Exploring the feasibility of tradable credits for congestion management

Krabbenborg, Lizet; Molin, Eric; Annema, Jan Anne; van Wee, Bert

DOI
10.1080/03081060.2021.1883226

Publication date
2021

Document Version
Final published version

Published in
Transportation Planning and Technology

Transportation Planning and Technology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/gtpt20

Exploring the feasibility of tradable credits for congestion management

Lizet Krabbenborg, Eric Molin, Jan Anne Annema & Bert van Wee

To cite this article: Lizet Krabbenborg, Eric Molin, Jan Anne Annema & Bert van Wee (2021) Exploring the feasibility of tradable credits for congestion management, Transportation Planning and Technology, 44:3, 246-261, DOI: 10.1080/03081060.2021.1883226

To link to this article: https://doi.org/10.1080/03081060.2021.1883226

Published online: 16 Feb 2021.

TRANSPORTATION PLANNING AND TECHNOLOGY
2021, VOL. 44, NO. 3, 246–261
https://doi.org/10.1080/03081060.2021.1883226

Routledge
Taylor & Francis Group

Exploring the feasibility of tradable credits for congestion management

Lizet Krabbenborg, Eric Molin, Jan Anne Annema and Bert van Wee

Department of Engineering Systems and Services, Delft University of Technology, Delft, The Netherlands

ABSTRACT

Tradable credits for congestion management are a novel policy concept that is receiving increased interest in transportation research. This interest is mainly driven by the belief that the concept can count on stronger social support and hence has a better prospect for implementation than charging-based instruments. This paper is the first to provide an analysis of the social, political, economic and technical feasibility of this concept. To this end, policymakers and researchers from the field of transport have been interviewed. The results reveal so many barriers and challenges in the social and political context that some seem insurmountable, which exposes a difference with expectations formulated in the literature. We reflect on possible options to overcome or avoid barriers but conclude that the concept of tradable peak credits lies very far from the current way of thinking about road use and seems unable to compete with more established charging schemes.

ARTICLE HISTORY
Received 4 March 2020
Accepted 21 December 2020

KEYWORDS
Congestion management; tradable mobility credits; road pricing; feasibility

1. Introduction

Although congestion pricing is generally seen as the most efficient way to manage the increasing congestion in urban areas, only a few schemes have been implemented worldwide. Many attempts failed due to a wide variety of factors, with the (lack of) public and political support as the most frequently mentioned factor (Vonk Noordegraaf, Annema, and van Wee 2014). Congestion pricing is unpopular for different reasons, including the expected ineffectiveness and perceived unfairness of the scheme, car users' self-interest and the scepticism of the government's use of the revenues (cf., Schade and Schlag 2003).

Recently, interest in tradable credits applied to congestion management has increased within academia, as this concept can address the above-mentioned concerns (cf., Dogterom, Ettema, and Dijst 2017; Fan and Jiang 2013; Grant-Muller and Xu 2014). Because the concept can be operationalised using many different designs (Fan and Jiang 2013), it needs to be specified with more precision for research purposes. In this paper, we use the following description: An authority establishes a clear limit (cap) for

CONTACT Lizet Krabbenborg lizet.krabbenborg@minienw.nl Department of Engineering Systems and Services, Delft University of Technology, Building 31, Jaffalaan 5, 2628 BX Delft, The Netherlands
Supplemental data for this article can be accessed at https://doi.org/10.1080/03081060.2021.1883226.

car use on a certain stretch of road, during a certain period of a day. This cap is translated into a number of credits that are distributed (free of charge) among the participants every week, month or other unit of time. Participants pay a credit when they use the defined road during the defined time of day, and they can sell and buy credits on a market where supply and demand set the price. Participants can be households, but also taxpayers or car owners for example.

A tradable credit scheme is potentially effective in reducing car use since the cap guarantees the predefined reduction in car use. Whereas with a congestion charge, the price is controlled instead of the car use. Furthermore, the budget-neutral tradable scheme can address equity issues in a flexible way through the allocation of free credits and provides the opportunity for users to make financial gains from the system. Lastly, the scheme does not generate revenues for the government as the money circulates between users.

These characteristics of the concept may lead to higher acceptability, and hence feasibility, but they are no guarantee for policy implementation. The cap-and-trade principle has been used in policies to, for example, limit greenhouse gas emissions and encourage sustainable fisheries (Sovacool 2011) but a personal tradable credits scheme has not yet been implemented anywhere and consequently, there is no relevant experience or evidence base. Feitelson and Salomon (2004) state that before a new policy can be adopted in practice, it does not only need to be technically and economically feasible, but it also needs sufficient public and political support. Vonk Noordegraaf, Annema, and van de Riet (2012) furthermore state that the likelihood of a road pricing policy being adopted not only depends on whether it is seen as feasible, but also on whether a policy opportunity occurs, and great political decisiveness is required. So far, most studies on tradable credits for mobility management focus on the scheme design, the effects on traffic flows or the behavioural responses of car users (see Section 2). Studies on the feasibility of related concepts show varying results, but to the best of the authors' knowledge, an in-depth analysis of whether and under which circumstances the theoretical concept of tradable credits for congestion management is considered feasible, and hence can become a real policy option for congestion management, is still missing.

In this paper, we therefore, explore the social, political, economic and technical feasibility of tradable peak credits (TPC). We will present possible barriers and reflect on how they can be overcome or avoided – if possible. The outcomes can be used to steer further research in the search for an effective yet acceptable congestion management instrument. Since TPC schemes are still a concept rather than a fully developed scheme and we seek to explore, explain and understand this new phenomenon, a qualitative research approach seems suitable. To that effect, semi-structured interviews with policymakers and researchers from the field of transport in the Netherlands were held. These interviewees were expected to be able to quickly understand the rather complex concept and provide key insights into potential barriers to policy adoption. The use of semi-structured, in-depth interviews allows us to both have guidance and flexibility. The fixed set of questions helps to gather information on all subtopics, while it also leaves room for spontaneous reactions and hence relevant information may be gathered that has not been previously anticipated.

The paper proceeds with an overview of recent literature on the feasibility and policy challenges of policies involving (personal) tradable credits. Thereafter, an outline of the

methodology follows in Section 3. Next, the outcomes of the interviews are presented before discussing them and comparing them with recent empirical studies and theories from literature on policy processes. The final section presents conclusions and recommendations.

2. Literature on the feasibility of tradable credits

To the best of our knowledge, no extensive studies have been conducted on the feasibility or barriers to the adoption of policies involving TPC. However, studies on related instruments may provide some relevant insights. Relevant literature regarding the feasibility of TPC can be divided into three categories: cap-and-trade systems (applied to industries), personal carbon trading and personal credits in the transport domain.

Ever since Coase (1960) presented the idea of tradable property rights as a more efficient way to manage negative externalities such as emissions, all kinds of cap-and-trade systems, transferable rights and tradable credits have been studied and promoted by economists (cf., Crocker 1966; Dales 1968). Actual policy implementation did not occur at first because the concept was generally seen as impractical and many considered it ethically ambiguous. Later, the required technologies improved and confidence in the efficiency and equity of direct government intervention diminished (Ellerman 2003) while other approaches were tried and failed (Tietenberg 2003). Since the mid-1990s, several tradable credit schemes have been implemented in markets such as agriculture (Sovacool 2011). Still, these schemes remain controversial and not every attempt to implement a scheme succeeds. Several proposals have been analysed regarding the policy obstacles (OECD 2000; Sovacool 2011). The level of the cap, the allocation of the (free) credits and the nature of the problem are all topics that can lead to lengthy debate among stakeholders, including the users. Furthermore, governments may be concerned about high administrative costs, loss of revenues, the risk that big companies exploit market power in the credit market, free-riders and loss of dynamic efficiency. Thus, tradable permit schemes are implemented in various markets despite these controversies, and with increasing familiarity this number may further increase.

The idea of applying tradable permits at citizen level evolved as a policy idea aimed to reduce carbon emissions in the mid-1990s. Ten years later, personal carbon trading (PCT) was being studied, mainly in the UK. The government had ambitious carbon reduction goals and the PCT concept was explored, inspired by the belief that it is a policy that reduces emissions in an efficient and fair way (Fawcett 2010). Studies on social feasibility find support levels of around 25–40% (Owen et al. 2008; Wallace et al. 2010), up to 80% (Bristow et al. 2010). These levels are relatively high given the radical novelty of the concept. Moreover, these studies found that PCT is preferred over an equivalent carbon tax. Parag and Eyre (2010) explored the wider feasibility of PCT by identifying barriers in the policy arena using theories from literature on policy processes and Woerdman and Bolderdijk (2017) defined barriers using insights from economics and behavioural science. Parag and Eyre concluded that the evidence base is currently inadequate to predict whether PCT would be adopted as a policy instrument. Woerdman and Bolderdijk concluded that the scheme can be feasible from a micro-economic and behavioural perspective but argue that the implementation is unlikely from an institutional-economic point of view, especially because of its integration with, in their

case, the existing European Union's Emissions Trading Scheme (EU-ETS). The small number of governmental studies are more negative. In the UK, the Department for Environment, Food & Rural Affairs (Defra) declared that PCT seems to be an idea currently ahead of its time, with lack of social acceptability as its main weakness (Defra 2008). The IPPR (2009) came to a similar conclusion after interviews with stakeholders. Many interviewees find it an attractive idea in theory but think it will not be workable. They have concerns about practicalities and costs, but mostly about fairness.

Attention to personal credits in the transport domain arose in academia when Verhoef, Nijkamp, and Rietveld (1997) and Viegas (2001) explored the concept. Further studies followed: on the effects of tradable credits on the transportation network, market design and transaction costs, and user responses (cf., Dogterom, Ettema, and Dijst 2018b; Wang et al. 2012; Yang and Wang 2011). Grant-Muller and Xu (2014) concluded in their review that credits could be feasibly introduced and have some advantages over other instruments to reduce congestion, specifically concerning efficiency and equity. Although economic viability is often an important requirement for a policy to become feasible, it is not sufficient, as we argued in the introduction. However, studies on the wider feasibility and policy challenges are scarce. Social acceptability has been studied a few times. Dogterom et al. (2018a) studied car users' acceptance of a tradable kilometre's credits scheme in the Netherlands and Beijing and found support levels of 25% and 67%, respectively. Kockelman and Kalmanje (2005) found that about 25% of their respondents supported the concept of (non-tradable) credit-based congestion pricing (CBCP). Gulipalli, Kalmanje, and Kockelman (2008) conducted a survey among experts who were asked to predict the effects and share their concerns and ideas for implementation of CBCP in Texas. Most respondents expected CBCP to be more effective than conventional congestion pricing, although many were concerned about the level of administrative costs. They were positive about the technological viability and because most transport economists supported CBCP.

3. Methodology

The feasibility of TPC and barriers to policy implementation are primarily explored using semi-structured interviews. The interviews were conducted within the context of the situation in the Netherlands.

3.1. Case background: road pricing in the Netherlands

Many types of road pricing have been discussed and considered in the Netherlands. In 2010, a road pricing policy was at an advanced stage, involving many policymakers and scientists, when the new coalition government decided to cancel the implementation. Since 2010, the ruling coalitions have declared all road charging instruments controversial. Instead, experiments rewarding peak hour avoidance were allowed and organised. Given that rewarding for peak hour avoidance is not a durable solution and charging for road use not an accepted solution, the idea of TPC was further developed. The first ideas regarding personal credits for mobility management were published over 20 years ago (Verhoef, Nijkamp, and Rietveld 1997) and from 2016 and beyond, the first steps towards a real-world pilot were taken in a consortium consisting of academics and municipalities.

3.2. Interviews

3.2.1. Selection of interviewees

The concept of tradable credits for mobility management is quite unknown even for most professionals working in the field of transportation. Therefore, we selected the interviewees based on their knowledge and experience with road pricing in general. A list of researchers was compiled, based on publications on road pricing. This group covered different fields of research which are relevant for road pricing, including psychology, public administration, human geography, economics and transport engineering. As for the policymakers, we aimed to select policymakers at different governmental levels: those who were concerned with road pricing on a national level, as well as professionals who were the road pricing experts in large municipalities. A few leading Dutch researchers were excluded because they were involved in the authors' research consortium. During the interviews, a snowballing technique was used to extend the list of names. In total, we interviewed 16 people in 14 interviews, since four respondents preferred to do the interview as a couple. After the 11th interview, no new insights were given by the interviewees. After three more interviews without finding any new insights, we considered the data collection to be saturated.

3.2.2. Interview structure and data analysis

Since we seek to take a broad perspective on the feasibility and implementation of a novel policy idea, we adopted an existing framework to structure the interview questions and minimise the risk of overlooking relevant aspects of feasibility. To that end, we found the political-economics framework of Feitelson and Salomon (2004) the most suited because their framework was developed to analyse the adoption of technical innovations in a complex public–private context involving many actor categories. This framework has been used before in the transportation literature to study, for example, the performance of the hyperloop (van Goeverden et al. 2018), and the implementation process of road pricing (Vonk Noordegraaf, Annema, and van de Riet 2012).

The four types of feasibility as described by Feitelson and Salomon (2004) were used to guide the interviews. Their framework is illustrated in Figure 1. According to them, a first

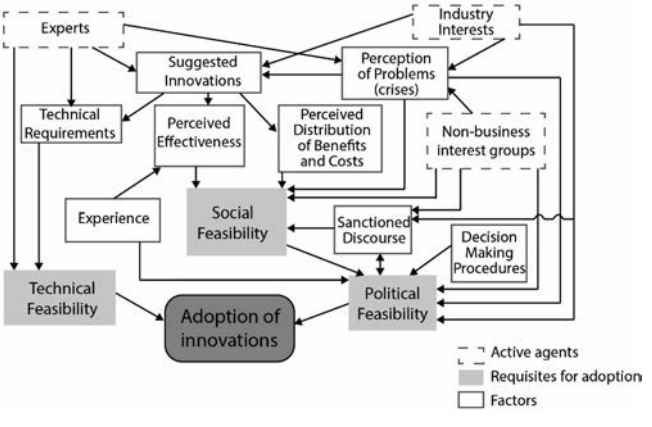

Figure 1. Feitelson and Salomon's feasibility framework.

fundamental condition for a transport innovation to be considered as a new policy is that is has to be seen as technically feasible. When people do not believe that it can be used, it is very likely to fail. Furthermore, the benefits need to outweigh the (among others technical) costs in order to be feasible from an economic point of view. In the case of road pricing, multiple studies showed that these schemes are still not widely implemented despite economic and technical feasibility. As they explain, that is because social and political feasibility are also prerequisites for adoption. An innovation can be considered socially feasible when a majority of voters are likely to support it. According to them, social feasibility depends heavily on the public perceptions of problems, expected effectiveness and whether people are positive about the distribution of benefits and costs. These perceptions can be influenced by experience with similar policies and can also be affected by active agents that support or criticise the innovations. In that way, they influence the 'sanctioned discourse'. That discourse encompasses the policy ideas that are seen by the media and elites as publicly acceptable. Political feasibility is partly determined by social feasibility since politicians take their voters' preferences into account. Indeed, it is assumed that politicians want to be re-elected. For the same reason, politicians can also be influenced by interest groups since they need their support for their re-election and/or want to avoid negative publicity.

In order to leave space for spontaneous reactions unrelated to the framework, the interviews started with general questions such as 'What is your opinion on tradable peak credits?' and 'What are the main barriers for the implementation of a system involving tradable peak credits in the Netherlands?'

The interview questions and a text about TPC were sent to the interviewees a week in advance in order to facilitate preparation (see Appendix A for the translated text and questions). The interviews took one hour on average and took place in February and March 2018. The interviews were transcribed and summarised.

The summaries were first analysed in an impressionistic way to get an understanding of the interviewees' positions regarding each type of feasibility. Then, we analysed the barriers to implementation in a structured way using the principles of content analysis (Elo and Kyngäs 2008). We coded the barriers using an inductive method within each type of feasibility.

4. Findings and discussion

Section 4.1. presents the findings, grouped in the order that the questions were asked, although these categories are interconnected rather than fully distinct. The numbers between brackets refer to the interviewees. The letter 'G' stands for governmental employee and 'R' for researcher. Section 4.2 presents a broader discussion based on the findings and relates them to empirical studies and theories on policy processes.

4.1. Results

4.1.1. Technical feasibility

Although technical feasibility heavily depends on the exact scheme design, most respondents expect that TPC is technically feasible considering current developments in the ICT field. These respondents mention that the principle of trading is already in use as

emission rights, for example, which seems to work. Nevertheless, two respondents mention that it is 'the most challenging concept in terms of technique of all road pricing solutions' [R4, R7]. Others are less positive and doubt whether the government is capable of implementing such an instrument:

> An independent app developer might come a long way, but considering that such an instrument would probably fall under the government's responsibility (because it is a public resource), through politics many requirements will be introduced which would make the instrument complex, technically speaking [G3]

and: 'You can expect problems similar to other government projects involving automation when introducing such a large and complex instrument' [G6].

As the TPC concept is a relatively complex policy, interviewees foresee barriers regarding privacy issues [R2; R5; R8; G2; G8] or problems with enforcement [R2; R5; R7; R8; G1; G2; G6; G7; G8]. Furthermore, the technical system requires a very high level of security in combination with the administration and detection system, which decreases the technical feasibility [R1]. Lastly, mobility behaviour is hard to predict which makes the exact design of the instrument difficult to determine. While in the end, as already stated, the exact end design determines the technical feasibility of the instrument.

4.1.2. Economic feasibility

Many interviewees believe TPC schemes have the potential to effectively reduce and control congestion and create benefits for society. Indeed, the cap can guarantee the traffic flow – with exemptions for congestion caused by collisions or extreme weather conditions. However, some have doubts whether people will understand the system and the price signals properly, whereas this is a requirement for the scheme to be effective [R3; R8; G1; G4; G5; G6; G7]. The effectiveness of the instrument depends on the level and dynamics of the prices. The question hereby arises whether the behavioural effects will flatten out after a while [R6; G5]. Some interviewees are clearly negative about the effectiveness:

> I think market forces are imperfect. Not everyone will trade: some will forget to buy, or leave their credits on their account. So it is a lot of hassle. Or others simply do not care about the prices. When you constantly have to calculate the costs, you start to ignore the prices at a certain moment. Constant price incentives do not steer behaviour. A credit price should be high enough in order to be effective .[G7]

Another risk is that tradable credits crowd out the intrinsic motivation of people:

> Tradable credits really focus on demand and supply (…). That bothers me, especially because I'm afraid that people forget the aim of the policy due to the focus on trading. Thus, trading or earning money becomes the goal instead of the higher goals (reducing emissions, congestion, improving liveability). [R5]

Multiple interviewees mention the trade-off between differentiation of the prices and the user transaction costs as a dilemma that is relevant for feasibility:

> Theoretically, higher differentiation in prices makes a better instrument. Thus: different tariffs depending on place and time. However, trading takes time. When individuals spend more time on trading, then they save travel time. (…) The trading should run

almost automatically. Thus, effectiveness increases with precise differentiated prices but that will drive participants crazy in practice' [R3]

and: 'The effectiveness is highest when a participant deals with the instrument on a daily basis. Although, he might fall back into his old habits' [G4]. Other risks mentioned concern the under-utilization of the roads [R3; R7; G4; G5; G7]. Empty roads might also negatively influence public support [R3]. Therefore, the definition of the optimal cap is important: 'When the cap is too high, there is a risk that people pay credits but are still experiencing congestion. When the cap is too low, traffic flow is excellent but with a high drop in demand' [G5]. Another risk regarding the cap is that too many credits are distributed, as happened in the EU-ETS program. 'Political parties may say: we will distribute an X amount of extra credits' [G6]. Furthermore, some think the effectiveness may be decreased due to speculation [G7] and latent growth [G2].

The respondents are less outspoken on the question of whether the instrument is cost-efficient, thus whether societal benefits exceed societal cost. Some mention that the system costs will be relatively high [R2; R2; R4; R6; R7; G1]. Besides, the cost efficiency also depends on the definition of costs within the societal cost-benefit framework: 'When you also include costs for future generations/environment/nuisance, and so on, it becomes more complex' [R5] and 'You should also consider the negative effects for the labour market. I think the likelihood that a societal cost benefit analysis is negative is quite high' [G3]. However, another interviewee remarks that the costs of such a pricing instrument will always be lower compared to infrastructure expansion [G2].

4.1.2. Social feasibility

All interviewees evaluated the overall social feasibility as very low. A few interviewees expect that the instrument will be received by the public in a similar way as congestion pricing [R5; G1]. Only two interviewees expect the social feasibility to be higher than a charging instrument, but still quite low. The remaining interviewees expect that the social acceptability will even be lower compared to a charging instrument. The following barriers are mentioned.

The perceived unfairness is, unsurprisingly, mentioned by almost all interviewees as an important barrier to social feasibility. The unfairness between different incomes [R2; R5; R6; G2] is mentioned: 'Certain groups can get the idea that the richest people will own the most credits' [R2], but also the lack of an alternative [G1] is mentioned. While a kilometre or congestion charge implies that everyone loses, a TPC scheme does not. The interviewees recognise that this may benefit the perceived fairness, but others emphasise that there will always be people who have to pay more than in the status quo. Again, this can be perceived as being unfair [R3; R4; G1; R7; G2]. Related to fairness is the distribution of the credits. Indeed, the way in which the credits are distributed, and to whom, define the distributional outcome of the scheme. Many interviewees consider the distribution of credits to be a main barrier [R2; R4; R5; R7; R8; G2; G4; G6; G7]. They explain that the distribution 'will raise so many questions and discussion' [R2] and any distribution will lead to a redistribution in wealth so there will always be people who find it unfair [R4].

The fear that that people may be excluded from the road during peak hours because they cannot afford the credit price is also mentioned as a barrier to social feasibility.

Theoretically, the credit price can greatly increase and hence become unaffordable for people with lower incomes. People can be excluded because they cannot afford the credit [R1; R4; R6; G3; G4; G6; G7] or because they do not understand the system because they are visitors or not familiar with technology, for example [R3; G2; G3]. Also, the uncertainty due to the varying credit prices decreases the acceptability [R6; G6; G7]. Furthermore, many interviewees mention the infringement of people's freedom as an important barrier [R1; R2; R4; R6; R8; G2; G4; G5; G6; G7; G8]. One interviewee even draws a parallel with the 'feeling of gasoline vouchers'[G5]. This may stir up a public debate whether it is desirable or acceptable to turn the public road into a market product [G2].

The expected ineffectiveness is also seen as a barrier, just like regular road pricing is perceived in literature on this subject. A TPC scheme has the unique characteristic that, theoretically, it can guarantee the reduction in trips because of the cap. As one interviewee mentioned: 'Acceptability is higher when effects can be guaranteed' [R6]. On the other hand, opponents will 'always claim that it will not work anyway' [R3; R5; R6; R8; G1; G2; G5] or cause privacy issues [G5; R7; R8; G2; G4]. A TPC scheme does raise some new arguments for opponents. People can be sceptical of government-run ICT projects because in the past the government has conducted a few ICT projects that are considered to be failures [R6]. People from the public may also expect TPC to be ineffective because users can speculate or commit fraud with the credits or hack the system [R6; G2; G8].

However, the most reoccurring barrier identified is the 'hassle' or the transaction costs the trading requires [R3; R4; R6; R7; G2; G5; G6; G7] although a few interviewees think that some people might see this as a fun aspect: 'People like to be smarter than their neighbour'. However, most mention trading as an aspect that decreases social feasibility. The trading requires extra time and effort from the users and also makes the concept more complex and difficult to understand. Hence, multiple interviewees think the intelligibility – whether people understand the system correctly – can be quite low. The fact that the TPC concept is so novel and different from existing policies, decreases the social feasibility [R3; R4; R6; G1; G3; G4; G5; G6; G7; G8].

4.1.3. Political feasibility

Many of the interviewees argue that the political feasibility probably correlates strongly with the social feasibility since political parties are heavily influenced by their voters' preferences. Hence, low social support leads to low political support. Still, there are also other factors or actors besides social feasibility that influence political feasibility. The interviewees mentioned the following barriers.

Policy integration in the context of the EU is seen as a possible barrier [R1; G5; G7]:

> Tradable peak credits are unknown and haven't been proven anywhere yet. Also, an EU-wide legal basis is missing. A kilometre charge, on the other hand, is in line with European policy guidelines that support 'pay according to use'. Thus, a system with tradable peak credits requires even more courage and perseverance from our politicians. I expect the political feasibility to be very low because of that. Why would a politician take such a risk? How can a politician 'score' with such an instrument?. [R1]

The complexity is also seen as a political barrier. The TPC concept is relatively complex and contains many design options. According to some interviewees, this is an important

barrier to political feasibility since 'the devil is in the detail': there are too many details that can become a topic of political debate [R1; R2; G2; G3; G4]. Multiple interviewees argue that it would be hard for a politician to explain the added value of TPC to the public [R1; G1; G2; G3; G7]: 'A minister cannot sell this instrument, it is not explainable to the public' [G3]. This also relates to the fact that the current evidence base is lacking [R1; R2; R5; R8; R2].

The lack of revenues can also become a barrier. In contrast to a charging instrument, a TPC system will cost money and the revenues from parking and car possession will decrease, without generating any new revenue stream to the government. This might lower the political feasibility [R6; G1; G4; G5; G7; G8].

Lastly, some stakeholders are seen as potential barriers. Stakeholders, such as newspapers, can negatively influence the public debate and hence be a barrier to political acceptability [R2]. Political feasibility may also be lower because road pricing has already been discussed many times before and stakeholders may be fed up with it [R6].

4.2. Discussing the findings

The interviews revealed a wide range of potential barriers and indicate that the main barriers lie in the social and political context. This section presents a broader discussion. We first discuss barriers related to the scheme design and to the international context. Thereafter, we discuss potential barriers and ways to avoid or overcome them in the next steps in the process of policy development. The barriers are compared to what has been found in the small number of empirical studies on tradable mobility credits. Obviously, no real-world empirical studies exist on the context and policy approach of TPC. Hence, we also have also used literature on road pricing and theories from the area of policy processes in our discussion of the findings.

4.2.1. Scheme design

First of all, the intelligibility – whether people understand the scheme, and behave as expected – was often mentioned as barrier. This corresponds with literature on road pricing, which found that understanding a scheme is a requisite for a scheme to be effective and acceptable (Giuliano 1992). In general, people prefer simple, predictable tariffs (Bonsall et al. 2007). Dogterom, Ettema, and Dijst (2018b) report that, in their experiment on tradable kilometre credits, many people adapted their behaviour in a rather complex way, which suggests that they understood the scheme. However, this conclusion is based on their sample of 308 respondents, whereas 918 people started the experiment. It is plausible that people who do not understand the scheme are underrepresented in their final sample. Furthermore, the tradable credit scheme in Dogterom et al.'s experiment was somewhat simplified since they used fixed price levels. Brands et al. (2019) did use dynamic prices in their lab experiment on tradable parking permits and found that most choices were made in a rational way, which indicates that they understood the scheme. This sample is probably also not representative of the average car user or citizen since the participants were recruited from a former peak hour rewarding project, which consists of frequent car users who are interested in these kinds of projects. Thus, more research on the intelligibility of TPC is needed. The way in which the information is presented and explained should get extra attention

since, according to Bonsall et al. (2007), this probably heavily influences people's ability to understand a scheme.

Also, the hassle, referring to the perceived time and (mental) effort that is required by the users, is another frequently mentioned factor which has barely been studied. Indeed, regular road pricing schemes do not require much action by the user. The effect of transaction costs on the way the market functions has been studied (Nie 2012) but it is still rather unclear how potential users perceive the hassle and how this affects their acceptability level. Brands et al. (2019) report that a majority of their respondents (strongly) agreed with the statement: 'participating in the experiment took little time or effort', which suggests that the transaction costs are relatively low. In their experiment, participants were asked to make a choice every working day, for two weeks. Thus, the interviewees expect a lot of hassle, while the respondents in Brands' experiment did not experience much hassle. The perceived 'hassle' is relevant for further study since a higher number of transactions lead to a more effective instrument, while too many transactions may decrease public acceptability. If trading requires too much effort, a non-tradable alternative (such as CBCP) may be better.

The distribution of the credits was seen as an important barrier since it determines the distribution of costs and benefits to a great extent, hence: who will be the winners and losers of the scheme? Although the literature on tradable credits repeatedly mentioned the distribution of the credits as an important characteristic, the public acceptability of different allocations has barely been studied. Most studies confronted their respondents with one particular scheme design (often, one where all participants would receive an equal share of credits) when they asked for their opinion. Bristow et al. (2010) did vary the allocation mechanisms and found that most people prefer a PCT scheme in which permits are equally distributed, with extra permits for those with a greater need, like living in a rural area, poor housing or disability, for example. Hence, the optimal distribution of credits, in terms of acceptability level, is still rather vague.

Nine interviewees mentioned the risk of social exclusion as a barrier to acceptability. The market mechanism can lead to prices which are unaffordable for certain people and consequentially may exclude them from using the road during peak hours. The regulators of TPC can diminish this problem by putting a maximum on the credit price and allocating extra credits to those in greater need. However, whether the wider public would accept an unequal distribution of credits is unknown. Moreover, TPC may also exclude people who do not understand the system. Hence, the ease of use of the system is very important and, as stated before, the intelligibility of all the types of people who would be subject to the scheme should be studied.

4.2.2. Context and regulations

As mentioned by a policymaker, local governments do not have the autonomy and authorisation to introduce a road pricing system in the Netherlands. What is more, the EU regulatory context can also create barriers even if a TPC scheme is introduced on a national scale or local governments get permission to introduce road pricing. It is unlikely that foreign license plates will receive free initial credits and exempting them from the credit system will decrease public acceptability. Hence, surrounding countries will probably oppose the introduction of a system which disadvantages foreign license plates. This also happened when Germany tried to introduce a toll which disadvantages

foreign license plates since the revenues of the toll would be used to compensate German car users. The European Court, therefore, forbade the toll (BBC 2019). Thus, when designing the scheme, the international regulatory context should also be taken into account, which further complicates the process.

Furthermore, an interviewee pointed out that some lobby groups may prefer TPC and become advocates. However, other stakeholders may oppose TPC. Lobby groups and political parties with environmental goals will probably prefer regular road pricing over TPC since the 'polluter pays principle' applies less to TPC. Besides, TPC can lead to moral objections since one can consider it 'a right to pollute'. Hence, they may become active opponents of TPC. To our knowledge, the opinions of relevant lobby groups and other stakeholders, such as political parties, have not been studied yet.

4.2.3. Additional barriers in policy development

The interviewees indicated that their perception of feasibility may change in the future if new studies or experiments reveal new insights. The following steps in the policy process may affect the feasibility.

First of all, many of the factors mentioned by the interviewees relate to the unclear policy design. This is a non-exhaustive list of unclear aspects: How to determine the cap? *Who receives the credits? How (often) are the credits distributed? How often do participants have to trade? How to deal with exemptions such as visitors and foreign license plates? Who, if anyone, would regulate the price? Where, and at what times are the credits needed? How will the scheme be regulated and by whom? Can participants also give credits to their visitors, for example?* Although some of these questions can be regarded as minor details that do not affect the mechanisms of TPC, they need to be answered since they might be crucial for the social and political acceptability. TPC should first stabilise into a dominant, fully developed design before it can pass through a 'window of opportunity' (Geels and Schot 2007). Real-world experiments can help to find a dominant design. Although experiments cannot simulate all aspects and effects of a TPC scheme, varying experiments can nevertheless help with understanding the effects and mechanisms of TPC. Experiments based on voluntary participation, in areas where congestion is strongest, in order to capture the largest benefits and provide proof of concept about the effects and technical aspects, may change people's acceptability and reinforce the beliefs in the technical feasibility.

Regardless of the amount of evidence about the concept, the moral objection of changing a public road into a tradable, marketable product remains. Here, framing can play a role. Introducing the concept in a positive way, emphasising the effects on congestion and avoiding it being seen as a rationing concept that infringes on people's perception of freedom. The budget neutral aspect should be emphasised: people receive a set of free credits and they can buy some extra credits if needed or sell credits and earn some money. The trading aspect seems to add to the perceived complexity and therefore should not get a prominent role in the framing and communication. However, if the idea of marketing public property conflicts with people's deep core beliefs, it is unlikely that this will change through communication style or an adjusted scheme design. Therefore, future studies should try to better understand the underlying reasons for the public opposing (or proposing) TPC.

Even if a TPC scheme is considered feasible in all aspects, that does not necessarily mean it will be implemented. According to Kingdon's multiple-streams model (Kingdon 2003), decisions regarding new policies can only be taken if there is a (coincidental) coupling of three streams: the solution stream, the problem stream, and a stream of political events (Koppenjan 1993). When the streams meet, a so-called policy window occurs and during these time windows, decision makers can make a decision about the solution to a problem. Regarding TPC, it is likely that the streams will meet again in the future, since the congestion problem is further increasing. Currently, however, TPC schemes are not within the 'basket of policy solutions'. If TPC further matures into a fully developed design, strong advocates will be needed who can place TPC in the solution stream. Then, TPC has to compete with the more established road charging solutions that are already in the solution stream. A future development that may decrease the likeliness of a TPC scheme being selected is the expected increase in electric vehicles. When the share of electric vehicles becomes substantial, the government may look for a different way of collecting taxes, instead of the excise duties on gasoline. This may be an additional reason for the government to prefer a policy that generates revenues, such as a kilometre charge, over a budget neutral option.

Lastly, if a TPC policy becomes part of the solution stream and is selected as a solution during a policy window, it will probably lead to a long and complex policy process. As pointed out by Ardıç, Annema, and van Wee (2015), traditional road pricing is already too complex to be handled in one political cycle. Because of all the details and design options, a long negotiation process is needed. They explain that consensual political systems, such as the Dutch political system, are already known for the low capacity for innovation, and when a long negotiation process covers multiple coalitions (agreements) this gets even lower.

5. Conclusions

Tradable peak credits (TPC) are a new idea for congestion management and radically different from established alternatives. This study has explored the feasibility of the concept and identified potential barriers to the implementation of such a policy, by interviewing policymakers and academics in the Netherlands. We found that all interviewees were generally sceptical or unreservedly negative about the concept, despite the theoretical advantages of TPC *qua* effectiveness and public acceptability, and they identified many potential barriers. The empirical studies and theories from the literature on policy processes identified some more challenges to the development of a TPC policy, including international regulations and the long negotiation process in the policy arena. Although the number of interviewees was limited, the contrast between the expectations expressed in the literature on tradable credits and our findings is striking.

Most interviewees thought the concept would be technically possible but found it hard to estimate whether the costs of such a system would exceed the (societal) benefits in this conceptual phase. The results showed that the main challenges lie in the context of social and political feasibility. The distribution of credits, the intelligibility and the balance between transaction costs and effectiveness were seen, in particular, as important challenges. Although most interviewees considered TPC unfeasible, they did not rule out the possibility that this will change in the future. Some of the barriers they foresee

may be overcome by adjustments to the scheme design or in the policy process, as discussed. The concept might achieve greater momentum if the design becomes more precise. Also, real-world experiments in congested areas can provide proofs of concept about the effectiveness and technical feasibility of the concept and this may lead to an increase in acceptability. Other barriers however seem insurmountable, such as the moral objection of 'trading access to public property' at this point in time. This requires a new way of thinking about car use and road access – a paradigm shift.

This study is limited since it is a small-scale exploratory study capturing only one moment in time. New insights, increasing congestion problems or decreasing trust in established policies can all lead to different conclusions regarding the feasibility of TPC. Besides, this study only considered the feasibility in the Netherlands. This country has a long history of road pricing alternatives, and many of the interviewees showed that they have trust in these alternatives. Policy acceptability is quite different in other countries, for example China (Liu, Lucas, and Marsden 2019), where Dogterom et al. (2018a) found strong support for tradable kilometre credits among car users. Thus, TPC might be more viable in such areas. Moreover, this study reports on the expectations of policymakers and researchers regarding the feasibility aspects. As the discussion showed, studies on TPC are scarce and many of the interviewees' assumptions and predictions could not be verified. More research is needed on the actual public and political acceptability, the economic cost and benefits, and the technical requirements.

Based on the current knowledge base, we conclude that tradable peak credits as a policy solution have a low feasibility and faces even more barriers than the simpler congestion charging alternatives. TPC may be conceptually elegant, but the concept lies very far from the current way of thinking about the use of public roads and a paradigm shift is needed before it can compete with more established and rigorously examined alternatives.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Lizet Krabbenborg http://orcid.org/0000-0002-2798-2804
Eric Molin http://orcid.org/0000-0003-4486-9608

References

IPPR. 2009. *Plan B? The Prospects for Personal Carbon Trading*. Institute for Public Policy Research. Accessed https://www.ippr.org/publications/plan-b-the-prospects-for-personal-carbon-trading.

Ardıç, Özgül, Jan Anne Annema, and Bert van Wee. 2015. "Non-implementation of Road Pricing Policy in the Netherlands: An Application of the 'Advocacy Coalition Framework'." *European Journal of Transport and Infrastructure Research* 15: 116–146.

BBC. 2019. "German Road Toll Discriminates Against Foreigners – ECJ." Accessed August 1, 2019. https://www.bbc.com/news/world-europe-48674703.

Bonsall, Peter, Jeremy Shires, John Maule, Bryan Matthews, and Jo Beale. 2007. "Responses to Complex Pricing Signals: Theory, Evidence and Implications for Road Pricing."

Transportation Research Part A: Policy and Practice 41 (7): 672–683. doi:10.1016/j.tra.2006.06.001.

Brands, Devi, Erik T. Verhoef, Jasper Knockaert, and Paul Koster. 2019. "Tradable Permits to Manage Urban Mobility: Market Design and Experimental Implementation." Tinbergen Institute Discussion Paper 007/VIII.

Bristow, Abigail L., Mark Wardman, Alberto M. Zanni, and Phani K. Chintakayala. 2010. "Public Acceptability of Personal Carbon Trading and Carbon Tax." *Ecological Economics* 69 (9): 1824–1837. doi:10.1016/j.ecolecon.2010.04.021.

Coase, R. A. 1960. "The Problem of Societal Cost." *Journal of Law and Economics* 3: 1–44.

Crocker, T. D. 1966. "The Structuring of Atmospheric Pollution Control Systems." In *The Economics of Air Pollution: A Symposium*, edited by H. Wolozin. New York: Norton & Norton. 61–86.

Dales, J. H. 1968. *Pollution, Property & Prices*. Toronto: University of Toronto Press.

Defra. 2008. *Synthesis Report of the Findings from Defra's Pre-feasibility Study Into Personal Carbon Trading*. London: Department for Environment, Food & Rural Affairs.

Dogterom, Nico, Yue Bao, Meng Xu, and Dick Ettema. 2018a. "Acceptability of a Tradable Driving Credit Scheme in the Netherlands and Beijing." *Case Studies on Transport Policy* 6 (4): 499–509.

Dogterom, Nico, Dick Ettema, and Martin Dijst. 2017. "Tradable Credits for Managing Car Travel: A Review of Empirical Research and Relevant Behavioural Approaches." *Transport Reviews* 37 (3): 322–343. doi:10.1080/01441647.2016.1245219.

Dogterom, Nico, Dick Ettema, and Martin Dijst. 2018b. "Behavioural Effects of a Tradable Driving Credit Scheme: Results of an Online Stated Adaptation Experiment in the Netherlands." *Transportation Research Part A: Policy and Practice* 107: 52–64. doi:10.1016/j.tra.2017.11.004.

Ellerman, A. D. 2003. "Tradable Permits: A Market-based Allocation System for the Environment." *CESifo Forum* 4 (1): 3–32.

Elo, Satu, and Helvi Kyngäs. 2008. "The Qualitative Content Analysis Process." *Journal of Nursing Management* 62 (1): 107–115.

Fan, Wenbo, and Xinguo Jiang. 2013. "Tradable Mobility Permits in Roadway Capacity Allocation: Review and Appraisal." *Transport Policy* 30: 132–142. doi:10.1016/j.tranpol.2013.09.002.

Fawcett, Tina. 2010. "Personal Carbon Trading: A Policy Ahead of Its Time?" *Energy Policy* 38 (11): 6868–6876. doi:10.1016/j.enpol.2010.07.001.

Feitelson, Eran, and Ilan Salomon. 2004. "The Political Economy of Transport Innovations." In *Transport Development and Innovations in an Evolving World*, edited by M. Beuthe, V. Himanen, A. Reggiani, and L. Zamparini. Berlin: Springer. 11–26.

Geels, Frank W., and Johan Schot. 2007. "Typology of Sociotechnical Transition Pathways." *Research Policy* 36 (3): 399–417. doi:10.1016/j.respol.2007.01.003.

Giuliano, Genevieve. 1992. "An Assessment of the Political Acceptability of Congestion Pricing." *Transportation* 19 (4): 335–358. doi:10.1007/BF01098638.

Grant-Muller, Susan, and Meng Xu. 2014. "The Role of Tradable Credit Schemes in Road Traffic Congestion Management." *Transport Reviews* 34 (2): 128–149. doi:10.1080/01441647.2014.880754.

Gulipalli, Pradeep K., Sukumar Kalmanje, and Kara M. Kockelman. 2008. "Credit-based Congestion Pricing: Expert Expectations and Guidelines for Application." *Journal of the Transportation Research Forum* 47 (2): 5–19.

Kingdon, John. 2003. *Agendas, Alternatives, and Public Policies*. 2nd ed. New York: Pearson.

Kockelman, Kara M., and Sukumar Kalmanje. 2005. "Credit-based Congestion Pricing: A Policy Proposal and the Public's Response." *Transportation Research Part A: Policy and Practice* 39 (7–9): 671–690. doi:10.1016/j.tra.2005.02.014.

Koppenjan, Johannes Franciscus Maria. 1993. *Management Van De Beleidsvorming [Management of Policy Making]*. Den Haag: VUGA.

Liu, Qiyang, Karen Lucas, and Greg Marsden. 2019. "Public Acceptability of Congestion Charging in Beijing, China: How Transferrable Are Western Ideas of Public Acceptability?" *International Journal of Sustainable Transportation* 78 (2): 1–14. doi:10.1080/15568318.2019.1695158.

Nie, Yu. 2012. "Transaction Costs and Tradable Mobility Credits." *Transportation Research Part B: Methodological* 46 (1): 189–203. doi:10.1016/j.trb.2011.10.002.
OECD. 2000. *Implementing Domestic Tradable Permits for Environmental Protection*. Paris: OECD Publishing. https://doi.org/10.1787/9789264181182-en.
Owen, L., L. Edgar, S. Prince, and C. Doble. 2008. *Personal Carbon Trading: Public Acceptability: A Report to the Department for Environment, Food & Rural Affairs*. London: Department for Environment. Food & Rural Affairs.
Parag, Y., and N. Eyre. 2010. "Barriers to Personal Carbon Trading in the Policy Arena." *Climate Policy* 10 (4): 353–368. doi:10.3763/cpol.2009.0009.
Schade, Jens, and Bernhard Schlag. 2003. *Acceptability of Transport Pricing Strategies*. Oxford: Elsevier.
Sovacool, Benjamin K. 2011. "The Policy Challenges of Tradable Credits: A Critical Review of Eight Markets." *Energy Policy* 39 (2): 575–585. doi:10.1016/j.enpol.2010.10.029.
Tietenberg, Tom. 2003. "The Tradable-Permits Approach to Protecting the Commons: Lessons for Climate Change." *Oxford Review of Economic Policy* 19 (3): 400–419.
van Goeverden, Kees, Dimitris Milakis, Milan Janic, and Rob Konings. 2018. "Analysis and Modelling of Performances of the HL (Hyperloop) Transport System." *European Transport Research Review* 10 (2): 28. doi:10.1186/s12544-018-0312-x.
Verhoef, Erik, P. Nijkamp, and Piet Rietveld. 1997. "Tradeable Permits: Their Potential in the Regulation of Road Transport Externalities." *Environment and Planning B: Planning and Design* 24: 527–548.
Viegas, Jose M. 2001. "Making Urban Road Pricing Acceptable and Effective: Searching for Quality and Equity in Urban Mobility." *Transport Policy* 8: 289–294.
Vonk Noordegraaf, Diana, Jan Anne Annema, and Odette van de Riet. 2012. "The Policy Implementation Process for Road Pricing in the Netherlands." In *Transition Towards Sustainable Mobility: The Role of Instruments, Individuals and Institutions*, edited by H. Geerlings, Y. Shiftan, and Dominic Stead. Farnham: Ashgate. 327–346.
Vonk Noordegraaf, Diana, Jan Anne Annema, and Bert van Wee. 2014. "Policy Implementation Lessons from Six Road Pricing Cases." *Transportation Research Part A: Policy and Practice* 59: 172–191. doi:10.1016/j.tra.2013.11.003.
Wallace, Andrew A., Katherine N. Irvine, Andrew J. Wright, and Paul D. Fleming. 2010. "Public Attitudes to Personal Carbon Allowances: Findings from a Mixed-method Study." *Climate Policy* 10 (4): 385–409.
Wang, Xiaolei, Hai Yang, Daoli Zhu, and Changmin Li. 2012. "Tradable Travel Credits for Congestion Management with Heterogeneous Users." *Transportation Research Part E: Logistics and Transportation Review* 48 (2): 426–437. doi:10.1016/j.tre.2011.10.007.
Woerdman, Edwin, and Jan Willem Bolderdijk. 2017. "Emissions Trading for Households? A Behavioral Law and Economics Perspective." *European Journal of Law & Economics* 44 (3): 553–578. doi:10.1007/s10657-015-9516-x.
Yang, Hai, and Xiaolei Wang. 2011. "Managing Network Mobility with Tradable Credits." *Transportation Research Part B: Methodological* 45 (3): 580–594. doi:10.1016/j.trb.2010.10.002.