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Abstract

Motorized transport currently produces a wide array of negative externalities, such as congestion, accidents, land use, CO_2 emissions, noise and local air pollution as well as their subsequent impacts on health. Increasing economic activity and population growth are likely to exacerbate this challenge over the coming decades, as they are likely to cause further increases in personal and commercial mobility across all transportation sectors. Road pricing has been proposed as one policy instrument to manage increased congestion, shift mobility behaviours, and reduce greenhouse gas emissions. Broadly, road pricing charges private transportation users (e.g. drivers) for driving on roads/motorways (tolls) or driving into city centres (entrance fees). Recently, the Federal Council has proposed initial steps towards road pricing within Switzerland. But, as of current, very little is known about road pricing policy preferences amongst Swiss residents. Adopting nationally representative data from the longitudinal Swiss Mobility Panel, we implement a novel conjoint experimental design to identify preferred forms of road pricing policy packages, particularly with respect to pricing mechanisms and costs, expected average speeds, and revenue recycling. Furthermore, we explore how support for road pricing is conditioned upon non-economic stimuli, such as reducing greenhouse emissions, noise and air pollution. We find that while citizens do broadly support road pricing instrument, the desired level of stringency remains largely influenced by monetary and time-expediency factors.

Keywords

road pricing, transport politics, governance, public opinion, survey experiment, policy designs

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1 Introduction

Private motorized transport contributes to a wide array of negative externalities, such as congestion, accidents, land use, CO_2 emissions, noise and local air pollution as well as their subsequent impacts on health (ARE Bundesamt für Raumentwicklung, 2018; Nocera, 2021; Currie *et al.*, 2014; Cavallaro *et al.*, 2018). Increasing economic activity and population growth will exacerbate this challenge over the coming decades because they are likely to cause further increases in private motorised transport, with a projected increase of 18% in daily kilometres travelled per person until 2040 in Switzerland (ARE Bundesamt für Raumentwicklung, 2016). In order to reduce those externalities, it is therefore imperative to develop a more sustainable future transportation infrastructure as well as policies that change mobility behaviours.

As a large share of distance travelled per person per day is through commuting into city centres by cars (Molloy *et al.*, 2021), one of the main strategies to reduce externalities created by private motorized transport is to shift people to more sustainable modes of transport (Creutzig *et al.*, 2018) and make them avoid peak times (Börjesson and Kristoffersson, 2015).

Road pricing policies, such as motorway tolls or congestion charges (i.e. usually introducing a toll to enter certain areas), are commonly adopted instruments that serve as cost-efficient solutions to environmental externalities (Schaffer, 2021). However, public opinion has been a barrier for policy adoption, as policies aimed at changing transport behaviours are highly politically salient and bear clear personal costs (Culpepper, 2011) - as for example recent failures of introducing measures in France or Switzerland (Carattini *et al.*, 2017; Douenne and Fabre, 2020) have demonstrated. So even though so far there are only few cities in the world that have successfully implemented road pricing policies (e.g. London, Stockholm or Gothenburg), countries such as Switzerland plan to experiment with such policies in order to steer mobility in the future (Federal Council, 2016).

However, little is known about road pricing policy preferences in Switzerland. While Vrtic *et al.* (2007) have highlighted the role of monetary and time-expediency factors testing different road pricing designs, to our knowledge, Baranzini *et al.* (2021) presents the only study testing whether ex-ante information provisioning has an effect on road pricing policy support for different road pricing designs in a sample of Geneva residents.

Here we explore road pricing policy preferences amongst Swiss residents using a conjoint survey experimental design building on Vrtic *et al.* (2007), implemented in the Swiss

Mobility Panel in 2021. We explore support for road pricing policies across five broader dimensions: motorway toll pricing, average motorway speed during peak hours, city center entrance fees, average speed on urban roads during peak hours, and revenue recycling. Further, we implement an informational treatment to assess how knowledge of environmental benefits can shape road pricing policy preferences. Lastly, we explore how preferences differ by sub-group characteristics (car ownership, environmental attitudes, high income earners and those living in urban areas). These findings build upon recent work on road pricing policies in Switzerland, exploring an emerging area of public policy.

2 Background

2.1 Road Pricing

Road pricing policies in the form of motorway tolls or entrance fees (e.g. required payments to enter certain areas of cities during peak traffic times) are often preferred instruments to regulate transport, because they internalize externalities in a cost-efficient way (Schaffer, 2021). Previous empirical research on such congestion charges in Gothenburg, (Börjesson and Kristoffersson, 2015), Stockholm (Eliasson *et al.*, 2009), London (Leape, 2006) or Singapore (Agarwal and Koo, 2016) also demonstrate that those policies are effective in steering mobility behaviour and are capable of reducing negative transport externalities (e.g. Isaksen and Johansen, 2021).

However, such policies are extremely unpopular because they disincentivise people from driving by increasing the costs of these behaviours (so called "market-based push measures", see Wicki *et al.*, 2019). Generally, coercive environmental policies are unpopular (de Groot and Schuitema, 2012), but for taxes such as road pricing this is even more the case because costs are transparent to individual users in contrast to other command-and-control measures where citizens usually underestimate the costs policies create (Kirchgässner and Schneider, 2003; Stadelmann-Steffen and Dermont, 2018).

Further, the most efficient road pricing schemes are usually the least equitable and therefore raise questions about mobility justice (Creutzig *et al.*, 2020; Kristoffersson *et al.*, 2017; Mullen and Marsden, 2016). However, stringent policies need to be perceived as fair in order to receive public support (Huber *et al.*, 2020). The lack of public support for road pricing is often noted as a main reason barrier to adoption, evidenced by the low number of road pricing schemes currently in place (Gu *et al.*, 2018).

Yet, recent research investigates how policy areas with lower public support can alleviate such feasibility barriers. In particular, research focusing on policy designs has identified policy packages as means to develop policies which incorporate popular and unpopular components, to maximize feasibility and efficacy of these proposals. One notable strand of such research focuses on perceptions of fairness and equity, particularly in policies involving increased tax burdens. In the example of support for carbon taxation policies, proposals which incorporate elements of redistribution towards those most directly effected by the policies (revenue recycling), have been found to increase public support (Carattini *et al.*, 2019; Beiser-McGrath and Bernauer, 2019).

Assessing public support by decomposing policy packages into its elements allows for a better understanding of politically feasible policy designs (Bansak *et al.*, 2021; Wicki *et al.*, 2019, 2020). The main design elements of road pricing policies are the level of stringency (i.e. the tax rate), the effectiveness of the policy (e.g. the potential speed gains one could achieve) as well as the way in which the revenue raised through the tax would be used. In practice, both motorway tolls (pricing per kilometre) as well as entrance fees (one-time charge) for bigger towns and cities can be used in order to implement road pricing (Kristoffersson and Börjesson, 2021). Therefore, public support for different levels of policy stringency and potential speed gains needs to be separately assessed for motorway tolls and entrance fees empirically.

2.1.1 Policy stringency

Most importantly, public support for road pricing is decreasing with the level of policy stringency, which is in this case the price level. This has been demonstrated in a multitude of studies on environmental taxes in general (e.g. Carattini *et al.*, 2017), but also for road pricing schemes as just recently has been confirmed for a particular road pricing proposal in Switzerland (Baranzini *et al.*, 2021).

H1: Support for road pricing policies will be proportional to the level of motorway tolls and entrance fees.

2.1.2 Policy effectiveness

Policy support for stringent policies in the transport sector such as road pricing is dependent on beliefs about policy effectiveness (Huber *et al.*, 2020; Schuitema *et al.*, 2010). One of the main goals of road pricing is to reduce congestion and the negative effects such as low average speed levels that come with it. We would therefore expect that road pricing policies that provide average speed levels which are closer to the maximum speed allowed also receive higher public support.

H2: The higher the average driving speed during peak hour is for motorways and urban roads, the higher public support for road pricing is.

2.1.3 Revenue recycling

The inclusion of revenue recycling, i.e. a mechanism through which revenues raised by pricing policies are earmarked and returned back to society is usually seen to increase public support for environmental taxes (Carattini *et al.*, 2019; Drews and van den Bergh, 2016). This is because citizens are suspicious of new taxes in general and it needs to become clear to them how the tax can have a positive impact on the environment (Sælen and Kallbekken, 2011) as well as how it alleviates disproportional burdens for certain parts of society (Schaffer, 2021).

This is also true in the case of road pricing policies (Jaensirisak *et al.*, 2005). There are different way of how revenues could be earmarked, such as for example to fund public transport (Kottenhoff and Brundell Freij, 2009) or other 'green' transport infrastructure and research in green technology (Hsu *et al.*, 2008). In the case of road pricing, earmarking revenues for investments into public transportation is commonly associated with highest policy support (e.g. Baranzini *et al.*, 2021; Grisolía *et al.*, 2015; Vrtic *et al.*, 2007). This is because the environmental benefit of using public transport is clear and the provision of affordable alternatives to cars can counter some of the concerns regarding fairness that were mentioned above.

Other uses of the revenue raised such as for example for fiscal purposes generally lead to greater opposition because citizens do not understand the link between the tax and the way the revenue is used (Sælen and Kallbekken, 2011).

H3: Support for road pricing policy packages is highest if they include revenue recycling in order to finance public transportation.

2.2 Environmental benefits of road pricing policies

The use of road pricing in the form of city entrance fees has a clear record of reducing congestion in urban areas by shifting commuters to use public transport and avoid peak times (Kristoffersson and Börjesson, 2021). As a large share of distance travelled per person per day is through commuting into city centres by cars (Molloy *et al.*, 2021), this does not only have a positive effect on traffic, but also reduces negative environmental externalities created by individual motorized transport such as GHG emissions (Cavallaro *et al.*, 2018), air and noise pollution as well as their subsequent health impacts (Currie *et al.*, 2014; ARE Bundesamt für Raumentwicklung, 2018; Anderson, 2014). The positive effect of congestion charging on environmental externalities has been demonstrated in ex-post policy analyses for cases such as London, Stockholm, Milan or Bergen (Isaksen and Johansen, 2021; Croci, 2016).

However, road pricing policy support with a focus on *environmental* public goods provision seem to be less frequently discussed compared to monetary and time-expediency factors as the main policy objective is to use available road space in a most efficient way (Börjesson and Kristoffersson, 2015). This is surprising, as research indicates that information deficits about the expected environmental benefits of road pricing policies are a barrier to policy support (Hensher and Li, 2013). There is ample observational evidence that policy support increased after the implementation of road pricing schemes (e.g. Eliasson, 2014; Hansla *et al.*, 2017), and Eliasson and Jonsson (2011) found evidence that this is also due to the perception of environmental benefits of congestion charging in the Stockholm case. Road pricing policy support is therefore likely not only dependent on policy design features with regards to monetary and time-expediency factors (Vrtic *et al.*, 2007), but also depending on to what extent such a policy is perceived to contribute to environmental public goods.

To our knowledge, Baranzini *et al.* (2021) are the only ones that tested whether ex-ante information provisioning about environmental public good provisioning has an effect on road pricing policy support. They explore how informational treatments noting the benefits of reduced congestion and increased air quality shape road pricing policy preferences in Geneva. They find that prompting respondents with the benefits of increased air quality increases their likelihood to support higher city entrance fees - but find non-significant effects for congestion benefit framing. Accordingly, we suggest expanding upon these findings to the explore the broader population of Swiss residents, across a wider set of environmental benefits of road pricing policies: reductions to CO_2 emission, improved air quality, reduced noise pollution. Therefore, we form the following expectation.

H4: Support for more stringent road pricing policy packages is higher when information on environmental benefits of those policies are made transparent to citizens.

2.3 Differences in Road Pricing Preferences by Sub-groups

Further, different sub-groups of Swiss residents may hold divergent road pricing policy preferences. Generally, policy proximity, i.e. the extent that you are affected by a policy can be expected to heavily influence policy preferences (Huber and Wicki, 2021). In the case of road pricing, we therefore look at car ownership, as the reduction of car usage is the main policy objective of road pricing policies. Additionally, we look at residential locations (i.e. the difference between citizens living in urban environments vs. suburban/rural environments), as this also influences to what extent somebody is affected by the different design elements of the road pricing policy package (e.g. city entrance fees). Individuals with higher income levels have also been found to be willing to pay more for highway tolls and reduced communting time (Dill and Weinstein, 2007; Brownstone *et al.*, 2003). Last, we investigate whether findings about other common drivers of environmental policy support, namely environmental attitudes (Poortinga *et al.*, 2004), are generalizable to preferences for paying higher road pricing fees and support for environmental friendly infrastucture projects. For example, Eriksson *et al.* (2008) note that heightened environmental attitudes increases support for public transportation policies.

Here we also explore a set of subgroup hypotheses:

H5: Swiss residents will be more likely to support personally costly road pricing policy packages when they have the following characteristics: (i) no car ownership, (ii) heightened environmental attitudes, (iii) have higher income, and (iv) live in urban areas.

3 Data and Methods

We adopt data from Wave 2 (Summer 2021) of the Swiss Mobility Panel (SMP). The SMP is a longitudinal panel drawn from a nationally-representative sample of Swiss residents. The SMP is conducted semi-annually, with the first initial baseline recruitment wave conducted in Fall 2020. Respondents are recruited from a random sample drawn from household registry data provided by the Bureau for Federal Statistics, stratified by statistical region (NUTS-2). Respondents are invited to participate in the survey via post, and the survey is conducted online. Given the mobility subject matter, and online implementation, the maximum age for respondents is capped at 75 years old, to ensure representativity of results to the general population. The response rate for Wave 1 was 32.89 %. The sample was checked against population demographic characteristics and was found to be representative. Wave 2 of the SMP has a total of n=6927 completed responses, of which around 50% (n=3448) got randomly assigned the survey arm that includes the data used for this paper.

Data and analysis replication materials are available by request.

3.1 Road Pricing Conjoint Experiment

In order to study respondents multidimensional preferences for road pricing policies, we implemented a conjoint survey experimental design (Bansak *et al.*, 2021; Hainmueller *et al.*, 2014).

In the conjoint experiment, respondents were asked to evaluate two policy proposals, A and B, displayed side-by-side in a tabular form. Each of the policy proposals was composed of five attributes. Each of these attributes, in turn, represented a dimension of a road pricing policy package that could hypothetically be implemented in Switzerland (see Figure 2).

The particular attribute values making up policies A and B were drawn randomly from the full set of attribute values (see Table A1). Respondents completed five rounds of the choice experiment. In order to measure respondents' policy preferences, we used two separate questions. As the main outcome (response) variable in the conjoint experiment, respondents were asked to indicate which of the two policy proposals they would support

Figure 1: **Example of choice task.**

	Proposal A	Proposal B
Motorway Tolls	10 Rp/km	25 Rp/km
City Center Entrance Fees	5 CHF per day	25 CHF per day
Average Speed on Motorways during peak hours [km/hr]	90 km/hr	120 km/hr
Average Speed on Urban Roads during peak hours [km/hr]	40 km/hr	35 km/hr
Additional Public Revenue is to be used...	Reduce Federal Government Deficit	Reduce Federal Government Deficit

Suppose you had to decide between the two proposals in a referendum today. Would you rather support Proposal A or Proposal B?

Proposal A

Proposal B

Data: Swiss Mobility Panel, Wave 2, 2021

if they had to vote in a referendum today. As a secondary outcome variable, respondents could state for each proposal to what extent they would favour or oppose it on a 5-point likert scale, ranging from 'strongly favour' to 'strongly oppose' or indicating that they 'don't know'.

3.2 Informational Treatment Vignette

Before entering the conjoint experiment, we randomly exposed respondents to single informational treatments about the environmental benefits of city entrance fees in order to assess its influence on road pricing policy preferences, following a vignette experimental design (Mutz, 2011). In total, we randomly assigned one control treatment (n= 862) and three vignette treatments on different environmental benefits of road pricing, i.e. CO2 emission reductions (n= 862), air pollution reduction (n = 860) and noise pollution reduction (n= 864).

The control treatment consists of a general description of road pricing and its general intention of reducing traffic and congestion. It further introduces respondents to the importance of surveying public opinion on this issue due to potential pilot projects in Switzerland in the future.

The three vignette treatment groups were additionally exposed to information on environmental benefits of the policy as followed:

"Recently, new mobility pricing schemes were implemented in several parts of Europe, which charged drivers with fees when they entered city centers. One benefit of the new system was [ENVIRONMENTAL BENEFIT VIGNETTE]"

The three different environmental benefit vignettes are displayed in Table 1.

3.3 Subgroups

We explore how road pricing policy preferences vary by several sub-group characteristics. First, *car owners* are operationalized by an item asking the respondent 'do you have access to a car?'. If the respondent answers either 'yes, I own a car' or 'yes, I have a company car' then they are coded a '1' car owner. If they do not, then they are coded as a non sub-group member ('0'). Second, we adopt a well-established indicator for environmental attitudes (Diekmann *et al.*, 2009). Using principal component analysis, we generate a single factor score for these 10 items. Then, to identify those with *high environmental attitudes*, we set respondents with the 75^{th} percentile or higher as '1', while those less than this threshold are coded as '0'. Next, we explore *high income* earners as those with

Table 1: Overview of Environmental Benefit Vignettes

Environmental benefit	Vignette
CO_2 emission reduction	a reduction in CO_2 emissions, which is responsible for climate change. Reductions in CO_2 emissions can be attributed to decreased car traffic within the city centers, and to reduced congestion levels (creating more fuel-efficient driving conditions). It is estimated that CO_2 emissions **decreased by roughly 15%** after implementation of the mobility pricing system.
Air pollution reduction	an increase in local air quality, due to reduced vehicle-based pollution. Reductions in vehicle pollution can be attributed to decreased car traffic within the city centers, and to reduced congestion levels. It is estimated that air quality **increased by roughly 15%** after implementation of the mobility pricing system.
Noise pollution reduction	a decrease in the noise generated from vehicles. Reductions in noise can be attributed to less traffic within the city centers, and to reduced congestion levels. It is estimated that traffic noise **decreased by roughly 15%** after implementation of the mobility pricing system.

Data: Swiss Mobility Panel, Wave 2, 2021

a household income of $\geq$ 14.000 CHF per month, corresponding to $\sim$ 20% of the sample. Lastly, using geocodes for the respondents' registered address, we identify those living in an *urban residence* according to the Swiss Federal Office for Statistics' classification scheme 'Stadt/Land-Typologie 2012' BFS Bundesamt für Statistik (2022), but for which the 'intermediary' category is recoded to 'rural'.

3.4 Estimation Strategy

We analysed the data collected in the conjoint experiment based on marginal means for the main dependent variable, the binary choice outcome. All results are estimated based on a linear regression model, with clustered standard errors by respondent, from which we predict marginal means (Leeper *et al.*, 2020). The marginal means can be directly interpreted as the average choice probability for all those policy-packages where the respective attribute level was present. This allows to draw inferences about the popularity of different policy dimension characteristics. For all figures using marginal means, we also plot a line at the 0.50 probability of selecting a proposal with these given characteristics. This allows for substantive interpretation of whether a majority of Swiss residents support this proposal, or not.

In order to conduct subgroup analyses we display marginal means by subgroups to understand the effects for each of the policy attributes, also based on the recommendations by (Leeper *et al.*, 2020). For the subgroup figures (see Fig. 4-6), we present the marginal means for the full sample, sub-group members and non sub-group members, along with the 95% confidence intervals for these estimated marginal means. For interpretation, significant differences between the sub-group members and non-members can be observed when the 95% confidence intervals do not overlap.

Similarly, we analysed the data on the vignette experiment on non-environmental benefits by comparing conditional marginal means for the control group versus any vignette treatment exposure. This allows us to compare whether preferences differ depending on the type of environmental benefit respondents were exposed to. Again, interpretation of significant differences can be made in the same way, with comparison of 95% confidence intervals.

4 Results

We first explore support for road pricing policy proposals using the conjoint experimental design across five policy attributes: motorway tolls, average speed on motorways during peak hours, city center entrance fees, average speed on urban city roads during peak hours, revenue recycling. The direct effect of each attribute characteristic is estimated using a marginal means approach (Hainmueller *et al.*, 2014).

We find that road pricing policy proposal support in Switzerland is primarily a product of preferences for decreased costs and higher driving speeds (see Fig. 2). Road pricing proposals that cost less (e.g. 5Rp/km motorway tolls/5 CHF per day entrance fees) are preferred by $\sim 15-20\%$ over those including higher fees (e.g. 25Rp/km motorway tolls/25 CHF per day entrance fees). Similarly, road pricing proposals that promise higher average speeds (e.g. ≥ 110 km/hr on motorways and ≥ 45 km/hr on urban city roads) are preferred by $\sim 10-15\%$ over those where the average speeds are lower (e.g. 80 km/hr on motorways and 25 km/hr on urban city roads).

Furthermore, we find substantive variation with regards to revenue recycling (how new public funding generated from road pricing fees will be earmarked for usage). Respondents prefer proposals that directly fund public transportation and development of green infrastructure. While alternatively, respondents are more likely to reject proposals which reduce petrol taxes or the federal deficit. These findings suggest that Swiss residents prefer that revenue generated from road pricing be directed towards developing public infrastructures, over the alternative schemes focused on rebating the increased tax burden.

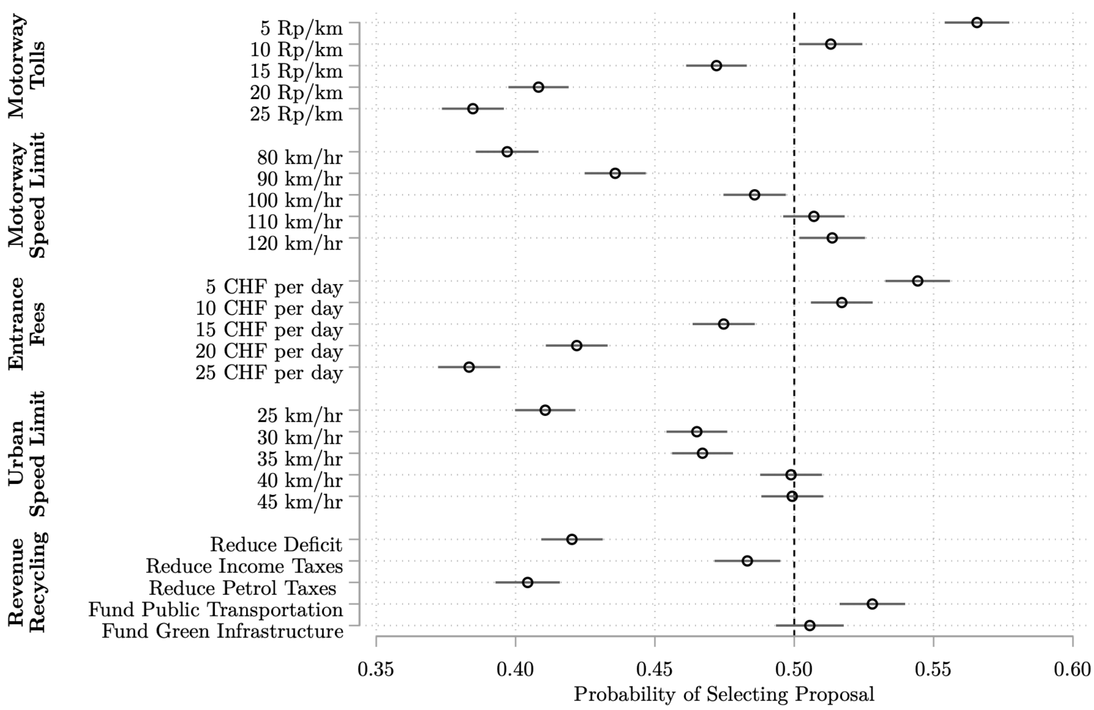
Overall, most road pricing policy proposals fail to generate a majority approval. Rather, only proposals which include six of twenty-five total policy characteristics are found to have significantly more support than the 50% threshold (listed in order of preference): 5Rp/km motorway toll, 5CHF per day entrance fee, new revenue used to fund public transportation, 10CHF per day entrance fee, 120 km/hr average speeds on the motorway, and 10Rp/km motorway tolls. While the least popular policy characteristics are 25CHF per day entrance fees, 25Rp/km motorway tolls, 80 km/hr average speeds on the motorway and using new revenue to reduce petrol taxes.

4.1 Informational Treatment

Next we explore how the patterning of support for road pricing instruments is influenced by informational treatments regarding the environmental benefits of such policies (Fig 3). Each respondent was randomly assigned to one of four informational treatment branches; reduction of CO_2 emissions, reduced noise pollution, increase in local air quality, and a control (no information presented).

In general, we find limited evidence of significant differences in policy instrument preferences between treatment groups. That is, road pricing policy preferences do not appear to be a function of the environmental benefits of these policies. Regardless of informational treatments for these policy preferences, Switzerland residents prefer policies are the least costly (e.g. 5 Rp/km, 5 CHF per day), and are against policies that have the least speed benefits (e.g. 80 km/hr on the highway, 25 km/hr in city centers) and those that go towards reducing federal budgetary deficits or petrol taxes. Indeed, it appears that

Figure 2: **Marginal Means of Road Pricing Attributes.**Estimated using OLS regression techniques from conjoint analysis experimental design with dimensions of motorway tolls, average speed on motorways during peak hours, city center entrance fees, average speed on urban city roads during peak hour, revenue recycling (respondent level clustered standard errors). Dependent variable is individual choices preferences towards road pricing policy proposal. Reporting 95% confidence interval.



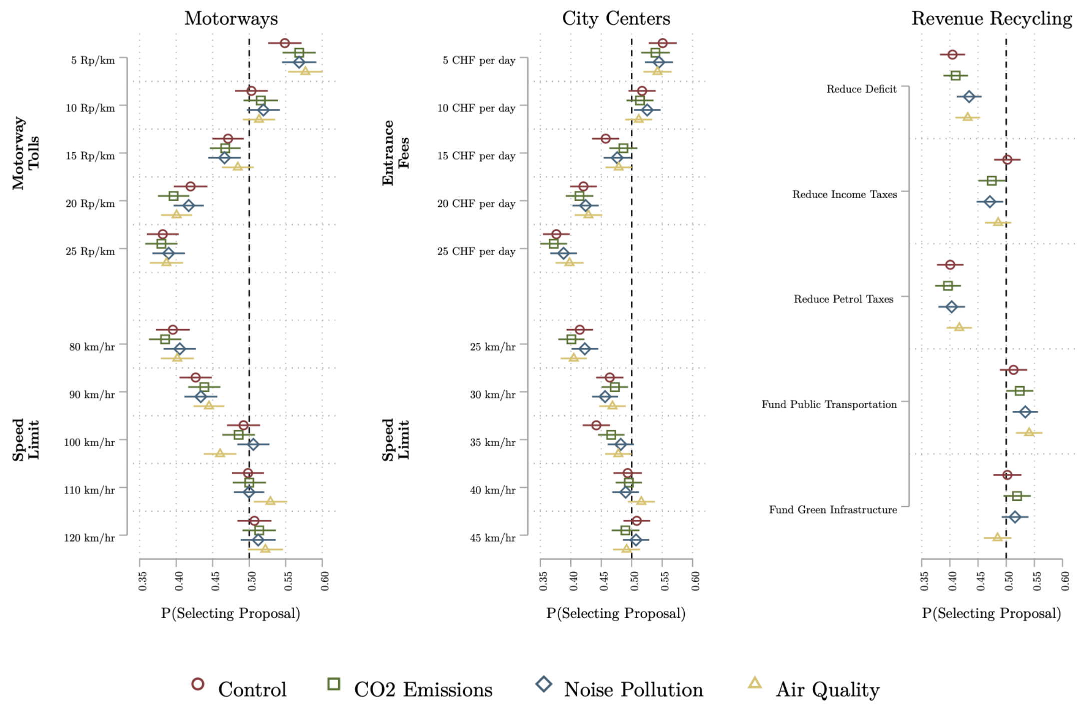
Data: Swiss Mobility Panel, Wave 2, 2021

evaluations of road pricing policy preference remain a function of time, monetary and re-distributional preferences.

4.2 Sub-group analyses

Lastly, we investigate support for road pricing policies by respondent subgroups: car owners, urban dwellers, high household income earners and high environmental attitudes. For each policy attribute, we compare the predicted probability (marginal means) of policy support between those that have the characteristic, and those that do not. For the predicted probabilities, we plot 95% confidence intervals - where significant differences between sub-group members and non-sub group members are indicated by whether these

Figure 3: **Marginal Means of Road Pricing Attributes by Informational Treatment.** Estimated using OLS regression techniques of each dimensions of motorway tolls, average speed on motorways during peak hours, city center entrance fees, average speed on urban city roads during peak hour, revenue recycling (respondent level clustered standard errors) by informational treatment (control, CO_2 emissions, noise pollution, air quality) interactive product term. Marginal means are calculated for full factorial of possible interactive product terms. Reporting 95% confidence intervals.

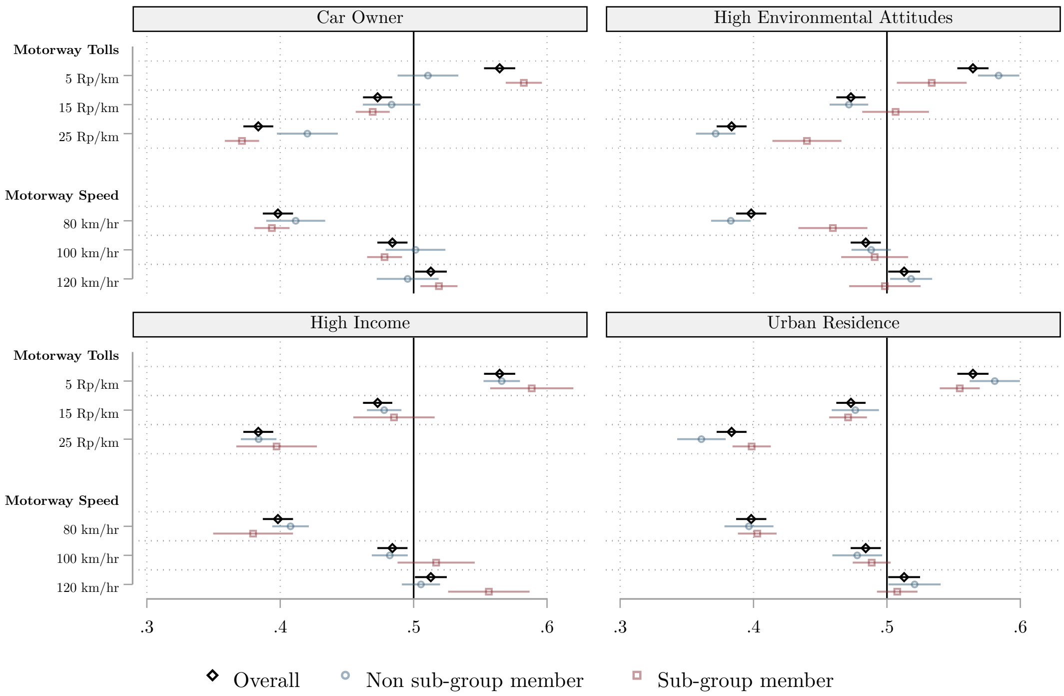


Data: Swiss Mobility Panel, Wave 2, 2021

confidence intervals overlap. We present the sub-group analyses of policy attributes for motorway road pricing (Fig. 4), city centers (Fig. 5), and revenue recycling (Fig. 6) separately to ease interpretation of these results.

First, for motorway tolls, we find significant differences for car owners (those that either own a car themselves, or have a company car), in their likelihood ($\sim 8\%$) to support the lowest level of motorway tolls (5Rp/km). While alternatively, those who do not own a car are slightly more likely to prefer policies with higher motorway tolls. We also find substantial, significant differences between respondents with high environmental attitudes ($\geq 75^{th}$ percentile) and those not belonging to this subgroup. For example, those with high environmental attitudes are roughly $\sim 7\%$ more likely to support policies with the highest motorway tolls, as well as those with the lowest speed benefits (80 km/hr). Lastly, we find minimal differences for the sub-groups of high income earners (monthly household income of $\geq$ 14.000 CHF) and those living in urban city centers, with one notable exception. While high income earners do not appear to be more or less likely than non-high income earners to support policies with regard to the price of motorway tolls, they are more likely to support those with the highest motorway speed gains.

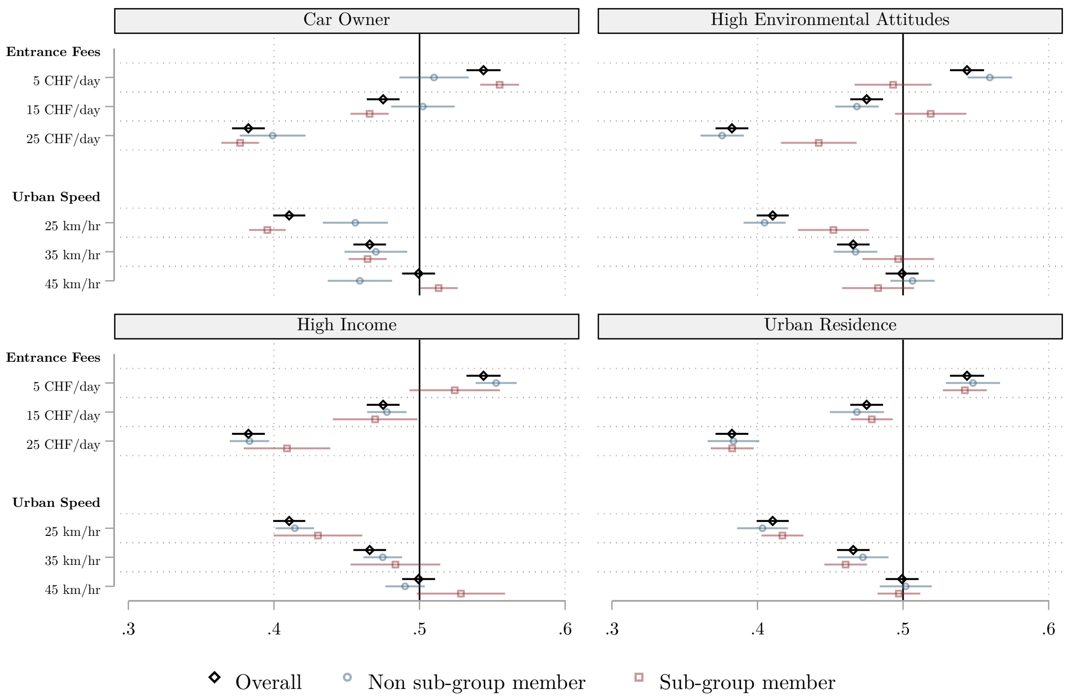
Figure 4: **Marginal Means of Motorway Road Pricing Attributes by Subgroups**. Estimated using OLS regression techniques of each dimensions of motorway road pricing (tolls and average speed on motorways during peak hours) for the full sample (in black), as well as sub-group (blue) and non-sub group (red) membership. We explore the dimensions by four sub-groups: car ownership, high environmental attitudes, high income, and urban residence, where sub-group membership means the respondent has the characteristic (e.g. they own a car), and non sub-group member means the respondent does not have the characteristic (e.g. they are not classified as having high environmental attitudes). See Subgroups (Section 3.3) for further discussion. Estimates of marginal means are reported with 95% confidence intervals.



Data: Swiss Mobility Panel, Wave 2, 2021

Second, we turn our attention to the patterns of support for city center road pricing attributes by these sub-group characteristics (Fig. 5). Here we again find significant differences based upon car ownership. Those who own a car are $\sim$ 5% more likely than those that do not to support policies with the lowest city center entrance fees (5 CHF/day), as well as those with the highest speeds on urban roads (45 km/hr). Further, we similarly find that people with high environmental attitudes are more likely than those without high environmental attitudes to support policies with the greatest entrance fees (25 CHF/day), and those with the lowest urban speeds (25 km/hr). Notably, we find not significant differences between urban city and non-urban city dwellers. Indeed, residential location does not appear to be a strong driver support for road pricing speed or costs policy attributes.

Figure 5: **Marginal Means of City Center Road Pricing Attributes by Subgroups.** Estimated using OLS regression techniques of each dimensions of city center road pricing policy dimensions (entrance fees and average speed on urban roads during peak hours) for the full sample (in black), as well as sub-group (blue) and non-sub group (red) membership. We explore the dimensions by four sub-groups: car ownership, high environmental attitudes, high income, and urban residence, where sub-group membership means the respondent has the characteristic (e.g. they own a car), and non sub-group member means the respondent does not have the characteristic (e.g. they are not classified as having high environmental attitudes). See Subgroups (Section 3.3) for further discussion. Estimates of marginal means are reported with 95% confidence intervals.



Data: Swiss Mobility Panel, Wave 2, 2021

Lastly, we explore the how support for road pricing policy revenue recycling policy dimensions varies by subgroup characteristics (Fig. 6). Here we find the most substantive differences in support are driven environmental attitudes. Swiss residents with high environmental attitudes are roughly 20% more likely to support measures which fund green infrastructure, 10% more likely to support those that fund public transportation, and 10% less likely to support those that reduce petrol taxes than people that do not have high environmental attitudes. Similar patterns also emerge for differences between car and non-car owners, where car owners are 9% more likely to support policies which reduce petrol taxes, while 8% less likely to support those that fund public transportation and green infrastructure.

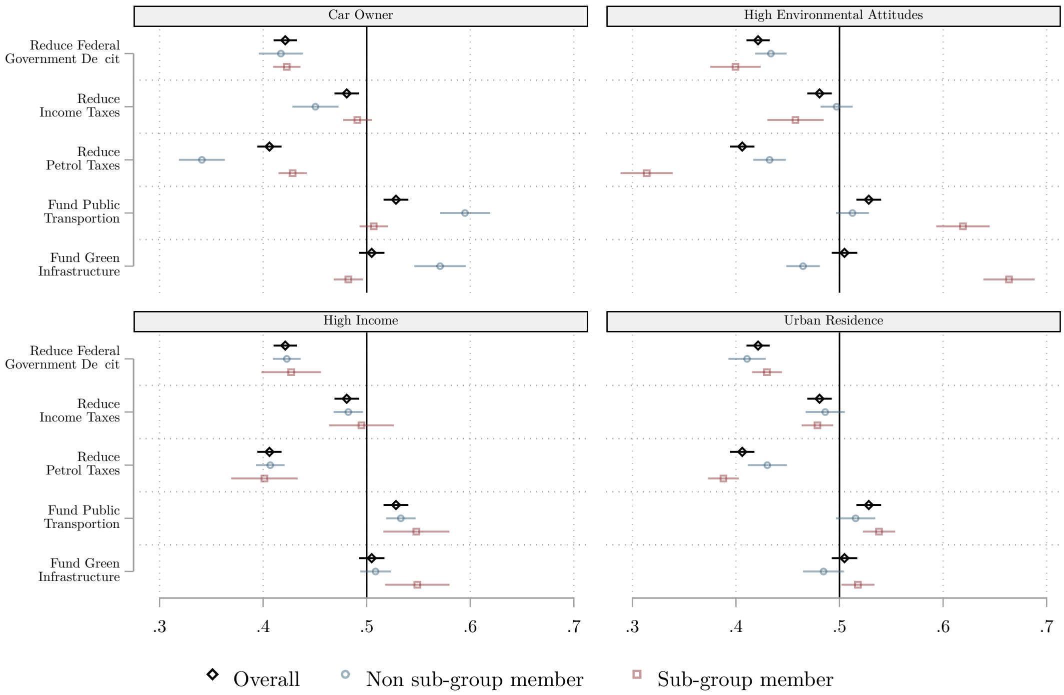
Further, we also find some smaller differences for the sub-groups of high income earners and urban residents. For example, high income earners are slightly more likely than non-high income earners to support policies that fund green infrastructure, while non-urban residents are slightly more likely than urban residents to support policies that would reduce petrol taxes.

Overall, these findings suggest that road pricing policy preferences are non-monolithic amongst Swiss residents. Indeed, substantive differences are present between sub-groups membership in car ownership and environmental attitudes. As part of continuing this project, we intend to engage further analyses - particularly to note whether other environmental characteristics (such as exposure to air and noise pollution) can further shape road pricing policy prefernece s.

4.3 Discrete Choice Model

For the purposes of the initial analyses of the road pricing conjoint experiment, we adopted methodological approaches commonly used within political science to evaluate such designs (Hainmueller *et al.*, 2014; Leeper *et al.*, 2020). For future analyses of this conjoint experiment, we will explore these findings using discrete choice modelling approaches. Here we will apply methods using random utility theory to model the discrete choices between policy designs made by the respondents (McFadden *et al.*, 1973). Further, we will also adopt subsequent analyses to identify policy designs (policy packages consisting of various policy instruments) which optimize support for road pricing initiatives (Givoni *et al.*, 2013). Notably, such future work will examine the trade-offs between attributes such as average road speed and motorway costs, to evaluate the optimal point in which price Swiss residents will be willing to pay to drive at varied desired speed levels (Vrtic

Figure 6: **Marginal Means of Motorway Revenue Recycling Attributes by Subgroups.** Estimated using OLS regression techniques of each dimensions of revenue recycling policies (reducing government deficits, income taxes, petrol taxes and increasing finding for public transport and green infrastructure.) for the full sample (in black), as well as sub-group (blue) and non-sub group (red) membership. We explore the dimensions by four sub-groups: car ownership, high environmental attitudes, high income, and urban residence, where sub-group membership means the respondent has the characteristic (e.g. they own a car), and non sub-group member means the respondent does not have the characteristic (e.g. they are not classified as having high environmental attitudes). See Subgroups (Section 3.3) for further discussion. Estimates of marginal means are reported with 95% confidence intervals.



Data: Swiss Mobility Panel, Wave 2, 2021

et al., 2007; Axhausen *et al.*, 2021).

5 Conclusion

We investigated public support for road pricing policies within Swiss residents, finding instruments which had the lowest cost ($\leq$ 10Rp/km, $\leq$ 10CHF/day), highest average speed gains on the motorway (120 km/hr) and whose increased revenue was stipulated to be used for further development of public transportation infrastructure received a majority of support. While, alternatively, proposals which included higher costs, lower speed gains, and whose revenue was stipulated for usage to reduce the deficit, reduce income taxes, and reduce petrol taxes received less than majority support. These findings support previous literature on the role of costs (e.g. Carattini *et al.*, 2017; Baranzini *et al.*, 2021), speed gains (e.g. Huber *et al.*, 2020; Schuitema *et al.*, 2010) and revenue distribution for road pricing policies (e.g. Kottenhoff and Brundell Freij, 2009; Baranzini *et al.*, 2021), and are in line with our expectations (Hypotheses 1-3).

Further, we explored how informational treatments about the environmental benefits of road pricing policies can shape preferences. Using an experimental vignette design, we find non-substantive differences between policy preferences amongst treatment groups - in opposition to our expectations in Hypothesis 4. These findings suggest that rather, road pricing policy preferences are somewhat well formed, and are not suspect to informational manipulation regarding the environmental benefits of these policy instruments.

Lastly, we investigate differences in support for road pricing policies by sub-group characteristics. We find that support is often conditioned by car ownership (with preferences for lower fees and increased speeds) and heightened environmental attitudes (preferring policies with increased costs and those that support funding public transportation and green infrastructure). But, surprisingly, we find little differences based upon whether the respondent is a high income earner, or if they live in an urban area.

In sum, these findings contribute to the growing literature on road pricing policy preferences in Switzerland (see Baranzini and Carattini, 2017; Vrtic *et al.*, 2007; Axhausen *et al.*, 2021), as well as exploration of the role of costs, effectiveness, and revenue recycling within public policy designs (Bansak *et al.*, 2021; Wicki *et al.*, 2019, 2020).

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Table A1: Overview of Policy Attributes in Conjoint Experiment

Attributes	Values
Stringency Motorway tolls – Price per kilometer	• 5 Rp/km • 10 Rp/km • 15 Rp/km • 20 Rp/km • 25 Rp/km
Stringency City center entrance fee – One-off entrance price	• 5 CHF • 10 CHF • 15 CHF • 20 CHF • 25 CHF
Effectiveness – Average speed on motorways during peak hours in km/h	• 80 km/h • 90 km/h • 100 km/h • 110 km/h • 120 km/h
Effectiveness – Average speed on urban roads during peak hours in km/h	• 25 km/h • 30 km/h • 35 km/h • 40 km/h • 45 km/h
Redistribution – Purpose of additional public revenue	• Reduce petrol taxes • Reduce federal government deficit • Reduce income taxes • Fund Green Infrastructure • Fund public transportation

Data: Swiss Mobility Panel, Wave 2, 2021