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Differences in perceptions of fuel duties and emissions trading in road transport

Abstract

The transport sector is responsible for around 20% of global CO2 emissions, and road transport alone contributes to three-quarters of that share. A separate Emissions Trading System (ETS) in the EU will be implemented in 2027, covering road transport, buildings and additional sectors (mainly small industry). The likely outcomes of such policy are higher fuel prices, leading to less fuel consumption and reduced road transport emissions. Given that the inclusion of road transport in the EU ETS was originally proposed by the UK in the 2000s, and that the UK is exploring possible improvements to its own UK ETS, it is not impossible that the idea of emissions trading in road transport could be revisited in the UK. This article explores differences in perceptions of fuel price increases as a result of an increase in fuel duties or as a result of the introduction of a parallel ETS for road transport. This research employs a Serious Game to elicit perceptions. The game was designed to create situations where car drivers would need to make decisions in response to an increase in the pump price of fuel. Ultimately, the idea was to get the study participants to reflect on their travel decisions both in the game and in real life. Possible responses included changing their cars, modifying their travel behaviour and moving house. The data was analyzed using an interpretive approach, which contributed to the understanding of how participants experience and rationalize their decisions after fuel price increases. The main finding is that emissions trading seems to be seen more positively than an increase in fuel duties. The study participants associated emissions trading with a reduction in GHG emissions, and fuel duty increases to an increase in pump prices. When they were reminded that emissions trading would also cause pump prices to increase, they still seemed to be open to the idea of such a policy, and when they were reminded that the increase in fuel duties would also be aimed at reducing GHG emissions, they changed their attitude slightly towards a more positive one.

Keywords

Fuel taxes. Tradable permits. EU ETS. CO2 emissions. Road transport policies. Policy perceptions.

Differences in perceptions of fuel duties and emissions trading in road transport

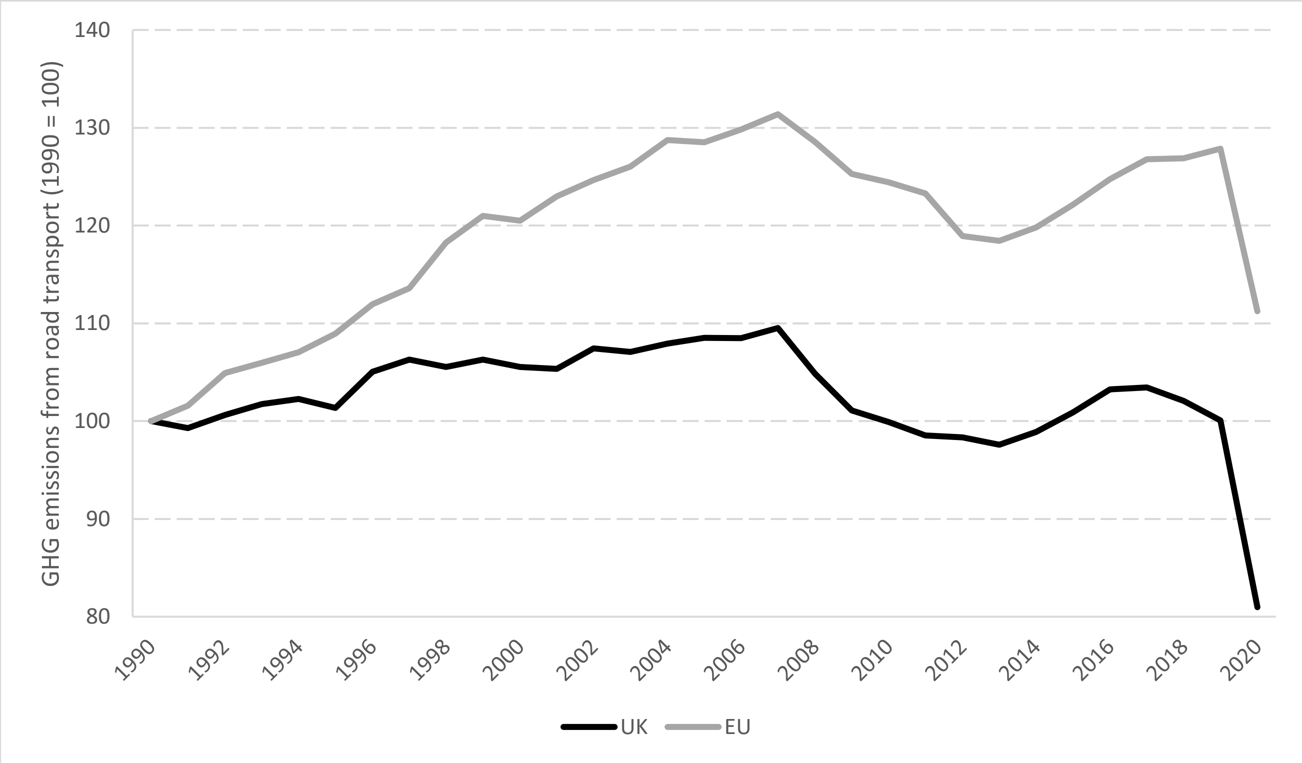
Nomenclature	
FD	Fuel Duty
ETS	Emissions Trading System
ETS-RT	Emissions Trading System-Road Transport
SG	Serious Games

1. Introduction

The United Kingdom (UK) has set a target of net-zero emissions by 2050 (Department for Business, Energy and Industrial Strategy, 2020), with an intermediate target of 78% reduction by 2035 relative to 1990 levels (Department for Business, Energy and Industrial Strategy et al., 2021). The European Union (EU) has also set a target of net-zero by 2050, with an intermediate target of 55% reduction by 2030 relative to 1990 levels (Official Journal of the European Union, 2021, Regulation (EU) 2021/1119, 30 June).

Road transport is therefore a key area to tackle. Figure 1 shows GHG emissions from road transport in the UK and in the EU between 1990 and 2020 (with 1990 = 100). As it can be seen, they only declined drastically during the travel restrictions of the COVID-19 pandemic. Between 1990 and 2019, they increased some years, and decreased others. Clearly, neither the UK nor the rest of Europe are on course to meeting their net-zero commitments.

Figure 1: GHG emissions from road transport in the UK and in the EU between 1990 and 2020 (1990 = 100)



Source: Department for Transport (2022a, Table ENV0201/TSGB0306) and European Environment Agency (2022)

A number of policies designed to reduce GHG emissions from road transport have been implemented in countries around the world, including European countries and the UK, and legislation has been passed regarding bans on the sale of new non-zero emission vehicles with different years as target dates, depending on the country. In addition to that, in April 2023, the European Council adopted a European Commission proposal to amend Directive 2003/87/EC (Council of the European Union, 2023a). This amendment includes, amongst other changes, a separate but parallel ETS applied to fuels used for combustion in the building and road transport sectors and in industrial activities not covered by the original EU ETS. The new system will apply from 2027 to distributors that supply fuels to buildings, road transport and additional industrial sectors (Council of the European Union, 2023a). The new EU legislation does not include the UK, where in January 2021, following Brexit, the EU ETS was replaced with the UK ETS. However, considering that the inclusion of road transport in the EU ETS was originally proposed by the UK in the 2000s (Department for Transport, 2007, p. 160), and that the UK ETS is likely to be improved and expanded, as evidenced by the 2022 UK government joint consultation (Department for Business, Energy and Industrial Strategy, 2022), it is not impossible that the idea of emissions trading in road transport could be revisited in the UK.

This article explores differences in perceptions of fuel price increases as a result of an increase in fuel duties or as a result of the introduction of a parallel ETS for road transport in the UK. Perceptions are important because "it is likely they most strongly correlate with and affect preferences for… policies" (PytlikZillig et al., 2018). If the ETS for road transport in the UK were implemented upstream, as will be the case in the EU, it is very likely that the additional costs, or at least part of them, would be passed on to drivers, who would face higher pump prices. Increasing fuel duties would also result in higher pump prices. If the higher pump price resulting from an increase in fuel duties were identical to the higher pump price resulting from the introduction of an ETS for road transport, the reason behind the increase should, in principle, make no difference to drivers. If it indeed were to make no difference to drivers, there would be no point in introducing emissions trading in road transport, which would entail substantial additional administrative costs compared to an increase in fuel duties, which have been in place for over a century in the UK. However, identical pump price increases could be perceived differently depending on whether they were the result of an increase in fuel duties or the result of the introduction of emissions trading because, even within a framework of consumer rationality, drivers may have different preferences regarding policies to internalize the climate change externality. For example, drivers may perceive fuel duties as pure, distortive, taxes with the only aim of financing government expenditure, and emissions trading as a tool to combat climate change. The problem is that any difference in perceptions could potentially have impacts on the success or failure of either policy. The qualitative data employed in the present study does not intend to achieve statistical representativeness, but instead, seeks to achieve data saturation, and is used mainly, to investigate differences in perceptions if the fuel price increases as a result of an increase in fuel duties or as a result of the introduction of a parallel ETS for road transport. The sample is composed of Cardiff residents who use the car as their main mode of transport.

The article proceeds as follows. Section 2 summarizes the policy context. Section 3 critically reviews the literature. Section 4 presents and justifies the methodology. Section 5 analyzes the results and discusses the findings, and Section 6 concludes and provides some policy recommendations and lines for future research.

2. Policy context

There are a number of policies in place in the UK and in other European countries, as well as in the EU as a whole, which are designed to reduce GHG emissions from road transport. In this section, we discuss some of these, including why the EU has introduced legislation to implement a separate but parallel emissions trading scheme for buildings, road transport and additional sectors and why it is not unthinkable that the UK could follow suit.

2.1 Fuel taxes and climate change

Fuel excise taxes "are not primarily motivated by climate objectives" (Organization for Economic Co-operation and Development, 2021a, p. 7) but climate objectives are frequently used by governments in European countries, including the UK, to justify their high level. In most European countries, and in the UK, for example, the tax component represents over half of the pump price of petrol and diesel (International Energy Agency, 2020, pp. xxvi-xxvii), when both VAT and the excise tax are taken into account.

There have been attempts to compare these high fuel taxes in Europe with the external costs of road transport, which include congestion, accidents, noise, air pollution and climate change, and the main finding has been that they do not fully internalize road transport externalities (Parry et al., 2014; Santos, 2017). In any case, taxes are blunt instruments to internalize any externality that is not related to the fuel carbon content, which is what causes the climate change externality. The climate change externality is actually more than internalized by fuel taxes in the UK and in most countries in Europe (Santos, 2017, p. 24), assuming values for the shadow price of carbon commonly accepted in the academic literature and in policy making circles. On similar lines, the Organization for Economic Co-operation and Development (2021b) calculates effective carbon rates of fuel duties assuming they only need to internalize the climate change externality, and, not surprisingly, they find that petrol and diesel taxes represent effective carbon rates of 90% to 100% in virtually every country in Europe, even assuming a shadow price of carbon of 120 Euros per tonne of CO2. These relatively high fuel taxes in European countries have had an effect on demand, which would otherwise be higher (Sterner, 2007), a finding corroborated for Finland, even though there, fuel (carbon) taxes are less than fully passed on to consumer prices (Harju et al., 2022). The problem is that GHG emissions from road transport are still above 1990 levels despite fuel taxes in the UK and in Europe being high and more than internalizing the climate change externality.

2.2 Vehicle taxes and subsidies

Vehicle registration taxes and vehicle annual (circulation) taxes are in place in most countries around the world, including European countries and the UK. Many countries in Europe, including the UK, make some of these taxes dependant on CO2 emissions or fuel consumption (Runkel and Mahler, 2018). In addition, a number of countries had, and some still have, purchase subsidies for electric vehicles (Department for Transport, Office for Zero Emission Vehicles and Harrison, 2022; European Automobile Manufacturers' Association, 2022). Despite these efforts, in 2021, battery electric and plug-in hybrid cars only represented 1.5% of the total EU car fleet, and only three countries had a share of battery electric cars higher than 2% (European Automobile Manufacturers' Association, 2023). There is some evidence, however, that in the UK, for example, the slightly differentiated vehicle excise duty encouraged the purchase of low-emission vehicles and discouraged the purchase of very polluting vehicles between 2005 and 2010, although the effect on the average CO2 emissions rate of new cars was small because clean cars and very polluting cars have a small share in the market (Cerruti et al., 2019). In contrast, in the Netherlands, the effect of differentiated vehicle purchase taxes, annual road taxes (equivalent to the vehicle excise duty in the UK) and company car taxes was an increase in the share of new zero and low emission cars between 2008 and 2013, and a (consequent) decrease in average CO2 emissions of new cars (Kok, 2015). Overall, however, as stated above, GHG emissions from road transport in Europe have increased steadily over the years, except for the period of the COVID-19 pandemic (European Environment Agency, 2022, 2023).

2.3 Charging infrastructure

Charging infrastructure is central for a successful mass penetration of zero emission vehicles (Coffman et al., 2017; Santos and Davies, 2020). As of 2023, both the EU and the UK are in the process of stepping-up the roll-out of charging infrastructure for electricity and to some extent, hydrogen. The EU is implementing mandatory deployment targets for electric recharging and hydrogen refuelling infrastructure for the road sector (European Commission, 2023). The UK has developed a strategy to "remove charging infrastructure as both a perceived, and a real, barrier to the adoption of electric vehicles (Department for Transport, 2022b). That said, the impacts of the currently planned development of this infrastructure in the UK and in the rest of Europe will take time to materialize.

2.4 Ban on the sale of non-zero emission vehicles

Since 2009, the EU has set CO2 emission targets for new cars and since 2011, for new vans (Vehicle Certification Agency, 2022, p. 9). These EU standards have obviously reduced CO2 emissions from new cars and vans, which would have been higher otherwise. In March 2023, the European Council adopted even stricter CO2 emission performance standards for new cars and vans, with a target of 55% emissions reductions for new cars and 50% for new vans from 2030 to 2034 compared to 2021 levels, and importantly, a target of 100% emissions reductions for both new cars and vans from 2035 (Council of the European Union, 2023b). The 100% target is essentially a ban on the sale of non-zero emission vehicles. In the UK, the ban on the sale of new non-zero emission vehicles also starts in 2035, with a target of 80% of new cars and 70% of new vans to be zero emission by 2030 (Department for Transport and the Rt Hon Mark Harper MP, 2023).

These bans mean that non-zero emission vehicles will eventually disappear from the roads both in the EU and in the UK. The problem, however, is that it is unclear when they will disappear, and whether the reduction in CO2 emissions will be fast enough to achieve net-zero by 2050. Non-zero emission vehicles will be sold right until the year before the year the ban kicks in, they could be kept for longer, and the second-hand market could become stronger.

2.5 Emissions trading

If fuel taxes already internalize the climate change externality (Santos, 2017; Organization for Economic Co-operation and Development, 2021b), an additional cap-and-trade system or any additional tax will make climate policy less efficient from an economic perspective. From a target-consistent perspective, however, additional instruments can be considered enablers to reach net-zero by 2050.

Driven by the concern that the existing EU ETS would not be sufficient for achieving the target reductions in net emissions of at least 55% by 2030, compared to 1990 levels, in July 2021, the European Commission produced a proposal for a directive amending Directive 2003/87/EC to introduce several initiatives, including the “extension of emissions trading to the buildings and road transport sectors or to all combustion fuels outside the existing ETS” (European Commission, 2021a). Eventually, in April 2023, the European Council adopted the proposal (Council of the European Union, 2023a). Road transport emissions will be capped by a separate ETS that will allow permit trading with the building sector. This new system will regulate upstream fuel suppliers.

As already explained, the new EU legislation does not include the UK, which is not part of the EU any longer. The UK has its own UK ETS and is not currently considering an ETS for road transport. However, the UK was a pioneer in the 2000s, when it proposed the inclusion of road transport in the EU ETS (Department for Transport, 2007, p. 160). In addition, the UK ETS may be expanded, as demonstrated by the 2022 UK government joint consultation (Department for Business, Energy and Industrial Strategy, 2022). With all that in mind, the idea of including CO2 emissions from road transport in the UK in the UK ETS or in a separate UK ETS may be brought back to the table.

Interestingly, there has never been any comparative analysis of public perceptions of emissions trading for road transport versus fuel duties. There have been studies regarding tradeable permits in road transport, which we review in the section that follows, but none dig into public perceptions of tradable permits versus other policies. That is exactly what this study concentrates on.

3. Previous Work

3.1 Fuel duties and emissions trading to internalize the climate change externality

As already explained above, fuel duties in Europe and also in the UK are high enough to internalize the climate change externality (Santos, 2017, Organization for Economic Co-operation and Development, 2021b). The problem is that, as shown in Figure 1, GHG emissions from road transport in Europe are still higher than in 1990, despite higher engine efficiency, use of biofuels, and some uptake of electric vehicles (European Environment Agency, 2022, 2023). In the UK, the situation is similar. GHG emissions from road transport are higher than in 1990 (Department for Transport, 2022a, Table ENV0201/TSGB0306), although they have grown more slowly.

Although, from a theoretical perspective, it would not make sense to introduce emissions trading in a market where the climate change externality is seemingly being internalized, it would make sense to do so, or to increase fuel taxes, if policy were designed with the net-zero target in mind. A net-zero target makes sense, not only in view of what the science is telling us (Santos, 2022), but also when considering that the estimated Social Cost of Carbon spans a wide range, from US$10 per tonne of CO2 to US$1,000 per tonne of CO2 (Ricke et al., 2018), casting doubt on whether the climate change externality is indeed being internalized (via fuel duties).

Having different prices for CO2 is in general a sign of poor cost-efficiency in abatement (Ovaere and Proost, 2022, p. 4). Having a homogeneous carbon price or cap is efficient because abatement takes place where it is cheapest. The problem as of 2023 is that, given the net-zero target for 2050, abatement needs to take place everywhere where it is technologically feasible, not just where it is cheapest (Santos, 2022). From that perspective, increasing fuel taxes or introducing a separate cap-and-trade system for road transport, seems reasonable.

Cap-and-trade in road transport has never been implemented, but there have been a number of studies that have considered design, social acceptability and equity (Raux and Marlot, 2005), distributional impacts (Wadud et al., 2008), and in the case of the EU ETS, impact on the allowance price (Flaschsland et al., 2011). In addition, over two decades ago, Albrecht (2001) modelled a cap-and-trade system for vehicle manufacturers, allowing them to buy and sell permits from other sectors of the economy, and found that very significant reductions of CO2 emissions could be achieved. A few years later, Zanni et al. (2013) explored behavioural responses to a hypothetical carbon trading scheme (with personal permits) and a carbon tax, and found that both were capable of reducing individual carbon consumption, but the effectiveness of carbon trading relative to a simple carbon tax was not sufficient to justify the introduction of such a complex scheme. Specifically focusing on the inclusion of road transport in the EU ETS, allowing trading with other sectors, Heinrichs et al. (2014) found that this would yield a reduction in CO2 emissions, but also a reduction in mitigation efforts in the road transport sector.

Emissions trading in road transport as an alternative to fuel taxes, has the potential to deliver the same outcome but with less public rejection (Lyons and Chatterjee, 2002; Raux, 2002). Examples of rejection toward fuel tax increases include the fuel protests in the UK in 2000 (Santos and Cathesides, 2005) and the yellow vest movement in France in 2018 (Witte, 2019). In addition, unlike in the UK, explicit additional fuel taxes at EU level would require unanimous agreement of all member states (Ovaere and Proost, 2022, p. 3). This would have probably been more difficult to achieve than the decision to implement a cap-and-trade system for road transport was.

Although permits may trigger less rejection, the choice between permits and taxes in road transport is not simple. Aldy et al. (2008) compare the choice of CO2 taxes versus permits, and find a strong case for taxes, mainly on uncertainty, fiscal, and distributional grounds, especially if permits are grandfathered. The grandfathering of permits is not a trivial issue, especially considering that the free allocation of permits in the EU ETS resulted in substantial windfall profits of European energy intensive companies, some of which received too many free permits, only to sell them for a profit and to make consumers pay for non-existent carbon costs. These companies made over €24 billion from the EU ETS during 2008-2014 (Carbon Market Watch, 2016). For that reason, free allocation would not seem appropriate in road transport, as this could enable fuel producers to increase fuel prices not justified on any increase in costs (except for the new opportunity costs of not selling the permits received for free), and make windfall profits.

As demonstrated above, a number of studies have been conducted on emissions trading in road transport (Albrecht, 2001; Raux, 2002; Lyons and Chatterjee, 2002; Raux and Marlot, 2005; Wadud et al., 2008; Raux, 2010; Zanni et al., 2013; Heinrichs et al. 2014), but not much empirical work has been carried out to compare perceptions of fuel duties versus emissions trading, especially in the UK.

3.2 Serious Games as research tools

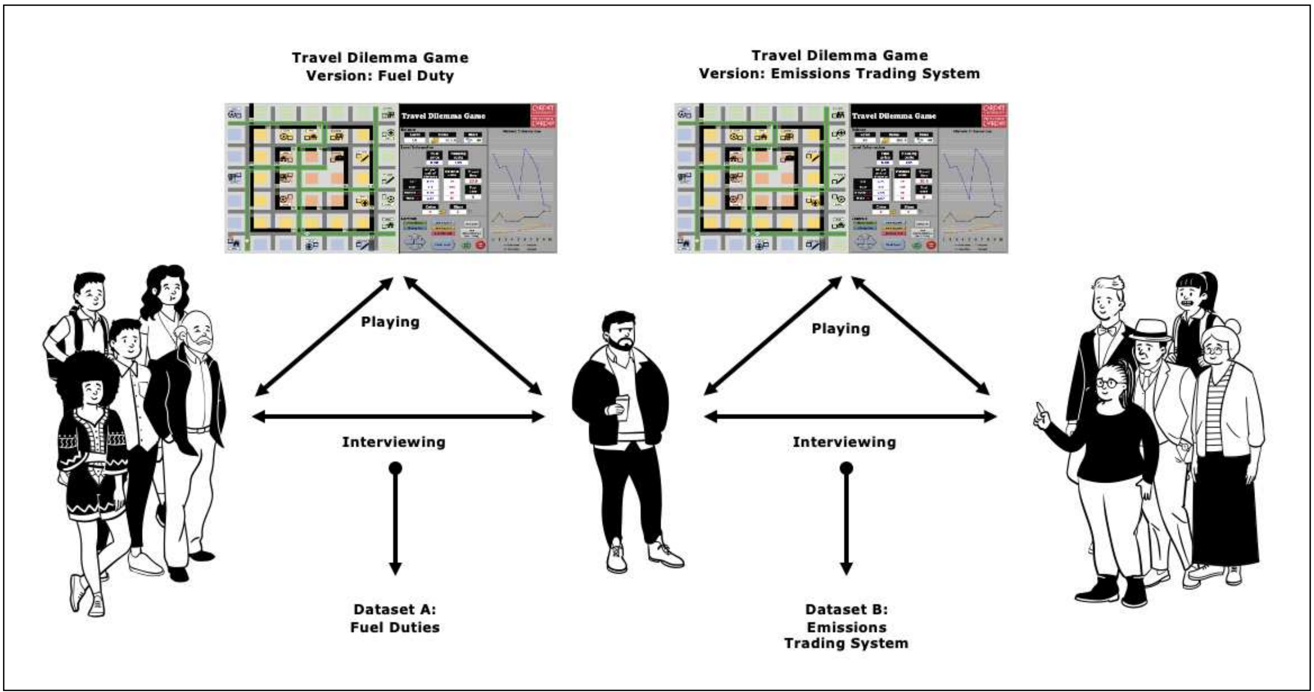
Serious Games (SG) are games designed and employed for educational and research purposes instead of recreational purposes. The study of games, in general, is a well-developed field (Lankoski and Björk, 2015). However, the systematization of SG in the context of research and analysis is yet in its early stages (Ritterfeld et al., 2009; Loh et al., 2016) to the extent that there is lack of consensus about how to label these games (Aldrich, 2009). This does not imply that using games for research purposes is a novelty. They have been widely used in fields like economics (Ellsberg, 1961; Kahneman and Tversky, 1979), psychology, and education (Blumberg et al., 2013; Sudarmilah et al., 2018) and, more recently, in biosecurity (Merrill, Koliba et al., 2019; Merrill, Moegenburg et al., 2019).

Cruz-Cunha (2012) provides an extensive compendium of knowledge on SG as a research tool, but the chapters on SG in transport policy development and evaluation are limited, as is the case of other publications about SG, like Aldrich (2009) and Cody et al. (2009). Having said that, SG have been used in transport studies, in the subfields of traffic planning and design, transport operation and control, behavioural simulation, road safety and education (Shi et al., 2020). SG are also useful as research instruments, as they can strengthen theoretical frameworks around social understanding (Kourounioti et al., 2018). The duality *design-analysis* described by Klabbers (2006), an innate characteristic of SG, makes them powerful tools for comprehending complex social systems, like transport systems.

4. Research Strategy

The experiment in the present study involved the use of a SG, the Travel Dilemma Game, as an interviewing tool. The game was designed in Excel, with the idea of facilitating a conversation about decisions that drivers would make after fuel price increases. The experimental component of the research was introduced in the game through the variable embodying the reason behind the price increase. There were two variations of the game, one where the pump price of fuel increased as a result of an increase in Fuel Duties (FD), and another one where the pump price of fuel increased as a result of the introduction of an Emissions Trading System in road transport (ETS-RT), as illustrated in Figure 2. The game worked in the same way for either of the variations; the difference was presented to the players at the beginning of each of the game's levels while they received the instructions and the follow-up questions.

Figure 2: Research strategy using two variations of the Travel Dilemma Game to generate different datasets for the comparative analytical process



4.1 The Travel Dilemma Game

Initially, the game was conceived to be played by the participants. The idea was that the participants would play the game, and the researcher would help them through the process while simultaneously asking them questions. The risk with such an approach was that the players would take too long to familiarize themselves with the game, learn to move the token through the board and manipulate the control panel. This would have had a negative impact on the time required to collect the data, which in turn would have risked the players' willingness to participate in the research. Sharing the files with the participants for them to play the game at home in their own time would have had additional difficulties, such as the game being more time-consuming for the players, the players not fully understanding how to play it, the researcher not having access to information on how they had made decisions at the different game levels, and players not returning their played games to the researcher, or not even finishing the game. A solution to this barrier was established by designing the game so that both participant and researcher were players with different roles, interacting in a synchronic virtual session. In practice, the researcher used a telecommunication platform (Microsoft Teams) to share the screen where the game was executed. The researcher controlled the buttons and read the instructions while the participants concentrated on making decisions and answering the questions asked by the researcher. With this strategy, the risk of the participant being unable to play the game was eliminated, and each session had a maximum duration of 1.5 hours.

The game was developed to facilitate a conversation about the potential consequences of an increase in the pump price of fuel resulting from different policies, and whenever possible, to link the conversation to the real world. The game represented quasi-realistic situations that car drivers would face in the event of an increase in fuel prices. Whenever it was possible, relative prices were realistic. For example, the purchase prices of different propulsion engines (petrol, hybrid, electric) had the same ratios as those in the real world, as did housing and transport costs. Other ratios, such as income to housing or transport costs, were not realistic, and this was necessary for two reasons: first, to maintain the simplicity of the game, and second, to create situations where the players were forced to make decisions according to the limited income they were given, which was measured in “Coins”. The parameters used in the game, such as car and house prices, are presented in the Appendix.

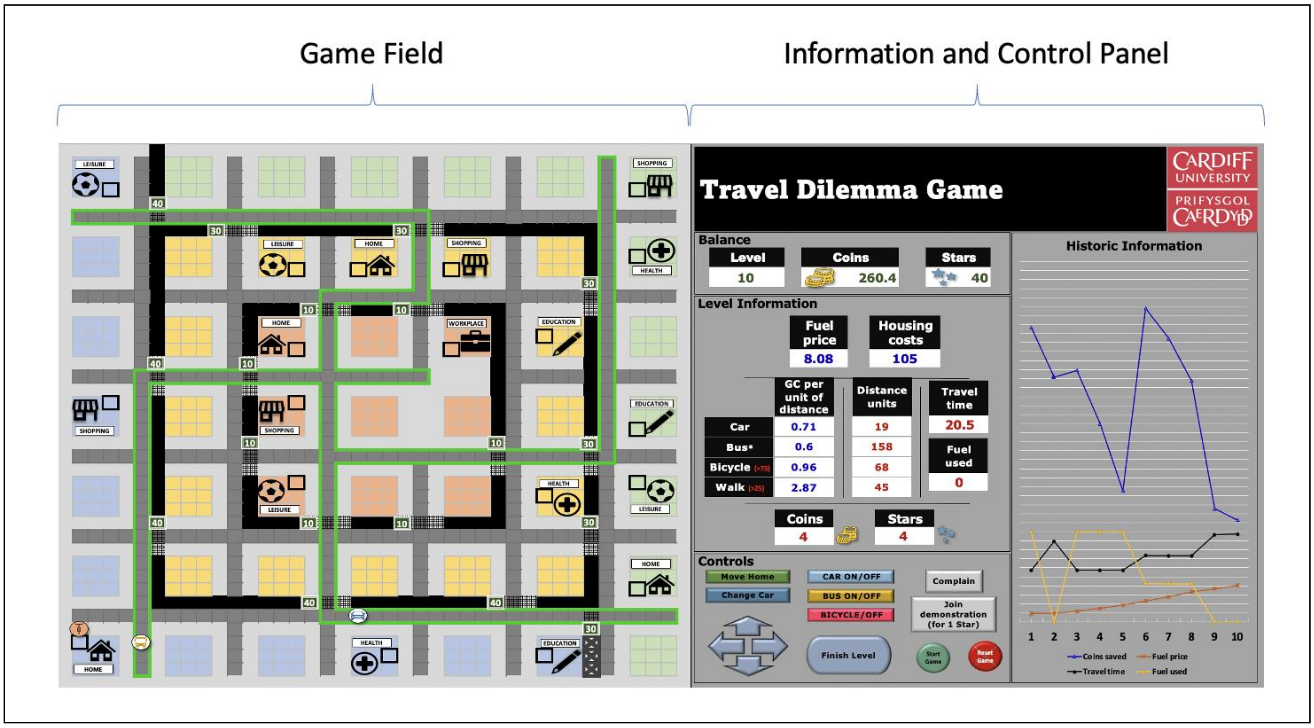
The game field was designed to represent a square city with blocks, streets, sidewalks, and buildings. Like a city, it was divided into zones or neighbourhoods, in this case, by using different colours. The whole game field was built of small squares, with each one, except for the meshed ones, representing one unit of distance (1 square = 1 unit of distance). The zones were separated from one another by black squares and connected by meshed squares, as shown in Figure 3.

4.1.1 The rules of the game

1. The aim of the game was to collect as many “Stars” as possible.
2. The players got one Star every time they visited a facility. The facilities were Health, Education, Leisure, and Shopping. Only one Star, per facility, per level, could be obtained. Therefore, a maximum of four Stars could be collected in each level.
3. The players also obtained Coins by visiting the Workplace. The Workplace could be visited only once per level.
4. The player could not go negative on the accumulated balance of Coins.
5. The players had to follow the instructions given at the beginning of each level.
6. None of the transport modes could cross the black squares, which were blocked.

7. The players could only make a “decision type” if it had been previously introduced in the game, e.g., they were able to change their car after this option had been introduced, not before.
8. The players had to bring the person token back home to finish the level.

Figure 3: The Travel Dilemma Game: Main View



4.1.2 Players and roles

A single person could play the game, but as explained above, for this research, it was necessary to do it between two people, the researcher and the participant.

- Player 1, the researcher (or interviewer), was in charge of moving the token through the board and manipulating the control panel.
- Player 2, the participant (or interviewee), made all the decisions according to the changes in the indicators, such as fuel price, housing costs, travel time, fuel used, number of coins, number of stars, etc.

Having two players, the interviewee, and the interviewer, who was acquainted with the game and could easily manipulate it, allowed the interviewee to concentrate on what was important for the research: making decisions and commenting on them, and essentially, thinking aloud.

4.1.3 Decisions and levels

The decisions that the players had to make during the game were the essential elements of the game, as they were the component that was aimed at triggering a discussion about the perception of an increase in the pump price of fuel resulting from different policies. Six decisions could be made:

a) To choose which transport mode to use (car, bus, bicycle, walk), each with an associated time and fuel cost, with the fuel cost for walking and cycling being zero,
b) To replace their car with a more efficient car,
c) To not visit some of the facilities (such as health, education, shopping or leisure facilities) to reduce expenses,
d) To move house,
e) To complain about the policies (FD increase or the introduction of an ETS-RT) triggering an increase in pump prices (with the complaint being some sort of formal complaint to the government, or simply moaning), and
f) To join a demonstration against the pump price increase.

All the decisions described above had costs, which were expressed in "coins", except joining a demonstration, whose cost was a "star" and complaining about the policies, which had no cost and was mainly an option for the players to express their opinion. The game was designed to introduce those decisions at different levels of the game. At Level 4, for example, the players had to decide whether to replace their car with a more efficient one. Regardless of the decision they made at this level, they were allowed to revisit the decision at subsequent levels. The rationale for introducing those decisions was to bring those topics into the conversation and try to identify how those decisions were influenced by the policy triggering the fuel price increase.

The "person token" had to visit the workplace to obtain coins (to symbolize wages) and the different facilities to obtain stars (to symbolize utility). After visiting the workplace and the facilities, the "person token" had to return home in order to proceed to the following level. Player 1 (the interviewer) asked a number of questions during each level. For example, when the pump price of fuel was increased, the question was: "Would the fuel price increase stop you from doing any kind of activity?" This was a question related to the Travel Dilemma Game, which would make Player 2 think about the possibility of saving coins (at the cost of not getting any stars), but inevitably, they would also think about the activities they undertook in real life, like for example, visits to the gym.

The game included ten levels, and at the beginning of each level, the players were given instructions to follow. The first three levels were designed for Player 2 (the interviewee) to get familiar with the game, interface, and rules. Levels 4-9 gradually introduced decisions (a) to (f). At Level 10, the players could revisit any decision (a) to (f). The research was designed to compare participants' perceptions when the fuel pump price increased as a result of an increase in FD or when it increased as a result of the introduction of an ETS-RT. It was through the instructions and the guiding questions that the interviewer addressed the two policies. The same questions were rephrased in each version of the game, with one referring to FD and the other referring to the ETS-RT.

One issue that was not discussed with the participants at any point was revenue allocation. The reason for this was that revenues from both an increase in FD and the introduction of an ETS-RT would go to the government and the government could allocate the revenues from one policy or the other in the same way, and the amount of revenues could, in theory, also be the same. In that context, use of revenues would not trigger different perceptions. Use of revenues can have an impact on public acceptability (Kallbekken and Sælen, 2011; Schuitema et al., 2011) but the aim of the game was to elicit perceptions regarding two different policies, not different revenue allocations. Revenues from FD and revenues from the ETS-RT if the permits were auctioned would go to the government. The government could then allocate the revenues to environmental projects, or to support poor households and small businesses to cope with fuel price increases, or to support public and/or active transport, to name a few options. In the EU, for example, the revenues from the parallel ETS applied to fuels used for combustion in the building and road transport sectors and in industrial activities not covered by the original EU ETS will be used for climate projects and to support vulnerable households and small businesses via a Social Climate Fund (European Commission, 2021b). Revenues and revenue allocation were implicitly assumed to be the same for both policies, and so they were not discussed.

4.2 Qualitative data and methodological remarks

As part of the data collection process, ten games were played between July and August 2022. The ten participants were Cardiff residents[1] that reported that the car was their primary mode of transport. The qualitative sample was defined to seek data saturation rather than statistical significance, as suggested by Edwards and Holland (2013). The participants engaged in individual sessions that lasted 1 hour and 27 minutes on average. The interview recordings were automatically transcribed by Microsoft Teams. As it can be expected, the automatic transcripts were highly inaccurate, but they constituted a valuable starting point and saved time. The fragments of the transcripts used for the analysis were corrected to guarantee maximum fidelity to what had been said in the interviews.

An advantage of using the game as an interview aid was that it made the interviews dynamic. A significant risk was identified at the beginning of the research concerning the time required for the interviews. Using the game helped to make the 90-minute-long interviews an enjoyable time. Because of the game, the participants could reflect on the hypothetical decisions they had made in the game and compare them with the decisions they had made or would make in real life, producing rich and detailed data.

During the game, the participants established different objectives and goals, e.g., saving coins to be able to buy a flat in the city centre, investing in a more efficient car as soon as possible, or using different modes of transport. The level of engagement of the participants with their goals reached the point where they became upset when an unnecessary movement was performed by the researcher. An example of such a situation is evidenced in the fragments below:

… there should be an option to undo or cancel in case you make a mistake, which you did. It wasn't my fault. So, you probably spent an extra, I don't know, 20 coins. (Participant 4)

Yeah, you wasted my fuel there. […] Just like my husband. (Participant 6)

[1] The characteristics of the participants are presented in the Appendix.

Some comments highlighted the participants' positive experience of playing the game. Participant 6 reflected on how the game's situations made her think about her current travel behaviour:

I enjoyed it and it's good to make me think even more about what I'm doing. (Participant 6)

5. Results and discussion

The main purpose of the conversation between player and researcher (or interviewee and interviewer) was to gather evidence regarding perceptual differences between an increase in FD, and the hypothetical implementation of an ETS-RT, both of which would translate into an increase in the pump price of fuel.

Participant 9, for example, seemed to favour ETS-RT because of its direct association with CO2 emissions, and Participants 2 and 10 stated that an increase in fuel prices following the introduction of an ETS-RT could then be justified:

I could understand that as a consumer, and I think it's more likely to drive people to care more about the environment. (Participant 6)

I think it's important to try and reduce emissions, so I think I would be willing to sacrifice maybe the use of a petrol car for that. (Participant 2)

Participant 3 stated that if the increase in FD were understood as a tool to reduce emissions, it would be more acceptable, but also suggested that the issue with fuel price increases is that drivers often do not have alternatives to the car:

That could be a strategy to move people to public transport, … to other ways of traveling. But I think the biggest barrier there is our public transport system isn't good enough. It isn't good enough to sort of incentivize people. (Participant 3)

Participant 6 highlighted the importance of raising awareness around the consequences of unsustainable and unnecessary fuel consumption:

It would be part of educating people because people just don't think enough. I mean, you see people racing along the motorway, now they're still going, you know, 90 miles an hour. They're using far more fuel than they need to, just to save a minute or two or five minutes at most on their journey. (Participant 6)

The idea of an increase in FD was immediately associated with an increase in the pump price:

Increasing fuel tax would be very hard to accept [...] fuel prices have gone up to an absurd level now, and that's the thing, it's affecting everything, isn't it? The cost of fuel is driving inflation. (Participant 10)

In general, the perceptions of an increase in FD were negative. The participants focused on the negative impact such increase would have on their budgets and viewed the increase as a tool to raise government revenues. Once they understood that the increase in FD would be associated with a reduction in CO2 emissions, they were slightly more positive. Perceptions of an ETS-RT, on the other hand, were positive probably because the participants immediately associated it with CO2 emissions reductions. They failed to perceive the negative impact such a scheme would have on their budgets, and even when they were reminded of this by the researcher, they still seemed to be open to the idea of an ETS-RT.

How the participants viewed the increase in FD and the introduction of an ETS-RT seems to have been influenced by their understanding of climate change policy, their dislike of tax increases, and their experience of all-time high pump prices during the summer of 2022[2], when the games were played.

When the participants were reminded that a FD increase would have environmental benefits, or the introduction of an ETS-RT would increase the pump price, there was a slight change in attitude towards FD, although not so much towards ETS-RT. An important caveat is that the comparison was between a situation that the participants knew well due to their recent experience (increase in pump prices, albeit not because of an increase in FD but because of an

[2] Pump prices in the UK in June 2022 were the highest ever recorded (Trading Economics, 2022; Royal Automobile Club, 2022).

increase in the world price of crude oil) and a situation which was hypothetical, and which the participants had no experience of.

5.1 Transition to more sustainable modes of transport

As explained in Section 4, one of the options available to drivers during the game was to replace their car with a more efficient car. However, barriers preventing them from doing this were identified during the interviews. Car-dependency was highlighted by many as a problem that applies to them and to most people. Participant 8, for example, recalled his childhood in continental Europe, when fuel prices were significantly lower than they are now. He noted that, despite prices having increased over the years, many people have not been dissuaded from using the car as their main mode of transport. This opinion unveils the dependency generated by cars:

I remember when I was a kid in France [...] I remember people saying, oh, when the price goes up enough, no one will take the car anymore. Well, now the price is much higher, and people keep using the car. They protest. But they need it. (Participant 8)

"Convenience" is how Participant 2 described why the car is his primary mode of transport. As a parent, he must optimize his use of time to accomplish many tasks, and the car is the only realistic option. This participant remarked that the car is the best option "considering where all the different places are", implying the intrinsic value of land use planning for transport behaviour:

I've got young children, so I need to kind of transport them to school, when they're in school, I need to get back to work. I like going to the gym, so I need to get to the gym. I've got a very limited amount of time in which I'm able to do those things, so I need a method of transport that's efficient, ... that gets me there when I need to be there, and the only way I can do that, realistically considering where all the different places are, is by car. (Participant 2)

Cycling as an alternative mode of transport to replace the car was not viable for many of the participants. Participant 8, for example, defined himself as not a "big cyclist", a term that means, as he explained, someone who does not feel comfortable on a bicycle:

Okay, so by a very big cyclist, I would mean someone who uses the bike every day and feels very comfortable on a bike. I don't feel comfortable on a bike, I never cycled regularly when growing up. (Participant 2)

Another factor linked with car ownership and usage, perhaps less intuitive than convenience, is the emotional attachment between the driver and the car. Participant 3 represented one of those cases. She owns a Volkswagen Beetle and replacing her vehicle for her is unthinkable because the Beetle is no longer manufactured and there are no electric versions of it.

There's absolutely no way I would change my car. I'd probably sell my property before I changed my car. [...] If I died tomorrow, my friends would say 'at least she got a Beetle.' They would, honestly, they'd say oh, and she got a Beetle. (Participant 3)

Despite Participant 2's view, the emotional factor was the least common barrier mentioned by the participants.

In the game, the participants were given two options of cars that were more efficient than the initial one, but they were not informed if those options represented electric, hybrid or any other type of technology. They were also asked whether in real life they had considered or would consider changing their cars as a consequence of fuel price increases. At first, the interviewees seemed to consider replacing their cars with more efficient ones. Participant 9, for example, commented that a smaller engine would be the solution to higher pump prices:

What would I be looking for? So, I guess, a small engine. Um, which results in less fuel in the filling it up. So that would be definitely something I'd look into. (Participant 9)

The majority of the participants, however, suggested that in the event of higher pump prices, they would consider electric or hybrid vehicles. The problem that emerged, however, was that although they were in principle open to buying electric or hybrid vehicles, the initial purchase price of such vehicles was very high, which made them an unsuitable alternative for many participants:

I'm thinking it can't be electric because that would be... it would be a huge, huge difference in price. (Participant 3)

It's something that we would consider. Yeah, but obviously then there's the capital cost of changing the car, um… We don't have the cash to buy a new car, so for the moment we're stuck with what we've got. We have two vehicles though, one of which is petrol and the other is diesel. (Participant 10)

That's a dilemma. That's a moral dilemma and a financial dilemma that I struggle with, but truly, we don't have enough money for a good hybrid or electric car. (Participant 6)

The initial expense of an electric is extortionate compared to petrol or diesel. It's just not for most people, I think not just myself, but for most people, despite the increase in fuel cost, it's just not a financially viable option. (Partcipant 4)

Based on his experience, Participant 2 provided a different perspective in terms of EVs' purchase cost and cost of operation. He explained that the initial costs of an EV and a fossil fuel vehicle are very similar, but EVs are more cost efficient in the long run and are also zero emission. However, he also expressed that, despite the continuous technological improvements, the battery capacity and charging infrastructure continue to be barriers against the adoption of EVs:

It was worth to try and get something that was maybe less polluting, may be cheaper in the long term as well. Yeah, but it has negatives as well, you know, because it was the same price as a fuel car, roughly of the same type, but with the electric car it only has a certain amount of mileage, so it's great to use in Cardiff, but if I want to go anywhere outside of Cardiff, it's a bit of a hassle and I need to find a charging point… so, unfortunately for long trips or trips longer than two hours, I would still use the petrol car. (Participant 2)

A few participants also explained that they would not consider replacing their current cars with a more efficient car in the real world. Instead, they would keep their vehicles until they stopped working:

I think when my car does eventually die because it is a very old car, I will be getting something like a hybrid car, for instance, or something a lot more efficient and practical. (Participant 7)

I don't think about changing my car that much. I usually keep my cars until they don't drive anymore or totally break down. […] I suppose the big thing we're all holding back on is the government ban on the sale of new petrol and diesel vehicles, which is about six or eight years away, isn't it? (Participant 5)

Another issue that was also raised by some players was that the post-pandemic work environment allows many to continue working from home some or all of the time. As already highlighted, one of the requirements to participate in this research was that the car was their main mode of transport. A few participants, even though they worked from home, still considered their cars their main mode of transport. New post-pandemic home-workers are less impacted by fuel price increases. Even if the car continues to be their main mode of transport, they would not consider replacing it:

I would need to use a lot of fuel to make it interesting. […] We don't drive enough to consider buying a new car. (Participant 8)

It is something that I've considered, but it's also not something that's practical for me right now […] I was given my car by my granny when she could no longer use it. It's a very small car with a tiny, tiny capacity for fuel, a tiny, tiny engine, so it is quite fuel efficient already. And I don't use it much, I don't commute on a daily basis. I use the car to go to do activities, to go and see my family, to go and see friends. (Participant 7)

When asked if higher fuel prices would trigger considerable changes in car use, a number of participants said that no, they would continue to use their car almost as much. Participant 2 was the most emphatic when expressing his reluctance to change travel behaviour due to increased fuel prices. In his view, the convenience delivered by the car outweighs any increase in fuel costs. He explained that the car delivers a good quality of life and freedom:

When I measure fuel price increases against the convenience of getting my child to school, coming back home in time for work, you know, if it costs a bit more, it costs a bit more […] Take the train or the bus, no, no, no, I wouldn't. No, I think there's a point at which you also have to just look at your own quality of life, you know, and what you want to do with your leisure time, and, you know, I've got family that live outside of Cardiff. I've used the train before but it's not as great, you know. Sometimes, if you want to go for a holiday with your *partner or something, you know, you might go somewhere that's really close to a train station so it's just, I don't know. I think I would rather try and find a way around it first before saying no car absolutely no, just train, you know, I think I'd try and still use the car to get there. (Participant 2)*

Similarly, Participant 3 thought that the running costs of a car would not become too expensive to the point of becoming virtually impossible to use during her lifetime. This participant, recognized that an improved public transport system and appropriate infrastructure for other modes of transport could promote a modal shift:

I think the biggest barrier is our public transport system isn't good enough. […] If they were to increase fuel duties, I'd be really annoyed, unless that money were to be ring-fenced to improve other modes of transport, then I would be okay with that. (Participant 3)

Another point of view was provided by Participant 7, who, despite currently working from home, defined the car as her main mode of transport. The participant uses the car to travel for leisure activities which are of high importance for her. She even suggested she would rather sacrifice other habits of consumption rather than reduce car use, which she considers essential to be able to do the things she enjoys:

The things I use the car for are things that I really enjoy, so I'm going out to do my hobbies, which I value above, you know, a lot […] having a takeaway, for instance. And obviously the car comes into play there. So, I'd rather use the car instead of missing out on other things. (Participant 7)

If pump prices were to increase (further), as a result of either a FD increase or the introduction of an ETS-RT, most participants stated they would continue to use the car:

We just sort of bite the bullet… If we need to go somewhere and it means taking the car... We're aware of the cost. It's something we just have to put up with. So, it wouldn't stop us from making the journey. (Participant 10)

The reason … we don't talk about that is that we're in a position to increase our income if we need to… (Participant 5)

It's only affected me in the sense that I think twice about going and driving long distances to explore different places in Wales, to be honest, that's the main way it's affected me, you know. (Participant 1)

5.2 Moving house

Moving house was an option offered from Level 6 onwards. Not many participants stated that they would move house to reduce fuel consumption in response to higher pump prices. Some commented on other factors they value where they live, including the sense of community and architecture (Participant 5), and access to schools and parks (Participant 10).

Participant 4, however, did state that moving house would be a viable option to reduce fuel consumption in the case of higher pump prices:

I would adapt by living close to work, you know, like I said, in real life I live close to work and that's a big plus. So, I definitely don't want to be spending loads of fuel just to get to work. (Participant 4)

Participant 7 analyzed the option of moving house from the perspective of total living costs. She argued that moving to somewhere more central would reduce transport costs but would increase other living costs, like the price of a pint down the pub:

If you're moving to get rid of transport costs, you're probably going to move into the city but rent, housing prices, um… price of drinks … I'm thinking in terms of pint prices, they'll go up. […] But if you're moving into the middle of nowhere, it's gonna be cheaper to live. But you're going to use the car to go everywhere. So, I think it's just expensive no matter what you do. I'm not sure how much moving is going to change that. (Participant 7)

There was a characteristic shared by many of the participants: they worked fully or partially remotely after COVID. This was especially relevant when discussing the possibility of moving house in response to an increase in fuel prices. The pandemic has left a new option open to them, which is not to commute every day. The fragments below show why remote working has become an intrinsic element to be considered within the transport policymaking process:

At the moment, with COVID, I know that everything seems to be possible to be done remotely so not many people need to travel anymore. But I think pre COVID, probably yes. […] But at the moment… employers are being more flexible. (Participant 2)

Yes, if I had to go five days a week, yes. A bit less now… because of working remotely that's less of an issue. (Participant 8)

6. Conclusions and policy recommendations

The present study has explored the differences in perceptions of fuel price increases that result from an increase in fuel duties or that result from the hypothetical implementation of an ETS for road transport. The starting point was that both policies would be targeted at reducing CO2 emissions from road transport, and both would result in increases in the pump price of fuel. The sample was designed to achieve data saturation rather than statistical representativeness. The participants were ten Cardiff residents for whom the car is their main mode of transport, and so the study is only exploratory rather than definitive. Their perceptions were elicited via a game they played with the researcher, whilst the researcher asked them questions regarding the strategies they chose when playing.

The most important finding is that an ETS-RT seemed to be seen more positively than an increase in FD. The participants associated the ETS-RT with a reduction in CO2 emissions, and the FD increases with an increase in the pump price of fuel, alongside a government trying to extract more money from taxpayers.

The second most important finding is that, clearly, the participants' views regarding an increase in FD and the introduction of an ETS-RT seem to have been impacted by their understanding of climate change policy, their dislike of tax increases, and their experience of all-time high pump prices, which was very fresh in their minds at the time of the experiment.

In addition, most participants initially failed to understand that an increase in fuel duties would have the same aim as an ETS-RT and an ETS-RT would have similar impacts on pump prices to those of a FD increase. When the researcher reminded the participants that the ETS-RT would also yield an increase in pump prices, they still seemed to be open to the idea of such a policy, and when the researcher reminded the participants that the increase in FD would be targeted at CO2 emissions reductions, there seemed to be a slight change in attitude towards a more positive one.

One scenario that was not considered was the grandfathering of permits. Freely allocated permits could be perceived as more acceptable than an increase in fuel duties (Raux and Marlot, 2005). However, the experience of the EU ETS demonstrates that non-existent carbon costs can be passed on to consumers via higher prices under free allocation of permits (Carbon Market Watch, 2016).

The conclusion of this study on perceptions is that the participants would be more receptive of an ETS-RT, at least initially. An important caveat is that the comparison made was between a situation that the participants have experience of (increase in pump prices, albeit not because of an increase in FD) and a situation which is hypothetical, and which the participants have no experience of (the introduction of an ETS-RT). If implemented, the ETS-RT would be very likely to increase pump prices. Still, the feelings of warm glow about paying a higher price to care for our planet may survive in consumers' minds and make the policy more acceptable than an increase in FD.

The obvious policy implication from these exploratory findings is that the UK government could consider the implementation of an ETS-RT, despite it being administratively more costly (and therefore less efficient) than an increase in FD, only because it seems to trigger more positive attitudes. Having said that, the time to reduce CO2 emissions from road transport is quickly running up, and aggressive policies to promote low (or zero) emission transport modes are urgently needed, including the electrification of the vehicle fleet. Once most of the fleet is electric, neither an increase in FD nor an ETS-RT will be needed. At that point, the government will face a different challenge, as revenues from fuel duties will eventually dry up. In that context, alternative ways of charging road users will be needed, with the main aim of raising much needed revenues for the Treasury, but that problem falls outside the scope of the present study.

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Appendix

This Appendix describes the parameters that were embedded in the game and the reason behind their choice, and summarizes the main characteristics of the participants, as reported by themselves.

Car types and performance factors

The use of three different car types was aimed at providing the players with alternatives in their decision-making process.

The three car types available were presented from least efficient to most efficient, resembling petrol, hybrid and electric. At Level 4, the players were presented with the option of replacing their petrol car with a more efficient car, if they were able to afford it. This option remained available until Level 10. Table A.1 shows the pre-tax purchase costs and fuel consumption that were used as the basis for the ratios assumed for the game, which are presented in Table A.2.

Table A.1: Car pre-tax purchase costs and efficiency values used to compute relative costs and efficiencies

Car type	Vehicle reference [a]	Pre-tax purchase price without VAT (£)	Fuel consumption (l/100 km combined)[b]
Petrol	Ford Focus	16,595	4.6
Hybrid	Toyota Auris Hybrid	18,011	3.9
Electric	Nissan Leaf	22,696	2.2

Source: Santos and Rembalski (2021)

[a] The models on the table are all medium size cars.

[b] For electric cars an equivalent is given. One litre of petrol contains roughly the energy equivalent of 8.8 kWh of electricity. The electricity consumption for the Nissan Leaf is 19.4 kWh/100 km, as per manufacturer's website (Santos and Rembalski, 2021).

Table A.2: Relative pre-tax purchase costs and efficiencies of the cars used in the game, with petrol car as the reference

Car type	Vehicle reference	Relative pre-tax purchase price without VAT	Relative fuel consumption[a]
Petrol	Ford Focus	1	1
Hybrid	Toyota Auris Hybrid	1.09	0.85
Electric	Nissan Leaf	1.37	0.47

Source: Table A.1

[a] For electric cars an equivalent is given

In the game, the relative purchase costs and relative efficiencies from Table A.2 were used but the absolute pre-tax purchase prices and absolute efficiencies from Table A.1 were replaced with discretional values to keep the game simple. The idea was to facilitate a discussion about changing to more efficient cars in response to an increase in the pump price of fuel.

Table A.3 shows the values that were used, keeping the ratios the same as in Table A.2.

Table A.3: Car pre-tax purchase costs and efficiency values used in the game

Car type	Pre-tax purchase price without VAT (coins)	Efficiency (distance units/fuel units)[a]
Petrol	600	10
Hybrid	654	12
Electric	822	21

Source: Discretional values keeping the ratios from Table A.2

[a] For electric cars an equivalent is given

House types and characteristics

Like in the case of cars, houses in the game had discretional values to keep the game simple, but the ratio between these discretional values was based on information from the real world.

The game had two zones defined as hinterlands, which were blue and green on the board, as shown in Figure 3. In addition, there was a suburb, shown in yellow on the board, and the city centre, shown in pink.

The relative costs of housing in the different zones (hinterlands, the suburb, and the city centre) were based on the value per square metre, as defined in McDonald and Bessis (2018).

In the game, the players had to pay rent/mortgage once at every level of the game. Players moving house had to pay for moving costs too, in addition to the rent/mortgage. Moving costs to the different zones were set discretionally but respected the relative costs of rent/mortgage across the different zones, the rationale being that people moving to more expensive houses in the real world often have higher moving costs because they take more possessions along with them and pay a higher stamp duty.

Table A.4 shows the ratios from McDonald and Bessis (2018) and the discretional values that were used in the game.

Table A.4: Housing costs used in the game

Zone	Category[a]	Relative costs	Rent/Mortgage	Moving costs
Blue	Hinterland	1	105	240
Green	Hinterland	1.01	106	242
Yellow	Suburb	1.06	111	254
Pink	City	1.16	122	278

Source: the relative costs were sourced from McDonald and Bessis (2018, p. 10), whilst the absolute costs in coins were set discretionally.

[a] The categories of hinterland, suburb and city were decided on the basis of McDonald and Bessis (2018), but hinterland was further subdivided in two different zones, with the green one being closer to the workplace on the game board.

Time costs of travel

Due to the simplicity of the game, it was necessary to make the time costs of travel by car substantially lower (much lower than in the real world) than the time costs of travel by foot, bicycle or public transport. This was achieved by assuming a higher speed and a lower time cost per unit of time for cars. In reality, drivers tend to have higher values of time, and therefore, higher time costs per unit of time (Department for Transport, 2018). The idea was to stimulate a conversation on the impact of an increase in fuel prices, and to ensure that timewise, walking was more costly than cycling, cycling was more costly than travelling by bus and travelling by bus was more costly than travelling by car.

Table A.5 presents the speeds and values of time assumed in the game.

Table A.5: Speeds and values of time assumed in the game

Transport mode	Speed (unit of distance/unit of time)	Value of time (coins/unit of time)
Car	30	10
Bus	25	14
Bicyle	15	14
Walk	5	14

Source: all the values in Table A.5 were discretionally set.

Fuel prices

Fuel prices were increased from Level 3 onwards in steps of 25%, 20% and 10%. The increases were the same in both versions of the game, but the reason behind the increase was an increase in Fuel Duties (FD) in one version of the game, and the introduction of an Emissions Trading System in road transport (ETS-RT) in the other version of the game. Fuel price increases were designed to make the players think carefully about the increase itself and then make their decisions. Table A.6 shows the fuel prices and the fuel price increases used in the game at each level.

Table A.6: Fuel prices and fuel price increases used in the game

Level	Percentage increase (%)	Fuel price
1	0	1.90
2	0	1.90
3	25	2.38
4	25	2.97
5	25	3.71
6	25	4.64
7	20	5.57

8	20	6.68
9	10	7.35
10	10	8.08

Source: authors' assumptions

The game was not a simulation game. The purpose of the game was to get the participants to think about their travel decisions both in the game and in real life, in order to understand any differences in perceptions of fuel price increases as a result of an increase in fuel duties or as a result of the introduction of a parallel ETS for road transport. For this reason, and to keep the game simple, electric cars were modelled as using the fuel equivalent of electricity displayed in Table A.3.

As for the prices assumed, electricity prices and petrol prices are not stable in the real world and this is reflected in the relative costs per km of electric cars and petrol cars.

Assuming the fuel consumption of the Ford Focus and the electricity consumption of the Nissan Leaf used by Santos and Rembalski (2021) and an average pump price of petrol of 153 pence per litre for September 2023 (Department for Energy Security and Net Zero, 2023), and an average price of domestic electricity of 27 pence per kWh for October-December 2023 (Office of Gas and Electricity Markets, 2023), the ratio of the cost per km of an electric car to the cost per km of a petrol car is 0.74. However, energy prices in previous years were different. For example, when petrol and domestic electricity prices from 2017 (Table A1.3.7, Department for Transport, 2018) are assumed, the ratio is 0.59.

The Royal Automobile Club (2023) calculates costs per mile of different powertrains over time, assuming consumptions of 7.1 l/100 km for a petrol car and 17.8 kWh/100 km for an electric car.[3] The ratio of the cost per km of an electric car charged at home to the cost per km of a petrol car went from 0.38 in October 2021, to 0.42 in January 2022, to 0.59 in April 2023 (Royal Automobile Club, 2023).

[3] The original numbers are 8.8 miles/litre for a petrol car and 3.5 miles/kWh for an electric car (Royal Automobile Club, 2023).

Since the game was not intended to be a simulation, let alone reflect price trends, the fuel prices of Table A.6 were used for the operating cost of electric cars, combined with the efficiencies of Table A.3. This gave a ratio of the cost per unit of distance of an electric car to the cost per unit of distance of a petrol car of 0.47, which is reasonable and falls within the range of relative costs recorded in reality.

There was an imperfection in the Excel programming, which allowed the price of the fuel equivalent paid by electric car drivers to increase along with the price of petrol, when this should have been kept constant, reducing the ratio of the cost per unit of distance of an electric car to the cost per unit of distance of a petrol car. However, the decisions of the players were not affected, and if anything, the conclusions are more robust because many players switched to an electric car and kept the electric car, even with a constant (rather than declining) ratio of 0.47.

Bus fares

Buses could only use designated routes on the board and bus fares (or monetary costs of bus travel) were discretionally set at 0.03 coins per unit of distance. They were set low to ensure that the monetary costs of travelling by bus were substantially lower than the monetary costs of travelling by car.

Other parameters

Table A.7 shows the remaining parameters used in the game. The parameters were defined discretionally to generate situations where the player had to decide how to proceed.

Table A.7: Other parameters used in the game

Coins	The coins were paid to the player as a salary for working, and for this the player had to visit the workplace. As explained in Section 4, the workplace could be visited only once per level, to earn a salary of 275 coins. The coins were then used to cover transport and housing costs.

Stars	The stars were rewards that represented the satisfaction obtained when visiting a facility. As explained in Section 4, the facilities were Health, Education, Leisure, and Shopping, and only one star, per facility, per level, could be obtained. The aim was to collect as many stars as possible, but when faced with fuel price increases, the players could decide to forego visiting one or more facilities.
House locations	The different zones where the houses were located meant that the distances that needed to be travelled to get to the workplace and to the different facilities were different. For example, a house in the blue zone was very far from the workplace and from the facilities, which were far away from each other too, whereas a house in the green zone was far from the workplace but close to the facilities, which were relatively close to each other too.
Free allowance for cycling and walking	The generalized costs (GC) of travel per unit of distance for all modes included monetary costs and time costs. The monetary costs of walking and cycling were the lowest, as they were zero. The time costs of walking and cycling were the highest. Furthermore, the layout of the town on the board and the design of the squares, needed for simplicity, meant that walking and cycling were often prohibitively expensive in terms of time costs. To make these modes valid options, a free allowance was introduced. At each level, 1 to 10, walking and cycling had a free allowance of zero time cost for the first 75 units of distance and the first 25 units of distance, respectively. The free allowances that were not used could not be carried over to the following level. These free allowances made walking and cycling appealing for short distances. They were calculated as the number of squares that a player could travel during five units of time, which were 75 squares for cyclists and 25 squares for pedestrians.

Participants' characteristics

Table A.8 presents the participants' characteristics, as reported by themselves.

Table A.8: Participants' characteristics

Participant No	Version of the game	Main characteristics
1	FD	Male, 26 years old. He has been living in Cardiff for the last three months, and using the car as his main mode of transport. Before, he lived in London and used the underground as his main mode of transport. He got his driving licence three years ago but only started using the car a year ago.
2	ETS	Male, 42 years old. He has been living in Cardiff for about 17 years. He owns two cars, one petrol and one electric. He has been using the electric car for four years. He got his licence when he was 17 years old and has been using the car as his main mode of transport since then.
3	FD	Female, 42 years old. She has been living in Cardiff most of her life. She uses the car almost every day to go to work; she has two jobs. Her job is too far to cycle. She works with babies as a nursery nurse.
4	ETS	Male, 32 years old. He lives in Pontypridd and uses the car nearly every day to go to work. His commuting time is 7 minutes. He works as a lecturer. He also uses the car to go to social activities in Cardiff. He travels around 700 miles a month.
5	FD	Male, 59 years old. He works in the field of mental health. He works primarily in the West area of Cardiff, but sometimes he also travels to Bristol. He uses the car to visit people as part of his job. For non-work related trips, he tries not to use the car and sometimes he cycles.
6	FD	Female, 71 years old. Retired. She lives in North Cardiff. She uses the car most days of the week to go shopping and to visit friends and family. She uses the bus to go into the city centre, but the car to go everywhere else.

7	FD	Female, 21 years old. She lives in Cardiff. She works mainly from home, goes to the office once a month, and for this she uses the car. She also uses the car as her main mode of transport to get to the swimming pool and other leisure activities.
8	ETS	Male, 40 years old. He uses the car twice a week to go to the office. The average trip to work is 15 minutes each way. Sometimes he uses the car during the week to travel around Wales and further. He has been living in Cardiff for the last four years.
9	FD	Female, 31 years old. She lives in Cardiff. Her job entails caring for people with disabilities, which requires her to go to work two to three times per week. She uses the car virtually every day, including work-related trips and other activities like shopping. She travels a maximum of 3 miles to work.
10	ETS	Male, 77 years old. Retired. He was born in Cardiff and currently lives in Cardiff, but he lived and worked in England for most of his life. He came back to Cardiff in 2006. He uses the car almost on a daily basis, normally for short trips. His wife tends to make longer trips than him.

References

Albrecht, J., 2001. Tradable CO2 permits for cars and trucks, Journal of Cleaner Production, 9(2), 179–189. https://doi.org/10.1016/S0959-6526(00)00069-X

Aldrich, C., 2009. The complete Guide to Simulations and Serious Games: How the Most Valuable Content Will Be Created in the Age Beyond Gutenberg to Google, San Francisco: Pfeiffer & Company. ISBN: 978-0-470-46273-7

Aldy, J. E., Ley, E., Parry, I. W. H., 2008. A tax-based approach to slowing global climate change, National Tax Journal, 61(3), 493–517. https://doi.org/10.17310/ntj.2008.3.09

Blumberg, F. C., Almonte, D. E., Anthony, J. S., Hashimoto, N., 2013. Serious Games: What Are They? What Do They Do? Why Should We Play Them? In: Dill, K. E. (Ed.), The Oxford Handbook of Media Psychology. Oxford: Oxford Library of Psychology, Chapter 19, 334–351. https://doi.org/10.1093/oxfordhb/9780195398809.013.0019

Carbon Market Watch, 2016. Industry windfall profits from Europe’s carbon market. https://carbonmarketwatch.org/wp-content/uploads/2016/03/Policy-brief_Industry-windfall-profits-from-Europe’s_web_final-1.pdf

Cerruti, D., Alberini, A., Linn. J., 2019. Charging drivers by the Pound: How does the UK vehicle tax system affect CO2 emissions?, Environmental and Resource Economics, 74, 99–129. https://doi.org/10.1007/s10640-018-00310-x

Cody, M. J., Ritterfeld, U., Vorderer, P., 2009. Serious games: mechanisms and effects. New York-London: Routledge. https://doi.org/10.4324/9780203891650

Coffman, M., Bernstein, P., Wee, S., 2017. Electric vehicles revisited: a review of factors that affect adoption, Transport Reviews, 37, 79–93. https://doi.org/10.1080/01441647.2016.1217282

Council of the European Union, 2023a. ‘Fit for 55’: Council adopts key pieces of legislation delivering on 2030 climate targets, Press Release, 25 April. https://www.consilium.europa.eu/en/press/press-releases/2023/04/25/fit-for-55-council-adopts-key-pieces-of-legislation-delivering-on-2030-climate-targets/

Council of the European Union, 2023b. ‘Fit for 55’: Council adopts regulation on CO2 emissions for new cars and vans, Press Release, 28 March. https://www.consilium.europa.eu/en/press/press-releases/2023/03/28/fit-for-55-council-adopts-regulation-on-co2-emissions-for-new-cars-and-vans/

Cruz-Cunha, M. M. (Ed.), 2012. Handbook of Research on Serious Games as Educational, Business and Research Tools. IGI Global. ISBN: 9781466601499

Department for Business, Energy and Industrial Strategy, 2022. Developing the UK Emissions Trading Scheme (UK ETS). https://www.gov.uk/government/consultations/developing-the-uk-emissions-trading-scheme-uk-ets

Department for Business, Energy and Industrial Strategy, Prime Minister's Office, The RT Hon Kwasi Kwarteng MP, The RT Hon Sir Alok Sharma KCMG MP, and the Rt Hon Boris Johnson, 202. UK enshrines new target in law to slash emissions by 78% by 2035, Press Release, 20 April. https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035

Department for Energy Security and Net Zero, 2023. Weekly road fuel prices. https://www.gov.uk/government/statistics/weekly-road-fuel-prices

Department for Transport, 2007. Annual Report 2007. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/243425/7095.pdf

Department for Transport, 2018. TAG Data Book. https://www.gov.uk/government/publications/tag-data-book

Department for Transport, 2022b. UK electric vehicle infrastructure strategy, Policy paper. https://www.gov.uk/government/publications/uk-electric-vehicle-infrastructure-strategy

Department for Transport, 2022a. Greenhouse gas emissions by transport mode (Table ENV0201/TSGB0306). https://www.gov.uk/government/statistical-data-sets/tsgb03

Department for Transport and the Rt Hon Mark Harper MP, 2023. Government sets out path to zero emission vehicles by 2035. https://www.gov.uk/government/news/government-sets-out-path-to-zero-emission-vehicles-by-2035#:~:text=The%20zero%20emission%20vehicle%20(%20ZEV,increasing%20to%20100%25%20by%202035.

Department for Transport, Office for Low Emission Vehicles, Department for Business, Energy & Industrial Strategy, the Rt Hon Alok Sharma MP, and the Rt Hon Grant Shapps MP, 2020. Government takes historic step towards net-zero with end of sale of new petrol and diesel cars by 2030. https://www.gov.uk/government/news/government-takes-historic-step-towards-net-zero-with-end-of-sale-of-new-petrol-and-diesel-cars-by-2030

Department for Transport, Office for Zero Emission Vehicles and Trudy Harrison MP, 2022, Plug-in grant for cars to end as focus moves to improving electric vehicle charging. https://www.gov.uk/government/news/plug-in-grant-for-cars-to-end-as-focus-moves-to-improving-electric-vehicle-charging#:~:text=The%20government%20is%20today%20(14,half%20a%20million%20electric%20cars

Edwards, R., Holland, J., 2013. What is Qualitative Interviewing? London: Bloomsbury Publishing Plc. ISBN: 9781780938523

Ellsberg, D., 1961. Risk, ambiguity, and the savage axioms, The Quarterly Journal of Economics, 75(4), 643–669. https://doi.org/10.2307/1884324

European Automobile Manufacturers' Association, 2022. Overview – Electric vehicles: tax benefits & purchase incentives in the European Union 2022. https://www.acea.auto/fact/overview-electric-vehicles-tax-benefits-purchase-incentives-in-the-european-union-2022/

European Automobile Manufacturers' Association, 2023. Report – Vehicles in use, Europe 2023. https://www.acea.auto/publication/report-vehicles-in-use-europe-2023/#:~:text=96.4%25%20of%20all%20trucks%20in,electric%20and%201.8%25%20hybrid%20electric

European Commission, 2021a. Impact assessment report accompanying the document Directive of the European Parliament and of the Council: amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU)

2015/757 - Part ¼. Luxembourg: Publications Office. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021SC0601

European Commission, 2021b. Questions and Answers – Emissions Trading – Putting a Price on Carbon. https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3542

European Commission, 2023. European Green Deal: ambitious new law agreed to deploy sufficient alternative fuels infrastructure, Press Release, 28 March. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1867

European Environment Agency, 2022. Greenhouse gas emission from transport in Europe. https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport#:~:text=The%20emissions%20then%20decreased%20by,rebound%20effect%20of%20the%20economy

European Environment Agency, 2023. Road Transport. https://www.eea.europa.eu/en/topics/in-depth/road-transport

Flachsland, C., Brunner, S., Edenhofer, O., Creutzig, F., 2011. Climate policies for road transport revisited (II): Closing the policy gap with cap-and-trade, Energy Policy, 39(4), 2100-2110. https://doi.org/10.1016/j.enpol.2011.01.053

Harju, J., Kosonen, T., Laukkanen, M., Palanne, K., 2022. The heterogeneous incidence of fuel carbon taxes: Evidence from station-level data, Journal of Environmental Economics and Management, 112, 102607. https://doi.org/10.1016/j.jeem.2021.102607

Heinrichs, H., Jochem, P., Fichtner, W., 2014. Including road transport in the EU ETS (European Emissions Trading System): A model-based analysis of the German electricity and transport sector, Energy, 69, 708e720. http://dx.doi.org/10.1016/j.energy.2014.03.061

International Energy Agency, 2020. Statistics Report: Energy Prices and Taxes for OECD Countries. France: IEA. ISBN: 9789264512542

Kahneman, D., Tversky, A., 1979. Prospect theory: an analysis of decision under risk, Econometrica, 47(2), 263–291. https://doi.org/10.2307/1914185

Kallbekken, S., Sælen, H., 2011. Public acceptance for environmental taxes: self-interest, environmental and distributional concerns, Energy Policy, 39, 2966–2973. https://doi.org/10.1016/j.ecolecon.2010.06.003

Klabbers, J. H., 2006. A framework for artifact assessment and theory testing, Simulation and Gaming, 37(2), 155–173. https://doi.org/10.1177/10468781062879

Kok, R., 2015. Six years of CO2-based tax incentives for new passenger cars in The Netherlands: Impacts on purchasing behavior trends and CO2 effectiveness, Transportation Research Part A: Policy and Practice, 77, 137–153. http://dx.doi.org/10.1016/j.tra.2015.04.009

Kourounioti, I., Kurapati, S., Lukosch, H., Tavasszy, L., Verbraeck, A., 2018. Simulation Games to Study Transportation Issues and Solutions: Studies on Synchromodality. Transportation Research Record, 2672(44), 72–81. https://doi.org/10.1177/0361198118792334

Lankoski, P., Björk, S., 2015. Game research methods: An overview. Pittsburgh: ETC Press. ISBN: 9781312884731

Loh, C. S., Li, I.-H., Sheng, Y., 2016. Comparison of similarity measures to differentiate players' actions and decision-making profiles in serious games analytics, Computers in Human Behavior, 64, 562–574. https://doi.org/10.1016/j.chb.2016.07.024

Lyons, G., Chatterjee, K. (Eds.), 2002. Transport lessons from the fuel tax protests of 2000. London: Routledge. ISBN 13: 978-0-7546-1844

McDonald, R., Bessis, H., 2018. City Space Race. Balancing the need for homes and offices in cities. London: Centre for Cities. https://www.centreforcities.org/wp-content/uploads/2018/03/18-03-22-City-Space-Race-Balancing-the-need-for-homes-and-offices-in-cities-final.pdf

Merrill, S.C., Koliba, C.J., Moegenburg, S.M., Zia, A., Parker, J., Sellnow, T., Wiltshire, S., Bucini, G., Danehy, C., Smith, J.M., 2019. Decision-making in livestock biosecurity practices amidst environmental and social uncertainty: Evidence from an experimental game, PLoS ONE, 14(4), 1–20. https://doi.org/10.1371/journal.pone.0214500

Merrill, S.C., Moegenburg, S., Koliba, C.J., Zia, A., Trinity, L., Clark, E., Bucini, G., Wiltshire, S., Sellnow, T., Sellnow, D., Smith, J.M., 2019. Willingness to comply with biosecurity in livestock facilities: Evidence from experimental simulations. Frontiers in Veterinary Science, 6 (156), 1–17. https://www.frontiersin.org/articles/10.3389/fvets.2019.00156/full

Official Journal of the European Union, 2021. Regulation (EU) 2021/ 1119 of the European Parliament and of the Council of 30 June 2021, establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (‘European Climate Law’). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119&from=EN

Office of Gas and Electricity Markets, 2023. Energy Price Cap: Price for customers on a standard variable tariff. https://www.ofgem.gov.uk/information-consumers/energy-advice-households/energy-price-cap

Organization for Economic Co-operation and Development, 2021a. Effective Carbon Rates 2021: Pricing Carbon Emissions through Taxes and Emissions Trading. https://www.oecd.org/tax/tax-policy/effective-carbon-rates-2021-0e8e24f5-en.htm

Organization for Economic Co-operation and Development, 2021b. Effective Carbon Rates. OECD Stat. https://stats.oecd.org/Index.aspx?DataSetCode=ECR#:~:text=ECRs%20measures%20carbon%20pricing%20of,and%20tradable%20emission%20permit%20prices.

Ovaere, M., Proost, S., 2022. Cost-effective reduction of fossil energy use in the European transport sector: An assessment of the Fit for 55 Package, Energy Policy, 168, 113085. https://doi.org/10.1016/j.enpol.2022.113085

Parry, I.W.H., Heine, D., Lis, E., Li, S., 2014. Getting Prices Right: From Principle to Practice. International Monetary Fund, Washington D.C. ISBN/ISSN: 9781484388570

PytlikZillig, L.M., Hutchens, M.J., Muhlberger, P., Gonzalez, F.J., Tomkins, A.J., 2018. The Big Picture, in Deliberative Public Engagement with Science, SpringerBriefs in Psychology, Springer, Cham. https://doi.org/10.1007/978-3-319-78160-0_1

Raux, C., 2002. The Use of Transferable Permits in the Transport Sector. In: Organization for Economic Co-operation and Development (Ed.), Implementing Domestic Tradeable Permits: Recent Developments and Future Challenges, Paris: OECD, Chapter 5, 141–185. https://doi.org/10.1787/9789264191983-en

Blumberg, F. C., Almonte, D. E., Anthony, J. S., Hashimoto, N., 2013. Serious Games: What Are They? What Do They Do? Why Should We Play Them? In: Dill, K. E. (Ed.), The Oxford Handbook of Media Psychology. Oxford: Oxford Library of Psychology, Chapter 19, 334–351. https://doi.org/10.1093/oxfordhb/9780195398809.013.0019

Raux, C., 2010. The potential for CO2 emissions trading in transport: the case of personal vehicles and freight, Energy Efficiency, 3, 133–148. https://doi.org/10.1007/s12053-009-9065-7

Raux, C., Marlot, G., 2005. A system of tradable CO2 permits applied to fuel consumption by motorists, Transport Policy, 12(3), 255–265. https://doi.org/10.1016/j.tranpol.2005.02.006

Ricke, K., Drouet, L., Caldeira, K., Tavoni, M., 2018. Country-level social cost of carbon, Nature Climate Change 8, October, 895-900. https://doi.org/10.1038/s41558-018-0282-y

Ritterfeld, U., Cody, M., Vorderer, P., 2009. Introduction. In: Ritterfeld, U., Cody, M., Vorderer, P. (Eds.), Serious Games: Mechanisms and Effects. Abingdon: Taylor & Francis Group, 3–9. https://doi.org/10.4324/9780203891650

Royal Automobile Club, 2022. Petrol and diesel prices in the UK. https://www.rac.co.uk/drive/advice/fuel-watch/

Royal Automobile Club, 2023. Average cost per mile. https://www.rac.co.uk/drive/electric-cars/charging/electric-car-public-charging-costs-rac-charge-watch/

Runkel M., Mahler A., 2018. Fair and low carbon vehicle taxation in Europe, a comparison of CO2-based car taxation in EU-28. Norway and Switzerland. https://www.semanticscholar.org/paper/A-comparison-of-CO2-based-car-taxation-in-EU-28%2C-Runkel-Mahler/02d58014630d586c0f799080fbacf2833a0fafda

Santos, G., 2017. Road fuel taxes in Europe: Do they internalize road transport externalities?, Transport Policy, 53, 120–134. https://doi.org/10.1016/j.tranpol.2016.09.009

Santos, G., 2022. Climate change policy and carbon pricing, Energy Policy, 168, 112985. https://doi.org/10.1016/j.enpol.2022.112985

Santos, G., Catchesides, T., 2005. Distributional consequences of gasoline taxation in the United Kingdom, Transportation Research Record, 1924, 103–111. https://doi.org/10.1177/0361198105192400113

Santos, G., Davies, H., 2020. Incentives for Quick Penetration of Electric Vehicles in Five European countries: Perceptions from Experts and Stakeholders, Transportation Research Part A: Policy and Practice, 137, 326-342. http://dx.doi.org/10.1016/j.tra.2018.10.034

Santos, G., Rembalski, S., 2021. Do electric vehicles need subsidies in the UK?, Energy Policy, 149, 111890. https://doi.org/10.1016/j.enpol.2020.111890

Schuitema, G., Steg, L., van Kruining, M., 2011. When Are Transport Pricing Policies Fair and Acceptable?, Social Justice Research, 24, 66–84. https://doi.org/10.1007/s11211-011-0124-9

Shi, X., Chang, H., Xue, S., Bao, J., Zhang, H., 2020. Serious Games for Transportation Research: An Overview. Reston, American Society of Civil Engineers. https://doi.org/10.1061/9780784483053.371

Sterner, T., 2007. Fuel taxes: An important instrument for climate policy, Energy Policy, 35, 3194–3202. https://doi.org/10.1016/j.enpol.2006.10.025

Sudarmilah, E., Fadlilah, U., Supriyono, H., Irsyadi, F., Nugroho, Y., Fatmawati, A., 2018. A Review: Is there any Benefit in Serious Games?, Human-Dedicated Sustainable Product and Process Design: Materials, Resources, and Energy, American Institute of Physics Conference Series, 1977(1), id.020059. https://doi.org/*10.1063/1.5042915*

Trading Economics, 2022. Gasoline Prices in the United Kingdom decreased to 1.34 USD/Liter in November from 1.91 USD/Liter in October of 2022. https://tradingeconomics.com/united-kingdom/gasoline-prices

Vehicle Certification Agency, 2022. New UK Car and Van CO2 Regulations. https://www.vehicle-certification-agency.gov.uk/download-publication/3899/New-Car-and-Van-CO2-Regulations-Guidance-2022/

Wadud, Z., Noland, R., Graham, D., 2008. Equity analysis of personal tradable carbon permits for the road transport sector, Environmental Science and Policy, 11(6), 533–544. https://doi.org/10.1016/j.envsci.2008.04.002

Witte, M. D., 2019. Stanford University News. https://news.stanford.edu/2019/01/23/know-frances-yellow-vest-movement/

Zanni, A. M., Bristow, A. L., Wardman, M., 2013. The potential behavioural effect of personal carbon trading: results from an experimental survey, Journal of Environmental Economics and Policy, 2(2), 222–243. https://doi.org/10.1080/21606544.2013.782471