

Internalisation of external costs of transport in Flanders

Delhaye, E I^{*ab}, De Ceuster, G^a, Vanhove F^a, Maerivoet, S^a

^a*Transport & Mobility Leuven, Diestsesteenweg 57, 3010 Leuven, Belgium*

^b*KU Leuven, 3000 Leuven, Belgium*

Abstract

In this study we calculate the private costs, marginal external costs, and degree of internalization for all modes in Flanders for the period 2000-2014, with an outlook towards 2016. The private costs are the costs for the user. For road transport these include the vehicle purchase costs, insurances, maintenance, fuel costs, etc. For transport services (bus, train, plane) this is the ticket price. Marginal external costs are the costs the user does not take into account when deciding to make a trip. They are called marginal as we focus on the additional effect of that one trip. We considered congestion, environment (air pollution and greenhouse gasses), noise, safety, infrastructure wear & tear and health.

The internalization of external costs determines the extent to which the user does take into account part of these external costs via taxes and levies. In the case of full internalization, the user pays for all the costs he causes via taxes and levies. Today, in most cases, the user does not pay the full costs he causes.

Based on our calculations we assessed the evolution of the degree of internalization over time. Is Flanders heading towards the “polluter pays principle”? Which steps are needed to evolve to a better pricing? We found that over the years the level of internalisation is mainly driven by changes in external costs rather than by a targeted adjustment of taxes. Recent changes in taxation such as the changes in the car registration tax, the yearly road tax and the km charge for trucks did lead to an increase in internalisation, but we are still far from full internalisation. Moreover, it would be better to differentiate taxes not only on environmental performance but also on time and place. The levels of internalisation are also very different – not only between modes but also within the road mode.

Keywords: external costs, internalization, private costs, road, bike, air transport, shipping, rail

* Corresponding author. Tel.: +32 16 74.51.22.
E-mail address: eef.delhaye@tmlleuven.be

1. Introduction

This article is based on Delhaye, E. et. al. (2017). It discusses the private costs, the external costs and the level of internalization of transport in Flanders for the period 2000-2014, with an outlook towards 2016. We first describe in more detail how the external costs and private costs were calculated. Next, we discuss the level of internalization, its importance and its evolution over time.

2. Which external costs are considered?

In this study, we consider the following external costs: costs caused by noise, congestion, accidents, damage to infrastructure, and environmental costs. In some cases, there are also external benefits such as the health benefits of cycling. Figures 1 and 2 below show the different marginal external costs for different modes and fuel types per 100 passenger-km for passenger transport and per 100 tonne-km for freight transport.

The marginal external congestion costs are the additional time costs² caused by a road user to other road users by driving an additional vehicle kilometre. The user's own time costs are not part of the marginal external congestion costs. These external costs are particularly high during peak hours and in urban areas. The congestion costs in the figures are averaged over peak and off-peak and over all road types. The figures also clearly show that the congestion costs account for the major share of the external costs for passenger cars and lorries. For public transport there exists another cost of congestion i.e. discomfort caused by crowding. This is not included in the calculations.

The marginal external environmental costs are the costs due to climate change (CO₂, CH₄ and N₂O) and air pollution (SO₂, NO_x, NMVOC, heavy metals, PM_{2,5} and PM₁₀). The non-exhaust emissions of PM and heavy metals are also taken into account in the calculation of the marginal external environmental costs – as are the indirect emissions³. They are calculated as the product of the different emission factors⁴ (in kg/km) with the respective monetary valuations⁵ (in euro/kg). For maritime shipping, we assume that not all emissions which happen on the North Sea reach the main land, leading to lower damage costs of emissions from maritime shipping. The figure shows that the share of the marginal external environmental costs (as a consequence of emissions) in the total external costs decreased between 2000 and 2014.

The marginal external noise costs are very low for all modes, both in absolute and relative terms. The methodology used is based on Ecorys (2005), the impact is based on Dekonink, L. (2016) and the valuation on Standaardmethodiek MKBA transport.

The marginal external accident costs of road transport are the additional accident costs for society due to a road user driving an additional kilometre. The damage costs covered by the insurance of the vehicle are not included in these external costs. The methodology is based on Lindberg (2006), while the monetary values are based on HEATCO and GRACE. The accident risk is calculated using national statistics. Especially motorcyclists have high marginal external accident costs due to their high accident risk, particularly for accidents leading to severe physical damage. Cyclists also have relatively high accident costs, mainly as a consequence of their relatively high accident risk – although they have a much smaller “external” part. Lorries are, per driven kilometre, relatively less involved in accidents. However, a larger part of the accident costs are external for lorries as the probability that the lorry driver himself gets hurt is lower than the probability that the other party in the accident

² Values of time uses are based on KIM (2013) and Federaal Planbureau (2015). The values of time do not evolve over time. The congestion curves were estimated using real travel time data in Delhaye et. al (2017).

³ The indirect emissions take into account the emissions which occur “from well-to-tank”. Hence they include the resource extraction, the distribution, the fuel refining and electricity and the distribution to the vehicle. They do not include the emissions from vehicle production or infrastructure construction.

⁴ Direct emissions of road transport are based on Vlaamse Emissie-Inventaris lucht (VMM). These are based on COPERT 4 v1.1.3 and are based on measures in a “real” driving context. Direct emissions of rail, inland waterways and maritime start from the EMMOSS model and of air transport from the EMMOL model. Indirect emissions are based on CE Delft (2011) and CE Delft (2015)

⁵ For air pollutants based on VITO (2010) and for greenhouse gasses based on Ricardo-AEA (2014).

gets severely injured. For all vehicle types, we see a decrease in the accident risk over the years, leading to a decreasing marginal external accident cost over time.

The marginal external infrastructure costs are the additional costs for maintenance and repair of the road surface, locks, docks, etc., which are dependent on the traffic volume. An additional lorry damages, depending on its axle weight, the road surface to a lesser or greater extent. For passenger vehicles, these marginal costs equal zero as the axle weight is very limited. For lorries, these costs represent only a small portion of the total external costs. Also for the other modes, we see that the marginal external infrastructure costs are relatively low. The methodology for road transport is again based on GRACE. Information on infrastructure costs were taken from De Ceuster (2012). For rail, we used the value given by Munduch (2002), for inland waterways and maritime, we use the values from Schrotten, A. et.al. (2010). For air transport, they are assumed to be internalised via the airport charges.

The marginal benefits of health are unique for cyclists. These benefits are threefold: improved health for the cyclist in the form of avoided early death and/or increase in quality of life, savings for the social security system, and increase in productivity due to lower absence rates. They were calculated in Delhaye et.al (2017) on the base of a literature review.

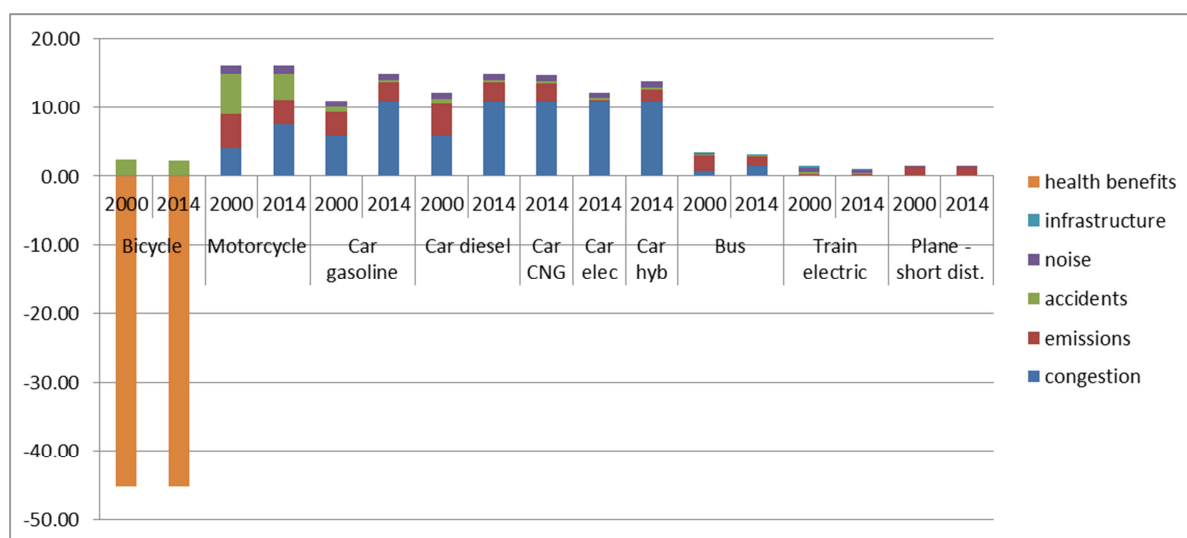


Figure 1: Marginal external costs of passenger transport (Flanders, 2000 and 2014), euro per 100 passenger-km. Source: TML

When we focus on the differences in marginal external costs between the different modes of passenger transport (Figure 1) we can make the following conclusions. The marginal external costs per passenger kilometre increased over time for passenger cars. For the other passenger modes, they remained relatively constant, for electric rail they decreased. In 2014, the highest marginal external costs (per passenger-km) for passenger transport were for motorbikes, followed by passenger cars. Over time, the marginal external costs for motorcycling remained relatively constant, but the relative shares of the different costs changed. The environmental and accident costs decreased over time, while the congestion cost increased. Cyclists have marginal health benefits. The differences between the passenger cars are relatively low due to the predominance of the congestion costs – even when comparing with alternative fuel passenger cars. The differences that exist are entirely attributable to differences in environmental costs. In 2014, the marginal external costs of an electric car were about 82 % of the external costs of a diesel car. These figures express the marginal external costs per passenger-km, hence transport (bus and rail) and aviation have much lower marginal external costs due to their economies of scale. Hence, the occupancy rate is very important for this comparison. For buses, there is a strong decrease in the marginal external environmental costs, but this is set off by the increase in the congestion costs. For aviation, the most important costs are the environmental costs, and greenhouse gasses in particular. The electric train has the lowest marginal external costs – in which noise has the largest share (41 %).

For freight transport, it is clear that road transport performs worse than rail, inland waterways and maritime transport (Figure 2).

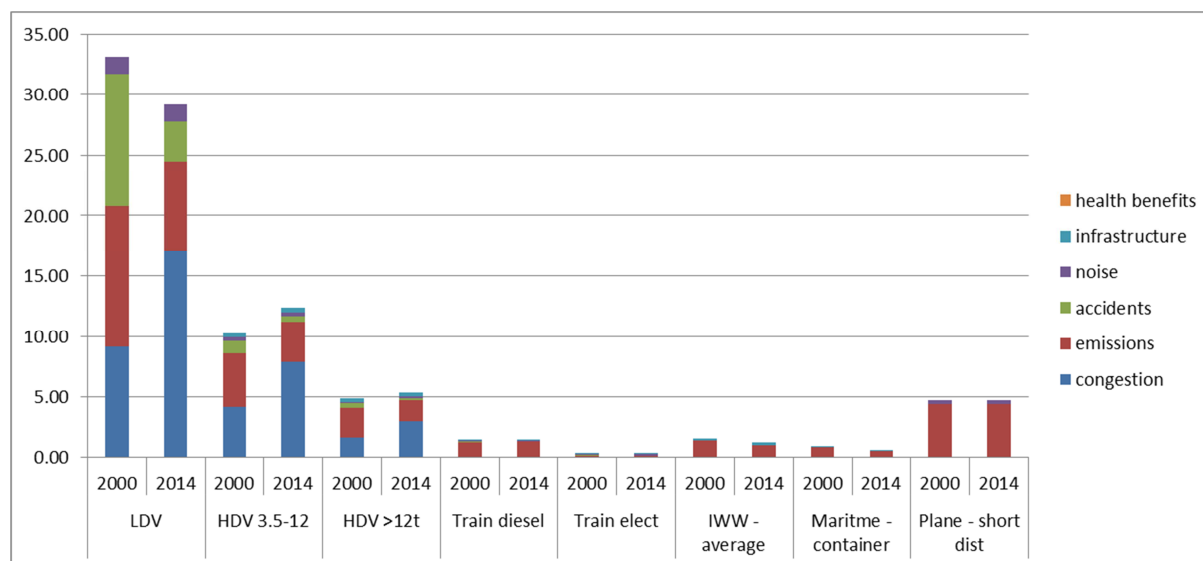


Figure 2: Marginal external costs of freight transport (Flanders, 2000 and 2014), euro per 100 tonne-km. Source: TML

There are two reasons for this. Firstly, congestion plays an important role in the external costs of road modes. This is not the case for the other modes. For heavy-duty vehicles, the marginal external congestion costs represented 55 % to 64 % of the total external costs in 2014; in 2000 this was only one third. Secondly, the very low loading factors for road play a negative role in the comparison. The loading factor for road is below 50 %, whereas a loading factor of 71 % is assumed for inland waterways and maritime transport.

Per tonne-km the light-duty vehicle performs worst due to its low occupancy rate. For this mode, the decrease in accident and environmental costs is notable. This decrease dominates the increase in congestion costs. For heavy-duty vehicles between 3.5 and 12 t the marginal external costs increase due to the increase in congestion; for heavy-duty vehicles >12 t this increase is compensated by the improved environmental performance. The heavy-duty vehicle >12t and short-haul aviation have comparable marginal external costs. Aviation is outperformed by shipping. Electric rail has the lowest marginal external costs.

3. Calculation of the private costs and taxes.

Even today, the user already pays for the use of transport modes. Transport is not for free. There are costs for the user, the so-called private costs (such as the cost of a train or bus fee, fuel costs, vehicle purchase costs, insurance costs, etc.) and there are taxes and levies.

For road transport the costs are calculated in great detail, distinguishing between fuel costs, costs and subsidies when purchasing a vehicle (purchase costs, VAT and taxes), and yearly costs such as the road tax, maintenance, insurance and the Eurovignet (replaced by the kilometre charge in 2016 and hence only included in section 7). Figures 3 and 4 below show the private costs distinguishing between net costs (purchase cost, maintenance, etc. including labour taxes) and taxes (including VAT).

It is clear that electric vehicles are still expensive. Disregarding this type of vehicles, we see that the user pays between 12 and 32 euros per 100 passenger kilometres. The purchase costs and the VAT have the largest share in the total costs a car user has to pay. The difference in purchase price per kilometre is mainly determined by the differences in the number of kilometres people drive with their car. On average, the absolute purchase costs are higher for diesel cars than for gasoline cars, but this is compensated by the fact that diesel cars drive more kilometres due to the lower fuel costs.

Riding a motorbike is more expensive than a car with a cost of about 71 euros per 100 kilometres. The tax level is about the same, but the purchase cost and insurances per kilometre are higher for the motorbike rider.

Taking into account the subsidies, the costs for buses is about -9.18 euros per 100 passenger kilometres. This indicates that buses are over-subsidised as the subsidies are higher than the costs.

For rail, we calculated the costs in detail. Passenger transport via rail only pays 6 % VAT. The difference with the normal VAT rate of 21 % is considered to be an indirect subsidy and hence is added to the other subsidies. It is clear from this picture that rail is heavily subsidized.

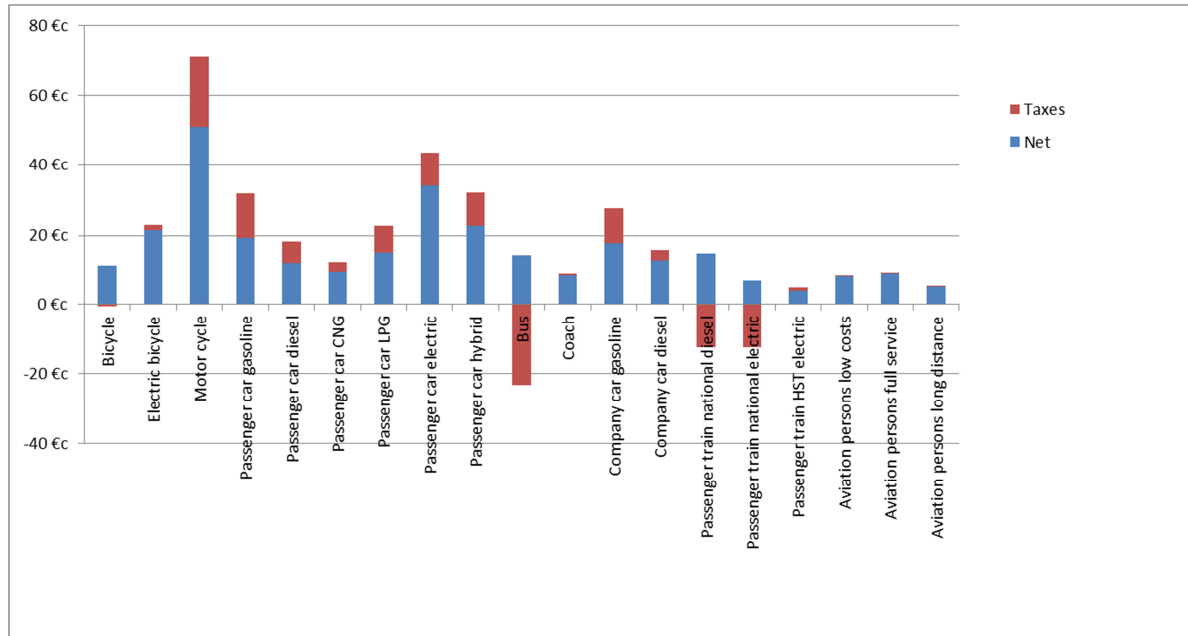


Figure 3: Total price per passenger km in 2014, passenger modes, in constant prices euro2015. Source: TML.

Figure 4 below shows the net costs (including labour taxes) and the transport taxes (including VAT) of freight transport per 100 tonne-km. The cost of road freight transport varies between 11 and 140 euros per 100 tonne-km. For road freight the most important cost element are the labour costs and labour taxes (varying from 37 % of total costs for the heaviest-duty vehicle and about 70 % for the light-duty vehicle). For freight transport the cheapest mode per tonne-km is maritime shipping (with the exception of RoRo), followed by the larger inland waterway vessels.

For inland waterways, the costs for three types of vessels were calculated: “spits” (a small vessel M3 of 350 tonnes), a “European Ship” (an average M5 long Dortmund-Emschanel vessel with an empty weight of 1280 tons) and a large cargo ship (A large M8 Rhine vessel, which can load 200 TEU on 4 layers). We distinguished between fixed costs (personnel costs, costs for maintenance and repair, etc.) and the variable costs such as energy and taxes. The most important costs for inland waterways are the fuel costs and the personnel costs.

For maritime shipping, we distinguish between three types of vessels: RoRo, container and bulk. For the costs, we distinguish between personnel costs, insurance costs, maintenance and repair costs, port costs, fuel costs, etc. For maritime transport, we see more variation with respect to the most important cost categories. Important cost components are again the fuel costs, the capital costs (depreciation and interest costs) and the personnel cost.

For aviation, we distinguish between short and long hauls. With respect to the costs we distinguish between purchase/leasing cost, costs of air traffic control, take-off fees, passenger fees, maintenance, ground services, fuel costs and personnel costs.

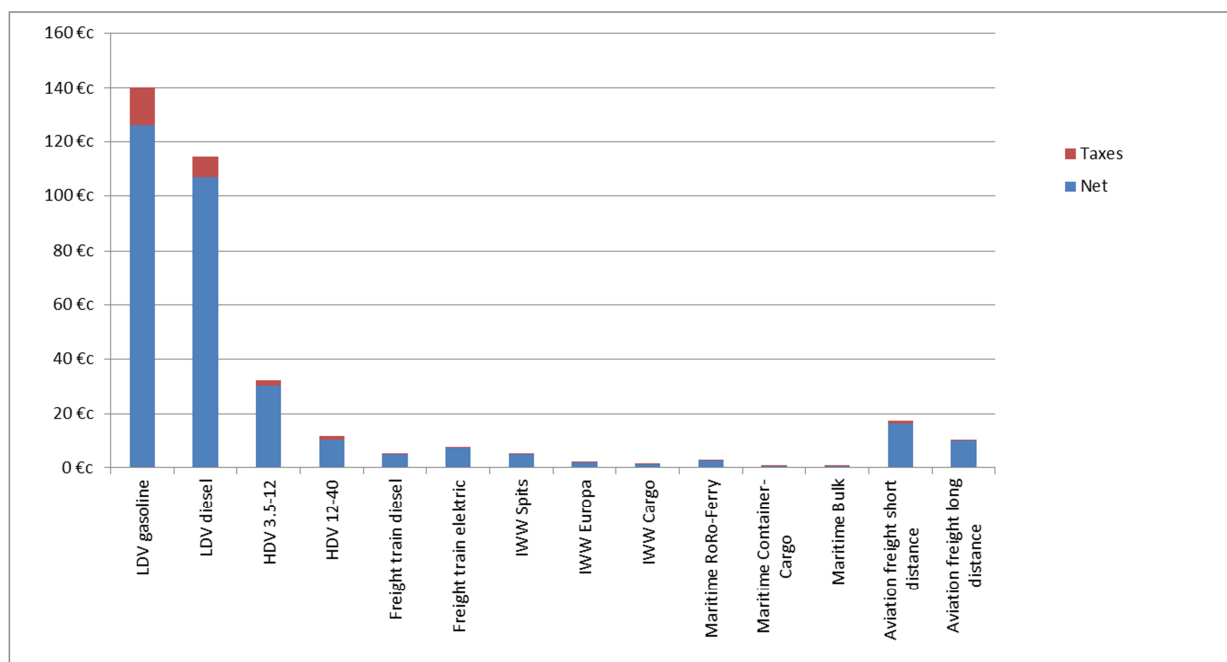


Figure 4: Total price per tonne-km in 2014, freight modes, in constant prices euro2015. Source: TML.

4. What is internalization of marginal external costs?

The transport user is not always aware of the nuisances transport causes. Think for example of air pollution, climate change, noise nuisance, accidents and – for lorries, rail, inland waterway and sea transport – damage to infrastructure. This nuisance causes marginal external costs of transport. These costs are called external as each of these aspects comes at a price, which is not paid directly by the polluter, but by society as a whole. They are, in other words, external to the decision of the user. The user only takes into account his private costs (for example, fuel costs and the price of a train ticket), taxes and levies (for example the annual road tax). They are called marginal as we only consider the additional external costs caused by an additional vehicle kilometre⁶.

Internalization of external costs deals with the question to what extent the user pays for part of these external costs via taxes and levies. Full internalization implies that the user pays for all the costs he causes via taxes and levies⁷. Note that two approaches can be taken. In a first approach, the “polluters pays” principle, all external costs needs to be paid by those who causes it. In this logic one should compare average costs to average benefits. In the second approach, the focus lies on the incentive effects of prices, requiring marginal costs to equal marginal benefits. When marginal does not equal average costs/benefits, the two approaches do not lead to the same result. Note that we take a rather mixed approach as we compare marginal external costs to the average tax level. This means that we somewhat overestimate the level of internalisation.

5. To what extent does the transport user internalize their external costs?

Currently, most users do not pay for the nuisances they cause. Figure 5 below shows the degree of internalization for the different modes examined in this study. The numbers are relative: the sum of all external costs equals 100%. The small grey bars show to what extent the taxes cover the marginal external costs. A negative tax represents a subsidy. For cyclists, the marginal benefits are larger than the marginal costs, so that the sum of external “costs” does not equal 100 %.

⁶ All information is calculated at vehicle level. To come to costs per passenger-/tonkm we divided these costs by the load factor.

⁷ It is also possible to internalize external costs using tradeable emission or mobility rights.

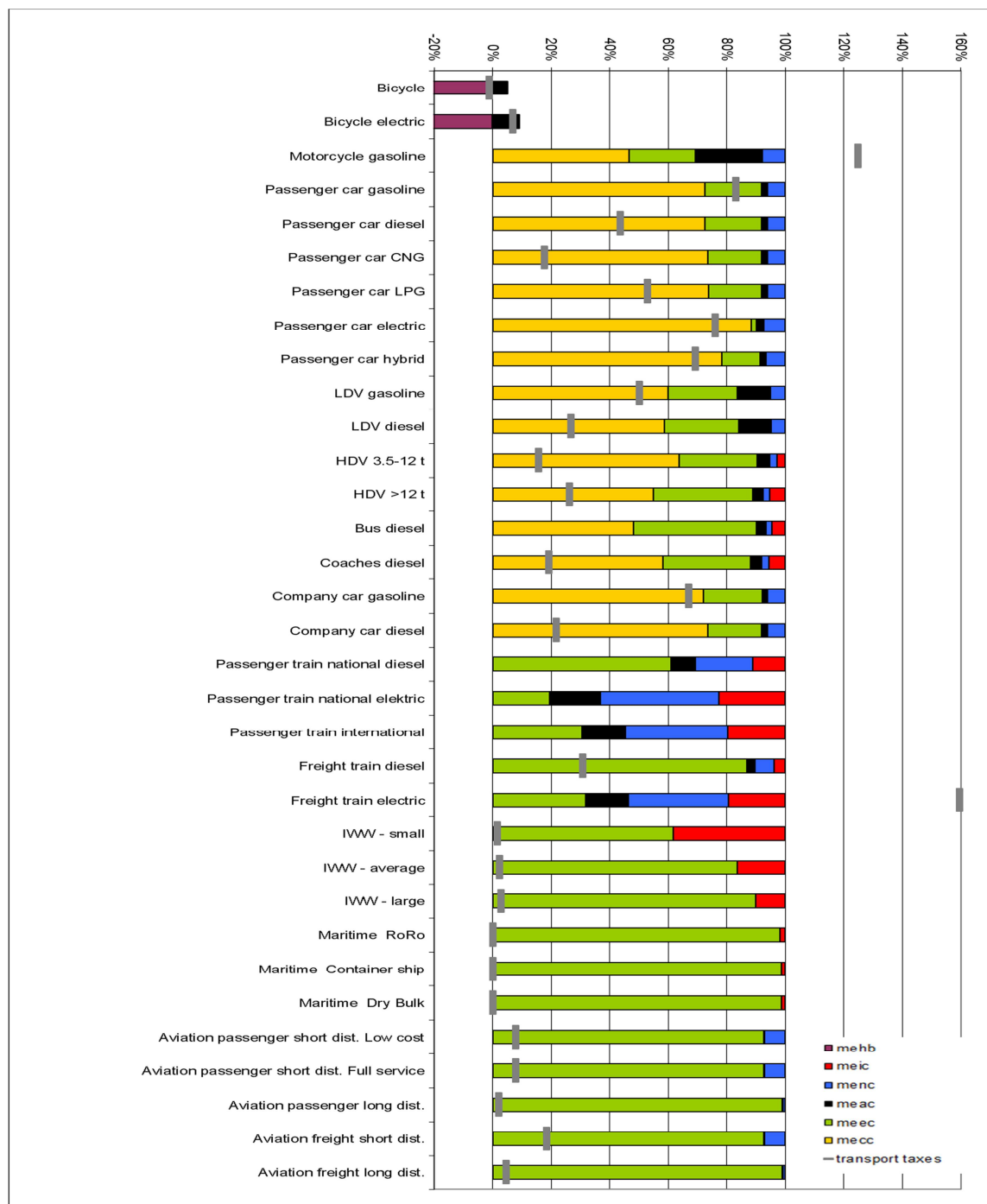


Figure 5: Internalization of external costs for all transport modes, euro per 100 vehicle kilometres (total marginal external costs = 100%), Flanders, 2014. Source: TML

The degree of internalization for the modes bus and passenger train fall outside the scale of this graph. The degree of internalization for bus is -744 %, for passenger train national diesel -540 % and for passenger train electric -1115 %.

- mehb = marginal external health benefit
- meic = marginal external infrastructure cost
- menc = marginal external noise cost
- meac = marginal external accident cost
- meec = marginal external environmental cost
- mecc = marginal external congestion cost

Figure 5 clearly shows that current taxes and levies on transport capture only a portion of the external costs. We find that, in general, the degree of internalization is the largest for road transport, and for motorcycles and passenger cars in particular. The taxes for motorcycles are higher than their external costs. Among the passenger cars, the gasoline car has the highest level of internalization (80 %). Diesel cars only internalize 42 %. Company cars (defined as cars owned by a company but also used for personal purposes) have a much lower level of internalization with only 66 % for gasoline cars and 21 % for diesel cars. Due to its high subsidization, public transport does not internalize its external cost. The subsidies are about 7 times higher than the external costs for buses and about 5 (diesel) to 11 (electric) times higher for rail (national passenger transport). Coaches only internalize 19 %. Air transport for passengers internalizes about 8% on short hauls, and only 2% on long hauls.

For freight transport, the level of internalization for light-duty vehicles varies between 27 % and 50 %, depending on the fuel type (diesel versus gasoline). Heavy-duty vehicles internalize between 15 % and 26 % of their external costs. Rail freight transport internalizes about 30 % (diesel) and even pays more than its costs when electric (159 %). For freight air transport, there is a large difference between short (18 %) and long (4 %) distance transport. For maritime and inland waterways, the degree of internalization is low to inexistent.

6. What is the importance of differentiated taxes for road transport?

For road transport, we can make a further distinction in terms of time (peak versus off-peak hours) and place (motorways, other roads, and urban roads) of transport. On average, the gasoline car does not internalize its external costs. However, gasoline passenger cars pay too much in some situations. This is the case for example during off-peak hours on motorways and in peak hours on “other roads”. Diesel cars, on the other hand, internalize less than gasoline cars. They never pay too much. Company cars – and certainly diesel cars – internalize much less than private owned cars. Within the group of passenger cars using alternative fuels, it is clear that CNG cars are (over)subsidized. Their marginal external costs are very similar to gasoline cars, but they pay far fewer taxes. The level of internalization for cars using alternative fuels lies between that of the diesel and the gasoline car. A similar picture is obtained for lorries. In general, they pay too little, particularly in peak hours on motorways and in urban environments.

This implies that it would be economically optimal to differentiate taxes and levies in terms of fuel type, place, and time of transport⁸. Today, most taxes are dependent mainly on fuel type/environmental performance of the vehicle. In 2016, a start towards a location dependent charge was made with the introduction of the kilometre charge for heavy-duty vehicles (see section 7).

7. How did the level of internalization evolve over time?

Figure 6 shows the evolution of the level of internalization over time for road transport. For most passenger cars, the level of internalization decreases. This is more linked to the increase in external costs – congestion in particular – than to a decrease in taxes. Taxes remained relatively constant over time (in real terms). Taxes on company cars did increase between 2012 and 2014 due to the reduction of the VAT deduction and the increase in the imputed taxable benefit (and hence a decrease of the implicit subsidy) since 2013. This led to an increase in the level of internalization. For lorries, the level of internalization is relatively constant (not yet taking into account the kilometre charge). Light-duty vehicles using diesel are the exception with an increase in their level of internalization.

⁸ The calculations take account of the average environmental performance of the vehicle fleet, but do not further distinguish between Euro standards. Different Euro standards have a different impact on marginal external environmental costs. Given the importance of the congestion costs, it seems more important to differentiate with respect to time and place.

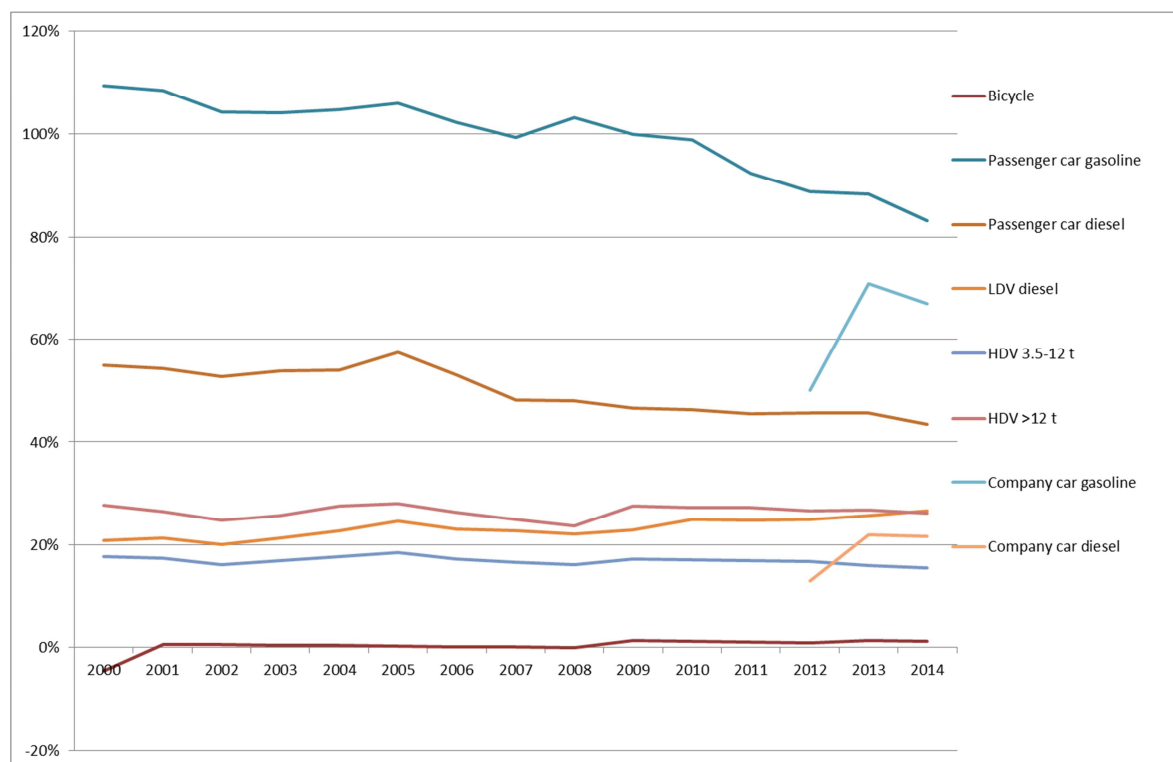


Figure 6: Internalization of external costs over time (2000-2014) – road transport. Source: TML

For non-road transport we observed that the level of internalization of diesel freight trains decreased. For electric freight trains and international passenger transport, the level of internalization remains rather constant. National passenger rail transport is more and more subsidized and hence the level of internalization decreases. For shipping, the level of internalization remains relatively constant for inland waterways, whereas it remains virtually zero for maritime shipping. For air transport, the level of internalization also remains relatively constant – although this is partly caused by the lack of differentiated time series for many elements.

In 2016, several measures were taken which affect the level of internalization to a greater or lesser extent. The kilometre charge for heavy-duty vehicles increased (when keeping all other private and external costs fixed at the level of 2014) the level of internalization for heavy-duty vehicles 3.5-12t from 15 % to 34 % and from 26 % to 45 % for heavy-duty vehicles of more than 12t. The change in the car registration tax and yearly road tax also increased the level of internalization – although to a lesser extent. When all other private and external costs are fixed at the level of 2014, the level of internalization increases from 83 % to 86 % for gasoline cars and from 44 % to 46 % for diesel cars.

8. Does this mean that Flanders is on the right track?

Not really....

Over the years, changes in the level of internalization are mainly driven by developments in external costs (improvements in environmental performance, increasing congestion) rather than by a targeted adjustment of taxes. Overall, we observe a declining trend in the level of internalization. Over the last years, there have been some changes. For company cars, we see a marked increase in the degree of internalization, mainly due to the change in the imputed taxable benefit in 2012. However, the difference with “ordinary” cars remains high. The introduction of the kilometre charge for heavy-duty vehicles was a first step in the right direction. The changes to the car registration tax (BIV) and the yearly road tax for cars in 2016 also had a slightly positive effect.

If we look at the degree of internalization, we see large differences between the different modes. Road transport internalizes relatively much of its external costs, but inland waterways and maritime shipping do not. Freight rail is at the same level as road freight transport (for diesel traction) or pays more than its costs (for electric traction).

For aviation, the level of internalization is relatively low. Moreover, there are also major differences within road transport itself. For example, the taxes levied on CNG cars are much lower than for gasoline cars – although the differences in external costs are small.

There are also large subsidies for public transport (bus and rail). The question can be asked whether the difference with the other modes is not too large? On the other hand, subsidies can be used to stimulate modes with lower external costs, and there are also other reasons such as providing accessibility.

From an economic theory perspective, users have to pay the right price. This means that users pay the full marginal costs – for all modes. When we set the taxes and levies equal to the external costs, the modes with the lowest social costs (= net private costs and external costs) are bicycles, rail-electric, buses and aviation. The most important reason for the low social cost for aviation is the high occupancy rate compared to other modes. Also in freight transport, the alternative modes such as rail and water remain considerably cheaper (per tonne-km). It is not because road transport has the largest level of internalization today that a further internalization for the other modes will lead to large changes in their relative prices.

Finally, today taxes are mostly differentiated with respect to the environmental performance of the vehicles – if they are differentiated at all. Given that external costs also depend on the time and place, it would be better to differentiate them further. This has started for road freight with the introduction of the kilometre charge with a differentiation in terms of place, but this could be further differentiated by time period and/or extended to passenger cars.

Acknowledgements

Financial support of Vlaamse Milieu Maatschappij (VMM) in the framework of MIRA (Milieurapport Vlaanderen) is gratefully acknowledged.

9. References

- CE Delft (2011) STREAM International Freight 2011. Comparison of transport modes on a EU scale with the STREAM database.
- CE Delft (2015) STREAM personenvervoer 2014. Studie naar transportemissies van alle modaliteiten – emissiekentallen 2011.
- Dekonink, L. (2016) Actualisatie van de geluidsindicatoren, studie in opdracht van MIRA.
- Delhaye E., De Ceuster G., Vanhove F., Maerivoet S. (2017) Internalisering van externe kosten van transport in Vlaanderen: actualisering 2016, studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij, MIRA, door Transport & Mobility Leuven.
- De Ceuster, G. (2012) Infrastructuurkosten Vlaanderen. Berekeningen op basis van gegevens van AWV in het kader van de kilometerheffing vrachtwagens.
- De Nocker et.al (2010) Actualisering van de externe milieuschadekosten (algemeen voor Vlaanderen) met betrekking tot luchtverontreiniging en klimaatsverandering.
- Ecorys (2005) Charging and pricing in the area of inland waterways. Practical guideline for realistic transport pricing.
- Federaal Planbureau (2015) Vooruitzichten van de transportvraag in België tegen 2030.
- GRACE. www.grace-eu.org
- KIM (2013). De maatschappelijke waarde van kortere en betrouwbare reistijden.
- Lindberg (2006) Marginal cost case studies for road and rail transport. Deliverable D3. GRACE. Funded by the 6th Framework Programme. ITS University of Leeds. Leeds.
- MKBA transport infrastructuurprojecten – kengetallenboek
- Munduch et.al. (2002). External infrastructure costs of the Australian railway system. Vienna University Department of Economics Working Paper Series.
- Ricardo –AEA (2014) Update external costs.
- Schroten, A. et.al. (2010) External infrastructure costs of freight transport Paris-Amsterdam Corridor. Deliverable 1 – Overview of costs, taxes and charges. CE Delft.