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Estimating the value of life and injury for pedestrians using a stated preference framework

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ABSTRACT

Introduction: The incidence of pedestrian death over the period 2010 to 2014 per 1000,000 in North Cyprus is about 2.5 times that of the EU, with 10.5 times more pedestrian road injuries than deaths. With the prospect of North Cyprus entering the EU, many investments need to be undertaken to improve road safety in order to reach EU benchmarks. *Method:* We conducted a stated choice experiment to identify the preferences and tradeoffs of pedestrians in North Cyprus for improved walking times, pedestrian costs, and safety. The choice of route was examined using mixed logit models to obtain the marginal utilities associated with each attribute of the routes that consumers chose. These were used to estimate the individuals' willingness to pay (WTP) to save walking time and to avoid pedestrian fatalities and injuries. We then used the results to obtain community-wide estimates of the value of a statistical life (VSL) saved, the value of an injury (VI) prevented, and the value per hour of walking time saved. *Results:* The estimate of the VSL was €699,434 and the estimate of VI was €20,077. These values are consistent, after adjusting for differences in incomes, with the median results of similar studies done for EU countries. The estimated value of time to pedestrians is €7.20 per person hour. *Conclusions:* The ratio of deaths to injuries is much higher for pedestrians than for road accidents, and this is completely consistent with the higher estimated WTP to avoid a pedestrian accident than to avoid a car accident. The value of time of €7.20 is quite high relative to the wages earned. *Practical applications:* Findings provide a set of information on the VRR for fatalities and injuries and the value of pedestrian time that is critical for conducing ex ante appraisals of investments to improve pedestrian safety.

1. Introduction

Nearly 90% of the world's 1.25 million road fatalities occur in low- and middle-income countries, which account for just 54% of the world's motorized vehicles. Almost 22% of those killed are pedestrians (World Health Organization, 2015). A fatality is defined as a pedestrian who dies within 30 days as a result of injuries sustained in an accident involving an automobile. An injury is defined as a pedestrian who was severely injured, hospitalized, or suffering minor injuries as a result of an accident involving an automobile.

While total EU road fatalities fell by 18% over the 2010–2014 period, pedestrian fatalities decreased by just 11%. In the period 2010–2014, the average incidence of pedestrian fatalities in North Cyprus was around 8 per year, or 28 pedestrian fatalities per million population. This was about two and half times the EU rate of 11 pedestrian fatalities per million population per year. The incidence in North Cyprus of various non-fatal pedestrian injuries averaged 84 injuries per year, or 294 injuries per million population, which is about 10.5 times greater than the number of pedestrian fatalities (European Commission Road Safety Statistics website, 2013; Census, 2015; Road Traffic Accident Prevention Association, 2014).

This paper investigates Turkish-Cypriot pedestrians' attitudes to road safety in order to estimate their willingness to pay (WTP) to reduce the risk of an accident, and so determine the value of risk reduction (VRR) (Hensher, 1994; Hensher, Rose, & Greene, 2005). This method has also been used to establish Turkish-Cypriot drivers' attitudes to road safety (Niroomand & Jenkins, 2016).

Attitudes to the risk of an accident are often assessed using stated preference methods such as contingent valuation (CV), which basically presents the risk of injury as the probability of an accident occurring (Beattie et al., 1998; Carthy et al., 1998; Jones-Lee, 1994; Jones-Lee, O'Reilly, & Philips, 1993; Viscusi, Magat, & Huber, 1991). This approach assigns a cost to road safety that implies a tradeoff between risk and cost of travel.

Although CV is theoretically more precise among the stated preferences methods in defining the economic welfare arising from environmental goods and services, it has been criticized by behaviorists

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(Fischhoff, 1991, 1997) as well as some economists (Diamond & Hausman, 1994; Hausman, 1993). They have argued that embedding is a common problem that could discredit CV studies. The embedding effect arises when people have a positive feeling toward supporting an activity in general. The value (stated as WTP) that respondents assign to individual public goods or services through answering a questionnaire is often not the same as the value that they would assign to a bundle of such goods and services through a market mechanism. The absence of a direct market affects the quality of CV responses.

To address some of the defects of the CV method, a number of recent road-safety studies have used stated choice (SC) or conjoint analysis techniques, in which individuals choose between bundles of attributes presented as hypothetical scenarios (Hensher, Rose, Ortúzar, & Rizzi, 2009, 2011; Iragüen & Ortúzar, 2004; Rizzi & Ortúzar, 2003, 2006; Svensson & Johansson, 2010). As such, the SC method is better able to establish likely choice behavior (Louviere, Hensher, Swait, & Adamowicz, 2000; McFadden, 1998).

In this study, the benefits of improved pedestrian road safety are quantified by means of an SC survey of residents of North Cyprus. Once respondents have selected preferred scenarios, the value of each attribute—for example, road type or safety feature—is estimated, in order to quantify the overall benefit of improved road safety. These results are used to measure pedestrians' WTP to reduce the risk of fatality and injury, and thus to estimate a measure of the value of a statistical life (VSL) and the value of an injury (VI) (Andersson, 2007; Elvik, Høye, Vaa, & Sørensen, 2009).

1.1. Pedestrian safety in North Cyprus

Cyprus is the third-largest island in the Mediterranean, the northeastern part of which is populated by some 286,000 Turkish Cypriots. According to the 2013 Census, the average age of the Turkish-Cypriot population was 33 years. Annual per capita gross national income (GNI) in 2014 was €10,989 and the minimum wage was TL1,675 (€572) per month (€6864 per year).[1] The economy is heavily dependent on tourism (21% of GDP), higher education services (11.5%), and transportation and communications (12%).

The only significant pedestrian-safety feature in North Cyprus is the zebra crossing: there are very few pedestrian overpasses, traffic lights, sidewalks or walkways. As a result, most pedestrian accidents in North Cyprus occur while attempting to cross a road. This lack of pedestrian safety is of particular concern given the 50,000 or so international students and many long-term foreign residents in North Cyprus—two groups that tend to walk rather than drive. Those aged 21–44 are most likely to be involved in pedestrian accidents involving automobiles (Road Traffic Accident Prevention Association, 2014).

Carefully selected investments in transport, road safety, and driver education could play a major role in alleviating the social and economic consequences of poor road safety in North Cyprus. However, the process of identifying which projects would provide the greatest benefit requires detailed cost-benefit analysis (CBA), based on the values of key parameters. The objective of this paper is to derive three such parameters: the value of time saved by walkway enhancements; the value per life saved; and the value of prevented injury.

Pedestrians were asked to choose among alternative combinations of road type, walkways, and additional safety measures. Each of these choice sets was then adjusted to maximize the accuracy of the estimates.

The paper comprises six sections. Section 2 presents the authors' approach to valuing risk reduction, while Section 3 presents the design of the stated choice experiment. Section 4 describes the process of data collection and analysis; Section 5 presents model findings and limitations; and Sections 6 and 7 present discussions and conclusions.

[1] Based on an average exchange rate of 2.93TL/euro for May 2014 (Central Bank of the Republic of Turkey website).

2. The value of fatality and injury risk reductions

This section presents the concept of value of risk reduction (VRR) in the context of road safety, setting out how estimates of pedestrians' willingness to pay (WTP) for incremental or marginal improvements in road safety can be used to derive VRRs for pedestrian death or injury. It is important to note that this exercise is an attempt to estimate the marginal economic welfare benefits arising from interventions that improve pedestrian safety, not the total value of pedestrian safety.

2.1. Modeling the valuation of risk reduction

Risk is measured by the number of fatalities as a proportion of the pedestrian population. Pedestrians' willingness to pay (WTP) to avoid death or injury on the road is equal to the marginal rate of substitution (MRS) between the risk of death (or injury) and income (Hojman, Ortúzar, & Rizzi, 2005; Veisten, Flügel, Rizzi, & Elvik, 2013).

Because road safety is a public good, the value to society of improving road safety is equal to the MRS between individual risk of fatality (or injury) and income, summed over all individuals walking a particular route. This yields the subjective value or WTP for reducing by one the expected number of fatal accidents (or injuries) on that route. The estimated value of risk reduction (VRR) is equal to the value of avoiding death (or injury) per unit of society's demand for this public good of road safety (Drèze, 1962; Jones-Lee, 1974).

2.2. Estimating values of statistical lives and injuries

The average pedestrian WTP for a reduction in the risk of fatality or injury per trip is calculated as follows. The pedestrian population's exposure to risk is measured by the number of pedestrian trips and associated kilometers per walking trip undertaken by each pedestrian.[2] The average WTP per pedestrian per trip to reduce fatalities or injuries will be determined by the risk of such an event occurring during a trip, as well as other factors. The WTP per kilometer is found by dividing the WTP per trip by the number of kilometers per trip. The estimated VRR is be derived from (WTP per km)/(risk per km). Risk per kilometer of a given route is derived from (number of fatalities or injuries per year)/(annual average number of walking kilometers—AAWKM). Aggregated average WTP per trip is calculated based on actual trip activity.

3. Designing the stated choice experiment

The stated choice (SC) experiment expresses alternatives in terms of different combinations of road-safety attributes, estimating the marginal WTP for each alternative attribute. Improvements in road safety, walking times, and municipality charges for a given route are then expressed as costs (Hensher, 2004; Veisten et al., 2013).

To generate the SC experiment, pedestrians were asked to choose between a pair of alternative routes and the current route. The SC experiment derives the independent contributions of each of the attributes of a given route, to elicit pedestrians' preferences for road safety, walking times, and municipality charges.[3]

A number of pilot questionnaires were conducted in order to identify the most realistic attributes possible (Hensher et al., 2005, 2009; Hojman et al., 2005; Rizzi & Ortúzar, 2003, 2006; Veisten et al., 2013).[4] The final questionnaire was further modified to take account of additional insights gathered from pilot-study focus groups.

[2] Data used to calculate the chance of fatality or injury was obtained from the Road Safety Branch of the Road and Traffic Authority of North Cyprus and the State Planning Organization.

[3] Higher municipality charges will be necessary if pedestrian infrastructure is to be upgraded.

[4] A total of 40 initial respondents from different part of North Cyprus were questioned for the pilot interview.

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