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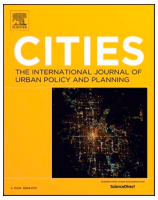

Give and take: Moral aspects of travelers' intentions to participate in a hypothetical established social routing scheme

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ABSTRACT

Social routing schemes are widely regarded as promising tools to reduce traffic congestion in urban networks. We contribute to the growing literature on such schemes and their effect on travel behavior, by exploring the interaction between the characteristics and framing of the scheme on the one hand, and travelers' moral personality and moral motivations on the other hand. Our method uses a two-wave stated intention experiment eliciting preferences in a hypothetical context where a social routing scheme is presumed to have been established already. This is followed by a morality survey. We hypothesize and then confirm the following: when a social routing scheme is framed and designed as an altruistic effort requesting personal sacrifices for the benefit of other travelers, people who strongly adhere to care related notions of morality are attracted to such a scheme. On the contrary, a scheme that is designed and framed as a collective endeavour which would also benefit participating travelers attracts those who strongly adhere to moral notions related to fairness. We derive tentative policy recommendations from our findings, suggesting that a collective good scheme, albeit more difficult to implement, is likely to be more viable in the long run.

1. Introduction

In and around most cities in the urbanized world, governments are struggling with congested road infrastructures. As is by now well recognized, an important key to a solution to this problem lies in influencing traveler behavior in such a way that travel demand is more evenly spread across available network capacity. Such a 'system optimal' distribution of traffic would generate large gains in accessibility and travel times, compared to the user equilibrium that arises when all travelers behave independently without any form of coordination. Various approaches have been tried to reduce this so-called 'price of anarchy' and move towards a better distribution of travel demand, including regulation, information provision, pricing and other incentive schemes (e.g. Albalate & Fageda, 2019; Liu et al., 2017; Noordegraaf et al., 2014; de Palma et al., 2018; Knockaert et al., 2012). Unfortunately, these policies all suffer from a trade-off between effectiveness and public acceptance: the most effective schemes (regulation and pricing) are unpopular among the general public (Gu et al., 2018; Krabbenborg et al., 2020), while the schemes that enjoy higher levels of acceptance among the public (such as information provision and soft incentive schemes) are considerably less effective in redistributing traffic (Chatterjee & Mcdonald, 2004).

The idea of social routing schemes is believed to combine relatively high levels of effectiveness and acceptance. The idea behind such schemes is that car users voluntarily agree, every once in a while, to choose a different route (or departure time, or even travel mode) with a somewhat higher travel time than their normal route, for the benefit of the system at large. A recent flurry of research has explored such policies

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(Djavadian et al., 2014; van Essen et al., 2016; Klein et al., 2018; van Essen et al., 2020b; Kröller et al., 2021; Mariotte et al., 2021; Koller, 2021), and the general consensus is that they indeed have the potential to deliver sizable gains in travel times by inching closer towards a system optimal distribution of traffic (Chen et al., 2021; Çolak et al., 2016; Eikenbroek et al., 2021; van Essen et al., 2020a). Many open questions remain, though; this paper aims to help find answers to some of those.

Particularly, we address an aspect of social routing schemes that hitherto has not received the attention it deserves: the role of morality, as in the 'moral personality' of travelers and the 'moral motivations' behind their choices, and how these interact with the characteristics and framing of the social routing system. To uncover how different moral effects may play a role on the long run, we focus on travelers' stated intention of joining established schemes. This means that the schemes are not presented as new ones, but rather as if they are already in place; which gives the benefit of taking the effect of established social norms into account. As in any form of social or collective behavior, the perception of the social norm can be expected to play an important role in the decision to join a social routing system. Our first contribution to the literature lies in the use of a widely established morality scale (Moral Foundations Questionnaire or MFQ; Graham et al., 2009) to measure the moral orientation of travelers. The MFQ provides a multi-dimensional picture of someone's morality. We show how the various dimensions of travelers' moral personalities are associated with their stated intentions to join a social routing scheme. In addition to the MFQ, which measures deep-seated moral values and convictions, we also use more specific morality-related questions targeted at the particular choice situation at hand – whether or not to join a social routing scheme. Whereas the MFQ measures, in a general and abstract sense, moral personality, the more specific questions measure contextual moral motivations. Recent literature suggests that the former measurements are more stable but less predictive of actual behavior, than the latter (Kroesen & Chorus, 2018); we set out to explore, among other things, whether this holds for the context of social routing and we aim to identify which personality- and motivation-related aspects help determine travelers stated intentions in this morally sensitive context.

Our second contribution lies in the way the social routing scheme is characterized and framed towards travelers. In addition to conventional characteristics (such as the difference between the travel time of the social alternative and that of someone's normal travel alternative), we distinguish between so-called 'sacrifice-based' and 'collective good' schemes. The former asks the traveler to make a personal sacrifice – in terms of a longer travel time – for the greater good, while the latter asks the traveler to join a collective endeavour that will result in lower travel times for themselves as well as for others in the long run. Given that traffic is often conceptualized as a matter of collective action, it is somewhat surprising that studies into travelers' acceptance of social routing, so far, have not investigated the collective action nature of such a scheme in detail. Theoretically, we offer a new, collective good-perspective on social routing that seems more aligned with the nature of traffic.

Our third contribution lies in highlighting, using a combination of conceptual and empirical analysis, the interactions between travelers' moral personality and moral motivations on the one hand and the framing of the social routing scheme (sacrifice-based versus collective good) on the other hand. We show how different dimensions of a traveler's moral personality and motivations influence in different ways their stated intention to join a scheme, depending on how the scheme is framed. Research in moral psychology helps us to interpret these interactions in meaningful ways.

The empirical part of our study is based on a large-scale, two-wave data collection effort, consisting of a stated intention experiment and a morality survey. Resulting data are analyzed using a series of advanced discrete choice models. Together, these empirical analyses allow us to tentatively derive implications for policy makers as to the role of moral aspects in the optimal development and implementation of social routing schemes. Furthermore, the estimates can serve as input in dynamic models, providing a base for agent-based models and network simulations.

The remainder of the paper is structured as follows: section 'Theoretical background' describes the fundamental differences between the two types of social routing schemes considered in this study and the moral motivations they aim to trigger. Section 'Data and methodology' presents the stated intention experiment and the morality survey and touches upon data collection and sample aspects. Section 'Empirical results and interpretation' presents the model estimations and interprets them in light of theories and notions from moral psychology. Section 'Conclusions and implications' summarizes the main takeaways from our study, translates these into tentative policy recommendations, and suggests avenues for further research on the topic.

2. Theoretical background

To move people towards making the social choice in their route choice and reach a system optimum, at least three different motivations appear in the literature: self-interest, altruism, and free ride avoidance, or more specifically, fairness. The first of these has received wide attention so far in the literature. The second motivation has come up in the context of investigating to what extent people are willing to choose the social route when there are no external incentives but only the right information. For example an alternative route would be provided and it would be indicated that, although the suggested route may be longer for the individual personally, it will contribute to saving travel time on the collective level. The third motivation of free ride avoidance and the different effects it has compared to altruism in a social routing system, seems to have received little attention so far. In the following, we argue that the motivation of free ride avoidance or fairness can be used to build a 'collective good based' social routing system, and that it can be a viable way to move people towards choosing the social route and reach the system optimum without relying on external incentives.

To get a better understanding of an individual's moral motivation to contribute to a collective good and not free ride it seems helpful to consider normative accounts of free riding given by moral philosophers. Cullity (1995) explains that the free rider gives herself an objectionable preferential treatment "in allowing herself not to pay for goods that she either does or ought to realize are worth paying for, and that she only receives because others are moved by the same realization to pay". This amounts to unfairness. Giving yourself a preferential treatment in collective good situations that cannot be reasonably justified is wrong even when no-one is directly harmed. Building on this, we establish that in order to target the free riding avoidance motivation in a social routing system we have to (1) make it clear to travelers that the system is a collective good, where everyone has to contribute to achieve success and (2) make sure that there is no reasonable justification for free riding.

The first condition can be met with information provision. In order to meet the second condition, there must be a fair distribution of costs and benefits among beneficiaries (otherwise those who contribute but do not benefit, or benefit significantly less than others, could object against the scheme) and the individual costs should not be higher than the individual benefits in the long run (otherwise the scheme is not worth to participate in at all). In situations where the above two conditions are met, free riding should be regarded as unfair because one profits from other people's contributions without contributing oneself and there is no reason to justify it. According to Cullity (1995) this is unfair even when the scheme has been imposed on someone involuntarily. As long as the scheme is fair and participation is overall beneficial, one should pay their share for the benefits provided by the scheme. Based on this normative account, it can be expected that when a collective good situation is as described above, considerations of fairness -in the sense of not wanting to unjustly profit from other people's contributions- may play a role in the decisions that people make. On the other hand, when the above conditions are not met, we have an altruistic, or 'sacrifice-

based' scheme at hand. If there is no fair allocation of the benefits or benefits for the individual in the long run, a contributing individual is most probably driven by an altruistic motivation like that of 'care': sacrificing one's own good for the benefit of others. Not joining a sacrifice-based scheme may indicate a lack of care, but does not amount to unfairness. On the flip side, participating in a collective good scheme does not amount to altruism, but rather being fair.

Considering these two distinct moral motivations and taking into account that a participant of a social routing scheme will participate over a longer period of time consisting of recurring longer trips, it may be expected that a collective good scheme is the more viable system. In this system the individual profits oneself from the generated collective good in the long run, while non-participation remains unfair. A sacrifice-based scheme that runs solely on information provision without assurance of individual benefit, can only count on people's altruism or care. It seems questionable, at the least, whether this could sustain long term participation. Arguably, in this context, the motivation of fairness harbours a stronger social and normative force than that of altruism.

Some of the recent literature also investigated different motivations in social routing systems, but mostly relying on information-level differences (Klein & Ben-Elia, 2018; van Essen et al., 2020b). Following our theoretical framework, many of the information based social routing systems that are considered in the literature should be categorized as sacrifice-based schemes. For instance, van Essen et al. (2020b) conceptualizes the social choice as one that entails "personal travel time sacrifice for the benefit of others" (p.1048). The design of the stated choice experiments does not include the recurrence of trips and thus lacks the assurance of individual benefit in the long run -making the motivation it triggers altruistic without testing its (lack of) sustainability in the long run. The revealed choice experiment of this study does include a recurrence of trips and also a principle of distributing the costs (28 participants are asked to drive the longer route to work for two days a week). Though this gets closer to a collective good scheme, the crucial assurance of individual benefit over the long run that needs to be in place is lacking and -importantly- there is no experience of profiting from other people's contributions when not complying -i.e. free riding.

Other literature does more or less construct the social routing scheme as a collective good scheme but miss, or at least do not thematize, the specific moral motivation that plays a role here. Klein & Ben-Elia, 2018, for instance, do explicitly take the recurrence of trips and the fair distribution of costs and benefits into account in their investigation of social routing systems. They argue that if these conditions are met and the individual benefits in the long run there is no need to rely on the unreliable motivation of altruism. The scheme should be regarded as a repeated game in which it is in people's own self- interest to cooperate and produce the collective good. However, as the authors make clear, when the group size in a repeated game increases -like in a social routing scheme- cooperation becomes less likely. In their experiment they test whether cooperation can be sustained through triggering an 'intrinsic motivation' by providing the information that following the recommended routes will lead to shorter average travel time for everyone in the end. However, what the 'intrinsic motivation' exactly entails here is not explicated. If it still refers to a form of self-interest it does not suffice for compliance. First of all, it is questionable whether in reality the individual gain in travel time is noticeable for the individual herself, especially given the variation of travel time due to random everyday incidents (van Essen et al., 2020b). Secondly, and more fundamental, pure self-interest within a collective good scheme leads to free-riding. Hence, a moral motivation must be assumed here that is not made explicit nor is further conceptualized: fairness or free-ride avoidance. Assuming that freeride avoidance plays a role here instead of mere self-interest also solves the first problem: even if travel gains are not noticeable for participants who sometimes drive longer routes, this seems less plausible for free riders who always take the shorter route. At least they should notice a reduction in congestion. As this amounts to profiting without contributing, the motivation of free ride avoidance can, theoretically, still play a role in steering individuals to compliance while self-interest cannot.

The social routing system as a collective good scheme with the specific moral motivation of fairness or free-ride avoidance -though sometimes partly or implicitly assumed in the literature- has, so far, not been explicitly conceptualized nor empirically investigated and been compared to the more frequently relied on sacrifice-based scheme.

In our study -building on our conceptual framework- we explicitly focus on these distinct moral motivations of altruism and free-ride avoidance. Although theoretically speaking, free-riding is primarily a violation of the principle of fairness and not making sacrifices for others a lack of altruism or care, the question on what basis individuals in real life make these choices is empirical. In our empirical study we therefore focus on the above described moral motivational differences and their aspects such as how much contribution is asked from the individual and how others behave under the social routing system. The following section describes our experimental approach and methodology.

3. Data and methodology

Our experimental approach has two main parts: a stated intention experiment (first wave) and a morality survey (second wave). For the first wave we designed the stated intention experiment the following way: participants are asked whether they would join a social routing scheme with specific attributes. The response is binary, yes or no. The attributes of the social routing scheme are:

- number of days, out of 10, on which the commuter will be asked to use the social route (levels can be 2 and 4 days out of ten),
- average additional travel time, representing the number of minutes the social route is slower than the non-social alternative (levels can be 3 and 7 min),
- total travel time saved in the system over 10 days if the commuter participates in the scheme (levels can be 40 and 75 min), and
- participation rate, which indicates the percentage of fellow road users that join the scheme (levels can be 20 % and 80 %).

Following our theoretical framework, we test the difference between sacrifice-based and collective good based incentives by embedding the above characteristics into two different schemes. The 'Sacrifice-based scheme' makes no mention about potential gain for the respondents themselves. The 'Collective good scheme' presents the decision as whether the respondent is willing to contribute to an outcome that is beneficial to all travelers, including the respondent. We highlighted that the overall travel time for the participating travelers is lower with the scheme than without it. We do not guarantee this in the Sacrifice-based scheme. Aside from this, the two presented schemes are the same. Each participant is assigned to one treatment (Sacrifice-based versus Collective good), where the schemes are considered to be established. This means that the participation rate is already on a higher than zero level, which allows us to study the effects under a hypothetical social norm, and provide a base for studying whether such schemes are sustainable in the long run. Such descriptive methods have been proved effective in creating a sense of social norm among respondents in the travel behavior domain (Kormos et al., 2015). In our stated choice experiment, each participant answers 16 questions with varying attributes within their respective scheme. As such, each participant evaluates all possible attribute level combinations in a full factorial design. Fig. 1 shows an example choice task for both schemes. Note that this approach goes beyond a mere framing exercise: the two schemes are inherently different in the sense that the collective good scheme would be designed in order to make everyone better off, including those who regularly choose the social route. It is also made clear that because the scheme was implemented one's regular route to work has become faster. Hence, not participating amounts to free riding as described in Section 2. In order to prevent an overload of information in the choice tasks, we did not add a

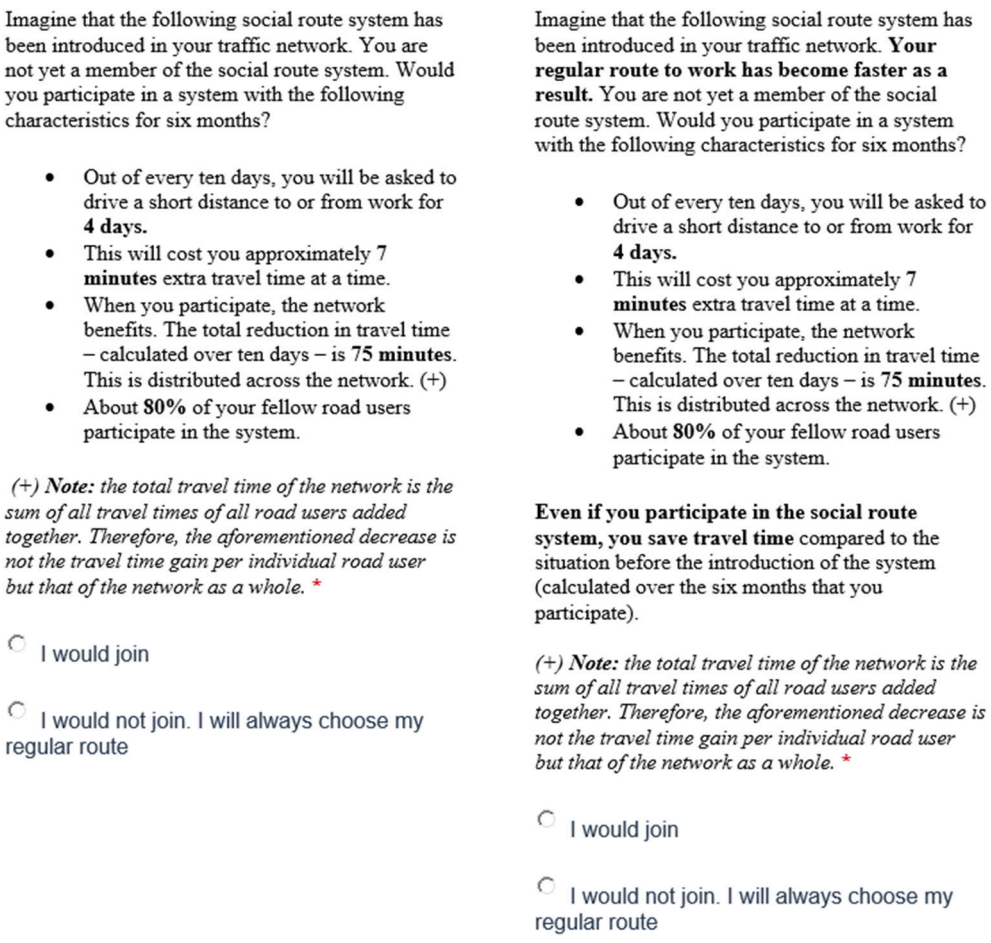

Fig. 1. Two example choice tasks of our stated choice experiment. The first column shows the sacrifice-based scheme, the second column shows the collective good scheme.

statement on the fair distribution of costs and benefits. As benefits are probably unnoticeable, their differences across travelers are even smaller, therefore making sure there are no losers implies the system is more or less fair without going into complicated details of the benefit-distribution.

After the choice tasks we asked the respondents about their motivations when making their decisions. Respondents indicated on a Likert-scale from 1 to 5 how important the following motivations were for them when making their decisions:

- "To do something for my fellow road users",
- "Make sure that others don't profit from my personal contribution",
- "Help solve congestion for me and my fellow road users",
- "Make sure that I do not profit from other road users' contributions while not contributing myself',
- "Ensure that my own travel time is minimized".

In the second wave, we collected data on the moral character of respondents using the widely used Moral Foundations Questionnaire (MFQ). MFQ is built on the Moral Foundations Theory (MFT, Graham et al., 2009), which argues that at least five basic 'moral foundations' are the same across people and cultures. Moral characters only differ in the extent to which they value these basic foundations. Namely, these foundations are care / harm, fairness / cheating, loyalty / betrayal, authority / subversion, sanctity / degradation. We use the MFQ with 30 questions and statements where respondents choose to what extent they agree with a statement or to what extent something is crucial for them when making a moral decision.

We collected the data from a representative panel of the Dutch population in 2021, for the first wave in March, for the second wave in April.[2] Travelers who commute by car and are above 18 years old were recruited. Respondents first filled in the choice experiment, then two weeks later the MFQ. As the MFQ has two control questions, we use these to detect inattentiveness. Similarly to Viďak et al. (2020), we also use the following rule: those who reply 2 to 5 to question 6 (meaning it is from somewhat to extremely relevant to them whether or not someone was good at math when making a judgment of moral right and wrong) or 1 to 3 to question 21 (meaning they firmly to slightly disagree with doing good is better than doing bad) were excluded from the analysis. Our final sample consisted of 786 respondents (395 in the altruism frame and 391 in the collective good frame) and 12,576 choice tasks. In this data that we used for our analysis, 46 % of participants are female, the average age is 45.3, and the mean of their average trip to work is 27.8 min.

The choice experiment and morality survey were analyzed using Discrete Choice Models (DCMs, for an extensive overview, see Train (2009)). For benchmark, we use the binary logit model, a regression model where the dependent variable is binary, in this case whether or not someone joins the social routing scheme. The explanatory variables are the specifics of the scheme (additional travel time, number of days to drive the longer route, travel time benefit for all, and participation rate). The binary logit cannot account for random taste variation (i.e., taste

[2] The study was approved by the human research ethics committee (case number of application: 1039).

differences that cannot be linked to observed determinants). In order to account for such random taste variation, we use panel mixed logit models which allow us to estimate not just one taste parameter for the population, but also a distribution for them. The following section shows our estimation results.

4. Empirical results and interpretation

We first present a simple base model to set the stage for our analyses, see Table 1. We estimate a binary logit model on the combined data of the two schemes. We use the linear additive form for the utility. Each attribute weight includes a dummy indicator that takes a value of 1 for responses from the Collective good scheme and 0 for responses from the Sacrifice-based scheme. The utility specification can be found in the Appendix. We directly obtain all parameter estimates and standard errors for the Sacrifice-based scheme and the indicator terms (indicating the respective difference between the two schemes). Then we obtain the Collective good scheme estimates by adding the Sacrifice-based scheme's corresponding estimates and the differences. The standard errors are calculated using the Delta method.

This binary logit model predicts the stated intention to join a social routing scheme with particular attributes, as a linear function of the attribute values. We distinguish between the two schemes (Sacrifice-based versus Collective good), to explore whether sensitivities to attributes are specific to a particular scheme. It may be noticed that all parameters have the expected sign, with Number of days and Additional travel time being valued negatively and Network travel time benefit and Participation rate being valued positively. All but one parameter are significant at a 1 % level: Network travel time benefit is not significant at conventional levels of confidence. The only significant difference between the two schemes is found for the attribute Additional travel time, which is valued more negatively in the Sacrifice-based frame than in the Collective good frame. This difference is intuitive, as the Collective good frame promises travelers that they will not be worse off compared to the situation without a social routing scheme in place, even though for particular days they may experience a slightly longer travel time than they would have, if they would not have joined the scheme. To get an idea of the implied sensitivity of the different attributes, we computed the predicted probability that a randomly sampled traveler would intend to join a social routing scheme with particularly unattractive versus particularly attractive attributes under a particular frame. Penetration rates vary between 31 % and 75 % for the Sacrifice-based frame, and between 36 % and 74 % for the Collective good frame. This suggests that the latter scheme is slightly more popular, which is in line with the observed empirical frequencies in the dataset.

Table 1
Binary logit model of differences in the two schemes. The model is estimated on the combined data of both schemes. The corresponding systematic utility function of differences can be found in the Appendix. *, ** & ***, respectively represent significance at 10 %, 5 % & 1 % levels.

	Sacrifice-based Est.(SE)	Collective good Est.(SE)	Differences Est.(SE)
Predisposition to social route	1.949(0.176) ***	1.663 (0.159) ***	−0.287 (0.237)
Number of days	−0.235 (0.025) ***	−0.202 (0.024) ***	0.033 (0.035)
Additional travel time	−0.272 (0.019) ***	−0.220 (0.018) ***	0.051 (0.027) ***
Network travel time benefit	0.0003 (0.001)	0.0002 (0.001)	−0.0001 (0.002)
Participation rate	0.0049 (0.001) ***	0.0055 (0.001) ***	0.0006 (0.001)
Estimated parameters (k)	10		
McFadden R^2	0.058		
Final-loglikelihood	−8199.9		
Number of choices	12,576		

As can be seen when inspecting McFadden's rho-square, the model fit of this base model is rather poor, suggesting that the incorporation of panel effects (i.e., acknowledging that choices made by one individual may be correlated) in combination with heterogeneity in tastes could lead to a more realistic model. The results of such a panel mixed logit model are presented in Table 2.

The mixed logit model is also estimated on the combined data of the Sacrifice-based and Collective good schemes. However, in the mixed logit specification, we allow for differences between the two schemes in terms of mean and standard deviation estimates for each attribute, including the constant for joining the social route. More specifically, we include a dummy variable defined exactly as previously in the binary logit model and interact it with each attribute's mean and standard deviation. A significant difference in the mean estimates for an attribute indicates that the specific attribute has a different effect (on the decision to join the scheme) under the Collective good scheme and the Sacrifice-based scheme. On the other hand, a significant difference in the standard deviation estimates for an attribute informs about variations in the level of heterogeneity in the attribute's effect (on the decision to join the scheme) across the two schemes.

After exploring various distributional assumptions, all parameters are modeled with a normal distribution, which proved to lead to the most stable convergence. As a first observation, the model fit improves greatly, suggesting that as expected, panel effects and heterogeneity are important factors behind the choices made by participants. Signs and significance levels are the same as in the binary logit model (sensitivity to Network travel time benefit again being the only non-significant effect); additionally it is found that all parameters come with high and significant levels of heterogeneity. This implies that the variation within the sample in terms of sensitivity to the attributes of the proposed routing scheme, is considerable. As in the binary logit model, we find that the sensitivity to Additional travel time is, again intuitively, greater for the Sacrifice-based scheme than for the Collective good frame.

To explore whether or not, in what ways and to what extent, moral personality as measured by the MFQ plays a role in explaining stated intentions for joining the social routing schemes, we interacted five morality-dummies with the constant that captures travelers' average inclination to join the social route. For the utility specification see Appendix. Note that the use of dummies was motivated by model stability considerations, as was the decision to not estimate a standard deviation for the constant simultaneously with the morality-interactions. Each dummy represents a particular moral dimension (Care, Fairness, Ingroup, Authority, Purity); whenever the individual would score at least 24 out of 30 points for a particular dimension, the corresponding dummy would take on the value of 1. Note that each dimension was measured by means of six questions, each having answer categories ranging from 0 (not at all relevant or strongly disagree) to 5 (extremely relevant or strongly agree). As such, each dummy is informative of whether or not someone scored very high on the corresponding moral dimension, implying that they believe that the particular moral foundation is key to their personal morality. Models were estimated using the Apollo package (Hess & Palma, 2019) in R; we used 16,000 MLHS draws (Hess et al., 2006) for the random parameters, after verifying that results were similar to models with half that number of draws. Results are presented in Table 3.

These outcomes can be summarized as follows: under the Sacrifice-based frame, whether someone strongly adheres to the Care foundation has a significant (at 1 % level) and sizable positive effect on their intention to join the social routing scheme. Other moral dimensions do not have a significant effect. Under the Collective good frame, Fairness has a significant (at 5 % level) and positive effect of moderate size, while Ingroup has a significant (at 5 % level) and negative effect. Note that the effect of Ingroup is also negative, but not significantly so, under the Sacrifice-based frame. Authority and Purity do not have significant effects on stated intentions to join the social routing scheme, under either frame.

Table 2
Mixed Logit model for the differences in the two frames. The model is estimated on the combined data of both schemes. A normal distribution is assumed for all explanatory variables. The corresponding systematic utility function of differences can be found in the Appendix. *, ** & ***, respectively represent significance at 10 %, 5 % & 1 % levels.

	Sacrifice-based		Collective good		Difference in mean	Difference in std.dev
	Est. (SE)	Std.dev (SE)	Est. (SE)	Std.dev (SE)	Est. (SE)	Est. (SE)
Predisposition to social route	7.485 (0.564)***	6.111 (0.436)***	6.191 (0.521)***	5.985 (0.458)***	−1.294 (0.493)***	−0.126 (0.116)
Number of days	−0.984 (0.117)***	0.975 (0.163)***	−0.811 (0.092) ***	0.865 (0.108)***	0.174 (0.143)	−0.111 (0.155)
Additional travel time	−1.123 (0.086) ***	0.891 (0.093) ***	−0.869 (0.076) ***	0.943 (0.078)***	0.254 (0.094)***	0.052 (0.115)
Network travel time benefit	0.004 (0.004)	0.054 (0.008)***	0.003 (0.004)	0.035 (0.004)***	−0.001 (0.001)	−0.019 (0.009)**
Participation rate	0.022 (0.003)***	0.034 (0.004)***	0.023 (0.003) ***	0.038 (0.003)***	0.002 (0.004)	0.004 (0.003)
McFadden R^2	0.51					
Final-LL	−4258					
Estimated parameters (k)	20					
Number of choices	12,576					

Table 3
Mixed logit models estimated separately for the two schemes, using MFQ interactions with the alternative specific constants, or in other words, the predisposition to join the social routing system (ASC_SR). See Appendix for the utility specification. The four scheme-specific attributes are assumed to have a normal distribution. Alternative specific constants are interacted with moral dummies (being 1 if the cumulative score is at least 24 out of 30 points). *, ** & ***, respectively represent significance at 10 %, 5 % & 1 % levels.

Variable	Sacrifice-based		Collective good	
	Est. (SE)	Std.dev (SE)	Est. (SE)	Std.dev (SE)
Predisposition to social route (ASC_SR)	5.490 (0.303)***		4.485 (0.335)***	
Number of days	−0.811 (0.077)***	0.861 (0.083)***	−0.698 (0.076)***	0.772 (0.094)***
Additional travel time	−0.949 (0.062)***	0.737 (0.080)***	−0.755 (0.067)***	0.932 (0.091)***
Network travel time benefit	0.001 (0.009)	0.060 (0.007)***	0.005 (0.005)	0.051 (0.005)***
Participation rate	0.017 (0.003)***	0.029 (0.003)***	0.021 (0.003)***	0.036 (0.004)***
ASC_SR x Care	2.047 (0.615)***		0.479 (0.558)	
ASC_SR x Fairness	0.807 (0.770)		1.340 (0.665)**	
ASC_SR x Ingroup	−1.418 (1.276)		−2.845 (1.415)**	
ASC_SR x Authority	0.819 (1.023)		2.184 (1.683)	
ASC_SR x Purity	−1.083 (1.053)		1.486 (1.314)	
McFadden R^2	0.49		0.50	
Final-LL	−2215.5		−2165.9	
Estimated parameters (k)	14		14	
Number of choices	6320		6256	

We consider the differential effects of Care and Fairness under the two schemes an important and intuitive result: as conceptualized, a social routing scheme that is designed and framed as a sacrifice-based scheme in which travelers make personal sacrifices for other travelers, taps into the Care dimension of people's morality, making those that strongly adhere to this dimension particularly susceptible to joining the scheme. In contrast, the Care dimension does not seem to play a role when the scheme is designed and positioned as a collective good to which all are expected to contribute to the common good. In this frame, fairness is a leading factor, implying that travelers who strongly adhere to the Fairness dimension or morality are particularly likely to join the Collective good scheme. Given the nature of the two schemes, this result is intuitive, in the sense that not participating to a Collective good scheme (as opposed to not joining a Sacrifice-based scheme) may be considered as unfair: the scheme is beneficial to the traveler -joining the scheme would make the traveler better off than before the scheme was implemented-, not joining would thus amount to unjustly benefitting from other people's contributions without contributing oneself and, hence, a form of free riding. These empirical findings lend support to our theoretical exposition (presented in Section 2) regarding the difference between sacrifice-based social routing schemes and collective good schemes, in terms of the moral motivations they tap into.

To grasp the negative effect of Ingroup on joining the social routing scheme (under both frames, but only significantly so under the Collective good scheme), it is good to look at the particular questions used to measure this dimension in the MFQ: these relate to loyalty to e.g. family, implying a distinction between in-group and out-group loyalty. It has been argued in another travel behavior context (van den Berg et al., 2020) that this particular definition and measurement of Ingroup morality could actually imply that those who score high on this dimension, are less willing to collaborate with or care for strangers outside their own in-group, as would be the case in joining a social routing scheme. As such, the negative association found in our experiment is in line with previous findings and interpretations.

It has been suggested that the moral values elicited by the MFQ are so general, abstract and deep-seated that they make poor predictors of concrete moral behaviors in real life (Kroesen & Chorus, 2018; van den Berg et al., 2020). Our results do find meaningful associations, which is probably partly due to the fact that our measured 'behaviors' are actually stated intentions in a rather abstract experiment setting. Nonetheless, we also explore associations with more contextually related moral motivations, which we operationalize by means of five questions. (note that these motivational questions were asked directly after the choice experiment in contrast with the moral foundation questions which were asked in the second wave administered two weeks later; this provides another reason why we would expect the answers of the motivational questions to correlate relatively strongly to the stated intentions to join a scheme) The resulting answers, on a Likert scale ranging from 1 to 5, are taken to be proxy measurements of five moral motivations for joining (or not) the social routing schemes presented in the experiment. We label these motivations as: Altruism ("To do something for my fellow road users"), Competition ("Make sure that others don't profit from my personal contribution"), Common good ("Help solve congestion for me and my fellow road users"), Fairness ("Make sure that I do not profit from other road users' contributions while not contributing myself"), and Individualism ("Ensure that my own travel time is minimized"). For each dimension, a dummy was created to identify those who strongly identify with a particular motivation, i.e. scored a 5 on the corresponding Likert scale. Models were estimated using 16,000 MLHS draws for the random parameters, after verifying that results were similar to models with half that number of draws.

Results are presented in Table 4 and can be summarized as follows: as expected, we over-all find stronger effects for these more contextual motivations, than we did for the generic moral personality dimensions. A clear distinction can be observed between the effects under the

Table 4
Mixed logit models estimated separately for the two schemes, using contextual moral motivation interactions with the alternative specific constants, or in other words, the predisposition to join the social routing system (ASC_SR). See Appendix for the utility specification. *, ** & ***, respectively represent significance at 10 %, 5 % & 1 % levels.

Variable	Sacrifice-based		Collective good	
	Est. (SE)	Std.dev (SE)	Est. (SE)	Std.dev (SE)
Predisposition to social route (ASC_SR)	7.32 (0.60)***	6.27 (0.50)***	5.23 (0.61)***	5.10 (0.44)***
Number of days	−0.95 (0.09)***	1.01 (0.11)***	−0.79 (0.09)***	0.97 (011)***
Additional travel time	−1.12 (0.08)***	0.87 (0.08)***	−0.83 (0.07)***	0.90 (0.08)***
Network travel time benefit	0.03 (0.04)	0.49 (0.05)***	0.03 (0.06)	0.31 (0.04)***
Participation rate	0.21 (0.03)***	0.34 (0.03)***	0.24 (0.03)***	0.37 (0.03)***
ASC_SR × Individualism	−2.65 (0.85)***		−1.14 (0.85)	
ASC_SR × Altruism	2.55 (1.20)**		2.34 (2.11)	
ASC_SR × Competition	−1.36 (1.49)		−3.68 (1.30)***	
ASC_SR × Common good	4.46 (0.84)***		4.75 (0.82)***	
ASC_SR × Fairness	0.87(1.47)		4.97 (1.96)**	
McFadden R^2	0.51		0.52	
Final-LL	−2133.16		−2092.97	
Estimated parameters (k)	15		15	
Number of choices	6320		6256	

Sacrifice-based frame versus the Collective good frame: under the Sacrifice-based frame, Individualism is negatively associated with joining the social routing scheme and Altruism and Common good are positively associated with joining. These relations are intuitive. Competition and Fairness do not have a significant effect, although their signs are as expected. Under the Collective good frame, Individualism and Altruism are not associated with joining the scheme (but note that signs are as expected). Just like in the Sacrifice-based scheme, Common good is positively related to joining the scheme under the Collective good frame. Under this frame, Competition (negative) and Fairness (positive) are both significantly related to the intention to join the scheme, whereas these had no significant association under the Sacrifice-based scheme.

These differential associations between moral motivations and the stated intention to join the social routing system under the two distinct schemes, are in line with intuition as well as the conceptualizations presented further above. Since the Sacrifice-based scheme emphasizes the sacrifice made for other road users, this resonates with people whose motivation to join is driven by altruistic and common good related motivations, and it scares off those people with individualistic motivations (ensuring low travel times for themselves). In contrast, the Collective good scheme emphasizes the notion that also participants benefit from the scheme, attracting those for whom fairness and contributing to a common goal (fighting congestion) is important. The Collective good scheme does not scare off people with individualistic motivation as much (although the sign is, as expected, negative, it is not significant), despite the shortest travel time is always ensured with free riding. Those with competitive motivations are less likely than others to join a Collective good scheme, which is intuitive as the scheme is implicitly equitable in the sense of creating a more uniform distribution of travel times across participants by asking everyone to take turns and 'take one for the team'.

Note that in real life, the attributes that are considered in our study (e.g., additional travel time on the social route; travel time saved at a network level) are all endogenous variables. This means that the decision made by participants to a real-life social routing scheme will have an influence on each one of them, and that each of these variables in turn influences each other. In our choice experiment and analyses, we are able to treat these attributes as if they were exogenous and can be independently varied. Varying them systematically through the choice tasks allows us to extract their marginal effects on the willingness to join different social routing schemes, under controlled conditions. This method has several benefits which are complementary to the benefits that would be obtained by real-life observational studies. For example, using the statistical method of discrete choice models, we can establish in a controlled fashion, which attributes have a different marginal effect between the two social routing scheme contexts; in our case, only the additional travel time on the social route turns out to have a significantly different effect on participation. Second, the obtained (under controlled, experimental conditions) marginal effects provide a clean starting point for use in dynamic models which aim to study network wide dynamics over the long run. Such network studies which aim to assess social routing policies often assume full compliance (e.g., Angelelli et al., 2016), however it is more realistic to assume that there is a significant share of people who freeride (e.g., van Essen et al., 2020a). Attributes such as additional travel time spent on the social route, or the participation rate of other travelers, have a significant effect on whether people join such schemes, and thus, whether the scheme is successful in the long run. Our experimental approach allows us to obtain first insights into these variables' effect on participation, as a base for further, real life and network level studies.

As this study focuses on how people interact with an existing social norm, we examine schemes which are considered to be established (i.e., at least 20 % participation rate, and at least 40 min travel time saved in the system in each choice task). This phase is highly dependent on behavior under a social norm both directly (e.g., peer imitation or reciprocity) and indirectly: the more people participate, the smaller the required individual contribution is. It may be noted here that, in social routing schemes, the initial phase is also crucial, even if a social norm is not yet in place. Convincing the first few people to participate in such a scheme is a challenging task. In an experiment that wishes to uncover the initial participation process (as opposed to our study, which is focused on a post-initial phase), formulating the question in a hypothetical way can be a solution to this challenge. This means, instead of presenting their current levels (which is the case in our experiment, in the long run), network travel time benefit and participation rate could be presented at their optimal level. For example, the following statement could be used: "This system can achieve 60 minutes network travel time benefit, if at least 50% of all road users participate in the system." For a collective good based scheme, this could be followed by an additional statement, such as: "In this case, everyone within the network, including the participants, benefits in the long run."

5. Conclusions and discussion

Social routing schemes are touted as having the potential to reduce congestion while enjoying a relatively high level of public acceptance. These considerations have motivated a growing literature describing research efforts aimed at understanding travel behavior in the context of such schemes. The ultimate goal of such studies is to identify the most promising schemes in terms of their acceptance by travelers and their subsequent effects on network wide travel times. While the scientific community is nowhere near finding complete and reliable answers, much progress has been made. This paper contributes to this endeavour by focusing on an aspect of social routing schemes that hitherto has been underexplored: moral personality and moral motivations. Specifically, we looked into the interaction between the characteristics and framing of the scheme on the one hand, and travelers' moral personality and moral motivations on the other hand.

Using conceptual expositions and stated intention experiments, we shed light on these behavioral interactions: we hypothesize and

empirically confirm that when the scheme is framed and designed as an altruistic effort (requesting personal sacrifices for the benefit of other travelers), mostly people who adhere to care related notions of morality are attracted to such a scheme. Contrary, a scheme that is designed and framed as a collective endeavour which would also benefit participating travelers (relative to the situation without a social routing scheme) attracts those who strongly adhere to moral notions related to fairness. These associations were found both at the level of generic personal morality as well as at the level of more targeted (to the specific context) moral motivations, implying robustness of these results. Interestingly, while moral personality and moral motivations turned out to significantly interact with the framing of the social routing schemes, the overall popularity of the schemes was about equal under the two frames – the Collective good frame only inducing slightly higher levels of stated intention to join the scheme.

We believe that the results presented in this paper have a relevance, albeit tentatively, for practitioners and policy makers. The main reason for being cautious here, is that our empirical results are obtained using a stated intention survey. Although there is growing evidence of the reliability and external validity of properly designed stated choice experiments, especially when they mimic situations that participants can easily relate to (Haghani et al., 2021; Rossetti & Hurtubia, 2020), we wish to note here that real life pilots are needed to further study the role of morality in the acceptance and effectiveness of social routing schemes. One differential outcome that we would expect from real life pilots is a larger difference between the overall willingness to join the sacrificed-based scheme and the collective good scheme. The particular downside of the former scheme of not benefitting from one's contribution over recurrent trips, as stipulated in Section 2, is expected to be a stronger driving force in a real life setting compared to stated intentions. Nonetheless, what our findings do suggest is that morality plays a role in travelers' acceptance (willingness to join) social routing schemes and hence plays a role in defining their network level effects. Moreover, we find that different types of schemes appeal to different types of road users, in ways that align with intuition and literature on moral decision making. Where a sacrifice-based scheme taps into notions of care, a collective good scheme taps into notions of fairness, broadly speaking. This leaves road authorities with a consequential decision to make: what type of social routing scheme, if any, should they implement?

The following considerations are relevant here: first, it should be noted that a sacrifice-based scheme is easier to implement than a collective good scheme, simply because the former does not need to live up to the promise of generating travel time gains – relative to the situation without a scheme – to participants. On the contrary, in order to be perceived as credible, a collective good scheme would need to ensure that most or all participants would benefit from joining the scheme even when occasionally being diverted to a slower route or less convenient departure time. This is not an easy task for a traffic authority, as it demands very careful forecasting and optimization; it is unclear whether the current state of technology would allow for such a tailored distribution of travel time benefits, although promising steps are made towards ever more sophisticated social routing schemes (Chen et al., 2021). It goes without saying that a scheme which claims that it also benefits participants, but in reality fails to live up to that promise, is doomed. The sacrifice-based scheme is much easier to implement as it makes no such promises.

The second consideration relates to the difficulty for sacrifice-based schemes in maintaining the loyalty of participants: our experiment affirms what other studies have found, in that willingness to join a scheme is determined by the size of the sacrifice – in terms of how often one is asked to choose the social alternative as well as in terms of the travel time difference with the usual alternative – and by the number of participants. This could easily set in motion a vicious circle of reduced willingness to participate: once a participating traveler becomes tired of making sacrifices for their fellow road users, they may be tempted to drop out. Once other participating travelers notice, they will become less likely to remain in the scheme (as the number of participants positively affects one's willingness to join). Furthermore, every traveler that leaves the scheme would trigger an increase in the sacrifices that need to be made by other participants to obtain the same system optimum, further eroding the willingness of the remaining travelers to continue their participation. Such a race to the bottom could easily and quickly lead to a depletion of altruistic motivations even among those with strong adherence to notions of care. No one wants to be the sole altruistic agent surrounded by a group of free riders. Such a destructive tipping point dynamic is less likely to occur when the scheme is set up as a collective routing scheme: in such a scheme, there is a much more limited incentive to drop out, as there are also personal benefits associated with participating. Furthermore, it seems reasonable to expect that free riding in the context of a fair social routing scheme has a higher chance of being frowned upon by others compared to just not being altruistic in a sacrifice-based social routing scheme, as stipulated in Section 2. As such, we believe that social norms and peer pressure are more likely to sustain a collective good scheme than a sacrifice-based one.

As a third consideration, the distribution of costs and benefits across different 'moral types' should be considered by transport authorities. Our results suggest that a distinct group of care-oriented travelers would carry the largest burden of travel time sacrifices under a sacrifice-based scheme, whereas individualistic travelers would reap the benefits. Irrespective of how behaviorally sustainable such a distribution is in practice (see discussion above), the question should be asked whether society and its policy makers should actually be willing to accept such a situation. In contrast, the collective good scheme by design does not create a burden for any particular 'moral type': although participants to the scheme, driven mostly by fairness considerations, will benefit less than free riders, the former too will reap some benefits compared to the situation without a social routing scheme. As such, from a distributional justice perspective, a collective good frame may be preferred over a sacrifice-based scheme.

However, our results suggest that there is no silver bullet in the form of a social routing scheme that would be viable in the long run, in terms of travelers' willingness to participate, while at the same time being fair and easy to implement. This however, is a tentative conclusion drawn at this particular moment: as technology progresses and our understanding of traveler behavior – including moral aspects – advances, (partial) solutions to this conundrum may be found, building on the large and growing body of literature on the topic of social routing to which this paper contributes.

CRediT authorship contribution statement

Teodora Szep: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Tom van den Berg:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Nicolas Cointe:** Conceptualization, Writing – review & editing. **Aemiro Melkamu Daniel:** Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – review & editing. **Andreia Martinho:** Conceptualization, Writing – review & editing, Project administration. **Tanzhe Tang:** Conceptualization, Writing – review & editing. **Caspar Chorus:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be uploaded to the 4TU repository

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Appendix A

The systematic utility specification for the binary logit model of Table 1:

$$V_{SR,nt} = \sum_{k=0}^{K} (\beta_k + \delta_k F)\, x_{knt}$$

Where the k represents the four basic attributes and the average inclination to join the scheme and $\beta_k$their corresponding weights in the Sacrifice-based scheme. δ_k represents the difference between the estimate of parameter k for the Collective good scheme (F = 1) and the Sacrifice-based scheme (F = 0). Using this utility specification, the probability that individual *n* chooses to join the social routing scheme in choice occasion *t* is given by a binary logit model displayed in Table 1. The same systematic utility is used in Table 2, except $V_{SR,\,nt}$, β_k, and $\delta_k$are not considered to be a single value, but a distribution instead.

The systematic utility specification for the morality interactions (Tables 3 and 4) are also in a linear additive form:

$$V_{SR,nt} = \sum_{k=0}^{K} \beta_k\, x_{knt} + \sum_{m=0}^{M} \beta_m\, D_{mn}$$

Where *m* represents the moral foundations/motivations and $\beta_m$their corresponding weights. $D_{mn}$is a dummy variable which takes the value of 1 if individual *n* strongly adheres to foundation/motivation *m*. The weights of the moral foundations/motivations are non-random, while the weights of the four basic attributes are normally distributed random variables. The weight for the average inclination to join the scheme is non-random for the moral personality (or MFQ scores) model (Table 3), and normally distributed random for the contextual moral motivation model (Table 4). This is due to stability reasons. These two specifications are estimated separately on the two schemes.

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