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By Carlo Fezzi, CSERGE, School of Environmental Sciences, University of East Anglia

Ian J. Bateman, CSERGE, School of Environmental Sciences, University of East Anglia

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Keywords: Value of Time, Value of Travel Time Savings, Recreation Demand Models, Revealed Preferences, Willingness to Pay Space

JEL Classification: Q50

Address for correspondence:

Carlo Fezzi
CSERGE, School of Environmental Sciences
University of East Anglia
Norwich NR4 7TJ
UK
E-mail: c.fezzi@uea.ac.uk

Estimating the Value of Travel Time to Recreational Sites Using Revealed Preferences

Carlo Fezzi[1] and Ian J. Bateman[1]

Abstract

The opportunity Value of Travel Time (VTT) is one of the most important parts of the total cost of day-long recreational activities and arguably the most difficult to estimate. While numerous studies have criticized the use of salaries to proxy the relevant shadow values, a consensus on an alternative measure still has to emerge. This paper uses a revealed preference approach to estimate the VTT for recreational trips by modeling individuals' preferences for toll roads and deriving their willingness-to-pay to reduce travel time. Our case-study sites are three beaches located in the Italian Riviera Romagnola, whose road network is a mix of toll and free access roads. By carrying-out face-to-face interviews, we re-construct respondents' routes, indentify their time-cost trade-offs and ultimately estimate their VTT. Results show considerable heterogeneity in values with the VTT for day-long recreational visits being significantly higher than the one of longer holidays.

[1] CSERGE, School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, UK. Emails: c.fezzi@uea.ac.uk, i.bateman@uea.ac.uk.

1. Introduction

The opportunity value of travel time is one of the most important parts of the total costs of day-long recreational activities and, probably, the most difficult to estimate (e.g. Larson, 1993; Lew and Larson, 2005). While numerous studies have criticized the use of salaries to proxy the relevant shadow values, a consensus on an alternative measure still has to emerge (Palmquist et al., 2010). The notion that the Value of Travel Time (VTT) does not have to be necessarily equal to the wage rate was first recognized in the influential papers by Beesley (1965), Becker (1965) and DeSerpa (1971). Alternative solutions adopted in the literature are assuming a VTT equal to a fixed fraction of the salary (typically 1/3 following the recommendation of Cesario, 1976) or to a proportion which can be estimated by the data (McConnell and Strand, 1981). While these models are useful as broad approximations, they are also rather ad hoc and not always give reliable parameter estimates (Smith et al., 1983; Haab and McConnell, 2002).

Another option is to use labor market decisions to estimate the VTT. Bockstael et al. (1987) differentiate between individuals working fixed or flexible hours and estimate different opportunity costs of time accordingly. Feather and Shaw (1999) use stated preference questions to identify over-employed and under-employed workers and, by adapting the Heckman (1974) labor-supply model, to estimate their shadow values of time. Larson and Shaikh (2001) analyze the implication of binding constraints in time and money for recreational demand models, and Lew and Larson (2005) develop further that framework as a mixed-logit model (McFadden and Train, 2000) which allows the VTT to change according to respondent's observed and un-observed characteristics.

Crucial for these approaches is the assumption that the value of time is invariant to the scale in which decisions are made and, therefore, remains the same in choices based on daily, weekly and annual time budgets. This hypothesis allows using the values inferred on long-term decisions, such as those concerning the labor market, as proxies for the VTT in short-term decisions, such as those in day-long (or shorter) recreational activities. Palmquist et al., (2010), on the other hand, believe that these choices can involve significantly different margins and, therefore, shadow values of time. Their analysis compares labor market (long-run) choices and household maintenance (short-run) decision and shows that the value of time can actually change when different trade-offs are involved.

Intuitively, one would also expect the value of time to change according to the different activity. Considering the VTT, in particular, this may change according to the purpose of the trip, the mode of travel, the level of traffic, the length of the journey (DeSerpa, 1971; Makie et al., 2001). A long strand of research in transport economics has indentified and estimated the impact of these factors by using Stated Preference (SP) experiments (Louviere et al., 2000; Hensher, 2001 for reviews), by modeling actual behaviour (e.g. Beesley, 1965; Steimetz and Brownstone, 2005) as Revealed Preferences (RP), or by implementing a combination of the two (e.g. Brownstone and Small, 2005; Small et al., 2005, Fosgerau et al., 2010).

There are various reasons which limit the insights that past RP data provided on the VTT for recreation. First, samples were composed almost exclusively by travellers for work-related trips, which are characterized by very different constraints and, therefore, hold different VTT.[2] Second, the time savings analyzed were typically small (of the order of 5-10 minutes) and on relatively short trips. Therefore, if the marginal value of time is not constant, their VTT cannot be extrapolated to the longer journeys required to reach recreational sites (Palmquist et al., 2010).[3] Thirdly, most RP data are burdened by high collinearly among cost and travel-time variables (Hensher, 2001; Small et al., 2005).

This paper extends this line of RP research to estimate the VTT for recreational trips by modeling individuals' preferences for toll roads. Our sampling scheme differs from those implemented in other VTT studies since, rather than analyzing a specific toll road section (e.g. Brownstone and Small, 2005; Small et al., 2005, Steimetz and Brownstone, 2005) we sample respondents directly on recreational sites. This choice allows us to focus on leisure-related journeys. Our case study sites are three beaches located in the Italian Riviera Romagnola, whose road network is a mix of toll and free access roads. Toll roads are faster

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[2] For example, Steimetz and Brownstone (2005) estimate analyze the willingness to pay for access to free-flow lanes in an otherwise congested Californian highway, finding a VTT for work-related trips more than 4 times higher than the one corresponding to other trips. However, in their sample of 537 people only 7% of the respondents were travelling for non-work related reasons.

[3] For instance, in the studies by Small et al. (2005) and Steimetz and Brownstone (2005) on the use of express (free flow) lanes the highest value of time savings are respectively lower than 12 and 20 minutes, with average trip lengths of 40 and 25 miles.

and can save a significant amount of travel time, particularly for long-distance travellers (e.g. more than 60 miles). However, they require a higher monetary cost. By re-constructing respondents' routes to the beach we indentify individuals' trade-offs and their willingness-to-pay to save travel time.

The rest of the paper is organized as follows. Section 2 presents the data collection strategy and the descriptive statistics, Section 3 introduces the econometric model and Section 4 illustrated the estimation results. Section 5 concludes indicating also avenues for further research.

2. Empirical setting and data overview

Our study takes advantage of the peculiar structure of the Italian road network, where most high-speed highways require an access fee. Charges are proportional to the length of the highway used (with little variation on a per km basis), constant through-out the year and publicly available on the site www.autostrade.it. These highways link all major Italian cities and can be accessed at special stations, located every 10-20 km, which connect them to the ordinary road network. The travel time savings obtained from using these highways, therefore, are not always proportional to the toll, but also depend on the location of the stations and on the alternative routes available. By analyzing choices of individuals travelling from and to different location we obtain considerable variation in money-time trade-offs which allow estimating the willingness to pay for reducing travel time (i.e. the VTT).

In order to focus on the VTT for recreation, we survey individuals directly on the visited sites. We choose as case-study three beaches located on the Italian Riviera Romagnola: Rimini, Cesenatico and Igea-Marina. These locations are very popular, and attract visitors from the entire country. Rimini is the most famous resort of the Riviera, and it is also the most expensive, Cesenatico is slightly cheaper and visited both by families and young people, while Igea-Marina is the smallest and cheapest beach of the three, and it is mainly visited by families. This diversity allows us generate a heterogeneous sample, varying respondents' age, income and distance travelled. Furthermore, since the surrounding road network consists of one toll highway and a few alternative free high-speed roads, also the cost per minute of travel time saved is highly variable. Our sample includes both short, one day, visits to the beach and longer holidays, lasting more than a week. This allows us to test weather different planning horizons imply different values of time, as advocated by Palmquist et al. (2010), or whether the VTT is invariant to choices based on daily, weekly and annual time budgets, as assumed by Feather and Shaw (1999) and Lew and Larson (2005) among others.

We interviewed individuals face-to-face during the months of August and September 2010 and asked them information on their trip, route choice and socio-economical characteristics. The rate of non-response was very low, with less than 5% of the people interviewed refusing to take part in the analysis. A reproduction of the questionnaire, translated in English, is available in the Appendix. We assume that respondents undertake a two-stage decision process. In the first stage they choose which site to visit and in the second stage they select the best route among those available to access it, valuing travel time and monetary cost. Since we are interested in estimating the VTT for recreation and not in valuing the beaches, here the focus is on the second-stage decision only. For this reason we restrict the analysis to respondents who face route options with different tolls, and hence reveal trade-offs between money and travel time. This yields a sample of 397 observations.

Since respondents are incapable of knowing the exact length of each alternative route a priori, the relevant travel time in this study is the expected travel time. We assume that individuals have a feel for the distribution of the travel time required by each possible route, based on their experience and on the information they gather before the trip. This approach is standard in VTT RP studies (e.g. Brownstone and Small, 2005; Small et al., 2005, Steimetz and Brownstone, 2005). As a benchmark, we use the site www.google.maps.com to calculate expected the travel times. As showed in previous research, for project evaluation these engineering estimates are more appropriate and reliable than people perceptions of travel time (Steimetz and Brownstone, 2005).

Since the number of possible routes connecting two points on a road network is, at least in theory, infinite, we use a few simple rules to indentify meaningful routes and, thereby, determine appropriate choice-sets for each respondent. The base choice-set includes the fastest route excluding any toll road (i.e. the free fastest route, FFR), the fastest route with tolls (FTT), the fastest route by accessing the toll road one station after the one in FTT (FT1A) and the fastest route by exiting the toll road one station earlier than the one in FTT (FT1E). These last two choices are relevant if the respondent's house or the beach is located in-between toll-road stations, and entering/exiting the highway in the next/earlier station provides better time-money trade-offs than the both FFR and FTT. Finally, we include in each respondent's choice-set all the alternative routes chosen by individuals travelling from the same area. Areas are defined in terms of toll road use and group together individuals with the same entrance and exit according to the FTT. Only 25% of the respondents belong to areas in which routes other than FRR, FTT, FT1A and FT1E are chosen.

Routes' descriptive statistics are reported in Table 1. The variability in travel times is great. Considering the FTT, for example, travel time ranges from less than 30 minutes to more than 6 hours. For most people (55%) the FTT is the preferred route, followed by the FRR (14%). Only 14% of the respondents choose an alternative route

[Table 1 about here]

Route choice descriptive statistics

The descriptive statistics of all the other variables included in the study are reported in Table 2. Variables such as driver's income, age and number of passengers show great heterogeneity. Most drivers are male (71%) and most passengers are older than 16.

[Table 2 about here]

Descriptive statistics

3. The econometric model

As mentioned in the previous section, we assume that individuals first choose which recreational site to visit and then evaluate the possible route to get there. This allows us to estimate the VTT by modelling the route choice as conditional on the beach choice.

Assuming that utility is linear in income and, for simplicity, eliminating the portion of utility which is constant among alternatives, we can write the utility that person n (n=1,...,N) enjoys for choosing route j (j=1,...,k) as:

(1) $U_{n,i} = \theta_n c_{i,n} + \beta_n t_{i,n} + \varepsilon_{i,n}$,

where $t_{i,n}$ indicates the route time, $c_{i,n}$ the route toll and the residual term $\varepsilon_{i,n}$ accounts for unobserved characteristics of the respondent and the route. By assuming each $\varepsilon_{i,n}$ independently and identically distributed according to a type I extreme value distribution the probability $p_{i,n}$ that person n chooses route i can be written in a conditional logit form (McFadden, 1974) as:

(2) $$p_{n,i} = \frac{\exp(\theta_n c_{i,n} + \beta_n t_{i,n})}{\sum_{j=1}^{k} \exp(\theta_n c_{j,n} + \beta_n t_{j,n})} .$$

The parameters θ_n and β_n represents the marginal utility of money and time. To capture respondent's heterogeneity we specify the time parameter as:

(3) $\beta_n = \overline{\beta} + \boldsymbol{\lambda}\mathbf{Z}_n + u_n$,

where the variables $\mathbf{Z}_\mathrm{n}$ include the socio-economic characteristics of the respondent (age, income, sex, etc.), the parameters $\boldsymbol{\lambda}$ represent observed heterogeneity and the random effect u_n capture the un-observed heterogeneity. This leads to a mixed-logit specification (McFadden and Train, 2000) with a random-parameter for time. We assume the term u_n to be normally distributed. We also tried a log-normal specification but, similar to others (e.g. Small et al., 2005), we failed to achieve convergence.

In the set-up illustrated by equation (1), the VTT is simply the ratio between the derivative of the utility function with respect to the travel time and with respect to the toll:

(4) $$VTT_n = \frac{\partial U_{n,i} / \partial t_{i,n}}{\partial U_{n,i} / \partial t_{i,n}} = \frac{\beta_n}{\theta_n} .$$

This quantity is person-specific, since the two derivatives depend on both the observed and un-observed respondents' characteristics. To test the hypothesis of a non-constant VTT across different time budgets (Palmquist et al., 2010) we also estimate a specification with different random-parameters for respondents undertaking a daily visit and for those staying for longer holidays. If the corresponding parameters are significantly different, then the hypothesis will not be rejected. Estimation is carried-out by simulated maximum likelihood, with 500 Halton draws to compute the random parameter distribution (Train, 2003), by implementing the *mixlogit* command in Stata.

4. Estimation results

Table 3 reports the estimation results of various specifications. We start considering Model A: the simplest model including only travel time and toll in a conditional logit form. The estimated VTT is about 12 €/hour, which is close to the value reported by Browstone and Small (2005) for non-work related trips ($10.83/hour), and to the baseline value ($19.61/hour) estimated by Palmquist et al. (2010). Model B investigates respondents' heterogeneity by fitting a random-parameter for time and by adding interaction-terms of time with the socio-economic characteristics (age, income and sex). The un-observed sources of heterogeneity are strong, as the random-parameter of time presents a highly significant standard error. Considering an interval equal to +/- one standard error, the VTT varies from about 10€/hour to 27€/hour. On the other hand, the effect of the observed characteristics does not appear to be remarkable, with only the coefficient of age being significant.[4] This parameter estimates a lower VTT for the age group "older than 60 years", which contain a high proportion of retired workers who, having more free time, also have lower VTT.

[Table 3 about here]

Model estimates and corresponding VTT

Model C tests weather the VTT changes with the length of the holiday, estimating two separate random-parameters for time: one for respondents undertaking a day visit (122, 30% of the sample) and one for those staying for longer holidays (275, 70% of the sample). The two parameters appear to be significantly different, with the coefficient for day trips being, on average, about one-half higher than the one for longer vacations. This result can be explained by the different time constraints faced by these two groups of beach-goers. For people

[4] The table reports only one specification for income. We tried several different ones but in none of them the coefficient resulted significant at the 5% level.

travelling for day-trips, time is a very scarce resource, and each minute spent in the car is actually a minute less on the beach. Individuals taking longer holidays, on the other hand, had already allocated several days to leisure activities and, therefore, are less constrained. In particular, people travelling long distances (some respondents are travelling 5 or 6 hours) may have already allocated the first day of the vacation to the travel and, therefore, could be not particularly worse-off with a slightly longer trip. The estimated distribution of the VTT for the two groups of respondents are plotted in Figure 1. Not only the means differ, but also the spreads, with the VTT for day-trips being much more heterogeneous. A possible explanation is that day-trips require much lower budgets than longer vacation and, therefore, can also be undertaken by individuals with very modest income. These respondents could not be willing to pay for the tolls and, therefore, have very low VTT.

[Figure 1 about here]

5. Conclusions and further research

About 10 years ago Larson and Shaikh (2001) defined the integration of the role of time into environmental valuation models as "one of the most challenging and important areas of recreational demand research". After a decade, a consensus on the appropriate Value of Travel Time (VTT) is far from being achieved (Palmquist et al., 2010). This paper contributes to this research by estimating the VTT for recreation using revealed preference data.

The study takes advantage of the atypical structure of the Italian road network, where most high-speed highways require an access fee. By conducting face-to-face interviews on three popular beaches, we re-construct respondents' routes, indentify time-cost trade-offs and ultimately estimate the VTT. Compared with previous studies, which use decisions on the labor market (e.g. Lew and Larson, 2005) or household maintenance (Palmquist et al., 2010) to estimate the value of time, our analysis has the important advantage of being based on actual travel-choice decisions for recreation. This is crucial, since different activities involve different constraints and, therefore, can have different values of time.

We find that the VTT changes according to the nature of the trip: for day trip its mean value is about 24€/hour whereas for longer vacations is significantly lower, and near 17€/hour. This difference can be explained considering that people are facing different time budgets when undertaking these two types of recreations. Arguably, time is a much scarcer resource for those individuals undertaking day trips than for those involved in multi-day holidays which, therefore, have a lower VTT. Finally, there is substantial heterogeneity in preferences with mixed logit specification being superior to the standard logit. Surprisingly, income does not seem to play a key-role in determining the VTT.

We believe this is not a final paper but rather a work in progress and we are currently extending this research in various directions. First, we are considering alternative model specifications, such as those based on latent class (Boxall and Adamowicz, 2002). Second, in our face-to-face interviews, we also collected contingent valuation data on alternative route preferences. Comparing those stated preferences with the revealed preference estimates is also one of the further objectives of our analysis.

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Appendix I: Tables and Figures

Table 1

Route choice descriptive statistics

Route	*Time (minutes)*			*Toll (€)*			*% chosen*
	mean	*min*	*max*	*mean*	*min*	*max*	
FRR	139.7	28.0	495.0	12.95	1.00	37.60	55.2
FTT	237.3	35.0	763.0	0.00	0.00	0.00	14.1
FT1A	150.4	35.0	498.0	11.90	0.3	37.1	7.5
FT1E	146.5	36.0	502.0	12.40	0.5	37.3	3.9
other routes	180.2	62.0	356.0	10.3	2.1	16.8	14.4

Notes: total number of observations equal to 397, the statistics of the alternative route refer only to those respondents who has those options in the choice-set opted for it (25% of the sample), whereas the other statistics refer to the full sample.

Table 2

Descriptive statistics

	$\overline{x}$	$\hat{s}(x)$	min	max
income (€/month)	1467	890	175	8000
sex (1=f, 0 =m)	0.29	0.45	0.00	1.00
age (years)	40.40	12.57	18.00	85.00
people in the car	2.85	1.18	1	7
> 16 years old	2.29	0.87	1	7
< 16 years old	0.58	0.83	0	4

Notes: $\overline{x}$ indicates the sample mean, $\hat{s}(x)$ the sample standard deviation. The statistics on age, sex and income (after tax) refer to the driver.

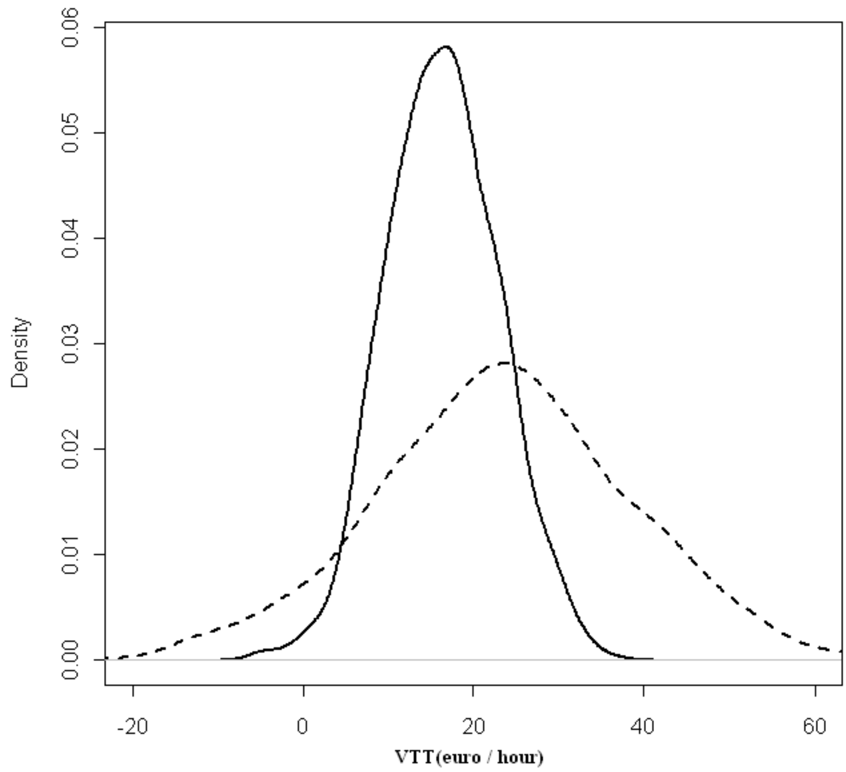
Table 3

Model estimates and corresponding VTT

	Model A *base model*			**Model B** *preferences' heterogeneity*			**Model C** *two time random parameters*		
	coef.	*z-stat*	*sig*	*coef.*	*t-stat*	*p.val*	*coef.*	*t-stat*	*p.val*
toll	-0.314	-7.03	***	-0.563	-6.61	***	-0.562		
time	-0.063	-8.27	***	-0.177	-8.52	***	--		
*time * I(age > 60)*	--			0.056	1.98	**	0.049		
*time * I(income < 500)*	--			0.025	1.29		--		
*time * I(sex = female)*	--			0.003	0.84		--		
*time * I(1 day holiday)*	--			--			-0.221	-5.80	***
*time * I(1 longer holiday)*	--			--			-0.156	-7.15	***
sd(time)	--			0.077			--		
sd(time - 1 day holiday -)	--			--			0.139	3.24	***
sd(time - longer holiday-)	--			--			0.061	4.71	***
pseudo R2	0.129			0.174			0.178		
Log-lik	- 559.5			-530.04			-528.00		
mean VTT (€/h)	12.1			18.9			--		
-1 se	--			10.7			--		
+1 se	--			27.1			--		
mean VTT 1 day (€/h)	--			--			16.7		
mean VTT long trip (€/h)	--			--			23.6		

Notes: "time1" and "time2" are orthogonal polynomials of travel time, to eliminate collinearity, "highway" is a dummy variable identifying weather the route includes an highway, "alone" indicates a person driving alone. [a] =VTT for families/individuals with an income per worker higher than 2400 €/months, [b]=VTT for individuals driving alone.

Figure 1: VTT distribution for respondents undertaking day trips (dotted line) and for those taking longer holidays (solid line).



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