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A stated preference model to value reductions in community severance caused by roads

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ABSTRACT

This paper uses a stated preference survey to estimate the value of reductions in community severance (the "barrier effect" of transport infrastructure on pedestrians). The survey was conducted in four urban areas in England. Participants were asked whether they would cross a road without designated crossing facilities in order 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. This method provides information for the inclusion of severance effects in the appraisal of interventions to change road design and to control motorised traffic. The estimated value per walking trip of reducing the number of vehicle lanes from 3 to 2 and from 2 to 1 is £1.28 and £1.00 respectively. The value of adding a central reservation (median strip) is £1.08. The value of reducing traffic levels from medium to low and from high to medium is £0.76 and £1.08 respectively The value of reducing speed limits below 30mph is £0.45. These values depend on age, gender, disability, health condition, mobility restrictions, qualifications, location, and walking behaviour.

1. Introduction

Transport systems have a number of negative effects that are not priced in the market. The economic value of these impacts is relevant for decisions about pricing policies and investment in the transport system. Over the years, economists have developed sophisticated methods for assigning monetary values to some of those effects, including congestion, accident risk, noise, air pollution, water pollution, and climate change (Mayeres et al., 1996; Maibach et al., 2007; CE Delft et al., 2011). In comparison, community severance has been relatively neglected by economists and transport planners. Community severance, an issue also known as barrier effect, arises when transport infrastructure (such as roads and railways) or high volumes of motorised road traffic cut through communities, disrupting the walking mobility and accessibility of local residents (Tate, 1997; Read and Cramphorn, 2001; James et al., 2005; Bradbury et al., 2007; Anciaes, 2015; Anciaes et al., 2016a, 2016b; Mindell et al., 2017). This impact can have major negative consequences for public health, well-being, and social inclusion (Mindell and Karlsen, 2012), 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., 2016b). The valuation of severance is difficult because in general it is also difficult to assign values to the benefits and costs of walking. The task is especially problematic when severance leads to trip suppression, as it requires the understanding of the complex set of psychological and social aspects that shape travel behaviour (Anciaes et al., 2016a). In the United Kingdom, severance is classified as an impact that is currently not feasible to monetise (UK DfT, 2017, p.2). In the past, official guidance documents for transport appraisal in some countries have proposed methods for the calculation of the value of severance. For example, in Denmark, the effect was set at 50% of the value of roadside noise (Vejdirektoratet, 1992) and in Sweden, the values depended on the age groups affected (Vägverket, 1989). However, these methods were seldom used in practice and were not included in more recent documents for transport appraisal in those countries.

This paper develops a method 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 existence of central reservation/median strip) and traffic characteristics (density and speed). The method is based on a survey carried out in the areas surrounding four major roads in England. The survey included a stated preference exercise in which participants chose between crossing the road informally with no special provision (under varying scenarios for the road design and traffic

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characteristics) in order to access a cheaper shop or a bus stop in a cheaper travel zone on the other side of the road. Mixed logit models were used to derive the value of the willingness to accept the saving in order to cross the road.

The rest of the paper proceeds as follows. Section 2 reviews the use of stated preference methods to value community severance. Sections 3 and 4 describe the study areas and the study design. Section 5 analyses the participants' trading behaviour. Section 6 reports the results of the modelling of the choices. Section 7 analyses the reasons given by participants for their choices. Section 8 concludes the paper.

2. Literature review

Community severance is a non-marketed 'bad', so methods of economic valuation are usually needed to determine its value. A growing number of studies have started to assess severance using methods similar to those used to assess other negative effects of transport (such as noise and air pollution). In particular, stated preference methods have been used to assess preferences regarding different aspects of severance or different mitigation measures. These methods consist of surveys where participants choose among hypothetical alternatives. Preferences can be estimated in terms of willingness to pay/accept or to trade-off marginal changes in the attributes of the problem.

Contingent valuation is a stated preference method in which participants are asked directly about their willingness to pay for or accept a certain change (Mitchell and Carson, 1989). Soguel (1995) used this method to assess the cost of severance in a city in Switzerland, assuming that effect could be removed through the construction of a tunnel. The participants' maximum willingness to pay was determined by an open-ended question, followed by a bidding game. Grudemo et al. (2002) also used contingent valuation with binary choices to derive the willingness to pay to bury roads and railways that restrict access to recreational spaces, and Maddison and Mourato (2001) used payment cards to elicit values for changes in the layout of a road that restricts access to a site with cultural value.

Advances in statistics and computing have contributed to the development of more sophisticated stated preference methods such as choice modelling (Hanley et al., 2011). This technique is based on surveys where participants choose from alternatives defined by several attributes. The choices are then modelled as functions of the attribute levels and the characteristics of the participants. If one of the attributes defines the payment or compensation associated with each alternative, then it is possible to calculate the willingness to pay or to accept compensation for changes in the other attributes.

This technique has been widely used to value other negative impacts of transport such as noise (Bristow et al., 2015) and in recent years has started to be applied to the valuation of community severance and related issues. For example, Grisolía et al. (2015) estimated the willingness to pay for burying a road in Spain, considering the types of land use and amenities on the surface and the cost of the project, as reflected in an increase in local taxes. The study found that people 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, finding that participants were willing to pay £64 per year for a road pedestrianisation project.

Stated preference methods can also be used to model perceptions and behavioural responses to different types and levels of severance, even when not including a cost attribute in the experiment. This approach assumes that severance can be mitigated by policies that are less radical than building a road tunnel or pedestrianisation, such as traffic control, road redesign, and provision of crossing facilities. Preferences are captured as trade-off values between road and traffic attributes and walking time or distance. A proposal was made by (Read and Cramphorn (2001), Ch.4) for including this type of approach in official guidance for transport appraisal in New Zealand, but this proposal was never implemented. A decade later, Meltofte and Nørby (2012) used a similar method in a study in Denmark to derive 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 pedestrian delay, traffic density, and walking distance to crossing facilities.

A few studies of pedestrian safety have also used stated preference surveys. For example, Hensher et al. (2011) estimated preferences for different types of crossing facilities, total walking time, delay at the crossings, number of traffic lanes, traffic speeds, safety outcomes (measured as predicted numbers of deaths and injuries), and increases in local taxes. 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.

The negative impact of major roads on the ability to cross the road can also be assessed alongside broader impacts of the road on walking. For example, Kelly et al. (2011) developed a 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.

The present study builds on these previous efforts, by assuming thatthe disutility of crossing the road depends on the characteristics of the road (number of traffic lanes and presence of a central reservation) and traffic (density and speed). The modelling of the choices for crossing the road under different cost saving scenarios allows for the estimation of trade-off values, expressed in monetary terms, between crossing roads with more and less adverse conditions. These trade-off values can be used as indicators of the benefits of reducing severance.

3. Study areas

The survey was conducted in the areas surrounding four major roads, in London (Seven Sisters Road and Finchley Road), Southend-on-Sea (Queensway), and Birmingham (Stratford Road) (Fig. 1). Research using participatory mapping, video surveys, street audits, space syntax, and a health and mobility survey revealed that these roads are a barrier to the movement of pedestrians, especially for older people, with negative effects on the frequency of walking trips and on levels of accessibility to local facilities. There is a high incidence of irregular crossing behaviour (away from designated crossing facilities) but many local residents have also developed strategies for avoiding crossing the road in dangerous locations, such as choosing alternative destinations or routes, or using buses.

The two roads in London have three lanes for motorised traffic in each direction and high traffic levels (annual average daily flows of 35,420 vehicles in Seven Sisters Road and 46,617 vehicles in Finchley Road, according to 2015 data from the UK Department for Transport). The 800 m section of Seven Sisters Road selected as case study crosses through the neighbourhood of Woodberry Down, a residential area with few workplaces, shops, or facilities. There are no pedestrian crossings near bus stops, leading to a high incidence of dangerous crossing behaviour (Fig. 1a). The selected 1.7 km section of Finchley Road is a major destination for pedestrians accessing underground stations, shopping centres, and other facilities. The large majority of these places are located on the west side of the road. There are walls and guard railings preventing pedestrians from crossing in many locations (Fig. 1b).

The two roads outside London have two lanes in each direction and lower traffic levels comparing with the roads in London (daily flows of 11,669 to 19,893 in Southend, depending on the section, and 15,608 in