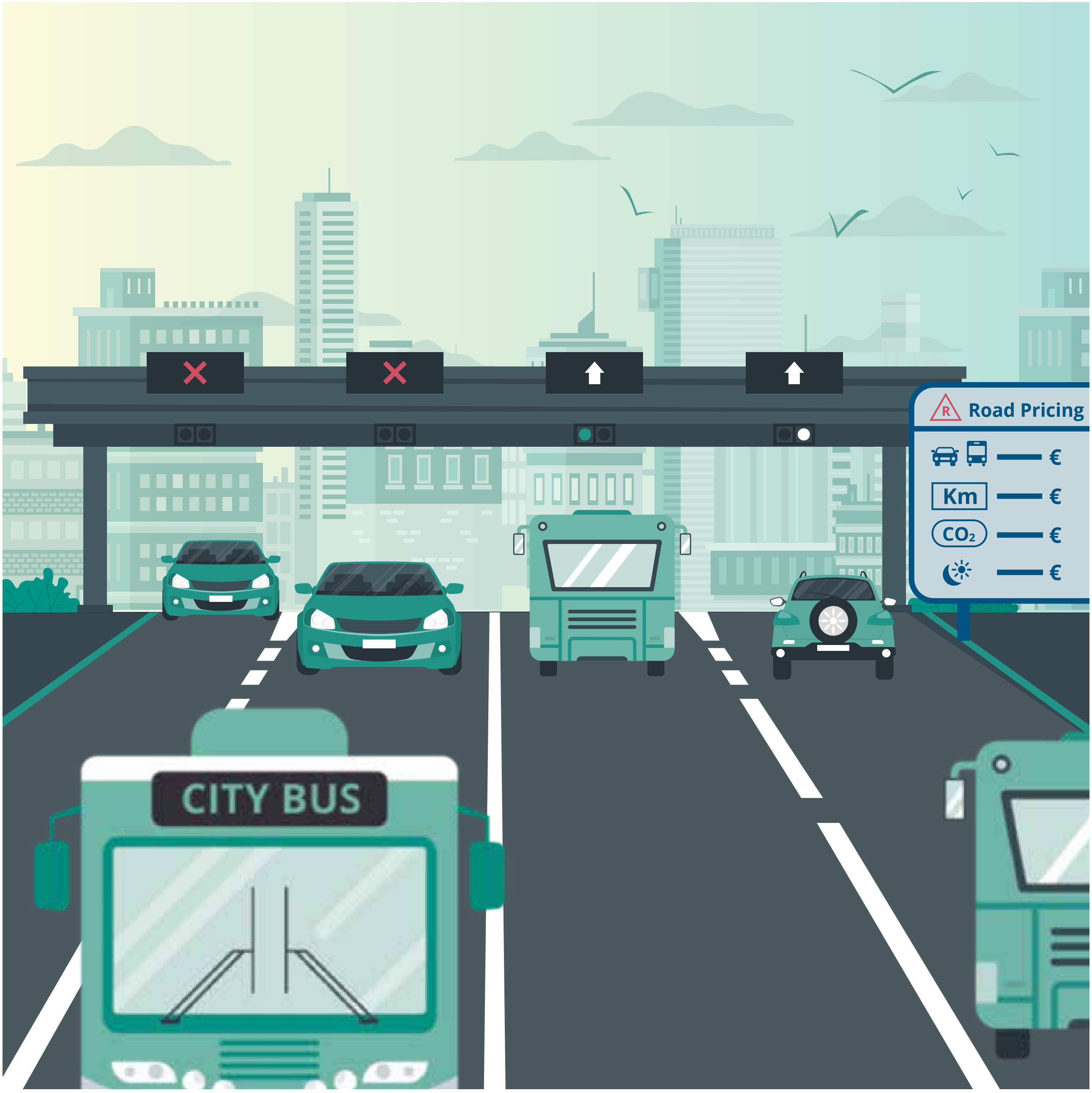
Annex 7
Digitalisation in road transport pricing



Context: road/urban transport; internalisation of the external costs of transport

A-S-I: general. Digitalisation supports the development of more comprehensive transport pricing schemes and facilitates their implementation, as well as the implementation of other transport policies.

Time frame: short to medium term. Digital tools are available and several pilot or full-scale projects are already ongoing.

A7.1 Definition

Digitalisation can enable various types of policies for transport. This factsheet focuses on policies on road pricing, urban access restrictions and smart parking.

A7.1.1 Road pricing

Road transport incurs various marginal external costs. External costs or negative externalities are costs imposed on uninvolved third parties that originate from the activity of one or more different actors, while the actors causing them are not confronted with them in any way. The term 'marginal' indicates that the costs arise from an additional trip or kilometre travelled. The external costs of transport include environmental costs (air pollution, noise, climate change) as well as accident costs and congestion caused by traffic (EC, 2019a). These marginal external costs can be internalised through transport taxes. In this way, the final users can take them into account when deciding on the number of trips, the distance travelled, the modal choices, the environmental performance of their vehicle, the timing of their travel, the route selected, etc. The concept of externalities and the use of corrective taxes to internalise them originated in the work of Pigou (1920). Hence such corrective taxation is also called 'Pigouvian taxation'. Notably, pricing these externalities also reflects the 'polluter pays' principle.

Different pricing instruments exist for road transport, such as vehicle taxes, fuel taxes, parking charges and road user charges. Economic theory indicates that it is best to use pricing instruments that are closely related to the factors that determine the external cost levels. For example, congestion problems vary according to the time and location of travel. Therefore, an instrument such as road pricing, which can be differentiated across these dimensions, is best, as it gives incentives to travel less in the peak periods or in areas with a lot of traffic. In contrast, fuel taxation is only a rough instrument for tackling congestion, as it does not allow transport users to make this differentiation, but it can give good incentives to reduce CO_2 emissions if it takes into account the differences in CO_2 emissions per litre of the different fuels.

In general, a distinction can be made between different types of road pricing that can be further differentiated according to the determinants of the external costs (vehicle type, environmental characteristics, location, time of day, road type, etc.):

- Distance based charges: an amount is paid per kilometre driven. It can be due on all roads or a selection of roads, in a country or region or only in certain zones.

- Cordon pricing: drivers pay a charge when they drive through a cordon around a certain area. People who drive only in the area within the cordon do not pay. A cordon system can consist of several cordons.

- Area licence/time-based toll: a fee to be paid when one wishes to drive within a certain area during a certain period.

- High occupancy toll lanes: lanes on which vehicles with a minimum number of occupants and other exempt vehicles can drive free of charge. Other vehicles can use the lanes if the drivers pay a toll. Tolls are set at a level that ensure a speed advantage for toll lanes over unmanaged lanes.

A7.1.2 Urban access restrictions

Various European cities and towns regulate or impose restrictions on vehicles driving in all or part of their territory. This can serve various purposes such as improving liveability or air quality or reducing congestion.

Aside from urban road pricing, which was discussed in the previous section, the regulations can also take the form of low-emission zones (LEZs) or other entry restrictions. The latter cover, for example, access only during certain times or for certain vehicles.

A system with automatic number plate recognition (ANPR) cameras is also used for the implementation of such regulations. For example, the LEZs of Antwerp, Ghent and Brussels in Belgium use number plate recognition to check whether vehicles are conforming with the LEZ prescriptions.

Digitalisation can also help to implement other types of policy. For example, Arnd and Cré (2018) discuss the role of digitalisation in parking policies. Sant et al. (2021) present research on a smart parking system in Malta that is based on green internet of things (IoT) devices to manage unused garage spaces.

A7.2 Context

Worldwide, the interest in road user charging is growing in order to deal with congestion problems as well as to attain environmental goals. In addition, road pricing, in contrast to other instruments such as fuel taxation, can be easily differentiated across multiple dimensions (e.g. congestion problems that differ according to the time and location of travel). The need is for an instrument that is closely related to the factors that determine the external cost levels, as this will give transport users a direct incentive to adapt their transport choices and thereby reduce their externalities (Mayeres, 2003).

The European Commission handbook on external costs (EC, 2019a) indicates that the external costs of road transport are substantial: EUR 820 billion in 2016. The largest impact categories are accident costs (38%) and congestion costs (32%), followed by the environmental impacts: climate change (10%), noise (7%), air pollution (6%), habitat damage (4%) and the costs of well-to-tank emissions (3%).

In the 2011 White Paper *Roadmap to a single European transport area — Towards a competitive and resource efficient transport system* (EC, 2011), the European Commission called for 'the full and mandatory internalisation of external costs (including noise, local pollution and congestion) on top of the mandatory recovery of wear and tear costs for road and rail transport'. The Eurovignette Directive (EU, 1999) set the framework for the charging of heavy-duty vehicles (HDVs). In February 2022 a revision was adopted (Directive (EU) 2022/362) (EU, 2022d) containing new rules on road charging on the Trans-European Transport Network (TEN-T) for HDVs, as well as extending some of its principles to passenger cars and light commercial vehicles if countries wish to apply charges for these vehicles as well. Existing time-based vignettes for HDVs on the TEN-T network should be phased out by 2030 and replaced by distance-based charging to conform with the 'user pays' principle. To support the environmental sustainability of road transport, road charging rates will have to be differentiated based on CO_2 emissions for trucks and buses and based on environmental performance (i.e. air pollutants and CO_2 emissions) for vans and minibuses, as of 2026. Zero- or low-emission vehicles should be charged less. In addition, Member States can apply 'tolls and user charges on other roads, provided that the imposition of tolls and user charges on such other roads does not discriminate against international traffic and does not result in the distortion of competition between operators'. Road pricing can therefore be implemented at local or regional/country scale and for all roads or for part of the road network.

While the concept of road pricing is not new (Pigou, 1920; Vickrey, 1963), digital technologies make it much easier to implement than before, especially if one wants to apply differential pricing. De Ceuster and Mayeres (2021) give an overview of the available technologies. Short-range and microwave communication are widely applied, with dedicated short-range communication the most popular standard. Vehicles are equipped with a tag that can be identified by roadside equipment. Each time a vehicle passes this equipment, it is charged. The system is easy to use and cheap for simple road networks. However, it is less suited to large networks, as a lot of roadside equipment would need to be installed. Urban systems, such as the cordon tolls in Sweden and the London congestion charge, and some motorway systems make use of ANPR cameras. In this case, no device is needed in the vehicle. Cameras at the roadside register every passing vehicle. Vehicles that are registered must pay the toll.

The implementation of area-wide charging schemes on a large scale requires the use of a global navigation satellite system (GNSS). Each vehicle is equipped with a device that is used to determine its position and that is connected to a central system. The charges are calculated by the device itself or by the central system, based on the location of the vehicle, the time of driving and other elements included in the charge formula. Such a system was introduced in Germany in 2005 for charging HDVs on motorways and main roads, followed by other European countries. Singapore is preparing the roll-out of a similar system for all vehicles. Also in global satellite-based systems, there is a role for ANPR cameras, namely for enforcement purposes to check that vehicle drivers pay the road user charges.

Urban access restrictions such as LEZs or other restrictions are used to address local air pollution and noise or to improve the liveability of cities and towns. Solutions for parking also work at the local scale.

A7.3 Time frame

Various types of road charging schemes are already applied across the world. Currently, most charging schemes are a time-based vignette, a highway toll or a distance-based charge for HDVs on main roads. The latter applies in several European countries: Austria, Belgium, Bulgaria, Czechia, Germany, Hungary, Poland, Slovenia, Slovakia and Switzerland (Impargo, 2021). There are also some examples of urban charging systems: cordon tolls in Norway (Bergen, Oslo, Trondheim), Sweden (Stockholm, Gothenburg), Italy (Milan) and the electronic road pricing system that was introduced in Singapore in 1998. Examples of area licensing schemes were used in Singapore between 1975 and 1998 and the congestion charge that was introduced in London in 2003.

General (i.e. for all vehicle types) area-wide road pricing over larger areas has been studied in a number of countries or regions (e.g. the Netherlands, Flanders, Brussels Capital Region). However, no examples of such systems covering all vehicles and roads yet exist. Still, there is a continued interest in road pricing for the purposes of mitigating congestion and reducing emissions. With the greater uptake of electric vehicles that is expected in future years and the fact that they are more energy efficient and that electricity is taxed less than conventional fuels, the need to control the other external costs will remain or even grow. In addition, road pricing offers an alternative source of revenue for governments instead of fuel taxation during times when electrification is taking off.

GNSS-based road pricing now commonly uses onboard units in vehicles. Examples are the systems for HDVs in Belgium, Bulgaria, Czechia, Germany, Hungary, Poland and Slovakia. Denmark, Lithuania and the Netherlands are planning to introduce such systems for HDVs (GNSS Consulting, 2022). An alternative could be to use drivers' own mobile phones and/or in-vehicle telematics as a device instead, thereby reducing the system costs. Various market players are working on this new development (Grosche et al., 2022). For example, the use of smartphones is being considered in the SmartMove system that is under investigation for the Brussels Capital Region (Brussels Capital Region, 2021). The certification process and privacy concerns are two very important points to consider.

A7.4 Expected environmental impacts

Given the broad scope of this factsheet, its structure and assessment of environmental impacts are different from the previous ones, and it showcases examples covering different approaches. Indeed, digitalisation enables the development of diverse road pricing tools.

A7.4.1 Road pricing

While road pricing is often implemented or considered an instrument to mitigate congestion, or to raise revenues, it can also contribute to reducing the environmental costs of road transport in the areas where it is implemented. Indeed, several variants of the above-mentioned general categories of road pricing exist, as well as combinations of the different systems (e.g. combination of a kilometre charge with an area licence). For this reason, in the following, and at variance with previous factsheets, the expected environmental impacts will be discussed from a general standpoint and with the help of existing examples.

Table A7.1 presents a general overview of the environmental impacts observed for three urban pricing schemes in Europe (Croci, 2016): the London congestion charge, the cordon toll in Stockholm and the Ecopass system in Milan, which evolved from an LEZ to Area C, a road pricing scheme. The schemes have reduced emission levels. It should be noted that road pricing was not the only measure introduced. For example, in London and Stockholm the schemes were accompanied by improvements in the availability of public transport.

An analysis by Green et al. (2020) confirms that the London congestion charge did indeed significantly reduce the emissions of a range of air pollutants. By mitigating congestion the charge led to reductions in emissions that went beyond what could be expected from the reduction in traffic volumes alone by reducing the emissions per kilometre, thanks to less traffic jams. However, because exemptions were given to buses and taxis, and because the congestion charge was accompanied by an increase in bus services, nitrogen oxide pollution increased. The authors conclude that the parameters of such charges must be set carefully to avoid unwanted effects.

For the Stockholm congestion charge, Eliasson (2009) estimates that the investment and start-up costs were 'recovered' in terms of social benefits in around 4 years. The environmental benefits related to the reduction in greenhouse gases are estimated to be SEK 64 million per year and those related to lower air pollution SEK 22 million per year. This compares with a social benefit (excluding investment and operational costs) of SEK 683 million per year. At the time of the study SEK 10 was equivalent to about EUR 1.1.

According to Danielis et al. (2012), the Ecopass in Milan achieved a net social benefit of between EUR 5.7 million in 2008 and EUR 9.6 million in 2010. The congestion and accident costs were the main externalities that were reduced. The environmental benefits, which were the official political motivation for the system, were considerably smaller. They equalled EUR 0.45 million in 2008 to EUR 1 million in 2010. Considering the change in air pollution levels in Milan and the surrounding region, after a court order suspended Area C in Milan in 2012, and transferring the US monetary value of the unit cost of air pollution to Italy, Gibson and Carnovale (2015) arrive at an environmental benefit of USD 3 billion, which is substantially higher than the previous estimate.

It is important to mention that in all three cases a significant modal shift to more sustainable public transport modes was realised. More advanced pricing schemes could potentially deliver additional benefits. For example, it could be expected that, with road charges that are differentiated according to the environmental characteristics of the vehicles, there would be an incentive to shift to cleaner vehicles, changing the composition of the vehicle fleet and promoting the use of cleaner vehicles over more polluting ones. Moreover, schemes that increase the price per kilometre within a certain area, give an incentive to increase the occupancy rate of passenger vehicles or the load factor of goods vehicles. If the price signal is also differentiated on the basis of the location, it could reduce the number of people who are affected by air pollution and noise in particularly affected areas.

Under the influence of EU emissions legislation, first, the environmental performance of the road fleet will improve substantially, especially when more electric vehicles enter the fleet. In that case the benefits of road pricing in terms of the reduction in exhaust emissions will become smaller. However, even with electrification other environmental costs of transport remain (non-exhaust emissions, well-to-tank emissions, noise pollution). Second, other factsheets have pointed to the risk that the beneficial environmental effects of digitalisation will be reduced or even completely offset by the so-called digital rebound. Third, congestion is expected to increase in both the EU Reference Scenario 2020 with existing policies and in the policy scenarios underlying the European Commission's Fit for 55 proposals. Electric vehicles do not offer a solution to this problem and might even make it worse if they lead to lower driving costs. An increased demand for transport by electric vehicles might also make it more difficult to decarbonise the electricity sector. For these different reasons, it is important to optimise transport levels by internalising the external costs of transport. Road pricing can contribute to this goal, together with other instruments.

The case studies below present the results of simulations for the SmartMove system in the Brussels Capital Region and a pilot-scale implementation of Pigouvian taxation in Switzerland.

Table A7.1 Impacts of urban road pricing schemes in London, Stockholm and Milan

	London	Stockholm	Milan
Change in all traffic volumes compared to (reference year)	-14% (2003) -16% (2006) -21% (2008)	-21% (2006) -19% (2007) -18% (2008) -18% (2009) -19% (2010) -20% (2011)	Ecopass: -20.8% (2008) -17% (2009) -19.3% (2010) Euro IV diesel charged -10.8% (2011) Area C: -38.5% (2012) -37.6% (2013) -36.8% (2014)
Modal shift	Switch by car drivers to public transport (about 10% increase in underground and bus passengers with destinations in the area)	99% of commuters renouncing car use switched to public transport	Switch by car drivers to public transport (about 12% increase in passengers exiting subway stations inside the area)
Change in emissions in the area	-13% NOx, -15% PM_{10}, -16% CO_2	-13% PM_{10}, -13% CO_2	-15% PM_{10} in 2011 compared to pre-Ecopass period. Further 18% PM_{10} in 2012 (first year of Area C) compared to 2011

Note: NOx, nitrogen oxides; PM_{10}, particulate matter with a diameter of 10µm or less.

Source: Croci (2016).

A7.4.2 Low-emission zones

The environmental benefits of LEZs arise because the most polluting vehicles can no longer drive in the zone or only under a number of conditions. Drivers of such vehicles can adapt in different ways: by replacing their vehicle with one that is allowed to enter, by switching modes for their trips in the LEZ, by changing destinations or by no longer making the trip by car. The environmental benefits depend on several factors:

- The share of the vehicles that are no longer allowed in traffic within the LEZ — the higher this share, the higher the potential improvement in air quality when the vehicles are banned.
- The difference in environmental performance between the vehicles that are allowed and those that are not — the larger this difference, the higher the potential environmental benefit.
- The extent to which the traffic within the area of the LEZ contributes to the level of air pollution in the LEZ and surrounding areas — if the air pollution is influenced to a large extent by other sources, the environmental benefit of the LEZ will be smaller.
- The population density and its composition in the area that benefits from the LEZ — the larger the population density and the larger the share of people that are vulnerable to air pollution, the larger the benefit of better air quality.
- The fate of the vehicles that are no longer allowed in the LEZ — their destination is of relevance.

Aside from access restrictions, other initiatives can discourage the use of cars in urban areas. Indeed, increasing the monetary costs of parking makes car transport less attractive and more sustainable modes more attractive.

Discouraging the use of cars in city centres can have additional positive environmental effects. It can reduce the land needed for parking spots, freeing up land that can be used for infrastructure for sustainable transport modes such as walking or cycling, making them more attractive, or that can be used to create more green areas in the city and increase the water permeability of surfaces. It can also reduce the amount of cruising in search of a parking spot. Hampshire and Schoup (2018) estimate that 15% of traffic in central Stuttgart is cruising. Eliminating this traffic will, however, not reduce the traffic volume by 15% because of rebound effects in congested cities.

A7.5 Policy corner

The digital technologies to implement road transport pricing schemes already exist. Nevertheless, the number of road pricing schemes in urban areas is still limited, and while a number of countries have introduced road user charges for HDVs on a large scale, there are no examples yet of such systems for light-duty vehicles. One of the main obstacles to their full-scale application lies in the lack of public acceptance. Several different motivations have been reported in the scientific literature (De Borger, and Proost, 2012; Börjesson et al., 2016; Schade, 2017):

- the public's lack of familiarity with new types of pricing schemes, resulting in uncertainty about the costs of changing transport choices and about the benefits of road pricing;
- the perception of road pricing as just another tax that comes on top of existing taxation;
- distrust about how the revenues will be used;
- concerns about equity across different income groups, people with different professional activities, people with different access to public transport, etc.;
- privacy concerns;
- difficulty in understand charging systems if the tariff schemes contain a lot of differentiation and if the charging systems differ by country or city.

In addition, the current economic climate, with high energy prices and inflation, makes the acceptance of road pricing even more difficult.

In general, parking policies are more readily accepted, which explains why many cities already charge high prices for on-street parking. New digital solutions, however, can increase the performance of such systems.

Some future developments are expected to make implementing the policies more attractive:

- further technological developments that are expected to lower the costs of digital solutions and increase their usefulness;
- the loss of fuel tax revenue as a consequence of the electrification of the vehicle fleet;

- the need to internalise the additional external costs that will arise if electrification will lead to lower driving costs;
- the need for a policy framework that can address any unwanted digital rebound due to the ongoing digitalisation of road transport.

A7.6 Bottom line

Digitalisation can enable the development and implementation of road pricing schemes that allow transport costs to be fully internalised. Such approaches have demonstrated the ability to effectively promote a modal shift to more sustainable transport modes, albeit at pilot scale. Despite not being a new concept, its implementation was impractical without the support of digital technology. Lastly, road pricing schemes can help to mitigate the unwanted rebound effects of digitalisation.

A7.7 Case study 7.1: SmartMove Brussels

Through a modelling study, the Brussels Capital Region analysed the effects of introducing road pricing for light-duty vehicles in its territory, in parallel to the per kilometre charge that already applies for HDVs. Compared to existing urban road pricing schemes in Europe, this system would apply to a much larger area, namely about 161km^2.

The charge consists of a per kilometre charge and a daily access charge. Both apply only during the working week. The per kilometre charge is higher during peak than off-peak periods and zero in the evening and over night. The daily access charge depends on the vehicles' fiscal power and powertrain technology (electric or not) and on the time of the day (peak vs off-peak). Several charge levels were studied. Here the results are reported for a daily access charge with a weighted average level of EUR 0.66 during the off-peak period only and double that amount for travels during the peak period. The kilometre charge is EUR 0.2/km in the peak period and EUR 0.08/km otherwise. For Brussels residents, the existing car purchase and annual vehicle taxes are abolished in the scenario.

Under these conditions model simulations indicate that SmartMove leads to the following results (De Ceuster et al., 2020):

- a reduction in the number of vehicle-km travelled by cars, vans and motorcycles of 7.7%;
- a reduction in congestion: the extra travelling time per kilometre compared to free flow speed is reduced by 30%;
- a reduction in passenger-km travelled of 2% (for all modes taken together) and a fall in the number of car passenger-km travelled of 6.7%;
- based on the 2020 vehicle fleet composition, CO_2 emissions decreased by more than 5%, and the decrease in emissions of air pollutants ranged between 4.8% and 5.3%, depending on the pollutant.

Car users who travel less by car are expected to adapt as follows: by making fewer trips or reducing the length of their trip in Brussels (53% of car passenger-km are expected to disappear, as drivers switch to bus-tram-metro (20%), train (14%) or cycling or walking (12%). For commuting and business travel there also is a shift to more carpooling. Overall, the environmental benefits are estimated to equal EUR 9.8 million.

This simulation does not yet consider the effect on the vehicle stock of differentiating the SmartMove charge according to the vehicle's fiscal power (giving an incentive to drive less powerful vehicles) and the type of propulsion. This is likely to lead to underestimating the impact. However, the environmental performance of the vehicle fleet in future years is expected to improve, partially reducing the impact of SmartMove on air pollutant and greenhouse gas emissions.

A7.8 Case study 7.2: Pigouvian transport pricing in Switzerland

The Swiss Competence Center for Energy Research, the Swiss Federal Roads Office and the Swiss Federal Office of Transport jointly financed a study on the impacts of a Pigouvian transport pricing scheme in Switzerland. The empirical work was conducted by ETH Zürich, the University of Basel and the Zurich University of Applied Sciences (Axhausen et al., 2021). The main objective of the project was to investigate the impact of a pricing scheme on behavioural shifts towards optimised and more sustainable travel patterns. In addition, the effectiveness of increasing the awareness of citizens through soft measures was explored. These do not involve an increase in transport costs but include measures such as sharing targeted information on the external costs associated with transport. The study took place in urban agglomerations in the German- and French-speaking parts of Switzerland from September 2019 to January 2020.

It involved a sample of 3,700 participants, selected through an initial survey among 21,800 individuals. Participants were identified based on a set of criteria such as living in a metropolitan area, being between 18 and 65 years old, travelling by car (either their own or shared) at least twice a week, and being able to use a smartphone and to walk without assistance. The last points were to ensure that participants have a free choice of mode and unimpeded access to the transport network. The study was 8 weeks long overall (from September 2019 to January 2020). It was divided into an observation period of 4 weeks followed by a 'treatment' period. Participants were enticed to actively participate in and complete the study through an incentive of CHF100 per person to be paid at the end of the treatment period. During this second period, participants were divided into three groups: a control group for which no additional action apart from monitoring was taken; an information group to which specific information about the impact of the participants' transport choices was provided; and a pricing group in which, in addition to receiving information, the Pigouvian scheme was also implemented. In that scheme, the external costs of transport due to climate change, health effects (i.e. air pollution, road accidents) and also congestion and crowding on public transport were internalised in the final user price. The set-up allowed, through the control group, decoupling the effect of the pricing scheme from the effects occurring for other reasons in the sample (e.g. general traffic volume, road repairs, weather) during the period of testing. In addition, by analysing the behaviour of the second group, it was possible to see how an increased awareness of transport externalities can influence transport choices.

The participants were tracked with a dedicated application installed on their smartphones, using the smartphone's location services. The app used machine learning algorithms to correctly identify not only trip parameters, such as duration, distance or the route followed, but also the mode of transport. This is an example on how digital technologies could promote the realisation of such pricing schemes that would otherwise be very difficult to implement in practice.

The study demonstrated that a time- and location-based transport pricing scheme that internalises the external transport costs can effectively reduce the external costs in the pricing group by approximately 5%, with a short-term elasticity of -0.31. This means that an increase in the transport price of 10% causes a decrease in the external costs of 3.1%. The researchers point out that this is largely in line with previous before-and-after studies of urban road pricing schemes and with the effects induced, for example, by an increase in the fuel price.

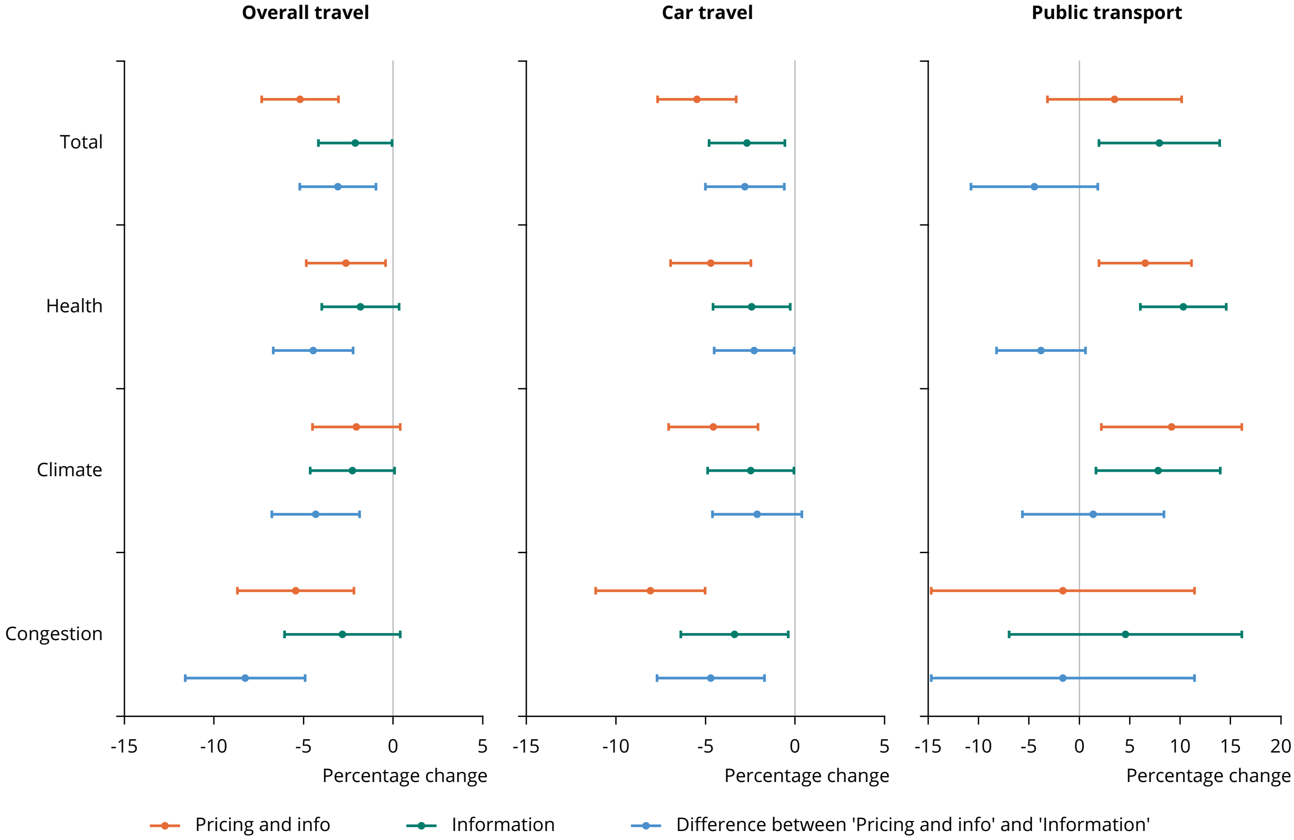
Figure A7.1 shows that, in general, it is possible to reduce the externalities associated with transport. This result can be achieved, albeit to different extents, not only by applying a Pigouvian pricing scheme, which confronts users with the external costs they impose, but also providing people with information on their external costs. Indeed, if information provided were the only relevant aspect, the relative bars would have been identical to those associated with the treatment including pricing and information. On the other side, if the information component were completely irrelevant, the relative bars associated with it would have been zero. To summarise, this suggests that providing information alone has a more limited effect than providing the combination of both measures. Interestingly, it can also be noted that, for congestion, the monetary component is relatively more important than for the other types of external costs, possibly because people understand it better than other environmental costs.

The middle and right panels of Figure A7.1 show that the reduction in external costs achieved is mainly due to a modal shift from car to public transport. Indeed, the reduction in the distance travelled by car is statistically significant and in the order of 3%. The share of public transport and active modes such as biking and walking increases.

The effects of applying this transport pricing scheme did not vary significantly with education level, age group or income level. The effects on congestion were significantly higher for men than for women. Preliminary data suggest that lower income households may be less sensitive to pricing (although the difference is not significant at conventional levels). Although this may look counter-intuitive, it is consistent with the hypothesis that people with high incomes tend to have jobs that are more flexible in terms of working hours.

Lastly, it should be mentioned that the number of participants in the study was limited, and this should be taken into account when considering the results reported here. An extensive transport modelling study or a full-blown experiment (such as that done in Stockholm before the official introduction of the cordon toll) can help to better understand these effects on large scale and to achieve the optimal design of a future pricing scheme.

Figure A7.1 **Treatment effects on the external costs of transport: overall travel (left), car travel (middle), public transport (right)**



Note: The bars denote the 80% confidence intervals.

Source: Axhausen et al. (2021).