Public support for tradable peak credit schemes

ABSTRACT –Congestion charging is generally regarded as an effective tool to manage the ongoing growth in car use and to battle congestion. However, public support is generally lacking and congestion charges have therefore barely been implemented. The novel concept of tradable peak credits (TPC), which is based on the cap-and-trade principle, is revenue neutral, cheaper for road users than a congestion charge and therefore may lead to stronger public support. This paper is the first that aims to quantify the support levels of TPC among the public and to explore the influence of scheme design, socio-economic characteristics and attitudes on support levels. To that end, a stated choice experiment is conducted in which respondents were asked whether they would vote for implementation of different TPC schemes. The discrete choice model shows that 32% up to a small majority of 52% supports different TPC schemes. A rather large share however (dis)likes TPC regardless of the scheme design since attitudes have more explanatory power than scheme characteristics. The results of this study do not indicate that TPC can count on strong public support. Nevertheless, this is a first exploratory study and hence this short paper ends with recommendations for further research.

2934 words

1. Introduction

Despite strong theoretical arguments for congestion charging as a tool to battle growth in car use, only a few cities have actually implemented a scheme. The lack of public support is often mentioned as main barrier to implementation. Hence, public acceptability of different road pricing solutions became an extensively studied topic (e.g. Hamilton *et al.*, 2014; Schade and Schlag, 2003; Ubbels and Verhoef, 2006). In these studies, recurring reasons why people oppose congestion charging include their expectation of low effectiveness of the pricing solution, perceived unfairness of the scheme's redistribution of welfare, distrust in the government's use of the revenues and the expected increase in travel costs.

Academic interest has therefore increased in the concept of tradable credits as tool to approach roadway capacity allocation and manage congestion (e.g. Grant-Muller and Xu, 2014; Verhoef, Nijkamp and Rietveld, 1997). Tradable credits for congestion management are still a concept rather than a developed policy. The basic concept is that the regulator (e.g. government) determines a firm limit, hence a *cap*, on the total level of car use in a certain area or road stretch during a certain time period. This cap is translated into units (peak credits in this case), which are distributed among recipients (e.g. citizens or road users) via a certain allocation method every trading period (e.g. week or month), and creates a market where people can *trade* their peak credits as supply and demand set the price of a credit. When car users use the defined area during the defined time period, a credit will be taken from their budget. An advantage of such a cap-and-trade system is that the operator has control over the number of cars using the defined area. Whereas in a pricing based solution the control over the flow of cars is less since the price elasticity of various car users are unknown (Fan and Jiang, 2013). Higher effectiveness is beneficial for the road authorities, but may also positively affect public support. The allocation of the free credits and the absence of governmental revenues may enhance public acceptability as well.

The notion that TPC can count on more public support than a congestion charge is incited by empirical studies on the related concept of personal tradable carbon permits. These studies generally found stronger support for the proposed tradable carbon permits than for an equivalent carbon tax (Bristow *et al.*, 2010; Harwatt *et al.*, 2011). However, support may strongly depends on the exact scheme design, as shown by Bristow et al. (2010) who found support levels ranging from 22% up to 80%. Especially the way in which the permits are allocated are found to influence support levels. The few studies that looked into acceptability of credits for mobility management show also diverse results (Dogterom *et al.*, 2018; Kockelman and Kalmanje, 2005). These studies however considered schemes that are either not tradable and/or not focused on congestion reduction. To the best of our knowledge, what the public support for tradable credits for congestion management is and whether it is higher than for a congestion charge, has not been studied yet.

The main aim of this study is therefore to quantify the public support for implementation of TPC. Since TPC can be designed in different ways and many of the scheme characteristics may be important for support, this study also aims to explore the influence of these characteristics on support. Furthermore, since previous road pricing acceptability studies and a previous focus group study on TPC conducted by the authors, showed that not only scheme characteristics but also certain socio-economic characteristics and to a greater extent attitudes, such as fairness and expected effectiveness, may explain support levels (e.g. Gehlert *et al.*, 2011; Schade and Schlag, 2003), the influence of these variables will be studied as well.

2. Methodology

To serve these aims, an online survey is designed that consists of four parts. In the first part, the TPC concept was explained to the respondent. Basically, a TPC scheme is presented that can be applied on all highways and provincial roads in the city during peak hours on weekdays. The government decides how many (free) credits are issued. Participants have an online account to manage and trade their credits. The credit price is determined by supply and demand, but the maximum credit price is set on 6 euros. People cannot buy more credits than they can use themselves in a particular specified period of time, which is the credit allocation interval. The credits are redeemed automatically when people use the specified roads during peak hours. If people drive there with an empty credit account, they receive a notification to buy a credit. If they do not do this, the system will automatically buy a credit plus a small fee of 1 euro extra. In the second part, a stated choice experiment followed in which respondents were presented with 6 choice tasks. They were first asked to choose between different TPC schemes and then whether they would vote in favour of introduction of their preferred scheme in case a referendum was organised. These attributes and their levels were selected with the help of five experts. The first two attributes focus on how the (free) credits need to be distributed. The third attribute is about how often the credits will be distributed and the fourth attribute is on how often the credit price will fluctuate (see table 1). Thereafter, 23 attitudinal statements followed that are based on a literature review and the focus group sessions. An exploratory factor analysis revealed the following 9 attitudes that were included as summated scales in the model estimations: perceived effectiveness, importance of certainty, expected hassle, expected infringement, perceived fairness, trust, general problem perception, personal problem perception and perceived behavioural control. The final part consisted of questions regarding socio-demographic characteristics and mobility habits.

Table 1 Overview of attributes and attribute levels used in the choice experiment

Attribute	Levels
Eligible recipients of free credits	All residents of the municipality
	All residents of the municipality who own a car
	All residents of the municipality + people who work there
	All residents of the municipality + people who work there and own a car
Distribution principle	Credits are equally distributed among all recipients
	People who have travelled more km will receive more credits
	People who work more hours per week receive more credits than people who work less hours per week
	People with a lower income receive more credits than people with a higher income
Credits allocation interval	Weekly
	Monthly
Credit price fluctuation	Every minute
	Every day

The sample consists of people living in and near two of the biggest municipalities in the Netherlands: Amsterdam and Utrecht. Both groups received a survey in which TPC was suggested in their city. In total, we collected data of 502 citizens. Although female, retired and higher educated people are somewhat overrepresented in the sample, all main socio-economic groups are well represented and since socio-economic variables are no strong predictors of acceptability, we believe the sample is suitable to gain a first insight into the acceptability of TPC and relations with background variables.

To explore people's preferences for TPC scheme designs, a discrete choice model based on the utility maximization theory is estimated from the observed choices. Because we are interested in the contribution of

groups of variables to the explanation, we estimated and compared a series of models. First a simple MNL model was estimated containing only the attributes, which is a significant improvement over de the null-model. Then, socio-economic variables were added to the model, which led to a small yet significant improvement of the model fit. Thirdly, attitudinal variables were added which led to a strong improvement of model fit. In the fourth step, we added an error component to our model and estimated a panel ML model that takes into account that the six choices made by each respondent correlate. This also led to significant improvement of the model. Lastly, sigma's were added to the model, which denote the standard deviations of the assumed normal distributions of attribute parameter tastes. Including the sigma's for credit distributions led to an improvement of model fit. The final panel ML model has a final Log Likelihood of -2188.167 and a rho-square of 0.339.

3. Results

The results are presented in table 2 and will be discussed in accordance with the model estimation procedure.

Regarding the attributes, support is stronger when the credit price fluctuates on a daily basis instead of every minute and also, a monthly distribution of credits is preferred over a weekly interval. These values imply that people generally prefer schemes that require less 'trading hassle'. Another explanation is that a daily price fluctuation gives less uncertainty about travel costs. Both attributes have however relatively small values. The way in which the credits are distributed affects support levels considerably more than the other two attributes. People prefer 'equal distribution', whereas the distribution in which lower incomes receive extra credits is least preferred. This suggests that people on average do not like TPC to redistribute welfare. Nevertheless, the sigma's are significant and relatively large. This means that the tastes regarding the distributional principles are very heterogeneous. Regarding the attribute eligible recipients, most respondents prefer a TPC scheme in which not only the residents on the municipality receive credits, but also people who work there and own a car. Thus apparently, on average people prefer a scheme in which all people who (can) actually use the road receive credits. Hence, there is little support for giving credits to people who do not own a car. Wrapped up, people on average find that credits should be equally distributed, but not to people who do not use the road. However, the significant and relatively large sigma's indicate that preferences regarding which people should receive free credits vary considerably among people. Thus, the way in which the credits are distributed and to whom is quite important, but consensus on this is a far cry.

Only a few socio-economic variables and their interactions with attributes turned out to be statistically significant. Educational level and work situation are both significant. Higher educated people and students have a stronger dislike for TPC. This finding contrasts with most earlier studies on the relation between conventional road pricing acceptability and educational level (Börjesson *et al.*, 2015; Ubbels and Verhoef, 2006). However, Dogterom et al. (2018) also found a negative, yet insignificant relationship between tradable driving credits acceptability and educational level. This is interesting, also because an experiment on trading behaviour with parking permits (Brands *et al.*, 2019) showed that higher educated people are better traders than lower educated people. Thus, this suggests that better trading skills do not necessarily lead to stronger support. Furthermore, people who live in the municipalities of Utrecht and Amsterdam have a larger dislike for TPC than people who live in the surrounding areas. This is somewhat surprising since in all suggested TPC schemes citizens of Utrecht and Amsterdam would receive credits while this is not the case for those who live in the surrounding municipalities. A possible explanation for this is that people living in the municipality will always be confronted with TPC, whereas people living in the surrounding areas may have the option to avoid the area by traveling to other cities. Furthermore, remarkable is that inhabitants of Amsterdam/Utrecht are slightly more negative than average about the schemes in which only credits are given to them instead of also giving credits to for example people who work in these cities, which seems to run counter to their self-interest.

The attitudinal variables have relatively strong relations with support. Five attitudinal variables are found to significantly influence utility. The *perceived fairness* and *expected effectiveness* have most influence on support. As expected, people who are positive about the expected effectiveness and who are positive about *fairness*, show stronger support for TPC. Furthermore, support is stronger when people do not find TPC *infringing on their freedom* (only significant at a 10% level) and if they *trust* the government and the technical feasibility. Less obvious is the positive value for the attitudinal variable *certainty*. This value indicates that people who attach importance to have certainty about travel costs and travel time show stronger support to TPC. On the one hand,

this makes sense because introduction of TPC can make travel times less uncertain, on the other hand, the travel costs become more uncertain. Thus, these people find certainty about travel times more important than certainty about travel costs, and/or they underestimate the increased uncertainty about travel costs within a TPC system. Within the set of attitudinal variables, it can be concluded that 'expected effectiveness' and '*perceived fairness'* have a stronger relation with support than the other three attitudinal variables.

Table 2 Results of the final panel ML model with error component structure

Name	Value	Rob. Std err	Rob. t-test	Rob. p-value
Constant_TPC	-3.4	0.714	-4.76	0.00
D1_equal distribution	0.599	0.108	5.56	0.00
D2_more km traveled, more credits	-0.101	0.124	-0.816	0.414
D3_more hrs working, more credits	-0.234	0.102	-2.3	0.02
D4_ *lower income, more credits*	*- 0.264*			
F1_fluctuation_minute	-0.192	0.0602	-3.19	0.00
F2_fluctuation_daily	*0.192*			
I1_interval_weekly	-0.147	0.0435	-3.38	0.00
I2_interval_montlhy	*0.147*			
R1_residents municipality	-0.287	0.0601	-4.78	0.00
R2_residents municipality who own car	0.0659	0.134	0.491	0.624
R3_residents municipality + people who work there	0.0624	0.0913	0.684	0.494
R4_residents municipality + people who work there that own a car	*0.1587*			
Level of education	-0.346	0.131	-2.64	0.01
work situation_other	0.428	0.454	0.943	0.35
work situation_retired	0.503	0.339	1.48	0.14
work situation_student	-1.13	0.527	-2.14	0.03
Residence in municipality	-1.7	0.357	-4.76	0.00
Interaction_residence in municipality_R1	-0.287	0.0601	-4.78	0.00
Attitude_perceived fairness	1.21	0.264	4.58	0.00
Attitude_expected effectiveness	1.17	0.227	5.15	0.00
Attitude_importance certainty	0.509	0.228	2.23	0.03
Attitude_trust	0.496	0.218	2.28	0.02
Attitude_infringement	-0.342	0.204	-1.67	0.09
Sigma_ D1_equal distribution	0.681	0.125	5.43	0.00
Sigma_ D2_more km traveled, more credits	0.662	0.116	5.69	0.00
Sigma_ D3_more hrs working, more credits	0.74	0.12	6.18	0.00
Sigma_ R1_residents municipality	0.648	0.125	5.18	0.00
Sigma_ R2_residents municipality who own a car	0.31	0.148	2.09	0.04
Sigma_C_TPC	3.33	0.245	13.6	0

The final model is used to illustrate the support levels of different TPC schemes. This probability is simulated with 500 Halton draws. The most preferred scheme design has a support level of 52.4%. Thus, a small majority would vote in favour of this scheme. In this scheme design, *all residents of the municipality + people who work there and own a car* receive credits which are *equally distributed* on a *monthly basis* and the credit price fluctuates *daily*. The least preferred TPC scheme has a predicted support level of 32.3%. Especially the way in which the credits is allocated is decisive for gaining a majority or not.

4. Conclusions

Based on the results of this experiment, we formulate the following main conclusions.

The result suggest that on average people prefer the status quo over implementing TPC. Overall, support increases if the credits are distributed monthly, the credit price fluctuates daily, the credits are distributed equally, preferably among residents in the municipality plus people who work there and own a car. This indicates that on average people prefer schemes that require less trading effort and in which credits are

distributed equally, but preferably only to people who actually use the road. The tastes regarding the allocation of credits are however very heterogeneous. Depending on the scheme design support, levels range from 32.3% to 52.4%. Thus, these results do indicate that only a small majority of the people is in favour of the implementation of the most attractive TPC scheme. Our finding that only a relatively small group of people changed their accept/reject position due to the exact scheme design, is in contrast to earlier studies on tradable carbon permits who found that support levels increases from 20% to 80% (Bristow *et al.*, 2010). On the other hand, other road pricing studies state that attitudes are indeed very important in predicting road pricing acceptability. Furthermore, scheme characteristics have only limited impact on scheme preference. Attitudes, especially perceived effectiveness and fairness, whether people live in the municipality, and to a limited extent socio-demographics, in particular level of education and being a student, are stronger related to preference.

The results have to be interpreted with some caution since this is a first quantitative exploratory study regarding public support of TPC that has some limitations. TPC was presented to the respondents without mentioning system costs. Due to the trading platform it is likely that a TPC system is more expensive than a congestion charge. It would be interesting to further study the public support from a citizen perspective by confronting respondents with the societal costs (e.g. system costs) and benefits (e.g. reduction congestion) of both instruments. Furthermore, this paper studied the support levels based on peoples' first impression of this novel instrument about which they had never heard before. It is unknown whether and how acceptability and preferences change when people get more acquainted with the concept. Revealed preference studies that examine the support of people who have actually been using tradable credits in field studies would be very helpful in this respect.

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