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## Using revealed preferences to estimate the Value of Travel Time to recreation sites<sup>☆, ☆ ☆</sup>

Carlo Fezzi<sup>\*</sup>, Ian J. Bateman, Silvia Ferrini

CSERGE, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK

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### ABSTRACT

The opportunity Value of Travel Time (VTT) is one of the most important elements of the total cost of recreation day-trips and arguably the most difficult to estimate. Most studies build upon the theoretical framework proposed by [Becker \(1965\)](#) by using a combination of revealed and stated preference data to estimate a value of time which is uniform in all activities and under all circumstances. This restriction is relaxed by [DeSerpa's \(1971\)](#) model which allows the value of saving time to be activity-specific. We present the first analysis which uses actual driving choices between open access and toll roads to estimate a VTT specific for recreation trips, thereby providing a value which conforms to both Becker's and DeSerpa's theoretical models. Using these findings we conduct a Monte Carlo simulation to identify generalizable results for subsequent valuation studies. Our results indicate that 3/4 of the wage rate provides a reasonable approximation of the average VTT for recreation trips, while the commonly implemented assumption of 1/3 of the wage rate generates downward biased results.

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### Introduction

Recreation demand models evaluate the welfare provided by a natural resource by combining information on respondent's characteristics, site visits and travel costs, which include both "out of pocket" costs (e.g. fuel and vehicle maintenance) and the opportunity cost of travel time. [Feather and Shaw \(1999\)](#), among others, show that this approach produces welfare estimates that can vary up to a factor of three depending on the approach used to calculate the Value of Travel Time (VTT). On these grounds, the large volume of trips made to open-access recreational sites every year places the VTT among the key parameters for environmental and public policy evaluation (e.g. [National Survey on Recreation and the Environment, 2000](#); [Natural England, 2010](#)). Nevertheless, a consensus on the appropriate VTT to use in recreation demand modeling is still far from being achieved ([Palmquist et al., 2010](#)). This paper contributes to the debate by developing a novel

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<sup>\*</sup> Corresponding author.

E-mail address: [c.fezzi@uea.ac.uk](mailto:c.fezzi@uea.ac.uk) (C. Fezzi).

Revealed Preference (RP) method for estimating a VTT specific to leisure related journeys by modeling route choices to open-access recreation sites. In addition, it presents a Monte Carlo simulation testing simple and generalizable VTT assumptions for future environmental valuation studies.

VTT estimates are typically based on the theoretical models describing economic decisions under limited time allocation developed by [Becker \(1965\)](#) and [DeSerpa \(1971\)](#). Becker's framework assumes fixed time and monetary prices for each good and derives a (shadow) value of time which is uniform in all activities and under all circumstances. While this result can appear questionable, it allows the VTT to be derived by analyzing any decision in which individuals trade-off money for time. For example, Stated Preference (SP) questions concerning labor market choices have been often used in the environmental valuation literature to derive the VTT for recreation demand models (e.g. [Bockstael et al., 1987](#); [Feather and Shaw, 1999](#); [Lew and Larson, 2005](#)).

DeSerpa's theory can be thought as a generalization of Becker's framework. While in Becker's approach both money and time costs are fixed; in DeSerpa's model only the monetary costs are set, while the amount of time devoted to each activity is allowed to vary depending on individuals' preferences. This generalization allows the marginal utility of time (or the value of saving time) to vary among activities. Intuitively, the more an individual dislikes an activity, the higher should be her value of saving time in that specific task. While this new framework is certainly richer than Becker's original model, it has not yet been implemented in empirical recreation demand studies because of its strict data requirements. Ultimately, within DeSerpa's model, only decisions made by individuals when traveling to recreation sites can reveal their VTT for recreation. Nevertheless, estimating the VTT within a recreation demand model without including any further stated preference information (e.g. [McConnell and Strand, 1981](#)) is problematic because of the high correlation between the travel-cost and travel-time variables (e.g. [Haab and McConnell, 2002](#); [Small et al., 2005](#)).

The main contribution of this paper is to resolve this issue by modeling the time–money trade-offs faced by individuals traveling to recreation sites when choosing between toll and free access roads, thereby providing an estimate of the VTT which is valid in both Becker's and DeSerpa's frameworks. Inferring VTT from toll road choices is particularly appealing, since saving travel time by avoiding congestions is the primary reason for the existence of toll roads and toll lanes. Indeed, using toll road decision to measure the VTT has a long history in transport economics (e.g. [Bhat, 1995](#); [Brownstone and Small, 2005](#); [Small et al., 2005](#); [Steimetz and Brownstone, 2005](#); [Fosgerau et al., 2010](#)). A recent paper by [Wolff \(in press\)](#) argues that this type of analyses may suffer from omitted variable bias and that modeling the relationship between vehicle speed and gasoline prices provides more robust VTT estimates. Ultimately, we believe that both approaches are valuable by having different strengths and weaknesses. While omitted variable bias is a potential concern for any applied econometric exercise, a key advantage of studying toll purchases is that they are explicitly related to time saving. In contrast, gas price is not the main variable affecting vehicle speed. More important factors are the level of traffic, the road and weather conditions, and even features which are very hard to measure such as the glare caused by the sun when it is low on the horizon ([U.S. Department of Transport, 2008](#)). Some of these impacts are difficult to account for (even by using fixed effects), without running into measurement-error problems.<sup>1</sup> In addition, toll payment is highly visible trade-off between time and cost, while drivers are liable to see gasoline purchases (which are necessarily in past) as sunk costs and exhibit behaviors which do not confirm to economic rationality ([Garland and Newport, 1991](#)).

This analyses is distinguished from previous RP VTT studies by at least two additional features. First, rather than analyzing rush-hour commuters' choices on a single toll road section we consider respondents traveling from home to different recreation sites. This allows us to consider much larger time savings and longer trips. For example, the mean travel time saving in [Small et al. \(2005\)](#) is around 6 min, while our respondents, on average, can save more than 1 h of travel time by using toll roads. Second, by sampling respondents directly at the visited sites, we can focus on leisure related journeys and estimate a VTT specific to recreation. While there is considerable empirical evidence reporting significant changes in the VTT according to the purpose of the trip, the mode of travel or the level of congestion (e.g. [Beesley, 1965](#); [Makie et al., 2001](#); [Brownstone and Small, 2005](#); [Small et al., 2005](#); [Fosgerau et al., 2010](#)), to our knowledge is the first analysis which estimates a VTT specific to recreational trips using RP data on route choices.

Our case-study sites are three beaches located on the Italian Riviera Romagnola, whose road network is a mix of toll and free access roads. Toll roads allow faster speed and can save a significant amount of travel time, particularly for long-distance trips. However, they require higher monetary costs. By reconstructing respondents' routes to the beach we identify individuals' trade-offs and their willingness-to-pay to save time when traveling to recreation sites. In line with previous literature (e.g. [Lew and Larson, 2005](#); [Small et al., 2005](#)) we find that individuals differ substantially in their VTT, and that both observed and unobserved heterogeneity are significant. In order to investigate the robustness of a readily generalizable, yet empirically supported, VTT for future studies, we implement a Monte Carlo simulation showing that using a fixed fraction (about 3/4) of the average wage rate generates defensible welfare estimates. Such findings also suggest that the commonly adopted strategy of assuming a VTT equal to 1/3 of the respondent's wage rate (following [Cesario, 1976](#))

<sup>1</sup> Perhaps surprisingly, the [U.S. Department of Transport \(2008\)](#) estimates that the sun glare accounts for more than 60% of the road accidents attributable to adverse atmospheric conditions, causing every year more than three times the accidents attributable to fog, rain and snow put together. Its impact depends on a multitude of factors, such as the geometry and the orientation of the roadway and on the presence of buildings or trees blocking the sunlight. Since this effect also varies non-linearly with the time of the day and across the year, fixed-effects are not likely to be able to provide a solution, but by eliminating a lot of variation attributable to other sources, may actually exacerbate the omitted variable problem.

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