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RESEARCH ARTICLE

Fast track or Slo-Mo? Public support and temporal preferences for phasing out fossil fuel cars in the United States

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ABSTRACT

Policies to phase out fossil fuel cars are key to averting dangerous and irreversible changes to the earth's climate. Given the potential impacts of such policies on every-day routines and behaviours, the factors that might increase or decrease their public acceptance require investigation. Here we study the role of specific policy design features in shaping Americans' preferences for policy proposals to phase out fossil fuel cars. In light of the urgency of action against climate change, we are specifically interested in citizens' preferences with respect to the *timing* of phase-out policies. Based on a demographically representative sample of 1,520 American residents rating 24,320 hypothetical policy scenarios in a conjoint experiment, we find that Americans prefer phase-out policies to be implemented no later than 2030. Policy features other than timing are also important: higher policy costs significantly reduce public support; subsidies for alternative technologies are preferred over taxes and bans; and policy co-benefits in terms of pollution reduction increase public support only when they are substantial. The study also investigates the role of individual characteristics in shaping policy preferences, finding that perceived psychological distance of climate change and party identification influence policy preferences. The results of this study have important implications for the political feasibility of rapid decarbonization initiatives like the 'Green New Deal' that are now being discussed in the US and beyond. Among these is the insight that smart sequencing of policies (early implementation of subsidies for low-emission technologies, followed by tax increases and/or bans) might help ensure majority support for a fossil fuel car phase-out.

Key Policy Insights

- On average, respondents prefer policies to phase out fossil fuel cars to take effect no later than 2030.
- Party identification and perceived psychological distance of climate change influence timing preferences for phase-out policies.
- On average, subsidies for low-emission alternatives find higher public support than hard regulations, such as increases of fossil fuels taxes and bans on new fossil fuel cars sales.
- Smart sequencing of subsidies for alternative technologies and hard regulations should help increase the public acceptance of a phase-out of fossil-fuel cars.

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Decarbonization; climate change policies; phase-out; fossil fuel vehicles; temporal preferences; conjoint experiment

1. Introduction

To mitigate the effects of anthropogenic climate change, rapid and comprehensive mitigation measures are required (IPCC, 2018; Rockström et al., 2017; Steffen et al., 2018). With markets alone not providing sufficient incentives for individuals, firms, and entire societies to switch from carbon-intensive to carbon-neutral

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systems of production and consumption in a timely fashion, public policies are important in steering societal actors into the necessary decarbonization pathways (Fri & Savitz, 2014). In fact, political coalitions have spurred governments around the world to introduce policies for the phase-in of clean technologies in climate-relevant sectors (Meckling, Kelsey, Biber, & Zysman, 2015). While this has opened up new business opportunities, fossil fuel consumption is still rising globally (IEA, 2018a). The problem is that most governments layer support schemes for new technologies on top of existing policies and institutions, instead of dismantling existing fossil fuel systems (Laird, 2016; Stokes & Breetz, 2018). However, to overcome carbon lock-in (Unruh, 2002), phase-out policies will most likely be needed (Geels, Sovacool, Schwanen, & Sorrell, 2017; Kivimaa & Kern, 2016).

In democracies in particular, governments in charge of designing such policies need to be responsive to their constituencies. Given their desire for re-election, politicians' incentives to enact policies that are opposed by a majority of voters are limited (Downs, 1957; Druckman, 2013). Recently, concern has risen that voters are becoming an increasing barrier to ambitious climate policies, driven by the rise of right-wing populism and post-truth politics (Batel & Devine-Wright, 2018; Fraune & Knodt, 2018; Lockwood, 2018). Opposition to climate policies can arise in particular if these are (perceived to be) poorly designed, as has been seen in the protest movement of the French Gilets Jaunes, which was fuelled by a proposed increase in gasoline taxes. Understanding the drivers of citizens' climate policy preferences is therefore of crucial importance for both policymakers and researchers.

Recent climate assessments have stressed the urgency of significant measures to avert irreversible damages to the earth's climate (IPCC, 2018; US Global Change Research, 2018). Against this background, we specifically investigate citizens' preferences regarding *temporal* aspects of climate policy implementation, a key factor for assessing the political feasibility of rapid low-carbon transitions. Considering that decarbonization is humanity's first industrial transformation that faces a deadline (Schmitz, 2015), it is important to understand whether citizens support the implementation of decarbonization policies as early as possible or are (still) in favour of postponing them to later dates.

Concretely, our study employs a conjoint experiment to investigate support for policies to phase out fossil fuel vehicles for personal transportation. Decarbonizing the transportation sector is a key element in global efforts to mitigate climate change (Creutzig et al., 2015; Fuglestvedt, Berntsen, Myhre, Rypdal, & Skeie, 2008). The role of citizens is particularly important in transforming this sector, as such transformation efforts not only hinge upon changes in technologies and investment flows, but also on fundamental shifts in user practices, habits, and social norms (Creutzig et al., 2018). In addition to assessing the extent to which citizens' preferences on phase-out policies are affected by the timing of policy implementation, we investigate the impact of other key policy design features, including policy instruments, policy co-benefits in terms of pollution reduction, policy cost, and endorsements by parties and stakeholders. We do so in the context of the US, the second largest CO_2 emitting country in the world.

Our study makes two main contributions. First, while recent research on climate and energy policy has acknowledged the centrality of phase-out of, and divestment from, fossil fuels (Ayling & Gunningham, 2017; Davidson, 2019; Rockström et al., 2017; Rogge & Johnstone, 2017), we are among the first to explore citizens' policy preferences in this realm. Second, given the urgency of more ambitious mitigation action, we investigate the extent to which citizens' preferences are moved by different policy implementation time horizons. As will be explained, our results are significant in suggesting that Americans' proclivity to procrastinate in terms of climate change action is surprisingly low. Earlier policy action is clearly preferred over action enacted later than 2030. However, temporal policy preferences are significantly moderated by individual-level psychological and political characteristics.

2. Background

2.1. Phasing out fossil fuel cars

Phasing out fossil fuel cars is a mitigation option that could substantially contribute to a deep decarbonization of the transportation sector and hence energy systems more broadly. Rockström et al. (2017) indicate that, to limit global mean temperature rise to 2°C, internal combustion engines for personal transportation need to disappear by 2040, as oil has to exit the global energy mix by that time at the latest. In the US, the transportation sector is the largest contributor to greenhouse gas (GHG) emissions, accounting for 29% of total emissions.[1] Overcoming carbon lock-in in the transportation sector is a challenge in multiple ways, but many researchers agree that the main obstacles in the transformation of energy systems are not economic or technological, but socio-political in nature (Diesendorf & Elliston, 2018; Jacobson & Delucchi, 2011; Stokes & Breetz, 2018).

Many jurisdictions around the world are discussing and implementing policies to phase out cars with internal combustion engines (IEA, 2018b). While most of the countries that have announced a ban on fossil fuel cars are in Europe (e.g. Norway, France, Great Britain), China and India have also signalled their intent to ban internal combustion engines (see Table S9 in the Supplementary Material (SM)). However, the legal status of these announcements varies significantly, and no country has passed binding legislation so far (Meckling & Nahm, 2019). In the US no significant policy innovation can currently be expected on the federal level, but the state of California in 2018 was the first to discuss a legislative act to ban the registration of new fossil fuel cars starting in 2040. Carbon taxes or fuel tax increases constitute other policy instruments that could contribute to a phase-out. However, taxes can be problematic from a public acceptance perspective. In particular, taxes sometimes face vigorous public opposition if their design does not take potential social inequities into account. Yet, there are also examples of smartly designed environmental taxes that result in increasing public support over time, as in the case of British Columbia, where a carbon tax was introduced in 2008 and is still in effect (Murray & Rivers, 2015). Other policy instruments that ultimately target the same objective, like subsidies for low-emission transportation alternatives, have already been enacted in various places. In the US, the federal government and several states offer financial incentives like tax credits for the purchase of electric vehicles, but polling suggests that awareness of electric vehicles is still extremely low among citizens.[2]

2.2. Theoretical framework

2.2.1. Temporal preferences

Research in behavioural science has shown that humans are not particularly good at making forward-looking decisions, but instead tend to be oriented toward immediate benefits (Frederick, Loewenstein, & O'donoghue, 2002) and the status quo (Weber & Johnson, 2015). When applied to decisions relevant for long-term sustainability, such present bias can threaten the future of humanity (Weber, 2017). When it comes to political preferences, self-interested citizens may not be inclined to accept economic costs if benefits that might accrue from policy action are significantly delayed (Jacobs & Matthews, 2012), as is often the case in the context of climate change mitigation. Hence, we can hypothesize that citizens, when faced with the choice of enacting climate policies now versus ten or more years from now, will favour later over immediate action. This expectation is backed by the fact that climate change is still often depicted as a problem with consequences distant in time (Brügger, Dessai, Devine-Wright, Morton, & Pidgeon, 2015), which might lead citizens to perceive the problem as one that can safely be addressed sometime in the future. This of course conflicts with evidence from climate science suggesting that urgent action is required to avoid the crossing of climate tipping points, which could lead to uncontrollable and irreversible climate change (e.g. Lenton, 2011; Lontzek, Cai, Judd, & Lenton, 2015)

2.2.2. Psychological distance of climate change and party identification

Preferences for different temporal trajectories of climate action cannot be assumed to be the same across the US population. Some individuals will be more aware of the urgency for climate action and hence support earlier policy implementation. This might be the case especially for citizens who have already personally experienced climate change impacts (Egan & Mullin, 2017; Haden et al., 2012; Spence, Poortinga, Butler, & Pidgeon, 2011) or expect them in the near future.

This idea ties in with the literature on psychological distance. Psychological distance is defined as the extent to which something is perceived as far away vs. close to the self (Trope & Liberman, 2010). In the context of climate change, psychological distance indicates the extent to which people perceive climate change to be a 'threat that is more likely to affect strangers remote in time and space rather than oneself, the people one knows, or nearby places' (Brügger, Morton, & Dessai, 2016, p. 126). Perceived psychological distance of climate change can therefore be hypothesized to affect temporal policy preferences. Accordingly, citizens who perceive climate change to be proximal should be in favour of earlier policy implementation. Citizens who perceive climate change to be distant, on the other hand, can be expected to prefer policy implementation as far in the future as possible.

In light of the polarization of climate politics in the US (Jasny, Waggle, & Fisher, 2015; Weber & Stern, 2011), we examine citizens' party identification as a second factor potentially moderating their preferences regarding temporal aspects of policy implementation. Given that climate skepticism is far greater among Republicans than Democrats (McCright & Dunlap, 2011), we assume Republicans' support for climate policy action to increase as a function of later implementation dates, while we expect Democrats' support to increase as a function of earlier implementation dates. In the context of phasing out fossil fuel-based technologies, the influence of party identification on temporal preferences has not been investigated so far. Regarding the large group of Americans describing themselves as Independents,[3] our expectation is that their average timing preference is somewhere between Democrats' assumed preference for early policy action and Republicans' assumed preference for later action. Our expectation is based on results of prior research showing that depending on the subject matter, Independents' policy preferences are sometimes closer to those of Democrats and in other cases closer to those of Republicans (e.g. Hardisty, Johnson, & Weber, 2010; Leiserowitz, Maibach, Roser-Renouf, & Hmielowski, 2011).

3. Methodology

3.1. Sample

We conducted a conjoint experiment implemented in an online survey, which was fielded in October 2018. We contracted with the survey company Lightspeed, with access to approximately 1.3 million respondents in the US. From this panel, a sample that demographically represents the US was drawn based on a matching algorithm. Despite some small deviations, the sample ($n = 1{,}520$ American residents) matches the US population well in terms of age, gender, census regions, household income, and party identification (see Table S1 in SM).[4] This sampling approach is standard in experimental studies of political preferences, in which the estimation of treatment effects is the primary objective (Bolsen, Druckman, & Cook, 2014; Druckman & Kam, 2011). As shown by Ansolabehere and Schaffner (2014; see also Sanders, Clarke, Stewart, & Whiteley, 2007), a carefully conducted matched sampling approach based on opt-in Internet panels also produces accurate population estimates and replicates the basic correlation structures of probability samples. Our study was preregistered at the Open Science Framework and approved by Princeton University's Institutional Review Board.

3.2. Study design

Social scientists have recently adopted conjoint analysis as a method to measure citizens' policy preferences (e.g. Bechtel, Hainmueller, & Margalit, 2017; Gallego & Marx, 2017; Hainmueller & Hopkins, 2015). A conjoint experiment simulates a decision situation by exposing people to two or more scenarios – in our case, two hypothetical policy proposals – and asking them to rank and/or rate these scenarios according to their preferences. These scenarios vary on multiple dimensions, in our case different policy attributes. Based on respondents' choices over several rounds, we can simultaneously estimate the individual effects of several policy attributes on policy preferences (Gampfer, Bernauer, & Kachi, 2014). Although respondents might not be able to consciously evaluate the importance they would assign to the different dimensions if asked explicitly, the conjoint analysis allows eliciting the weight respondents attribute to these dimensions. Conjoint experiments also have the potential to substantially mitigate the problem of social desirability bias that chronically plagues public opinion research on environmental matters, as potential trade-offs that often remain unaddressed in simpler survey questions are explicitly incorporated into the choice alternatives (Hainmueller, Hopkins, & Yamamoto, 2014). In our case, using conjoint analysis reduces the likelihood of overestimating citizens' appetite for ambitious climate policies.

Table 1. Policy attributes and attribute levels for the conjoint experiment.

Policy attribute	Level 1	Level 2	Level 3	Level 4
Policy types	Ban on new fossil fuel car sales	Government subsidies for low-emission transportation alternatives	Increase in fossil fuel taxes	–
Policy cost (per household, per month)	\$2	\$6	\$10	\$14
Beginning of policy implementation	2020	2030	2040	2050
Pollution reduction within one year after policy enactment	10%	20%	30%	–
Policy endorsement by	US Alliance of Automobile Manufacturers	Greenpeace	Democratic Party	Republican Party

At the beginning of the experiment, participants were made familiar with the context of the policy debate. This included information about the contribution the transportation sector makes to climate change. Moreover, it was highlighted that many climate scientists agree that phasing out fossil fuels is a necessary measure to avert dangerous climate change, and that several countries have already taken measures towards decarbonization of their transportation systems (see the SM for the complete information given to respondents). Next, respondents were made familiar with five attributes of a potential policy to phase out fossil fuel cars and the specific levels of the attributes, which we defined based on a screening of the scientific literature and media releases referring to policies to phase out fossil fuel cars. The attributes were explained to respondents in the order in which we present them here. First, different policy types or instruments could be used to initiate a phase-out of fossil fuel cars, such as a ban on new car sales, subsidies for low-emission transportation alternatives, or an increase in fossil fuel taxes. Second, a phase-out would lead to costs for consumers, which we assumed to take on values between \$2 and 14 per month and household. Third, we calibrated the timing attribute using increments of 10 years from 2020 to 2050. Fourth, as a phase-out of fossil fuel cars would not only lead to reductions in CO_2 emissions, but also in particulate matters and other pollutants with adverse health impacts, we defined rough levels of pollution reduction, ranging from 10 to 30% within one year after policy enactment. The final attribute captures endorsement of a policy proposal by different stakeholders. We calibrated this attribute by including endorsements by the Democratic or Republican Party, or by two key visible policy stakeholders, Greenpeace and the US Alliance of Automobile Manufacturers. Table 1 provides an overview on all attributes and levels.

After receiving information on the five policy attributes, respondents were exposed to eight consecutive pairs of hypothetical policy proposals to phase out fossil fuel cars. We employed complete randomization: the levels of the five attributes characterizing any given policy proposal varied randomly both within and across the binary comparisons (Hainmueller et al., 2014). The order in which the attributes appeared in the description of proposals was randomized across respondents but fixed for each respondent, to prevent the confounding of attribute effects with order effects while at the same time limiting experimental complexity and cognitive load on respondents. For each choice, respondents indicated their policy preference based on two outcome measures. First, they were asked to choose which scenario they preferred ('forced choice outcome'). Second, simulating a referendum, participants were asked to indicate, on a scale from 0 to 10, how likely they would vote for each proposal if it were the object of a direct democratic vote ('rating outcome'). Apart from the conjoint experiment, the survey included a number of items to measure moderators and covariates of interest. Figure S1 in the SM entails a visualization of a choice task, and Tables S2 and S3 provide information on measurement and aggregation of variables.

3.3. Empirical model

For the analysis of the conjoint experiment, we collapsed the answers from the 11-point ratings into binary measures of policy support, using the median (which is 5) as the cutoff value (see Bechtel et al., 2017). The rationale is that while the rating scale allowed respondents to assess each policy proposal individually and on a fine-grained scale, a political vote (as simulated in the rating task) ultimately boils down to a yes or no. The resulting dependent variable 'Vote for Phase-Out' is coded 0 for cases where a respondent rejects a proposal or is neutral about it (values 0–5 on the original scale) and 1 for cases where a respondent supports a proposal (values 6–10 on the original scale). Since respondents were exposed to eight consecutive pairs of policy proposals, our analyses rely on a total of 24,320 observations. As Bansak, Hainmueller, Hopkins, and Yamamoto (2018) show, marginal effects derived from conjoint experiments are robust to a large number of choice tasks (as much as 30), which is why satisficing is unlikely to degrade respondents' response quality in our setting.

In the first step, we are interested in the average marginal effects of attribute levels on policy support. As our experiment is based on a fully randomized conjoint design, the causal effects of policy attributes on policy support are non-parametrically identified (Bechtel & Scheve, 2013). Hence, as Hainmueller et al. (2014) show, with a fully randomized design, a simple difference-in-means estimator yields unbiased estimates. This means that average marginal effects for individual attribute levels can be estimated by fitting a simple regression of the dependent variable, which is policy support, on a set of dummy variables capturing the attribute levels of interest. These dummy variables take the value one if the respective attribute level was present in a policy proposal, and zero otherwise. For each attribute, one level is fixed as a baseline against which to compare the marginal effects, so that the regression coefficient for each dummy variable corresponds to the average marginal effect of the respective attribute level relative to the omitted reference level of the same attribute. Hence, we estimate the following main model:

$$y_{ijk} = \boldsymbol{\beta X}_{ijk} + e_{ijk} \tag{1}$$

where a respondent i's vote y for proposal k in task j is modelled as a function of $\boldsymbol{X}_{ijk}$, which represents a vector containing the attribute levels of the policy proposal presented to i in k. To account for within-respondent correlations in responses, we cluster standard errors e by respondent. By estimating this model, we obtain marginal effects β for all attribute levels simultaneously.

As we are also interested in exploring whether the marginal effects vary across the theoretically relevant subgroups specified in Section 2.2.2, we additionally compute marginal effects conditional on respondents' level of psychological distance of climate change and party identification. As these characteristics are not affected by the experimental treatments, the conditional effects are also non-parametrically identified given the fully randomized design (Bechtel & Scheve, 2013).

4. Results and discussion

4.1. Pre-experimental support for phase-out policies

After being provided with basic facts about the climate impact of fossil fuel-based transportation systems and policy initiatives announced by several countries, but before receiving information about the attributes and attribute levels that characterized potential policy proposals in the conjoint experiment, respondents were asked about the extent to which they support policies to phase out fossil fuel cars. Mapping the results from the original 6-point scale (from 'Do not support at all' to 'Strongly support') onto the probability scale, the average support level ($M = .63$; $SD = .26$) indicates that most respondents seem to support such policies in principle. About 34% of respondents stated that they (strongly) support policies to phase out fossil fuel cars (corresponding to '5' or '6' on the 6-point scale), while 20% stated that they (strongly) oppose such measures ('1' or '2'; see Figure S9). However, assessing policy support this way is likely to overestimate the public's enthusiasm and does not tell us anything about more specific dimensions of support, such as the preferred timing and policy instruments. More fine-grained insights about citizens' policy preferences can be derived from our conjoint experiment.

4.2. Insights from the conjoint experiment

Figure 1 shows the marginal effects associated with each attribute level. The horizontal lines represent their 95% confidence intervals. For each of the five attributes, one level serves as the baseline category, which is shown without confidence interval. As our interest lies primarily with the temporal dimension of policy implementation, Figure 1 shows the effects of different implementation years first, followed by all other attribute levels.

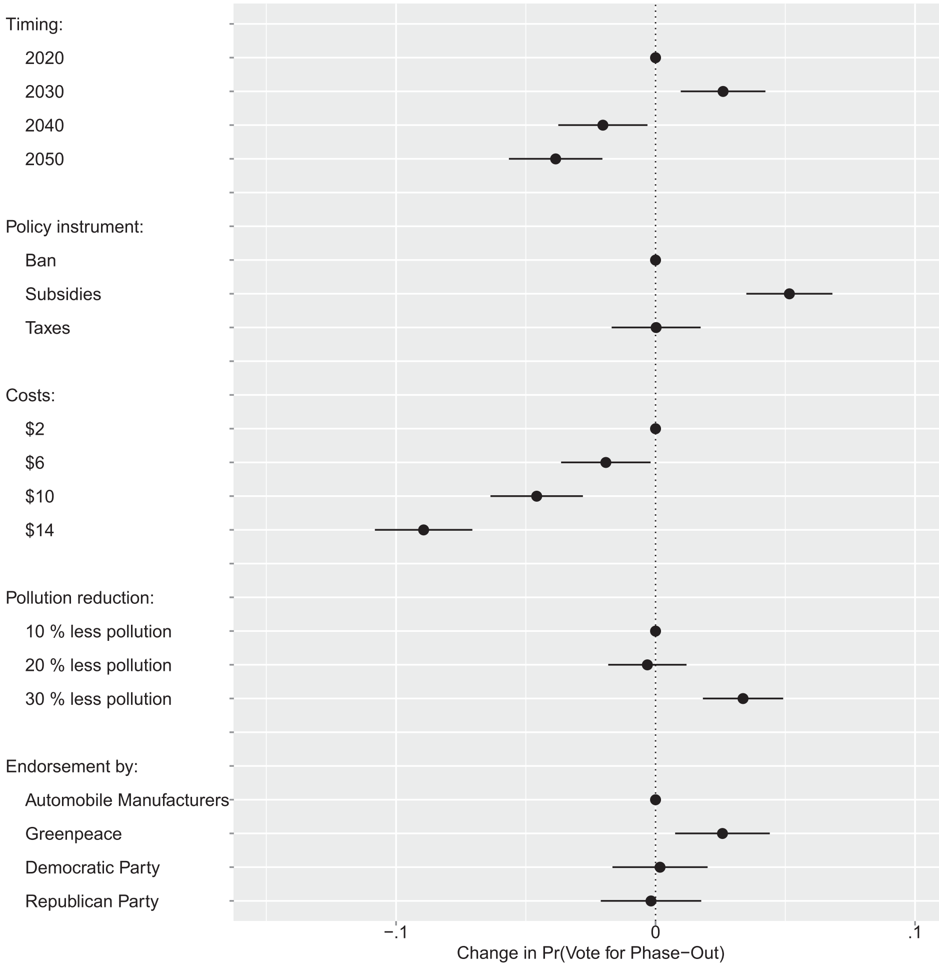

Figure 1. Average effects of phase-out policy attributes on policy support. Each dot represents an average marginal effect of an attribute level on the probability of voting for a policy proposal in relation to a proposal with the reference level for the same attribute. The horizontal bars represent the associated 95% confidence intervals. Dots without bars represent the reference level for each policy attribute. Calculations are based on linear regression analyses with dichotomized rating outcomes and standard errors grouped at the level of the individual (clustered standard errors; see Table S4). $N = 24{,}320$ policy proposals.

For the timing attribute, we see that the temporal distance of policy implementation clearly impacts citizens' appraisal of policies. Policy implementation in 2030 significantly increases the probability that respondents support the proposal, compared to implementation in 2020. While this is in line with our expectation that citizens prefer later over immediate action, implementation dates later than 2030 significantly *decrease* the probability to support a proposal, compared with the baseline category of immediate policy action (i.e. in 2020). The probability that voters support policies implemented in 2040 is 4.6 percentage points lower than the probability to support policies implemented in 2030. Below we further explore whether this partly surprising finding can be explained by a perceived urgency to act on climate change.

As for the second attribute, policy instrument, proposals including the provision of *subsidies* for low-emission transportation alternatives have higher probabilities to be supported than *bans* on new fossil fuel car sales or increases in fossil fuel *taxes*. Trying to achieve decarbonization of the transportation system with subsidies instead of a ban or an increase in gasoline taxes leads to a 5.2 percentage point increase in the probability that citizens will support the proposal. These results are in line with earlier research showing that citizens prefer subsidies over taxes (Cherry, Kallbekken, & Kroll, 2012) and tend to be reluctant to accept 'hard regulations' like bans and tax increases (Attari et al., 2009) in the transportation sector.

Not surprisingly, the cost induced by a policy leads to an (almost) monotonic decrease in a proposal's probability to be supported. The probability to support a policy that would come at a monthly cost of $14 per household is 8.9 percentage points lower than the probability to support a policy with a monthly cost of $2 per household. Roughly, every dollar in monthly household cost leads to a decrease in policy support of 0.75 percentage points. Our analysis hence confirms that keeping the costs citizens have to bear for decarbonization within reasonable limits is essential to ensuring public support.

The co-benefits of phase-out policies in terms of pollution reduction lead to significant changes in public support only when they are substantial. While policy support is equivalent for policies that lead to 10 or 20% of pollution reduction, achieving a 30% reduction results in a substantial increase in the probability to support a policy of 3.4 percentage points compared to the baseline level of 10%.

Finally, when investigating the whole sample, endorsements by stakeholders do not seem to strongly influence average public support, apart from the increase in the probability to support policies endorsed by Greenpeace when compared with policies endorsed by the Automobile Alliance. The seemingly low influence of endorsements is not surprising, as it is known that perceived trustworthiness is a requirement for elite cues to play an effective role in the formation of political preferences (Druckman, 2001; Nicholson, 2011). We therefore conducted additional analyses to explore whether trust in stakeholders moderates this relationship. As we show in the SM (Figure S2), stakeholder endorsements do indeed have sizeable effects within certain subgroups. In particular, endorsement by political parties significantly increases policy support among respondents who perceive the respective party as trustworthy, and significantly decreases support by respondents who perceive it as not trustworthy.

We ran several robustness checks with the conjoint experiment data. First, we re-estimated the effects using logit models, and the results remain unchanged. Moreover, neither exclusion of respondents who completed the experiment exceptionally fast nor replicating the analysis based only on the first three choice tasks each respondent completed lead to substantially different results (see SM).

4.3. Temporal preferences for climate policy implementation: conditional effects

To better understand temporal preferences for policy implementation, we investigate two factors that we hypothesized to be relevant for perceptions of urgency of climate change action: perceived psychological distance of climate change, and party identification. As shown in Figure 2(a), psychological distance moderates the impact of policy timing on policy support.[5] We find that, in the subgroup of respondents with high perceived distance, the malleability of policy support as a function of different implementation times is limited. Implementation in 2030 leads to higher support than implementation in 2020, but the differences between implementation in 2020, 2040 or 2050 are statistically indistinguishable from zero. Policy support by individuals with a low psychological distance, on the other hand, is not significantly influenced by implementation in 2020 versus 2030, but their probability to support a policy option significantly decreases by 5.5 (9.5) percentage points if implementation is delayed to 2040 (2050), compared to 2030.

Party identification is also systematically related to temporal policy preferences.[6] The time horizon of policy implementation plays a role in determining each partisan group's preferences, but in different ways (see Figure 2(b)). Republicans' support increases for policies implemented in 2030, while immediate (2020) or later (from 2040 onward) implementation are supported to the same extent. This is different for Democrats and Independents, whose preferences are influenced in similar ways by different time horizons. In both groups, policy support is similar for implementation in 2020 and 2030, but support decreases significantly if implementation takes place only in 2040 or later (with the difference between 2020 and 2040 slightly failing to attain statistical significance for Democrats). However, these effects about relative differences in policy support as a function of implementation time should not be mistaken with absolute support. In the SM, we show simulation results to predict absolute levels of support, indicating that average policy support among Democrats is about 68–69% for measures implemented in 2020 or 2030, while support is considerably lower among Independents (47% for 2020 / 48% for 2030) and Republicans (51 / 55%; see Table S6).

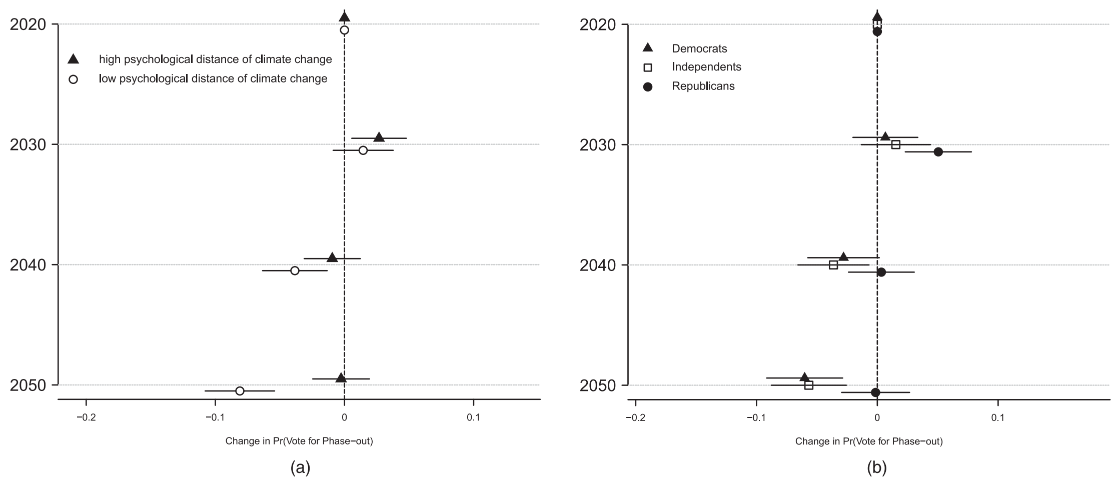

Figure 2. Average effects of timing attribute on policy support, by psychological distance of climate change and party identification. Symbols represent average marginal effects for the policy attribute 'beginning of policy implementation', conditional on psychological distance of climate change (a) and party identification (b). Subgroups for perceived psychological distance of climate change were generated by taking a median split on the original factor variable. Partisan subsamples represent 545 self-identified Democrats, 495 self-identified Independents, and 480 self-identified Republicans. Calculations are based on linear regression analyses with dichotomized rating outcomes, the full set of attribute values as predictors, and clustered standard errors (see Table S5). $N = 24,320$ policy proposals.

4.4. Do temporal preferences interact with policy instrument preferences?

Knowing that both the timing of policy implementation and instrument choice have an influence on Americans' preferences for phase-out policies, policymakers may be interested to know whether the two attributes interact in shaping preferences. Recent research on strategies for decarbonization has proposed smart sequencing of climate policies as an effective way to avoid political dead-ends in the decarbonization of energy systems (Meckling, Sterner, & Wagner, 2017). For instance, subsidies for the purchase of electric vehicles could be introduced early on and be combined with taxes that are ratcheted up over time, while a ban on newly registered cars with an internal combustion engine could be enacted later. However, there has been little effort so far to assess whether these ideas of policy sequencing resonate with public preferences.

Figure 3 shows that respondents' preferences are not driven by such an interaction. This illustration is based on a regression model that interacts the policy timing attribute and the policy instrument attribute. Taking 2050 as reference category, we see that Americans prefer each type of policy to be implemented in 2020 or 2030 when compared to 2050, with the differences between policy instruments being negligible and statistically non-significant. In light of our previous finding that subsidies are generally preferred over other policy instruments (see Figure 1), it may be tempting for policymakers to disregard hard regulations as complementary measures. However, subsidies for low-emission alternatives alone are not likely to ultimately phase out internal combustion engines, which is why tax increases and bans may still be considered. To further explore the prospects of smartly sequenced measures beyond subsidies gaining public support, we compute (absolute) support levels based on predicted values. Here, we take advantage of the fact that we posed the rating task as a probabilistic question, asking respondents to indicate how likely they would vote for each proposal in a direct vote. Rescaling the policy ratings and mapping them onto the set [0, 100] allows us to predict levels of support for specific policy proposals by (first) estimating the effect of policy attributes on the rescaled rating variable, and (second) computing predicted values for policy proposals of interest (Bechtel & Scheve, 2013).

Figure 4 contains the bandwidths of all predicted values for the three policy instruments in 2020 and 2030.[7] While support for all policy instruments is generally higher if implemented in 2030 than in 2020, the bandwidths of predicted support include the pivotal 50% threshold for all instruments already in 2020. For example, the predicted level of support for an increase in fossil fuel taxes implemented in 2020 ranges from 43.2 to 52.6% in our sample, depending on the calibration of other attributes. Given the differences in absolute support levels

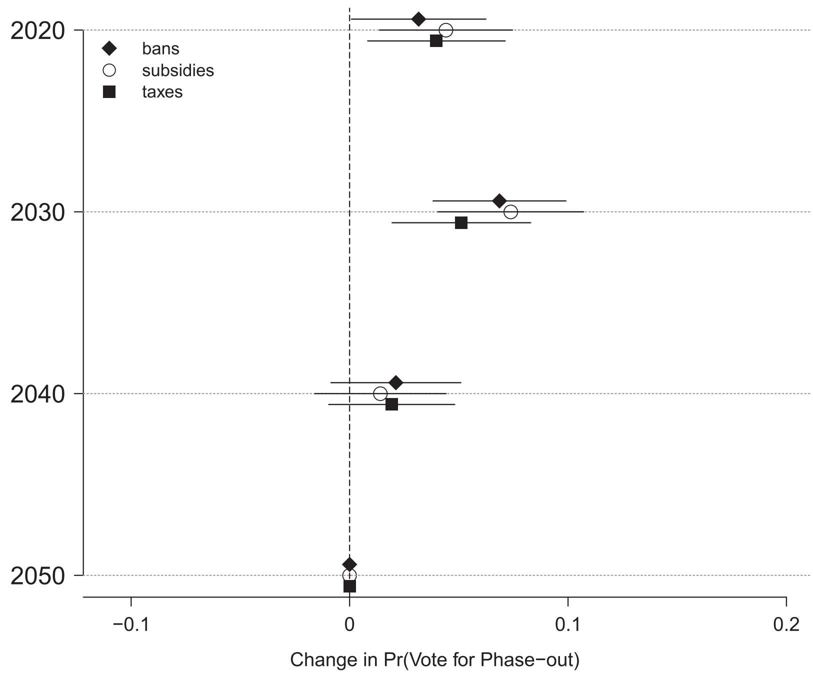

Figure 3. Interaction of policy instrument and timing attribute. Symbols represent effects for the attribute 'beginning of policy implementation' on phase-out support, conditional on policy instruments. Calculations are based on linear regression analyses with dichotomized rating outcomes, the full set of attribute values as predictors, and clustered standard errors (see Table S7). $N = 24{,}320$ policy proposals.

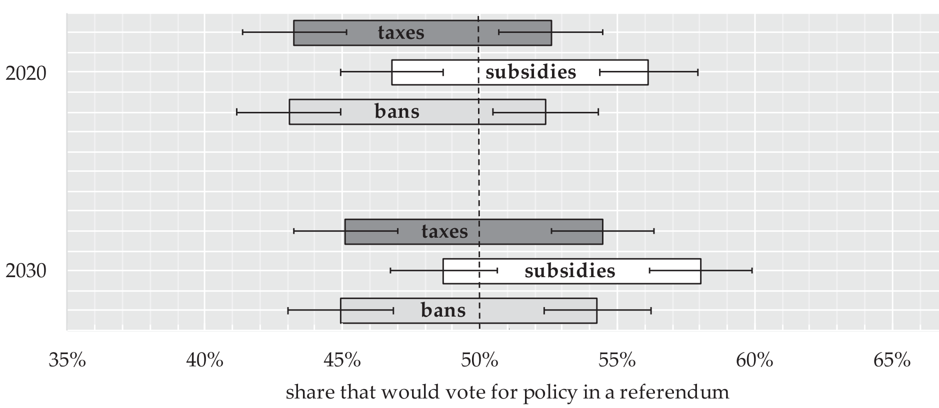

Figure 4. Bandwidths of predicted phase-out policy support. Bars include all predicted levels of public support for implementation of different policy instruments in 2020 and 2030, contingent on other policy features. Lower bounds represent scenarios with lowest predicted support for each instrument x timing combination (including 95% confidence intervals), and upper bounds represent scenarios with highest predicted support for each instrument x timing combination (including 95% confidence intervals). Predicted values are based on rating outcomes from $N = 24{,}320$ policy proposals.

between the policy instruments, Figure 4 provides evidence that there is indeed a case for policy sequencing also from a public opinion perspective. For subsidies, the majority of predicted values derived from our sample is above 50% already for implementation in 2020, while about half of policy scenarios that include bans or tax increases attain majority support if implemented in 2030. However, these numbers should be approached with caution given the mixed reliability of stated preference approaches when it comes to estimating absolute levels of preferences (Hainmueller, Hangartner, & Yamamoto, 2015). In general, getting the policy design 'right' will be decisive in ensuring majority support for decarbonization policies.

4.5. Explaining policy support

In the final step of our empirical analysis, we broaden our perspective by investigating factors that explain support for phase-out policies. Our dependent variable is average policy support, computed by averaging over the 16 individual ratings given by each respondent in the conjoint tasks. We regress this policy support measure ($M = .49$; $SD = .24$) on several independent variables (for further details, see Table S3). As Table 2 shows, the strongest predictor of policy support is perceived psychological distance of climate change. Support is also significantly and positively related to pro-environmental behaviour, younger age, urban place of residence, and not owning a car. Moreover, there is a positive effect for Democrats and a negative effect for Independents (both significant), with Republicans as baseline. We also find a significant but very small effect of gender, with males providing more policy support.

4.6. Limitations

Using a conjoint design allowed us to investigate the role of different policy attributes and how they interact with respondents' characteristics in shaping policy preferences. Compared to standard surveys, conjoint experiments are less vulnerable to demand effects and social desirability bias (e.g. Wallander, 2009). Indeed, we find that measuring phase-out policy support with a simple question before the conjoint experiment suggests that support is higher than when it is obtained through the conjoint ratings. The levels of support derived from the conjoint experiment are most likely more realistic than measures based on simpler survey questions.

At the same time, our study design entails a number of limitations. The choice to fully randomize policy scenarios implies that respondents were sometimes confronted with relatively far-fetched scenarios, such as Republicans advocating for tax increases. While including such atypical scenarios does not pose a threat to internal validity, they might threaten external validity (Hainmueller et al., 2014). Following the procedure proposed by Hainmueller et al. (2014, p. 26), we tested whether the presence of atypical scenarios seriously distracted respondents. As Figure S5 shows, while marginal effects of respondents that were exposed to less versus more atypical scenarios differ somewhat, these differences do not compromise our general interpretations. We also tested whether being exposed to a higher number of partisan endorsements (as opposed to endorsements by interest groups) distracted respondents, but as Figure S6 shows, the results of corresponding subgroup analyses do not differ substantially from those obtained from the full sample. Another concern refers to hypothetical bias, the problem that while respondents might indicate voting in favour of a specific policy proposal in the hypothetical choice situation of our experiment, some of them would probably cast a no-vote in a real ballot. We cannot exclude this possibility. However, our study is not primarily interested in voting behaviour. Rather, we use

Table 2. Explaining support for phase-out policies.

	Support for phase-out policies obtained through conjoint
Age	−0.0233*** (0.0031)
Gender (baseline female)	0.0212* (0.0101)
Income	−0.0015 (0.0027)
Rural (baseline urban)	−0.0300*** (0.0076)
Car ownership	−0.0113* (0.0053)
Democrat (baseline Republican)	0.0391** (0.0127)
Independent (baseline Republican)	−0.0341** (0.0129)
Pro-environmental behaviour	0.0335*** (0.0059)
Psychological distance of climate change (high to low)	0.1034*** (0.0060)
Energy knowledge	0.0034 (0.0051)
Constant	0.5934*** (0.0267)
N	1,511
R^2	0.388

Notes: Coefficients from OLS regressions; standard errors in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The dependent variable is average policy support as obtained through the rating outcome of the conjoint experiment. For measurements of predictor variables, see Tables S2 and S3. Age was recoded to 6 groups (18–29; 30–39; 40–49; 50–59; 60–69; 70+). Party identification is captured with two dummy variables for Democrats and Independents, respectively. Continuous predictor variables were standardized before conducting the analysis (Mean = 0; SD = 1).

this outcome as an easily accessible way to experimentally investigate the extent to which specific policy characteristics influence support for phase-out policies in the transportation sector more generally.

Lastly, an alternative explanation of our result that citizens on average prefer phase-out policies to be implemented in 2030 is that people might generally prefer climate policies that are always 'just 10 years away'. To borrow from Trope and Liberman (2010), a decade's remove might provide just the right balance of concreteness and abstraction. While it would be beneficial to further investigate this hypothesis, it is worth noting that the patterns of timing preferences vary considerably among subgroups (see Section 4.3). It is also likely that the temporal distance of policy implementation that maximizes public support depends on the behavioural relevance of climate policies. While our study is about policies that entail implications for most citizens' everyday behaviours, temporal preferences for climate policies in sectors that carry less behavioural relevance might differ. For instance, Rinscheid and Wüstenhagen (2019) found that Germans prefer a phase-out of coal-fired power plants by 2025 over 2030 or later dates. Taken together, these findings call for further research on temporal perceptions in the field of climate policy and beyond.

5. Conclusions and policy implications

The decarbonization of the transportation sector is a key element of global attempts to tackle climate change and avert irreversible damages to planet earth. However, the needed transformation will most likely not occur without the enactment of far-reaching public policies to phase out fossil fuel cars. Contributing to the literature on the social acceptance of climate and energy transition policies, we employ a conjoint experiment to study how various policy attributes influence Americans' support for policies to phase out fossil fuel cars. Our aim is to examine causal connections between experimental treatments (the attributes of policy proposals) and the outcome of interest (policy support), rather than quantifying the level of climate policy support in the US population (see Howe, Mildenberger, Marlon, & Leiserowitz, 2015; Motta, Chapman, Stecula, Haglin, & Kahan, 2019).

Given the urgency of climate action, we focus in particular on preferences with respect to the temporal dimension of policy implementation. Based on the ratings of 24,320 hypothetical policy scenarios, we find that Americans' support for policies to phase-out fossil fuel cars is maximized if these are implemented in 2030. On average, later implementation dates significantly decrease policy support, although the preferences of certain groups (Republicans; people with a high psychological distance relative to climate change) are less influenced by implementation timing. In an additional exploratory analysis documented in the SM (see Figure S7), we find that the perceived feasibility of phasing out fossil fuel cars is another factor that moderates citizens' preferences. While perceiving the phase-out to be infeasible is associated with preferences for later policy action, higher perceived feasibility links up with preferences for an early phase-out (i.e. no later than 2030).

Taken together, our study suggests that status quo bias among citizens is less pronounced than expected, providing further evidence that such bias is a transient and malleable phenomenon (Weber, 2015). Our results also suggest that the coming decade might provide a window of opportunity for adopting effective phase-out policies for fossil fuel cars that find public support. However, our conjoint analysis also highlights that majority support for policies may depend on how they will eventually be designed. For instance, we find that Americans prefer subsidies over hard regulations. Although the results indicate no interaction between policy instrument and timing, predicted levels of public support suggest that a sequencing approach that starts with introducing incentives for alternative technologies (subsidies) and proceeds with hard regulations (bans, taxes) might obtain wider public acceptance. We would like to encourage future studies to more thoroughly investigate citizens' understanding of policies that will take internal combustion engines off the road, including their understanding of policy co-benefits (e.g. less pollution, less noise) and potentially more challenging side effects (e.g. changes in user practices).

In light of concerns about voter backlash against ambitious climate policies, the finding that our respondents show low willingness to postpone phase-out policies to after 2030 is encouraging. Phasing out internal combustion engines for newly registered cars by 2030 would in fact follow the roadmap for rapid decarbonization compatible with the Paris Agreement sketched by Rockström et al. (2017). These results have important implications for the political feasibility of initiatives like the Green New Deal that are now being discussed in the US and beyond. The Green New Deal currently focuses mostly on a 'carrot' approach, based on subsidies and industrial policy.[8] In fact, existing incentive schemes at the state and federal levels, like the US federal 'Qualified Plug-In Electric Vehicle Tax Credit',[9] are important first steps in the decarbonization of the transportation sector. As consumer choices are often based on a comparison of upfront costs, using subsidies to bring these down for low-emissions alternatives is a key element in modifying the relevant choice architecture (Kunreuther & Weber, 2014; Kunreuther et al., 2014; Yoeli et al., 2017). However, subsidies alone might be insufficient to speed up the transformation at the needed pace and do also bear some risks like rent capture and costly lock-in (Meckling et al., 2017). Hard regulations will most likely be necessary to reach required mitigation goals. As our analysis shows, a smart sequencing of carrot and stick policies may be a promising strategy to increase their public acceptance.

Notes

1. See https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions. Globally, transportation is responsible for 23% of energy-related CO_2-emissions (Sims et al., 2014).
2. See https://www.greentechmedia.com/articles/read/consumers-lack-ev-awareness-even-in-the-nations-largest-market#gs.2t1aeh
3. More than a third of the American electorate consider themselves as Independents (see Gallup, 2019). According to data from the Pew Research Center (2018), the share of Independents has increased from 30 to 37% between 1994 and 2017.
4. As the sample is taken from a panel of respondents that have given consent to participate in online surveys, it is a nonprobability sample.
5. Perceived psychological distance was measured with five items. Using factor analysis, one latent factor was extracted (see Table S2 in the SM). We took a median split on the factor variable to generate subgroups for high versus low perceived psychological distance of climate change.
6. Party identification was measured with one item, using a seven-point scale from 'Strong Democrat' to 'Strong Republican'. Based on this, we created three subgroups for Democrats, Independents and Republicans. See Table S2 (SM) for details.
7. Here, we focus on public support within the timeframes identified as crucial for policy action by climate scientists (e.g. Rockström et al., 2017); i.e. we do not include years later than 2030.
8. See, e.g. https://www.congress.gov/116/bills/hres109/BILLS-116hres109ih.pdf (in particular p. 9).
9. https://www.energy.gov/eere/electricvehicles/electric-vehicles-tax-credits-and-other-incentives.

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