Selfishness and Altruism in the Distribution of Travel Time and Income

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Abstract

Most economic models assume that individuals act out their preferences based on self-interest alone. However, there have also been other paradigms in economics that aim to capture aspects of behavior that include fairness, reciprocity, and altruism. In this study we empirically examine preferences of travel time and income distributions with and without the respondent knowing their own position in each distribution. The data comes from a Stated Preference experiment where subjects were presented paired alternative distributions of travel time and income. The alternatives require a tradeoff between distributional concerns and the respondent's own position. Choices also do not penalize or reward any particular choice. Overall, choices show individuals are willing forgo alternatives where they would be individually well off in the interest of distributional concerns in both the travel time and income cases. Exclusively self-interested choices are seen more in the income questions, where nearly 25% of respondents express such preferences, than in the travel time case, where only 5% of respondents make such choices. The results also suggest that respondents prioritize their own position differently relative to regional distributions of travel time and income. Estimated choice models show that when it comes to travel time, individuals are more concerned with societal average travel time followed by the standard deviation in the region and finally their own travel time, while in the case of income they are more concerned with their own income, followed by a desire for more variability, and finally increasing the minimum income in their region. When individuals do not know their fate after a policy change that affects regional travel time, their choices appear to be mainly motivated by risk averse behavior and aim to reduce variability in outcomes. On the other hand, in the income context, the expected value appears to drive choices. In all cases, population-wide tastes are also estimated and reported.

keywords: *selfishness, altruism, travel time distribution, income distribution, preferences, inequality, choice experiment.*

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1 Introduction

Both time and money are scarce resources. We schedule our daily activities and prioritize among them in the 24 hours available. We are willing to use some of that time to travel to activities often balancing between the time travelled, time spent at the destination, and time left for other activities. We treat money in the same fashion. Most of us have to live within a budget and prioritize how it is spent or saved for other purposes. There are of course differences between the two. The value of time is contingent on the activities it is tied to. Time during a leisurely drive has a different value from that spent over the morning commute which is again different from what it would be during an emergency. Money on the other hand doesn't usually suffer from such fluctuations in the short run, while over the long run its value can change dramatically.

Distributional concerns over income have long been a part of political and economic discourse. The impact of how income is distributed in a society shows up in disparities in living conditions, education, skills, and health outcomes. Many governments put in place redistributive policies through taxation and spending to address these disparities. Comparatively, the distribution of travel time attracts much less attention even though many transportation policies also alter travel time distributions either implicitly or explicitly. But debates are seldom framed in terms of travel time distribution. These views prevail because travel time outcomes are mostly seen as arising from household choices of residence and destinations.

Transportation system changes, including traffic signals and ramp meters, advanced travel guidance systems, and route expansions, alter travel time distributions and create winners and losers. Individual reactions to these outcomes may depend on how much the losers from these policies lose as well as whether they understand the overall societal gains to be had from the change. Properly understanding the thresholds that people accept can help engineers, planners, and policy makers adjust their prescriptions by balancing efficiency with what is behaviorally acceptable. Preferences about policies where people are fully informed about what they may give up personally and what is broadly gained by the region or community may be different from situations where such information is missing or incorrect.

This paper reports on an experiment where individuals are asked to trade off their own travel time and income for overall changes in travel time distributions and income distributions, respectively. The travel time questions in the experiments are framed in the context of a transportation improvement. The end distribution of the improvements and where it leaves the traveller are explicitly shown. In the income context, preferences reflect a choice between alternate locations where the person wishes to live. In this case no policy is presented which alters the individuals own income to avoid the intricacies of political debates around taxation and the role of government in redistributing income. Respondents choose a region to live in given two similar jobs in places where the income distributions and offered salaries are different. Both sets of questions are also asked in a context where respondents do not know their own position. This allows us to discuss how preferences change when uncertainty about one's own fate is introduced.

The next section provides a brief background on economic models that consider fairness and distribution as part of decision making. That is followed by a discussion of the survey and a section on the data. The choice patterns under conditions where respondents know their position in the travel time and income distributions are then discussed. That is followed by a section where a choice model is estimated using the data. Finally, section 5 provides summary and conclusions.

2 Background

The traditional economic paradigm is that people are self-interested actors whose choices derive from a goal of maximizing their individual utility. The rational utility maximizing actor is concerned about getting the highest utility given his budget by allocating it to consumption at prevailing prices. Increases in income lead to higher utilities and maximization of individual utility drives consumption decisions. Allocation of time for the utility maximizing individual also proceeds similarly though there exists a hard constraint where increases in time are not possible. Given this constraint the individual chooses an allocation of time between different activities that leads to the highest utility. Some activities such as work are linked to generating the income that goes to consumption; other time is allocated to leisure and still other is allocated to activities such as travel where there are minimum time requirements (DeSerpa, 1971; Evans, 1972). This formulation leads to the derivation of different values of time and also provides the basis for a value of travel time savings for activities such as travel where a person spends the minimum required time (DeSerpa, 1971; Mackie et al., 2001).

We do not dispute that choices are in large part self-interested. People choose where to live so that the location best suits their needs subject to a budget. They choose particular routes to go to work because they expect it will bring them to their destination faster. We have no evidence that any traveler makes systematic route or destination choices so that others are able to have shorter travel times (though individuals often yield to others at intersections, merges, or lane changes, which is a small version of this phenomenon, accruing delay to avoid delay for another). This is however not to argue that individuals would not want reduced travel time for others even while being self-interested. Such behavior may be observed because individuals see benefits from redistribution even if it leaves them personally worse off in one dimension. For instance higher travel time may be acceptable if individuals see that the change that increases their travel time also reduces overall pollution, the benefits of which they will share directly. Alternatively, altruistic preferences, where people accept higher travel times for some other global gain may also be present. Personal position may be sacrificed if people believe some level of overall efficiency is realized, or if they perceive that being fair to others, a group that includes friends and relatives, is a good thing or is consistent with their moral values. These kinds of choices are presented to people often through policy initiatives that have the effect of altering their own experiences as well as that of those around them.

In the transportation context, the willingness for such tradeoffs can inform implementation of ramp metering, signals, advanced traveler information systems, and other Intelligent Transportation Systems technologies, which by their very nature adjust time distributions while fulfilling different societal/global objectives (e.g. see (Zhang and Levinson, 2005)). The implication here would be that individuals may have a willingness to pay (or at least have a willingness to give up) some of their own travel time, if they knew that policy measures could leave a majority of others well off.

A willingness to forego one's own income for a distribution that avoids extreme poverty is also possible. One can be motivated by a variety of concerns none of which are necessarily looking at fairness itself as an end (Scanlon, 1997). If one perceives that more equality will lead to a better quality of life, better healthcare, less crime, or better schools, these may in fact be within the individuals self-interest since these benefits apply to the individual as well as their kin. The self-interested paradigm need not change to accommodate these concerns. But preferences can also be driven by the desire to see others well off, though the motivations behind such willingness could be difficult to discern (Elster, 2006).

Several experiments from ultimatum games summarized in Thaler (1988) provide evidence for the existence of fairness consideration in decision making. In such games one person would offer another a share s of a total amount x. In the event of acceptance, the proposer gets $x - s$ and the acceptor s. If the acceptor rejects the offer, then both get nothing. While the game theoretic solution (for a non-repeated game) to this problem is that the person proposing should offer a very small amount and the person getting the offer should accept any positive gain, experimental findings do not reflect this outcome. For instance, in the experiments of Guth et al. (1982), most of the offers made were generous and were accepted, while in the experiments of Kahneman et al. (1986), respondents were willing to reject what were unfair offers even when it meant the payoffs to themselves would have been positive. More recently, Marchetti et al. (2011) have shown acceptance rates also depend on the characteristics of those making the offer. The rejections show the existence of a willingness to pay to attain fairness from others (Kahneman et al., 1986). While those who offered generous amounts may have been motivated by a need for fairness, fear of rejection might also induce a similar behavior.

Attempts to incorporate fairness into traditional economic models have been made. For instance Rabin (1993) proposes a model where people are nice to those who are nice to them, and mean to those who are mean to them. Fehr and Schmidt (1999) offers a theory of fairness based on the hypothesis that individuals want equitable outcomes. A utility form is proposed that penalizes an unfair allocation. In this framework, both an advantageous (where the individual is earning more than others) as well as a disadvantageous inequality (where they are earning less) are penalized. Bolton and Ockenfels (2000) also find support for inequality aversion using their theory of Equity, Reciprocity and Competition. They propose to account for the anomalies in the experiments with a model where players try to maximize a "motivation function" which depends on their payoff (in absolute terms) and their relative share of the payoff. Engelmann and Strobel (2004), on the other hand, argue that efficiency and maximin strategies explain the observed behavior rather than the inequality aversion models offered in Fehr and Schmidt (1999) and Bolton and Ockenfels (2000).

Adopting a different strategy from the game theoretic approach, Carlsson et al. (2005) try to understand whether individuals are inequality averse or just risk averse. In their study they ask respondents to choose a society for their grandchild to live in using uniform income distributions. In one set of cases, the position of the grandchild is given and in another the position is not known. They propose utility forms from which both risk aversion and inequality aversion coefficients can be extracted. When the position for the grandchild is known, there is no risk to the grandchild and choices reflect preferences on inequality. When the grandchild's position is unknown, both risk and inequality aversion can play a role in the decision. They find that many people are inequality averse as well as risk averse. In addition they report a sizable correlation between individual risk and inequality aversion.

The survey for our study is similar to the one used by Carlsson et al. (2005) but with a few notable differences including the types of distributions used and the method of analysis. Our aim is to test whether distributional considerations affect choices about own travel time and income distributions, how these preferences change once uncertainty about own position is introduced, and whether these preferences are informed by different aspects of the distributions for travel time and income. The following sections discuss the survey used to gather data for this study and the participants followed by the analysis and interpretations of what respondents choices imply.

3 Survey

The data for this analysis comes from a computer-based Stated Preference survey administered at the University of Minnesota in March of 2006. The Stated Preference (SP) approach was chosen because it allows the exploration of tradeoffs that are hard to observe in real life. In this setting we are able to test preferences over a range of individual and societal travel time and income distributions that in reality would not be observed for the same individual. A revealed preference approach would be difficult to undertake because there are many factors outside of the researcher's and the respondent's control that dictate where one lives. The SP approach gives us more control over the variables of interest. Even with some of its limitations, a stated preference approach seems to be the most straight forward way to empirically evaluate the tradeoffs we are interested in this paper.

The survey consists of two parts. One part deals with the distribution of travel time in the community where people live and their own position in that distribution. These questions are posed in the context of a project which is about to alter travel time distributions in the respondents area. A second part deals with the distribution of income and the persons position in that distribution. Since policy scenarios that redistribute income may be politicized, these questions are posed within the context of a relocation decision to one of two locations because of a job change where different income distributions are observed.

3.1 Survey Design

The travel time questions are posed as before and after scenarios resulting from a change in policy. Respondents are told that a study is underway to put in place a new ramp metering strategy. They are informed that when put in place, this strategy will lead to a redistribution of travel time for people in the Twin Cities area. Histograms are used to depict the travel time distributions in the before and after scenarios. The respondent's personal position in either case is also identified. An example of the question is given in figure 1(a). The respondent is then asked to choose between the before and after conditions.

In the second case, we consider income. In this case, respondents are told that a job offer is on the table for them which requires them to relocate to a new area. There are two job offers located in two different cities. The respondent is told that the positions are virtually identical and that the cost of living is equal in either city. The income distribution in the two locations is however different. In either case the distribution of income for residents of each city is given using a histogram and the offered salary for the respondent is also given. Figure 1(b) shows one of the questions. The respondent is then asked to choose between the two offers.

The design of both the travel time and income questionnaires were based on the differences in personal position, differences in social average, and differences in the standard deviation of the distributions in question. For travel time, the before after differences between own time was set up so that the difference could be a at least as good as before the change or loss, the societal average difference was setup to be either negative (societal average increasing) or positive (decreasing in after period). These were in addition paired with large and small differences in the standard deviation of the population distribution. This roughly 2X2X2 design has 8 potential combinations for the three factors. Next alternative distributions whose differences would satisfy these requirements were generated. Since we are using continuous variables, these alternatives were generated with the goal of also limiting the correlation between the design variables. The final coverage of the travel time questions of differences in own time, societal average travel time and standard deviation is as shown in figure 2(a). The figure shows just differences in the variables of interest in the paired presentations. The 'Base' is a relative origin for each presentation and doesn't refer to the same before distribution.

A similar approach is used in developing the paired differences for the income questions. The coverage for the income questions is also given in figure 2(b). Again, the presented diagram reflects the differences in the paired choices. In the figure, since place 1 and 2 are interchangable as opposed to the travel time case where there is a clear 'before' case, switching them for a subset of the presentations would occupy the two remaining quadrants. Correlations between own position, societal average and standard deviation were within ± 0.1 for the travel time case and within ± 0.3 for the income case.

Three of the travel time questions and four of the income presentations were asked in a different format of each respondent. Respondents were asked to choose a distribution, under the same conditions as before, but without knowing what their personal position in the distributions were (i.e. from behind a *veil of ignorance*). These questions will allow us to test whether distributional concerns are different when people do not know their own position. In the other scenarios, the respondent must decide if they are willing to trade some of their own income or travel time to live in a region that has a more equal distribution. In total, respondents were given a eighteen questions relating to time preferences and seventeen questions relating to income preferences.

3.2 Survey Administration

Prior to starting the survey individuals are given a quick tutorial on interpreting distributions that are presented by using histograms. The tutorial takes them through mean and variance identification, comparing mean and variance of different distributions, reading frequency of an event occurrence based on given distributions and identifying their own positions within a distribution when explicitly indicated. The survey then presents the respondents with a series of binary alternatives where they make choices based on their own personal position as well as the position of those around them in the travel time and income contexts discussed above. There were a total of three randomizations that were used to preorder the survey questions. In addition the information was presented in two ways. In one case the distributions for the alternatives were placed one over the other and in the other they were placed side by side. One of these was installed per computer. As respondents came in, they were each randomly assigned to a computer.

3.3 Participants

Subjects for the survey were recruited via email from the University of Minnesota's employee database. Invitations were sent out to 2500 randomly selected non-faculty, non-student employees who had not participated in previous transportation studies conducted by the authors. The recruitment email indicated that individuals were invited to participate in a computer based commute study and offered $15 for participation. Participants were asked to come to a central testing station, where the survey was administered. Based on previous experience of similar recruitments, a target of 200 participants was set (split evenly between male and female). A total of 187 respondents agreed and participated in the study. Descriptive statistics for the subjects are given in Table 1.

In addition to the income and travel time questions, a separate set of questions about route preferences was also administered along with the survey (Tilahun and Levinson, 2010). Two questions in that set were control questions that were used to gauge whether respondents understood the distributions that they were making choices over. Briefly, the questions asked if the respondent would pay a higher toll to use a route that had on average a longer travel time and large variance of travel time between the same origin-destination pair. Only eight of the 187 respondents made what appeared to be an irrational choice, illustrating respondents largely understood the questions.

Table 1: Demographic characteristics of respondents (Total = 187)

Variable	Description	Count	Proportion
Sex	Male	99	52.9%
	Female	88	47.1%
Age	Mean (Range)		40.6 (22-65)
Education	College Level	151	80.7%
	Less than college level	35	18.7%
	Unknown	1	0.5%
Personal income	$< \$30,000$	34	18.2%
	\$30,000 - \$45,000	84	44.9%
	\$45,000 - \$60,000	45	24.1%
	\$60,000 - \$75,000	17	9.1%
	\$75,000 - \$100,000	6	3.2%
	$>\$100,000$	0	0%
	Unknown	1	0.5%
Household size	1	47	25.1%
	2	69	36.9%
	3	34	18.2%
	4+	32	17.1%
	Unknown (5)	5	2.7%
Usual mode (Year round)	Car	138	73.8%
	Transit	32	17.1%
	Bike	10	5.3%
	Walk	5	2.7%
	Unknown	2	1.1%
Commute time	< 15 Minutes	22	11.8%
	15 - 29 Minutes	98	52.4%
	30 - 44 Minutes	47	25.1%
	45 - 59 Minutes	10	5.3%
	≥ 60 Minutes	9	4.8%
	Unknown	1	0.5%

4 Analysis and Results

4.1 Self-interested Choices

In a majority of the travel time and income choices that a respondent faces, one alternative leaves him personally better off than the other (either with a lower travel time or a higher personal income, respectively). This was true in 12 of the 15 travel time questions and 11 of the 13 income questions. The remaining questions leave the respondent at the same position in either scenario while altering the distribution of travel time and income. If respondents were solely interested in their own well-being, they would simply pick the alternative that would leave them better off in the questions where their positions were unequal. However, purely self-interested choices were observed only for a subset of the respondents. In the travel time questions, only 10 of the 187 respondents (5.3%) chose the lower travel time alternative for themselves in all 12 questions. The proportion that consistently chose the higher personal income alternative was relatively larger for the income questions. Here, 47 of the 187 respondents (25.1%) chose in a solely self-interested manner on all 11 questions. This still leaves 75% of the respondents who were willing to forego personal income for other distributional concerns. Table 2 presents the cumulative proportion of respondents who chose in a manner consistent with self-interest.

While no one always chose the higher travel time or lower income alternative, about a third of the respondents for income (33.2%) and nearly a quarter for travel time (23%) chose alternatives that were not to their personal advantage in over half the questions. Looking at per-subject choices, the median proportion of questions a subject answered in a self-interested manner is 72% for income (out of 11 questions) while it was 58% for travel time (out of 13 questions). Unlike results in ultimatum games which involve penalties, subjects in this survey had no direct incentive that could influence their decision to be fair to others (aside from some psychic reward of being perceived as a fair person either to themselves or to the research team). Yet, the choices show altruistic motivations for a large portion of the subjects.

Table 2: Cumulative frequency of self-interested choices in the income and travel time questions

Percent of questions answered in self-interest	Percent of respondents Travel time	 Income
100%	5.3%	25.1%
≥75%	29.4%	44.4%
≥50%	77.0%	66.8%
<50%	23.0%	33.2%
0%	0%	0%

100% of questions = 11 for income and 12 for travel time

4.2 Choices where own position is uncertain

As discussed earlier, a limited number of questions posed travel time and income questions where the respondent did not know their own position. Because there is an element of uncertainty, choices in this instance may be quite different from choices where respondents know their position (where there is no uncertainty). Seven questions from the previous set (3 for travel time, 4 for income) were takes and the respondent's income removed from these questions. These would be the original position in Rawls (1999) formulation, where the respondent would choose a fair distribution lest they find themselves in either the highest travel time or lowest income group, respectively.

Here again, there is a great deal of variation in how respondents evaluate these alternatives. Relatively simple choices mechanisms are possible in each case that can neatly explain one motivation or another. For example in the income case, respondents may be motivated by the risk of falling into the lowest income category and may seek to avoid those situations. Or, they may seek the distribution with the highest expected income (average) for the distribution - regarding this as their most likely outcome. In the travel time case, the risk of ending up with the highest travel time may lead them to select the distribution with a less extreme outcome, or the lower average may be the most attractive. Alternatively, highly risk-seeking behavior may dominate where respondents align choices with the most optimistic outcomes.

In tables 3 and 4 we summarize the frequency with which similar consistent behavior was observed. As can be seen, the proportion who consistently selected alternatives based on simple rules is not very large especially in the income case. The most consistent behavior in the travel time case, is to opt for a smaller standard deviation when own travel time is not known, where 42% of respondents consistently chose this alternative. In the income case, the largest percentage is for the highest average income where 35.8% of respondents chose the higher average income alternative every time. The highest minimum income alternative, which was chosen always in by 65.2% of respondents, is not included in this table because only two of the four veiled income choices had unequal minimums.

Table 3: Percent of respondents with consistent choices over travel time attributes

	Lowest average travel time	Lowest standard deviation	Lowest maximum travel time	Lowest minimum travel time
100% consistent with alternative that has...	21.9%	42.2%	7.5%	7.5%

Table 4: Percent of respondents with consistent choices over income attributes

	Highest average income	Lowest standard deviation	Highest standard deviation	Highest maximum income
100% consistent with alternative that has...	35.8%	12.3%	16.6%	16.6%

5 Model estimates

The analysis herein assumes a rational utility maximizing individual. We assume that distributional outcomes in travel time and income have a direct impact on utility. Linear utility functions are specified using the person's position in the distribution as well variables that capture the overall distribution of commute time and income in the region. For both travel time and income, alternative specifications that used the person's own income, the regional average, the regional maximum (for travel time), the regional minimum (for income), and the standard deviation of the regional distribution were used to explain the choices. A mixed logit model is used to estimate the parameters of the utility function.

The utility for respondent i from choice k is given by

$$U_{ik} = \beta_i' x_{ik} + \epsilon_{ik}$$

where:

β_i': is a vector of the unobserved parameters for person i which has a density $f(\beta_i/\theta)$ in the population, where θ represents the parameters of the density distribution

ϵ_{ik}: is an unobserved random term distributed iid extreme value

x_{ik}: is a vector of observed variables that characterize the attributes of the choice for individual i in setting k. x includes the variables used both for travel time and income respectively:

- O_{ik}: respondent's own position in the distribution
- D_{ik}: the standard deviation of the regional distribution
- S_{ik}: the average of the regional distribution
- M_{ik}: the minimum income observed in the region
- M^*_{ik}: the maximum travel time observed in the region

These models were estimated using the R software (R Development Core Team, 2011) and the *mlogit* package (Croissant, 2011). The next sections discuss the best fitting models for choices where the respondent was aware of his fate in the choice scenario (the unveiled scenario) and where individuals did not know what their personal position would be (the veiled scenario) for the travel time and income questions separately.

5.1 Travel time

The best fitting model for the travel time data describes choices in terms of own travel time, the standard deviation of the region's travel time, and the region's average travel time. Parameter estimates for this model are given in Table 5. The questions were asked in the context of a before-after policy implementation scenario. The estimated model indicates that on average respondents had some bias against the status quo position and favored change. This was more true for men, who were significantly more likely to vote against the status quo than women. Age played a role favoring the status quo with each additional year increasing the odds of choosing the status quo by 2.2%, all other things equal.

The model also captures significant variation in the preferences over own travel time, societal average and the standard deviation of the distribution of travel time. In the population, each additional minute of personal travel time, population wide average travel time, and increases in variances all lead to a reduction in the utility of the decision maker. The distribution of these parameters in the population is modeled using a triangular distribution whose characteristics are also shown in Table 5. The coefficients for own time (β_O), societal time (β_S) are negative consistent with the assumption that increases in time lead to a disutility. For about 98% the parameter for the standard deviation (β_D) is also negative, suggesting narrower distributions are largely preferred. Though correlation among the random effects was tested, it was dropped from the model since the model without correlations performed just as well based on a likelihood ratio test. Respondents wanted to reduce own time, societal/regional average, as well as the dispersion in travel time in their region.

The estimates also show that the average impact of an increase in societal average travel time is larger than than the average for a one minute increase in personal travel time in the population. To estimate the marginal rate of substitution (MRS), we use simulated coefficients based on the estimated coefficients for β_O, β_S and β_D and their respective distributions. The mean MRS between the societal average (S) and own time (O) is 1.20 – a willingness to increase own travel time by 1.20 minutes for a minute reduction in the societal mean. For the standard deviation, the mean MRS is 1.41 of own minutes for a decrease in 1 minute of the standard deviation. These values along with the standard error of the mean and the distribution of the MRS values is given in Table 6. These values are based on averages from a 1000 replications of 10000 random draws for the coefficients.

To compare what happens when own position is not known, a similarly specified model was estimated using the questions where the respondents own position was unknown. The estimates are shown in Table 7. This model was based on a limited set of questions. On average the model shows there is a gender bias where men are more likely to disfavor the status

Table 5: Model for unveiled travel time questions

	Estimate	Std. Error	t-value	$Pr(>\|t\|)$
β_S	-0.252	0.017	-14.853	0.000***
β_O	-0.218	0.011	-19.578	0.000***
β_D	-0.297	0.072	-4.118	0.000***
β_X	-0.541	0.104	-5.188	0.000***
β_A	0.022	0.004	5.032	0.000***
Intercept	-1.037	0.254	-4.074	0.000***
Heterogeneity in mean preferences:				
span(β_S)	0.134	0.028	4.745	0.000***
span(β_O)	0.095	0.016	5.878	0.000***
span(β_D)	0.366	0.042	8.628	0.000***
Log likelihood		-1274.4		
McFadden ρ^2:		0.279		
Likelihood ratio test:	$\chi^2 = 984.58$ ($p \leq 0.000$)			
Number of obs: 2790	Subjects = 186			

Table 6: Marginal rates of substitution for O, S and D in unveiled situations (travel time)

	Mean ($\bar{X}$)	Std. Error($\sigma_{\bar{X}}$)	Std. deviation (σ_X)
Unveiled β_S/β_O	1.20	0.003	0.35
Unveiled β_D/β_O	1.41	0.008	0.77
Unveiled β_D/β_S	1.24	0.007	0.71

quo option and opt for the change than women.Subjects also showed a strong preference for reduction of the standard deviation and the average preference over the societal average was not statistically different from zero. Since the distribution of coefficient for the regional average (β_S) spans 0, the moments for the WTP/MRS based on willingness to exchange the expected travel time (regional average) do not exist (Daly et al., 2012). Despite this limitation, the coefficients still allow us to discuss the apparent shift in preferences once own-position is veiled.

In the veiled models, the random coefficients exhibit a strong negative correlation between preferences for societal average time and the standard deviation for the distribution. As opposed to the veiled condition where almost all respondents had a preference for lower variance and lower societal average, here there is a significant number that favors wider variance with larger travel time, or larger variance (23%) or a larger societal average (18%). Since the random terms β_S and β_D are negatively correlated, the joint distribution is used to evaluate how these preferences exhibit themselves in the population. Based on 10,000 simulations using the estimated distributions for β_S and β_D and the estimated covariance matrix between these terms, the joint preferences are as shown in Table 8. For over have the population (58.5%), both a reduction in societal average travel time and a reduction in the

Table 7: Model for veiled travel time questions

	Estimate	Std. Error	t-value	$Pr(>\|t\|)$
β_S	-0.291	0.207	-1.4	0.161
β_D	-0.748	0.237	-3.151	0.002**
β_X	-1.886	0.644	-2.928	0.003**
Intercept	-0.529	0.668	-0.793	0.428
Cholesky matrix of random parameters:				
$\beta_s : \beta_s$	-0.729	0.279	-2.608	0.009**
$\beta_s : \beta_d$	1.977	0.605	3.268	0.001**
$\beta_d : \beta_d$	-1.298	0.461	-2.819	0.005**
Heterogeneity in mean preferences:				
span(β_S)	0.729			
span(β_D)	2.365			
$cov(\beta_S, \beta_D)$	-1.440			
Log likelihood		-242.42		
McFadden ρ^2:		0.228		
Likelihood ratio test:		$\chi^2 = 143.33$ ($p \leq 0.000$)		
Number of obs: 561		Subjects = 187		

variance is sought. A further 18.5% seeks a narrower distribution of the standard deviation but with positive estimates for the societal average travel time. The remaining 23% exhibit a preference for higher variance distributions after implementation when they don't know their position. Almost no one (.01%) has a preference for both higher variance and higher average.

A comparison with the situation where own position is known shows that in general when there is no uncertainty about own position, people are almost unanimous in their interest to reduce the regional average travel time. A majority are also interested in lowering the spread of the distribution though a few (∼2%) tend to prefer wider distributions of travel time. In general, there are almost no cases where higher societal average travel times are sought. When uncertainty about ones own position is introduced, the simulation results suggest a shift in preferences. About a fifth now have positive attitudes about increasing the societal average coupled with a decrease in the standard deviation. About a quarter exhibit risk-seeking behavior where the dispersion is increased but societal averages are reduced. The remaining prefer a reduction in the regional average and standard deviation as in the unveiled case and there are no cases where larger variance and larger societal averages are sought at the same time. If the distributional assumptions in the models hold, clear willingness to pay estimates are also only possible in cases where respondents know about their own fate. Uncertainty creates a shift in preferences that makes the WTP values (those based on regional expected values) unidentifiable. In the cases where respondents knew their own position, they valued both unit changes in the standard deviation and unit changes in the regional average higher than unit changes in their own personal time.

Table 8: Distribution of preferences over societal average and standard deviation of the distribution when own position is uncertain based on simulations

	Position known		Position unknown	
	$\beta_D \leq 0$	$\beta_D > 0$	$\beta_D \leq 0$	$\beta_D > 0$
$\beta_S \leq 0$	98.5%	1.5%	58.5%	23.0%
$\beta_S > 0$	0%	0%	18.5%	0.0%

The results from the first model suggest that given clear policy goals, the average respondent is willing to trade off some of their own travel time to achieve broader societal goals of a lower societal average travel time and, for a majority of the responding population, for a narrower distributions of travel time. These preferences are clear especially when the respondents are certain about their own fate. Uncertainty about own travel time shifts preferences so that the distribution of tastes over the standard deviation as well as the societal average is much wider under this latter case. In real applications, what this means is that it is important to provide people with some information about their own fate after policy or project implementation. Absent that information, about 42% start to favor outcomes that are at least in one dimension (mean travel time or variance) not very desirable. The informed respondent is willing to consider the fate of those around him even while they are interested in reducing their own travel time.

5.2 Income

Separate models for the income preferences were also estimated based on the preference data under conditions where the person was aware of their own income and where their position is not known. As discussed earlier, this question is presented in the context where a person is choosing to relocate between two different locations. The two models are presented in tables 9 and 10. In both cases, the intercept term is not statistically significant suggesting there is no preference towards any given alternative that may have arisen from the questionnaire's format. Choices were also not explained by personal factors such as age, sex, household income or education.

In the model where own position is known (Table 9), the utility is increasing in own income, standard deviation of income, as well as the minimum income in the region. The average impact on utility is largest for a change in own income, followed by a unit increase in the regional standard deviation and finally an increase in the minimum income for the region. People want to be well off personally, live in a place that is on average wealthier and where there are few very low earners. The model assumes that the random parameter for all three preferences has a triangular distribution. The coefficient for own income is always positive spanning the range from (0.006 to 0.37). Mean coefficients for the standard deviation and minimum income are both positive and statistically significant. Coefficient for the standard deviation range from 0 to 0.20. However, the range of estimates for the regional minimum in-

Table 9: Model for unveiled income questions

	Estimate	Std. Error	t-value	$Pr(>\|t\|)$
β_O (own income)	0.187	0.017	11.121	0.000 ***
β_D (std deviation)	0.100	0.020	5.134	0.000 ***
β_M (minimum income)	0.043	0.006	7.300	0.000 ***
(Intercept)	-0.312	0.225	-1.390	0.164
Cholesky matrix of random parameters:				
β_O:β_O	0.181	0.023	7.963	0.000 ***
β_D:β_D	-0.095	0.016	-6.027	0.000 ***
β_M:β_M	0.059	0.007	8.882	0.000 ***
β_O:β_D	0.036	0.015	2.425	0.015 *
β_O:β_M	-0.031	0.007	-4.685	0.000 ***
β_D:β_M	-0.044	0.007	-6.222	0.000 ***
Heterogeneity in mean preferences:				
$span(\beta_O)$	0.182			
$span(\beta_D)$	0.101			
$span(\beta_M)$	0.080			
$cov(\beta_O, \beta_D)$	0.007			
$cov(\beta_O, \beta_M)$	-0.006			
$cov(\beta_D, \beta_M)$	0.003			
Log likelihood		-1156.9		
McFadden ρ^2:		0.267		
Likelihood ratio test:		$\chi^2 = 842.93$ ($p \leq 0.000$)		
Number of obs: 2431		Subjects = 187		

come suggests that about 11% have a preference for lower minimum incomes. The coefficient ranges from -0.04 to 0.12. The model also shows a statistically significant moderate correlation between preferences for income, standard deviation, and minimum income. Positive correlations are observed between preferences for personal income and variance as well as for variance minimum income. There is negative correlation between preferences for personal income and the minimum regional income. The higher the preference for personal income, the higher the preference for income variance, and the less the person cared for regional minimum incomes. Conversely, those who cared about the regional minimums had lower preferences for own income and larger income variance.

As was done in the travel time case, a veiled model was also estimated for income. The result is presented in Table 10. The important variables in explaining choice in this case are the societal average and the standard deviation, with a large negative correlation between these preferences. Overall the estimate for societal average shows is positive for 98% of the population. The mean preferences for the standard deviation is not statistically different from zero, and about half the population (53%) shows a negative preference - one which we interpret as risk aversion - while the other half shows a positive preference for dispersion.

The negative correlation of preferences implies that those with preferences for lower variance sought higher average incomes. The remainder were less concerned with the mean (though mostly still showing positive preferences for the societal average) but seeking a wider distribution at the same time. The veil of own position thus induces preferences that are quite distinct over the measure of dispersion.

Table 10: Model for veiled income questions

	Estimate	Std. Error	t-value	$Pr(>\|t\|)$
β_D (std. deviation)	-0.015	0.065	-0.237	0.812
β_S (societal average)	0.263	0.054	4.920	0.000 ***
Intercept	-0.802	0.540	-1.485	0.137
Cholesky matrix of random parameters:				
β_S:β_S	0.326	0.075	4.338	0.000***
β_D:β_D	0.343	0.071	4.835	0.000***
β_S:β_D	-0.337	0.081	-4.185	0.000***
Heterogeneity in mean preferences:				
$span(\beta_D)$	0.481			
$span(\beta_S)$	0.326			
$cov(\beta_S, \beta_D)$	-0.110			
Log likelihood		-367.19		
McFadden ρ^2:		0.292		
Likelihood ratio test:		$\chi^2 = 302.6$ ($p \leq 0.000$)		
Number of obs: 748		Subjects = 187		

Willingness to pay for a change in the standard deviation against own income for the unveiled as well as veiled conditions was estimated through simulation in each case using a 1000 replications each of 10000 simulated parameters. Since the distributions for these parameters were assumed to be triangular with correlation, the simulation was done by first generating parameters from a multivariate normal distributions with the estimated mean and covariance structure. The generated numbers for β_O and β_D were then replaced by values having the same cumulative probability using triangular distributions whose characteristics are estimated in the two income model. The resulting simulated $\beta_i^{'}$ have similar correlation structures as that estimated in the model. When own position is known (the unveiled case) the mean willingness to pay for a \$1000 reduction in the standard deviation is \$570 (σ=\$162). The mean WTP estimates for raising the minimum by \$1000 is \$264 (σ=\$245). In the veiled case, since the distribution of coefficient for the standard deviation (β_S) spans 0, the moments for the WTP/MRS does not exist (Daly et al., 2012). However, if we omit the less 0.55% of people with coefficients for $beta_S$ less than 0 from the analysis, MRS summaries can be calculated between the β_D and β_S describing the population. This gives a mean marginal rate of substitution to forego a \$104 in the regional average for a \$1000 dollar decrease in the standard deviation. Separating those with negative and positive estimates for β_D (with different risk profiles), the MRS for those that are risk averse is to give up \$156 in the regional average for a \$1000 decrease in the standard deviation. For the risk seeking respondents, the MRS is \$115 for each \$1000 increase in the standard deviation. The WTP estimates under the veiled and unveiled cases are included in Table 11.

Table 11: Simulated WTP for changes in income distributional variables based on veiled and unveiled personal positions

Survey	Description	MRS	Mean ($\bar{X}$)	Std. Error ($\sigma_{\bar{X}}$)	Std. Deviation (σ_X)
Unveiled		β_D/β_O	\$570	\$5.1	\$162
choices		β_M/β_O	\$264	\$7.8	\$245
Veiled	($\beta_S > 0.01$)	β_D/β_S	-\$104	\$4.5	\$145
choices	($\beta_D < 0, \beta_S > 0.01$)	β_D/β_S	-\$156	\$3.2	\$89
	($\beta_D > 0, \beta_S > 0.01$)	β_D/β_S	\$115	\$9.1	\$124

As was the case with travel time, preferences over the standard deviation shift when uncertainty about own position is introduced. In the income case, people shift from favoring wider distributions when their position is known to having a mixed distribution where 57% prefer lower variances and the remainder want an expansion of the variance. In the travel time case, the shift was from everyone preferring a narrower distribution to nearly a quarter seeking to expand the standard deviation.

Overall the income estimates indicate preferences to prioritize own income followed by standard deviation and the minimum income for the region when one knows their own position. In general people want higher personal incomes, higher variance and a higher regional minimum when they know their position. In Dollar terms, they value a unit reduction in the standard deviation of income than unit reductions in the region's minimum. When ones position is not known, preferences over the region's average are primarily positive (for 99% of the population); however, preferences over the variance are split with about half preferring reduction in variance while increasing the regional mean, and the other half preferring higher variance but with less focus on the regional average.

6 Discussion

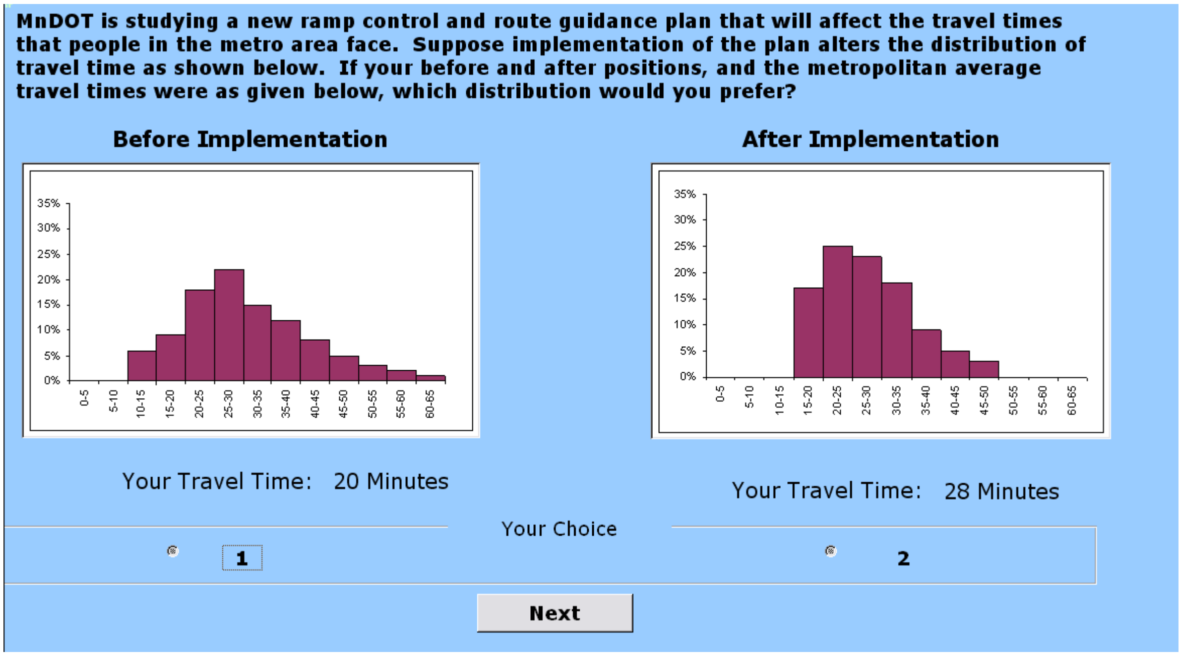
This paper examines individual preferences over travel time and income distributions. Traditional economic models posit that choices are mainly self-interested though several exceptions to this have been documented in the experimental economics literature. The empirical evidence from our survey also illustrates that choices are complex and do not easily fall into one category. We observe choices both in income and travel time distributions where individuals are willing to forego some of their own wellbeing (either in terms of higher income, or lower travel times) to allow for distributions that increase minimum income or reduce average travel time in the region. Willingness to pay measures for outcomes that were altruistic (reduced variance or increased minimum income for others) even at personal loss were recorded.

In contrast with ultimatum game experiments, our presentations do not have explicit penalties for purely self-interested decisions. However in a majority of cases, purely self-interested choices were not observed. In fact, only 5.3% of respondents always chose the lower travel time alternative for themselves in the choices presented. Most showed a willingness to improve travel time outcomes for others to varying degrees. The proportion for income that always chose the better outcome for themselves was higher with about a quarter of the respondents consistently choosing in that manner. But that still leaves three quarters of the respondents who traded their own incomes to achieve the well being of others.

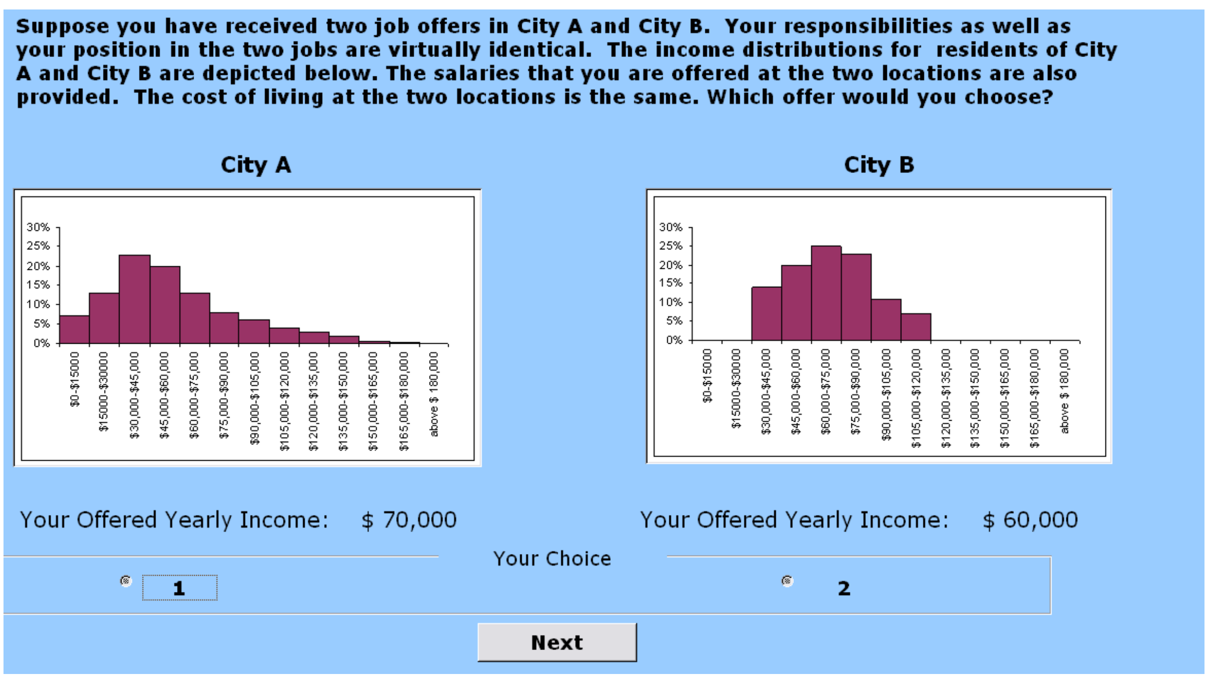
In the estimated unveiled income model (table 9), the average parameter for own-position in the income case pointed to the importance of own-position as compared to other variables. In the travel time case, respondents cared less about unit changes in own position as compared to societal measures. Perhaps this may may be because they believe they are more likely to face different travel time conditions (e.g. either due to a job change, due to non-work travel, etc.) than they are to face different income conditions. These order of preferences also suggest that preferences about income and time may be informed differently based on the best fitting models and parameter estimates discussed in the previous section. Travel time preferences seem predominantly to be informed by societal average, followed by the own travel time, and finally by the standard deviation of the distribution considered. For income, unit shifts in own income take priority, followed by a higher standard deviation, and finally the minimum of the distributions. These preferences are also correlated with one another.

Though the data which looks at preferences when own position is uncertain is limited, it suggests that preferences about travel time mainly focus on a reduction of the standard deviation of the distribution when a person does not know their own fate with mixed preferences over the societal average. For income, a strategy to increase the regional average income explains the choices most with variable preferences over the standard deviation.

We had started out with a hypothesis that choices are likely not entirely self regarding. The summary of choices and the estimated models support this hypothesis. The question of how to capture the other regarding preferences is tested with different specifications of the utility function and the best models are reported here. Overall, the study illustrates that choices are seldom explained in terms of very simple motivations. Fewer than a majority in both the veiled and unveiled choice alternatives chose in a manner that was purely in line with one strategy exclusively. Most respondents showed a combination of altruism and selfishness depending on the questions asked, suggesting that clearly articulated policy goals would have backers even among those that stand to lose some of their own immediate welfare.

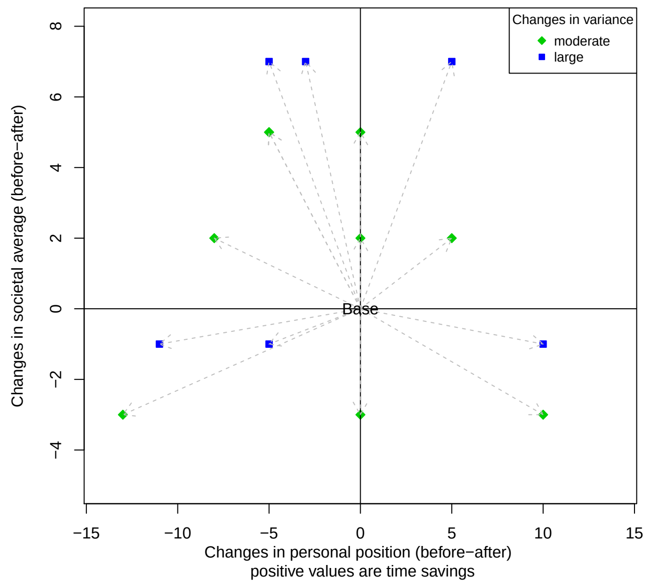


(a) Example travel time question

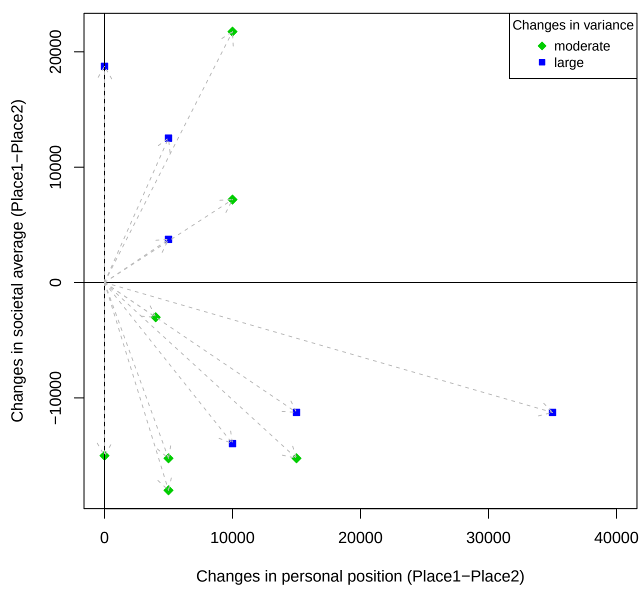


(b) Example income distribution question

Figure 1: Stated preference questions



(a) Travel time differences



(b) Income differences

Figure 2: Differences in travel time and income conditions among alternatives

References

G.E. Bolton and A. Ockenfels. A theory of equity, reciprocity and competition. *American Economic Review*, 90(1):166–193, 2000.

F. Carlsson, D. Daruvala, and O. Johansson-Stenman. Are people inequality-averse, or just risk-averse? *Economica*, 72(287):375–396, 2005.

Yves Croissant. *mlogit: multinomial logit model*, 2011. URL http://CRAN.R-project.org/package=mlogit. R package version 0.2-2.

A. Daly, S. Hess, and K. Train. Assuring finite moments for willingness to pay in random coefficient models. *Transportation*, 39(1):19–31, 2012.

A.C. DeSerpa. A theory of the economics of time. *The Economic Journal*, 81(324):828–846, 1971.

J. Elster. Altruistic behavior and altruistic motivations. *Handbook on the Economics of Giving, Reciprocity and Altruism*, 1:183–206, 2006.

D. Engelmann and M. Strobel. Inequality aversion, efficiency, and maximin preferences in simple distribution experiments. *The American Economic Review*, 94(4):857–869, 2004.

A.W. Evans. On the theory of the valuation and allocation of time*. *Scottish Journal of Political Economy*, 19(1):1–17, 1972.

E. Fehr and K.M. Schmidt. A theory of fairness, competition, and cooperation*. *Quarterly journal of Economics*, 114(3):817–868, 1999.

W. Guth, R. Schmittberger, and B. Schwarze. An experimental analysis of ultimatum bargaining. *Journal of Economic Behavior & Organization*, 3(4):367–388, 1982.

D. Kahneman, J.L. Knetsch, and R.H. Thaler. Fairness and the assumptions of economics. *Journal of Business*, pages 285–300, 1986.

PJ Mackie, S. Jara-Dıaz, and AS Fowkes. The value of travel time savings in evaluation. *Transportation Research Part E: Logistics and Transportation Review*, 37(2):91–106, 2001.

A. Marchetti, I. Castelli, K.M. Harlé, and A.G. Sanfey. Expectations and outcome: The role of proposer features in the ultimatum game. *Journal of Economic Psychology*, 2011.

R Development Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2011. URL http://www.R-project.org/. ISBN 3-900051-07-0.

M. Rabin. Incorporating fairness into game theory and economics. *The American Economic Review*, pages 1281–1302, 1993.

J. Rawls. *A theory of justice.* Belknap Press, 1999.

T. Scanlon. *The diversity of objections to inequality*. Dept. of Philosophy, University of Kansas (Lawrence, Kan.), 1997.

R.H. Thaler. Anomalies: The ultimatum game. *The Journal of Economic Perspectives*, 2 (4):195–206, 1988.

N.Y. Tilahun and D.M. Levinson. A moment of time: Reliability in route choice using stated preference. *Journal of Intelligent Transportation Systems*, 14(3):179–187, 2010.

L. Zhang and D. Levinson. Balancing efficiency and equity of ramp meters. *Journal of transportation engineering*, 131:477, 2005.