

Helmers, Viola; Frondel, Manuel; Sommer, Stephan

Conference Paper

On the Acceptance of Congestion Charges: Experimental Evidence for Six European Countries

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2023: Growth and the "sociale Frage"

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Helmers, Viola; Frondel, Manuel; Sommer, Stephan (2023) : On the Acceptance of Congestion Charges: Experimental Evidence for Six European Countries, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2023: Growth and the "sociale Frage", ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg

This Version is available at:

<https://hdl.handle.net/10419/277706>

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On the Acceptance of Congestion Charges: Experimental Evidence for six European Countries

Viola Helmers^{1,2}, Stephan Sommer^{1,3}, Manuel Frondel^{1,4}

March 1, 2023

Preliminary draft. Do not cite or quote.

Abstract

Traffic congestion has negative impacts on air quality, greenhouse gas emission rates, and overall quality of life in cities. It has been shown that a congestion charge, where a fee has to be paid for entering a city by car, can effectively reduce congestion and its detrimental effects. Nonetheless, the adoption of such policies within Europe has been limited to a handful of cities. In this paper we estimate the impact of information on public support for congestion charges. We conducted an information treatment experiment within a survey with over 9,000 participants from six European countries. Our results show that providing information about the policy's effectiveness increases approval by 6.7% while information about changes in public opinion after implementation has no significant effect. Attaching a specific price to the charge lowers acceptance overall and decreases the effect of the effectiveness information treatment to 4.1%. In addition, the results show that some general prior knowledge about congestion charges is one of the driving factors for approval, shown by a significantly higher acceptance rate in the United Kingdom, where 76.9% of the participants were familiar with congestion charges, than in the other surveyed countries. We conclude that clear information campaigns regarding the policy design itself and its benefits for commuters and city-dwellers are essential for securing public support for congestion charge policies.

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

JEL codes: R48, C25

Correspondence: Viola Helmers, RWI – Leibniz Institute for Economic Research, Hohenzollernstr. 1–3, D-45128 Essen, viola.helmerts@rwi-essen.de

¹ RWI Leibniz Institute for Economic Research

² Ruhr Graduate School for Economics

³ Hochschule Bochum

⁴ Ruhr University Bochum

Acknowledgments: We gratefully acknowledge financial support by the German Federal Ministry for Economic Affairs and Energy (BMWi) and the German Federal Ministry for Education and Research (BMBF) in the framework of the Kopernikus project Ariadne. The experiment in this paper was preregistered in the AEA RCT Registry (AEARCTR-0010644; <https://www.socialscienceregistry.org/trials/10644>).

1 Introduction

Traffic congestion in cities is a classic Pigouvian externality, causing negative impacts such as harmful emissions and noise. 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 (ITF 2017). Additionally, the Covid-19 pandemic and its lockdowns made the effect of smaller traffic loads on air quality and other external costs clearly observable (Berman and Ebisu 2020, Cicala et al. 2020, 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, Abdelkhalek, and Mézáros 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. 2011, Nie et al. 2007). A congestion charge, through reducing traffic, can also be a tool for regionally reducing greenhouse gas (GHG) emissions. 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 2009, Anas and Lindsey 2011, Wang et al. 2013, 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 con-

cerns people voice about congestion charges refer to equity (Kristofferson 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 six European countries. The experiment was conducted within a large-scale international survey with participants from France, Italy, Poland, Greece, Spain, and the United Kingdom. Each of the 9,000 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 an information treatment. Additionally, we randomly assigned each participant one of three price levels, and then posed a second question of whether they were willing to pay this fee for driving into a city. The results of our analysis indicate that while the “effectiveness” information treatment consistently had a significant positive effect on acceptability, the “public opinion” information treatment did not. Participants who received the “effectiveness” information treatment were 6.7% more likely to approve or strongly approve of the proposed congestion charge in general, and still 4.1% 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 decreased the likelihood of a participant’s willingness to pay by 11.8% and the highest price level reduced it by 18.0%. An additional conclusion from our results is that widespread previous knowledge about

the nature of the congestion charge, such as in the United Kingdom, also raises 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 is 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, representative sample of 15,000 persons across six 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 to actually implement 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. 201, 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. 2016, 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. 2016, 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, Eliasson, and Hamilton 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

We conducted an intra-European household survey in France, Italy, Poland, Greece, Spain, and the United Kingdom. In these countries we collaborated with the market research institute Bilendi as an implementing agency and drew samples of 1,500 individuals per country. 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 the United Kingdom, the price levels used were £2, £5, and £10 and they were adjusted for each of the other countries according to their nominal per capita expenditure and given in their national currency. The list of values by country can be found in the Appendix, Table A1. In our analysis, the price levels are denoted

as “Low”, “Medium”, and “High” and the elicited acceptance for paying these prices as part of a congestion charge will be referred to as the Willingness-to-pay (WTP). 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.

Table 1: Descriptive statistics of survey participants

	Mean	Std.E.	Min	Max
Gender: female (0/1)	0.5	-	0	1
Age	44.276	13.968	18.000	69.000
University education (0/1)	0.28	-	0	1
Frequent driving into city (0/1)	0.31	-	0	1
Aware of closest public transport (0/1)	0.92	-	0	1
Owens a car (0/1)	0.97	-	0	1
Owens ticket for public transport (0/1)	0.30	-	0	1
Believes in climate change (0/1)	0.90	-	0	1
Previous knowledge about congestion charges (0/1)	0.37	-	0	1
Low income	0.27	-	0	1
Medium-high income	0.37	-	0	1
High income	0.35	-	0	1

Table 2: Acceptance of congestion charge, by treatment group and price level

	Approve	Do not approve	Don’t know
Before specifying price of charge:			
Total	27.5%	65.9%	6.6%
Control group	24.2%	69.0%	6.8%
Treatment group 1: Effectiveness information	29.8%	63.4%	6.8%
Treatment group 2: Public opinion information	28.6%	65.2%	6.2%
After specifying price of charge:			
Total	22.6%	65.6%	11.8%
Control group	20.2%	68.7%	11.1%
Treatment group 1: Effectiveness information	23.8%	63.6%	12.5%
Treatment group 2: Public opinion information	23.7%	64.4%	12.0%
Low price level	30.0%	57.2%	12.8%
Medium price level	20.90%	66.4%	12.7%
High price level	16.8%	73.1%	10.0%

The responses to our acceptance and WTP questions are summarized in Table 2. Preliminary observations here are that (i) approval seems to increase after both information treatments and (ii) attaching a specific price to the proposed congestion charge leads to a WTP response that is on average smaller than the Acceptance response before setting the price. The proportion of “Don’t know” responses is also higher for the WTP question. Looking at the WTP 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.

To further 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 the willingness-to-pay (WTP) question as dependent variable and the respective price level assigned to each participant as an additional covariable:

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

$$y_{2i} = \gamma_0 + \gamma_1 T_i + \gamma_2 p_i + \gamma_3 X_i + \gamma_4 \text{country}_i + v_i \quad (2)$$

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 designates each respondent's country of residence, and ϵ_i and v_i are random error terms. The confounding factors described at the beginning of this section as well as the standard socioeconomic variables of age, gender, income, and education are included as covariates.

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. The three estimated regressions contain different sets of covariates. The basic model only includes the dependent variable, the treatment variable, and the country dummies, the socioeconomic model in addition includes the standard variables of gender, age, education, and income as covariates, and the full model finally includes an additional fourteen variables on individual mobility behavior and opinions.

4 Results

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 all three models and ranges from 5.8% in the model with socioeconomic covariates to 6.7% in the full model, meaning that participants who received this information treatment are 5.8% to 6.7% 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 statistically significant at the 0.1% level in the basic model and the model with socioeconomic covariates, but only at the 5% level in the full model and ranges from 3.7% in the full model to 5.4% in the socioeconomic model, meaning that participants who received this particular information treatment are 3.7% to 5.4% more likely to approve of a congestion charge. This effect is statistically significantly smaller than the effectiveness information treatment.

It is noteworthy that with both treatments 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 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, female participants who own a car and use it to commute were 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 were more likely to accept the policy. Participants who saw the traffic problems listed in the survey as a rather significant issue for themselves personally were also more

likely to approve of the charge, as were those who believe in climate change. The coefficients of socioeconomic covariates decrease after additional variables on behavior and opinion are added. In the full model, income joins the ranks of significant explanatory variables, with participants with higher incomes having a higher likelihood of approving of the policy.

The country dummies were statistically significant in each of the three models. All coefficients are negative, which means that participants from any of these five countries are, on average, less likely to approve of a congestion charge than participants in the UK, the group that served as the model's baseline. Removing the UK participants from the models entirely, results shown in the Appendix in Table A5, leads to slightly lower effect estimates (between 5.2% and 5.6%) while the remaining country dummies cease to be significant. This indicates that our participants from the UK as a group have transport policy views which structurally differ from the other countries included in our study. Our data shows that 76.9% of survey participants from the UK had heard of a congestion charge before, which is more than double than the percentage of any other studied country, see Appendix, Table A2. This is likely due to the fact that London's congestion charge has been in place for nearly 20 years. The UK transport system also employs different pricing schemes for peak and off-peak hours, similarly to how congestion pricing is often handled, which might be another reason the UK citizens are less hesitant about congestion schemes that are designed in a similar way.

Next, the three models were estimated again, this time with the participants' willingness-to-pay (WTP) regarding the three randomly assigned respective price levels as the dependent variable. The results are presented in Table 4. 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 4.2% to 4.6% more likely to be willing to pay the charge, while the latter only has a statistically significant effect in the basic model and the socioeconomic model, where the treatment leads to an increase of 3.9% and 3.8% in likelihood to accept the charge, respectively. In

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

	Basic Model		Socioec. Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.059***	(0.012)	0.058***	(0.012)	0.067***	(0.017)
Public opinion information	0.045***	(0.012)	0.043***	(0.012)	0.037*	(0.017)
France	-0.152***	(0.017)	-0.126***	(0.017)	-0.132***	(0.028)
Italy	-0.139***	(0.017)	-0.128***	(0.017)	-0.106***	(0.029)
Poland	-0.116***	(0.017)	-0.094***	(0.017)	-0.101***	(0.028)
Spain	-0.105***	(0.017)	-0.097***	(0.017)	-0.163***	(0.027)
Greece	-0.091***	(0.017)	-0.077***	(0.017)	-0.134***	(0.027)
Gender: female			-0.033***	(0.010)	-0.011	(0.014)
Age			-0.001***	(0.000)	-0.001	(0.001)
University education			0.087***	(0.011)	0.037*	(0.015)
Medium-high income			0.019	(0.012)	0.037*	(0.019)
High income			0.015	(0.013)	0.038*	(0.019)
Lives in city					0.015	(0.015)
Commute (km)					-0.000	(0.000)
Nearest transport stop known					0.007	(0.029)
Public transport frequent					0.023	(0.016)
Owns car					-0.134***	(0.040)
Commutes by car					-0.034*	(0.016)
Has public transport ticket					0.089***	(0.016)
Locus of control					-0.010	(0.006)
Environmental attitude					-0.013	(0.011)
Believes in climate change					0.101***	(0.025)
Prior knowledge congestion charges					0.058***	(0.015)
Drives into city often					0.021	(0.015)
Opinion traffic problems (general)					0.029	(0.016)
Opinion traffic problems (personal)					0.034*	(0.014)
Constant	0.361***	(0.014)	0.391***	(0.024)	0.213**	(0.076)
Observations	8601		8601		4428	
R-Squared	0.01		0.03		0.05	
Adjusted R-Squared	0.01		0.03		0.05	
F-Statistic: p-value	0.00		0.00		0.00	

the full model, after adding in additional control variables, no statistically significant effect of the “public opinion” information treatment could be detected. 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 lowers the acceptance rate. The effect is statistically significant and stronger the higher the specified price is. Participants who were given the medium price level were 10.4% to 11.8% less likely to state that they were willing to pay the congestion charge, and those who were given the high price level were 15.6% to 18.0% less likely to be willing to pay it.

The covariates had similar effects on approval as in Table 3. Tertiary education, availability of frequent public transport, ownership of a public transport ticket, a belief in climate change, and prior knowledge about congestion charges affect likelihood of

Table 4: 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		Socioec. Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.044***	(0.011)	0.042***	(0.011)	0.041*	(0.016)
Public opinion information	0.039***	(0.011)	0.038**	(0.011)	0.019	(0.016)
Medium-high price of charge	-0.103***	(0.012)	-0.104***	(0.012)	-0.118***	(0.016)
High price of charge	-0.156***	(0.011)	-0.156***	(0.011)	-0.180***	(0.016)
France	-0.201***	(0.016)	-0.181***	(0.016)	-0.104***	(0.026)
Italy	-0.168***	(0.016)	-0.160***	(0.016)	-0.054	(0.028)
Poland	-0.002	(0.017)	0.015	(0.017)	0.074**	(0.027)
Spain	-0.135***	(0.016)	-0.129***	(0.016)	-0.125***	(0.026)
Greece	-0.002	(0.016)	0.007	(0.016)	0.025	(0.026)
Gender: female			-0.044***	(0.009)	-0.017	(0.014)
Age			-0.001	(0.000)	0.000	(0.001)
University education			0.070***	(0.011)	0.029	(0.015)
Medium-high income			0.001	(0.012)	0.027	(0.018)
High income			0.002	(0.012)	0.032	(0.018)
Lives in city					0.010	(0.015)
Commute (km)					-0.000	(0.000)
Nearest transport stop known					-0.025	(0.028)
Public transport frequent					0.032*	(0.015)
Owns car					-0.147***	(0.038)
Commutes by car					-0.034*	(0.015)
Has public transport ticket					0.121***	(0.015)
Locus of control					-0.015*	(0.006)
Environmental attitude					-0.010	(0.011)
Believes in climate change					0.092***	(0.024)
Prior knowledge congestion charges					0.133***	(0.015)
Drives into city often					0.008	(0.015)
Opinion traffic problems (general)					0.013	(0.015)
Opinion traffic problems (personal)					0.004	(0.013)
Constant	0.403***	(0.015)	0.417***	(0.024)	0.332***	(0.073)
Observations	8118		8118		4212	
R-Squared	0.06		0.07		0.12	
Adjusted R-Squared	0.06		0.07		0.12	
F-Statistic: p-value	0.00		0.00		0.00	

WTP positively, while owning and commuting with a car, identifying as female, and having a sense of a lack of control over one's life (LOC) affect it negatively. As before, the significance of the more general socioeconomic variables diminishes once the more specific transport, behavior, and worldview variables are added.

When attaching specific prices to the congestion charge, the difference between the UK and the six other countries in their likelihood of accepting a charge is larger than in the models that did not include prices. This indicates that UK citizens are less price-sensitive than those from the remaining countries, a logical effect since the UK is generally wealthier than many other European countries. Removing the UK from the specifications leads to the results presented in the Appendix in Table A5. Here, one can

see that the remaining countries still have heterogeneous reactions to the proposition of a congestion charge, and a more in-depth heterogeneity analysis is the next step.

We additionally estimated all six regressions in Table 3 and Table 4 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 A3 and Table A4 and do not discuss them here further.

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 24.2% of our sample approved or approved strongly of a congestion charge. This percentage rose to 29.8% for the group which received information on the policy's effect on air pollution, congestion, and accident rate, and to 29.6% for the group which received information about the positive change in public opinion which took place in Göteborg and Stockholm after the charge had already been implemented. An empirical analysis employing an Ordinary Least

Squares estimation revealed that the information about the charge's effectiveness increased the likelihood of approving a congestion charge by 6.7%. The information treatment concerning public opinion, on the other hand, ceased to exhibit a significant effect on approval when controlling for other factors such as travel behavior and personal opinions.

Attaching a specific price to the congestion charge generally lowered acceptance. Out of all participants in the control group only 20.2% of respondents were willing to pay for the charge, 23.8% and 23.7% in either treatment group, respectively, and cumulatively for all given price levels. When looking at the price-specific responses, irrespective of the treatment group, a very high proportion of 30.0% were willing to pay for the charge at the lowest price level, but only 20.9% and 16.8% at the medium and high price level, respectively. This hesitance was also apparent in the empirical estimation results, where being assigned the medium or high price level decreased likelihood of willingness to pay by 11.8% and 18.0%, respectively. In these models, the effectiveness information treatment had a slightly lower, but still statistically significant effect of 4.1%. The public opinion information treatment again had no effect once other factors were included.

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 had some prior knowledge about congestion charges, which is more than double that of any other included country. Participants from the UK also on average exhibited a higher approval rate and willingness-to-pay for congestion charges than participants from other countries. Even when excluding the UK from the analysis, prior knowledge about congestion charges continued to be a statistically significant influence on approval and WTP 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 charge fee, allocated randomly to respondents before survey question CM4a, in local currency

Fee Level	The UK	France	Italy	Poland	Spain	Greece
Low	£2.00	2.00 €	1.50 €	3.00 Zloty	1.50 €	1.00 €
Medium	£5.00	5.00 €	4.00 €	8.00 Zloty	3.00 €	2.50 €
High	£10.00	10.00 €	8.00 €	16.00 Zloty	6.00 €	5.00 €

Table A2: Results of survey question CM1a - Have you ever heard of the concept of a 'congestion charge' before?

	The UK	France	Italy	Poland	Spain	Greece	Total
Yes	76.90%	36.80%	13.80%	18.80%	34.50%	32.90%	35.60%
No	19.40%	60.80%	79.40%	72.10%	62.10%	63.50%	59.60%
Don't know	3.70%	2.50%	6.90%	9.10%	3.40%	3.60%	4.80%

Table A3: Marginal effects (dy/dx) derived from Probit regressions based on equation (1), binary dependent variable is acceptance of congestion charge

	Basic Model		Socioec. Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.059***	(0.012)	0.058***	(0.012)	0.067***	(0.017)
Public opinion information	0.045***	(0.012)	0.043***	(0.012)	0.037*	(0.017)
France	-0.152***	(0.017)	-0.126***	(0.017)	-0.132***	(0.028)
Italy	-0.139***	(0.017)	-0.128***	(0.017)	-0.106***	(0.029)
Poland	-0.116***	(0.017)	-0.094***	(0.017)	-0.101***	(0.028)
Spain	-0.105***	(0.017)	-0.097***	(0.017)	-0.163***	(0.027)
Greece	-0.091***	(0.017)	-0.077***	(0.017)	-0.134***	(0.027)
Gender: female			-0.033***	(0.010)	-0.011	(0.014)
Age			-0.001***	(0.000)	-0.001	(0.001)
University education			0.087***	(0.011)	0.037*	(0.015)
Medium-high income			0.019	(0.012)	0.037*	(0.019)
High income			0.015	(0.013)	0.038*	(0.019)
Lives in city					0.015	(0.015)
Commute (km)					-0.000	(0.000)
Nearest transport stop known					0.007	(0.029)
Public transport frequent					0.023	(0.016)
Owns car					-0.134***	(0.040)
Commutes by car					-0.034*	(0.016)
Has public transport ticket					0.089***	(0.016)
Locus of control					-0.010	(0.006)
Environmental attitude					-0.013	(0.011)
Believes in climate change					0.101***	(0.025)
Prior knowledge congestion charges					0.058***	(0.015)
Drives into city often					0.021	(0.015)
Opinion traffic problems (general)					0.029	(0.016)
Opinion traffic problems (personal)					0.034*	(0.014)
Constant	0.361***	(0.014)	0.391***	(0.024)	0.213**	(0.076)
Observations		8601		8601		4428
R-Squared		0.01		0.03		0.05
Adjusted R-Squared		0.01		0.03		0.05
F-Statistic: p-value		0.00		0.00		0.00

Table A4: 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		Socioec. Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.044***	(0.011)	0.042***	(0.011)	0.041*	(0.016)
Public opinion information	0.039***	(0.011)	0.038**	(0.011)	0.019	(0.016)
Medium-high price of charge	-0.103***	(0.012)	-0.104***	(0.012)	-0.118***	(0.016)
High price of charge	-0.156***	(0.011)	-0.156***	(0.011)	-0.180***	(0.016)
France	-0.201***	(0.016)	-0.181***	(0.016)	-0.104***	(0.026)
Italy	-0.168***	(0.016)	-0.160***	(0.016)	-0.054	(0.028)
Poland	-0.002	(0.017)	0.015	(0.017)	0.074**	(0.027)
Spain	-0.135***	(0.016)	-0.129***	(0.016)	-0.125***	(0.026)
Greece	-0.002	(0.016)	0.007	(0.016)	0.025	(0.026)
Gender: female			-0.044***	(0.009)	-0.017	(0.014)
Age			-0.001	(0.000)	0.000	(0.001)
University education			0.070***	(0.011)	0.029	(0.015)
Medium-high income			0.001	(0.012)	0.027	(0.018)
High income			0.002	(0.012)	0.032	(0.018)
Lives in city					0.010	(0.015)
Commute (km)					-0.000	(0.000)
Nearest transport stop known					-0.025	(0.028)
Public transport frequent					0.032*	(0.015)
Owns car					-0.147***	(0.038)
Commutes by car					-0.034*	(0.015)
Has public transport ticket					0.121***	(0.015)
Locus of control					-0.015*	(0.006)
Environmental attitude					-0.010	(0.011)
Believes in climate change					0.092***	(0.024)
Prior knowledge congestion charges					0.133***	(0.015)
Drives into city often					0.008	(0.015)
Opinion traffic problems (general)					0.013	(0.015)
Opinion traffic problems (personal)					0.004	(0.013)
Constant	0.403***	(0.015)	0.417***	(0.024)	0.332***	(0.073)
Observations	8118		8118		4212	
R-Squared	0.06		0.07		0.12	
Adjusted R-Squared	0.06		0.07		0.12	
F-Statistic: p-value	0.00		0.00		0.00	

Table A5: Results of OLS regressions based on equation (1), excluding the United Kingdom from data sample, binary dependent variable is acceptance of congestion charge

	Basic Model		Socioec. Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.052***	(0.013)	0.052***	(0.013)	0.054**	(0.018)
Public opinion information	0.040**	(0.013)	0.039**	(0.013)	0.031	(0.018)
Italy	0.013	(0.017)	0.001	(0.017)	0.028	(0.026)
Poland	0.037*	(0.017)	0.034*	(0.017)	0.032	(0.025)
Spain	0.047**	(0.017)	0.032	(0.017)	-0.032	(0.024)
Greece	0.062***	(0.017)	0.052**	(0.017)	-0.005	(0.024)
Gender: female			-0.031**	(0.011)	-0.008	(0.015)
Age			-0.001	(0.000)	0.000	(0.001)
University education			0.072***	(0.012)	0.034*	(0.016)
Medium-high income			0.003	(0.013)	0.030	(0.019)
High income			-0.003	(0.014)	0.022	(0.020)
Lives in city					-0.003	(0.016)
Commute (km)					-0.000	(0.000)
Nearest transport stop known					0.009	(0.030)
Public transport frequent					0.025	(0.017)
Owns car					-0.140**	(0.043)
Commutes by car					-0.033*	(0.017)
Has public transport ticket					0.092***	(0.017)
Locus of control					-0.015*	(0.007)
Environmental attitude					-0.005	(0.012)
Believes in climate change					0.075**	(0.027)
Prior knowledge congestion charges					0.072***	(0.016)
Drives into city often					0.015	(0.016)
Opinion traffic problems (general)					0.043*	(0.017)
Opinion traffic problems (personal)					0.027	(0.015)
Constant	0.213***	(0.014)	0.244***	(0.025)	0.039	(0.079)
Observations	7185		7185		3887	
R-Squared	0.01		0.01		0.04	
Adjusted R-Squared	0.00		0.01		0.04	
F-Statistic: p-value	0.00		0.00		0.00	

Table A6: Results of OLS regressions based on equation (2), excluding the United Kingdom from data sample, binary dependent variable is willingness to pay for congestion charge given randomly assigned price level

	Basic Model		Socioec. Model		Full model	
	Coeff.	Std. E.	Coeff.	Std. E.	Coeff.	Std. E.
Effectiveness Information	0.038**	(0.012)	0.037**	(0.012)	0.028	(0.017)
Public opinion information	0.027*	(0.012)	0.026*	(0.012)	0.011	(0.017)
Medium-high price of charge	-0.096***	(0.012)	-0.097***	(0.012)	-0.112***	(0.017)
High price of charge	-0.142***	(0.012)	-0.142***	(0.012)	-0.167***	(0.017)
Italy	0.032*	(0.016)	0.023	(0.016)	0.054*	(0.024)
Poland	0.199***	(0.016)	0.196***	(0.016)	0.178***	(0.024)
Spain	0.066***	(0.016)	0.054***	(0.016)	-0.013	(0.023)
Greece	0.199***	(0.016)	0.190***	(0.016)	0.138***	(0.023)
Gender: female			-0.044***	(0.010)	-0.016	(0.015)
Age			-0.000	(0.000)	0.000	(0.001)
University education			0.059***	(0.012)	0.022	(0.016)
Medium-high income			-0.011	(0.013)	0.018	(0.019)
High income			-0.015	(0.013)	0.016	(0.019)
Lives in city					-0.006	(0.016)
Commute (km)					-0.000	(0.000)
Nearest transport stop known					-0.027	(0.029)
Public transport frequent					0.031	(0.016)
Owns car					-0.175***	(0.041)
Commutes by car					-0.036*	(0.016)
Has public transport ticket					0.113***	(0.016)
Locus of control					-0.017**	(0.006)
Environmental attitude					-0.003	(0.012)
Believes in climate change					0.085***	(0.025)
Prior knowledge congestion charges					0.140***	(0.015)
Drives into city often					0.006	(0.015)
Opinion traffic problems (general)					0.020	(0.016)
Opinion traffic problems (personal)					-0.013	(0.014)
Constant	0.201***	(0.015)	0.228***	(0.024)	0.269***	(0.077)
Observations	6802		6802		3691	
R-Squared	0.06		0.07		0.12	
Adjusted R-Squared	0.06		0.06		0.11	
F-Statistic: p-value	0.00		0.00		0.00	