DOES PASSENGER TRANSPORT MODES INTERNALIZE THE EXTERNAL COST THEY PRODUCE? THE CASE STUDY OF THE MADRID-SEVILLE CORRIDOR

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ABSTRACT

The objective of this paper is to evaluate how much interurban passenger transport modes internalize the external costs they produce in order to calculate the efficient charge that the users would have to pay. This analysis is relevant since it affects the competitiveness of the different transport modes in the corridor. For this research the case study of the Madrid–Seville corridor in Spain has been chosen since several transport modes compete in this origin-destination pair. The research carries out a balance between the marginal external costs per user produced by each transportation mode and the charges that the users currently pay. The gap between the social marginal cost and the fare paid by the users will give us the extra–charge per passenger that each transportation mode would have to pay to internalize the external cost they produce. We found that that, unlike what many people think, the rail mode does not internalize all the external cost it produces whereas the road modes do it. This happens because even though the road modes pollute more, they also pay much more due to large discriminatory fuel taxes.

Keywords: transport externalities, High Speed Rail, road transport, transport charging, Madrid-Seville corridor

1. INTRODUCTION

Microeconomic theories state that the internalization of the external costs produced by different transport modes is a need to maximise social welfare (Pigou, 1920). The European Union has progressively moved towards this approach, particularly regarding heavy goods vehicles. The EU White Paper "European Transport Policy for 2010: Time to Decide" (European Commission, 2001) linked for the first time sustainability to transport pricing approaches. Until the publication of this paper, pricing policies were mostly based on covering the infrastructure cost (Timothy, 1992).

From 2001 onwards, the European Union has shown a much greater interest in facing the internalization of the external costs produced by transport. With this objective, the first question of the EU has been that of calculating the external costs of different transport modes. During the last few years, several studies and methodologies have been proposed for computing such costs. However, Quinet (2004) shows that the results from different studies are substantially different. Consequently, no consensus seems to exist among the scientific community regarding the quantification of such cost.

In order to have a set of guidelines to quantify the external costs of transport, the European Union asked the University of Delft to develop a computation methodology that might be applied to all the member states (Maibach et al., 2008). These guidelines focussed its attention on freight transport since the European Commission was not concerned about pricing interurban passengers transport modes.

The objective of this paper is to determine, taking into account the case study of the Madrid-Seville corridor, to what extent passenger transport modes internalize the external costs they produce. This paper is organised as follows. In section 2 a description of the state-of-the art on the internalization of external costs is reported. Section 3 describes the methodology adopted, while in section 4 the case study of the Madrid-Seville corridor is presented. In section 5 conclusions and further perspectives are reported.

The methodology of this research is based on a similar research study conducted previously by the transport research center TRANSyT of the Technical University of Madrid (Vassallo, Solís García; Pérez-Martínez and Pérez de Villar, 2005). They developed an economic balance of external costs vs. users' fees for different freight transport modes in Spain.

The most relevant finding of this paper is that unlike what many people think, the rail mode does not internalize all the external costs that it produces whereas the road modes do it. This happens because even though the road modes produce more pollution, they also pay much more. This happens because road modes are subjected to high fuel taxes that are not applicable to the rail mode.

2. INTERNALIZATION OF EXTERNAL COSTS FOR TRANSPORT MODES IN EUROPE

Since 1971 the European Union has been trying to establish a policy on pricing the infrastructure use. However, the strong opposition from some member states and road haulers to this policy stopped its progress for a long time (Vassallo, 2001). In 1998, the European Commission came back with the publication of the White Paper entitled "*Fair payment for infrastructure use: A phased approach to a common transport infrastructure charging framework strategy in the European Union*" (European Commission, 1998). This paper recommended that the member states should carry out a progressive harmonization of fee-charging principles for all the commercial transport modes by proposing an approach based on the "user-pay" principle.

Even though many of the objectives of the White Paper were not fully met due to the opposition of the member states, its publication brought some changes in the legislation. The Directive 1999/62 on "The Charging of Heavy Goods Vehicles for the Use of Certain Infrastructures (known as "Eurovignette" Directive)" passed a short time later. However, this Directive did not represent a great advance. Its main contribution was the implementation of a minimum tax rate on the ownership of those vehicles that had an authorized maximum gross laden weight of over 12 tones. This Directive also established that trucks should not be subject to fees in addition to whatever tolls they had to pay on toll-roads.

The White Paper "*European transport policy for 2010: time to decide*" published in 2001 (European Commission, 2001) represented an important milestone in the European transport policy. Its main objective was to put a new focus on sustainable transport and global strategy by gradually decoupling economic from transport growth (Pahaut and Sikow, 2006). Regarding road fee-charging, the White Paper reinforced the principle of paying for infrastructure use as a way of internalizing external transport costs, and announced the Commission's intention of proposing a Directive on charging fees for the use of road infrastructure. The mid-term review of the White Paper conducted in 2006 (European Commission, 2006) paid special attention to the possibility of modifying upward fee-charges in environmentally sensitive locations and urban areas.

The latest legislative advance in infrastructure fee-charging policy in the European Union has been the approval of the Directive 2006/38/EC amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructure. The Directive establishes that such fee-charges are to be applied in all the EU countries to commercial vehicles over 3.5 tones in the Trans European Transport Network and roads to which traffic can be diverted by 2012. However, the member states can exempt trucks below 12 tons from such payment if such fees would create significant adverse effects or transaction costs are higher than 30% of the revenues produced. Member states are free to impose fees for the use of the roads other than the trans-European Networks.

According to the Directive, charges can be implemented depending on distance, location of the road, damage to the pavement, EURO classification of the vehicle, time of the day, and congestion on the road. Revenues from HGV charges should be used for the maintenance of the infrastructure concerned and for the transport sector as a whole, in order to promote sustainable development of transport networks. The Directive set up the principles to charge fees to HGVs, but it does not yet establish the specific minimum charge to be applied. In this respect the Directive entrusted the European Commission with the mandate to present, no later than June 2008, a "generally applicable, transparent and comprehensible model" for the assessment of all external costs, a model which is intended to serve as the basis for future calculations of infrastructure charges. Owing to this, the Commission entrusted to a group of universities and research institutes the task of producing a guide to assess external transportation costs. At the time of writing this paper, a draft of this guide had already been completed but the final version of the document was not yet available. Regarding discriminatory fuel taxes, the Directive says that any future decision on setting up charges should take full account of the tax burden already borne by road haulage companies, including vehicle taxes and fuel excise duties.

Several aspects of the Directive draw our attention to the implementation of the infrastructure fee-charging policy in the European Union. First, while the initial steps towards the implementation of this policy considered all transportation modes, including private cars and coaches for the road, Directive 2006/38/EC talks only about Heavy Goods Vehicles, leaving aside other transport modes such as rail, air, and maritime transportation, as well as other vehicles such as cars and coaches. This omission seems to work against allocative efficiency and modal fairness. Second, the Directive does not say anything about the application of subsidies to other transport modes, as happens with railroads in many European Countries.

In its resolution of 11 March 2008 on sustainable European transport policy, Parliament urged the Commission to come up with a strategy for implementing charges to internalize external costs in all modes, and to prepare legislative proposals starting with a review of the current Directive. As a response to this called, the Commission submitted a strategy to internalize external costs (COM (2008) 435 final) along with a proposal to amend the current Directive (COM (2008) 436 final). Even though the strategy focused on internalising the external costs of all transport modes, the Directive refers only to implementing charges in heavy goods vehicle. Nothing is said either about passenger transport modes. The new Directive proposal, not yet passed, seeks to establish a framework which enables Member States to calculate and vary tolls on the basis of the costs of traffic based pollution and of congestion in a way compatible with the internal market. Such charges will encourage transport operators to use cleaner vehicles, choose less congested routes, optimise the loading of their vehicles, and ultimately make more efficient use of infrastructure.

3. METHODOLOGY TO ASSESS THE INTERNALIZATION OF EXTERNAL COSTS

A methodology traditionally used to asses whether the external costs produced by a transport mode are internalized or not consists of comparing the external marginal cost produced with the infrastructure charges paid by each transport vehicle (car, bus, train, plane and so on). This approach assumes that each transport mode covers all their internal costs or in other words, that the transport mode is not subsidized. If a transport mode were subsidized, subsidies would have to be subtracted from the charge side of the economic balance.

However, in this paper we are going to use a different approach (Fig. 1). Instead of paying our attention on the vehicle (train, car, plane and so on), we are going to focus on the user. Each user can be attributed a certain transport cost derived from her/his trip. For public transport modes, such as railways or buses, the only internal cost that the users bear is their personal time. Other costs, regardless they are or are not external for the transport operator, are not directly paid by the users so they are external costs for the users. However, in exchange for the service provided, the user has to pay a user fare to the public transport company. Consequently, in order to estimate whether external costs are internalized or not for public transport modes, we are going to compare the external cost attributed to the user with the fare the users pay.

Taxes are considered costs for this analysis—the costs of funding the public sector—as long as taxes are not discriminatory. For instance, income taxes or added value taxes are not discriminatory since they are equitably implemented over all transport modes. However, fuel taxes are discriminatory since, at least in Spain and in many other European countries, they are applicable only to the fuel used by road vehicles, but neither to the fuel nor to any other energy source used by railways, planes or vessels. As a consequence of that, we consider that discriminatory taxes are a hidden charge applicable to road vehicles (car and buses).

Unlike public transportation users, private car users pay most of the transport operation costs they produce: fuel, depreciation, repairs and so on. In this case, the user of the service coincides with the owner of the transport vehicle, therefore all the investment, maintenance and management costs, including the fuel, are internal as they are paid by the user of the service itself. The only costs which can be considered external are the costs the users do not pay: pollution, noise, congestion, climate change and accidents. In the case of the CAR mode, external costs are internalised by paying taxes, specifically fuel taxes. For this reason we compare the external cost cars produce with the hidden charges that cars pay because of the existence of discriminatory fuel taxes.

PUBLIC TRANSPORT MODE (BUS, TRAIN)			**PRIVATE TRANSPORT MODE (CAR)**	
MARGINAL EXTERNAL COST PER USER		AVERAGE CHARGE PER USER	MARGINAL EXTERNAL COST PER USER	AVERAGE CHARGE PER USER
EXTERNAL COST FOR THE COMPANY	Congestion	Transport fares	Congestion	Discriminatory fuel taxes
	Climate Change		Climate Change	
	Air Pollution		Air Pollution	
	Noise		Noise	
	Accidents		Accidents	
INTERNAL COSTS FOR THE COMPANY				

Figure 1- *Methodological approach*

4. THE CASE STUDY OF THE MADRID-SEVILLE CORRIDOR

We apply the methodology outlined above to the Madrid-Seville corridor case study (see Fig. 2). Four modes compete within this origin-destination pair: CAR, BUS, RAIL and AIR. We do not analyse the AIR mode in this paper because its market share is short and this mode is mostly taken by people who need to connect with other flights in Madrid. Cars and buses use the A4 highway, which is 530 km long. The most important RAIL service available is the High Speed Train (AVE) highlighted in Figure 2 which is 471 km. long and was opened in 1992 (Pérez-Martínez and López-Suárez, 2006).

The analysis of the modal share in the corridor is reported in Table 1.

Table 1 *- Number of users per year*

	CAR	BUS	RAIL	PLANE
Number of users (2007)	1,648,324	227,185	2,520,966	193,920
%	34%	8%	52%	4%

Source: Movilia 2006/2007, RENFE (2007),SOCIBUS s.a. (2007), AENA 2007.

The most used transport mode is the High Speed RAIL with a share greater than 50%. CAR share is 35% while BUS share is only 8%. The low use of the AIR mode is mainly due to the fact that the corridor is not so long and well served by other transport modes (Echeverri, 2001).

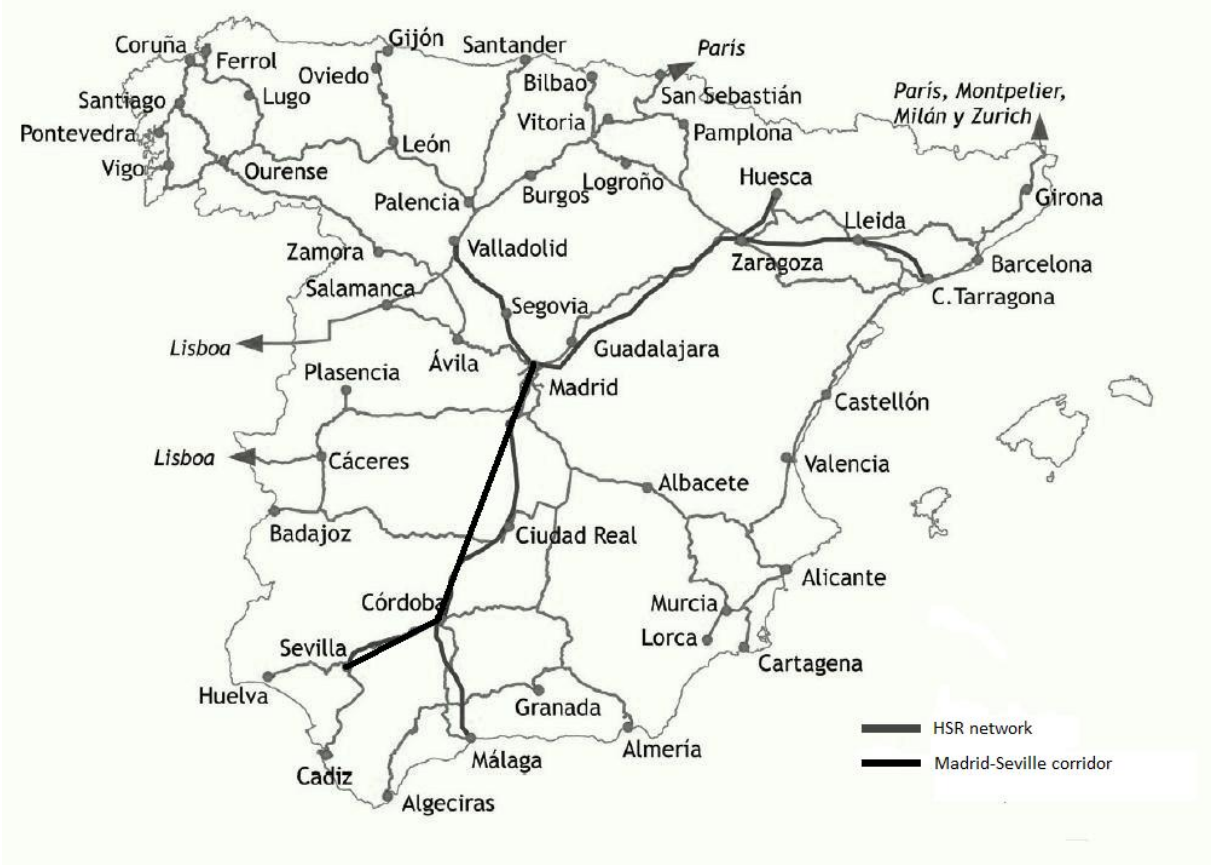

Figure 2 - *HSR Network in Spain*

4.1 Calculation of external costs

The first step has been the computation of the external costs for the different transport modes. In this research, we have adopted the following external costs: congestion, accidents, noise, air pollution and climate change. We have calculated the external costs by implementing the approach of the "Handbook on the estimation of external costs in the transport sector" (Maibach et al., 2008), which was entrusted by the European Commission to the University of Delft. We have used the figures of the manual that better fit the characteristics of the transportation modes and specificities of the corridors that we analyze. For instance, for the CAR mode, the average occupancy is 1.4. Regarding the calculation of congestion costs, the handbook mentioned above provides a maximum and a minimum figure for interurban infrastructure. In the end, we have decided to utilize the intermediate value. The marginal external costs per user and per trip are shown in Table 2.

It can be noted that the CAR produces much greater external costs that the public transport modes. The greenest transport mode is the High Speed RAIL. The BUS is very efficient in terms of external costs because it has a very high occupancy rate. In this corridor, buses carry on average 45 passengers each.

***Table 2** – Marginal external costs per users per trip (€)*

	CAR	BUS	RAIL
CONGESTION	0.379	0.041	0.005
ACCIDENTS	1.401	0.043	0.005
NOISE	0.038	0.008	0.069
CLIMATE CHANGE	1.514	0.173	0.349
AIR POLLUTION	0.704	0.500	0.097
TOTAL	4.036	0.765	0.525

Source: analysis of the authors

4.2 Economic balance

Piguvian taxes should equal marginal external costs, but they should do so at the optimal output level. However, as we do not know the optimal output level, once the externalities have been computed, we are going to evaluate whether the CAR, the BUS and the RAIL internalize the external costs they cause at the current output level. To that end, we calculate the gap between the marginal external costs per user and the average fare or charge per user for each transport mode. As we mentioned earlier, discriminatory taxes are considered charges paid by the users. For the calculation of marginal costs we did not consider costs, such as infrastructure investments, which remain fixed in the long-run when demand increases.

Economic balance for CAR

CAR is a private mode. Users of cars are mostly owners of the vehicles they drive; therefore all the internal costs related to the CAR usage are borne by them. Consequently, to evaluate the internalization of external costs, we have to compare the marginal external costs that they do not bear with the charges applicable to them. For this reason, we calculate only external costs. To that end, we have evaluated pollutant emissions, noise, accidents and climate change computed through the Handbook made by the University of Delft for the European Commission. We do not consider wear and tear costs for the CAR because the damage caused by cars to the pavement is negligible compared to other vehicles (Small et al. 1989).

These costs are balanced with the charges the users pay. Car users pay no direct tolls since the corridor is free of toll. Discriminatory fuel taxes are the only charge paid by them. In Spain, there are two types of fuel taxes: "*Impuesto Especial sobre Hidrocarburos (IEH)*" and "*Impuesto sobre Ventas de Minoristas de Determinados Hidrocarburos (IVMDH)*".

The former is an indirect tax based on the quantity of acquired fuel and it bears upon the production, the import and introduction in the Spanish market of given fuels. This tax has a direct impact on the final consumer. The latter was introduced by the law 24/2001. This tax is

also an indirect tax on the quantity of purchased product and it bears upon the retailing of the product subject to the IEH. The imposed tax is made up of two rates: the national one, which is always present, and that of the regional governments, which have certain freedom range to decide the tax to charge. These taxes are both subjected to a 16% of value added tax (VAT). The percentage of VAT corresponding to the fuel taxes is also a discriminatory tax.
The economic balance for the CAR mode is reported in Table 3.

***Table 3** – Economic balance for the CAR mode (€ per user per trip)*

EXTERNAL MARGINAL COSTS		CHARGES	
Congestion	0.379	IVMDH	1.778
Accident	1.401	IEH	16.420
Noise	0.038	VAT	2.911
Climate change	1.514		
Air pollution	0.704		
TOTAL	4.036	TOTAL	21.105

Source: analysis of the authors

It is worth noting that, even though the CAR is the most pollutant mode, the charges the CAR users pay through discriminatory—but not necessarily with distortionary—fuel taxes outweigh by far the external costs they produce. This result looks striking, because claims that car users are overcharged in this corridor. The reason for that is that fuel taxes are much higher than the external cost produced by them. This conclusion also holds when taking into account infrastructure capacity costs since congestion costs, which reflect the capacity constraint of the infrastructure, are also included in the computation of the external marginal costs.

Economic balance for BUS

The BUS is a public transport mode whose service is provided by a private company through a franchise awarded by the government. For the analysis of this mode, we are going to focus on the users to whom all the costs, except his time, are external.

The company that owns the franchise to operate the service in the Madrid-Seville corridor is SOCIBUS. This company has facilitated to us the economic and management data necessary to carry out the analysis. The average ticket cost for the link under study is €19.40 and the average occupancy of the vehicles is 45 out of 52 seats, which is a high occupancy. For the computation of the management costs, we have contrasted the results provided by SOCIBUS with the outcome of the ACOTRAVI software (version 1.0.1)[1] available at the website of the Ministerio de Fomento of Spain. The use of this software has enabled us to double check the results.

[1] www.fomento.es

Unlike cars, infrastructure wear and tear costs have been introduced for the BUS, since they are not negligible (Di Ciommo F. et al., 2008). Discriminatory fuel taxes are paid by the bus company to the government. Consequently, the bus company pass this tax on the users through the fare charged to them. Fuel taxes are hence incorporated implicitly in the value of that fare. These taxes are not considered a cost in the balance since they are discriminatory.

Table 4 – *Economic balance for the BUS mode (€ per user per trip)*

EXTERNAL MARGINAL COSTS PER USER			CHARGES	
INTERNAL COSTS FOR THE COMPANY	Amortization	1.645	Fare	19.400
	Drivers' salary	3.053		
	Maintenance	0.659		
	Tires	0.159		
	Vehicle Financing	0.575		
	Staff	1.216		
	Fiscal costs	0.082		
	Insurance	0.690		
	Indirect costs	2.054		
	Fuel (without discriminatory taxes)	1.313		
	VAT	0.210		
EXTERNAL COSTS FOR THE COMPANY	Wear and tear	0.140		
	Congestion	0.041		
	Accident	0.043		
	Noise	0.008		
	Climate change	0.174		
	Air pollution	0.500		
	TOTAL	12.561	TOTAL	19.400

Source: analysis of the authors

The main outcome is that the BUS mode internalizes by far all the external costs produced by it. The reason of this gap lies in the fact that fuel taxes are much greater than the external costs produced by the BUS mode.

Economic balance for RAIL

The approach used to assess the economic balance for the RAIL mode is the same as the one conducted for the BUS mode. The high speed rail service is provided by RENFE, which is the national Spanish rail company. Unlike the BUS mode, the RAIL mode is not subjected to any kind of discriminatory tax.

The external marginal costs have been computed considering the data provided by RENFE itself in its 2007 annual report. It is necessary to underline that since RENFE does not own the infrastructure for the service, it has to pay a fee to the rail infrastructure company (named

ADIF). This fee is higher than the wear and tear costs produced by the trains. Approximately 30% of this charge represents the infrastructure wear and tear costs. The average ticket price in 2007 to travel from Madrid to Seville was €40.485. The RAIL economic balance is reported in Table 5.

Table 5 *– Economic balance for the RAIL mode* **(€)**

EXTERNAL MARGINAL COSTS PER USER			CHARGES	
INTERNAL COSTS FOR THE COMPANY	Staff costs	6.971	Fare	40.485
	Other materials and services	14.562		
	Information System	0.510		
	Risk prevention	0.203		
	Others	1.041		
	Common cooperative center (before amortization and interests)	1.356		
	Interest and financial charges	2.603		
	Common cooperative center (after amortization and capital equipment)	0.186		
	Amortization and cost of the immobilized capital	4.766		
	Change in estimates for repairs	0.125		
	Moving expenses	5.039		
	Integria[2]	3.286		
	Energy Traction	3.238		
EXTERNAL COSTS FOR THE COMPANY	Wear and tear cost	3.080		
	Congestion	0.005		
	Accident	0.005		
	Noise	0.069		
	Climate change	0.349		
	Air pollution	0.097		
	TOTAL	47.516	TOTAL	40.485

Source: analysis of the authors

We found that, unlike the CAR and the BUS, the rail mode does not internalize the external costs they produce since the charge per user is lower than the marginal cost per user. The reason for that lies in two facts. First, the rail mode hardly covers its internal costs because it is subsidized by the public sector. And second, this mode does not pay any charge through discriminatory taxes.

[2] Rail maintenance and repair, with criteria of efficiency and competitiveness with the foreign sector.

5. CONCLUSIONS AND FURTHER PERSPECTIVES

This paper shows that the external marginal costs produced by BUS and CAR are higher than those produced by the High Speed RAIL, so we can claim that the High Speed RAIL is the cleanest of all the surface modes. However, road modes (CAR and BUS) internalize their external costs while High Speed RAIL does not do it. This happens for two major reasons: first, road modes are largely charged through discriminatory fuel taxes and secondly, High Speed RAIL is subsidized.

The main outcome of this paper is that, unlike the general though, road modes seem to internalize their external costs in non-congested interurban corridors while High Speed Rail does not. This does not contradict the fact that RAIL is the cleanest of all the transport modes. The results of this paper show that the competition between road and rail in the Madrid-Seville corridor is distorted, so allocative efficiency is not achieved. Results like this show that the European Union should not carry out a charging policy without a comprehensive analysis of the effects of discriminatory fuel taxes across different transport modes.

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