On the Acceptance of Congestion Charges: Experimental Evidence for Europe

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Abstract

Although there is ample empirical evidence that congestion charges can effectively reduce congestion and its detrimental effects, this instrument has only been implemented in a handful European cities so far. Embedding an information treatment experiment in a survey across seven European countries, this paper empirically investigates whether information on the effectiveness of congestion charges may increase the support for congestion charges. According to our estimation results and depending on the type of information given, it can raise acceptance by 6.4% to 8.8% . Attributing a concrete price level to the charge lowers acceptance and diminishes the effect of the information treatments to between 4.8% and 5.2%. We also observe heterogeneities as consequences of nationality and previous policy knowledge. Based on these results, we conclude that information campaigns on congestion charges and their benefits for commuters and city-dwellers are essential for securing public support for this instrument.

Keywords: Acceptability, congestion charge, public support, road pricing

JEL codes: R48, C25

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1 Introduction

Urbanization and consequently traffic volume are expected to increase in the coming decades, with total global motorized mobility projected to increase by 40% until 2030 and by 90% until 2050 (International Transport Forum, 2017). Additionally, the Covid-19 pandemic and its lockdowns made the effect of smaller traffic loads on air quality and other external costs exceedingly clear (Berman and Ebisu, 2020, Cicala et al., 2021, He et al., 2020, Muhammad et al., 2020). Introducing so-called "congestion charges", fees for the entrance into a larger city by car paid by all vehicles passing over a threshold around the city center, are an often-cited measure for addressing these issues. Congestion charges require car drivers to cover some of the costs incurred as a result of road congestion's negative impacts. In Europe, congestion charges have been introduced in London, Stockholm, Milan, and a few other cities (Shatanawi et al., 2020).

Reducing congestion lowers the risk of accidents and lowering pollution from traffic reduces the chance of various health issues (Zheng et al., 2010, Wilhelm et al., 2012, Nie et al., 2007). A congestion charge, through reducing traffic, can also be a tool for regionally reducing greenhouse gas (GHG) emissions. Congestion charges have been shown to Since they additionally raise revenue for the city or region, their benefits are widely considered to outweigh implementation and operation costs and for that reason they have long been promoted by economists and transport planners alike (Decorla-Souza and Kane, 1992, Leape, 2006, Eliasson et al., 2009, Anas and Lindsey, 2011, Wang et al., 2013, Z. Liu et al., 2017, Frondel, 2019).

Nevertheless, there has been no widespread implementation of congestion charges across the globe, mainly due to challenges of making it publicly and politically acceptable (Jones, 2003, Altshuler, 2010, Schuitema et al., 2010, Fürst and Dieplinger, 2014). Plans for a congestion charge in New York City were scrapped because of low public support, and similar policies were rejected through referenda by city inhabitants of Birmingham, Edinburgh, and Manchester (Baranzini et al., 2021). Common concerns people voice about congestion charges refer to equity (Kristoffersson et al., 2017), the use of the revenues (Jaensirisak et al., 2005), the complexity of the design, as well as privacy (Gu et al., 2018). Previous studies have also detected that people tend to incorrectly anticipate the effects: overestimating the potential negative impacts a congestion charge might have on them and underestimating the positive effects (Baranzini and Carattini, 2017).

Expanding this body of research, we carried out an information experiment to investigate the effect of two specific types of information on the acceptability of a congestion charge in seven European countries. The experiment was conducted within a large-scale international survey with participants from France, Italy, Poland, Greece, Spain, the United Kingdom, and Germany. Each of the 15,822 participants was randomly assigned to one of three groups. The first group was provided information about the positive effects that congestion charges in other cities have had on traffic-related problems, the "effectiveness" information treatment (Green et al., 2016, Börjesson et al., 2012, Börjesson and Kristoffersson, 2015). The second group received information about how these charges rise in popularity after they are implemented, the "public opinion" information treatment (Börjesson et al., 2012, Börjesson and Kristoffersson, 2015). The third group serves as the control group and did not receive any additional information. Moreover, we randomly assigned each participant one of three price levels, and asked whether they were willing to pay this fee for driving into a city.

The results of our analysis indicate that both information treatments had a significantly positive effect on the acceptance rate, with the "effectiveness" information treatment consistently having a stronger effect than the "public opinion" information treatment. Participants who received the "effectiveness" information treatment were 8.8% more likely to approve or strongly approve of the proposed congestion charge in general, and still 5.2% more likely to be willing to pay for it when a price was specified for the policy. Participants who received the "public opinion" information treatment were 6.4% more likely to approve or strongly approve of the proposed congestion charge in general, and still 4.8% more likely to be willing to pay for it when a price was specified for the policy. The price level also had a large impact, where being allocated the medium price level (€5 or equivalent) decreased the likelihood of a participant's willingness to pay by 13.4% and the highest price level (€10 or equivalent) reduced it by 22.7%. An additional conclusion from our results is that widespread previous knowledge about the nature of the congestion charge, such as in the United Kingdom and Germany, can raise acceptance rates significantly.

The contribution of this study to the existing body of research on congestion charges lies in providing insights into how acceptability of congestion charges in influenced by a) information on proven effectiveness of the measure and b) information on how opinions on it changed after implementation elsewhere. The appeal of the study lies in our large sample of 15,822 persons across seven European countries. The following section gives an overview of the existing body of literature on the topic of congestion charges. Section 3 lays out the survey design and the empirical methodology before Section 4 presents the results of our analysis and finally Section 5 concludes.

2 Background

The proposition to put a price on road traffic is almost 70 years old (Walters, 1961, Reynolds, 1963, Vickrey, 1963). The first city that implemented a congestion charging policy was Singapore in 1975, where traffic within the tolled zone decreased by 45% following the implementation (Khan, 2001). It was overhauled several times but is currently still in place. The first congestion charge in Europe was implemented in 2003 in London (Leape, 2006). This toll, too, has been increased and adapted but is still successfully operating. It was estimated to have decreased traffic by 30% and increased travel speed within the city, as well as reduced the rate and number of accidents involving cars (Leape, 2006).

Other cities followed suit and recorded similar positive effects. In Stockholm, the congestion charge implemented in 2007 led to a decrease in traffic volume of 20% and of kilometers driven inside the tolled area by 15% (Eliasson et al., 2009, Börjesson et al., 2016, Croci, 2016). The policy also had positive impacts on health through improving air quality, as prevalence of asthma in young children in Stockholm decreased during the trial run of the Stockholm congestion charge and then decreased further once the policy became permanent (Simeonova et al., 2018). A reverse effect was observed in Milan, where the city's congestion charging scheme was paused for eight weeks in 2012 due a legal dispute and researchers recorded a traffic increase of up to 20% as well as increases of carbon monoxide and small airborne particulate matter – especially PM10 – concentrations by 6% and 17%, respectively (Gibson and Carnovale, 2015).

Despite this overwhelming evidence on the positive effects of congestion charges, implementation has been slow and scattered. A lack of public and political support has been cited frequently as the main hurdle to a more widespread implementation (Gu et al., 2018, Altshuler, 2010, Schuitema et al., 2010). Several aspects, besides socioeconomic factors and political attitudes have been found to influence individuals' opinions about congestion charges. Age, gender, car ownership status, and whether someone commutes by car are commonly found factors (Shatanawi et al., 2020, C. Liu and Zheng, 2013. Shatanawi et al. (2016) also find that approval is positively influenced by an individual's prior knowledge about congestion schemes and that city-specific characteristics have a large influence. Another factor leading to higher acceptability is an individual expecting the scheme to be successful in reducing traffic-related issues (Schuitema et al., 2010, Török, 2015, Ghadi et al., 2018, Jaensirisak et al., 2005). This expectation is especially influential when the effects of the scheme are expected to benefit the individual personally (Fürst and Dieplinger, 2014). Along similar lines, individuals who perceive pollution and other traffic-related problems to be a large issue had more favorable views on congestion charges (Jaensirisak et al., 2005). To better isolate the effect of this experiment's information treatment on acceptance levels we elicited the participants' data and opinions regarding the above factors and include them in our analysis accordingly.

Our hypothesis – that supplying additional information will influence people's opinions on congestion charges – is mainly informed by two established concepts.

First, a lack of information about a scheme's effectiveness makes people unsure about its effects and makes them more likely to reject it (Shatanawi et al., 2020, Gu et al., 2018, Odeck and Kjerkreit, 2010). Providing this information by way of real-life evidence may therefore increase acceptance. Second, the existence of a status quo bias has been proposed as another reason for why people may reject a congestion charge before implementation but feel more positively about it after its implementation (Börjesson et al., 2016). A prominent example of this phenomenon is the Stockholm congestion charge, where approval of the charge rose from 40% before implementation to more than 50% after the trial run and was approved by the general public to become a long-term policy (Börjesson et al., 2012). Informing people beforehand that this change of opinion has occurred elsewhere may expose the status quo bias to them and thus affect their opinion.

3 Data and Methodology

The survey data we used for this study was collected through two different agencies. The German data was collected during a survey which was conducted by the market research institute forsa, who have a representative German household panel of over 10,000 internet users in Germany, from which 6,613 were drawn for this particular survey. Our experiment was part of a larger survey within the Ariadne-project. For the surveys in France, Italy, Poland, Greece, Spain, and the United Kingdom we collaborated with the market research institute Bilendi as an implementing agency and drew samples of about 1,500 individuals per country, 9,209 in total. All surveys were conducted online. The survey field phase started on November 21, 2022 and concluded on December 23, 2022. The participants of each country were sampled to be representative for their country in their distributions of age, education, and gender.

We gathered a large set of socio-economic and demographic background information as well as a large suite of data on psychological and political attitudes and environmental preferences. In addition we also gathered mobility-related information, including information on each participant's access to mobility options, such as their number of cars, number of bikes, public transport ticket ownership, and distance to closest public transport stop. We also elicited information on participants' mobility behavior, such as their dominant mode used for commuting, their commuting distance and time, how many kilometers they travelled by car in the last year, how often they drive into a city (and which city that is), as well as their opinions and feelings about cars and about public transport, and whether there is anything that would make them use their car less.

Prior to the information treatment experiment, participants answered several questions about their beliefs regarding congestion and congestion charges. We asked them whether they had heard of congestion charges, if they knew of cities with congestion charges, and how severe they find certain traffic-related problems to be, both with regards to society in general and to themselves specifically. Then, we explained how congestion charges work, how they are implemented and why they are implemented, followed by asking the participants what effect they would expect from such a congestion charge on several traffic-related problems. We then split our sample randomly into three groups. The first group of participants received information about the positive effect that congestion charges have had in other cities on noise levels, accidents, and traffic congestion (Börjesson et al., 2012, Börjesson et al., 2016, Green et al., 2016). The second group of participants received information on how acceptance of the scheme within the population rose significantly in Stockholm and Gothenburg after the charge had been implemented (Börjesson et al., 2012, Börjesson et al., 2016). The third group of participants did not receive any additional information in this step and served as the control group.

After the randomization into groups and the provision of the information, we asked the participants to state their acceptance of a congestion charge. In a first question, they were asked to state their approval on a Likert scale ranging from 1 (Disapprove strongly) to 5 (Approve strongly). We recoded the acceptance elicited on this Likert Scale into a binary variable for analysis, where "Approve" and "Strongly approve" are coded as 1 (i.e. active approval) and "Strongly disapprove", "Disapprove", and "Neither approve nor disapprove" are coded as 0.

In a second question, all participants were randomly assigned one of three price levels and were asked whether they would be willing to pay this fee for their entrance by car into a city. In Germany, the price levels given to participants were €2, €5, and €10 for daily entry, and the values were adjusted for each of the other countries according to their nominal per capita expenditure and given in their national currency. The list of price values by country can be found in the Appendix, Table A1. In our analysis, the three price levels are denoted as "Low", "Medium", and "High".

A summary of descriptive statistics of the covariates follows in Table 1. The income was reported by participants by choosing one of thirteen income brackets. These income brackets were then split into three terciles, denoted by "Low", "Medium", and "High", according to each country's data distribution. The sample taken in Germany shows slightly different distributions in several characteristics than the remaining countries' samples. For this reason, we ran our estimations both with and without including the German data. Results were not structurally different, therefore the latter is reported in the Appendix, Table A3.

Table 1: Descriptive statistics, means by country

	UK	France	Italy	Poland	Spain	Greece	Germany	Full sample
Gender: female (0/1)	0.50	0.49	0.51	0.51	0.51	0.48	0.39	0.45
Age	43.28	44.70	45.40	43.27	44.48	44.52	59.05	50.45
University education (0/1)	0.40	0.15	0.31	0.19	0.36	0.28	0.59	0.41
Frequent driving into city (0/1)	0.41	0.39	0.50	0.45	0.36	0.41	0.16	0.31
Aware of closest public transport (0/1)	0.93	0.91	0.90	0.87	0.95	0.95	0.99	0.95
Owns a car (0/1)	0.78	0.89	0.94	0.79	0.88	0.87	0.87	0.86
Owns ticket for public transport (0/1)	0.36	0.26	0.38	0.43	0.47	0.40	0.24	0.32
Believes in climate change (0/1)	0.40	0.48	0.52	0.35	0.54	0.43	0.49	0.47
Knew about congestion charges (0/1)	0.80	0.38	0.15	0.21	0.36	0.34	0.61	0.48
Low income (0/1)	0.24	0.29	0.22	0.33	0.31	0.24	0.30	0.28
Medium-high income (0/1)	0.39	0.37	0.44	0.28	0.35	0.42	0.31	0.35
High income (0/1)	0.37	0.34	0.34	0.39	0.34	0.34	0.39	0.37
N	1,531	1,548	1,532	1,530	1,537	1,531	6,613	15,822

To investigate the information treatment effects, we estimate models based on the two equations following below. Equation (1) pertains to a model using the elicited acceptance as dependent variable, and Equation (2) pertains to a model using participants yes/no answers to whether they would be willing to pay a congestion charge of a certain price as dependent variable and the respective price level assigned to each participant as an additional covariable:

$$y_{1i} = \beta_0 + \beta_1 T_i + \beta_2 X_i + \beta_3 country_i + \epsilon_i \quad (1)$$

$$y_{2i} = \gamma_0 + \gamma_1 T_i + \gamma_2 p_i + \gamma_3 X_i + \gamma 4 country_i + v_i \quad (2)$$

where y_{1i} is a binary variable representing acceptance of the congestion charge, y_{2i} is a binary variable indicating whether participant i is willing to pay for the congestion charge at randomly assigned price level p_i, T_i indicates the randomly assigned treatment group (Treatment 1, Treatment 2, or Control), X_i is a vector of socio-economic, attitudinal, and other control variables, $country_i$ is a categorical variable which designates each respondent's country of residence with the United Kingdom as the base category, and ϵ_i and v_i are random error terms.

Since the information treatments were randomly assigned, we can estimate the average treatment effect – represented above by β_1 and γ_1 – using Ordinary Least Squares (OLS). First, we estimated models on the approval of congestion charges elicited before attaching a specific cost to it, the results of which are presented in Table 3. Results using the acceptance elicited after stating the price as dependent variable are presented in Table 4. The three estimated regressions contain different sets of covariates. The basic model only includes the dependent variable, the treatment variable, and the country dummies and the full model includes socioeconomic variables and an additional fourteen variables on individual mobility behavior and opinions.

We additionally estimated all models using a Probit estimator as a robustness check, which returned very similar results. Therefore we report the marginal effects derived from these Probit regressions in the Appendix in Table A4 and Table A5 and do not discuss them in the main results section.

4 Results

Table 2 shows the rates of acceptance of a congestion charge by country. The rate shown here is the proportion of participants who "Strongly approve" or "Approve" of the charge. Overall, between 22% and 38% of participants approve of a congestion charge, varying by country. Going by these descriptive numbers, the two information treatments both seem to have had consistently positive effects on approval rates, the only exception being the responses from the Polish participants.

The results of the empirical analysis of the treatment effects are shown below in Table 3. The estimated effect of the “effectiveness” information treatment – informing participants about the effectiveness of charges in other cities – on the likelihood of approval of a congestion charge is statistically significant at the 0.1% level in both models and ranges from 7.6% in the basic model to 8.8% in the full model, meaning that participants who received this information treatment are 7.6% to 8.8% more likely to approve of a congestion charge.

The estimated effect of the “public opinion” information treatment – informing participants about how acceptance for congestion charges increased in other cities after implementation – on the approval of a congestion charge is also statistically significant at the 0.1% level in both models and ranges from 6.2% in the basic model to 6.4% in the full model, meaning that participants who received this particular information treatment are 6.2% to 6.4% more likely to approve of a congestion charge.

It is noteworthy that with the effectiveness information treatment, the estimated effect magnitude increases when including more explanatory variables, which is likely a sign that these explanatory variables were chosen well and are important for isolating the true treatment effect. For this reason, the treatment effect estimates from the full

Table 2: Acceptance of congestion charge, proportion by country and treatment group

	UK	France	Italy	Poland	Spain	Greece	Germany
Total	0.37	0.22	0.24	0.26	0.28	0.29	0.38
Control group	0.31	0.17	0.21	0.28	0.23	0.26	0.33
Treatment 1: Effectiveness info	0.40	0.25	0.27	0.24	0.31	0.32	0.43
Treatment 2: Public opinion info	0.39	0.25	0.24	0.26	0.28	0.30	0.42

Table 3: Results of OLS regressions based on equation (1), binary dependent variable is approval of congestion charge

	Basic Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.076**	(0.009)	0.088**	(0.010)
Public opinion information	0.062**	(0.009)	0.064**	(0.010)
France	-0.152**	(0.018)	-0.112**	(0.020)
Italy	-0.139**	(0.018)	-0.119**	(0.020)
Poland	-0.115**	(0.018)	-0.078**	(0.020)
Spain	-0.105**	(0.017)	-0.137**	(0.019)
Greece	-0.091**	(0.017)	-0.106**	(0.019)
Germany	0.007	(0.014)	0.035*	(0.018)
Gender: female			-0.013	(0.008)
Age			-0.001*	(0.000)
University education			0.056**	(0.009)
Medium-high income			0.027**	(0.010)
High income			0.029**	(0.011)
Lives in a suburb			-0.017	(0.016)
Lives in a town			0.000	(0.013)
Lives in a city			-0.002	(0.014)
Don't know/no answer			0.141	(0.144)
Nearest stop not known			-0.010	(0.025)
Nearest stop max 15 minutes away			-0.066**	(0.024)
Nearest stop more than 15 minutes away			-0.076**	(0.029)
Don't know/no answer			-0.023	(0.028)
Every 20-30 minutes			0.003	(0.013)
Every 10 to 20 minutes			0.011	(0.014)
Every 10 minutes or more frequently			0.050**	(0.015)
Don't know/not applicable			-0.048*	(0.020)
Owns a car			-0.068**	(0.011)
Don't know/no answer			-0.014	(0.072)
Commutes by car			-0.082**	(0.009)
Has public transport ticket			0.064**	(0.009)
Belief in man-made climate change=1			0.143**	(0.008)
Prior knowledge congestion charges			0.066**	(0.009)
Opinion traffic problems (general)			0.050**	(0.009)
Opinion traffic problems (personal)			0.005	(0.008)
Constant	0.349**	(0.014)	0.184**	(0.042)
Observations	14892		12950	
R-Squared	0.02		0.09	
Adjusted R-Squared	0.02		0.09	
F-Statistic: p-value	0.00		0.00	

model are presented as the main results of the study.

There are several covariates with a significant effect on the likelihood of accepting a congestion charge in our estimations. Older participants who own a car and use it to commute are less likely to approve of a congestion charge, while those with a university degree, access to frequent public transport, who own a ticket for public transport, and who had heard of the concept of a congestion charge before this survey are more likely to accept the policy, and so are those earning medium or high levels of income. Participants who saw the traffic problems listed in the survey as a rather significant issue, for themselves personally or in general, were also more likely to approve of the charge, as were those who believe in man-made climate change.

The country dummies, signifying how that particular countries' participants differed in congestion charge approval from the baseline country UK, show some significant patterns. Germany is the only country exhibiting a positive coefficient, which is statistically significant in the full model, meaning that German participants on average are more likely to aprove of a congestion charge than the baseline UK participants. The remaining countries' dummies also yield statistically significant coefficients, but all of them negative and much larger than the German coefficient in absolute value. This means that participants from France, Italy, Poland, Spain, and Greece on average are much less likely to approve of a congestion charge than those from the UK and from Germany. One potential reason for this might be the knowledge about congestion charges which participants had pre-survey. Our data shows that 76.9% of survey participants from the UK and 62.7% of those from Germany had heard of a congestion charge before, which is more than double than the percentage of any other studied country, see Appendix, Table A2.

Table 4 shows acceptance proportions by country after the congestion charge was connected to a specific price. Preliminary observations here are that (i) again approval seems to increase after both information treatments and (ii) attaching a specific price to the proposed congestion charge leads to an acceptance rate that is on average smaller than the acceptance rates before setting the price. Looking at the acceptance at the different price levels separately, the proportion that is willing to pay the lowest congestion charge rate is higher than the proportion that approves or strongly approves of a congestion charge overall. The reverse is true for the two higher price levels.

Table 4: Acceptance of congestion charge with concrete price, proportion by country and treatment group

	UK	France	Italy	Poland	Spain	Greece	Germany
Total	0.30	0.13	0.15	0.27	0.19	0.31	0.41
Control group	0.24	0.11	0.15	0.26	0.16	0.29	0.39
Treatment 1: Effectiveness info	0.31	0.12	0.15	0.29	0.20	0.36	0.44
Treatment 2: Public opinion info	0.33	0.16	0.16	0.28	0.20	0.29	0.44
Low price level	0.40	0.20	0.21	0.33	0.25	0.40	0.58
Medium price level	0.28	0.11	0.14	0.26	0.19	0.27	0.41
High price level	0.21	0.09	0.11	0.22	0.12	0.26	0.28

Table 5: Results of OLS regressions based on equation (2), binary dependent variable is willingness to pay for congestion charge given randomly assigned price level

	Basic Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.049**	(0.009)	0.052**	(0.010)
Public opinion information	0.043**	(0.009)	0.048**	(0.010)
Medium-high price of charge	-0.135**	(0.009)	-0.134**	(0.010)
High price of charge	-0.226**	(0.009)	-0.227**	(0.010)
France	-0.201**	(0.017)	-0.133**	(0.019)
Italy	-0.168**	(0.017)	-0.108**	(0.020)
Poland	-0.001	(0.018)	0.056**	(0.020)
Spain	-0.134**	(0.017)	-0.128**	(0.019)
Greece	-0.002	(0.017)	0.019	(0.019)
Germany	0.112**	(0.014)	0.128**	(0.017)
Gender: female			-0.009	(0.008)
Age			-0.000	(0.000)
University education			0.045**	(0.009)
Medium-high income			0.027**	(0.010)
High income			0.038**	(0.011)
Lives in a suburb			-0.020	(0.016)
Lives in a town			-0.006	(0.013)
Lives in a city			-0.026	(0.014)
Don't know/no answer			0.096	(0.138)
Nearest stop not known			-0.001	(0.024)
Nearest stop max 15 minutes away			-0.069**	(0.024)
Nearest stop more than 15 minutes away			-0.036	(0.028)
Don't know/no answer			-0.094**	(0.028)
Every 20-30 minutes			-0.011	(0.013)
Every 10 to 20 minutes			0.008	(0.013)
Every 10 minutes or more frequently			0.047**	(0.015)
Don't know/not applicable			-0.052**	(0.020)
Owns a car			-0.053**	(0.011)
Don't know/no answer			0.054	(0.075)
Commutes by car			-0.086**	(0.009)
Has public transport ticket			0.073**	(0.009)
Belief in man-made climate change=1			0.132**	(0.008)
Prior knowledge congestion charges			0.112**	(0.009)
Opinion traffic problems (general)			0.052**	(0.009)
Opinion traffic problems (personal)			-0.019*	(0.008)
Constant	0.434**	(0.015)	0.298**	(0.042)
Observations	14020		12231	
R-Squared	0.10		0.17	
Adjusted R-Squared	0.10		0.17	
F-Statistic: p-value	0.00		0.00	

The participants' acceptance of the charge regarding the three randomly assigned respective price levels was used as the dependent variable in regressions, results presented in Table 5. Here, the "effectiveness" information treatment again has a larger effect on the dependent variable than the "public opinion" information treatment. The former leads to participants being 4.9% to 5.2% more likely to be willing to pay the charge, while the latter leads to an increase of 4.3% to 4.8% in likelihood to accept the charge, respectively. The "effectiveness" information treatment therefore seems to have a consistently stronger influence on people's opinions than the "public opinion" information treatment.

Attaching a specific price to the congestion charge raises the acceptance rate at low prices (at 2€per day) but decreases acceptance at higher prices (€5 or €10 per day). This effect is statistically significant and stronger the higher the specified price is. Participants who were given the medium price level were 13.4% less likely to state that they were willing to pay the congestion charge, and those who were given the high price level were 22.7% less likely to be willing to pay it.

The covariates show similar effects on approval as in Table 3. Tertiary education, income level, availability of close and frequent public transport, ownership of a public transport ticket, a belief in man-made climate change, and prior knowledge about congestion charges affect likelihood of acceptance positively, while owning and commuting with a car affect it negatively. As before, adding the explanatory variables increases the estimated effect of the information treatments.

When attaching specific prices to the congestion charge, the difference between the UK and Germany and the five other countries in their likelihood of accepting a charge is generally larger than in the models that did not include prices. This indicates that UK and German citizens are less price-sensitive than those from the remaining countries, a logical effect since the UK and Germany are generally wealthier than many other European countries.

5 Conclusion

Traffic congestion in cities and on motorways is an everyday nuisance to commuters and city-dwellers in addition to having quantifiable negative effects on air quality, greenhouse gas emissions, and overall quality of life. Introducing a mandatory fee for entering the city by car, a so-called congestion charge, attaches a price to congestion's negative effects and in addition sets an incentive for all drivers to reevaluate their commuting behavior and timing, thereby reducing overall load during peak hours. As observed in cities where congestion charges were implemented and continued (Stockholm, Göteborg) and where congestion charges were intended but scrapped (New York City, Edinburgh), these policies rely on public support for their implementation and survival. Our study builds on previous research about the determinants of support for congestion charge policies by concentrating on the effect of information about such a policy's effect on air pollution, congestion, and accidents, and on the effect of informing people about changes in public opinion that have taken place where such a policy was implemented. The analysis delivered the following results:

Without any the information treatment, only 17%-33% of our sample approved or approved strongly of a congestion charge. Giving information and evidence for the effectiveness of currently implemented congestion charges raised approval by on average 8.8%, and by 5.2% once a specific price was attached to the hypothetical charge. Giving information on how public opinion on the charge had changed in Göteborg and Stockholm after implementation increased approval by 6.4% on average, and by 4.8% once a price was attached. A low price (€2 in Germany and purchasing power equivalent in the other countries) meant on average a higher approval rate than when no price at all was given, but increasing the price to €5 and €10 came with a approval decreases of 13.4% and 22.7%, respectively.

Our study also showed that general knowledge about the concept of congestion charges has a significant effect of opinion. 76.9% of participants from the UK and 62.7% of those from Germany had some prior knowledge about congestion charges, which is more than double that of any other included country. Participants from the UK and Germany also on average exhibited a higher approval rates for congestion charges than participants from other countries. Even when excluding Germany from the analysis, prior knowledge about congestion charges continued to be a statistically significant influence on approval rates.

Our policy advice is therefore straightforward. Information campaigns prior to the implementation of a congestion charge anywhere are vital to public support and should comprise two subjects for maximum effects. On the one hand, the reasoning behind and functioning of the to-be-implemented policy should be clearly and openly communicated. And on the other hand policymakers should take advantage of the large body of scientific work showing that congestion charges reduce air pollution, travel times, and accidents and should communicate these findings to their constituents to secure support for their congestion charge policy proposals.

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Appendix

A Tables and Figures

Table A1: Levels of Congestion Charges in Local Currency that are Randomly Allocated to Respondents

Fee Level	UK	France	Italy	Poland	Spain	Greece	Germany
Low	£2.0	2.0 €	1.5 €	3.0 Zloty	1.5 €	1.0 €	2.0 €
Medium	£5.0	5.0 €	4.0 €	8.0 Zloty	3.0 €	2.5 €	5.0 €
High	£10.0	10.0 €	8.0 €	16.0 Zloty	6.0 €	5.0 €	10.0 €

Table A2: Results on Survey Question CM1a - Have you ever heard of the concept of a ’congestion charge’ before?

	UK	France	Italy	Poland	Spain	Greece	Germany	Overall
Yes	76.9%	36.8%	13.8%	18.8%	34.5 %	32.9 %	62.7 %	46.7 %
No	19.4 %	60.8%	79.4%	72.1%	62.1 %	63.5 %	36.2 %	50.0 %
Don’t know	3.7%	2.5%	6.9%	9.1%	3.4 %	3.6 %	1.2 %	3.3 %

Table A3: Results of OLS regressions based on equations (1) and (2), binary dependent variable is acceptance of congestion charge, excluding German data

	No prices		With prices	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.070**	(0.013)	0.048**	(0.012)
Public opinion information	0.042**	(0.013)	0.038**	(0.012)
Medium-high price of charge			-0.109**	(0.012)
High price of charge			-0.165**	(0.012)
France	-0.124**	(0.020)	-0.140**	(0.019)
Italy	-0.126**	(0.021)	-0.098**	(0.020)
Poland	-0.087**	(0.021)	0.057**	(0.020)
Spain	-0.135**	(0.020)	-0.123**	(0.019)
Greece	-0.115**	(0.020)	0.022	(0.019)
Gender: female	-0.031**	(0.011)	-0.024*	(0.010)
Age	-0.001**	(0.000)	-0.000	(0.000)
University education	0.067**	(0.012)	0.046**	(0.012)
Medium-high income	0.031*	(0.014)	0.014	(0.013)
High income	0.027	(0.014)	0.020	(0.014)
Lives in a suburb	-0.007	(0.024)	-0.009	(0.023)
Lives in a town	-0.003	(0.019)	-0.021	(0.018)
Lives in a city	0.020	(0.020)	0.002	(0.019)
Don't know/no answer	0.139	(0.201)	0.191	(0.171)
Nearest stop not known	-0.022	(0.026)	-0.010	(0.025)
Nearest stop max 15 minutes away	-0.065*	(0.028)	-0.072**	(0.027)
Nearest stop more than 15 minutes away	-0.052	(0.033)	-0.009	(0.032)
Don't know/no answer	-0.035	(0.029)	-0.108**	(0.028)
Every 20-30 minutes	0.003	(0.018)	-0.009	(0.017)
Every 10 to 20 minutes	0.027	(0.018)	0.019	(0.017)
Every 10 minutes or more frequently	0.049**	(0.019)	0.053**	(0.018)
Don't know/not applicable	-0.033	(0.024)	-0.042	(0.023)
Owns a car	-0.075**	(0.017)	-0.074**	(0.017)
Don't know/no answer	-0.058	(0.072)	-0.003	(0.073)
Commutes by car	-0.027*	(0.012)	-0.040**	(0.011)
Has public transport ticket	0.057**	(0.011)	0.078**	(0.010)
Beliefs about drivers of climate change=1	0.071**	(0.011)	0.070**	(0.010)
Prior knowledge congestion charges	0.047**	(0.012)	0.112**	(0.012)
Opinion traffic problems (general)	0.025*	(0.012)	0.006	(0.011)
Opinion traffic problems (personal)	0.033**	(0.010)	0.012	(0.010)
Constant	0.267**	(0.051)	0.363**	(0.050)
Observations	7357		6948	
R-Squared	0.06		0.12	
Adjusted R-Squared	0.05		0.11	
F-Statistic: p-value	0.00		0.00	

Table A4: Marginal effects (dy/dx) derived from Probit regressions based on equation (1), binary dependent variable is acceptance of congestion charge

	Basic Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.076**	(0.009)	0.087**	(0.010)
Public opinion information	0.062**	(0.009)	0.062**	(0.010)
France	-0.152**	(0.017)	-0.115**	(0.019)
Italy	-0.139**	(0.017)	-0.114**	(0.020)
Poland	-0.115**	(0.018)	-0.075**	(0.020)
Spain	-0.105**	(0.018)	-0.124**	(0.019)
Greece	-0.090**	(0.018)	-0.098**	(0.019)
Germany	0.007	(0.014)	0.002	(0.017)
Gender: female			-0.015	(0.008)
Age			-0.000	(0.000)
University education			0.056**	(0.009)
Medium-high income			0.032**	(0.010)
High income			0.029**	(0.011)
Lives in a suburb			-0.018	(0.016)
Lives in a town			-0.001	(0.013)
Lives in a city			-0.004	(0.014)
Don't know/no answer			0.121	(0.155)
Nearest stop not known			-0.012	(0.027)
Nearest stop max 15 minutes away			-0.073**	(0.026)
Nearest stop more than 15 minutes away			-0.083**	(0.030)
Don't know/no answer			-0.027	(0.030)
Every 20-30 minutes			0.004	(0.013)
Every 10 to 20 minutes			0.011	(0.014)
Every 10 minutes or more frequently			0.047**	(0.015)
Don't know/not applicable			-0.054**	(0.020)
Owns a car			-0.114**	(0.014)
Don't know/no answer			-0.126*	(0.063)
Commutes by car			-0.069**	(0.009)
Has public transport ticket			0.058**	(0.009)
Beliefs about drivers of climate change=1			0.139**	(0.008)
Prior knowledge congestion charges			0.065**	(0.009)
Opinion traffic problems (general)			0.049**	(0.009)
Opinion traffic problems (personal)			0.010	(0.008)
Observations	14892		12950	

Table A5: Marginal effects (dy/dx) derived from Probit regressions based on equation (2), binary dependent variable is willingness to pay for congestion charge given randomly assigned price level

	Basic Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.049**	(0.009)	0.052**	(0.010)
Public opinion information	0.043**	(0.009)	0.046**	(0.010)
Medium-high price of charge	-0.134**	(0.010)	-0.134**	(0.010)
High price of charge	-0.224**	(0.009)	-0.229**	(0.010)
France	-0.200**	(0.016)	-0.144**	(0.018)
Italy	-0.167**	(0.016)	-0.107**	(0.019)
Poland	-0.000	(0.018)	0.061**	(0.021)
Spain	-0.134**	(0.017)	-0.117**	(0.018)
Greece	-0.001	(0.018)	0.026	(0.019)
Germany	0.112**	(0.014)	0.100**	(0.016)
Gender: female			-0.012	(0.008)
Age			-0.000	(0.000)
University education			0.044**	(0.009)
Medium-high income			0.031**	(0.010)
High income			0.038**	(0.010)
Lives in a suburb			-0.023	(0.015)
Lives in a town			-0.010	(0.013)
Lives in a city			-0.030*	(0.014)
Don't know/no answer			0.072	(0.148)
Nearest stop not known			-0.004	(0.026)
Nearest stop max 15 minutes away			-0.079**	(0.026)
Nearest stop more than 15 minutes away			-0.045	(0.030)
Don't know/no answer			-0.118**	(0.030)
Every 20-30 minutes			-0.010	(0.013)
Every 10 to 20 minutes			0.008	(0.014)
Every 10 minutes or more frequently			0.045**	(0.015)
Don't know/not applicable			-0.061**	(0.020)
Owns a car			-0.108**	(0.014)
Don't know/no answer			-0.086	(0.065)
Commutes by car			-0.072**	(0.009)
Has public transport ticket			0.069**	(0.009)
Beliefs about drivers of climate change=1			0.128**	(0.008)
Prior knowledge congestion charges			0.110**	(0.009)
Opinion traffic problems (general)			0.050**	(0.009)
Opinion traffic problems (personal)			-0.016*	(0.008)
Observations	14020		12231	

Table A6: Results of OLS regressions based on equation (1), Interaction of treatment with country variable

	Basic Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.093**	(0.031)	0.119**	(0.032)
Public opinion information	0.071*	(0.030)	0.064*	(0.032)
France	-0.156**	(0.031)	-0.106**	(0.033)
Italy	-0.118**	(0.030)	-0.093**	(0.033)
Poland	-0.043	(0.030)	0.004	(0.033)
Spain	-0.097**	(0.030)	-0.122**	(0.032)
Greece	-0.069*	(0.030)	-0.072*	(0.032)
Germany	-0.000	(0.024)	-0.003	(0.026)
Effectiveness Information × France	-0.007	(0.043)	-0.042	(0.046)
Effectiveness Information × Italy	-0.025	(0.043)	-0.041	(0.046)
Effectiveness Information × Poland	-0.134**	(0.043)	-0.151**	(0.046)
Effectiveness Information × Spain	-0.003	(0.043)	0.001	(0.045)
Effectiveness Information × Greece	-0.034	(0.043)	-0.057	(0.044)
Effectiveness Information × Germany	0.007	(0.034)	-0.009	(0.036)
Public opinion information × France	0.019	(0.043)	0.023	(0.045)
Public opinion information × Italy	-0.040	(0.043)	-0.022	(0.045)
Public opinion information × Poland	-0.083	(0.043)	-0.086	(0.046)
Public opinion information × Spain	-0.022	(0.043)	-0.016	(0.044)
Public opinion information × Greece	-0.031	(0.043)	-0.029	(0.044)
Public opinion information × Germany	0.015	(0.034)	0.027	(0.035)
Gender: female			-0.015	(0.008)
Age			-0.000	(0.000)
University education			0.057**	(0.009)
Medium-high income			0.033**	(0.010)
High income			0.030**	(0.011)
Lives in a suburb			-0.017	(0.016)
Lives in a town			-0.001	(0.013)
Lives in a city			-0.003	(0.014)
Don't know/no answer			0.121	(0.144)
Nearest stop not known			-0.009	(0.025)
Nearest stop max 15 minutes away			-0.062*	(0.024)
Nearest stop more than 15 minutes away			-0.073*	(0.029)
Don't know/no answer			-0.025	(0.028)
Every 20-30 minutes			0.003	(0.013)
Every 10 to 20 minutes			0.012	(0.014)
Every 10 minutes or more frequently			0.048**	(0.015)
Don't know/not applicable			-0.046*	(0.020)
Owns a car			-0.118**	(0.014)
Don't know/no answer			-0.139*	(0.063)
Commutes by car			-0.071**	(0.009)
Has public transport ticket			0.060**	(0.009)
Beliefs about drivers of climate change=1			0.142**	(0.008)
Prior knowledge congestion charges			0.067**	(0.009)
Opinion traffic problems (general)			0.050**	(0.009)
Opinion traffic problems (personal)			0.009	(0.008)
Constant	0.340**	(0.022)	0.220**	(0.046)
Observations	14892		12950	
R-Squared	0.03		0.10	
Adjusted R-Squared	0.02		0.09	
F-Statistic: p-value	0.00		0.00	

Table A7: Results of OLS regressions based on equation (2), Interaction of treatment with country variable

	Basic Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.074*	(0.030)	0.089**	(0.032)
Public opinion information	0.099**	(0.030)	0.089**	(0.032)
Medium-high price of charge	-0.135**	(0.009)	-0.135**	(0.010)
High price of charge	-0.226**	(0.009)	-0.228**	(0.010)
France	-0.164**	(0.030)	-0.094**	(0.032)
Italy	-0.114**	(0.030)	-0.052	(0.032)
Poland	0.035	(0.031)	0.103**	(0.033)
Spain	-0.108**	(0.030)	-0.097**	(0.031)
Greece	0.027	(0.030)	0.055	(0.032)
Germany	0.134**	(0.024)	0.125**	(0.026)
Effectiveness Information × France	-0.060	(0.042)	-0.075	(0.045)
Effectiveness Information × Italy	-0.071	(0.042)	-0.072	(0.045)
Effectiveness Information × Poland	-0.030	(0.044)	-0.055	(0.047)
Effectiveness Information × Spain	-0.025	(0.042)	-0.022	(0.044)
Effectiveness Information × Greece	0.005	(0.042)	-0.015	(0.044)
Effectiveness Information × Germany	-0.017	(0.033)	-0.032	(0.035)
Public opinion information × France	-0.050	(0.042)	-0.035	(0.044)
Public opinion information × Italy	-0.092*	(0.043)	-0.081	(0.045)
Public opinion information × Poland	-0.078	(0.043)	-0.081	(0.046)
Public opinion information × Spain	-0.055	(0.042)	-0.043	(0.044)
Public opinion information × Greece	-0.093*	(0.042)	-0.079	(0.043)
Public opinion information × Germany	-0.048	(0.034)	-0.027	(0.035)
Gender: female			-0.010	(0.008)
Age			-0.000	(0.000)
University education			0.047**	(0.009)
Medium-high income			0.034**	(0.010)
High income			0.041**	(0.010)
Lives in a suburb			-0.020	(0.016)
Lives in a town			-0.007	(0.013)
Lives in a city			-0.028*	(0.014)
Don't know/no answer			0.081	(0.138)
Nearest stop not known			0.000	(0.024)
Nearest stop max 15 minutes away			-0.066**	(0.024)
Nearest stop more than 15 minutes away			-0.033	(0.028)
Don't know/no answer			-0.094**	(0.028)
Every 20-30 minutes			-0.011	(0.013)
Every 10 to 20 minutes			0.009	(0.013)
Every 10 minutes or more frequently			0.046**	(0.015)
Don't know/not applicable			-0.050*	(0.020)
Owns a car			-0.110**	(0.014)
Don't know/no answer			-0.101	(0.065)
Commutes by car			-0.075**	(0.009)
Has public transport ticket			0.069**	(0.009)
Beliefs about drivers of climate change=1			0.131**	(0.008)
Prior knowledge congestion charges			0.113**	(0.009)
Opinion traffic problems (general)			0.051**	(0.009)
Opinion traffic problems (personal)			-0.016*	(0.008)
Constant	0.407**	(0.022)	0.322**	(0.046)
Observations	14020		12231	
R-Squared	0.10		0.18	
Adjusted R-Squared	0.10		0.17	
F-Statistic: p-value	0.00		0.00	