	7 896	6 883	7 561	6 884	8 210
Ship	48 513	52 931	48 377	52 290	48 398	53 450
Average costs (€ / 1000 tkm)						
HGV	26.94	27.54	26.94	27.54	26.94	27.54
Rail	11.76	10.41	11.76	10.41	11.76	10.41
Ship	8.83	6.55	8.83	6.55	8.83	6.55
Total costs (mill. €)						
HGV	1 767.2	2 059.0	1 769.6	2 051.0	1 769.7	2 051.0
Rail	81.5	82.2	80.9	78.7	80.9	85.4
Ship	428.4	346.9	427.2	342.7	427.3	350.3
All modes	**2 277.1**	**2 488.1**	**2 277.6**	**2 472.3**	**2 277.9**	**2 486.7**
Diff. to Base Case			**0.56**	**-15.72**	**0.84**	**-1.37**
Total external costs			**0.02%**	**-0.63%**	**0.04%**	**-0.06%**

Source: Fraunhofer ISI

10.4 Chapter conclusions

The external cost values computed in this section are considered plausible and mostly point in the right direction. However, they are not very significant when comparing them to actual toll revenue flows. We thus can conclude two things: raising motorway revenues for the purpose of reducing external costs requires significant upfront investments, and second round impacts on other modes, e.g. through detour traffic in rail and shipping networks, can neutralize or even reverse the positive effect of tolls. If improvements for the environment or in social aspects should be a declared goal in motorway tolling, tariff structures must be adapted accordingly. But that also involves additional system costs which may eat up parts of the additional benefits.

The results confirm the findings of the LivingRAIL study on mode shift impacts through pricing measures (Doll et al., 2015). HGV charging helps to shift goods from road to rail and waterway transport, but only to a limited extent. For more impact, it needs to be supported by flanking policies and options for avoiding charges on the road shall be minimized.

11 Conclusions

In order to explore the various aspects associated with the new instalment or the extension of HGV charging systems in European countries and regions, several quantitative and qualitative tools are applied. These comprise: literature review, assessment of statistical evidence, stakeholder consultations and the application of an economic and transport simulation model. The results provided by these tools are manifold and partly conflicting. In the following sections we thus summarize and interpret the material presented in Chapters 4 to 7 first in general along the 13 research questions, and finally derive conclusions on future road funding options for Spain.

11.1 Reflections on the study regions

Toll systems are a part of the transport, logistics and fiscal landscape of the countries they are located in. The design of toll systems accordingly, has to consider the economic system, goods production and consumption markets, tax levels and – not to forget – historical characteristics. Economic characteristics of a country may describe the export and import intensity, the economic power and the employment situation. The transport system may describe the availability and quality of infrastructures, while markets indicate the strength of particular sectors or commodities as forwarders or recipients of goods.

Historical and cultural features of economic systems may take different forms across Europe and manifest with the acceptance of certain technologies or organisational structures, and in the rejection of others. Vassallo et al. (Vassallo Magro, 2015) observe that acceptability is an important issue when it comes to road pricing systems. For example in France, the Écotaxe for cross-funding multimodal transport investments from road charges should have been implemented in January 2014, with an average value of 13 cents per kilometre. However, it was never implemented due to massive mobilizations of French transport operators. Similarly, the well-developed Dutch and the Danish plans for sophisticated HGV charging systems were buried after the political powers in the countries changed.

The relevance of transport for national economic prosperity depends. With logistics (or transport) intensity we can describe which amount of tons carried are required to generate the national gross domestic product (GDP). For sustainability reasons a low transport intensity is promoted by policy documents since the 1990s. The freight intensities of Germany and Spain basically follow the same structure, i.e. getting more intensive in the early 2000s and dropping back to late 1990s levels after the onset of the world economic crisis. However, the fluctuations in Spain are way more expressed than

in Germany or in the EU average. In the years 2001 to 2006 both, GDP and transport volumes grew considerably in Spain, while GDP stagnated and even declined in Germany. The transport intensities thus suggest the Spanish economy being much more dependent on the transport sector as a means to access European core markets, than Germany.

In contrast, the Logistics Performance Indices (LPI) issued by the World Bank since 2007, draw a quite encouraging picture for Spain. Despite the decline in volumes, the quality of the Spanish logistics sector has constantly improved, such that the country moved up from rank 26 to rank 18 within the past seven years.

The toll systems in the two case study countries, Spain and Germany, are quite different in those respects. Transferring recommendations from one country to another with rather different hard and soft economic features, as it is the case for the two countries studied here, is limited and thus needs to be expressed with care.

11.2 Overview of observations

Since the late 1960s the European Union has been discussing the need to introduce the pay per use model in order to contribute to cost internalisation. While the conceptual framework includes all modes and transport markets, road freight transport was identified by the EC's 1998 White Paper to start with the pay-per-use principle to carry real costs. This is known as the polluter pays or user cost pricing principle. Its final aim would be to mobilize economic resources to fund transport infrastructures and at the same time to internalize the external costs of transport for social efficiency. The Eurovignette directive (1999/62/CE and later its modification 2011/76/UE) takes into account these issues.

There are many countries that already apply the pay-per-use model on public roads, such as Switzerland, Austria, Germany, the Czech Republic and more recently, Belgium, Portugal and Poland. Other countries apply the pay-per-use model with private concessions for construction, maintenance, operation and toll collection. This is traditionally done on the Mediterranean countries France, Spain and Italy.

In this report we look across the various impacts of several types of tolling systems on the transport efficiency, on transport companies, on the wider economy and on sustainability. Our main conclusions can be summarized in a nutshell as follows:

- Transport efficiency in the road sector can be improved by increasing the cost pressure. But this comes at the price of restructuring the logistics sector, including company mergers and bankruptcies.

- Shift to alternative modes appears small for road, but may be considerable for rail and waterborne transport. However, considerable mode shift requires high quality and competitive alternatives to road in addition to adjustments in price levels.
- Profit margins in the transport sector are affected, but to a minor extent only as most companies can pass on additional costs to their clients. Only the large number of small transport companies, which have a too weak market position to negotiate for suitable deals, cannot balance additional costs within a larger network.
- Impacts on economic growth, employment and consumer prices are negligible. Impacts on such indicators will vanish in the fluctuations and longer-term trends of global and national markets.
- Road tolls create additional revenues. These are the more of benefit for the national economy the more transit traffic is using the toll road network. The availability of road toll revenues for rail or waterway projects is limited and their additional surplus for road network maintenance and expansion depends on policy decisions or on institutional arrangements.
- Alternative funding sources are possible and in most cases way cheaper than distance based road toll systems due to lower transaction costs. Although their flexibility, their sustainability impacts and the ability to include non-resident users are limited, from an efficiency point of view and to protect small companies taxes and vignettes may be preferred before distance based tolls.
- External costs are mitigated by road tolls, but to a minor extent only. The savings in external costs, which are dominated by avoided climate change and reduced accidents, are only a fraction of the costs needed to operate sophisticated charging systems.

In the following we discuss details of these findings along the 13 research questions of this study.

11.3 Evidence to the research questions

11.3.1 Effects on logistics efficiency

(1) How is the overall efficiency of the logistics sector affected?

Road tolls add to more efficiency in the haulage and logistics market. We measure transport efficiency by the utilisation of truck load space (operational efficiency), reduction of empty headings, and by distances travelled per ton (system efficiency).

- In Germany the introduction of the Lkw-Maut has contributed to further decrease the share of empty headings by 1% to 2% although the sector has already gone through a major efficiency improvement since the road logistics market liberalization in 1993. At the same time loads per loaded truck declined such that overall load space

utilisation only improved marginally. However, the increase of distances travelled per ton was stopped upon introduction of the Lkw-Maut and was even slightly reversed after the world economic crisis.

- For Spain the observed share of empty headings is rather stable and shippers do not expect it to change with alternative road pricing scenarios. With 47% of empty headings the overall efficiency of the Spanish trucking sector is, however, far below the German share of 20, providing substantial room for efficiency gains. The cautious expectations on potential efficiency gains put forward in the stakeholder interviews can thus be challenged.

New technologies could help a further improvement of logistics efficiency. The cost pressure on transport companies due to the Lkw-Maut in Germany proved to be limited as an estimated share of 70% to 80% of toll payments, i.e. those for loaded hauls, can mostly be passed on to the shipper. Moreover, haulage companies receive investment aids and other compensations of around 5% of tolls paid. The remaining additional cost burden for hauliers ranges around 2% in average, with higher values for smaller companies and peripheral locations. Though this does not justify expensive adaptation measures, the potential of new technologies for fleet and consignment management, as well as new trends coming from the shared economy, should not be disregarded to open up room for a further improvement of logistics efficiency in Spain, but also in the very competitive German logistics sector.

(2) Which impacts on specific groups of actors do occur?

Small and medium sized enterprises (SMEs) and hauliers from peripheral locations are most threatened by increasing toll costs. The polls among truckers before the introduction of the Lkw-Maut in Germany and the sector interviews carried out in Spain suggested that SMEs in transport along with manufacturers and producers may be threatened by toll roads.

- To cushion hard impacts of the Lkw-Maut, German introduced a compensation system in form of education and investment aids for clean trucks. By this mechanism around 20% of toll costs returned to the sector. Of the remaining cost burden an estimated share of 70% to 80% can be invoiced to the hauliers' clients. For SMEs, which often have profit margins around 2%, the remaining uncovered toll still constitutes a relevant cost factor.
- Due to the economic situation in Spain, hauliers have been reducing their costs, and in the case of own-services, they have not been able to renew their fleet, as can be seen in statistics on renewal activities. Therefore, compensations may be necessary to maintain certain stability in the sector as well.

(3) What are likely efficiency impacts of extending road charging systems?

High road toll scenarios may differ from the current situation as soon as costs increase beyond a certain tipping point. A look to Switzerland confirms that even more restrictive road haulage policies do not curb haulage, but change the functioning of the logistics sector. As for the introduction of road charging systems, theoretical models suggest improved vehicle load rates, optimising on labour and other production costs and, depending on the charge structure, the use of more environmentally friendly and energy efficient vehicles. Shippers should react by optimising warehousing and destination locations for shorter transport distances.

- While statistics on the German Lkw-Maut suggest little impacts of higher tolls, on HGV load rates in Germany, ASTRA-EC model applications indicate over-proportional impacts when doubling toll levels. The trend towards ever growing distances travelled per ton in Germany was apparently stopped upon introduction of the Lkw-Maut, a look on international figures, however, points on the dominance of prevailing economic conditions.
- Freight flows in the Spanish regions are driven by the seaports and import-export flows. The latter will suffer from higher tolls. In particular the still very high share of empty headings will most likely decline with higher toll, but will come at the expense of resstructuring the trucking sctor —bankruptcies and company mergers. Average distances by ton was heavily affected by the country's economic performance without any changes in tolling regimes.

(4) Do road charges contribute to a better use of all modes of transport?

Transport volumes of rail and shipping grow with higher HGV tolls, but the respective decline in road volumes is marginal. Considerable mode shift requires high quality and competitive alternatives to road in addition to adjustments in price levels. Positive examples for successful mode shift policies can be found in Switzerland and Austria, where high HGV tolls are accompanied by high investments in rail capacity.

- In Germany, the BAG market observations diagnosed that mode shift targets of the Lkw-Maut were not met despite positive expectations prior to its implementation. Transport model applications confirm that an expansion of the Lkw-Maut to all roads would lift rail and shipping volumes by 5% at a 1% decline of road volumes.
- In Spain the different track gauge to the rest of Europe make shifts to rail here more unlikely than for Germany. This is confirmed by stakeholder interviews and transport model applications. However, the low market share of the Spanish rail freight sector could lift current volumes by up to 12% in some regions.

11.3.2 Effects on the economic performance of the sector

(5) Which direct impacts do hauliers experience?

Hauliers will react on cost increases through saving labour and other costs, but the resulting net effect is most likely positive. The logistics sector has to cope with three types of toll impacts: cost increases, push towards adapting behaviour and benefits through transport investments. Options for counter-active measures include: pass on tolls, use cleaner and more fuel efficient vehicles, chose less distant destinations, save on personnel and other costs, flagging-out, merge companies, etc.

- For Germany we find a cost increase for hauliers in average of 2% to 5% as most tolls can be passed on to forwarders. International literature and ASTRA model results indicate that job losses in the haulage sector are over-compensated to 0,1% or 40 000 additional jobs in alternative modes or in the construction industry. Consumer price increases are negligible as transport costs account for no more than 3% of production costs. Toll impacts thus are limited to 0,4% of product cost at maximum.
- Even without changing toll regimes, Spain has seen an increase in logistics efficiency through the years of the economic crises. Studies on potential impacts of alternative HGV toll scenarios suggest that rich regions are more likely to benefit from road charging (+0.1% to +0.13% in La Rioja and Jaén),[16]. ASTRA-EC model results for employment and economic growth confirm this order of magnitude.

(6) How are commercial margins and bankruptcies affected?

Profit margins are critically reduced for parts of the haulage business even though large parts of tolls can be passed on to forwarders. To what extent toll increases threaten business continuity largely depends on company sizes and thus on their negotiating power against forwarders and industries. Although company structures in Spain and Germany largely differ, in both countries the bankruptcy risk in the transport business was found to be equal to the rest of the economy.

- In Germany profit margins are as low as 1% for small hauliers, and these most likely have to face a higher cost increase due to the Lkw-Maut. In contrast profit margins reach 6% and more for the big players, who only face 2% to 3% of toll costs. For SMEs in haulage the Lkw-Maut costs are thus way more threatening than for large companies, who also have more compensation options available.
- The commercial road haulage sector in Spain is highly atomised with 91% of companies have no more than five employees. These SMEs are generally in a weak position to pass on tolls and to negotiate higher freight rates accepted by their clients.

16 Guzman Valderrama (2013)

(7) Are there effects on consumer prices?

Consumer prices are not affected by road tolls. The share of production costs at product life cycle costs is so low, that their impact on product prices will hardly become visible. Price changes estimated by economic models range well below 1%.

- For Germany studies estimate a share of transport costs at production costs between 2% and 3%. With a transport cost increase of up to 15%, toll costs may impact product costs by 0.5% on average. Among a sample of goods a 2006 study finds timber products the most sensitive to road tolls.
- Literature for Spain confirms that a rearrangement of prices takes place, but that this would only be noticeable the first year of introduction of tolls. Hauliers interviewed showed concerns as the reimbursement of tolls by shippers..

(8) Do HGV tolls influence the positioning of countries as logistic hubs?

The relevance of HGV tolls on countries' competitiveness is largely determined by the use of the revenues. Transport costs are decisive for logistics systems, but international competitiveness is influenced by a variety of other factors too. Since 2007 the Wold Bank is issuing a ranking of countries with its Logistics Performance Index (LPI). Infrastructure quality and capacity is among the key LPI indicators.

- German commonly takes top positions between 1 and 3 in the LPI. Of concern, however, is the progressing deterioration of its motorway infrastructure. The Lkw-Maut tariffs are justified with renewal and extension costs for motorways and the revenues are earmarked to them. However a reduced allocation of general budget to transport purposes after the introduction of the Lkw-Maut did not ease the asset deterioration.
- According to the LPI the international position of Spain has clearly improved since 2007. The logistic sector has a relatively small dimension in Spain; however its productivity is considered equal to that of other big countries due to the high share of SMEs and the high density of logistics facilities.

11.3.3 Effects on budget, revenues and infrastructure:

(9) How do public revenues develop with road charging?

International traffic helps stabilize revenue flow, creates acceptance and additional income. Comparing the transit country Germany to the more or less peripheral Iberian Peninsula confirms this statement.

- 40% of the revenues from the German Lkw-Maut come from foreign truckers. The high share of transit traffic on German motorways constitutes a core argument for gaining acceptance of the Lkw-Maut system prior to its implementation and for the

tariff increase during the years of the financial and economic crisis. In consequence, the income from the Lkw-Maut of 4.5 billion Euros annually, constitutes the single most important source of revenue for the German Ministry for Transport and has been constantly increasing from 3.0 billion Euros since 2005.

- This component is largely missing for Spain, where most of the revenues stem from national hauliers. Driven by economic conditions of the country, revenues from car and truck tolling in Spain have peaked at 2.1 billion Euros around 2005 and then dropped to 1.6 billion Euros in 2013. Consequently, some concessionaires in Spain are experiencing financial difficulties. This development is driven by the economic development and by the share of international traffic in the countries.

Funds for road investment are determined by institutional settings and by earmarking rules. In publically owned and governed systems like the German Lkw-Maut, the allocation of revenues to specific sectors largely depends on political decisions.

- The Lkw-Maut Arrangement was criticized because the additional funding available for road works was minor compared to the tariff revenues. This is because in the year of introducing the Lkw-Maut, the transfer from the Ministry of Finance to the Transport Ministry was reduced considerably. After an initial distribution of revenues to all modes, since 2011 they are earmarked completely for federal roads to maintain acceptability of the system. Although the Transport Infrastructure Financing Society (VIFG) in Germany formally uses all Lkw-Maut revenues for road investments, the funding system is not closed as cost share for cars and non-tolled federal roads are decided by the finance minister.
- This household-dependency, on the other hand, ensures that the road funding system cannot go bankrupt, as appears to be the case in some Spanish concessions. On the other hand, Spanish road operators remain more independent of state funding needs and political preferences.

(10) Which impacts can be expected from alternative funding sources?

The primary objective of road tolls are funding rather than improving economic or social sustainability. Through the introduction of the German Lkw-Maut, external costs of 24.5 million Euros have been saved. In contrast, operating costs by the Toll Collect consortium were 540 million Euros and an additional 450 million Euros has been spent to incentivize the purchase of low emission trucks. Accordingly, road user charges shall be considered as a financing instrument rather than an instrument primarily to lower social impacts.

Vignette solutions lower transaction costs and stabilize income flow. Parts of Europe still apply the Eurovignette-System of area charges. The transaction costs of such vignette systems are low and they could be easily extended to a wider share of the road network and be differentiated according to vehicle size and emission stan-

dards. Vignette charges could thus to some extent, incentivize the modernization of truck fleets, contribute to mode shift and address funding needs. On the other hand, vignette solutions will cover only a fraction of infrastructure costs and will hardly incentivise a more sustainable purchase and use of vehicles as annual charge levels are low compared to distance based tolls for commercially used trucks. With an average annual price of 1250 €/a and around 120 thousand km per truck and year the Eurovignette corresponds to around 1€-Ct./km against 10-15 €-Ct./km for distance tolls on Europe. Moreover, the payment is done usually once a year without any further incentive to adjust behaviour. Vignettes will thus hardly contribute to logistics efficiency, neither do they promote the reduction of externalities and congestion (Gibson et al., 2014). Distance based charging has more potential for altering business models towards enhanced sustainability.

Tax based solutions are cheap but inflexible. The transaction costs of solving funding needs through taxes are low, as these systems are already in place and just need to be adapted. However, the incentive effect towards modernizing vehicle fleets or using cleaner trucks is limited, as foreign drivers cannot be addressed adequately and potential avoidance effects, e.g. tank tourism to avoid fuel taxes, may be relevant. Moreover, taxes are by definition not linked to spending in the same sector where they have been raised. The steadiness of funding investments and maintenance of road and alternative transport infrastructure is thus not guaranteed.

(11) Which impacts on road maintenance can be observed?

Road tolls need closed funding cycles to guarantee effective maintenance. In Germany, which constitutes the largest and one of the richest economies in Europe, the quality indicators for the federal motorway and trunk road network are rapidly deteriorating, despite the Lkw-Maut tariffs having been calculated on the basis of funds required for closing the investment gap of 4 to 8 million Euros estimated for the network. In contrast, interview results for Spain state clearly, that less congestion and better pavement conditions for toll roads is expected. The concession contracts between the national and regional governments and the concessionaires guarantee for certain quality standards and are thus considered a pre-condition for an effective use of toll revenues. The Austrian system of an autonomous funding and road operation agency may be a good compromise between concession and state owned models.

Intermodal infrastructure needs public funding. One of the few public models for a large-scale, cross funding of rail infrastructure by road user charges is the Swiss heavy vehicle fee. Other models like the intermodal, earmarking of the German Lkw-Maut and the planned Eco-Tax in France had to be resumed after strong protests from the truck-

ing sector. The success factor for the Swiss model is the country's strong instrument of citizen participation, which cannot be easily transferred to other European countries. Thus, although theoretically possible and foreseen to some extent in the Eurovignette-Directive, non-road infrastructure projects will require public spending.

11.3.4 Impacts on external costs

(12) To what extent can air pollution external costs and mortality be avoided?

Emission differentiated HGV tolls can reduce NOx and particle emissions in freight transport considerably. The demand driven effect alone, i.e. without incentives for purchasing or using cleaner trucks, is around 1% of external costs in the high toll case compared to current tolling regimes.

- Through a combination of incentives for the use of clean trucks, investment aids for purchasing modern vehicles and demand impacts on road transport volumes way higher reductions up to 5% of emissions can be expected. The more intensive use of trucks with high emission standards during the recession years after the world economic crisis indicates that the potential impacts may even exceed this estimate. It is, however, difficult to separate the toll effect from taxation and investment aid impacts.
- With undifferentiated and fragmented charges as in the Spanish system, demand effects lead to an emission reduction of 0.1% to 0.6% in road transport only.

Environmental standards of rail and shipping influence overall environmental results considerably. Total emissions in the freight sector are found to be smaller when considering all modes. This is because demand reduction in trucking partly shifts to freight trains, inland waterway and short sea shipping, causing emissions there. If environmental standards in these modes are less developed and / or longer detours compared to road are necessary, the overall environmental balance may be neutralized or may even reverse. Respective results have been found for particle emissions in Germany and for the Spanish case studies.

(13) How are greenhouse gas emissions, safety and other externalities affected?

The reduction of CO_2 emissions in freight transport follows the trend in the reduction of air pollutants. When considering all modes of transport, the extension of toll systems is found to lead to 0.7% less carbon emissions in Germany, 0.1% less emissions in La Rioja and 0,06% less in Jaén. These results are based on conservative estimates of technical and operational improvements in all modes in terms of energy consumption.

Climate gas emissions account for 60% to 70% of external costs, but with high uncertainties. Generally rail transport and shipping are four to five times more energy efficient than trucking. However, their advantage over road transport depends on a number of critical factors, most of all on load rates of trucks, rail cars and vessels, on the age structure of engines and on the degree of electrification and the primary energy sources for electricity production in rail transport. Moreover, the estimates of the economic costs of global warming differ widely and increase over time as the low hanging fruits of mitigation measures get more and more rare.

Non-Emission related external costs account for 15% to 30% of external costs in freight transport. These are accident costs (8% to 25%) and to a lesser extent, noise (5% to 7%). In particular, accident costs differ widely between Germany with 15% of total costs in 2015 and Spain with 25% of total costs.

In the Base Case external costs of road haulage are expected to decline more profoundly for Spain than for Germany. Under the assumption of vast improvement in safety, emission and fuel economy standards of Spanish trucks compared to the already more efficient German fleet, average external costs in Spain are expected to decline by 48% between 2015 and 2030, while they grow by 2% in Germany. The growth in Germany is mainly driven by increasing unit avoidance costs per ton of CO_2 as the low-hanging fruits of cheap mitigation measures will get more rare by 2030.

HGV toll scenarios impact the external costs of freight transport, but the total effect remains rather limited. Total and relative savings in external costs of the high toll scenarios relative to the Base Case are €38.5 million (0.5%) for Germany, €370 million (0.01%) for North-Eastern Spain and €1.37 million (0.06%) for Southern Spain. These figures most likely under-estimate the real impacts as incentives by emission-related tariff structures and targeted investment aids are not fully captured by the modelling tools applied.

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Annex 1: Survey design

Fraunhofer ISI

POLITÉCNICA

Dear interviewee,

Many thanks for accepting being part of this study. Your responses will be very helpful to understand the situation of tolling highways in Spain and Germany. This research study is carried out by the Research Institute Fraunhofer ISI and the Universidad Politécnica de Madrid. The aim of this study is to understand the actual impacts of existing toll charges and the hypothetical impacts of their extension to currently un-tolled roads on transport logistics and on the wider economy. The study intends to shed light on the positive and negative impacts of road user charges on the transport sector in general, in particular on the trucking business, regional economies, and on transport sustainability.

Please keep in mind that full confidentiality will be preserved and that the information contained in this questionnaire and records will not be disclosed to any other third parties.

Please fill in the next questions. Feel free to leave blank those questions that you are not able to answer or are not related to your sector. Answers are neither correct nor incorrect; we are just interested in hearing your experience and perception about tolling systems.

1. *Please describe your business and related information if applicable:*

Please describe your sector:

☐ Producer or manufacturer ☐ logistics company ☐ Road transport company
☐ Infrastructure manager / toll operator ☐ Public administrator
☐ Transport association: click to insert text
☐ Other: click to insert text

Size of the company *(Please describe when different subsidiaries & main offices)*:
Click to insert text

Address *(Please describe when different locations):*
Click to insert text

Distance (of the product distribution center) to the closest highway (which one?):
Click to insert text

Main destinations served:
Click to insert text.

If you are a logistics or forwarder company: Where do parcels/ goods come from?
Click to insert text

Does your company take actions to reduce environmental impacts? ☐ No ☐ Some ☐ Many
If other than *No*, which?
Click to insert text

2. *Please describe, if applicable, the impacts of non tolled / tolled roads in your organization:*

Which adjectives describe the state of the **non-tolled roads** that you normally take?

☐ Old ☐ New *Maintenance*: ☐ Poor ☐ Regular ☐ Good
☐ Unsafe ☐ Safe *Quality*: ☐ Poor ☐ Regular ☐ Good
☐ Others: Click here to insert text.

What are the cost burdens of **tolls** for your company (compared to non-tolled roads)?

Paperwork: ☐ Less ☐ Same ☐ More *Fuel costs:* ☐ Less ☐ Same ☐ More

Time costs: ☐ Less ☐ Same ☐ More *Others:* Text

How much do toll costs impact your production and/or product costs?

☐ Nothing ☐ Slightly ☐ Significantly

Can/Could you invoice toll costs to your customers? ☐ Not at all ☐ Partly ☐ Fully

If *Partly*, when? Insert text here

Do toll roads trigger higher vehicle load rates? ☐ No ☐ Slightly ☐ Significantly

Do toll roads impact your truck fleet structure? ☐ No ☐ Slightly ☐ Significantly

If *slightly* or *significantly*, how? Insert text

Is the lack of interoperability among toll roads a problem for your organization? ☐ No ☐ Yes

If *yes*, why?

Click to insert text.

Do you see other impacts of tolls in your business or do you have any comments?

Click to insert text

3. *Please choose, if applicable, how tolls impact the performance of your company?*

	Extreme reduction		No impact		Extreme increase
Profit margins	☐	☐	☐	☐	☐
Employment	☐	☐	☐	☐	☐
Wage levels	☐	☐	☐	☐	☐
Others (please describe):	Click to insert text				

4. *Please describe, if applicable, the impacts of tolls in your company's transport choices:*

When do you take toll roads? Click to insert text.

When do you take free roads? Click to insert text

How did the economic crisis influence your decision on taking toll roads?

Klicken Sie hier, um Text einzugeben.

Would you (or your client) propose another route to avoid paying tolls? ☐ No ☐ Yes If *yes*, when?

Click to insert text

Would you (or your client) change destinations to avoid paying tolls? ☐ No ☐ Yes If *yes*, when?

Click to insert text

Would you (or your client) use another mode to avoid paying tolls? ☐ No ☐ Yes If *yes*, when?

Click to insert text

Are alternative modes feasible for your business? ☐ No ☐ Yes Which or when? (i.e. rail)

Click to insert text

What are the main challenges with alternative modes?

Insert text here

Other impacts of tolls on your transport choices?

Insert text here

5. *From your point of view, what is the effect of toll roads in transport companies?*

	I totally disagree				*I totally agree*	*I don't know*
Toll roads reduce profit margins	☐	☐	☐	☐	☐	☐
Tolls may lead to a risk of bankruptcy of transport companies	☐	☐	☐	☐	☐	☐
Toll roads cause more administrative burdens to companies	☐	☐	☐	☐	☐	☐
Tolls reduce employment levels in transport companies	☐	☐	☐	☐	☐	☐
Tolls reduce wage levels in transport companies	☐	☐	☐	☐	☐	☐
Tolls are a threat to small-medium transport companies	☐	☐	☐	☐	☐	☐

6. *Please answer, if applicable:*

Have you experienced different toll systems?	☐ No ☐ Yes	If yes, in which countries?	☐ Spain ☐ Germany	☐ France ☐ Others: Others
Or do you know how they work and how do they compare to each other?	☐ No	☐ Yes		

If you are familiar with the German toll system (otherwise go to section 7): How would you perceive the following impacts in the regions around tolling systems in Germany?

	Very negative			*No impacts*		*Very positive*	*I do not know*
Economic development	☐	☐	☐	☐	☐	☐	☐
Employment situation	☐	☐	☐	☐	☐	☐	☐
Consumer prices	☐	☐	☐	☐	☐	☐	☐
Quality and availability of other modes	☐	☐	☐	☐	☐	☐	☐
Development of logistics hubs / ports	☐	☐	☐	☐	☐	☐	☐
Funding situation of transport infrastructures	☐	☐	☐	☐	☐	☐	☐

	Has not improved at all				*Has much improved*	*I do not know*
Road maintenance and quality service	☐	☐	☐	☐	☐	☐
Construction of new roads	☐	☐	☐	☐	☐	☐
Congestion and HGV traffic density	☐	☐	☐	☐	☐	☐
Logistics optimization / efficiency	☐	☐	☐	☐	☐	☐
Traffic safety	☐	☐	☐	☐	☐	☐
Air quality and climate gas emissions	☐	☐	☐	☐	☐	☐
Reduced noise impacts	☐	☐	☐	☐	☐	☐
Fuel costs	☐	☐	☐	☐	☐	☐
Do you perceive more trucks re-routing to tolling-free motorways?					☐ No	☐ Yes

Other impacts that you have perceived: Please click to insert text here

7. *Please give us your point of view regarding toll roads vs. toll-free roads*

From your point of view, how do **toll roads** perform compared to **free roads:**	*Totally worse*		*Same*	*Totally better*	*I don't know*

Traffic safety	☐	☐	☐	☐	☐	☐
Security (i.e. in resting areas)	☐	☐	☐	☐	☐	☐
State of pavement	☐	☐	☐	☐	☐	☐
Resting areas (toilets, restaurants, etc.)	☐	☐	☐	☐	☐	☐
Parking facilities	☐	☐	☐	☐	☐	☐
Congestion	☐	☐	☐	☐	☐	☐
State of pavement	☐	☐	☐	☐	☐	☐

What are other pros and cons of toll roads?

Click to insert text here.

If you had to choose a tolling system for your region, which one do you think is more appropriate?

☐ Traditional: Cars and trucks by no. of axles on specific motorway sections

☐ Austrian: HGVs only, differentiated by number of axles on all motorways

☐ German: HGVs only by number of axles and emissions category on all high level roads

Would you prefer other forms of road infrastructure funding? Which?

Click to insert text

Do you have any other comment?

Click to insert text

8. *For statistical analysis, we kindly ask you to include the following information. Remember that all information in this questionnaire will remain anonym.*

Your age: Click to insert age here Sex: Choose one option.

Your highest completed diploma:

☐ Lower secondary education
☐ Upper secondary education
☐ Undergraduate studies (first cycle)
☐ Master studies (Second cycle)
☐ PhD studies (Third cycle)
☐ Other: please describe

Many thanks for your help!

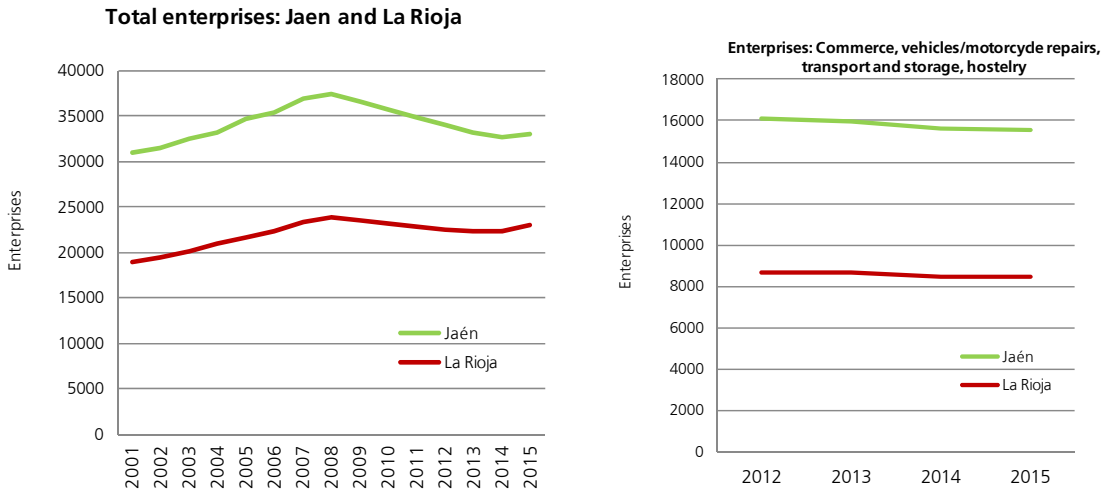
Annex 2: Spanish case study

Territorial characteristics

Spain has a total population of 46 million inhabitants (Instituto Nacional de Estadística, 2016). At the end of 2014, Spain had a total employment rate of 59.43%, whereas the unemployment rate was equal to 20.90%. It is worth noting that these numbers differ notably across different regions.

The service or tertiary sector is the most relevant activity in Spain. It has more weight in the economy than the other sectors, and it provides the most employment. In the secondary or manufacturing sector, activities such as the automotive industry and its accessories, production in the agri-food sector such as wine, the canning industry, milk products and sausages, are the most relevant. Finally, even if the primary sector is not as relevant as the rest of the sectors in the GDP, Spain is the most important producer of ecologic agriculture at the European level.

Figure 46: Jaén and La Rioja, enterprise statistics

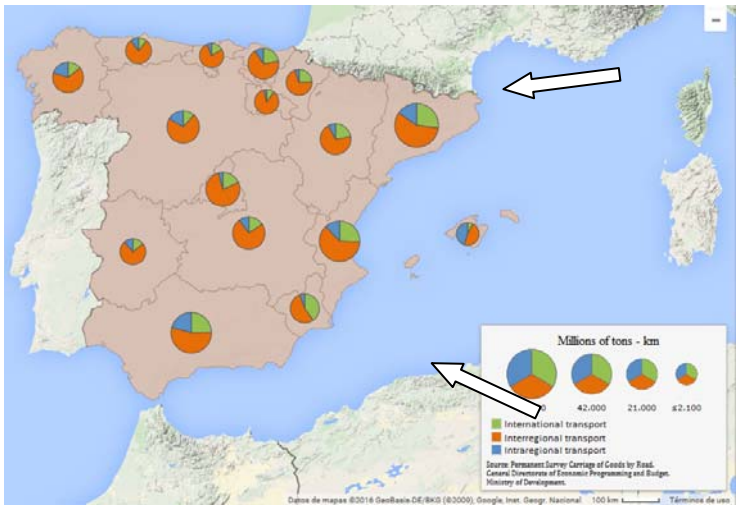


Source: INE (Instituto Nacional de Estadística (National Statistics Institute), Online)

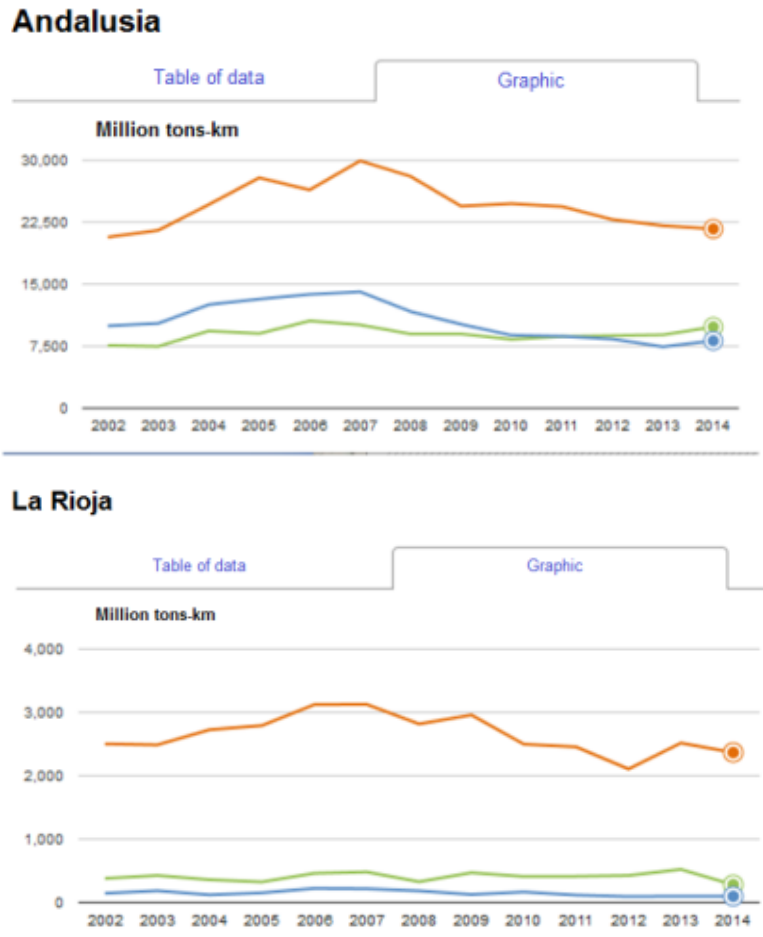
Due to a limited number of studies, other sources of information are useful to infer how toll charging scenarios could have an impact on different sectors.

Figure 47 shows how the traffic of goods behaves in different regions in Spain. In the case of both Andalucía and La Rioja regions, international transport is slightly more important than intra-regional transport.

Figure 47: Total transport of goods (million tonne-km) per type of traffic



Interregional transport International transport Intraregional transport



Source: Observatorio del Transporte y la Logística en Espana (2014b)

According to the DataComex (online), from 2004 to 2015, the two most important products that the province of La Rioja exported were manufactured articles (in general), and alcoholic beverages (within the group of beverages and tobacco). On the other hand, the two most important imported products were manufactured articles, and food and animal products. Whereas Jaén had olive oil (representing almost the entire share of section 4, which accounts for oils and wax), and machinery and transport equipment as the most important exported products.

Interesting to note that in both cases, trends neither seem to decrease the use of road as freight transport mode; nor increase the use of rail or other freight transport modes.

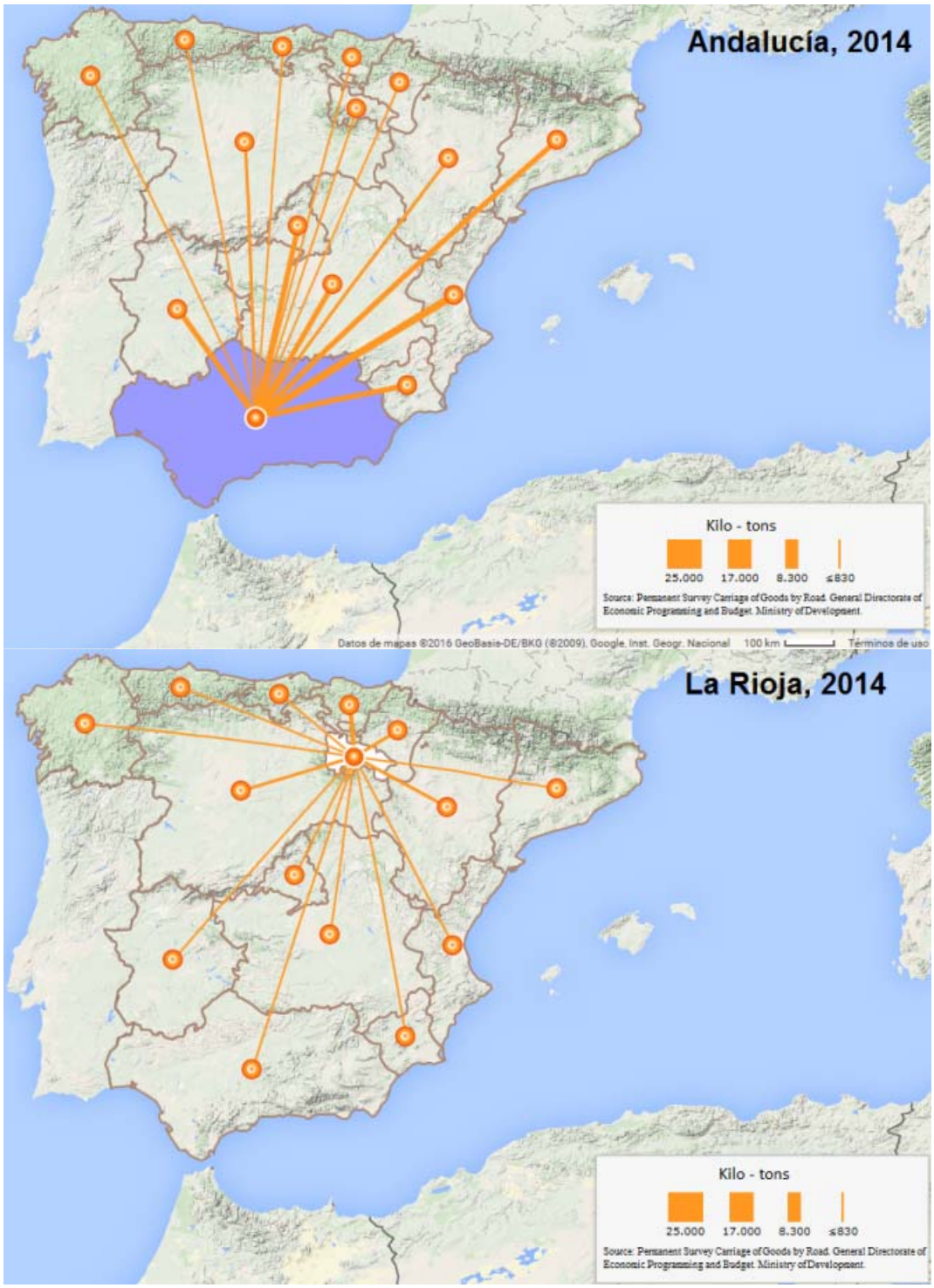
Jaén

Jaen is a Province within the Andalucía region (*Comunidad Autónoma*). It has a total population of 654 thousand inhabitants. At the end of 2015, it had an employment rate of 56.01% and an unemployment rate of 30.84% (in 2015) (Instituto Nacional de Estadística, 2016). Its Gross Domestic Product (GDP) per inhabitant was about 14,920 Euros in 2012, 7,642 € lower than the national average (INE).

Agriculture plays an important role in its economy with olive trees and wheat as its main products (Instituto de Estadística y Cartografía de Andalucía, 2016). It is said that the Jaen province is the largest worldwide producer of olive oil, accounting for 20% of worldwide production, and half of the total Spanish production. In fact, 78% of the total agricultural surface in Jaen is dedicated to olive harvesting. The olive trees of Jaen represent 25% of the total olive harvesting area in Spain and 42% of the Andalucía region (Esencia de Olivo, Online; Jaén.es, 2016). Other harvests of legumes and fruits are also important. Other relevant industries in the province are related to automotive, textile and the plastic sector (Jaén.es, 2016).

Figure 48 shows that the highest traffic of goods moving from the Andalucía region to the Valencia Community is 4,562 Kilotons.

Figure 48: Traffic of goods from the Spanish Regions Andalucía and La Rioja to other Spanish regions, in 1,000 tonne



Source: Observatorio del Transporte y la Logística en Espana (2014a)

La Rioja

It is a single province Region (*Comunidad Autónoma de la Rioja*). La Rioja has a total population of 317 thousand inhabitants. At the end of 2015, it had an employment rate of 59.38% and an unemployment rate of 13.97% (Instituto Nacional de Estadística [National Statistics Institute]).

The tertiary sector, or service sector, constitutes the main economic activity in La Rioja, followed by industry, construction and agriculture (Instituto de Estadística de la Rioja, 2015). Its Gross Domestic Product (GDP) per inhabitant was about 24,239 Euros in 2012, only 248 € lower than the national average (INE).

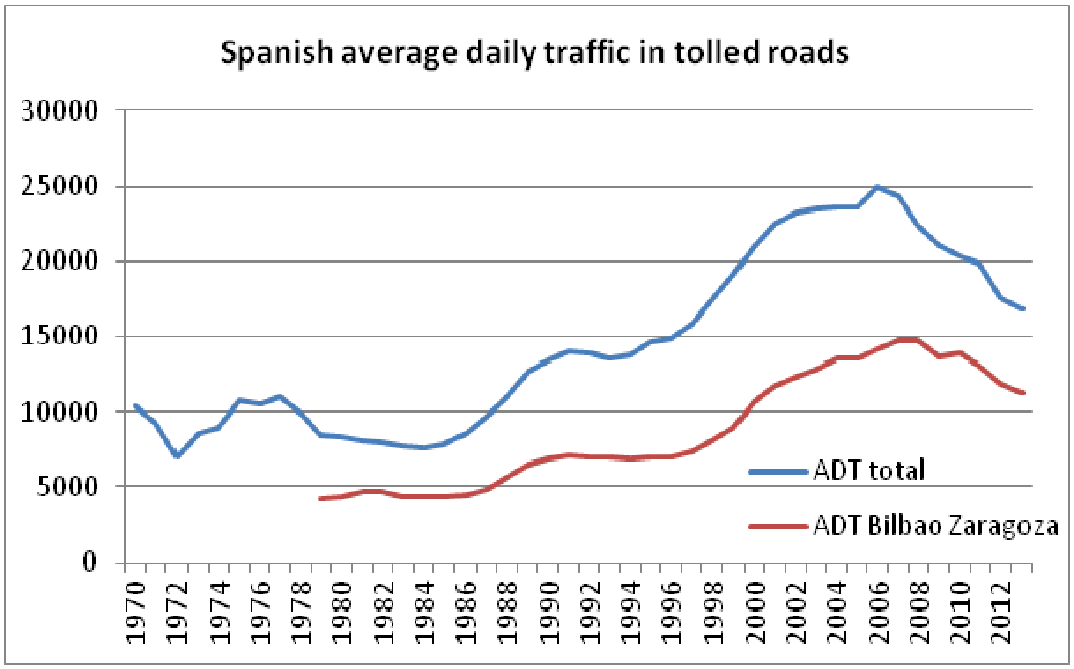
Figure 48 shows that in the case of La Rioja region, the highest traffic of goods goes to the Basque Country, accounting for 1,697 kilotons in 2014. Whereas in the case of Andalucía, the highest traffic goes to the Valencia Community, accounting for a total of 4,562 Kilotons in 2014.

The AP-68 crosses an important part of the territory in la Rioja. The name of the concession is Avasa, managed by Abertis. It was awarded in 1973 and between 1978 and 1980 was put into service (Ministerio de Fomento, 2015). The concession term expires in 2026. Financial results of this concession shown and discussed in Section 9.1.

Road statistics

The Concessions 2013 report (Ministerio de Fomento, 2015) provides data on traffic volumes by road type in Spain. It mentions that in general terms, the HGVs that used toll roads accounted for 12.41% of the total traffic and the rest were passenger vehicles. In this respect, the AVASA concession, which manages the toll road that crosses La Rioja, had 9.90% HGV traffic and the rest of it, 90.10%, were passenger vehicles. The Spanish average daily traffic in tolled roads is shown in Figure 49.

Figure 49: Average daily traffic in the Spanish tolled roads



Source: (Ministerio de Fomento, 2015)

Annex 3: Figures from literature on external costs

The body of literature on the external costs of transport has grown substantially since the mid 1990s. Here we refer only to selected European studies and sources with relevance for Germany and Spain.

As we stated before, one of the corner stone arguments for the introduction of differentiated kilometer-based road user charges is the reduction of environmental impacts from HGV traffic. According to the Shell HGV study for Germany (Lenz et al., 2010), other options for reducing the carbon footprint of trucks, such as alternative fuels or electrification, are limited.

For this purpose, the European Union's legislative framework in directive 2011/76/EC provides two instruments for fostering the use of environmentally friendly trucks:

- Charges may be differentiated by 100% according to Euro vehicle emission standards.
- The general infrastructure cost based charge levels may have an add-on for air pollution and noise impacts.

With these instruments, road user charges may impact the external effects and thus the external costs of transport in three ways:

- Avoidance of HGV trips through the optimization of load factors, destination choice and warehousing.
- Mode shift to more environmentally friendly options, such as rail and shipping.
- Improvement of the remaining truck trips by the purchase and use of more environmentally friendly vehicles.

The most recent review of the external costs of truck transport is provided by CE Delft on behalf of T&E (Schroten and Aanink [2016], see also T&E [2016]). They find environmental, social, congestion and infrastructure costs of trucks in the EU member states ranging from 119 to 167 billion Euros for the year 2013. The largest part (57 billion Euros) is due to infrastructure construction and wear and tear costs, followed by congestion with 27 to 44 billion Euros. The classical components of external costs, i.e. air and climate emissions, noise and accidents account for around 52 billion Euros out of a total of 143 billion Euros.

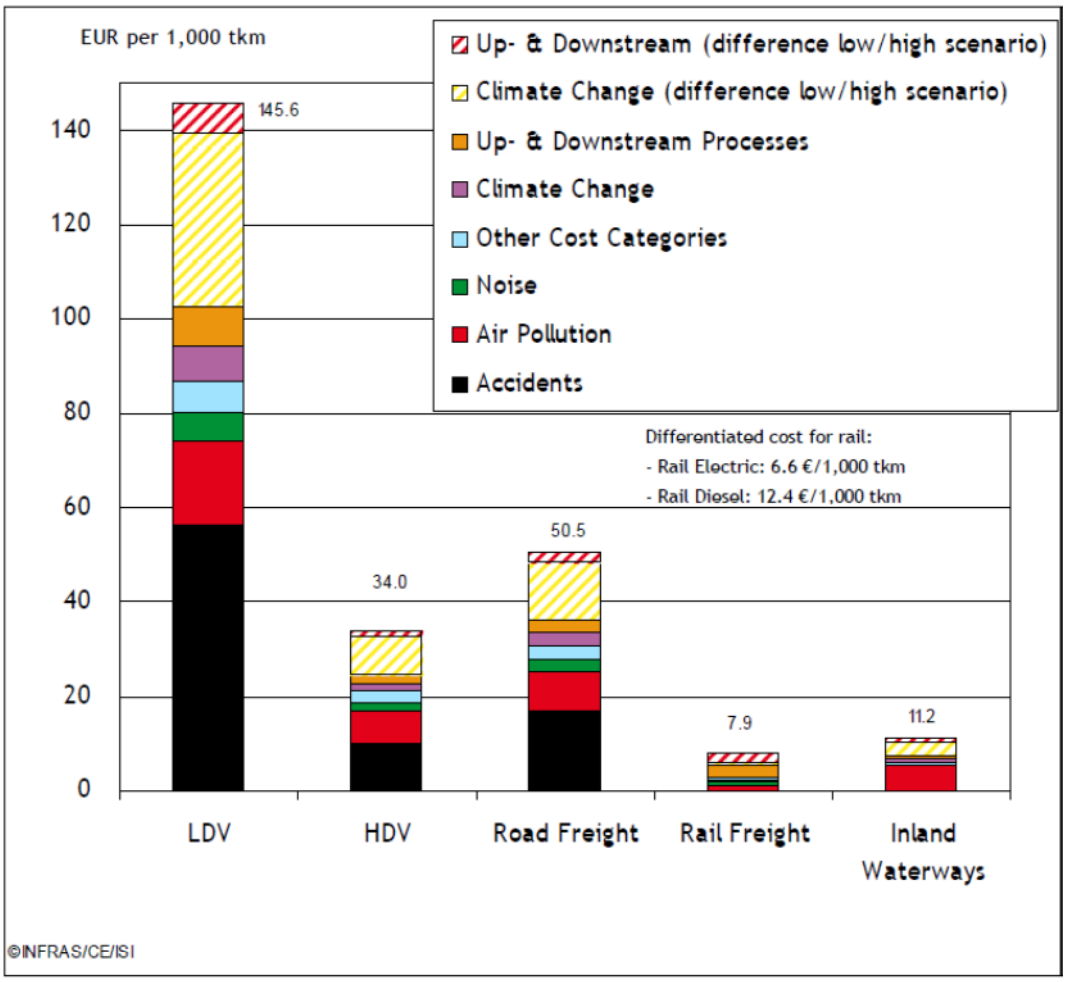
Table 22: Truck external costs in the EU28 for 2013

Cost Category	Average	Min.	Max.	Share
Air pollution	15	15	15	10%
Climate change	17	2	31	12%
Upstream emissions	4	3	5	3%
Noise	2	2	2	1%
Accidents	14	14	14	10%
Congestion	36	27	44	25%
Infrastructure	57	57	57	40%
TOTAL	144	119	167	100%

Source: figures from Schroten and Aanink (2016)

The CE Delft report “External costs of Transport in the EU, Update 2008” (van Essen et al., 2011) constitutes the 4th edition of the external cost studies for the International Union of Railways (UIC). It copes with all modes of transport, providing total and average cost figures. For trucks, average costs between 24.6 and 34.0 €/1000 tkm are computed, whereas the railways range between 5.3 and 7.9 €/1000 tkm. Total costs range between 26.7 and 42.7 billion Euros, and are thus quite lower than the 52 billion Euros estimated with the classical externalities in Schroten and Aanink (2016). If taking heavy and light trucks together and with regard to changes in unit costs over time, these differences can be explained.

Figure 50: Average external costs for EU27, Switzerland and Norway 2008



Source: van Essen et al. (2011)

The EC has, on request of the European Parliament, conducted two studies on the level of external costs of transport in Europe: the IMPACT study (Maibach et al., 2008) and the update of the IMPACT handbook by RICARDO-AEA (Korzhenevych et al., 2014). The 2008 edition of the handbook and its 2014 update provide and discuss details of recent studies on transport externalities without suggesting new approaches and values. For most cost categories, the figures presented can be traced back to the early studies by INFRAS, IWW and Fraunhofer-ISI for the UIC.

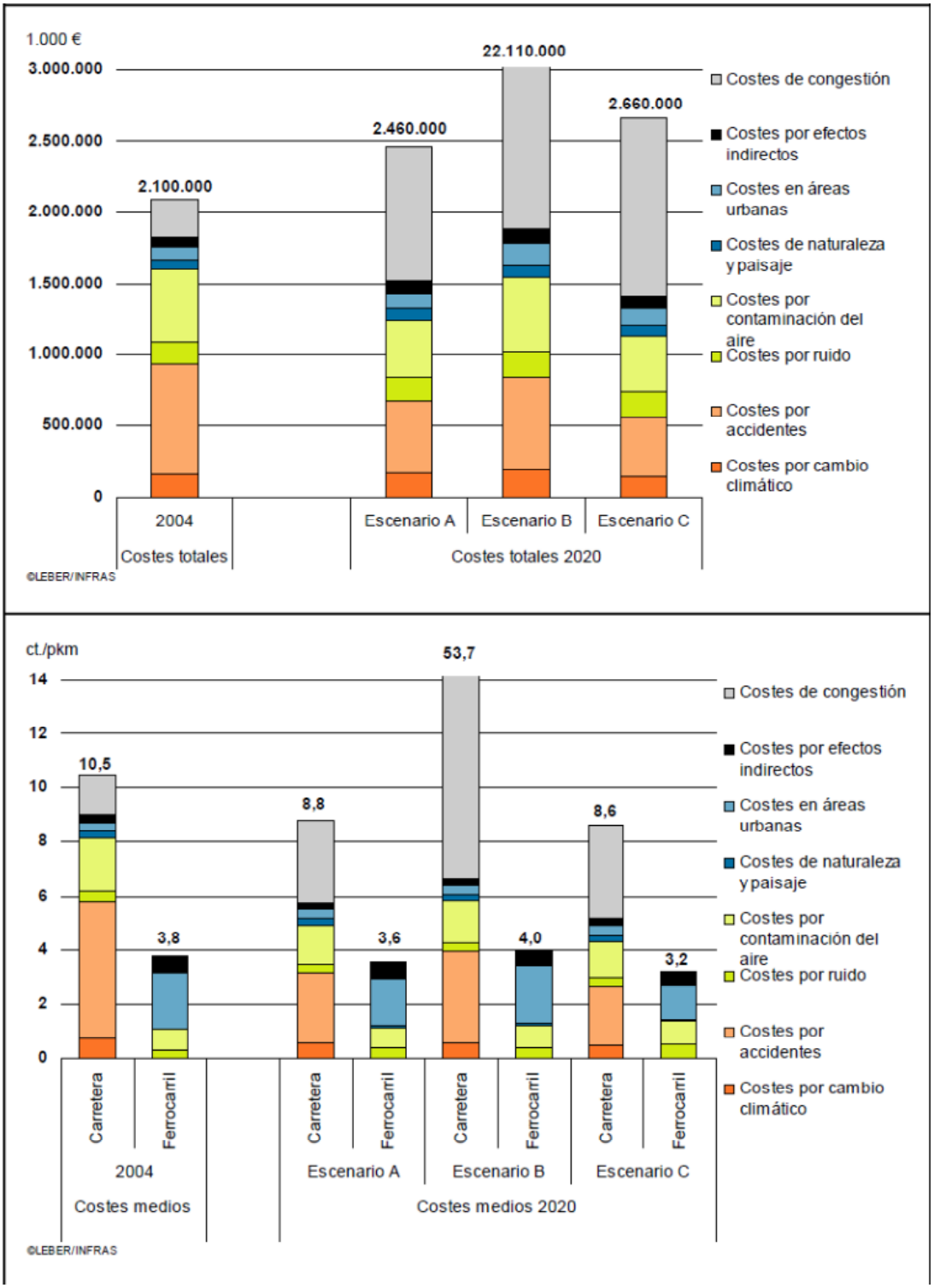
A study by the Technical University of Dresden (Becker et al, 2012) reviewed the literature on the external costs of car use in Europe. The authors challenged the low estimates of climate impacts by the EC handbook by saying that the statistical evidence on damage and avoidance costs justified values even beyond 200 Euros per tonne of CO_2-equivalent.

An overview of sustainability concepts and options for operational indicators is given in Deliverable 2.3 of the LivingRAIL study (Fiorello et al., 2013). Moreover, there are specific reports on external costs for Germany, Spain and other EU member states. On behalf of the German pro rail alliance, Allianz pro Schiene, Schreyer et al. (2007) have updated the UIC Study on the external costs of transport in Europe of as of 2004 for Germany and the base year 2005. The same authors (Schreyer et al., 2010) have looked at the external and private costs, revenues and subsidies of travel along various travel distances in order to identify suitable break-even points for each mode of transport in passenger travel on behalf of the initiative Air Transport for Germany. Latest methodological updates and unit cost estimates for transport, energy production, industry and households are provided by the methodological convention on estimating environmental costs by the Federal Environment Agency (UBA). While Schwermer (2012) summarizes the findings of the second edition, the third edition of the convention kicked-off in 2015.

Specifically for Spain, Leber and INFRAS (2006) have applied the methodology in Schreyer et al. (2007) to the Basque country. The study considers current costs at 2004 prices and three potential development paths of total and average external costs for road and rail transport in 2020 for passenger transport. Freight transport is not considered. Nonetheless, in order to provide an impression of the high uncertainty associated with the estimation of external costs, in particular on a limited local scale, Figure 51 presents the following results.

In the following elaboration, we concentrate on the recent international studies, i.e. latest work by CE Delft for Transport and Environment, the 2011 UIC update study and the 2014 update of the EC handbook on external costs.

Figure 51: External costs of road and rail passenger transport in the Basque country 2004 and 2020



Source: Leber and INFRAS (2004)