A Social Cost Benefit Analysis of Road Pricing in the Netherlands

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ABSTRACT

In the Netherlands, many political parties consider road pricing as an important instrument to improve accessibility. In 2012, 6 of the 10 parties had included some form of pricing policy in their election manifestos. The most recent SCBA of road pricing in the Netherlands dates from 2007. Since then, much has changed. For example, road congestion has decreased and new pricing systems have entered the market. Furthermore, a new version of the Dutch National Transport Model (Dutch: LMS) has been implemented.

Therefore, in order to re-evaluate the costs and benefits of road pricing schemes in the Netherlands, CPB Netherlands Bureau for Economic Policy Analysis and PBL Netherlands Environmental Assessment Agency conducted a new Social Cost Benefit Analysis (SCBA).

The main benefits associated with road pricing are reduced travel time, increased travel reliability, fewer traffic accidents and emission reductions. However, road pricing also leads to welfare losses due to a reduction in demand, a reduction in revenues from excise duties and both direct and indirect financing costs. Furthermore, the charge may increase the overall cost of a journey. This has a negative effect on accessibility for people and companies. A decrease in accessibility can lead to negative agglomeration effects. On the other hand, the average total journey costs can also decrease as a result of road pricing, which would improve accessibility, leading to positive agglomeration effects.

This paper focuses on four road pricing schemes for passenger vehicles. A flat rate charged on all roads, a congestion charge during peak hours on highly congested roads, a combination of these two, and a flat rate during peak hours on the main roads in western and central Netherlands. For the traffic implications of these pricing schemes we used the Dutch National Transport Model.

The SCBA uses the socio-economic long-term scenarios Global Economy (GE) and Regional Communities (RC) from the study Welfare, Prosperity and Quality of the Living Environment (Janssen, L.H.J.M. et al., 2006). The differences between the two scenarios are substantial. Under the GE scenario, the Netherlands is more prosperous and has a larger population than under the RC scenario.

Whether pricing is socially beneficial, strongly depends on the chosen form and scenario (congestion level). With an increasing population and an

expanding economy, we expect more traffic and congestion. In that case, road pricing is expected to be more socially beneficial. A large part of the social benefits are travel time benefits caused by reduced traffic congestion. Pricing policies specifically aimed at congested roads during peak hours are therefore efficient if the costs remain limited. The congestion charge has a small impact on total car use, but reduces congestion more efficiently, compared to a flat rate. Because cars are becoming safer and more energy efficient, the reduction in the external effects of road pricing is limited. The welfare loss, due to reduced demand, and the system costs outweigh the benefits of reduced congestion in case of a flat-rate pricing scheme, unless the congestion level is very high, as is the case under the GE scenario.

1. INTRODUCTION

In the Netherlands, many political parties consider pricing as an important instrument to improve accessibility. In 2012, 6 of the 10 parties had included some form of pricing policy in their election manifestos.

The main benefits associated with road pricing are reduced travel time, increased travel reliability, fewer traffic accidents and emission reductions. However, road pricing also leads to welfare losses due to a reduction in demand, a reduction in revenues from excise duties and both direct and indirect financing costs. Furthermore, the charge may increase the overall cost of a journey. This has a negative effect on accessibility for people and companies. A decrease in accessibility can lead to negative agglomeration effects. On the other hand, the average total journey costs can also decrease as a result of road pricing, which would improve accessibility, leading to positive agglomeration effects.

The last SCBA of road pricing in the Netherlands dates from 2007. Since then, much has changed. For example, the congestion has decreased and new pricing systems have entered the market. Furthermore a new version of the Dutch National Transport Model, used as instrument to calculate the traffic implications, has been implemented. Therefore, a new Social Cost Benefit Analysis (SCBA) has been conducted.

This study[1] focuses on four road pricing schemes for passenger vehicles:

1. a flat rate on all roads, of 7 ct/km[2].
2. a congestion charge during peak hours on highly congested roads, of 11 ct/km.
3. a combination of the first two.
4. a flat rate during peak hours for the main roads in western and central Netherlands, of 5 ct/km.

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[1] This paper is based on the study of CPB and PBL in 2015 and the corresponding background document. Authors of this study are in alphabetical order H. Hilbers (PBL), J. van Meerkerk (PBL), A. Verrips (CPB), W. Weijschede-Van Straaten (CPB) and P. Zwaneveld (CPB) with the assistance of A. Brouwers (CPB).
[2] All prices are in euros.

These pricing schemes are similar to the most likely alternatives in the election manifestos and the most likely alternatives currently under discussion in the Netherlands. The Appendix provides an impression of the Dutch roads that would be subject to a congestion charge and peak-hour charge.

The SCBA uses the socio-economic scenarios Global Economy (GE) and Regional Communities (RC) from the study Welfare, Prosperity and Quality of the Living Environment (Janssen, L.H.J.M. et al., 2006). The differences between the two scenarios are substantial. Under the GE scenario, the Netherlands is more prosperous and has a larger population than under the RC scenario. This leads to a significant bandwidth between the development of congestion and car use, as shown in the figure below.

Figure 1: development of car use (left) and congestion (right), under the GE and RC scenarios, based on forecasts using the Dutch National Transport Model
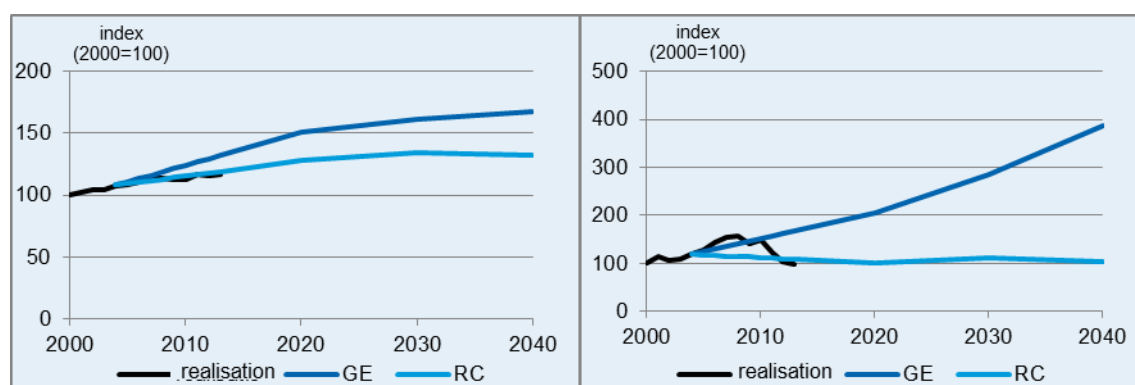
The Dutch National Transport Model is used for calculating the traffic implications of the various pricing policies[3].

The pricing policies apply to all passenger vehicles from 2020 to 2050. Although the effects on freight flows are included in the analysis, the pricing policies do not apply to trucks. Foreign cars on the Dutch roads would be charged as well. In this study, we assumed that the additional costs involved in the taxation of foreign cars will be completely offset by the revenues.

It is assumed that employers will not compensate their staff for the additional travel costs incurred by the road price, and that these costs are refunded by a reduction in car ownership tax, in such a way that the level of car ownership would remain unchanged. Additional analyses have shown that this will be the case if road pricing is introduced in combination with a partial abolition of the motor vehicle tax (Dutch: MRB) and a reduction in vehicle registration tax (Dutch: BPM).

Furthermore, It is assumed that, after 2020, no further investments will be made in additional road capacity.

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[3] The National Transport Model is the forecast model of the Dutch Ministry of Infrastructure and the Environment. The model can be used as a tool for the preparation of mobility projections under different environmental scenarios, to calculate the effects of infrastructure projects and to calculate the impact of various policies, such as road pricing.

The project alternatives can be technically implemented in various ways. The following technical systems are included in the analysis:

- a box with GPS function (A)
- an odometer (B)
- a simple box (C)
- an ANPR system (with registration via the vehicle registration plate) (D)
- a DSRC system (with a tag in the car) (E)
- a smart vignette (sticker in the car and registration along the way) (F) (Abel Delft, 2014).

This paper is structured as follows. Section 2 starts with a short description of the mechanism of road pricing. Section 3 shows the impacts on traffic volumes and congestion levels. Section 4 presents the outcomes of the SCBA, and additional analyses are presented in Section 5. Finally, in section 6 conclusions are drawn.

2. THE MECHANISM OF ROAD PRICING

Making a journey leads to costs for road users and for society.
The costs for road users consist of travelling expenses, travel time and the effort involved in making the journey. The total costs are sometimes called 'generalised cost' or travel 'resistance'. Opposite these costs are the benefits of a journey: reaching the destination. Economic theory assumes that a road user only makes a journey when the benefits are larger than the costs. In addition to the costs for road users, there are also social costs. Examples are road maintenance and management, accidents, congestion, environmental and noise pollution.

Road pricing discourages car use. A number of road users will choose to use their car less often. In general, there are the options to cancel the journey, choose another travel mode (e.g. public transport, bicycle), or a long-term solution, migrate or change jobs. With respect to a congestion charge during peak hours on highly congested roads, there is also the possibility to use a different route or travel at a different time. The decrease in the number of road users due to higher costs would lead to welfare losses. On the other hand, the reduction in car use will lead to less congestion. Road pricing changes the composition of the generalised costs; the cost component increases and travelling time decreases. Road users pay more for their journey, but they gain in travel time due to a decrease in congestion level.

As already noted, as a result of road pricing car use is discouraged. However, people differ in how they value travel time. In general, four types of road use can be distinguished: freight traffic, business traffic, commuter traffic, and social or recreational traffic. The last group generally values travel time the lowest and is therefore the most sensitive to increases in travel costs.

Motorists who value travel time relatively low will be more likely to cancel their journey, to change their route, or to depart at a different time, than road users who attach more value to travel time. Those who 'stay' experience a reduction

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in their travel time. Also, the reliability of the journey will increase for them as day-to-day variability of travel time caused by fluctuating congestion levels is reduced. Those who 'leave', experience a certain welfare loss, as they do not travel anymore or choose a less attractive alternative. On balance, also taking the different valuations of travel time between the different groups of road users into account, the result will be an increase in welfare, provided that the costs of introducing the road pricing scheme are not too high, and that the travel time benefits continue to outweigh the negative effects of a drop in demand. In case of a flat rate on all roads, however, fewer kilometres will be travelled in places where traffic jams were never a problem, even before road pricing was introduced. When the overall travel time reduction is limited and travel costs increases severely, the generalised cost of travel will increase. In that case, the negative effects of less car use together with the system costs will outweigh the benefits of reduced travel time.

The reduction in car use would also lead to indirect economic effects, in the form of so-called agglomeration effects. For example, due to the road charge, the barrier for commuter traffic becomes larger, which leads to a less well-functioning labour market. Other examples are fewer knowledge spillovers and fewer scale benefits. On the other hand, the benefits of reduced travel time and increasing reliability have positive agglomeration effects. The net effect depends on the ratio between the gains and the welfare losses.

The decrease in the number of kilometres would lead to fewer harmful emissions, less noise and fewer traffic accidents. It also depends on where the kilometres are made; urban areas are less safe than motorways. Fewer kilometres travelled by cars means less fuel use and, as such, lower tax revenues for the government. This means a loss of welfare. If the external effects, expressed in euros per kilometre, equal the excise duty on fuel, then the externalities will have been fully internalised.

The charged price rate will determine the magnitude of the effects. The higher the rate, the greater the reduction in car use. The welfare loss from the drop in demand could then outweigh the travel time saved. On the other hand, a rate that is too low would leads to minimal adaptations and effects.

## 3. IMPACT ON TRAFFIC VOLUME AND CONGESTION

The main mobility effects are shown in Figure 2. The figure shows an overview, in percentages, of the reduction in vehicle kilometres and the congestion levels of the four main project alternatives, with respect to a baseline situation without pricing in 2020[4].
A congestion charge and a flat rate charged during peak hours, tackle the congestion levels more effectively that a flat rate charged on all roads; the

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[4] Under the RC scenario, the decrease in traffic volume is mostly greater than under GE. Under RC, with substantially lower economic growth, people are more price sensitive. The decrease in congestion levels is also higher under RC than GE, because the GE scenario contains a higher traffic volume. However, the absolute decrease in the congestion level is higher under GE than under RC.

reduction in congestion is substantial, while the decrease in car use remains limited.

Figure 2: reduction in vehicle kilometres and congestion levels of the four main project alternatives in 2020
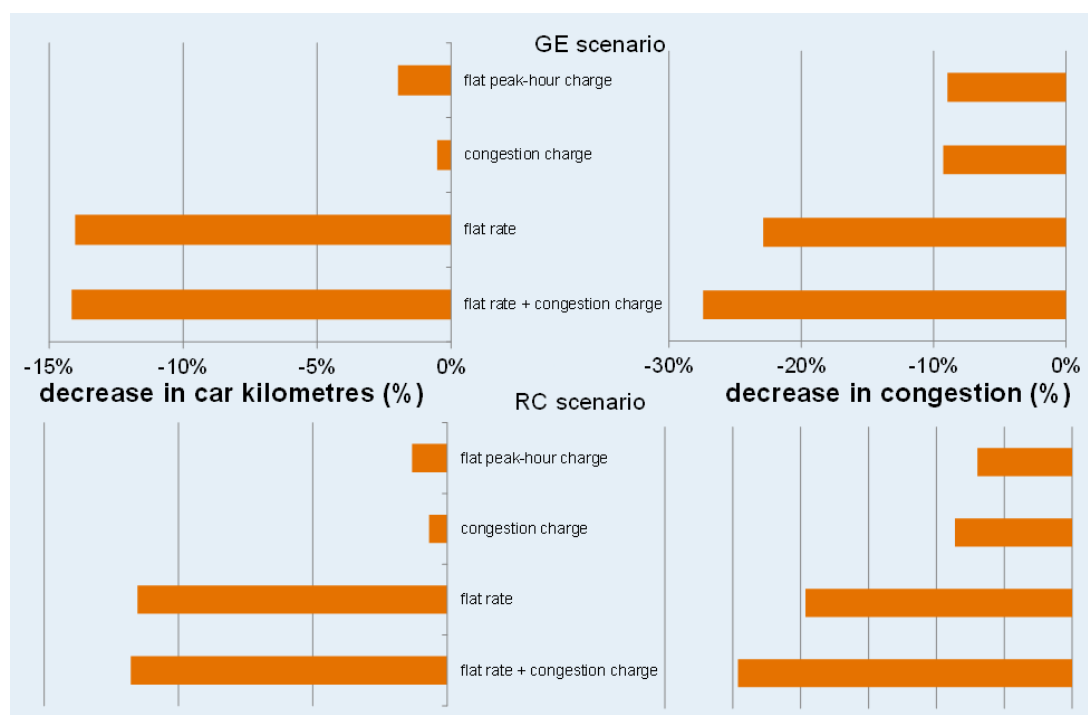
The decrease in the number of kilometres due to the congestion charge and the flat rate during peak hours is 0.5% and 2%, respectively.

The flat tax, whether or not combined with a congestion charge leads to a reduction in traffic volume under the RC and GE scenarios, by approximately 15% and 12%, respectively.

A reduction in car use does not imply an equivalent increase in the use of public transport. The decrease in the number of kilometres travelled by car is reflected only by an approximate 10% increase in those travelled by public transport.

4. WELFARE EFFECTS OF ROAD PRICING

Table 1 shows the effects of the congestion charge and the flat peak-hour charge for both scenarios (in net present value (NPV) for the year 2014, price level 2012)[5]. Table 2 shows the costs and benefits of the flat rate and the combination of a flat rate and a congestion charge. The effects of each project alternative are the same for the various technical systems, so the effects are shown only once for each alternative for the sake of clarity.

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[5] The discount rate is 5.5% (a real discount rate of 2.5% and a risk premium of 3%). For emissions a discount rate of 4% is used.

Table 1: SCBA results of the congestion charge and flat peak-hour charge (billion euros, NPV 2014, 2012 prices)

	Pricing policy Congestion charge						Pricing policy Flat peak-hour charge					
	RC scenario			GE scenario			RC scenario			GE scenario		
System (a)	D	E	F	D	E	F	D	E	F	D	E	F
Costs												
Investment	-0.1	-0.3	-0.1	-0.2	-0.5	-0.1	-0.2	-0.4	-0.1	-0.2	-0.5	-0.1
exploitation	-1.3	-2.4	-1.3	-1,5	-2,8	-1,4	-1,6	-2,5	-1,4	-1,7	-2,9	-1,5
Total costs	**-1.4**	**-2.7**	**-1.3**	**-1.7**	**-3.3**	**-1.5**	**-1.8**	**-2.9**	**-1.6**	**-1.9**	**-3.4**	**-1.6**
Effects												
Travel time	2.6	~	~	6.0	~	~	1.9	~	~	4.0	~	~
Distance	0.0	~	~	0.1	~	~	0.1	~	~	0.1	~	~
Reliability	0.6	~	~	1.5	~	~	0.5	~	~	1.0	~	~
Drop in demand	0.0	~	~	0.0	~	~	-0.2	~	~	-0.1	~	~
Time administration	-0.8	~	~	-1.3	~	~	-0.8	~	~	-1.3	~	~
Indirect effects	0.1	~	~	0.3	~	~	-0.2	~	~	0.0	~	~
Excise duty	-0.3	~	~	-0.3	~	~	-1.0	~	~	-0.6	~	~
Road maintenance	0.0	~	~	0.0	~	~	0.0	~	~	0.0	~	~
PT subsidy	0.0	~	~	0.1	~	~	0.2	~	~	0.1	~	~
Road safety	0.0	~	~	0.0	~	~	0.1	~	~	0.0	~	~
Noise	0.0	~	~	0.0	~	~	0.0	~	~	0.0	~	~
Pollution	0.0	~	~	0.1	~	~	0.2	~	~	0.1	~	~
Total effects	**2.4**	**~**	**~**	**6.2**	**~**	**~**	**0.8**	**~**	**~**	**3.4**	**~**	**~**
Net effect	**0.9**	**-0.4**	**1.0**	**4.5**	**2.9**	**4.7**	**-1.1**	**-2.2**	**-0.8**	**1.5**	**0.0**	**1.8**

(a)
D: an ANPR system (with registration via the vehicle registration plate)
E: a DSRC system (with registration via a tag in the car)
F: a smart vignette (sticker in the car and registration along the way)

The net effect of the congestion charge, for the most part, is positive under both scenarios, if the ANPR (D) or the smart vignette (F) are used. The travel time and reliability benefits of the congestion charge are substantial, while there are hardly any negative effects caused by reduced demand. The composition of the traffic on busy roads during peak hours changes; social and recreational traffic changes its route, time of travel, or modality, or cancels the journey, which benefits business traffic that places a relatively high value on travel time.

In comparison with the congestion charge, the flat peak-hour charge is less efficient. The lower rate leads to a smaller reduction in congestion. As the tax also is levied on roads without traffic jams, there is more loss of welfare due to a drop in demand, in comparison with the congestion charge. The SCBA result of the peak-hour charge is negative for the RC scenario and positive for the GE scenario.

With respect to the flat rate, whether or not in combination with an additional congestion charge, the benefits due to the shorter travel times do not compensate for the increase in costs. Especially on less busy roads and

during off-peak hours, the travel time gains are relatively small while the kilometre charge is the same as for busy roads and times.

Table 2: SCBA results of the flat rate charged on all roads and the flat rate in combination with a congestion charge (billion euros, NPV 2014, 2012 prices)

	Pricing policy Flat rate				Pricing policy Flat rate in combination with a congestion charge					
	RC scenario		GE scenario		RC scenario			GE scenario		
System (a)	B	C	B	C	B+F	C+E	A	B+F	C+E	A
Costs										
Investment	-0.1	-1.1	-0.2	-1.4	-0.2	-1.5	-1.7	-0.3	-1.9	-2.4
exploitation	-2.4	-3.1	-3.1	-4.1	-3.6	-5.5	-8.1	-4.5	-6.9	-10.2
Total costs	**-2.5**	**-4.2**	**-3.3**	**-5.5**	**-3.8**	**-6.9**	**-9.8**	**-4.7**	**-8.8**	**-12.6**
Effects										
Travel time	4.0	~	12.7	~	5.3	~	~	16.2	~	~
Distance	0.7	~	1.0	~	0.7	~	~	1.0	~	~
Reliability	1.0	~	3.2	~	1.3	~	~	4.1	~	~
Drop in demand	-4.9	~	-4.2	~	-5.0	~	~	-4.3	~	~
Time administration	-0.8	~	-1.3	~	-0.8	~	~	-1.3	~	~
Indirect effects	-5.1	~	-5.4	~	-5.1	~	~	-4.8	~	~
Excise duty	-7.4	~	-6.5	~	-7.5	~	~	-6.6	~	~
Road maintenance	0.3	~	0.3	~	0.3	~	~	0.3	~	~
PT subsidy	0.8	~	0.7	~	0.8	~	~	0.7	~	~
Road safety	3.2	~	4.5	~	3.2	~	~	4.4	~	~
Noise	0.5	~	0.4	~	0.5	~	~	0.5	~	~
Pollution	1.3	~	1.6	~	1.3	~	~	1.6	~	~
Total effects	**-6.3**	**~**	**7.0**	**~**	**-5.0**	**~**	**~**	**11.7**	**~**	**~**
Net effect	**-8.9**	**-10.6**	**3.7**	**1.5**	**-8.8**	**-11.9**	**-14.9**	**6.9**	**2.9**	**-0.9**

(a)
A: a box with a GPS function
B: an odometer
C: a simple box
E: a DSRC system (with registration via a tag in the car)
F: a smart vignette (sticker in the car and registration along the way)

General explanation of the costs and benefits

The gain in travel time resulting from a decrease in congestion is the main benefit, according to the SCBA. Motorists decide to cancel their journey, choose a different travel mode, postpone the moment of their journey or take another route. Fewer traffic jams will lead to more reliable journey times. Day-to-day variability of travel time due to fluctuating congestion levels deteriorates service reliability. The reliability benefits are calculated as a percentage (25%) of the travel time benefits.

The change in fuel costs caused by changing routes, the so-called distance revenues, are very limited. The drop in demand indicates the decrease in welfare as a result of the decrease in the number of car journeys.

The change in accessibility (higher taxation, shorter travel times) are accompanied by indirect effects. The indirect effects of the flat rate, whether

or not in combination with a congestion charge, are substantial and negative. A levy on all roads and throughout the whole day means that all motorists are taxed. Motorists on less busy routes do not experience the benefits of road pricing (shorter travel times and higher reliability). They experience only an increase in travel costs. Higher travel costs and the consequent substantial reduction in the number of journeys would lead to negative agglomeration effects that outweigh the positive effects. In case of congestion charges, the agglomeration effects are mainly positive as the shorter travel times outweigh the increased travel costs.

The <u>external effects</u> consist of road safety, noise and air pollution (carbon dioxide (CO_2), nitrogen oxides (NOx) and particulate matter ($PM_{2.5}$)) (VU, CE, 2014), (Bergh J. et al., 2012) (Bruyn, S.M. et al., 2010). Road safety accounts for the largest share. Because there is less driving, there is a benefit for all variants of road pricing, due to a reduction in external effects. With respect to the congestion charge, this benefit is partially cancelled out as some motorists switch to relatively unsafe roads.

As fewer kilometres travelled by cars means less fuel use, there is a <u>loss of tax revenue</u> (excise duty) for the government. The alternatives that use a flat rate charged on all roads cause the largest losses. The sum of the benefits of the external effects is lower than the loss in excise duties in all alternatives under both scenarios. Less car use leads to a decrease in the <u>cost of road maintenance</u>.

The alternatives that use a flat rate lead to an increase in the use of public transport. An increase in traffic in the off-peak hours leads to a more profitable <u>public transport exploitation</u>.

Motorists also have to spend time checking and paying the road pricing invoices. This extra time is a welfare loss. The category '<u>time administration</u>' is roughly estimated at approximately 1 billion euros NPV.

5. ADDITIONAL FINDINGS

Tables 3 and 4 provide an overview of several additional analyses and their impact on the SCBA net effect. In the first column, the SCBA results of the four main policy variants are shown. The effects of the additional variants are shown in the other columns. The tables show only the differences with the main variants. For example, the basic variant of the flat rate has an SCBA balance of -8.8 billion euros. A charge of 3 ct/km (instead of 7 ct/km) improves the SCBA result with +5.2 billion. By that, the total effect of a flat rate of 3 ct/km is -3.6 billion euros. The same holds for the other variants.

The height of the flat rate has a large effect on the SCBA results. A higher rate means more gains in travel time but greater losses of demand as well. Under the low scenario, the drop in demand is large, whereas the gain in travel time is only limited. As a result, a levy of 3 ct/km instead of 7 ct/km improves the result, but the net effect still remains negative. A charge of 11 ct/km is reducing profitability even further. Under GE, the net effect of a flat tax of 7 ct/km is higher than 11 ct/km and approximately equal to 3 ct/km. Additional analyses show that the 'optimal' rate changes with time. The higher the congestion level the higher the rate.

Table 3: Difference between the additional variants and main variants under the RC scenario

Pricing policy	SCBA result	Difference with the main variant				
	Main variant	Flat rate 3ct	Flat rate 11ct	Differentiated congestion charge	10-year postponement	Additional roads between 2020-2030
Congestion charge	0.9			+0.5	-0.4	-0.2
Peak-hour charge	-1.1				+0.4	-0.6
Flat rate	-8.8	+5.2	-7.7		+3.8	-0.7
Flat+Congestion	-8.9				+3.9	-0.3

Table 1: Difference between the additional variants and main variants in the GE scenario

Pricing policy	SCBA result	Difference with the main variant				
	Main variant	Flat rate 3ct	Flat rate 11ct	Differentiated congestion charge	10-year postponement	Additional roads between 2020-2030
Congestion charge	4.6			+2.1	-1.0	-0.2
Peak-hour charge	1.5				-0.3	-0.7
Flat rate	3.7	+1.2	-2.8		+2.3	-0.9
Flat+Congestion	6.9				+1.9	-1.4

A differentiated congestion charge[6] that depends on the degree of congestion has a higher efficiency than a flat congestion charge.

Under both scenarios, a 10-year postponement of the flat rate and a 10-year postponement of the flat rate combined with a congestion charge provides significantly better results, although the SCBA results remain negative under the RC scenario. Under the RC scenario both alternatives are unprofitable. Postponement of an unprofitable project logically produces a better result. Under the GE scenario the congestion level increases substantially over time. For both alternatives, the additional travel time benefits in the future are higher than the earlier loss of travel time benefits. Postponement, therefore, has a positive influence on the SCBA results.

On the other hand, a 10-year postponement of only the congestion charge reduces the SCBA result. Under GE, the increase in travel time savings later in time does not offset the earlier loss of travel time benefits. Postponement of the flat peak-hour charge leads to a higher return under RC and a marginally lower return under GE.

Introducing a pricing policy together with infrastructure investments until 2030 would lead to a lower impact of the pricing policy, as can be expected. As the

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[6] Depending on the degree of congestion, a price rate of 5, 11 or 17 eurocents is applied.

congestion level already has dropped because of new road investments, the effects of road pricing become smaller.

6.   CONCLUSIONS

To conclude, the congestion charge of 11 ct/km on busy roads during peak hours is socially beneficial at both high and low economic growth. Substantial savings in travel time are achieved, while car use decreases only moderately. As the impact on car use is limited, so are the effects on emissions and road safety, as well as the loss of welfare due to a drop in demand. The effectiveness of the congestion charge could be improved further by using a differentiated rate.

Congestion pricing, however, has several practical limitations. Charging only on busy roads does not make it clear for car users exactly in which places they have to pay. Furthermore, privacy and fraud have not been investigated in this study, but could lead to higher costs, as well.

Because of the practical concerns around the congestion charge, a more standard peak-hour charge on the main roads in western and central Netherlands was examined. In comparison with the congestion charge, this is less efficient. It has a lower rate per kilometre, applied to a much larger part of the road network. The lower rate of 5 ct/km leads to a smaller reduction in congestion. As the tax is levied on roads without traffic jams as well, there is more loss of welfare due to a drop in demand. The SCBA results on peak-hour charges are negative under the RC scenario and positive under the GE scenario.

A flat rate is only profitable, in the Netherlands, if the levels of congestion are more than double the current levels. Under RC, where the congestion increases very modestly, the net effect of charging a flat rate of either 3, 7 or 11 ct/km is negative. Under GE, the net effect is positive, because car use and congestion increase substantially over time.

Compared to a congestion charge, a flat rate reduces congestion less effectively. As it applies to all passenger kilometres in the Netherlands, it has a big impact on congestion levels, but it also has a major impact on total car use, leading to a significant loss of welfare.

A combination of a congestion charge of 11 ct/km and a flat rate of 7 ct/km is highly negative under the RC scenario. Under the GE scenario, this leads to a positive net effect, presuming that the system costs remain limited. This positive effect, however, is mainly due to the impact of the congestion charge.

In general, road pricing reduces car use. This leads to lower emissions, less noise and fewer road casualties. However, it also creates lower tax revenues resulting in a loss of prosperity. This welfare loss is greater than the gains from reduced emissions, noise and human casualties.

The 'optimal' rate depends on the level of congestion and therefore changes over time. Under the GE scenario, the congestion level is very high: in 2040, it is four times higher than under RC. The congestion level under the RC scenario is comparable with the current situation in the Netherlands.

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Charged roads in central Netherlands based on a congestion charge during peak hours (am) in 2020, under the RC scenario (left) and the GE scenario (right)
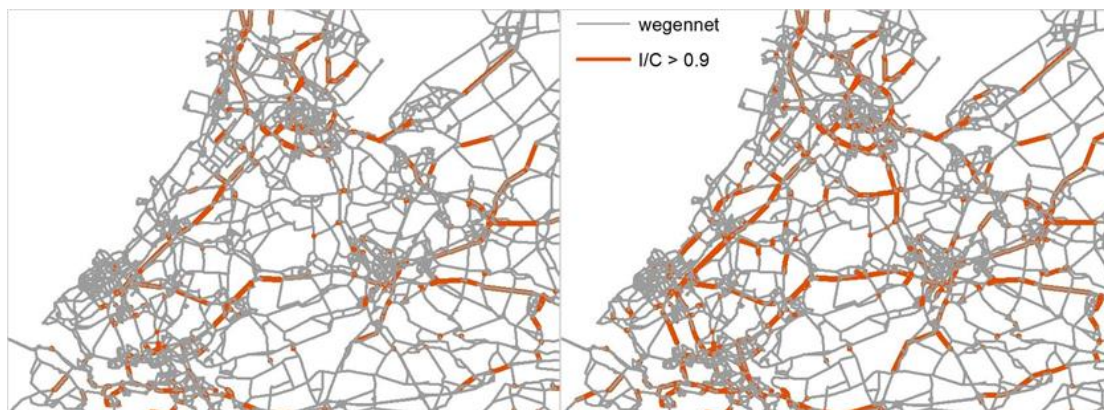
Charged roads in central Netherlands based on a flat peak-hour charge in 2020