Ministry of Infrastructure and Water Management

Expected effects of pay-per-use

Insights from literature and an expert session

KiM | Netherlands Institute for Transport Policy Analysis

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Summary

Pay-per-use (PPU) is a charge on car use set to be introduced in 2030, which will take the place of a charge on car ownership. As a result, the vehicle fleet is expected to grow in size, while total car use will fall because car drivers will seek out alternative modes of transport, will travel to more nearby destinations, or will refrain from making the journey in the first place. The decline in car use will probably lead to less congestion, fewer car accidents and lower NO_x, CO_2 and particulate matter emissions.

PPU also has economic and spatial implications. In the longer term, for example, PPU could influence the home and work locations of employees, even though total employment numbers are expected to remain unchanged. On balance, the economy will probably become slightly less efficient, because less congestion is still outweighed by the fall in demand for travel. These are all outcomes of an inventory of the possible effects of PPU, although those effects cannot yet been quantified.

The effects of PPU will influence social prosperity. The most important cost elements are likely to be the system and implementation costs, excise duties losses and a fall in demand. On the other hand, the most important benefit items are shorter journey times, less emissions and fewer road traffic accidents. The net effect of the proposed PPU system is still unknown.

Although much is known about the effects of PPU, a number of possible questions for further studies have been identified. They can be classified into three types. Firstly, uncertainties about the scale of the effects. These effects can better be estimated on the basis of new calculations, once the level of the PPU charge is known. Secondly, follow-up questions that require separate study, such as the consequences for delivery vans and the distribution aspects. Thirdly, there are inherent uncertainties, which even with further study will remain difficult to solve. One example is the extent to which people perceive PPU as a variable or a fixed cost item. If people come to view PPU as a fixed tax, there is a risk that the effects will be overestimated.

Contents

1 What is pay-per-use?

The coalition agreement contains the undertaking that by 2030 at the latest, the existing system of taxation on motor vehicles for all passenger cars and delivery vans will be converted into a tax based on the distance travelled by each vehicle. Freight traffic will be exempted from this pay-per-use (PPU) charge, in connection with the introduction of a heavy goods vehicle charge. PPU will be a charge on car use, whereas the current system of motor vehicle taxation is a charge on car ownership.

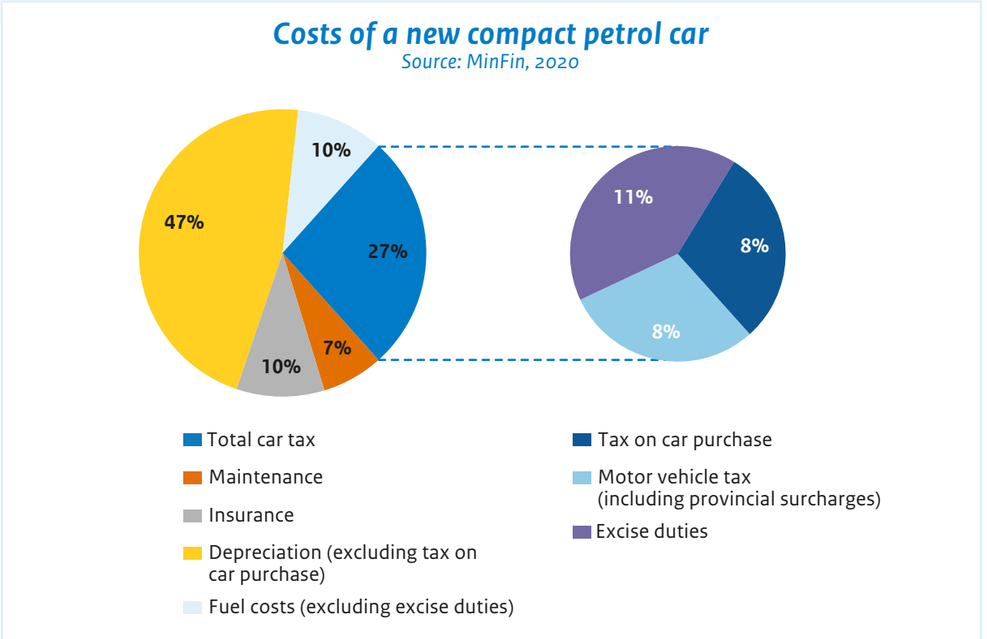
Why pay-per-use?

There are two reasons why PPU has been included in the coalition agreement. Firstly, PPU is intended to compensate for the fall in government revenue from excise duties and other car taxes (known as tax base erosion) due to the growing number of electric cars. Secondly, PPU should save 2.5 Mt of CO_2 in 2030, thereby contributing to the reduction of the climate problem.

What is set to change?

The motor vehicle tax will be converted from a tax on car ownership to a tax on car use. At the same time existing and planned toll charges in the Netherlands will expire. At present, the proportion of motor vehicle tax accruing to national government depends on the weight of the vehicle and the fuel type. Over and above the nationally collected tax, provinces levy the so-called provincial surcharges, which differ from province to province. At present, it is unclear whether – and, if so, in what form – these surcharges will be made part of the reform of the system of motor vehicle tax.

The other car taxes, i.e. the excise duties and the tax on car purchase, will remain in place. All in all, motor vehicle tax is just a small part of the overall costs of a car, as the following figure shows for a compact car in the B-segment.



The design of pay-per-use

The precise design of PPU is not yet clear. It is however clear that:

- Owners of all passenger cars and delivery vans registered in the Netherlands will pay a fixed amount per kilometre driven.
- The PPU rate will not be differentiated according to time and place. Dutch car owners will pay for every kilometre driven, including abroad, since where and when they drive is no longer relevant (as is also the case with the existing system of motor vehicle tax).
- Foreign nationals driving in the Netherlands will pay no PPU charge.
- The PPU charge will be introduced to be budget neutral (for government). In 2030, total revenue from car tax for national government must be the same as in 2025.
- The implementation costs must be covered by the PPU charge, while the introduction costs until 2030 are covered by the current budget.
- Exemptions and reduced charges in the current system of motor vehicle tax will remain in existence within the PPU charge system. Exceptions relating to the limited use of the road will in principle expire.
- The current system of motor vehicle tax will continue to apply to motorcycles, and motorcycle riders will therefore pay a fixed amount per year.

The PPU rate is not yet known. There is also considerable uncertainty about whether – and, if yes, how – the PPU charge will be differentiated according to weight, fuel type or environmental characteristics. This is currently being investigated.

Another major uncertainty relates to implementation; how and at which moment will the number of kilometres driven be registered and how frequently will be PPU charge be levied? These design issues could influence the effectiveness of the PPU charge. The effects described in the next chapter are based on the assumption that the PPU will be perceived as a variable charge. If it is viewed more as a fixed cost item, the effects are overestimated.

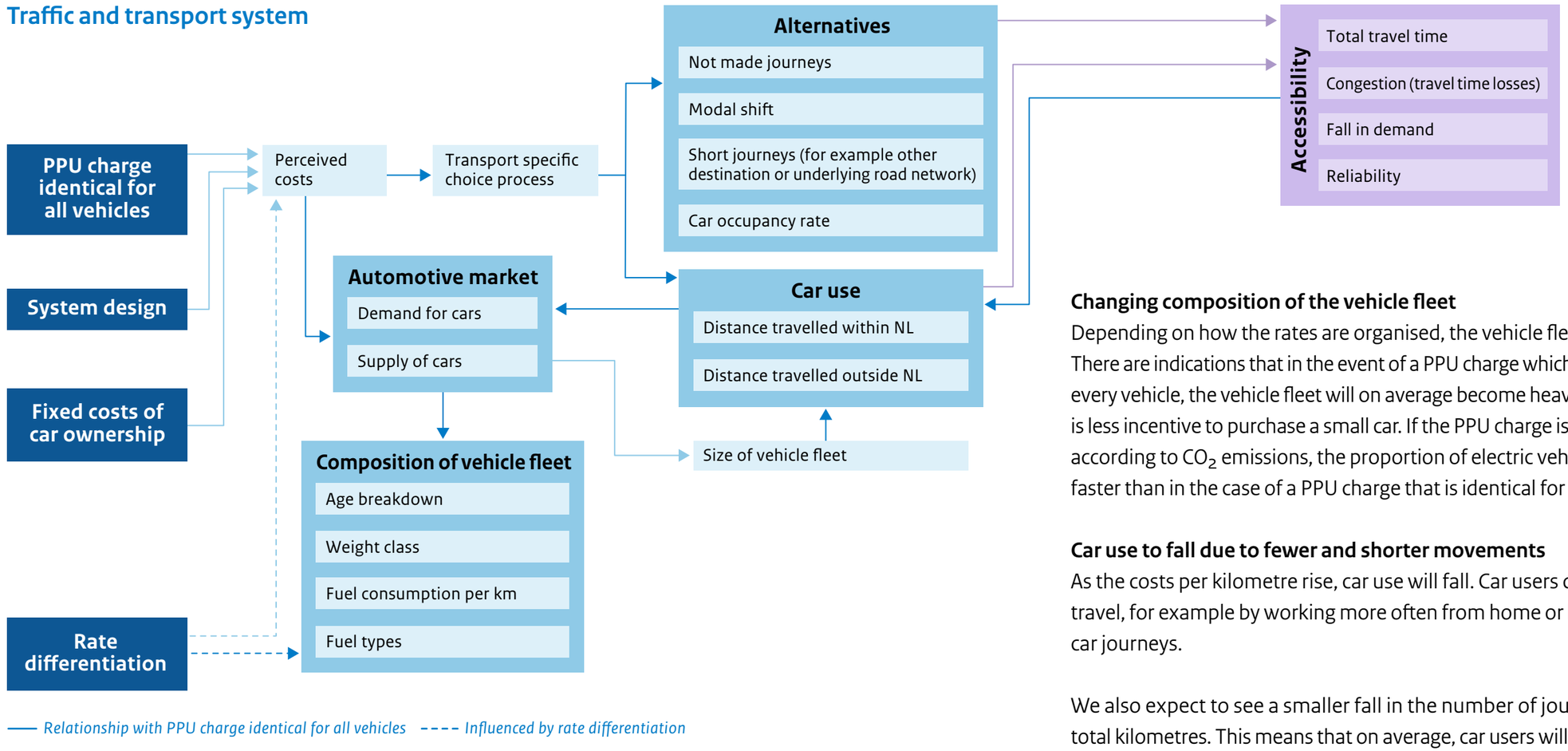
2 Possible effects

Pay-per-use will have effects on the perceived and actual cost of travel and will influence the choice of whether or not to travel by car. These choices not only influence the traffic and transport system, but also for example the automotive, housing and labour markets. We divide the effects of PPU into effects on accessibility, on road safety, on the human environment and on the economy. Many of these effects also have a spatial dimension and PPU could have consequences for example for the distribution between rich and poor, and between people living in rural areas and in cities. Here we describe all theoretically possible effects, without quantifying them. The effects are described in relation to the current system of car taxes and charges.

The effects of PPU will influence social prosperity. Calculations conducted on past PPU variants show that a flat rate charge, whether or not differentiated according to CO_2 emission will result in a loss of prosperity. The system costs and implementation costs, the loss of excise duty revenue and the fall in demand are the most important cost items, and these are higher than the most important benefit items, to wit journey time savings, lower emissions and fewer road traffic accidents. Whether the current plans will also result in a loss of prosperity could be determined in a new social cost-benefit analysis (SCBA). This analysis can be conducted once more is known about the eventual design of the PPU charge.

It is important to emphasise that the effects of PPU will not be expressed to their full extent immediately following the introduction of the PPU charge. People will need time to become familiar with the PPU and to consider their mobility patterns. It will be some time before their behaviour is fully adapted. To a certain extent, people will anticipate the PPU prior to its introduction by deliberately choosing to purchase or not to purchase a particular car. However, by its very nature, the vehicle fleet changes slowly. The average age of an end-of-life vehicle in the Netherlands is 19.6 years.

Traffic and transport system



Growth of the vehicle fleet
A proportion of households will purchase an extra car, because car ownership will become cheaper and therefore more accessible. On the other hand, another group will dispose of their car, if the variable costs of car usage rise. Recent simulation studies suggest that the first effect will be greater than the second, and that the vehicle fleet will grow.

Changing composition of the vehicle fleet
Depending on how the rates are organised, the vehicle fleet will change. There are indications that in the event of a PPU charge which is identical for every vehicle, the vehicle fleet will on average become heavier, since there is less incentive to purchase a small car. If the PPU charge is differentiated according to CO_2 emissions, the proportion of electric vehicles will grow faster than in the case of a PPU charge that is identical for all vehicles.

Car use to fall due to fewer and shorter movements
As the costs per kilometre rise, car use will fall. Car users can opt not to travel, for example by working more often from home or by combining car journeys.

We also expect to see a smaller fall in the number of journeys than in total kilometres. This means that on average, car users will make shorter journeys. In particular, this applies to social and recreational journeys. For example, they may choose to go shopping in the nearest city, instead of the capital city. In addition, car users will opt more often to travel via shorter routes (using minor roads). As a result, the fall in the volume of car traffic on the main road network will be more pronounced than on the underlying road network.

Switch to other modes of transport
A proportion of the car trips not undertaken will be undertaken using another mode of transport, such as train, (electric) bicycle, speed pedelec and bus, tram and metro. Car users will also carpool, or walk more often.

Less congestion and higher journey time reliability
Because of the fall in car use, there will be fewer (or shorter-lasting) traffic jams and less travel time delay. As a consequence, journey time reliability will rise. Consider the fact that even a small reduction in car use on a particular section of road can mean an end to all congestion on that road. All in all, this means that the fall in lost journey time is expected to be greater than the decline in car use.

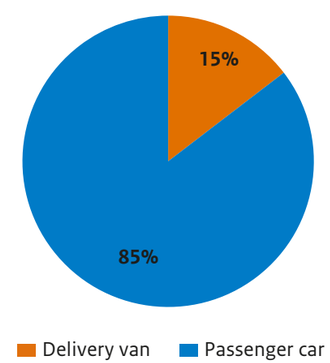
The total travel time delay will fall more on the main road network than on the underlying road network, because following the introduction of PPU, car drivers will make relatively more use of the underlying road network. Nonetheless, car use will decline on both the underlying and the main road network.

Will foreign car travel also be affected?
The above described effects could also apply to foreign travel. After all, kilometres driven abroad will be subject to the same charges as domestic kilometres. PPU could cause car users to choose not to travel abroad, or to do so less often, or to choose more nearby destinations. They could also opt for a different mode of transport, such as bus, train, aeroplane or foreign rental car.

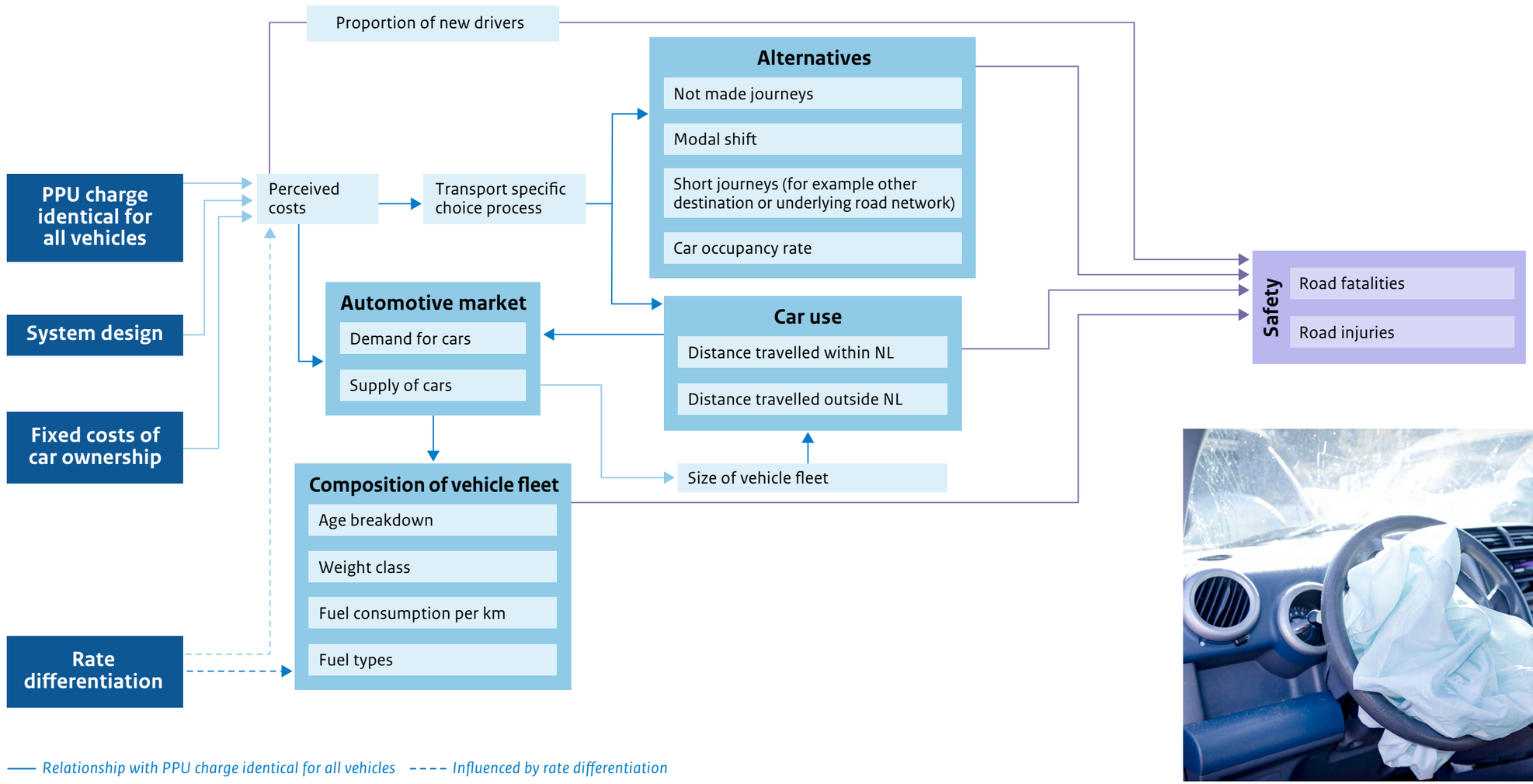
The consequences for accessibility poverty are uncertain
If a person is severely restricted in his or her possibilities for reaching destinations and attending activities, and as a consequence their ability to participate in society is negatively influenced resulting in a lower quality of life, this is referred to by the term 'accessibility poverty'. In particular for regular vehicle users in lower income groups who have few or no alternatives for the car at their disposal, PPU could increase the risk of accessibility poverty. On the other hand, there could be people for whom car ownership is made more affordable by PPU, thereby reducing accessibility problems. The net effect of PPU on accessibility poverty is currently unclear, because of the contradictory effects, and because the effects depend on the precise policy design. The exact effect is also difficult to assess because there is no consensus on when a person is suffering from accessibility poverty.

Uncertainty about the consequences for delivery vans
The effects outlined above relate only to passenger cars, and not delivery vans. Nonetheless, the drivers of delivery vans will demonstrate a number of behavioural responses similar to car drivers, such as taking shorter routes, combining activities or switching to other modes of transport such as an electric cargo bike. A shift is also expected towards electric or more fuel-efficient delivery vans, if the PPU rate is differentiated on the basis of CO_2 emissions. However, how much effect this will have on the size and composition of the delivery van fleet and for the use of delivery vans is uncertain. As the pie chart below shows, delivery vans are responsible for around 15% of the total distance travelled in the Netherlands, in 2019.

Distribution of distance travelled in the Netherlands in 2019
Source: Statistics Netherlands (CBS)



Road safety


Proportion of new drivers
Alternatives
Not made journeys
Modal shift
Short journeys (for example other destination or underlying road network)
Car occupancy rate
PPU charge identical for all vehicles
Perceived costs
Transport specific choice process
System design
Automotive market
Demand for cars
Supply of cars
Car use
Distance travelled within NL
Distance travelled outside NL
Fixed costs of car ownership
Size of vehicle fleet
Composition of vehicle fleet
Age breakdown
Weight class
Fuel consumption per km
Fuel types
Rate differentiation
Safety
Road fatalities
Road injuries
Relationship with PPU charge identical for all vehicles
Influenced by rate differentiation

Foreign studies suggest improved road safety
The majority of studies on the safety effects of road pricing measures in other countries reveal an improvement in road safety one year following their introduction. The effect differs depending on the context and the variants studied.

Above all less driving improves safety
The primary reason why PPU improves road safety is that fewer car kilometres are driven. There are around 1.6 traffic fatalities for every billion car kilometres driven in the Netherlands. The introduction of PPU results in fewer car kilometres, which will logically result in less road fatalities and injuries.

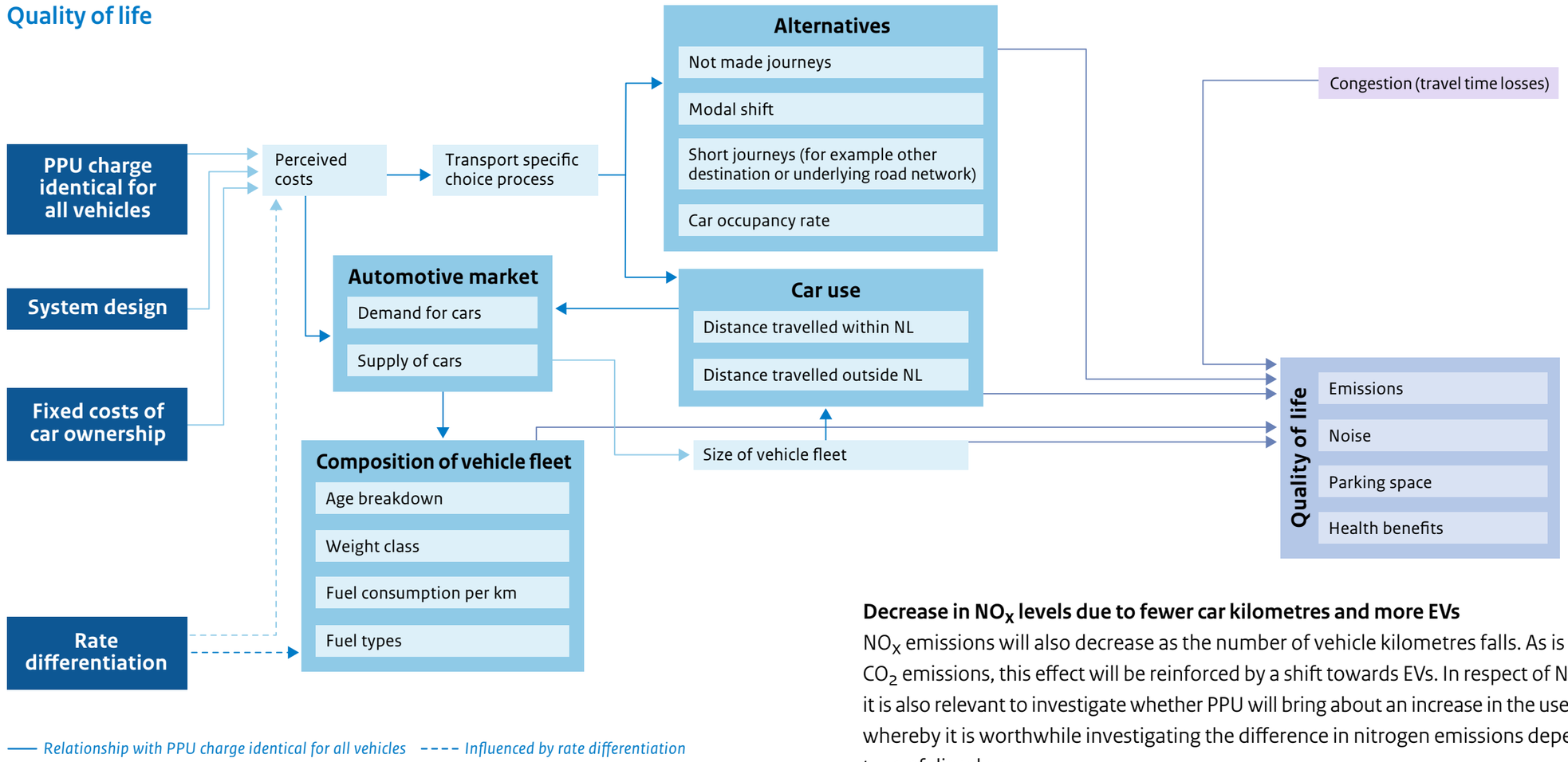
Safety improvement on both main and underlying road network
The risk of an accident on motorways is lower per vehicle kilometre than on other road types. When PPU is introduced, a proportion of motorway movements (which is part of the main road network) will probably shift to the underlying road network, because car drivers will opt for the shortest route (instead of fastest). Literature suggests that the fall in kilometres will be greatest on the main road network but that on balance there will probably also be a decrease on the underlying road network. In other words, a decline in the number of passenger car kilometres can be expected on all road types and that will probably result in a reduction in the number of accidents on all road types.

Modal shift may somewhat attenuate the improvement
Car driving is safer per kilometre than walking, cycling and motorcycle and scooter travel. Public transport, on the other hand, is safer than the car. As yet there are no precise analyses, but estimates suggest that the change in choice of transport mode as a consequence of PPU may somewhat attenuate the positive effect on road safety.

Changes in the vehicle fleet may have a minor effect
If PPU results in a younger vehicle fleet, this will probably have a slightly positive effect on road safety. New cars are safer than old cars as result of design improvements. At the same time, PPU may bring about a slight increase in average car weight. There is a discussion in literature about whether or not heavier cars result in a worsening of the safety situation of vulnerable road users.

More young drivers driving unsafely?
Young car drivers are relatively more often involved in accidents. If young people are encouraged to purchase and use a car more often or sooner as a result of the introduction of PPU, because car ownership becomes cheaper, it is possible that more accidents will take place. PPU may also cause a group of inexperienced (not young) car drivers to take to the road. If more inexperienced people start driving, this is expected to have at most a temporary negative effect on safety, since the more you drive the more experience you acquire. Whether PPU will indeed encourage more people to purchase cars, and who those people are, is still uncertain.

Quality of life



Decrease in CO_2 emissions due to fewer car kilometres and more EVs
When PPU is introduced, CO_2 emissions will decrease as the number of vehicle kilometres falls. This effect will be reinforced by a faster shift away from petrol-driven cars to fuel-efficient cars such as electric vehicles (EVs).

Decrease in NO_X levels due to fewer car kilometres and more EVs
NO_X emissions will also decrease as the number of vehicle kilometres falls. As is the case with CO_2 emissions, this effect will be reinforced by a shift towards EVs. In respect of NO_X emissions, it is also relevant to investigate whether PPU will bring about an increase in the use of diesel cars, whereby it is worthwhile investigating the difference in nitrogen emissions depending on the type of diesel car.

Fall in particulate matter due to fall in car kilometres
Particulate matter is not released only from combustion engines but also as a result of wear in particular from tyres and brakes. The introduction of PPU is expected to reduce the particulate matter generated by road traffic, above all as a result of the fall in vehicle kilometres.

PPU will also cause a shift towards EVs. There is no consensus in literature about the relationship between EV adoption and particulate matter emissions. EVs emit no particulate matter via the engine, and their braking is more economical than combustion engine cars, but they are heavier. As a result, their tyres undergo more wear, which results in more particulate matter emissions. The majority of studies conclude that a shift to EVs on balance has the potential to reduce particulate matter emissions.

The precise effect of less congestion on emissions is unknown
Emission rates per kilometre are lower from cars travelling at a constant speed. A reduction in congestion as a result of PPU is therefore expected to reinforce the effect of the fall in emissions. How great this effect will be is not known.

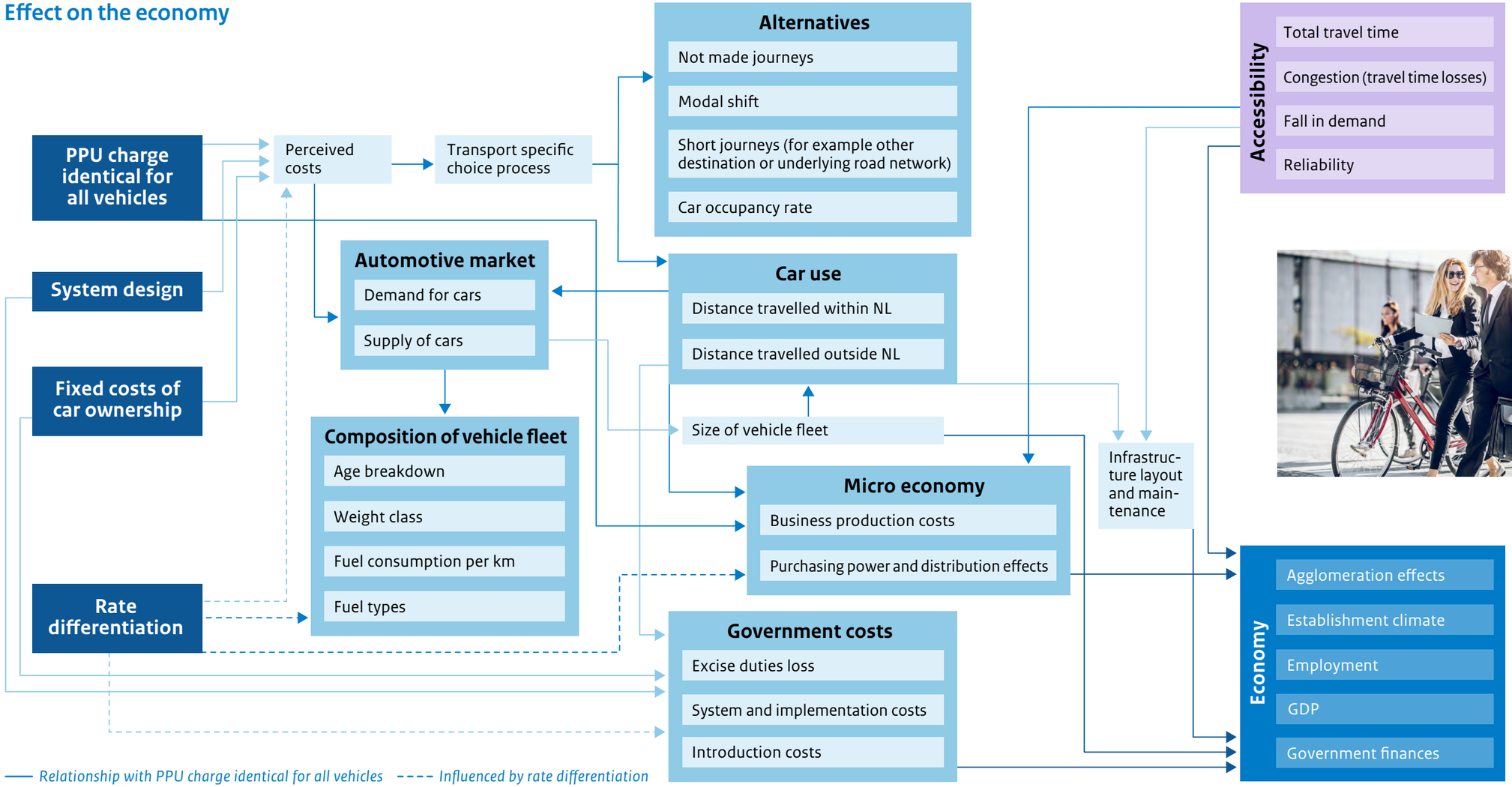
Noise nuisance will probably decline, but there has been little research in this area
The effect of PPU on noise has been less researched than its effect on emissions. This effect is often not considered in studies, or a pure linear relationship is assumed, between the number of car kilometres and car noise.

Changes in the vehicle fleet, such as heavier vehicles, and the modal shift also influence noise, but these effects are probably marginal. Moreover, noise nuisance has a very local and time-specific dimension, such that changes in choice of route and traffic journey timing could have consequences for noise nuisance.

If the vehicle fleet grows, parking pressure will increase
The introduction of PPU may result in a larger vehicle fleet. On top of the fact that more cars will have to be produced, this also means an increase in the use of space. To identify where parking pressure will increase, greater insight is needed into which people will purchase a car following the introduction of PPU, and where they live.

Health benefits due to growth in active modes of transport
Not only are the reduction in emissions and noise good for human health, but also the increase in walking and cycling. Although active modes of transport such as walking and cycling have a higher risk of road traffic accidents and the inhalation of polluted air, the health benefits of active movement as a whole considerably outweigh the negatives.

Effect on the economy



The continued effect of PPU will benefit some businesses and households and disadvantage others

At the level of individual households and businesses, in particular regular vehicle users including business drivers, will be confronted with higher travel costs, on balance. At the same time, there will be less traffic congestion. This is a benefit for example for transport companies and for rush hour drivers (above all for home-work travel and business drivers). Both increased travel costs and reduced congestion will influence the productivity of businesses and their employees and the purchasing power and spending patterns of consumers. This will, however, be different for different people. In other words, the distribution of the effects cannot be clearly specified in advance.

The effects on GDP are limited, but probably negative

The effects on individual businesses and households translate into an effect on gross domestic product (GDP). Above all we will see a number of shifts take place. Across the board, the effect on GDP will be limited, but probably slightly negative. The fall in demand for travel will outweigh the reduced congestion levels, as a result of which on balance the economy will become slightly less efficient.

Almost no employment effects are expected

PPU will have few consequences for the labour market, labour productivity or labour supply. PPU is not expected to create any additional employment at macroeconomic level. PPU could however lead to shifts on the labour market. Job opportunities could for example shift between locations or sectors.

Agglomeration effects contribute to overall prosperity

The effects on the economy are the result of changes in mobility and accessibility. To determine the impact on prosperity across the board, the majority of the effects on the economy are already included in the effects on journey times and car costs. The only other factors that could result in additional effects on prosperity are the benefits or disadvantages in terms of agglomeration. These are generated by effective proximity and include knowledge spillovers, economies of scale and bundling effects. They mean that employees and businesses can achieve a better match, allowing employees to be more productive, businesses to specialise and giving consumers having a greater freedom of choice that better ties in with their preferences. On balance, PPU appears likely to slightly reduce these types of benefits.

Effects on government finances uncertain

The underlying principle of budget neutrality for PPU sounds simple, but is anything but. Firstly, the system costs and implementation costs are still uncertain, at this stage. Secondly, there are complex relationships between rates and loss of demand that are difficult to predict prior to introduction. Thirdly, second order effects may occur that influence government expenditure, such as the changing costs of operating public transport, or less frequent maintenance of the road infrastructure. The scale of these effects for government finances is uncertain.

Spatial implications

The effects outlined above often also have a spatial dimension. The reduction in car traffic and the related emissions of particulate matter and NO_X, for example, are not the same everywhere. There are a number of other spatial effects, which we will discuss below.

Shorter home-work travel distances in the longer term

In the short term, people are not expected to change jobs in large numbers, when PPU is introduced. Travel costs are often partially reimbursed by employers, and for many people travel costs are of relatively little importance when choosing a job.

In the longer term, PPU charge could be a contributing factor in deciding for example whether or not to apply for a different job. In particular for people who have enjoyed lower education and who are looking for less specialist positions, the increase in travel costs could influence their choice of work location. This may result in a small reduction in home-work travel distances, after PPU is introduced.

In the long term, PPU will influence the choice of place of residence

It appears that PPU will have only a limited influence on the decision to move home. When someone decides to move home anyway, travel costs are certainly a factor in the choice of place of residence. In the longer term, PPU could therefore influence the housing market, which could be reflected in higher prices in certain areas where employment opportunities are plentiful.

Almost no influence on new construction locations

The home-work travel choices of consumers and the choice of location for businesses are above all reflected in the distribution of people and businesses across certain locations and less in the question where new homes are to be built, or new business parks created.

Little influence on choice of business location

For the time being, transport costs represent only a small proportion of total business costs; furthermore PPU only affects the costs of delivery vans and business drivers. Moreover, part of the cost rise due to PPU will be compensated for by productivity gains since less journey time will be lost on the road. As a consequence, little to no impact is expected on the spatial economic functioning of the Netherlands, if a flat rate PPU charge is introduced.

Unclear burden distribution between urban and rural areas

If PPU is introduced, it is unclear whether people in rural areas will experience more or fewer effects than people living in urban centres. We have identified the following differences between urban and rural areas:

- People living in rural areas on average travel more car kilometres per person than people who live in cities.
- In the Randstad conurbation there is more traffic congestion than in rural areas so urban dwellers may enjoy more benefits from journey time gains if congestion is reduced thanks to PPU.
- In the Randstad conurbation, cars are mainly used by people from higher income groups, while in the provinces of Groningen and Drenthe, for example, both medium and high income individuals are well represented in the top sections of car users.
- Car ownership in rural areas is higher than in cities. People in rural areas will benefit more from the scrapping of tax on car ownership.
- In general public transport is better organised in cities than in rural areas, making public transport more often an alternative for car travel.
- In cities, the distance to facilities is on average shorter than in rural areas, making walking and cycling more attractive alternatives.

3 Uncertainties and possible follow-up study questions

In this study, we identified a number of uncertainties and follow-up study questions, that are broken down into three groups below.

Reassessing the effects once the guiding principles are known

In this study, we identified the effects of PPU, without quantifying them. A quantified estimate of many of these effects, like the consequences for traffic performance, congestion, vehicle fleet size and composition and CO_2, NO_X and particulate matter emissions can be achieved on the basis of new calculations. These calculations can be conducted per future scenario, as soon as the guiding principles for the proposed PPU charge are further crystalised.

Given the uncertainties about the future, it is advisable to calculate multiple future scenarios, such as the high and low welfare, prosperity and quality of the living environment (WLO) scenarios. After determining the effects, a social cost-benefit analysis (SCBA) could be conducted, to better estimate the consequences of the proposed PPU charge for prosperity in the Netherlands.

Possible follow-up questions requiring separate study

The models generate a wealth of information about the effects of PPU, but additional study will be needed to gain greater clarity in respect of a number of subareas:

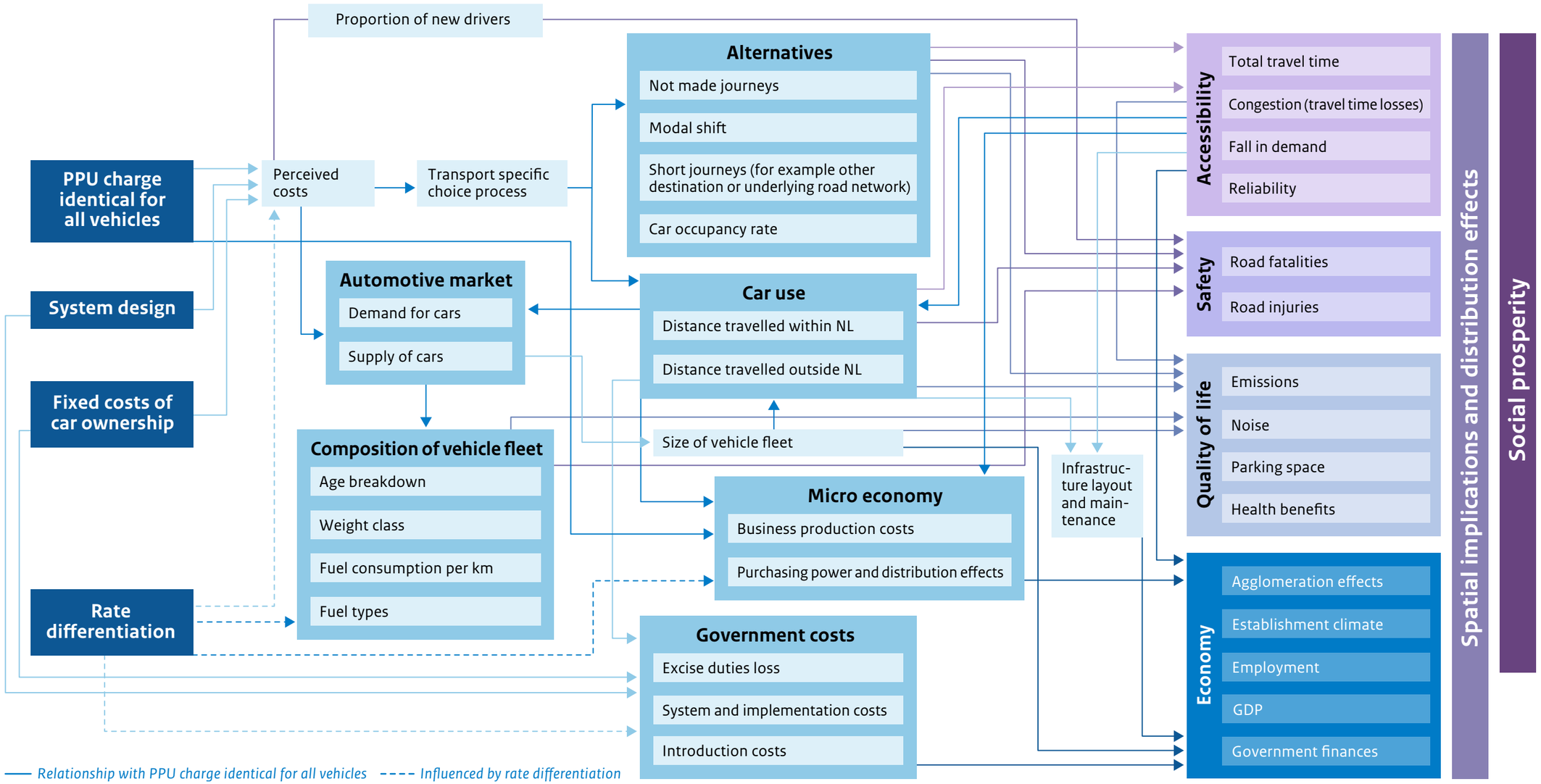
- What are the distribution effects of PPU? Who will pay more and who will pay less? And which groups will enjoy the benefits of less travel time delay and better air quality?
- What are the effects of PPU on the size, composition and use of the delivery van fleet?
- To what extent will PPU change foreign travel behaviour?
- To what extent will a modal shift occur towards electric bicycles and speed pedelecs if PPU is introduced? And what consequences will this shift have?

Inherent uncertainties

Ex-ante research does not much help improve the assessment of inherent uncertainties. The best thing you can do with uncertainties of this kind is be aware of their presence, conduct sensitivity analyses of various scenarios and possibly organise ex-post monitoring. In respect of PPU, the following inherent uncertainties have been recognised:

- Do people perceive PPU as a variable or as a fixed cost item? The extent to which people perceive it as a variable or fixed tax also depends on its design.
- What are the possible long-term spatial implications of PPU in respect of home and work locations? The effect is indirect but relevant, in the light of the major home construction needs.

4 Appendix: Conceptual model



Acknowledgements

Method

This study is based on an extensive literature study supplemented by insights from interviews and an expert session.

Background report

For more information on the data used, methodology, results and references, consult the background report (in Dutch) that can be downloaded via the website www.kimnet.nl

Knoope, M., Krabbenborg, L., Romijn, G. en P. Wortelboer-van Donselaar (2022). *Verwachte effecten van betalen naar gebruik. Inzichten vanuit de literatuur en een expertsessie.* Achtergrondrapport. The Hague: Netherlands Institute for Transport Policy Analysis (KiM).

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