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Road pricing for bus and coach

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Abstract

In this chapter, the authors examine the effects of road pricing on the demand for bus and coach services in Belgium. Buses and coaches are an essential part of a sustainable transport system. Due to their collective nature and advances in zero emission technology, they have a carbon footprint that is comparable to rail transport. However, although buses and coaches are a cost-effective mode of transport, they often do not have access to the same subsidy or tax shelter arrangements as their competitors from the rail or air transport sector. In this study, the authors introduced a brief exploration of the effects of a road pricing scheme on demand for buses and coaches. They looked at the effects on monetary and time costs for bus and coach on the one hand and its main competitor (car/air) on the other. Making use of time and price elasticities deduced from the literature, they estimated the effects for three different scenarios of pricing schemes and for three typical cases of coach or bus journeys.

1 Introduction

From a theoretical-economic perspective, road pricing is an instrument to internalize the many external costs that are associated with road transportation. Such an instrument should ensure that the damage road transportation causes to the environment, our health, and the economy is reflected in its price. In theory, overconsumption of mobility will consequently be avoided, resulting in welfare gains for all of us. From this perspective, the advantages of road-pricing are so self-evident that one can only wonder why such a system has not been generally implemented in our transportation system before.

However, a few problems exist with this view, the most important one being that it is rather simplistic. As we are all aware of, in reality, the world does not function the way a classic economic model assumes. For one thing, human decision making is only partially guided by rationality. Habits, attitudes, emotions, and even fear play an important role in our decisions about where to live and work, or about how and how often we choose to travel. Moreover, next to the presence of external costs, a number of other mechanisms disturb the functioning of the transportation market. Government interventions in the industry are very common and take many forms.

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Market regulations, direct subsidies, fiscal benefits, and monopolies by state-controlled institutes are the rules rather than the exceptions. Whether one supports these policies or not, they do influence the way the market functions and the way the introduction of a road pricing scheme will exert an effect on human behaviour. Therefore, it is important that, prior to the introduction of such a scheme, all possible effects are carefully examined, and appropriate measures are undertaken to avoid undesirable outcomes.

In this chapter, we will examine the effects of road pricing on the demand for bus and coach services in Belgium. Buses and coaches are an essential part of a sustainable transport system. Due to their collective nature and advances in zero emission technology, they have a carbon footprint that is comparable to rail transport (Borken-Kleefeld *et al.*, 2013). Moreover, the effectiveness of Euro VI-emission standards for heavy duty vehicles has reduced NO_x and particulate matter (PM) emissions in real-world operations to an absolute minimum (Muncrief, 2016). Buses and coaches are also a very versatile mode of transport. They can move small or larger groups, and in *Bus Rapid Transit*-applications, they can even be deployed for transporting large groups of passengers (Cervero, 2013). Being a relatively inexpensive transport mode, they are especially interesting when metro or (light) rail applications are not economically viable.

Since they offer transport operators with a green, cheap, and flexible solution, they are deployed in many different contexts including public transport, commuting to school or work, tourism, or occasional group transfers.

Nevertheless, buses and coaches also suffer from several important drawbacks. In general, they are assumed to offer a less satisfying travel experience as compared to rail, air, or the private car (e.g., Ettema *et al.*, 2011; Morris and Guerra, 2015). When deprived of segregated lanes, they get stuck in the same traffic jams as private cars do, which has an adverse effect on their punctuality and commercial speed. Investments in leg space and on-board facilities can improve comfort levels and attract passengers (Lannoo *et al.*, 2019), but on the downside, they push operational costs to a higher level. In addition, although buses and coaches are a cost-effective mode of transport, they often do not have access to the same subsidy or tax shelter arrangements as their competitors from the rail or air transport sector.

Given this specific position of buses and coaches in our transport system, we believe that it is of pivotal interest to investigate the effects road pricing schemes will exert upon them. After all, undesirable outcomes are not at all unlikely, and they can have consequences for all parts of our mobility system.

2 Methodology

2.1 Journey examples and road pricing scenarios

As mentioned above, buses and coaches are deployed in many different situations and for many different purposes. Depending on issues such as journey length, time of travel, location, or travel motive, road pricing can be expected to exert a certain (positive or negative) effect on travel demand. Therefore, we calculated the effects for three specific cases of coach journeys.

In the first case, we consider a day trip from Bastogne in the Walloon region to the Belgian coast (De Panne). We will calculate effects on demand for the coach and for the car, the latter being considered the main competitor in this kind of excursions. The second case is an international four days trip from Lommel in Flanders to London. For the second example, the plane is considered the main competitor

(connection from the airport of Eindhoven in neighbouring Holland, located approximately 40km from Lommel). The third and final case is a so-called Office Bus-line, a new concept that has been introduced by private bus companies. An office bus is a coach equipped with facilities allowing passengers to work while traveling: a fast and reliable Wi-Fi connection, a desk, ample space, and a coffee machine. The lines make a connection between office areas tormented by heavy congestion problems and the lack of well-served public transport connections on the one hand and several cities accommodating large numbers of commuters on the other. In this specific case, the line makes a connection between the periphery of Ghent and Brussels. Currently, it is a non-subsidized service to companies seeking to shift their employees from passenger car use to collective transport.

We opted not to include any cases from a public transport context because it is unlikely that a public company would include a tax increase in the ticket price, and therefore, the example would be of no interest for our research questions. The specific journeys that were studied are described in Table 1.

Not only are there very different kinds of bus and coach journeys, but also road pricing schemes can take many different forms. For an overview of these different forms, we refer to other contributions in this volume. In our contribution, we took a closer look at three different scenarios, the tariffs of which are shown in Table 1.

The three scenarios are, quite evidently, not chosen at random. The first scenario is based on the texts of the revision of the *Eurovignette Directive* that is currently on the table of European Union legislators. The text proposes to make the application of distance-based charges that are currently applicable for heavy duty goods vehicles mandatory for all heavy duty vehicles (Debyser, 2018). This means that the new legislation would introduce a kilometre based charge for buses and coaches, but not for private cars. The current scheme for heavy duty goods vehicles is a distance-based charge with different tariffs dependent on the maximum permissible mass of the vehicle and the euro norm of its engine, but not dependent on the time of day or the specific road junction used. In our calculations, we use the tariff applied to euro norm 5 and 6 and to weight class 12-32 tons, which is the weight class most buses and coaches would fall into. For the specific journeys studied in this example, the use of recent vehicles is very likely.

TABLE 1 Tariff overview for three scenarios of road pricing

	Bus/coach						Car					
	Peak			Off-peak			Peak			Off-peak		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Highway	12.4	26.3	0.0	12.4	17.3	0.0	0.0	15.0	15.0	0.0	9.0	9.0
Other roads	12.4	26.3	0.0	12.4	17.3	0.0	0.0	15.4	15.4	0.0	9.4	9.4
City	12.4	24.9	0.0	12.4	18.9	0.0	0.0	14.8	14.8	0.0	10.8	10.8

S= Scenario

The second scenario is based upon the decision of the Flemish Government to order a study on the application of a distance-based charge for all vehicle categories. The tariffs of this scheme are dependent on the time of travel (peak versus off-peak hours) and the kind of road that is used (highway, urban roads, or other roads). The aim of the scheme is threefold: to reduce congestion, to internalize external costs, and to make users pay for infrastructure costs. In order to reduce congestion, we apply a congestion charge of 4 eurocents per kilometre on urban roads and 6 eurocents per kilometre on

highways and other roads. Buses pay 1.5 times more than cars, a proportion that is currently proposed in the texts of the revision of the Eurovignette Directive (cf. *infra*). The charge is only introduced on peak hours and road junctions that are actually congested. We choose to apply a higher rate on non-urban roads because it is believed that, in the long run, this stimulates moving to city-centres, which will also help reduce congestion problems (De Vos, 2016). The external costs taken into account are based on external costs estimated for road transport in a recent study carried out on behalf of the Environmental Council of Flanders (Delhay *et al.*, 2017). Costs related to noise, direct emissions, and accidents are all taken into account. Finally, infrastructure costs for the entire road network are based on proper calculations. A rate of 3.9 eurocents per kilometre is applied. For buses, this rate is increased by 2.87 eurocents, which is estimated to be the marginal infrastructure costs of buses in Belgium (Delhay *et al.*, 2017).

The third and final scenario is a copy of the second one but introduces zero rates for bus and coach. This scenario should allow us to test the effects of a possible exemption applied to this mode.

2.2 Calculating effects on demand

Combining three journey examples with three road pricing scenarios results in nine situations for which the effect of road pricing can be examined. For every situation, a calculation is made based on the effects on the demand for coach/bus on the one hand and demands for its main competitor on the other.

Calculations are based on a simple model that takes four elements into account including (1) changes in monetary costs for the mode under consideration, (2) changes in time costs for the mode under consideration, (3) changes in monetary costs for the competing mode, and (4) changes in time costs for the competing mode.

TABLE 2 Elasticities used in the calculations

	Elasticity	Source
Price Elasticity Bus Commute	-0.85	Dunkerley <i>et al.</i> , 2018 (table A3)
Price Elasticity Bus Leisure	-1.1	Dunkerley <i>et al.</i> , 2018 (table A3)
Time Elasticity Bus Commute	-1.15	Dunkerley <i>et al.</i> , 2018 (table A4)
Time Elasticity Bus Leisure	-1.05	Dunkerley <i>et al.</i> , 2018 (table A4)
Price Elasticity Auto Commute	-0.24	Bogaert <i>et al.</i> , 2006 (tabel 10)
Price Elasticity Auto Leisure	-0.38	Bogaert <i>et al.</i> , 2006 (tabel 10)
Time Elasticity Auto Commute	-0.36	de Jong and Gunn, 2001 (table 3)
Time Elasticity Auto Leisure	-0.21	de Jong and Gunn, 2001 (table 3)
Demand bus after change in price of car (commute)	0.18	Bogaert <i>et al.</i> , 2006 (tabel 10)
Demand bus after change in price of car (leisure)	0.12	Bogaert <i>et al.</i> , 2006 (tabel 10)
Demand bus after change time cost of car (leisure)	0.46	de Jong and Gunn, 2001 (table 7)
Demand bus after change time cost of car (commute)	0.23	de Jong and Gunn, 2001 (table 7)
Demand car after change prince bus (leisure + commute)	0.116	Litman, 2010, (table 40)
Demand car after change time cost bus (leisure + commute)	0.09	Litman, 2010 (table7)
Demand air travel after change in prince bus	0.01	Dargay, 2010 (table 27)
Demand air travel after change in time cost bus	0.01	Dargay, 2010 (table 27)

Algebraically, the model can be represented by the following two equations:

$$\Delta Q_{bus} = E_{P_{bus}} * \Delta P_{bus} + E_{T_{bus}} * \Delta T_{bus} + CE_{P_{comp.}} * \Delta P_{comp.} + CE_{T_{comp.}} * \Delta T_{comp.}$$

$$\Delta Q_{comp.} = E_{P_{comp.}} * \Delta P_{comp.} + E_{T_{comp.}} * \Delta T_{comp.} + CE_{P_{bus}} * \Delta P_{bus} + CE_{T_{bus}} * \Delta T_{bus}$$

in which ΔQ_{bus} represents changes in demand for the bus and $\Delta Q_{comp.}$ changes in demand for the main competitor. Changes in monetary and time costs that are a consequence of the road pricing scheme are represented by ΔP and ΔT , respectively. In order to determine ΔP , we assumed that bus companies recharged the cost increase caused by the road pricing scheme entirely to their customers. Changes in ΔT are not based on calculations, but on estimations made by the authors.

$E_{P_{bus}}$ represents a price elasticity for the bus and $CE_{P_{comp.}}$ a cross price elasticity for the main competitor. Price elasticities are deduced from the literature. The values used and the sources from which they were collected are mentioned in Table 3.

3 Results

Table 3 shows the results of the calculations. For the first case (daytrip Bastogne-De Panne), we had a marginal cost of € 15.25 for the coach and € 56.64 for the car. The marginal cost for the coach ticket is equal to the cost of renting the bus divided by the number of passengers (cf. Table 1). For private cars, only fuel costs are included in the marginal cost. Cost of purchase, insurance, etc. are fixed costs and should therefore not be included. Although maintenance costs are in fact variable costs, we believe that the cost structure is too obscure for travellers to take them into account when deciding whether or not to take the car. Therefore, they are excluded from external costs. Time costs for the journey were estimated at nine hours and five minutes for the coach and 7 hours and 52 minutes for cars.

In the first scenario, the current heavy duty goods charge is applied to bus and coach. As can be read from Table 1, this means a constant charge of 12.4 eurocents per kilometre. To calculate the increase in marginal cost for the passengers of the coach, we first divided the tax for the journey by the number of passengers on-board and subtracted the cost of the current tax for coaches. The cost of the tax is estimated at 1.44 eurocents per kilometre⁶⁹. As an example of the daytrip, the first scenario leads to a marginal cost increase of 10% for the coach. Since there is no change in the marginal price of the car, there is no effect on congestion. Therefore, the time cost for both car and coach remains unchanged. As a result, the introduction of this road pricing scheme leads, in the case of the daytrip to the coast, to a decrease of 10.94% in demand for the coach and an increase of 1.15% for the car.

In the second case, we start from a marginal cost of € 75 for the coach and € 85 for the plane. The increase in marginal cost is lower as compared to the first example because a large part of the mileage of the journey is covered abroad. Under the first scenario, this leads to an increase of 1% in marginal cost and a decrease of 1.52% in demand for the coach. Since there is no change in monetary cost for air travel and in time costs for both modes, and since the cross elasticity of air travel for changes in monetary

⁶⁹ Although this is a fixed tax for the bus company, it is a variable cost for the traveller since the bus company includes the tax cost in the ticket price. We assume that the introduction of the road pricing scheme will replace the existing fixed road tax. This means that for the marginal cost increase, the cost of the old tax scheme should be deducted. For cars, this is different since the existing tax is not a marginal cost for the car user.

costs for coach is very low (see Table 3), the effect on demand for the plane is limited to an increase of 0.01%.

In the third example, the Office Bus-line, marginal costs were € 19.90 for the bus and € 12.29 for the car. Important to note here is that such special regular services are not submitted to the current tax scheme. Consequently, the increase in marginal cost caused by the road pricing scheme of the first scenario makes marginal costs increase by € 0.64 per passenger or by 3% of the ticket price. The result is that the demand for the office bus decreases by 2.71%, and the demand for the car increases by 0.37%.

The second scenario introduces a smart distance-based charge with time and place-dependent tariffs for bus and coach as well as for cars. Since the tariffs per kilometre are higher as compared to the first scenario, the increase in marginal costs is also higher. For the first example (daytrip to the coast), marginal costs increase for the coach is € 2.49 or 15% of the ticket price. For cars, the increase is as high as € 57.39 or 101% of the marginal cost before the tax. Both for cars and buses the scheme allows for a reduction of 10 minutes in travel time or about 2% of total time costs. This combination of factors drives demand for cars down by more than 36%. Demand for the coach, however, goes down by 3.27%. This negative evolution means that the improvement in the relative price competitiveness of the coach and the reduction in time costs are not sufficient to offset the increase in monetary cost.

In the example of the London trip, the effects are different. The increase in marginal costs is limited to € 1.85 per passenger for the coach, and there is a gain of ten minutes in travel time. There are no changes in monetary and time costs for air travel since this mode is not impacted by the road pricing scheme. The coach suffers a decrease of 1.55% in demand, and the demand for air travel goes up by 0.01%.

In the example of the Office Bus, the ticket price goes up by 6% or € 1.22. Marginal costs for car commuters go up by € 17.19 or 140%. Both bus and car reduce travel times by 15 minutes or 7% and 15%, respectively. This leads to an improvement in the relative competitiveness of the bus both in monetary and time cost terms. As a result, demand for the bus goes up by 21.75%, and demand for the car goes down by 28.25%.

In the third scenario, the same smart distance-based charge as in the second scenario is introduced, but with 0-tariffs for bus and coach. Since the introduction of the distance-based charge implies the disappearance of the fixed charge, this leads to a reduction in marginal travel costs for the coach both in the coast trip and the London trip examples. For the office bus example, there is no reduction since for this kind of transport no charge was in place. Monetary cost evolutions for the car remain the same as in the second scenario. In addition, the time costs for both coach and car remain the same.

TABLE 3 Results

		Scenario 1: applying current heavy duty goods charge to bus & coach		Scenario 2: smart distance-based charge, no exception for bus & coach		Scenario 3: smart distance-based charge, 0-tariffs for bus & coach	
		Bus/Coach	Car/Air	Bus/Coach	Car/Air	Bus/Coach	Car/Air
<i>Case 1: Daytrip Bastogne-De Panne</i>	Kilometres (return)	590		590		590	
	Marginal cost before road pricing	16.25 €	56.64 €	16.25 €	56.64 €	16.25 €	56.64 €
	Δ Marginal cost (€)	1.6163 €	0.0000 €	2.4928 €	57.3893 €	-0.2127 €	57.3893 €
	Δ Marginal cost (%)	10%	0%	15%	101%	-1%	101%
	Time cost before road pricing (min)	545	472	545	472	545	472
	Δ Time cost (min)	0	0	-10	-10	-10	-10
	Δ Time cost (%)	0%	0%	-2%	-2%	-2%	-2%
	Δ Demand (%)	-10.94%	1.15%	-3.27%	-36.44%	15.04%	-38.37%
<i>Case 2: International trip Lommel - Londen</i>	Kilometres (return)	900		900		900	
	Marginal cost before road pricing	75.00 €	85.00 €	75.00 €	85.00 €	75.00 €	85.00 €
	Δ Marginal cost (€)	1.0333 €	0.0000 €	1.8541 €	0.0000 €	-0.3245 €	0.0000 €
	Δ Marginal cost (%)	1%	0%	2%	0%	0%	0%
	Time cost before road pricing (min)	901	540	901	540	901	540
	Δ Time cost (min)	0	0	-10	0	-10	0
	Δ Time cost (%)	0%	0%	-1%	0%	-1%	0%
	Δ Demand (%)	-1.52%	0.01%	-1.55%	0.01%	1.64%	-0.02%
<i>Case 3: Office Bus line Gentbrugge - Zaventem</i>	Kilometres (return)	128		128		128	
	Marginal cost before road pricing	19.90 €	12.29 €	19.90 €	12.29 €	19.90 €	12.29 €
	Δ Marginal cost (€)	0.6349 €	0.0000 €	1.2233 €	17.1867 €	0.0000 €	17.1867 €
	Δ Marginal cost (%)	3%	0%	6%	140%	0%	140%
	Time cost before road pricing (min)	202	102	202	102	202	102
	Δ Time cost (min)	0	0	-15	-15	-15	-15
	Δ Time cost (%)	0%	0%	-7%	-15%	-7%	-15%
	Δ Demand (%)	-2.71%	0.37%	21.75%	-28.25%	26.97%	-28.96%

In the case of the coast trip, this results in an increase of over 15% in demand for coach travel. Demand for cars decreases by 38.37%, almost one percentage point more than the second scenario. For the London trip example, we have an increase of 1.64% in demand for the coach. This small change is still better than the decrease we noticed in the second scenario. This time there is also a marginal decrease of 0.02% in demand for air travel. Finally, for the office bus example, we notice a small reinforcement of the effects noticed in the second scenario, i.e., an increase of almost 27% in demand for the coach and a decrease of 29% in demand for the car.

4 Conclusion

In this study, we introduced a brief exploration of the effects of a road pricing scheme on demand for buses and coaches. We looked at the effects on monetary and time costs for bus and coach on the one hand and its main competitor (car/air) on the other. Making use of time and price elasticities deduced from the literature; we estimated the effects for three different scenarios of pricing schemes and three typical cases of coach or bus journeys.

The results show that the introduction of a pricing scheme pricing bus use but exempting car use has a strong negative effect on demand for the first, even when the current fixed tax scheme would disappear. This is especially the case for domestic occasional services. When the cost of the scheme is completely integrated into the ticket price, a strong reduction in demand can be expected. Since this would in turn negatively affect load factors and/or utilization days of the vehicle, such an evolution would put many companies under severe financial pressure. However, not integrating the cost into the ticket price would lead to strong cost increases and would have the same financial consequences. Moreover, since the price scheme improves the relative competitiveness of the car, small but relevant increases in demand for car trips are to be expected. It is clear that this scenario should be avoided, both from an economic and a sustainable transport perspective.

The effects of a general smart distance-based charge for all road transport modes are very different, at least for those journeys where the coach competes mostly with the car. This is due to the fact that the negative effects of a monetary cost increase are (partly) offset by the positive effects of the decrease in time costs and the increase in monetary costs for the car. In the case of the Office Bus, this even leads to an increase in demand. However, when interpreting the results, one should take into account that the model used for the estimation is a simplification of reality. For one thing, it does not take into account that coaches also compete with the train. Since the introduction of the pricing scheme deteriorates the competitive position of the coach compared to the train, it can be expected that the positive effects reported here will be somewhat weaker in reality. Moreover, it does not take into account that abolishing the fixed annual road tax for cars might lead to an increase in car ownership, which in turn stimulates car use.

For journeys where the coach competes with the plane, the introduction of the smart pricing scheme has a negative impact on demand for the coach and a positive one on demand for air transport. This is a clear example of an undesired effect of road pricing. Although the effects reported are small, they are not negligible. First of all, the negative effects of the charge would be larger when it would simultaneously be introduced to other European countries. Given the texts for the revision of the Eurovignette directive that are currently on the table, this is not at all unlikely. Second, one should take into account that, unlike coach travel, air travel momentarily benefits from VAT and excise duty exemptions and other forms of positive discrimination (Piket, 2009). For the coach, the introduction of a road pricing scheme would, therefore, mean adding a competitive disadvantage on top of many other competitive disadvantages that

already exist. In an ideal world, the introduction of a pricing scheme should be accompanied by measures abolishing these positive discriminations of air travel and the introduction of an equivalent system for the internalization of external costs. When these measures are politically impossible, other accompanying measures should be considered.

One possible measure would be the introduction of zero tariffs for bus and coach. Our analysis shows that in the case of competition with air, zero tariffs can turn the negative effects around. In the case of competition with the car, the positive effects are reinforced. Of course, zero tariffs are at odds with the goal of road pricing, i.e., to put the right price on road transportation. From an economic perspective, equal fiscal treatment of all modes and subsidies in line with the social added value of a mobility service are the optimal choices. However, given the existing political constraints, zero tariffs can constitute a good second best.