Danish Journal of Transportation Research

Carrot or Stick? – Traffic Policy Instruments to Influence Sustainable Transport Behaviour

Line Røjkjær Rasmussen, Aalborg University, AAU BUILD, lrr@build.aau.dk
Niels Agerholm, Danish Road Directorate, nsa@vd.dk
Anne Vingaard Olesen, Aalborg University, AAU BUILD, avo@build.aau.dk
Harry Lahrmann, Aalborg University, AAU BUILD, hsl@build.aau.dk

Article info

Article history
Received: 26/05/2021
Received in revised form: 24/03/2022
Accepted: 05/04/2022

Keywords:
Modal shift, Transport behaviour, Public transport, Stated preference, Traffic policy

Abstract

The Danish sector of transport has historically used a traffic policy strategy with attractive incentives, such as improvements in alternatives to private motoring, with the intention of promoting a voluntary modal shift. Despite this strategy, the Danish population drive more than ever before, and their emissions from road transport have continued to increase. This calls for a further investigation of how to influence transport behaviour to promote more climate-friendly transport. Various political approaches can be adopted to affect transport behaviour and patterns. The present paper contributes to the research into which traffic policy instruments are most effective in encouraging the modal shift towards public transport. This issue was studied through a questionnaire survey using a stated preference analysis approach. The analysis showed that it is extremely difficult to influence transport behaviour, with changes such as fare reductions and reduced travel time on public transport having a limited impact on the respondents. However, the results showed that improvements to public transport had a slightly greater impact when combined with instruments such as congestion charging or road pricing that directly target motorists.

Dansk resumé

Den danske transportsektor har historisk valgt en trafikpolitik som har gjort brug af tillokkende styringsmidler, såsom forbedringer af alternativerne til privatbilisme, i håb om at dette ville medføre et frivilligt transportmiddelskift. Til trods for dette kører den danske befolkning mere i bil end nogensinde før med en øget udledning af CO_2 fra vejtransporten til følge. Denne udvikling efterspørger nærmere undersøgelse af, hvordan vi kan fremme og opfordre til mere klimavenlig transport gennem påvirkning af transportadfærd. Påvirkning af transportadfærd og -mønstre kan forsøges opnået gennem brug af forskellige trafikpolitiske virkemidler, og nærværende artikel bidrager til forskningen omhandlende hvilke trafikpolitiske virkemidler, som med størst effekt kan fremme skiftet til kollektiv transport. Dette er undersøgt gennem en spørgeskemaundersøgelse baseret på en *stated preference* analyse. Analysen viste at det er ekstremt vanskeligt at påvirke transportadfærd, hvor ændringer i form af takstnedsættelser og kortere rejsetid med den kollektive transport havde en begrænset effekt på respondenterne. Resultaterne viste imidlertid, at forbedringer af den kollektive transport har en lidt større effekt, når disse sker i kombination med virkemidler som en trængselsafgift eller variable kørselsafgifter (road pricing), som er direkte rettet mod bilisternes kørsel.

1. Introduction

A considerable proportion of CO_2 emissions leading to climate change comes from the transport sector. Factors such as GDP growth, infrastructure expansion, low occupancy rates for commute trips, lower fuel costs as cars have become more energy efficient and the increase in car ownership have caused a continued rise in emissions from road transport. The total CO_2 emissions in Europe have been reduced by more than 20 percent since 1990 and a similar development of Danish emissions is shown in Figure 1, with 1990 index numbers providing the base values (European Environment Agency, 2020).

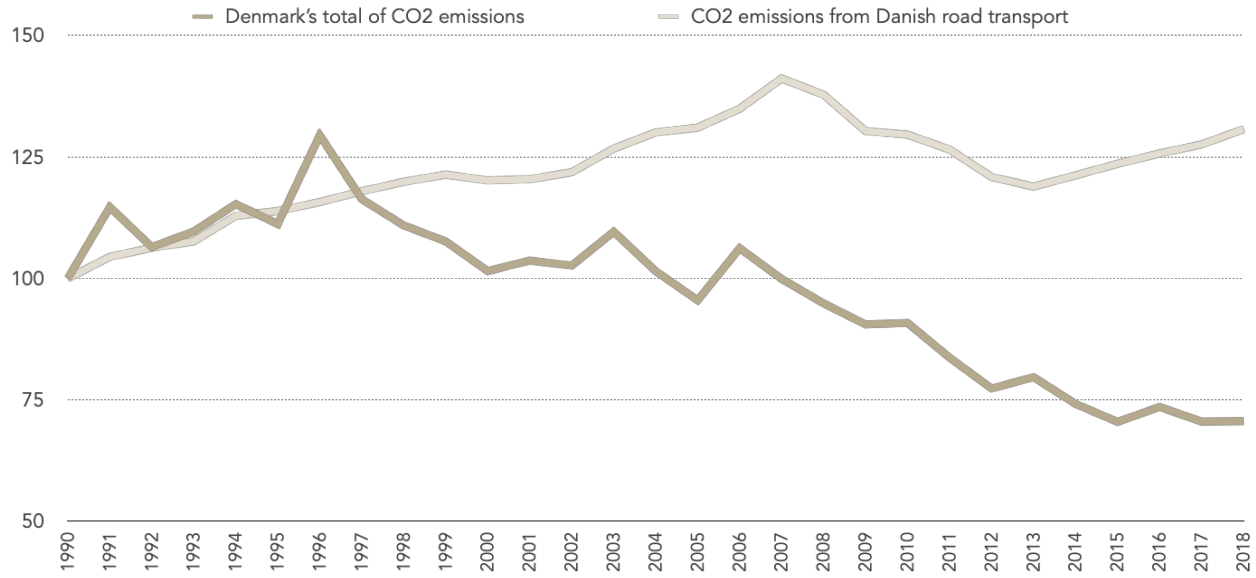

Fig. 1. Danish emissions of greenhouse gases since 1990 in index numbers, showing a relative increase in emissions from road transport compared to total emissions (European Environment Agency, 2020, *Modified*).

As Figure 1 illustrates, there was a nearly linear increase in emissions from road transport in Denmark up until the financial crisis beginning in 2007, which prompted a stagnation in the kilometres driven and helped curb the rising emissions of greenhouse gases from that sector. This decrease can also be partly attributed to the energy efficiency of cars, which has risen by more than 60 percent for petrol-driven cars since 1997, leading to a lower CO_2 intensity per distance driven (Jensen, 2017). However, since 2014, car sales and road traffic have increased considerably so that CO_2 emissions from Danish cars have increased again. Thus, road transport alone accounts for 32 percent of the country's current total discharge (European Environment Agency, 2020), and only a very small part of the energy consumption for the sector comes from renewable energy sources (Danmarks Statistik, 2018). At the same time, it has become more expensive to use public transport (PT), leaving consumers with no appealing alternatives to the use of private cars.

Additionally, a review of Danish transport action plans with an environmental and climate focus published in the past 30 years (from 1990 until present) shows that the most commonly chosen traffic policy strategy has been the use of incentives (Rasmussen, 2019a). The expectation behind this strategy was that, through the promotion of alternatives to private motoring, we would see a voluntary modal shift in transport behaviour. More radical means of control, such as increases in the vehicle registration tax and changes to tax structures and user fees, have been debated since 1990, but in recent years, incumbent governments have expressed a desire to implement more radical initiatives. Given the continued contribution of the transport sector to CO_2 emissions, the traffic policy used in the past 30 years has clearly been insufficient. It is crucial that the Danish government take more drastic action if it is to fulfil its objective of reducing greenhouse gas emissions by 70 percent in 2030 compared to 1990 (Klimarådet, 2020). This challenge will be addressed mainly using technology to improve the energy efficiency of transport modes, but it will be necessary to supplement the technological green transition with measures and regulations promoting more climate-friendly transport

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behaviour among the population. A common approach is the promotion of PT, as the average PT passenger has a lower emission of greenhouse gases than a motorist (Krawack, 2015). Furthermore, the Covid-19 pandemic has led to a significant decrease in the number of passengers using PT, resulting in an even greater need for proper political instruments to increase PT use.

To encourage this desired behaviour, it is essential to assess which traffic policy instruments are most effective in influencing sustainable transport behaviour, resulting in an increased use of PT. Therefore, the objective of the present paper is to further investigate different policy instruments and their potential to increase the use of PT among the population. This paper is based on the findings presented in a master's thesis by Rasmussen (2019a), presenting how a questionnaire focused on stated preference (SP) analysis was conducted among citizens in the Capital Region of Denmark to examine their preferences regarding and sensitivity to different policy instruments.

2. State-of-the-art

Political decision-making often refers to deliberations on how best to handle a challenge using which policy instruments. While policy objectives indicate the policy's direction, policy measures are implemented to take action on the policy (Givoni, 2014). Bemelmans-Videc et al. (1998) defined policy measures as "the set of techniques by which governmental authorities wield their power in attempting to ensure support and effect social change" and demonstrated how policy instruments can be classified into three typologies: regulation, economic means and information. In other words, the government may force the population, pay them or make them pay, or try to persuade them to engage in a given behaviour. Information is often considered the weakest approach, while financial incentives, such as subsidies and taxes, are considered the middle ground. With financial incentives, individuals are still free to choose their own behaviour, although certain actions may be made more attractive to them. Finally, restrictions are considered the most effective but also the most radical approach and will often be perceived as an excessive encroachment on personal freedom (Bemelmans-Videc et al., 1998).

This categorization of policy measures is commonly accepted and serves various purposes, as do the taxonomies of policy measures provided by many authors. A well-known taxonomy was developed by Hood (1983), who grouped instruments according to whether they rely on the use of nodality (or information), authority, treasure or organization, as well as whether they are designed to detect changes in a policy environment or to effect change in it (Howlett, 2008). An additional approach is to group policies into the three categories of physical policies, soft policies and knowledge policies. The common goal of these policy types is to make changes in travellers' behaviour but in different ways. While physical policies include physical infrastructure elements, soft policies inform travellers about the consequences of their transport choices, potentially influencing them to change their behaviour. Lastly, knowledge policies highlight the essential role of investment in research (Santos et al., 2010).

In traffic policy, the "stick or carrot" metaphor was first applied by Meyer (1999) regarding travel behaviour and transportation demand management in the United States. Gärling et al. (2002) used the term "push or pull" to refer to a similar phenomenon. This idea relates to the political decision to use incentives that restrict or discourage private motorized transport or promote the use of alternatives. More objectively, the question is best to influence motorists to reduce their private car use – by incentives or deterrents. The approach is also based on the belief that economically rational citizens act as desired when they are influenced by material resources and incentives. According to Litman (2011), the relative effect of incentives is uncertain, but it seems reasonable to assume that it will diminish with an increased level of incentive, meaning that incentive size might be of declining marginal impact. Effects that are more obvious can be expected in the short-term than the long-term, and these lasting effects might be limited or non-existent and will depend highly on the characteristics of the behaviour change (Agerholm, 2011).

Several studies have examined the difference between "carrot" and "stick" instruments. A study by Steg et al. (2005) focused on the acceptance of various measures to influence the reduction of CO_2 emissions in households. Instruments associated with the carrot were found to be preferred, proving that the distinction between carrot and stick measures is relevant to acceptability. Strategies that increase the cost of car use generally experience far lower support than those that intend to improve alternatives to car use. Other studies considering the reactions of road users to these two types of measures have found that stick-related instruments, primarily in the form of different tax policies, have a greater impact on transport behaviour than positive incentive measures, such as improvements to existing PT (O'Fallon et al., 2004; Espino et al., 2007).

In a Danish context there have been studies which examined the effect of fare reductions in PT. In 1997, the government reduced fares on local and regional PT in Denmark by an average of 10 percent. One year after the implementation of this measure, it had attracted new passengers only to a limited extent in urban areas where PT constituted a real alternative to other modes of transport and where awareness of the fare reduction was assessed as being highest (Toft & Elsbo, 1998). In a more extreme case, the train between the two Danish towns of Svendborg and Odense was free for all to use for one month in 2004. During the free month, the number of passengers doubled, as many people took the opportunity to try the train. Two months after the free month, an estimated 5 percent of the total passengers were newcomers (Albrecht & Magelund, 2004). In addition, Teknologirådet (2006) presented a report stating that a general national implementation of free PT would not be appropriate as the economic costs would be too large and the effect too small in terms of reduced congestion, the traffic environment and the number of crashes. A study analysing five bus accessibility projects concluded that there were improvements in terms of travel time and number of passengers (Hvid, 2016). The increased number of passengers, however, was uncertain, as it was difficult to assess to what degree the growth was due to the individual project or external factors, such as urban development or projects elsewhere on the bus routes. Measures related to the carrot could be of an even softer character than in these studies. They could include improvements of PT machinery, improved mobility options or increased public attention through such measures as gamification.

Instruments following a stick-related approach have been implemented in metropolitan areas, with many imposing various charges directly on drivers. The objective of toll rings or congestion charges, for instance, is to reduce car traffic incoming to a metropolitan area. Essential to such instruments is that the charge for cars driving into a city centre be higher during rush hour. Examples of this kind of measure can be found in London and Stockholm, which have had great success with the introduction of an attendance fee and a toll ring, respectively. In Stockholm, after a small introductory period, the traffic level stabilized to a level of 20 percent fewer cars during charging hours (Eliasson, 2008), while London experienced a similar reduction of 14 percent in cars driving to the city centre (Metz, 2018).

In the same category of measures, road pricing – charging drivers a tax per kilometres driven – can be implemented. This tax may vary according to time, place and vehicle type. Road pricing is thus based on the idea of applying corrective charges, with motorists paying for the costs they inflict on their surroundings, such as increased travel time for other road users in the event of congestion, and external costs, such as crashes, noise and pollution (Noordegraaf, 2016). Furthermore, Trængselskommissionen, The Committee on Congestion (2013), concluded that time- and place-dependent travel charges are the instrument with the greatest potential for effectively regulating car traffic. Its report recommended that further research work be conducted on this topic in the form of a large-scale nationwide trial. Despite the many positive effects expected of road pricing, there are no real-world cases of electronically charging individual private motorists for their use of the road network on a time- and location-dependent basis using GPS measurements.

Finally, studies have shown that combining traffic policy instruments has a greater effect and impact on road users than measures used individually (Marshall & Banister, 2000), and several studies recommend combining different tools to deal with transport challenges (May et al., 2006; Banister, 2008; Vieira et al., 2007). For attracting PT users, in particular, Dickinson and Wretstrand (2015) showed that while there is extensive knowledge of what characterizes attractive PT, relatively few studies describe the effects of policy

measures on promoting the modal shift from car to PT. One reason for this is that it can be difficult to distinguish the effects of individual instruments, which are rarely implemented separately but rather as part of larger policy packages. According to Givoni (2014), though the combination of policy measures should meet a target that could not be met with one policy measure alone.

3. Methods

The methodology for this research involved a questionnaire. The survey asked the respondents about the extent to which they weighed the climate and pro-environmentalism in their transport choices, as well as which transport policy instruments most influenced their choice of transport mode.

3.1 Participants

The questionnaire was conducted in April 2019 among 1.008 citizens living in the Capital Region of Denmark. The survey company Norstat sampled the respondents, stratifying them according to gender, age and municipality such that they constituted a representative sample of Norstat's web-based population panel of Capital Region residents aged 18–60 years. The age range was chosen to target respondents of working age, as the study concentrated on daily commuting, while the geographical selection of the capital region was based on an assessment that most residents had PT as a realistic transport alternative. Furthermore, basing the survey solely within the Capital Region helped avoid potential biases between the largest cities, which are characterized by different transport patterns and population compositions. However, only respondents from the most urban municipalities of the region, meaning those located closest to Copenhagen, were included because the nearby S-train stations would provide a realistic alternative to private car use.

Despite the stratified sampling, there was a small difference in the age distribution between the sample and the general population, so Norstat weighted the municipalities according to gender and age based on data from Statistics Denmark. Each respondent thus had a weight variable linked to the stratification, and all results presented in the report are based on weighted calculations. Unfortunately, it was not possible to check for representativeness regarding mileage to work and car availability in the given data, but they both seem to be fair reflections of the population.

3.2 Stated preference analysis construction

The respondents were presented with questions regarding their current transport choices, their attitudes concerning the environment, climate change and travel behaviour and their socio-demographic information. Only respondents with employment, using the commuting modes of interest and with the physical capability to change their mode of transport continued on to the SP analysis, resulting in the exclusion of 212 respondents. This left 796 respondents to complete the SP analysis.

As the questionnaire aimed to examine which traffic policy instruments have the greatest impact on transport behaviour, an SP question form was chosen. The method presents respondents with hypothetical choices, through which it is possible to clarify the relative importance of different parameters and assess their interaction with each other. The strength of SP is thus in illuminating initiatives that have not yet been implemented. The effects of potential instruments can be estimated by asking interviewees carefully selected hypothetical questions to reveal their likely reception of the measures. In this study, a fractional factor design was used. This design differs from the full factor design in excluding alternative answers that can derive from the core. With a fractional factor design, the number of alternatives can be reduced, which is useful when exclusively independent combinations of variables are considered. Fractional factor design can thus estimate the direct effects of various factors but cannot take any cross-effects into account (Norheim and Hanssen, 1990).

In the present study, the subject of interest was a modal shift to PT for daily commuting. Figure 2 illustrates the basic political approaches featured in the three SP choice games. The current motorists in the study were

faced with all three games, while the current cyclists were exposed only to game one, which contained incentives. The respondents then had to state the probability on a 7-point Likert scale that they would make a modal shift in the given scenarios. The Likert scale points were as follows: 1 = I will definitely not change, 2 = I am unlikely to change, 3 = I am not inclined to change, 4 = This means of transport is neither good nor bad, 5 = I am inclined to change, 6 = I am likely to change, 7 = I will definitely change.

Game 1 – Carrot
Improvements to existing public transport consisting of reduced fares, reduced travel time and increased frequency

Game 2 – Stick
Increased taxation of car use consisting of increased fuel tax, more expensive parking and implementation of a congestion charge or road pricing

Game 3 – Combined
A combination of reduced bus fares and reduced travel time in public transport with the simultaneous implementation of a congestion charge or road pricing

Fig. 2. Political approaches of the three SP choice games presented to current motorists.

The variables related to PT that the respondents had to weigh against each other were reduced travel time, reduced fare and increased frequency. The variables related to driving were increased fuel price, tolls (implementation of a congestion charge or road pricing) and increased parking fees. The parameters were regulated at three levels (unchanged scenario, low and high changes), as shown in Table 1. Figure 3 presents an illustrated scenario, as seen by the survey respondents.

Tab. 1. Level of parameters included in games 1, 2 and 3.

	Unchanged scenario	Low scenario	High scenario
Improvements of existing public transport			
Reduced travel time	0 %	5 %	15 %
Reduced fare	0 %	20 %	50 %
Increased frequency	0 %	50 %	100 %
Car-related taxes			
Increased fuel price (€ per litre)	App. 1.5 €	2 €	2.5 €
Implementation of tolls	-	Road pricing	Congestion charge
Increased parking fee	0 %	100 %	200 %

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Fig. 3. Example of scenario presentation (1 of 9 scenarios in game 1 on improving existing public transport).

3.3 Analysis and data processing

The scores in the SP scenarios were evaluated using a multivariate analysis containing three explanatory variables (three instruments examined per choice game), each of which varied at three levels, as shown in Table 1. The main model was designed to evaluate the individual instruments when other variables were included. The effect of a given instrument manifested as the estimated difference between the starting point (unchanged scenario), which represented the respondent's current situation, and the respective level of the instrument in the game. A weighted least squares method, recommended by Norheim and Hanssen (1990), was used to rank the scenarios according to a given scale. The weighted method controls for clustering and accounts for the statistical dependence of answers from the same person, not treating them as independent measurements. Without marking which measurements originated from a given respondent, the accuracy of the estimates would be exaggerated (Stata, 2013).

Furthermore, the analysis measured the *professional significance* (also known as practical significance) of changes applied with the instruments, considering the difference between the starting point and a change to be professionally significant at an estimated difference above 0.5. With an estimated difference of above 0.5, the instrument would result in movement on the 7-point scale, indicating that road users were affected by the instrument. This approach was chosen because the large amount of data means that almost all calculated differences were statistically significant at a 5% significance level, although the changes did not necessarily have any practical importance.

4. Results

4.1 Participants

Initially, the respondents were divided into groups according to their modal split. The "Motorists" group covered respondents who were daily car drivers or passengers (n = 283), "Public transport users" (PTU) covered respondents who commuted by bus or regional train, S-train or metro (n = 195), while "Cyclists" covered respondents who used their bikes for daily commuting (n = 318). The respondents' personal demographic characteristics are shown in Table 2, including the groups' gender, age, municipality, distance to workplace and car availability in the household. The respondents were also divided into two groups by municipality, Copenhagen and Frederiksberg, Frederiksberg being a minor municipality surrounded by the Municipality of Copenhagen, while the "Others" group includes the rest of the municipalities in the Capital Region of Denmark included in this survey.

As shown in Table 2, all groups differed according to every parameter by at least a 5 percent significance level except gender, for which an equal distribution was found. It is noteworthy that, in reference to age, there was an equal distribution between cyclists and PTU, and regarding mileage to work, motorists and PTU were also equal.

Tab. 2. Participant statistics stratified by modal split (n = 796) between motorists, cyclists, and public transport users (PTU).

	Motorists (n = 283)	Cyclists (n = 318)	PTU (n = 195)	*p*	*p*-value by pairs
Gender					
Male	53.7 %	48.4 %	47.6 %	0.28	$p = 0.86$ between cyclists and PTU
Female	46.3 %	51.6 %	52.4 %		
Age					
18–35 years	34.0 %	55.2 %	53.6 %		
36–49 years	39.3 %	28.1 %	27.0 %		
50–60 years	26.7 %	16.7 %	19.4 %		
Average	41.9 years	36.7 years	36.5 years	0.00	$p = 0.86$ between cyclists and PTU
Municipality					
CPH and FRB	26.4 %	69.6 %	52.9 %	0.00	
Others	73.6 %	30.4 %	47.1 %		
Mileage to work					
Average	21.8 km	6.2 km	20.2 km	0.00	$p = 0.52$ between motorists and PTU
Car availability					
1 car	60.1 %	41.0 %	37.6 %	0.00	
2 cars	35.9 %	2.2 %	4.7 %		
3 cars or more	3.7 %	0.0 %	0.6 %		
Borrow capability	0.3 %	22.6 %	20.2 %		
No access to car	0.0 %	34.1 %	36.8 %		

4.2 Effect of the political instruments

To identify the instruments with the greatest impact on transport behaviour, the estimated differences between the three SP choice games were observed. The first game presented improvements to existing PT – reduced travel time, reduced fare and increased frequency – to current motorists and cyclists. The results of the multivariate analysis are shown in Table 3 and illustrated in Figure 4. A positive difference indicates that the respondents were affected by the instrument, and a difference above 0.5 indicates that they moved on the 7-point Likert scale, representing an increased likelihood that they would make a modal shift towards PT in the given scenario.

The scenarios showed that current motorists were more likely to be affected by reduced travel time on PT than by fare reductions, which had a greater impact on cyclists. Thus, the most effective instrument overall was a 50 percent reduction in fare compared to the unchanged scenario with the existing fare price. This shows that motorists can be affected by an economic tool, although it is a less significant factor in their current transport choices stated previously in the questionnaire.

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Tab. 3. Multivariate analysis with estimated differences for game 1 by current commuter mode.

	Motorists (n = 283)			Cyclists (n = 318)		
	Difference	95 % CI	*p*	Difference	95 % CI	*p*
5 % reduced travel time	0.32	0.22 – 0.41	0.00	0.25	0.17 – 0.33	0.00
15 % reduced travel time	**0.81**	0.68 – 0.95	0.00	**0.53**	0.42 – 0.64	0.00
20 % reduced fare	0.40	0.28 – 0.52	0.00	**0.56**	0.43 – 0.69	0.00
50 % reduced fare	**0.79**	0.62 – 0.96	0.00	**0.95**	0.79 – 1.10	0.00
50 % increased frequency	0.21	0.11 – 0.32	0.00	0.07	-0.02 – 0.17	0.14
100 % increased frequency	0.20	0.07 – 0.33	0.00	0.12	0.01 – 0.24	0.04

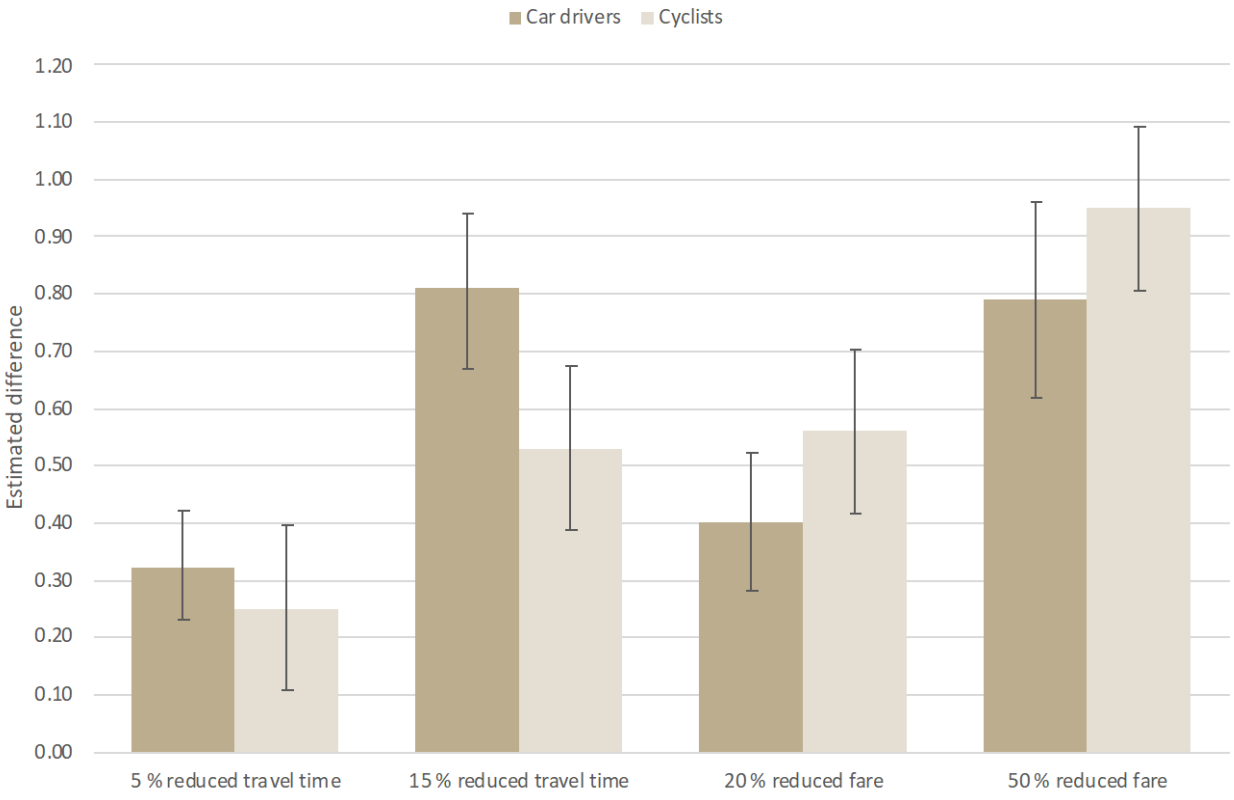

Fig. 4. Estimated differences, including 95 % confidence interval (CI), divided by commuter mode.

The second game, which contained direct charges on motorists, showed a greater impact on the drivers. A complete overview of the results for the motorist group is shown in Table 4. It appears that a high fuel price at 2.5 €/litre was the measure with the greatest impact on motorists, while the implementation of a congestion charge or road pricing were assessed equally under the given conditions. More doubtful is the effectiveness of an increased parking fee, for which neither of the two levels was professionally significant.

The first game, which used only incentives, had a generally lower impact than the direct charges on motorists, as shown by the size of its score on the 7-point Likert scale. Accordingly, direct charges seemed to have a greater influence on modal shifts than did improvements to PT.

Tab. 4. Multivariate analysis with scores and estimated differences for the current motorists (n = 283).

	Score	Difference	95 % CI	*p*
Game 1 – Carrot				
5 % reduced travel time	2.46	0.32	0.22 – 0.41	0.00
15 % reduced travel time	2.81	0.81	0.68 – 0.95	0.00
20 % reduced fare	2.46	0.40	0.28 – 0.52	0.00
50 % reduced fare	2.84	0.79	0.62 – 0.96	0.00
50 % increased frequency	2.24	0.21	0.11 – 0.32	0.00
100 % increased frequency	2.28	0.20	0.07 – 0.33	0.00
Game 2 – Stick				
Fuel price 2 €/litre	3.26	0.39	0.26 – 0.51	0.00
Fuel price 2,5 €/litre	3.47	0.64	0.47 – 0.81	0.00
Congestion charge	3.23	0.53	0.40 – 0.65	0.00
Road pricing	3.09	0.52	0.42 – 0.62	0.00
100 % increased parking fee	3.45	0.27	0.13 – 0.41	0.00
200 % increased parking fee	2.63	0.16	0.02 – 0.29	0.02
Game 3 – Combined				
5 % reduced travel time	2.72	0.43	0.25 – 0.60	0.00
15 % reduced travel time	3.28	0.88	0.69 – 1.07	0.00
20 % reduced fare	3.06	0.49	0.36 – 0.63	0.00
50 % reduced fare	3.18	0.96	0.76 – 1.16	0.00
Congestion charge	2.84	0.55	0.34 – 0.77	0.00
Road pricing	2.95	0.38	0.20 – 0.56	0.00

Finally, the third game combined congestion charges or road pricing with improvements to existing PT. In this choice game, the reduced fare became the most effective incentive instrument, overtaking the reduced travel time in the first game. In addition, the third game showed a slight but consistently greater effect of improvements to PT when combined with measures that directly target motorists. However, there was no opportunity to check for possible synergies.

5. Conclusion & Discussion

Our study evaluated which traffic policy instruments have the greatest impact on encouraging a modal shift towards PT. In sum, the study showed that carrot-related measures generally have a lower impact on potential PT users, as the respondents were more greatly affected by such instruments as road pricing and increased parking fees. This shows that the financial aspects of driving influence current motorists' transport choices when the price they impose is high enough.

Our study conflicts with the findings of Litman (2011), who stated that the effect of incentives diminishes with an increased level of incentive, which suggests that the size of an incentive might be of little importance

for its effectiveness. In contrast, our study showed that when fare reductions of 20 percent were increased to 50 percent, the estimated difference nearly doubled for motorists as well as cyclists. Unfortunately, the method used in this study cannot determine whether there may be diminishing marginal impacts. In this case it would have been relevant to consider a discrete choice model, as this would make it possible to tell how the probability of a given choice is influenced by changes in the variables included in the model. Anyhow, the present study still showed that motorists were not as greatly affected by this measure as cyclists and that the price reduction must be considerable to attract motorists. This finding raises political considerations regarding which improvements should be made to PT. If the government wanted to induce motorists to switch to PT, it would not be enough to improve PT and reduce the fare, as this alone was found to have little influence on motorists' transport choices, supporting the findings by Toft and Elsbo (1998). Instead, this kind of change would lead to a modal shift among existing cyclists.

The focus of the second game was on charges directly targeting motorists. The scores indicated that stick-related instruments in general had a greater impact on transport behaviour than incentive measures alone, supporting the findings of studies by O'Fallon et al. (2004) and Espino et al. (2007). In our study, a high fuel price was found to have the greatest impact on motorists on average, although this impact was not distinct. With a high tax on fuel, motorists would be encouraged to drive less, to drive more economically and to purchase energy-efficient cars, in addition to switching to other modes of transport. With increased fuel taxes, however, it is essential to counteract the potential rebound effect when a consumer buys an energy-efficient car: this purchase would lower their fuel costs, with the result that they drive more. This must be counteracted by ongoing regulation of the charges to ensure they are equivalent to those placed on a car of average performance. The second game also showed that road pricing and a congestion charge were perceived equally. Road pricing is, however, considered the best way to regulate traffic so that externalities are fairly priced and motorists pay for the costs they inflict on their surroundings (Noordegraaf, 2016).

The challenge related to the climate is not the main purpose of road pricing, as CO_2 emissions are global externalities that cannot be influenced by time and place. However, road pricing can be implemented in support of several aims, and there is nothing to prevent the use of a kilometre-based tax system to regulate the impact of CO_2 emissions on the climate once the system is established. Nevertheless, tolls have met with political reluctance (Rasmussen, 2019b), and the present study showed that road pricing did not have a nearly as great an impact on motorists as increased fuel prices. Still, it must be emphasized that the respondents may have had difficulty assessing the personal consequences of road pricing and congestion charging, whereas the effect of a fuel price of 2 €/litre is easier to assess. Behrendt (2013) claimed that respondents do not have sufficient knowledge of how such technical measures would affect the individual, arguing that Danes' knowledge is too limited to enable their assessment on a fair basis deal.

Another instrument that produced somewhat unexpected results was an increase in present parking rates. This instrument is usually considered to be a simple tool for influencing motorists, and its effect is expected to be greatest on commuting, as frequent prolonged parking is particularly sensitive to increased charges. The SP analysis performed showed, however, that the increased parking fee combined with higher fuel prices and tolls was the least effective instrument among these three measures. It was confirmed that the majority of motorists who responded to the survey (89 percent) had access to unlimited free parking at the workplace, which explains why a percentage increase in the fee made no sense and the unexpected result.

Finally, the scores showed that motorists were more strongly influenced towards a modal shift when the improvements to PT occurred in combination with charges associated with car driving. Thus, the estimated differences showed only a small contribution to the effect from game 1. In hindsight, it would have been interesting to include the increased fuel price in game 3, which combined sticks and carrots, as this was shown to be the stick-related measure with the greatest impact. Though the game construction did not enable possible synergies to be checked, taxes still seemed to have a greater influence on the modal shift than improvements to PT alone. This finding supports studies recommending that tools be combined to deal with transport challenges (May et al., 2006; Banister, 2008; Vieira et al., 2007).

Overall, through a well-executed fractional factor design with a large sample size of residents in the Capital Region of Denmark, this study has confirmed that the average willingness to pay to drive is still high among motorists. Therefore, if it is politically desirable to encourage some motorists to abandon their cars, it is insufficient simply to reduce PT fares. This measure has very little impact on motorists' transport choices but could be expected instead to relocate current cyclists. If PT is to attract more motorists, it is essential that travel time on PT is reduced as it also becomes more expensive to use private vehicles. This knowledge will meanwhile be useful in the present post-Covid-19 situation, in which PT has lost a considerable number of passengers and must fight to win them back. The political will to implement stricter instruments is crucial if the current targets for CO_2 emission reductions are to be achieved.

Acknowledgements
The cost of distributing the questionnaire to a representative sample of Norstat's web-based population panel was made possible thanks to a generous grant from RA's Støttefond.

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