How do pedestrians balance safety, walking time, and the utility of crossing the road? A stated preference study

STREET MOBILITY AND NETWORK ACCESSIBILITY SERIES

WORKING PAPER 08

June 2016

Paulo Rui Anciaes, Peter Jones

on behalf of the *Street Mobility* research team[1]

Abstract

This paper presents the results of a stated preference survey to estimate the value of reductions in community severance (the "barrier effect" of transport infrastructure on the mobility of pedestrians). In a first exercise, participants chose between crossing a road in a place without designated facilities or walking additional minutes to a place where the road is covered over. Half of the participants never chose to cross, regardless of the road design, traffic characteristics, and length of the detour. On average, the other half would only cross the road if the detour was at least 7.9 minutes (or longer, if the road had extra traffic lanes, no central reservation, or high traffic density). In a second exercise, participants were asked whether they would cross the road to access a cheaper shop or a bus stop on the other side of the road, instead of a more expensive one on their side of the road. 38% never chose to cross. The other 62% would only cross a road with high traffic density if the saving was at least £2.8, but would cross roads with other characteristics for smaller savings. Overall, the study suggests that many people are not willing to trade-off pedestrian safety with shorter walking times or cost savings. People who are willing to trade-off tend to attach greater importance to traffic density, comparing with aspects such as road design and traffic speed.

[1] The *Street Mobility* research team members are Jennifer Mindell, Nora Groce, Muki Haklay, Peter Jones, Shepley Orr, Shaun Scholes, Laura Vaughan, Paulo Anciaes, Jemima Stockton and Ashley Dhanani.

1. Introduction

Community severance arises when major transport infrastructure or high volumes of motorised traffic cut through communities, disrupting the walking mobility and accessibility of local residents. This impact can have major negative consequences for public health, well-being and social inclusion, but is not well captured in existing transport appraisal methods as it is poorly understood and lacks a basis for economic valuation. In most cases, the assessment of severance relies on ad-hoc procedures or on subjective qualitative scales (Anciaes *et al.* 2016).

This paper develops a stated preference model to estimate the value of road schemes that improve conditions for pedestrians crossing busy roads, including changes in road design (number of traffic lanes and central reservation) and traffic characteristics (density and speed). The study is a part of the Street Mobility and Network Accessibility project at University College London, which is developing tools to identify barriers to walking created by motorised transport (http://www.ucl.ac.uk/street-mobility)

The paper reports the results of two of the choice exercises that were included in the stated preference survey. In the first exercise, participants chose between crossing the road informally with no special provision (under varying scenarios for the road design and traffic characteristics) and walking additional minutes to a place where the road is covered over. In the second exercise, participants stated whether they would cross a road with no pedestrian provision in order to access a cheaper shop or bus stop on the other side of the road. Econometric models were used to derive willingness to walk further or to pay to avoid crossing the road in a place without crossing facilities.

The survey was conducted in the areas surrounding two busy roads in the United Kingdom, one in London (Finchley Road) and one in Southend-on-Sea (Queensway). These roads are a major barrier to pedestrian movement due to the high traffic densities and speeds, lack of crossing facilities, and presence of physical barriers to crossing, such as guard railings. The survey consisted of 100 interviews in each area. The samples contained a balanced number of males and females and of individuals aged below and over 50 years old.

The rest of the paper proceeds as follows. Section 2 reviews the state-of-the-art on stated preference methods applied to the study of community severance and related issues. Sections 3 and 4 report the results of the first and second stated preference exercises, respectively. Section 5 discusses the main issues arising from the analysis and concludes the paper.

2. Using stated preference methods to understand community severance

A growing number of studies have started to value community severance using stated preference models, a method that has been extensively used to study other negative effects of transport, such as noise and air pollution. This method is based on surveys where participants are asked to choose among hypothetical alternatives characterized by several attributes. Choices are then modelled as functions of the attribute levels and the characteristics of the participants. Trade-off values between the different attributes can be derived from the estimated models.

If one of the attributes defines the payment or compensation associated with each alternative, it is also possible to calculate the willingness to pay or to accept compensation for changes in the other attributes. For example, Grisolía *et al.* (2015) estimated the willingness to pay for burying a road, taking into consideration the cost of the project and the types of land use on the surface. The study found that local residents who currently walk in the area around the road are willing to pay €149 per year to finance the construction of a road tunnel and those who do not currently walk in that area are willing to pay €73. ITS and Atkins (2011) also estimated the value of policies that give different levels of priority to pedestrians, using different valuation methods. The study found that participants were willing to pay £64 per year for a road pedestrianisation project.

Stated preference methods can also be used to model people's perceptions and behavioural responses to different types and levels of severance. This approach assumes that the impact of the road can be mitigated by measures that are less radical than building a road tunnel or pedestrianisation, such as traffic control, road re-design, and provision of crossing facilities. A proposal was made by Read and Cramphorn (2001, Ch.4) for including this type of approach in official guidance for transport project assessment in New Zealand, but the proposal was never implemented. A decade later, Meltofte and Nørby (2012, 2013) used a similar method in an academic study in Denmark to derive people's trade-off values between number of lanes, traffic variables (density, composition, and speed), and distance to crossing facilities. Cantillo *et al.* (2015) also considered different options for the provision of crossing facilities, and modelled the choices between crossing the road informally and using signalised crossings and footbridges, taking into account the walking distance to these two types of facilities, delay, and traffic density.

Other studies have used a similar approach but focused on pedestrian safety. For example, Hensher *et al.* (2011) estimated preferences for different types of crossing facilities, delay at those crossings, number of traffic lanes, traffic speeds, and safety outcomes (measured as predicted numbers of deaths and injuries). The study assessed people's willingness to pay for the reduction of collision risk, but did not calculate trade-offs between the different methods to achieve this reduction, and did not consider impacts other than collision risk.

The negative impact of major roads on pedestrians' ability to cross the road can also be assessed alongside broader impacts of the road on the experience of walking. For example, Kelly *et al.* (2011) developed a stated preference model that considered attributes related to crossing the road (traffic density, speed, pedestrian delay and detours, and number of crossings) and to walking along the road (street lighting and characteristics of pavements). Garrod *et al.* (2002) also estimated preferences for the reduction of several impacts of motorised traffic, including traffic speed, noise, visual impacts, and waiting time to cross the road. The mitigation of the impacts was to be achieved by traffic calming measures, but these measures were not specified. Follow-up studies developed methodological questions about this experiment, finding that preferences for the improvements were polarised, with a larger group holding positive values and a smaller one with non-positive values (Scarpa and Willis 2006).

The present study builds on these previous efforts, by assessing the disutility of crossing a busy road in terms of two different units: walking times and monetary values. It is assumed that that disutility depends on the characteristics of the road (number of traffic lanes and presence of a central reservation) and and of traffic (density and speed). The trade-offs between changes in the road and traffic characteristics and walking times or monetary values can therefore be understood as indicators of the benefits of those changes in terms of reduced severance.

3. Willingness to walk to avoid crossing the road

3.1. Design of the stated preference exercise

The objective of the first stated preference exercise was to estimate the participants' willingness to walk to avoid crossing a road in a place without designated crossing facilities. Three options were presented in each question:

- Option A: Cross the road in a place without facilities
- Option B: Walk a given time and cross in a place where the road is covered over
- Option C: Avoid crossing the road altogether

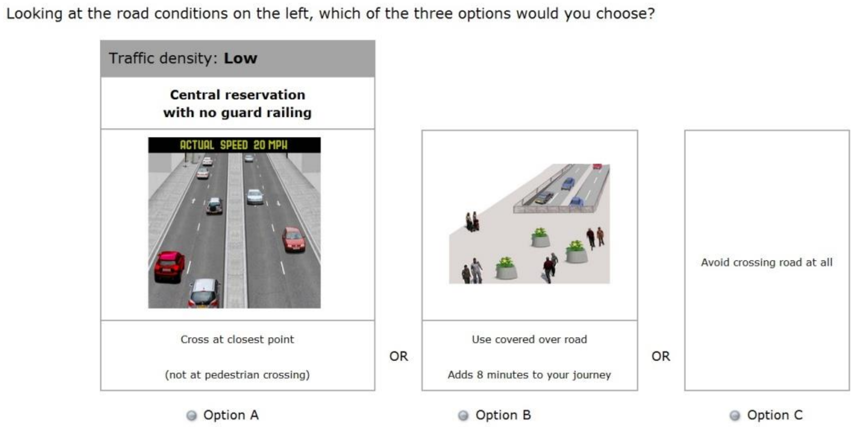
The exercise consisted of seven questions in the London survey and eight questions in the Southend survey. Table 1 presents the attributes and levels of the problem (the characteristics of the road and traffic in Option A and the walking time in Option B). The design of this exercise was constrained so that the range of possible values for the traffic speed attribute depended on the values of the traffic density attribute. It was assumed that high traffic density was always associated with low speeds (10 mph) due to road congestion. An efficient design was used, which generates data that allows for the minimization of the standard errors of the parameter estimates (Rose and Bliemer 2009). The design was obtained using the *Ngene* software.

Figure 1 shows an example of the questions, where the road in Option A has two lanes for motorised traffic in each direction, a central reservation, low traffic density, and 20mph speed, and the walking time in Option B is 8 minutes.

Table 1: First stated preference exercise: attributes and levels

Attributes	Levels
Number of lanes in each direction	-1 (one less lane than now) 0 (same as now: 3 lanes in London, 2 lanes in Southend)
Central reservation	Not Present Present (with no guard railings)
Traffic	Low density, speed=20mph Low density, speed=30mph Medium density, speed=20mph Medium density, speed=30mph High density, speed=10mph
Time added to journey	from 2 to 20 minutes, in 2 minute increments

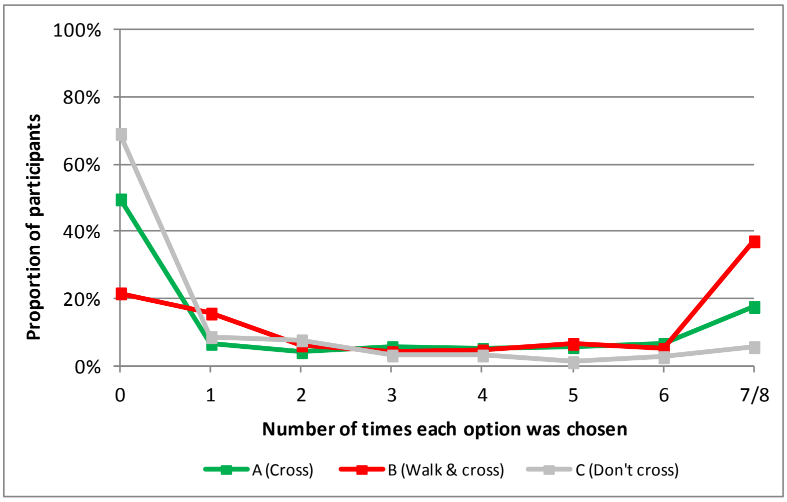
Figure 1: Example of question in the first stated preference exercise



3.2. Results: Trading behaviour

Many participants consistently chose the same option, regardless of the attribute levels presented. Figure 2 shows the proportion of participants by the number of times they chose each of the three options. Half of the participants never chose Option A ("cross") and 69% never chose Option C ("don't cross"). In addition, about half of the participants chose always the same option (A, B, or C).

Figure 2: Proportion of all participants by the number of times they chose each option



The group of participants that never chose to cross and the group that always chose the same option in all questions are labelled in further analysis as “non-crossers” and “non-traders” respectively. The group that chose to cross in at least one question and the one that did not always chose the same option in all questions are labelled as “crossers” and “traders”

Table 2 shows the results of a logit model explaining the probability of being a “non-crosser” (that is, always rejecting the "cross" option), where the explanatory variables are the characteristics of the participants and of their most recent walking trips. As expected, participants who stated that they cross the road most days have a lower probability and those with restricted mobility have a higher probability of being a "non-crosser".

The probability of being a "non-crosser" is also higher for participants in the Southend case study and for those living on the west side of the Finchley Road in the London case study. This reflects the lower need to cross the road in those areas, comparing with the east side of Finchley Road (which is mostly residential and has relatively few workplaces, shops, or other pedestrian destinations). Residents within walking distance to the road but with an obvious nearby place to cross safely also have a lower need to cross away from pedestrian facilities, as confirmed by a negative coefficient of the variable representing residence locations within 400m of the road but at more than 200m from the nearest crossing. The significance of spatial variables suggests that participants tend to approach the survey not as an abstract exercise but in relation to the conditions in the immediate vicinity of their homes.

Table 2: Logit model of the probability of being a "non-crosser" in the first stated preference exercise

Variable	Coefficient	p>|z|
constant	-0.94	0.05**
cross most days	-0.88	<0.01***
restricted mobility	2.14	<0.01***
London: west of road	1.40	<0.01***
Southend: west of road	1.60	0.01**
Southend: east of road	1.25	0.02**
<400m from road and >200m from crossing	-0.88	0.02**
n	200	
no coefficients log-likelihood	-139	
log-likelihood	-116	
Pseudo R^2	0.16	

Significance levels: ***1%, **5%, *10%

3.3. Results: Econometric models and trade-off values

The choices were analysed using econometric models. The data was reshaped so that each record represents the choice regarding each of the three options presented in each of the questions. The dependent variable is a dummy variable where 1 is the case where the participant chose the option presented. The explanatory variables are walking time and a series of dummy variables representing the characteristics of roads and traffic. The "don't cross" variable is equal to 1 in Option C and 0 in the other options. The "cross" variable is equal to 1 in Option A and 0 in the other options. This variable represents the option for crossing a road with no crossing facilities and the most convenient road design and traffic conditions for pedestrians (one less lane than at present, central reservation, low traffic density, and traffic speed lower than 30mph). Additional variables account for less convenient scenarios for pedestrians: the existing number of lanes, no reservation, medium and high traffic density, and speed higher than 30mph.

Two difference model specifications were tested. In the mixed logit model, the coefficients of all variables except walking time are assumed to be random (Ben Akiva and Bolduc 1996, McFadden and Train 2000). In this case, the utility of an option depends on attribute levels and on the characteristics of the participants. The utility can be specified as follows:

$$U_{i,j} = \beta_j x_{i,j} + \varepsilon_{i,j}$$

where $U_{i,j}$ is the utility of alternative i for individual j, $x_{i,j}$ is a vector measuring the attributes of each alternative, β_j is a vector of parameters, and $\varepsilon_{i,j}$ is an error term that follows the Extreme Value Type I distribution. The parameters β_j are assumed to be random. The probability that individual i chooses alternative j is

$$P_{i,j} = \int L_{i,j}(\beta) f(\beta|\theta) d\theta$$

where $L_{i,j}$ is the probability of choice for a fixed value of β, defined as

$$L_{i,j}(\beta_i) = \frac{e^{\beta_i x_{i,j}}}{\sum_k e^{\beta_i x_{i,k}}}$$

In the conditional logit model, the coefficients of all variables are assumed to be fixed across participants. In other words, the utility of an option depends only on the attribute levels. In the specification above, β is assumed to be fixed across all participants, and not random as in the mixed logit specification.

Table 3 shows the estimated coefficients of the two models and the values of the willingness to walk to avoid crossing the road in a place without crossing facilities. The value for each attribute is the ratio between the coefficient of that attribute and the coefficient of walking time.

All the road attributes are statistically significant, either alone or in combination with other attributes, and have the expected sign (negative). Participants prefer to avoid crossing roads with no crossing facilities, as shown by a negative coefficient of the variable for Option A ("cross"). When choosing to cross those roads, they prefer roads with one less lane than at present, with a central reservation, and with low traffic density and speed below 30mph, rather than roads with the existing number of lanes, without central reservation, with medium or high density, and with 30mph speed. The relative magnitude of the coefficients is consistent with prior expectations, as the coefficient of the variable representing high traffic density on a road without a central reservation is more negative than the representing medium traffic density on a similar road. The time and "don't cross" coefficients are negative, which means that participants prefer shorter walking times and to cross, rather than not to cross the road.

Table 3: Models of choices in the first stated preference exercise

	Conditional logit		Mixed logit	
Variable	Coefficient	Willingness to walk	Coefficient	Willingness to walk
time	-0.09***		-0.42***	
Option A (cross)	-1.35***	14.9	-8.06***	19.0
lanes=as now	-0.60***	6.6	-2.35***	5.5
no reservation			-2.02***	4.8
density=medium				
density=high	-0.31*	3.4	-1.53**	3.6
speed=30				
lanes=as now * speed=30			-1.16**	2.7
density=med* no reserv.	-0.57***	6.3	-1.69***	4.0
density=high* no reserv.	-0.61***	6.7	-1.99***	4.7
Option C (don't cross)	-2.60***	28.7	-11.33***	26.7
n	4500		4500	
groups	200		200	
no coefficients log-likelihood	-1648		-1648	
log-likelihood	-1411		-700	
Pseudo R^2	0.14		0.58	

Significance levels: ***1%, **5%, *10%.

Although the signs of the model coefficients are consistent with previous expectations, some of the estimated trade-off values are implausibly high. For example, the willingness to walk in order to be able to cross the road (the ratio of the "don't cross" and the time coefficients) is greater than the maximum walking time offered in Option B: 28.7 minutes in the conditional logit and 26.7 minutes in the mixed logit model. The willingness to walk to avoid crossing in a place without facilities is also high (14.9 and 19 minutes in the conditional and mixed logit models respectively). If we consider the worst scenarios for pedestrians, then the willingness to walk becomes greater than the maximum walking time offered in Option B (which is 20 minutes). For example, the willingness to walk to avoid crossing a road without facilities and with the current number of lanes is 21.6 (=14.9+6.7), using the conditional logit model and 24.5 (=19+5.5), using the mixed logit model.

The trade-off values become smaller when estimated only on the groups of "crossers" and "traders" (Table 4). For example, for the group of "crossers", the average willingness to walk to avoid crossing a road without facilities and with the current number of lanes is 12.9 (=7.5+5.4) and 13.9 (=7.9+6) using the conditional and mixed logit models respectively.

Table 4: Models of choices in the first stated preference exercise ("crossers" and "traders")

	Conditional Logit				Mixed logit			
	"crossers"		"traders"		"crossers"		"traders"	
Variable	coeff.	wtw	coeff.	wtw	coeff.	wtw	coeff.	wtw
time	-0.14***		-0.19***		-0.31***		-0.45***	
Option A (cross)	-1.02***	7.5	-2.54***	13.6	-2.45***	7.9	-6.18***	13.8
lanes=as now	-0.73***	5.4	-0.63***	3.4	-1.86***	6.0	-2.81***	6.2
no reservation	-1.03***	7.6	-0.94***	5.0	-2.67***	8.7	-2.30***	5.1
density=medium			-0.33*	1.8			-0.93**	2.1
density=high	-0.74***	5.5	-0.73***	3.9	-1.63***	5.3	-2.03***	4.5
speed=30								
Option C (don't cross)	-2.91***	21.5	-3.18***	17.0	-7.95***	25.8	-7.80***	17.4
n	2247		2211		2247		2211	
groups	101		99		101		99	
no coefficients log-likelihood	-823		-810		-823		-810	
log-likelihood	-567		-694		-432		-501	
Pseudo R^2	0.31		0.14		0.74		0.38	

Significance levels: ***1%, **5%, *10%; coeff: coefficient; wtw: willingness to walk to cross the road in a place without crossing facilities

4. Willingness to accept a cost saving to avoid crossing the road

4.1. Design of the stated preference exercise

The objective of the second stated preference exercise was to derive the particiants' willingness to forego a cost saving in order to avoid crossing a road in a place without designated crossing facilities. The scenario involves the participant having the opportunity of paying a lower shopping bill or public transport fare by crossing the road. Participants who stated they crossed the road to access public transport less often than once every 2-3 months or who are aged 60 or older were shown the shopping bill alternative. The other participants were shown the public transport alternative. Two options were presented in each question:

- Option A: Cross the road in a place without crossing facilities and pay a cheaper public transport fare or shopping bill on the other side
- Option B: Avoid crossing

The exercise consisted of seven questions in the London survey and eight questions in the Southend survey. Table 5 shows the attributes and levels of the problem. The cost savings presented to participants in the shopping bill segment are double of those presented to participants in the public transport segment. This is because return trips to shops always require crossing the road twice, but trips to bus stops only require crossing the road once, as bus stops for services running in opposite directions are usually located on opposite sides of the road.

Figure 3 shows an example of one of the questions, where the road in Option A has two lanes for motorised traffic in each direction, a central reservation, low traffic density, and 20mph speed, and the participant can save 80 pence if he/she crosses the road to use a bus stop on the other side.

Table 5: Second stated preference exercise: attributes and levels

Attributes	Levels
Number of lanes in each direction	As in the first exercise
Central reservation	
Traffic	
Cost saving	▪ Public transport segment: from 20p to £2, in 20p increments ▪ Shopping bill segment: from 40p to £4, in 40p increments

Figure 3: Example of question in the second stated preference exercise

Traffic density: **Low**

Central reservation with no guard railing

In this scenario, which of the two options would you choose?

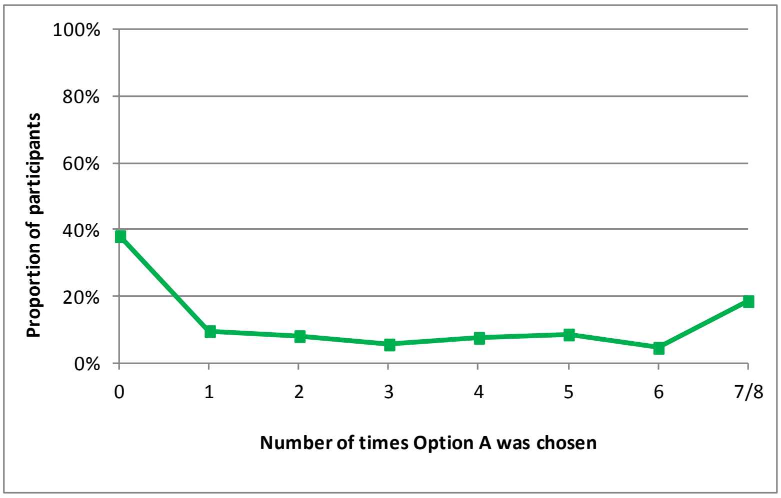
Option A	Option B
Cross at this point Saving 80p off your one-way ticket cost	Do not cross the road and pay the higher ticket cost

○ Option A ○ Option B

4.2. Trading behaviour

The issues related to non-trading behaviour found in the first exercise were also found in the second exercise. Figure 4 shows that 38% of participants never chose Option A ("cross") and 17% chose that option in all questions. Further analysis (not shown) revealed that 65% of the participants who never chose to cross the road in the first exercise also never chose to cross in the second exercise and 87% of participants who never crossed in the second exercise also never crossed in the first exercise.

Figure 4: Proportion of all participants by the number of times they chose Option A ("cross")



The model of the probability of being a "non-crosser" (Table 6) shows that residence location is the most important factor explining trading behaviour. The probability of never choosing to cross is higher for participants living in the parts of the study areas where there is a lower need to cross (that is, in the Southend case study area and in the area to the east of Finchley Road in the London case study). The probability is lower for participants living in areas where there is a higher need to cross away from pedestrian facilities (that is, areas within 400m of the road but more than 200m away from the nearest crossing facility). The propensity for being a non-crosser is also higher for females and individuals with restricted mobility, and lower for participants aged below 35.

Table 6: Logit model of the probability of being a "non-crosser" in the second stated preference exercise

Variable	Coefficient	p>|z|
constant	-2.72	<0.01***
age<35	-0.91	0.02**
restricted mobility	1.58	<0.01***
female	0.91	<0.01***
London: west of road	1.85	<0.01***
Southend: west of road	2.87	<0.01***
Southend: east of road	2.06	<0.01***
<400m from road and >200m from crossing	-0.64	0.10*
n	200	
no coefficients log-likelihood	-133	
log-likelihood	-110	
Pseudo R^2	0.18	

Significance levels: ***1%, **5%, *10%

4.3. Econometric models and trade-off values

The data was reshaped so that each record represents the participants' choice in each of the questions. A model was estimated where the dependent variable is a dummy variable for the case where the participant chose Option A ("cross and save"). The explanatory variables are the value of the cost saving and a series of dummy variables representing the characteristics of roads and traffic. The base scenario is a road with one less lane than at present, with a central reservation, and with low traffic density and traffic speed lower than 30mph.

The estimation used a random-effects logit model, as the conditional logit and mixed logit specifications require at least three options. The random-effects logit model includes a random constant term. The coefficients of the variables are fixed across participants. This specification assumes that the utility of an option depends on the attribute levels ($x_{i,j}$) and on unobserved individual effects (α_i):

$$U_{i,j} = \alpha_i + \beta_j x_{i,j} + \varepsilon_{i,j}$$

Table 7 shows the estimated coefficients and the values of the willingness to accept a cost saving in order to cross the road. As expected, the coefficient of the saving variable is significant and negative, which means participants prefer higher, rather than lower savings. The coefficients of the road and traffic conditions are significant and also have the expected sign (negative). Furthermore, the "high density" coefficient is more negative than the "medium density" one. The magnitude of the values is plausible but the value of the high density coefficient (£2.5) is above the maximum value offered, which is £2.

Table 7: Random-effects model of choices in the second stated preference exercise

Variable	Coefficient	willingness to accept cost saving
constant	-1.78***	
saving	0.86***	
lanes=as now	-1.40***	1.6
no reservation	-1.26***	1.7
density=medium	-0.95***	1.1
density=high	-2.11***	2.5
speed>=30	-0.43***	0.6
n	1500	
groups	200	
no coefficients log-likelihood	-647	
log-likelihood	-561	
Pseudo R^2	0.13	

Significance levels: ***1%, **5%, *10%

The model of the choices in the second exercise for participants who chose to cross in at least one question ("crossers") and for those who did not choose the same option (A or B) in all questions ("traders") yields trade-off values between cost saving and road attributes that are broadly similar to the ones found in the model using the whole sample (Table 8).

Table 8: Random-effects logit model of choices in the second stated preference exercise ("crossers" and "traders"

	"crossers"		"traders"	
Variable	coeff.	willingness to accept cost saving	coeff.	willingness to accept cost saving
constant	1.24***		-0.73***	
saving	0.92		0.73***	
lanes=as now	-1.40***	1.5	-1.37***	1.9
no reservation	-1.24***	1.4	-1.34***	1.8
density=medium	-1.15***	1.3	-1.02***	1.4
density=high	-2.56***	2.8	-2.15***	2.9
speed>=30	-0.72***	0.8	-0.56**	0.8
n	920		658	
groups	124		89	
no coefficients log-likelihood	-529		-445	
log-likelihood	-440		-359	
Pseudo R^2	0.17		0.19	

Significance levels: ***1%, **5%, *10%.

5. Discussion and conclusions

This paper presented the results of a stated preference survey to assess the value of reductions in community severance caused by major roads. The survey included two choice exercises, one where participants chose between crossing a road informally or walking to a safe crossing point, and another where participants chose between crossing the road informally and pay a lower shopping bill or public transport fare, or avoid crossing, and pay the current shopping bill or public transport fare.

The use of a stated preference survey for assessing the value of community severance revealed that on average participants are willing to walk or to forego a cost saving in order to avoid crossing a road in a place without crossing facilities. However, a large proportion of participants never chose options involving crossing the road. In the first exercise, this resulted in inflated trade-off values between the possibility of avoiding crossing the road in a place without facilities and the walking time to reach a place where the road is covered over. The trade-off values are considerably lower when the models exclude the group of participants who never chose the option for crossing the road. However, this solution excludes a large proportion of the sample from the analysis. It is also not clear what value should be assigned to this group if the results of this study are applied in transport appraisal.

In a few cases, the estimated trade-off values are above the maximum value offered in the exercise because the econometric models extrapolate the observed relationships between choices and walking times. This is especially the case of the "don't cross" alternative in the first exercise. Further analysis revealed that the issue also appears when using alternative model specifications, such as models estimated in willingness-to-pay (Train and Weeks 2005) and mixed logit models including correlation between coefficients. However, the value does not seem to be influenced by the number of "non-traders" and so it may express the real preferences of the participants in the survey.

A possible solution to the problems created by non-trading behaviour is to add a contingent valuation question to the survey, asking what is the maximum walking times people are prepared to walk to avoid crossing the road in a place without facilities. These times can be compared with the ones obtained in the stated preference exercises, in order to assess the validity of the high trade-off values obtained in these exercises. In alternative, the times stated by participants in the contingent valuation question can be used to scale the values obtained in the stated preference models. The average values stated by the group of "non-crossers" in the contingent valuation question can also be used as an indicator of their willingness to walk, replacing the inflated values obtained in the stated preference models.

The values obtained for the willingness to walk in the present study can also be interpreted in terms of the perceived disutility of the time spent crossing the road. Individuals may understand the walking times presented in the survey as delays and not as normal walking time, which may influence their choices, as the duration of delays tends to be overestimated. A method to test the hypothesis in the present survey would be to add a question asking how long people usually walk to reach a few key destinations. The comparison of the stated values and the values estimated from network models (incorporating detours and waiting at signalised crossings) may uncover a systematic overestimation of delays to cross the road. A conversion factor can then be applied to convert the perceived time for crossing the road into real time. As an analogy, the UK Department for Transport recommends that the non-work values of walking time as a means of interchange between modes of transport should be double of those of other non-work values of walking time, as interchange time is perceived differently from "normal" walking time.

Acknowledgements

The *Street Mobility and Network Accessibility* project is a three-year 'Design for Wellbeing' research project funded by the Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), and Arts and Humanities Research Council (AHRC). We thank Rob Sheldon, Alison Lawrence, and Chris Heywood from Accent for the design and implementation of the survey, and Paul Metcalfe from PJM Economics for the experimental design.

References

Anciaes, P R., Jones, P., Mindell, J M. (2016) Community severance: where is it found and at what cost? *Transport Reviews* 36(3), 293-317.

Ben-Akiva, M E., Bolduc, D (1996) Multinomial probit with a logit kernel and a general parametric specification of the covariance structure. Working Paper, Département d'Économique, Université Laval, Québec.

Cantillo, V., Arellana, J., Rolong, M. (2015) Modelling pedestrian crossing behaviour in urban roads: A latent variable approach. *Transportation Research F* **32**, 56-67.

Garrod, G D., Scarpa, R., Willis, K G. (2002) Estimating the benefits of traffic calming on through routes: A choice experiment approach. *Journal of Transport Economics and Policy* **36 (2)**, 211-231.

Grisolía, J. M., López, F., and Ortúzar, J de D. (2015) Burying the highway: The social valuation of community severance and amenity. *International Journal of Sustainable Transportation* **9 (4)**, 298-309.

Hensher, D. A., Rose, J. M., Ortúzar, J de D., Rizzi, L I. (2011) Estimating the value of risk reduction for pedestrians in the road environment: An exploratory analysis. *Journal of Choice Modelling* **4 (2)**, 70-94.

ITS (University of Leeds Institute for Transport Studies) and Atkins (2011) Valuation of townscapes and pedestrianisation. Report to the UK Department for Transport. Available from https://www.gov.uk/government/publications/valuation-of-townscapes-and-pedestrianisation

Kelly, C. E., Tight, M. R., Hodgson, F. C., and Page, M. W. (2011) A comparison of three methods for assessing the walkability of the pedestrian environment. *Journal of Transport Geography* **19 (6)**, 1500-1508.

McFadden, D., Train, K. (2000) Mixed MNL models for discrete response. *Journal of Applied Econometrics* **15 (5)**, 447-470.

Meltofte, K R., Nørby, L E. (2012) Over vejen - Vejen som trafikal barriere for fodgængere [On the Road - The road as a traffic barrier for pedestrians]. Msc. Thesis, Aalborg University, Denmark. Available from http://projekter.aau.dk/projekter/da/studentthesis/over-vejen%281a8858f4-bc06-4d2f-ad62-addf968104da%29.html [in Danish].

Read, M D., Cramphorn, B. (2001) Quantifying the impact of social severance caused by roads. Transfund New Zealand Research Report 201. Transfund New Zealand, Wellington.

Rose, J M., Bliemer, M C J. (2009) Constructing efficient stated choice experimental designs. *Transport Reviews* **29 (5)**, 587-617.

Scarpa, R., Willis, K G. (2006) Distribution of willingness-to-pay for speed reduction with non-positive bidders: is choice modelling consistent with contingent valuation? *Transport Reviews* **26 (4)**, 451-469.

Train, K., Weeks, M. (2005) Discrete choice models in preference space and willing-to-pay space., in R Scarpa and A Alberini (Eds.) *Applications of Simulation Methods in Environmental and Resource Economics*. Springer, Dordrecht., pp. 1-16.

All websites accessed on 7 June 2016.