Factors driving public support for road congestion reduction policies

Congestion charging, free public transport and more roads in Stockholm, Helsinki and Lyon

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ABSTRACT

Based on an across-the-board survey conducted among residents of Stockholm, Helsinki and Lyon, we explore the opinions on three policy measures to combat road congestion: congestion charging, free public transport and building more roads. The support for the two latter policies is substantially higher than the support for congestion charging, which is only supported by a majority in Stockholm. Self-interest is important for the formation of the opinion to all three policies. However, fundamental values and general political views, indicated by four attitudinal factors, are even more important in forming opinions towards the three transport policies. Of all attitudinal factors, the one indicating environmental concern most influences the support for all policies. Equity concerns, however, increase the support for free public transport and opposition to taxation increases the support for building more roads.

Our results further suggest that the opinions towards free public transport and building more roads can be mapped along the left-right political axis, where Environment and Equity are to the left and Pricing and Taxation are to the right. However, the opinion towards congestion charging cuts right through the political spectrum. The impact of the fundamental values and self-interest variables are similar for Stockholm and Helsinki, indicating that even if experience increases the overall support for charging, it does not change the relative strength of different political arguments to any major extent.

HIGHLIGHTS

We model the support for road pricing, free public transport (PT) and more roads

Support for free PT and more roads is higher than support for congestion charging

General attitudes are more important for transport policy opinions than self-interest

Environmental concerns is a strong predictor of opinions on all measures everywhere

Support for free PT and more roads, but not charges, is located along a left-right axis

KEYWORDS

Congestion charging; free public transport; more roads building, acceptability; public opinions, factor analysis; ordered logit.

1. INTRODUCTION

Congestion is an increasing problem in urban regions all over the globe. In this paper, we study the opinion towards three suggested policies to combat urban road congestion,-- congestion charging, free public transport and building more roads,-- and how these opinions are formed. The study is based on an across-the-board survey distributed in three cities: Stockholm, Helsinki and Lyon. The survey questions are designed to indicate fundamental values and more general political options related to environmental concern, equity, taxes and pricing of externalities and scarce resources, but also self-interest in the suggested measures and socioeconomic characteristics.

Hamilton et al. (2014) previously analyzed the public opinion towards congestion charging based on the same survey. They find that the opinion on congestion charging increases significantly with experience and that self-interest influences the opinion as expected. They also find a strong link between attitudes towards congestion charging and opinions related to more general issues, such as the natural environment and taxation (Hamilton et al., 2014). We extend their work in two ways. First, we explicitly study the impact of latent variables on the opinion towards three policies that we study. The latent variables are designed to indicate fundamental values and more general political views, not specifically related to transport policy. We assume that these are more developed in the respondent's mind and therefore more stable over time (Ajzen, 1991) than the opinion towards the transport policies we study. The survey questions, concerning more general issues, are used as indicators of these fundamental values. The latent variables are determined using factor analysis. We model the opinion towards congestion charging, free public transport and building more roads as a function of the latent variables, self-interest and socioeconomic variables. Second, we extend the analysis by Hamilton et al. (2014) by modelling the opinions towards free public transport and building more roads.

Congestion charging is a cost-efficient and effective policy to reduce congestion and is recommended by economists. Congestion charging also raises revenue and improves the local environment (Bonsall and Young, 2011). Theoretically, revenues raised by optimal congestion charging exactly pay for optimal road capacity (Mohring and Harwitz, 1962). However, low public and political support usually prevents its implementation and there are only a few real-world examples of congestion charging (London (2003), Stockholm (2006), Milano (2008), Singapore (1997)).

Free public transport (PT) is very uncommon (see Cats (2014) and Thøgersen (2009) for some examples) and is also inefficient from a welfare perspective (Van Dender and Proost, 2009). Moreover, free public transport would be very costly and increase congestion in the public transport system by substituting more walking and cycling trips than car trips with public transport (Preston, 2008). Subsidization, however, is justified because public transport exhibits economies of scale (Mohring, 1972), encourages economic activity and reduces road congestion (Parry and Small, 2009).

Building more roads was the dominant way of fighting congestion in the 1970s (OECD/ECMT, 2007). However, since road capacity extensions require large investments and space, and they give rise to negative externalities in terms of pollution and noise, this has long been questioned. The large literature on the potential to combat congestion with road capacity extensions also mainly indicates negative results due to generation of new traffic (see Schade

and Schlag (2003) for reviews). The Association for European Transport (2005) and Schuitema and Steg (2008) argue that the opinion for building more roads is currently low in Europe. However, the public opinion in favour of pull measures such as more roads and free/cheap public transport is in general higher than for push measures like congestion charging (Eriksson et al., 2008). This is also what we find in the present study. A likely reason is that the cost of the pull measures is more indirect, often left out from the public debate and it is often unclear who will pay for them (essentially depending on the tax system).

Survey-based attitude studies (Schade and Schlag, 2003; Jaensirisak et al., 2005 and De Borger and Proost, 2012) as well as studies based on real voting patterns (Hårsman and Quigley, 2010) indicate that the support for congestion charging is linked to self-interest. Self-interest is determined by out-of-pocket expenses, time savings and value of travel time (VTT), and benefits derived from the use of revenue. Self-interest relating to free public transport and building more roads is indicated by such factors as car access and use.

In the present study, the factor analysis resulted in four attitudinal factors labelled Environment, Equity, Pricing and Taxation, and these are interpreted as indicators of more fundamental values and general political views. We find that the factors have a strong prediction power for the public opinion of all three policies. Some variables reflecting self-interest, such as car access and car use, are also significant. The prediction power of the self-interest variables, however, is smaller than that of the attitudinal factors. This is the case for the opinions towards congestion charging, as found by Hamilton et al. (2014), but the attitudinal factors have an even stronger relative prediction power (over self-interest variables) for support for free public transport and building more roads.

Of all the attitudinal factors, those indicating environmental concern and support for policy interventions have the greatest influence on the opinion for all three measures in all three cities. The factor indicating equity concerns does not significantly influence the opinion towards congestion charging in Stockholm and Helsinki, but does in Lyon. In all cities, however, equity concerns increase the support for free public transport. The factor indicating opposition to taxation reduces the support for congestion charging and increases the support for building more roads.

One of the most well-established observations about attitudes to congestion charging, and road pricing in general, is that familiarity breeds acceptability (Brundell-Freij and Jonsson, 2009; Börjesson et al., 2012). An often-cited reason for the changes in the opinion towards congestion charges once they are introduced is that, before the introduction, people do not expect the benefit of the congestion charging to be as large as they turn out to be (Goodwin, 2006). We find that the impact of the fundamental values and self-interest variables are similar for Stockholm and Helsinki. This indicates that even if experience increases the overall support, it does not, to any major extent, change the relative strength of different political arguments in favour of or against congestion charging. It also contradicts the hypothesis that the reason for the change in opinion is that benefits are larger than expected.

The remainder of the paper is structured as follow. Section 2 describes the data. Section 3 presents the methodology and modelling results, including the factor analysis and the ordered logit modelling of the support for the three measures that we study. Section 4 discusses the results and concludes the paper.

2. DATA COLLECTION

This study is based on an across-the-board survey conducted among residents of Stockholm, Helsinki and Lyon in 2011. These cities were selected because they are similar with regard to size, urban planning and demography, but have different experiences regarding congestion charging. At the time the survey was conducted, there was a heated public debate in Helsinki concerning the introduction of a distance-based road user charge aimed at reducing congestion. The debated system was never implemented due to low public and political support. Lyon had peak hour pricing of a specific road segment in 1997, but the system was abolished soon after its implementation due to negative public opinion. Stockholm has had congestion charging since 2006 (Eliasson et al., 2009).

The survey includes questions regarding opinion towards congestion charging, free public transport and building more roads. It is identical in all cities except for some small adjustments to fit the local context. In Stockholm and Helsinki, it was a mail-back survey, whereas the interview was conducted over the telephone in Lyon. In all cites, a random sample of residents between 18 and 65 was recruited to participate in the survey. The response rates are similar across the cities and relatively low, which is common for surveys. The low response rate may bias the results in terms of opinion towards the measures we study. It has, however, presumably less impact on the effect of fundamental values and self-interest on the opinion toward these measures, which is the key interest of the present study.

A congestion charging system is presented in the survey and the respondents are asked how they would vote in a hypothetical referendum concerning the introduction of this scheme.[1] The response alternatives include ’certainly no’, ’probably no’, ’undecided’, ’probably yes’ and ’certainly yes’. In the Stockholm questionnaire the existing system is presented, in the Lyon questionnaire a hypothetical system similar to the Stockholm system is presented, and in the Helsinki questionnaire the debated system is presented.

The respondents are also asked to what extent they agree with the statements concerning free public transport and more road investments as shown in the bottom rows of Table 1. The responses are given on a seven-point Likert scale, ranging from ’agree completely’ to ’disagree completely’, with the option ’neutral’ in the middle. Stockholm has the highest support for congestion charging, whereas the support for free public transport and building more roads is similar across cities.

In Helsinki and Lyon, the support for free public transport and building more roads is substantially higher than the support for congestion charging. This might be because the survey did not mention the substantial public spending that these measures would demand, or who would bear the tax burden. However, this usually also holds in the public debate, where costs of public transport subsidization and infrastructure investments are rarely in focus. Moreover, it is also often unclear who will pay for them (essentially depending on the tax system).

The survey also asked to what extent the respondents agreed with statements related to the natural environment, public interventions, equity, pricing and taxation. These statements are

[1] In the Stockholm questionnaire the hypothetical referendum concerns abolishing the existing scheme.

used to indicate fundamental values and broader political views, which are assumed to form the opinion toward the three measures under study. Much effort was spent on formulating the questions so that they did not directly relate to congestion charging, free public transport and building more roads, but to more fundamental opinions assumed to be well-developed in the respondent's mind. The responses to these statements are reported in Table 1.

The survey also includes questions designed to capture socioeconomic characteristics, asking about: gender, age, household composition (number of adults and children in the household), income, employment status, and education attainment coded on four levels (0 = 'compulsory school', 1= 'college ', 2 = '<= three years of university', 3 = '> three years of university').

Self-interest with regard to congestion charging, free public transport and building more roads is indicated by survey questions on: value of time (ranging from 0 to 18 €/h on a seven level scale)[2], number of cars available in the household (coded on a four-level scale: 0, 1, 2, >2 cars), and trip frequencies by car, public transport and cycle (trip frequencies are coded on a four-level scale: 0 = 'rarely or never', 1 = 'a couple of times per month', 2 = 'a couple of times per week', 3 = 'every or almost every day').

The survey in Lyon and Stockholm also included a question about the number of trips per month that the respondent pays the charge (or would pay if it was implemented in Lyon). It is coded on a four-level scale: 0 = 'rarely or never', 1 = 'a couple of times per month', 2 = 'a couple of times per week', 3 = 'every or almost every day'. The survey in Helsinki asked about the number of kilometres per weekday the responded would travel within the charged zones if the suggested system was implemented.

Table 1 Description of cities and survey results.

Description\City	**Stockholm**	**Helsinki**	**Lyon**
Population city (metro area)	851,000 (2.1 million)	596,000 (1.1 million)	481,000 (2.1 million)
The congestion charging systems described in the survey used in the hypothetical referendum.	In/out passages from the inner city during 06:30-18:30. 1€, 1.5€ or 2€ per passage, capped at 6€ per day and car. Evening, night and weekend traffics not charged.	0.8€/km during 06:00-09:00 and 15:00-18:00 and 0.4€/km during 9-15 (zone 1). 0.4€/km for all charged hours 6-18 (zone 2). 6€ max per day and car. Evening, night and weekend traffics not charged.	Passages in Lyon (except for the 5th and the 9th districts) and Villeurbanne priced at 3€/day or 50 €/month. Operating 24h/24 and 7 days a week.

[2] The value of time was indicated by a question describing a hypothetical commuting trip: *On your commute by car you pass a bridge crossing a river. The bridge closes for repairs for some time. Another bridge is available some distance away, but the detour to use that bridge takes 20 minutes. Commuters also have the option to use a ferry, to save these 20 minutes. What is the maximum price you would be willing to pay for a ferry ticket?* This question measures the VTT in a crude way but the resulting value of time distribution resembles that observed in the Swedish value of time study (Börjesson and Eliasson, 2014).

Surveyed population (response rate)	N=1,837 (0.43)	N=1,178 (0.39)	N=1,500 (0.37)
Statement	Share of respondents agreeing with the statement [3]		
Motor traffic is one of the largest threats to Nature	0.70	0.57	0.77
More resources should be used to protect the natural environment	0.88	0.86	0.95
Automated speed camera surveillance is a reasonable way to save lives in traffic	0.87	0.86	0.60
It is reasonable that a highway user charge is lower outside rush hours	0.62	0.52	0.64
It would be reasonable if public transport fares were cheaper outside peak times	0.72	0.54	0.67
It would be reasonable if new bridges/roads were financed by road user charges	0.48	0.27	0.43
I think it is reasonable that air tickets are more expensive for departures in the peak hours	0.68	0.60	0.42
The government should prioritize reducing differences between rich and poor	0.75	0.78	0.83
If drivers with low income are offered a discount, I would become more positive to congestion charging	0.47	0.59	0.82
Taxes are too high in [country name]	0.69	0.77	0.77
Traffic congestion is one of the worst problems in [city name]	0.81	0.70	0.73
It would be reasonable if air traffic was subject to a special environmental tax	0.63	0.91	0.75
I think it would be reasonable if public transport was free in order to reduce congestion on the road.	0.74	0.59	0.66
I think it would be reasonable to build more roads to reduce road congestion.	0.66	0.62	0.66

[3] The share of respondents who have ticked the boxes 1-3 on the agree side of all respondents ticking box 1-3 (agree) or 5-7 (disagree), thus excluding the respondents who ticked the middle box 4 labelled 'neutral'. In the last row, the number refers to the share of respondents who would vote in favour of the charging (including the responses certainly yes and probably yes), disregarding the undecided respondents.

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In a referendum about the congestion charging, how would you vote?	0.68	0.35	0.32

3. MODEL ESTIMATION

We use factor analysis to reduce the dimensionality of the responses to the statements in Table 1. Factor analysis is an explorative method, here applied to capture the variability in the responses to the statements by a smaller number of latent and unobserved variables called factors. The factors are interpreted as indicators of the fundamental values. The factor analysis results in a factor index for each respondent, which is subsequently used to model the support for the measures that we are studying. Factor analysis is only justified to the extent that a meaningful interpretation of the factors is possible. The factor analysis and the resulting factors and their interpretation are described in Section 3.1.

In Section 3.2 we continue to model the support for congestion charging, free public transport and building more roads as function of the factors indices, socioeconomics and variables measuring self-interest (e.g. value of time, trip frequencies with different travel modes and toll payments). We apply an ordered logit model using the estimation software Biogeme (Bierlaire, 2003). The statistical software SPSS (version 21) is applied for the factor analysis.

3.1. FACTOR ANALYSIS

The first twelve statements presented in Table 1 are used as indicator variables and entered into a principal component analysis (PCA) with VARIMAX rotation. [4] The factor analysis resulted in four factors. We use only factors with eigenvalues greater than 1.[5] We used the same factors in each city in order to increase the comparability and generalization of the results.

The rotated factor loadings are displayed in Table 2 and measure the correlation between the indicator variables and the factors. The squared factor loading equals the share of variance in each indicator variable that is explained by the factor. The sum of the squared factor loadings of a given indicator variable across all factors is the communality, i.e. the variance in the indicator variable that is explained by the all the factors together. The communality, thus, measures the percent of the variance in a given indicator variable that is explained by all the factors jointly. Factor analysis is only justified if the indicator variables have high communality. Therefore, only variables with a factor loading of at least 0.4 are used for interpretation.

[4] The Kaiser -Meyer-Olkin statistic, indicating sampling adequacy, was 0.67. This is greater than 0.60, implying that our sample is suitable for using an explanatory factor analysis. The Bartlett test of sphericity was also significant (judging from the p-value that is inferior to 0.05) meaning that the factor analysis is statistically justified (McClendon, 1994; Bernstein et al., 1988; Flury and Riedwyl, 1988; Anderson et al., 2001; Brace et al., 2012). Finally,, Cronbach's Alpha tests measured 0.53, 0.53, 0.55 and 0.37 respectively for the four factors. This indicates a good internal consistency for the first three factors (values are over 0.50) and a slightly less good reliability for the last sub-scale.

[5] The eigenvalue of a factor is a measure of the sum of the variance of all the indicator variables included in the factor.

The factor analysis is an explorative analysis tool and only justified to the extent that the resulting factors can be interpreted in a meaningful way. The resulting factors all make sense and can be interpreted in the light of fundamental values associated with a political colour. We have labelled them accordingly. We have regressed the socioeconomic and travel-related variables on the factor indexes (see Table 5 in appendix A) to facilitate the interpretation. Income is left out as control variable because the frequency of non-response to income is larger. However, both education attainment and value of time are correlated with income.

The first factor indicates environmental concerns and support for public interventions. The statement about speed cameras is an indicator of support for public interventions not related to environmental concerns but we still label this factor Environment. The regression shows that the Environment factor index is positively correlated with cycling and public transport trip frequencies, value of time, being a parent, and being a woman. It is negatively correlated with car trip frequency.

The second factor is correlated with the statement indicating values related to equality between rich and poor in society. This factor is also correlated with the statement that more resources should be spent on protecting the environment, but we still label this factor Equity (see further discussion of the political interpretation). The Equity factor index is negatively correlated with education attainment, value of time, number of cars in the household, age, being male, and car trip frequency. It is positively correlated with cycling trip frequency.

The third factor correlates with statements indicating values related to pricing of externalities but also the users-pay principle in the statement regarding the toll revenues financing a new bridge. The Pricing factor index is positively correlated with value of time, age, and being male. It is negatively correlated with number of cars in the household.

The fourth factor correlates with the two statements reflecting tax opposition, one specifically concerning an environmental tax. It is also correlated with a statement regarding problems arising from road congestion. We label this factor Taxation. This factor is negatively correlated with education attainment, value of time, cycling, and public transport trip frequencies. It is positively correlated with number of cars in the household, car trip frequency, age, and being a woman. Since this factor is associated with high car use, the statement regarding congestion probably indicates positive values related to car use and road investments and low concern about the environment (consistent with the disagreement with the environmental tax statement), it seems that the anti-taxation attitudes are associated with high car use and low environmental concern.

Interpreting the factors in the light of a right-left political perspective, the Equity factors are clearly traditionally left, including a statement related to environmental concern. The latter makes sense, given that green politics are now well established as being left-wing in the Swedish, Finnish and French contexts. The Environment factor is also associated with the left-wing values, confirmed by the statement indicating support for public intervention within this factor. Both the Environment and the Equity factors are positively correlated with being female and cycling frequency, and are negatively correlated with car trip frequency. A major difference between the Environment factor and the Equity factor is that respondents scoring

high on the former on average have higher education, higher VTT and more cars in the household compared to respondents scoring high on the latter.

The Pricing factor is traditionally liberal and right-wing. The Taxation factor also represents values that are more right-wing and possibly also anti-green. The respondents scoring high on the Pricing factor are to a larger extent male and have on average higher education and VTT than respondents scoring high on the Taxation factor. The respondents scoring high on the Taxation factor have higher car trip frequency, lower bicycling trip frequency, and more cars in the household than those scoring high on the Pricing factor.

In the interpretation of the factors, we stress that they reflect the correlation of the responses with the statements, which is an empirical issue. In other words,., there is nothing fundamental to say that taxation opposition is associated with low environmental concern, but this seems to be an empirical finding supported by the fact that green politics are established on the left-wing in most countries. The support for policy intervention (a traditionally left-wing attitude) correlating with the environment factor is also an effect of environmental concerns being more common among left-wing voters.

Table 2 Results from the explanatory factor analysis: rotated factor loadings.

	Factors			
Statement	Environment/ Intervention	Equity	Pricing	Taxation
Motor traffic is one of the largest threats to Nature	0.73			
More resources should be used to protect the natural environment	0.58	0.48		
Automated speed camera surveillance is a reasonable way to save lives in traffic	0.55			
It is reasonable that a highway user charge is lower outside rush hours			0.78	
It would be reasonable if public transport fares were cheaper outside peak times			0.77	
It would be reasonable if new bridges/roads were financed by road user charges			0.47	
I think it is reasonable that air tickets are more expensive for departures in the peak hours			0.45	
The government should prioritize reducing differences between rich and poor		0.76		
If drivers with low income are offered a discount, I would become more positive to congestion charging		0.70		
Taxes are too high in [country name]				0.76
Traffic congestion is one of the worst problems in [city name]	0.50			0.60

It would be reasonable if air traffic was subject to a special environmental tax	0.42			-0.54
Average factor index				
Lyon	5.07	5.33	4.05	4.40
Stockholm	4.95	4.63	4.37	4.50
Helsinki	5.03	4.73	3.82	4.01

3.2. MODELLING

Next, we estimate ordered logit models to explore how different variables influence the opinions towards congestion charging, free public transport and building more roads. In the first model, the dependent variable is the question about the vote (final row of Table 1), for which the responses were indicated on a 5-grade scale, from 'certainly no' to 'certainly yes'. In the second model, the dependent variable is the response to the statement about free public transport (second row from the bottom of Table 1), indicated on a 7-grade scale from 'disagree completely' to 'agree completely'. In the third model, the dependent variable is the response to the statement about building more roads (third row from the bottom of Table 1), indicated on the same 7-grade scale.

The effect of socioeconomic variables, self-interest variables and attitudinal factors on the opinions towards the three policies is explored. Insignificant variables are excluded from the models. Income was tried in all models, but not significant in any of them, partly because it is highly correlated with value of time and education attainment. Estimation results are displayed in Table 3 below. All presented models are estimated on the pooled data from all three cities, but the parameters for the attitudinal factors are estimated separately for each city since they are of key interest in this paper. However, prior to estimating the models on the pooled data, separate models were estimated for each city. The χ^2-test of parameter restriction was applied to test the null hypothesis that the parameters of the three city-specific models are identical. It is conventional to use the significance level 0.05. For the pooling of the Stockholm and Helsinki models, the significance levels of the χ^2-test were 0.15, 0.48 and 0.95 respectively for congestion charging, free public transport and building more roads. Hence, we could not reject the null hypothesis that the parameters of the Stockholm and the Helsinki models are the same.

The pooling of the Lyon sample with the Stockholm and Helsinki samples was, however, rejected by the χ^2-test for the congestion charging and the free public transport models. Hence, according to this test, the parameters of the French sample are different from the Scandinavian samples. This might be due to cultural difference, and possibly also difference in survey method (see Section 2). The null hypothesis, however, is not rejected for the model of building more roads, with significance 0.48. For the sake of overview, we still pool the samples for all cities in all models, but estimate city-specific variables for the attitudinal factors.

3.2.1. OPINIONS TOWARDS CONGESTION CHARGING

The attitudinal factors strongly affect the opinion towards congestion charging, and they all have expected signs in all cities. The Environment factor is positive and has the largest effect on the support for congestion charging in all cities. The Taxation factor is negative and has the second largest effect on the support in Stockholm and Lyon. The support for charging increases with the Pricing factor in all cities, and in Helsinki the effect of this factor is larger than the effect of the factor Taxation. Hence, environmental concern and opposition to taxes seem to be strong arguments in favour and against, respectively, congestion charging. Pricing as an allocation mechanism is an argument in favour but seems weaker than the environment argument.

In Lyon, the Equity factor has a negative effect on the support for the charges, but it is smaller than the effect of the Taxation factor. The Equity factor does not, however, have any significant effect in Helsinki and Stockholm. One reason could be that the equity argument moves in two opposing directions. On the one hand, low income groups drive less and so tend to be less affected by congestion charging. On the other hand, they have lower values of time implying that they would be more negatively affected by congestion charging if they are using the charged road network (as discussed in Section 3.1). Hence, although a negative equity outcome is often put forward as an important argument against congestion charging in the public debate, this only seems to have a real effect on the support for congestion charging in Lyon, and even there equity effects do not seem to be the main argument against congestion charging.

Interestingly, opinion towards congestion charging does not coincide with the traditional right-left political dimension. High environmental concern (left-wing) and high support for pricing as an allocation mechanism (right-wing) increase the support for charging. Equity concern (left-wing) and tax opposition (right-wing) reduce the support for charges. In addition, the Environment and the Pricing factor both correlate with higher value of time. The Equity and the Taxation factors both correlate with low education. As shown below, the value of time and education attainment also directly influence the support for congestion charges in the same direction (lower education reduces and higher value of time increases the support).

The dummy variables for Helsinki and Lyon are negative, indicating an unexplained higher public acceptability in Stockholm. This unexplained effect is probably due to the experience of congestion charging in Stockholm, which is the only city that has congestion charges in place. However, the impact of the factors is similar for Sweden and Finland (except the stronger effect of the Taxation factor in Stockholm), and all other explanatory variables as well, as indicated by the χ^2-test described above. This suggests that even if experience increases the baseline support, it does not greatly change the relative strength of different variables explaining the support.

A number of self-interest variables are also significant and have the expected signs. More cars in the household reduce the support for charging. The toll payments are implemented as a combination of a dummy variable indicating if the respondents report that they (would hypothetically) pay the charge at all (more than rarely or never) and a linear variable for the number of charged trips per month (remember that all frequencies are coded on a four-level

scale 0 = 'rarely or never', 1 = 'a couple of times per month', 2 = 'a couple of times per week', 3 = 'every or almost every day') or kilometres in the charged zones in Helsinki. The value of travel ranges from 0 to 18 €/h on a seven-level scale. It is coded as a piece-wise linear variable with kinks as 3 and 15 €/h. Higher value of time and lower toll payments increase the support for congestion charging. Car trip frequency is coded as a piecewise linear variable with four levels (0, 1, 2, 3) with a kink at 1 = A couple of times per month. The support for congestion charging reduces with more frequent driving.

A dummy variable was created for identifying parents (having a child in the household). All else being equal, parents are more negative to charging, possible because they are more car-dependent than others. Education attainment (0 = 'compulsory school', 1= 'college ', 2 = '<= three years of university', 3 = '> three years of university') is implemented as a piecewise variable with the kink at 1, 'college'. Longer university education increases the support for congestion pricing.

3.2.2. OPINIONS TOWARDS FREE PUBLIC TRANSPORT

In contrast to the opinion of congestion pricing, opinions on free public transport seem to be more consistent with the right-left political spectrum. The left-wing attitudes are associated with more positive attitudes to free public transport. In Stockholm and Helsinki, the Environment factor has a strong and positive effect on the support for free public transport. The Equity factor also has a positive and significant effect. The other attitudinal factors, more to the right in the political spectrum, are not significant in these cities. In Lyon, however, all attitudinal factors correlate positively with the opinion towards free public transport. They have approximately the same effect, except the Equity factor, for which the parameter is more than twice as large as the parameters for the other factors. Hence, equity is likely the most important argument in favour of free public transport in Lyon, whereas environmental concern seems to be the most important argument in Stockholm and Helsinki.

Respondents without access to a car in the household are more positive to free public transport. This is clearly related to self-interest in regard to free public transport.

Moreover, a low education attainment increases the support for free public transport. The city-specific dummy variables are not significant. The more years spent at university and the higher value of time, the more negative the respondents are towards free public transport. Since high education and value of time correlate with higher income, this might be an effect of low self-interest in regard to free public transport. It might, however, also be an effect of better insight into the negative effect of free public transport among high income respondents.

None of the city-specific dummy variables are significant. Hence, the difference between the cities with regard to the public opinion on free public transport can be explained by the control variables.

3.2.3. OPINIONS TOWARDS BUILDING MORE ROADS

The attitudes towards building more roads are consistent with the right-left political spectrum. In all cities, the Taxation factor has by far the strongest effect on the support for building more roads. This is not surprising, given that this factor also seems associated with high car use and

low environmental concern. Pricing is only significant and positive in Lyon. In Stockholm and Helsinki, the Environment factor has a negative effect on the opinion for building more roads. The Equity factor also has a negative effect but is only significant in Stockholm.

In Lyon, all factors increase the support for building more roads (though the Equity factor is not significant), just as they increase the support for free public transport. Hence, environmental and equity considerations do not seem to constitute any major argument against building more roads. As in the other cities, however, the Taxation factor has the strongest positive effect.

Higher frequency of car use, more cars in the household and higher value of time increase the support for building more roads. Higher education, however, reduces the support. The support for building more roads is lower among women, possibly due to a lower preference for driving.

Even if the support for building more roads is similar across the cities according to Table 1, the city-specific variables are significant. All else being equal, the respondents in Helsinki are more positive to building more roads, and the respondents in Lyon less positive to building more roads, compared to Stockholm respondents.

Table 3 Summary of results of models explaining attitudes towards the three schemes. The parameters μ are the threshold parameters.

	Voting in favour of congestion charging		*Support for free public transport*		*Support for building more roads*	
Number of parameters	34		28		31	
Number of individuals	4,464		4,406		4,335	
Final log-likelihood	-5,946.96		-7,827.64		-7,530.23	
Adjusted rho-square	0.17		0.08		0.10	
Variable	Value	t-test	Value	t-test	Value	t-test
Constant	-0.6000	-1.64	-0.4720	-1.41	-1.1500	-3.08
Environment Helsinki	0.7380	10.68	0.2680	4.46	-0.2200	-3.62
Environment Lyon	0.6730	12.12	0.0825	1.68	0.1050	2.06
Environment Stockholm	0.5900	12.70	0.2890	6.51	-0.1060	-2.27
Equity Helsinki	0.0451	1.34	0.1460	4.36	-0.0082	-0.25
Equity Lyon	-0.1950	-4.94	0.2420	6.40	0.0251	0.64
Equity Stockholm	0.0229	1.10	0.0841	3.99	-0.0517	-2.33
Pricing Helsinki	0.1800	5.86	0.0318	1.10	-0.0212	-0.72
Pricing Lyon	0.0946	2.84	0.0657	2.08	0.1130	3.46
Pricing Stockholm	0.1200	5.32	0.0225	1.06	0.0370	1.57
Taxation Helsinki	-0.0779	-1.65	0.0198	0.44	0.2360	5.31
Taxation Lyon	-0.2690	-7.11	0.0752	2.15	0.4270	11.28
Taxation Stockholm	-0.2610	-8.75	0.0088	0.30	0.4870	14.80
Car trip frequency, piecewise, <= A couple of times per month	-0.0192	-0.18			-0.0186	-0.18
Car trip frequency, piecewise, > A couple of times per month	-0.1460	-2.97			0.2960	6.67
At least one car in the household, dummy	-0.3550	-3.92	-0.1980	-2.78	0.0053	0.06
One car per adult in the household, dummy	0.1010	0.92	0.0161	0.16	0.3460	3.33
More cars than adults in the household, dummy	-0.3150	-2.21	0.1870	1.42	0.2530	1.88
Education, piecewise, < Senior high school	-0.0502	-0.77	0.0169	0.27	-0.0937	-1.46
Highly educated, piecewise, > Senior high school	0.1860	4.90	-0.2160	-5.96	-0.1060	-2.88
Pay any charge, Stockholm Lyon, dummy	-0.0888	-1.04				
Pay any charge, Helsinki, dummy	-0.0562	-5.14				
Number of charged passages, Stockholm Lyon	-0.1850	-3.18				
Km travelled in tolled zones, Helsinki	-0.0060	-2.64				
Value of time, piecewise, < 3 €/h	-0.0002	-0.65	0.0005	2.08	0.0007	2.84
Value of time, piecewise, 3 – 15 €/h	0.3140	10.66	-0.1330	-4.81	-0.0106	-0.37
Value of time, piecewise, > 15 €/h	-0.3580	-1.23	0.5300	1.98	0.3260	1.18
Helsinki, dummy	-2.9700	-5.73	-0.4170	-0.91	1.0700	2.30
Lyon, dummy	-0.6820	-1.54	-0.3490	-0.82	-1.9400	-4.36
Parent, dummy	-0.2720	-4.07				
Female, dummy	-0.1410	-2.39			-0.2690	-4.74
μ_1	0.0000		0.0000		0.0000	

μ_2	1.1400	31.77	0.5390	19.61	0.6800	19.62
μ_3	1.6600	39.93	0.9270	27.64	1.1700	28.01
μ_4	3.3000	55.66	1.4700	37.81	1.9000	39.57
μ_5			2.0000	46.78	2.6100	49.43
μ_6			2.5000	54.15	3.2200	56.62

3.2.1. THE PREDICTION POWER OF THE ATTITUDINAL FACTORS

The Table 4 below compares the log likelihood values (LL) of a model (A) with only constants (including the city-specific constants), the full model (B), a model (C) with only factors and constants, and a model (D) with all variables of the full model except the factors. The variables of model D are mainly self-interest variables (since education and gender correlate with income, even these variables might be at least party related to self-interest) and constants.

Regarding the congestion charging models, the difference in LL between the full model (B) and the model with only constants (A) is 670.20. The difference in LL between the model with only the factors and the constants (C) and the model with only constants (A) is 463.12. Hence, the attitude factors account for 69 percent of the explanatory power of the full model, and the self-interest variables account for the remaining 31 percent.

Table 4 Predicting power of the attitudinal factors, self-interest (including socioeconomic variables).

		A. only constants	B. full model	C. constants and factors	D. full model excl. factors
Congestion charging	LL	-6,617.16	-5,946.96	-6,154.04	-6,308.88
	No. par.	6	34	18	22
	No. Obs.	4,464	4,464	4,464	4,464
	ΔLL_{XA} = LL of model X – LL of model A		670.20	463.12	308.28
	ΔLL_{XC} /ΔLL_{AB}			69%	46%
Free public transport	LL	-7,982.61	-7,827.64	-7,870.02	-7,933.36
	No. par.	8	28	20	16
	No. Obs.	4,406	4,406	4,406	4,406
	ΔLL_{XA} = LL of model X – LL of model A		154.97	112.59	49.26
	ΔLL_{XC} /ΔLL_{AB}			73%	32%
Building more roads	LL	-7,927.8	-7,530.23	-7,615.374	-7,775.54
	No. par.	8	31	20	19
	No. Obs.	4,335	4,335	4,335	4,335
	ΔLL_{XA} = LL of model X – LL of model A		397.57	312.43	152.26
	ΔLL_{XC} /ΔLL_{AB}			79%	38%

However, because the factors and the self-interest variables are correlated, the explanatory power of the factors and self-interest variables depend on the order in which they are added. The difference between the model with all variables except the factors (D) and the model with only constants (A) is 308.28. This means that the self-interest variables account for 46 percent of the explanatory power of the full model, and the attitudinal factors account for the remaining 54 percent.

Regardless of the order in which the variables are added, however, we may conclude that the fundamental values and attitudes related to more general political issues have a higher influence on the explanatory power of the model to predict the support for congestion charge than the self-interest variables. We arrive at the same general conclusions regarding the support for the other policies. In fact, the attitude factors have an even higher explanatory power than the self-interest variables in the models for free public transport (68-73 percent) and building more roads (62-79 percent).

Several studies, refereed in the introduction, have showed that the support for congestion charging is linked to self-interest. Our study is consistent with these findings - that self-interest is important for the formation of the opinion on all three policies. However, our findings also suggest that fundamental values and general political views are even more important in forming opinions towards all three transport policies that we have studied. Of all the fundamental values, environmental concern seems to be the most important for forming the opinion towards congestion charging, free public transport and building more roads, in particular in the Scandinavian cities.

4. CONCLUSION

In this paper, we explore how fundamental values and general political views form the support for three alternative transport policy measures to combat urban congestion: congestion charging, free public transport and building more roads. The support for the measures is indicated from a survey administered to respondents in the three cities of Stockholm, Helsinki and Lyon. A series of questions measuring attitudes towards a range of political issues are used as indicators of fundamental values. Factor analysis is then used to reduce the dimensionality of the question, resulting in four factors labelled Environment, Equity, Pricing and Taxation.

Interpreted in the light of a right-left political spectrum, the two former factors would be to the left and the two latter to the right. The support for congestion charging cuts through the right-left spectrum: increasing with high score on the Environment and the Pricing factor. The support for free public transport and building more roads varies more consistently with the right-left political spectrum; high score on the left-wing factors increases the support for free public transport and high score on the right-wing factors increases the support for building more roads.

A majority, 56 percent in all cities, is in favour of free public transport; in spite of the high cost of implementing such policy. The environmental and equity factors are strongly significant in increasing the support. This suggests that if policy makers would like to

discourage favourable opinions towards free PT, or highly subsidizing it, the cost for the tax-payers should be clearly announced (to mobilize tax opposers), in combination with emphasizing that it has a limited effect on the environment. (Drivers would not switch from car to public transport to any great extent. Rather, free public transport would generate new traffic and take market share from walking and cycling).

Building more roads is also supported by a large share of respondents in all cities, from 64 percent in Stockholm to 47 percent in Helsinki (and Lyon in between). As expected, environmental concern is negatively correlated with the support for building more roads in Stockholm and Helsinki. Equity seems to be a counterargument in Stockholm but is not significant in the other cities. In all cities, high score on the taxation factor strongly increases the support for building more roads, most likely because it correlates with high car use and low environmental concern.

Congestion charging obtains the lowest support of all policies in all cities, but Stockholm has a substantially higher support, with 57 percent of respondents in favour compared to 31 percent both in Helsinki and Lyon. Still, the impact of both fundamental values (indicated by the factors) and self-interest variables on the support is similar for Stockholm and Helsinki, suggesting that even if the experience in Stockholm increases the overall acceptability, it does not greatly change the relative strength of different political arguments or other drivers forming the opinion towards congestion charging. In all cities, the environmental concern seems to be the strongest argument in favour of the charge. The equity factor is not significant in Stockholm and Helsinki, possibly because low-income groups generally drive less than others in the central cities.

Several studies have showed that the support for congestion charging is linked to self-interest. Our study is consistent with these findings; self-interest is important for the formation of the opinion towards all three policies. However, our findings also suggest that fundamental values and general political views are even more important in forming opinions towards all three transport policies that we have studied, i.e. they have a stronger prediction power in the models. This relative prediction power of the factors is even higher in the models for free public transport (68-73 percent) and building more roads (62-79 percent), than in the model for congestion charging (54-69 percent)

The attitudinal factors, however, are not independent of the self-interest variables. For instance, education attainment and values of time are positively correlated with the Pricing factor, car use correlates negatively with the Environment factor, car use correlates positively with the Taxation factor, and value of time correlates negatively with the Equity factor. Hence, it seems that fundamental values and general political views reinforce self-interest variables in forming the support for transport policy measures in general.

Of all attitudinal factors, the Environmental factor has the strongest prediction power regarding all policies in all cities. Hence, environmental concern seems to be a key factor for the formation of the opinions towards transport policy measures in general. Moreover, since the environmental argument is the strongest in favour of congestion charging and the tax-opposition argument is the strongest in favour of building more roads, package solutions seem to be an option in order to establish support across a larger share of the population. This is

precisely what happened in Stockholm when the permanent charge was introduced together with the decision to build a new bypass in Stockholm.

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APPENDIX A

Table 5 Results from controlling factor indexes with socioeconomic variables. Variables with significance level higher than 5% are excluded from the model. The variables are explained in Section 2.

Factor label	Environment		Equity		Pricing		Tax	
Model	Value	t-stat	Value	t-stat	Value	t-stat	Value	t-stat
Constant	4.27	0.14	5.39	0.13	3.79	0.11	5.28	0.17
Education attainment			-0.13	-5.91			-0.28	-12.14
Value of time	0.06	3.78	-0.03	-2.00	0.20	12.02	-0.05	-2.86
Number of cars in the household			-0.17	-5.27	-0.08	-2.99	0.08	2.45
Lyon, dummy	0.20	3.80	0.67	13.25	-0.10	-1.93	-0.18	-3.48
Helsinki, dummy	0.15	2.39	0.19	3.42	-0.43	-7.37	-0.49	-8.15
Female, dummy	0.35	8.37	0.34	8.13	-0.17	-3.76	0.10	2.21
Age			-0.04	-2.30	0.09	4.45	0.05	2.37
Parent (having a child in the household), dummy	0.15	3.43						
Trip frequencies by PT	0.05	2.53					-0.11	-5.21
Trip frequencies by cycle	0.06	2.57	0.08	3.50			-0.12	-4.97
Trip frequencies by car	-0.09	-4.19	-0.05	-2.11			0.08	3.25