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The Impact of Speed Limits on Recreational Boating in the Lagoon of Venice

Speed limits were introduced in the Lagoon of Venice in 2002 to reduce wave motion, which damages environmentally sensitive areas in the broader Lagoon as well as buildings in the city of Venice. In this paper, we estimate the welfare losses experienced by recreational boaters as a result of the speed limits. We fit a single-site travel cost model to a sample of boaters intercepted as they depart from or arrive to marinas and launching ramps on the Lagoon. Our Poisson model is corrected for truncation and endogenous stratification. We construct three measures of the price per trip, which allow us to check the sensitivity of models and welfare estimates to possible measurement errors in the opportunity cost of time. Our results are robust to the measure of price used and conservatively peg the welfare losses of boaters to €5.2-6.7 million per year. Even under conservative assumptions, the welfare losses of boaters are sufficiently large that, given current monitoring and enforcement of the speed limits, we believe there is a strong incentive for boaters to disregard the limits.

Keywords: travel cost method, single-site model, speed limits, natural resource management.

1. Introduction and Motivation

Speed limits are sometimes imposed on navigational channels and waterways for safety reasons, and to protect wildlife, natural resources and structures (Parnell and Kofoed-Hansen 2001). Thomas and Stratis (2002) report that in 1989 the state of Florida imposed speed limits to avoid disrupting the natural habitat of the Florida manatee, an endangered species. Speed limits were imposed in 2002 in the Lagoon of Venice[2], a body of water on UNESCO's cultural heritage site list, and a unique hydrological and ecological system, to reduce wave motion, which is responsible for damage to historical buildings in the city of Venice, coastal erosion, and adverse effects on the Lagoon ecosystem.

At this time, these restrictions are in place in the navigable waters within the jurisdiction of the City of Venice, including shallow water areas (e.g., Bura-

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[2] Municipality of Venice, Ordinanza n. 09/2002 of the 2 February 2002; Ordinanza 31/2002 of the 27 September 2002; Ordinanza 42/2002 of the 15 November 2002.

no, Cavallino Treporti, Valli di Chioggia, Sant'Erasmo), many of which are highly prized for their ecological and environmental quality, but are also heavily used by boaters and tourists. The ordinances impose speed limits on motorboats exceeding 2.3 meters in length and prohibit access in specified areas, providing exceptions for "traditional" boats, which are slower and contribute less to wave motion. Natural resource managers are currently evaluating whether these restrictions should be extended to neighboring jurisdictions and other parts of the Lagoon as well.

When speed limit regulations are proposed, economists would recommend that natural resource managers weigh the gains from the regulations against the costs imposed on the users of the natural resource system.

Do the speed limit regulations pass the cost-benefit test? In the North and South Lagoon, for example, speed limits should help reduce the damage of wave motion to environmentally sensitive areas, like *barene* (shoals), may reduce impacts on buildings in Venice proper, and are unlikely to impact in any way commercial aquaculture. Recreational boaters, however, may stand to lose from speed limits because they limit their enjoyment of the regulated body of water and/or raise the cost of using it.

These costs and benefits have not been quantified before, and, to our knowledge, few studies have examined systematically the gains and losses on the regulated entities and communities of imposing speed limits in other bodies of water. Thomas and Stratis (2002) treat the imposition of speed limits as effectively eliminating routes. They fit a model of choice among alternative navigation routes, and estimate the welfare loss associated with the elimination of routes rendered useless by the speed limit.

Solomon et al. (2004) use the cost of speed limit law enforcement as a proxy for foregone development benefits in their benefit-cost analysis of a proposed safe minimum standard for the Florida manatee. The benefits of the policy include revenue from manatee-related ecotourism, ecological services provided by manatees, and the public's willingness to pay for conservation, which they elicit through a contingent valuation survey.

In this paper, we wish to estimate the losses experienced by recreational boat users in the Lagoon of Venice as a consequence of the speed limit, but choose a somewhat different approach. Specifically, we estimate a single-site model predicting the number of boating trips into the Lagoon as a function of price per trip and other individual characteristics.

The welfare losses of the speed limit are valued by treating the speed limit as an increase in the price per trip. This is due to an increase in fuel consumption per unit of distance traveled, and by the opportunity cost of the additional travel time. Our data come from a survey of recreational boaters intercepted at a total of 16 privately owned marinas and boat launching ramps on the Lagoon of Venice in May-August 2002.

We queried these boaters about the trips of the year 2001 – before the new speed limit regulations were implemented. We focus on recreational boaters because this is a category of Lagoon users whose trips are discretionary and likely to be sensitive to policies that alter the cost of a trip[3]. We focus on private marinas and ramps for three reasons. First, there are a total of 35 privately owned and operated marinas on the Lagoon waterfront, for a total of 5500 berths, 40% of which are on water. On average, each berth generates revenue for about €1200 a year, for a total of over €6 million euro a year. In addition to paying fees to the marinas, individual boaters are estimated to spend about €500-600 a year each directly for their boating trips. They also invest considerable amounts of money for maintenance and repairs. This is, therefore, an important industry that serves an important category of recreational users of the Lagoon of Venice.

Second, most of the privately owned marinas and ramps appear to be located near *barene*, the delicate natural environment and ecological systems at high risk of erosion due to the wave motion created by boats. For this reason, the speed limits in the Lagoon are particularly stringent in the vicinity of these marinas and boat launching points[4], implying that boat owners who keep their vessels there are likely to bear the full brunt of the speed limits.

Third, the speed limit regulations may have a large impact on the future development of private marinas. Many observers believe that the demand for berths will remain strong in the future, if all conditions remain the same. Virtually all of this demand will be met by private marinas. Marinas are currently virtually 100% occupied, and there are long waiting lists for berths at virtually all of them. Several plans have been drafted for building more, which conflict with the regulations seeking to reduce wave motion in the Lagoon by limiting boat traffic. These conflicts suggests that natural resource managers may wish to weigh boat traffic restrictions with the losses in welfare for recreationists (and for the marina industry) when making decisions about Lagoon use.

Because the survey was conducted before the new speed limits went into effect, we first fit a trip demand function using the current price of a trip. Next, we calculate what the price per trip would have been in the presence of the speed limits (it would have been higher), and calculate the corresponding welfare change. Clearly, our calculations presume that individual tastes were not altered by the policy, so that the demand function for trips remains the same. Our results are robust to the measure of price used and conservatively peg the welfare losses of boaters to €5.2-6.7 million per year. Even under conservative assumptions, the welfare losses of boaters are sufficiently large that, given current monitoring and enforcement of the speed limits, there is likely to be a strong incentive for boaters to disregard the limits. This suggests that the expected reduction in wave motion might be realized only with stepped-up enforcement, which in turn adds to the cost of the policy.

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[3] In addition, the wave motion created by these users is likely to affect primarily the highly prized *barene* in the North Lagoon, with some effects trickling down to the buildings of the Venice city center.

[4] The speed limits vary across the areas of the Lagoon, ranging from 5 kmh in the narrow canals closest to the shoals to 20 kmh in the widest navigation channels in the open Lagoon.

The remainder of the paper is organized as follows. Section II describes the survey design and administration and the data. Section III describes the Travel Cost Method, derives a model of Lagoon boating trips, and develops the econometric model. Section IV presents the results and the welfare estimates. We offer our concluding remarks in Section V.

2. The Survey and the Data

A. Characteristics of the Respondents

We developed a questionnaire eliciting information about boat ownership, use and trips into the Lagoon of Venice, and administered it on site at 16 private marina and ramp locations chosen to be geographically representative of the universe of Lagoon waterfront facilities and launching points situated on the mainland (a total of 35 marinas and/or ramps).

We thus systematically sampled every other marina from the bottom to the top ends of the Lagoon borders (i.e., from Chioggia to Jesolo via Marghera and Mestre; see Figure A.1 in the Appendix).

The questionnaire was administered in person by two interviewers (two honors students at the University of Padua) trained by the first author of this paper. The interviewers were instructed to contact every fifth person for participation in the survey if the marina appeared crowded, and virtually every obvious boat owner/user on the premises on slower days.The interviewers visited the marinas in May-August 2002 primarily on weekends (regardless of the weather) from the early morning to the late afternoon, so that boaters were intercepted before setting out and upon returning from an outing.

The first part of the questionnaire queries respondents about their boating trips into the Lagoon, including the total number of trips in the previous year, sites visited, travel time, etc.

The second part of the questionnaire investigates the respondents' boat ownership, boat characteristics (e.g., type, length, and engine power) and the annual costs of keeping the boat at a private marina. The third part of the questionnaire elicits individual expenditures on trips into the Lagoon, followed by questions about the respondents' demographics and individual characteristics, such as age, income, education, etc.

We contacted about 300 persons, for a total of 263 completed interviews. The response rate is thus 87.7%. As shown in table 1, the typical respondents is a male (72% of the sample) and full-time employed (80% of the sample). Professionals/clerical workers and self-employed persons account for 33.3% and 31.9% of the sample, respectively, and retired persons account for about 10 percent.

The average age is 45 years. About 48.8% percent of the sample has completed high school, and 11% has a college degree. The average family size is 3, and about 7.6% of the sample volunteer time to environmental organizations or initiatives.

Table 1 – Descriptive statistics of the respondents. N=263

Variable	Mean	Std. deviation	Min.	Max.	First quartile	Median	Third quartile
Male (dummy)	0.7186	0.4497	0	1	n/a	n/a	n/a
Age (years)	45.58	10.55	19	73	38	46	54
Full-time employed (dummy)	0.7947	0.4039	0	1	n/a	n/a	n/a
Retired (dummy)	0.1027	0.3040	0	1	n/a	n/a	n/a
High-school diploma (dummy)	0.4880	0.4998	0	1	n/a	n/a	n/a
College degree (dummy)	0.1103	0.0980	0	1	n/a	n/a	n/a
Household size	3.09	0.93	1	6	3	3	4
Household income (euro per year)	33,654	18,036	3,750	75,000	20,000	32,500	57,500
Environmental organization/volunteer	0.076	0.01	0	1	n/a	n/a	n/a

B. Ownership and Type of Boat

The majority of the respondents (88.2%) use their own boats. Regarding boat type, over three-quarters of the sample (76.4%) use a fiberglass boat and 10.4% uses a rubber dinghy. Traditional wood boats account for only 3% of the sample. The boats used by our respondents are generally small (the average length is 6.5 meters, and the median length is 5.5 meters), relatively new (the average age is 8.5 years) and powered by good engines (about 86 HP), almost half of which are two-stroke engines (47.9%). The power of the engine – which, combined with width and length, determines the wave motion created by the boat – varies with the type of boat. Traditional wood boats, for example, average about 48 HP[5], rubber dinghies 59, and fiberglass boats 94.

About 70% of our respondents keep their boats at private marinas, as might be expected, since we surveyed persons as they departed from or returned to private marinas or ramps. Respondents spend on average €1200 a year to keep their boats in private marinas and about €400 a year for maintenance, repairs, and insurance.

[5] We calculate this average after excluding one obvious outlier from the subsample of wood boats. Had this outlier of 440 Horse Power (HP) been included, the average engine power would have been about 104 HP.

Table 2a – Cost per trip in € before the speed limit policy

Variable	Mean	Std. deviation	Min.	Max.	First quartile	Median	Third quartile
Out-of-pocket cost per trip	43.32	33.52	2.22	173.33	17.68	34.00	60.00
Full cost per trip I (wage rate)	58.35	38.89	5.50	202.87	28.78	46.92	82.42
Full cost per trip II (1/3 of the wage rate)	48.45	35.08	3.30	183.08	21.79	39.13	68.16

Table 2b – Cost per trip in € after the speed limit policy

Variable	Mean	Std. deviation	Min.	Max.	First quartile	Median	Third quartile
Out-of-pocket cost per trip	125.45	127.70	2.67	799.06	54.51	111.02	216.44
Full cost per trip I (wage rate)	160.14	143.89	6.61	799.06	54.51	115.89	216.44
Full cost per trip II (1/3 of the wage rate)	137.74	132.88	5.73	755.05	43.83	97.30	177.90

C. Boating Trips

The number of annual Lagoon trips ranges from 1 to 70, the average is 9.6, the median is 6, the standard deviation is 10.00, and the first and third quartiles are 4 and 10, respectively. About three-quarters of the sample report taking ten or fewer trips per year, and 55% report taking 6 or fewer, suggesting that we should use a count data model for these data. There were a total of 202 valid observations for this variable.

We calculated three alternative measures of the cost of a trip into the Lagoon. The first is the out-of-pocket cost of the trip, which adds together the cost of travelling from home to the marina, fuel for the boat, food, etc[6]. The second and

[6] We calculated the out-of-pocket cost of the trip by using the conventional figure of €0.30 per kilometer driven from the respondent's home to the marina. The cost of boat fuel was computed based on the size and type of the boat, on whether the boat is a planing or a displacement boat, and on the power and make of the engine.

third are estimates of the full cost of a trip, and are equal to the out-of-pocket cost plus the opportunity cost of the time spent on the trip. These were based on the assumption that the wage rate is equal to individual annual income divided by 2000 hours. In one variant of the full cost of the trip, the opportunity cost of time is equal to total trip time multiplied by the wage rate. In the other variant, we performed the same calculation but – following much of the travel cost literature since Cesario (1976) – we assumed the opportunity cost of time to be equal to one-third of the wage rate. Since the goal of our study is to estimate the welfare loss (if any) associated to speed limit regulations, we also calculated the cost and time per trip in the presence of the speed limits.

We were able to calculate these six measures of price per trip (three variants with and without speed limits) for a total of 195 respondents. As shown in tables 2a and 2b, for these persons the average out-of-pocket cost of an excursion into the Lagoon ranges from €43 to €125 in the absence and presence of the speed limits, respectively. When we factor in the opportunity cost of time, the average cost of the trip ranges from €48 to €160. The speed limits raise fuel costs, since these boats are extremely fuel-inefficient at low speeds, as well as travel time[7]. It is not, therefore, surprising that the average cost per trip increases significantly with the imposition of the new speed limits.

3. The Travel Cost Model

We use the number of Lagoon boating trips in a year to fit a single-site travel cost model. The model allows us to estimate the surplus associated with visits at the current conditions and the change in surplus due to the speed limits.

A. The Single-site Travel Cost Model

In a single-site travel cost method (TCM) model, it is assumed that an individual's utility depends on aggregate consumption, *X*, leisure, *L* and trips *r* to the site:

$$U = U(X, L, r(q)) . \tag{1}$$

We further assume weak complementarity of trips with exogenously set quality at the site, *q*. In other words, $\partial U / \partial q = 0$ when $r = 0$ (people do not care about the quality of the site if they do not visit it), and *r* is increasing in *q*. The individual chooses *X*, *L* and *r* to maximize utility subject to the budget constraint:

$$y + w \cdot \bar{T} - L - r\left(t_1 + t_2\right) = X + \left(f + P_d \cdot d\right) \cdot r \tag{2}$$

[7] Since most of these boats have a flat hull and cannot plane at the low speeds imposed by the speed limits, restricting speed raises dramatically their consumption of fuel per kilometer.

where y is non-work income, w is the wage rate, $\bar{T}$ is total time, t_1 is travel time to the site, t_2 is time spent at the site, f is the access fee (if any), P_d is the cost per kilometer, and d is the distance to the site. The price of the aggregate good X is normalized to 1[8].

This yields the demand function for trips:

$$r^* = r^*\left(y, w, p_r, q\right) \tag{3}$$

where $p_r = w\left(t_1 + t_2\right) + f + p_d \cdot d$ is the full price of a trip.

We specify a log-linear demand function for trips. We focus on access to the Lagoon under the current conditions, and do not attempt to capture the effect on demand of changing site quality q. Formally,

$$r^* = \exp(\beta_0 + \beta_1 w + \beta_2 p_r)\ . \tag{4}$$

Equation (4) becomes an econometric model once (i) r^* is interpreted as the expected number of trips, and (ii) we introduce r, the observed number of trips, which is a random variable with expected value equal to r^*. To estimate the coefficients in equation (4), it is necessary to ask a sample of visitors and potential visitors to report the number of trips they took in a specified period (year or season), their cost per trip p_r, plus w, y, and other individual characteristics that might affect the demand for visits to the site. Ideally, the price per trip to an alternative site should also be included in the model, lest the estimated coefficient on own price per trip be biased, the severity of the bias depending on the correlation between the two price variables.

Once the demand function has been estimated, the consumer surplus provides an approximation of the welfare associated with visiting the site[9]. Formally, based on equation (4), the consumer surplus is equal to:

$$CS(p_0, q_0) = -\frac{1}{\beta_2} r_0\ , \tag{5}$$

where $r_0 = \exp(\beta_o + \beta_1 w + \beta_2 p_0)$ and p_0 is current price. The consumer surplus corresponding to this functional form for the recreational trip demand is the

[8] This model further assumes that travel time and time spent at the site are exogenous, that the opportunity costs for time travelling and on-site time are equal to the wage rate, that there is no utility or disutility from travelling to the site, and that each trip to the site is undertaken for no other purpose than visiting the site. It also assumes that individuals perceive and respond to changes in travel costs in the same way they would to changes in a fee for being admitted to the site (Freeman, 2003). Finally, the model assumes that work hours are flexible.

[9] Haab and McConnell (2003) argue that since income effects tend to be small, the consumer surplus is a good approximation to welfare in recreational demand studies.

shaded area in Figure 1. The loss of welfare due to the speed limits – the change in consumer surplus – is

$$-\frac{1}{\beta_2}\ r_0 - r_1 \ ,$$

where r_1 is the expected number of trips when the speed limits are in force, raising the price of a trip to p_1. We therefore assume that the speed limits do not shift the trip demand function[10].

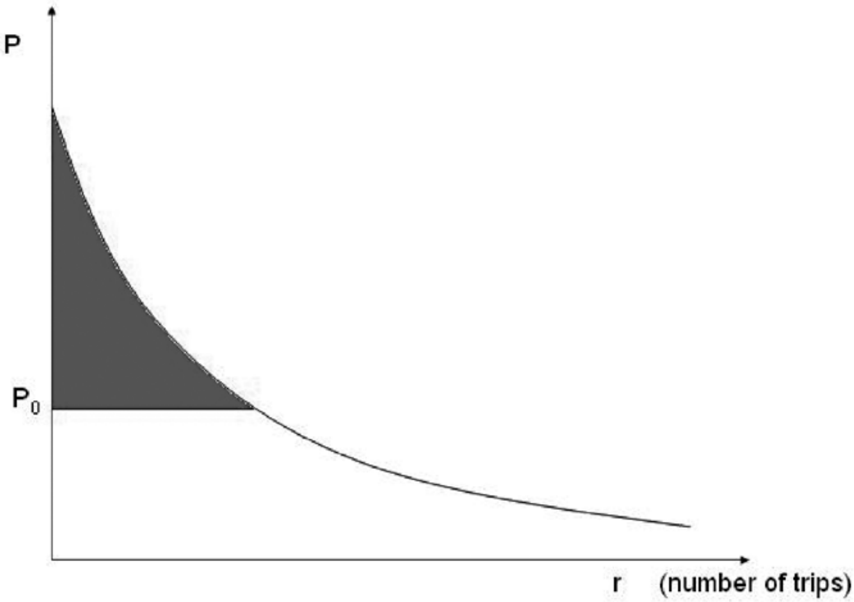

Figure 1 – Inverse demand function for trips and surplus (area in grey)

B. Measuring the Opportunity Cost of Time

The model of the previous section assumes that individuals can freely choose their work hours and that they do not derive any utility (or disutility) from working. Therefore, if individuals derive no utility from working, the wage rate can be used to estimate the opportunity cost (or shadow price) of time.

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[10] The speed limits would shift the trip demand function if the existence of the speed limit affects utility directly, in addition through changing the price and hence the optimal number of trips. We assume that it is not so, but are unable to test this assumption because we do not have observations from after the passage of the speed limit regulations. At this time, we only have data from before the new speed limits regulations.

In recreational demand studies, there is considerable disagreement on how to value time spent traveling to and/or on site. Since Cesario (1976), several recreation studies have valued time at a about one-third of the wage rate, a figure originally drawn from the transportation literature and was subsequently criticized as arbitrary (Shaw and Feather 1999)[11]. McConnell and Strand (1981) develop a procedure for estimating the value of time directly as a fraction of the wage rate, assuming that such proportion is the same for everyone. Smith et al. (1983) first impute wage rates for recreationists who do not report them and/or are not in the labor force using information from the Current Population Survey for individuals of similar observable characteristics[12], and then systematically experiment with using (i) the full wage rate or one-third of it, and (ii) including and excluding time on-site.

As in Smith et al., we run models where time is valued at 33% and 100% of the wage rate, respectively. We needed to secure the cooperation of private marina owners and boaters, and so we had to omit any questions that might have been interpreted as prying into the respondent's finances. This ruled out detailed questions about the respondent's occupation, wage, hours worked, secondary job(s), and other questions that have been employed in the recent literature to get at the value of time. Therefore, we are unable to implement the modeling approach by Bockstael et al. (1987), Larson and Shaikh (2001), and Feather and Shaw (1999). We recognize, however, that imputing the opportunity cost of time requires dealing squarely with two issues. The first is that the opportunity cost of time is higher than the wage rate if the individual receives utility from working, and lower if the individual receives disutility from working. The second is that many people are required to work a specified number of hours, which implies a kink in the budget constraint and raises the question of what exactly is the opportunity cost of time for these individuals.

Bockstael, Strand and Hanemann (1987) develop a utility-theoretic model where trips and other consumption goods have a money price and a time price (in that they require time). The model is completed by two budget constraints – the income budget constraint and the time budget constraint. The exact specification of these constraints depends on whether the individual works a fixed number of hours or can choose to work additional hours above and beyond those required by the primary job. Only the latter group trades off income for time at the margin – the others are either at a corner solution (they do not work) or at the kink of the budget constraint (for those who work the exogenous fixed number of hours).

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[11] The US Department of Transportation (1997, 2003) recently surveyed the literature on valuation of travel time and found a great degree of variation in the value of travel time. For business travel, DOT considers 80-120% of the total hourly compensation wage to be a plausible range, and recommends a best estimate of 100%. For personal travel, DOT suggests a plausible range of 35-90% of pre-tax wages, with a best estimate of 50-70% depending on whether travel is local or intercity.

[12] This procedure was recently implemented by Hynes et al. (2005) for Irish recreationists using labor market information from Eurostat, a general household survey.

Bockstael et al.'s choice of utility function results in the following trip demand functions:

$$r = \alpha + \gamma_1 \overline{Y} + \gamma_2 \overline{T} + \beta \gamma_1 p_1 + \beta \gamma_2 t_1 + \gamma_3 q + \varepsilon \quad (6)$$

for individuals that work a fixed number of hours and

$$r = \alpha + \gamma_1 \overline{Y} + \gamma_2 \overline{T} + \beta \gamma_1 (p_1 + w_D \overline{T}) + \beta \gamma_1 (p_1 + w_D t_1) + \gamma_3 q + \varepsilon \quad (7)$$

for individuals that can use their discretionary time to work more hours. In equations (6) and (7), $\overline{Y}$ is the sum of non-work income and the income from working the fixed number of hours, $\overline{T}$ is time available for discretionary activities (i.e., total time minus the fixed number of work hours), p_1 is the money price of a trip, t_1 the time it takes, w_D is the wage rate that can be earned by individuals who work in their discretionary time, and q is site quality. Demand equations (6) and (7) are estimated using a sample of sports anglers, some of whom hold secondary jobs or can otherwise work during their discretionary time.

Feather and Shaw (1999) propose a theoretical model that allows for flexible work hours, over-and under-employment, and then incorporate the shadow value of time in a choice model of river recreational destination. The model is estimated using data from the National Survey of Recreation and the Environment, where respondents were asked, among other things, whether they were currently employed, and, if so, whether they worked a fixed hour schedule or were free to choose their hours. Those respondents who worked for an hourly wage rate were asked whether they would be willing to work fewer hours to have more free time, and those that were not on a fixed schedule were asked whether they would be willing to work fewer hours for a proportionally lower salary in order to have more free time.Feather and Shaw find that for people that work more hours than they would prefer the shadow wage rate is greater than the market wage rate, while the converse is true for people who work fewer hours than they would prefer[13].

Larson and Shaikh (2001) lay out the restrictions that must be imposed on the parameters of recreational demand functions for them to be consistent with the two-budget model where individuals first choose how much time to work and reserve for discretionary activities, and then decide how many trips to take to one or more recreational sites.

Finally, they discuss the trip demand function in Bockstael et al. (1987), and show that the opportunity cost of time can be retrieved as the coefficient on leisure time divided by the coefficient on work income, even for individuals who do not have flexibility in their work hours.

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[13] Hausman et al. (1995) estimate the value of time by including travel time and out-of-pocket cost separately in their discrete choice model for Alaska recreationists.

C. The Econometric Model

We use a Poisson equation to describe boating trips into the Lagoon of Venice. This is appropriate because individuals do not report numerous trips (the average per year is about 10), so that a continuous distribution would provide a poor approximation to the observed data. Formally, letting Y denote a count-data variable, the probability function for Y implied by a Poisson model is:

$$\Pr(Y = y) = \frac{e^{-\lambda}\lambda^{y}}{y!} \quad , \tag{8}$$

where $\lambda > 0$ is the parameter indexing the Poisson distribution. Both the expected value and the variance of Y are equal to λ.

We specify a Poisson model where Y is the annual number of trips and λ is individual- specific:

$$\Pr(Y_i = y_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} \quad , \tag{9}$$

and

$$\lambda_i = \exp(\mathbf{x}_i\hat{\mathbf{a}}_1 + p_i\beta_2) \quad . \tag{10}$$

Clearly, λ_i is our operational equivalent of r^*. Following equation (4), $\mathbf{x}$ is a vector of determinants of Lagoon trips, including income, whereas p_i is the price per trip faced by the respondent, and β_1 and β_2 are unknown coefficients.

Estimation of the parameters in (10) is further complicated by the nature of our sample. Because we intercept people on site, (i) the observations are truncated from below at one, and (ii) the people that we are more likely to run into are the most avid visitors, i.e., those persons with the highest λ_is. Accordingly, if we wish to estimate the parameters in (10) using the method of maximum likelihood, the correct probability function is:

$$h(y) = \frac{y \cdot \Pr(y)}{\sum_{w=1}^{\infty} w \cdot \Pr(w)} = \frac{y \cdot \Pr(y)}{\lambda} \quad , \tag{11}$$

where Pr(•) is the Poisson distribution function (equation (9)), and the subscript i has been omitted to avoid notational clutter (Shaw 1988)[14].

[14] A similar type of adjustment can be implemented if we assume that the underlying distribution of trips is a negative binomial. Negative binomial distributions are frequently used in applied work because they relax the assumption implicit in the Poisson model that the expected number of trips is equal to the variance and lend themselves nicely to data affected by a prob-

The likelihood function of the sample is

$$\prod_i h(y_i)$$

and the log likelihood function is

$$\sum_i \log h(y_i) \ . \qquad (12)$$

It is easily shown (see Shaw 1988) that (11) is simplified to the probability function of a Poisson variate defined as $y = y - 1$. This approach produces population estimates of the coefficients (Englin and Shonkwiler 1995)[15].

D. Specification of the Econometric Model

In our theoretical model, the demand for trips (equation (4)) should depend on the full price of a trip, which includes the opportunity cost of time. Because of the data limitations discussed earlier, in this paper we are forced common practice and compute the opportunity cost of time in two ways, using the wage rate and one-third of the wage rate (Cesario 1976), respectively. Azevedo et al. (2003) point out that computing the opportunity cost of time in this fashion is likely to introduce measurement error in the price of a trip, which in turn results in attenuation bias (Greene 2003, pp. 83-86). Accordingly, we also run a specification of the model where we enter the out-of-pocket cost of a trip and income separately (as in Alberini et al., in press, and Hynes et al. 2005). Finally, it is important to tackle the issue of substitute sites. Ideally, the price per trip to an alternative site should be included in the model, lest the estimated coefficient on own price per trip be biased, the severity of the bias depending on the correlation between the two price variables.However, it is difficult to identify substitutes to the Lagoon of Venice, so we are forced to ignore this variable in our empirical work[16].

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lem known as overdispersion (i.e., the variance of trips is greater than the expected number of trips; see Greene, 2007). We experimented with estimating negative binomial models corrected for on-site sampling, but these models failed to converge. Computational difficulties with this variant of the negative binomial model are also reported by Haab and McConnell (2003) and Alberini and Reppas (2005). We therefore restrict attention to the Poisson model corrected for on-site sampling. Alberini and Reppas (2005) suggest that using a Poisson model in lieu of a negative binomial does not bias the estimates of the coefficients, even when the negative binomial model would have been the correct distribution to use.

[15] In this paper, we assume away the problem of exact recall of the number of trips taken in the year prior to the survey. Standard econometric arguments (see for example Bound and Krueger, 1991) show that as long as the recall error is expressed as a classical measurement error, the estimates of the regression coefficients are unbiased, although less efficient than if one was able to observe the true number of trips. Problems arise when the measurement error is correlated with the number of true trips, but we have no reason to believe that such a problem might be present here.

[16] We have argued in Alberini et al. (in press) that the Lagoon of Marano and the Po Delta serve as substitutes for the Venice Lagoon for fishing and hunting purposes. These locales, however,

We also examine how the demand for trips is shifted by individual characteristics. In sum, our candidate regressors are price per trip, income, a gender dummy, a dummy indicating whether the respondent is a retired person (which captures the availability of time[17]), age, a college education dummy, and a dummy for whether the respondent keeps his or her boat at a private marina (MARINA), which we regard as a measure of commitment to boating.

4. Results

In what follows, we report results based on the Poisson model with the correction for on-site sampling (eqns. (11)-(12)) and λ specified as an exponential function of the regressors, as in eqn. (10).

Table 3 displays the results of three alternative specifications, which differ in the measure of cost per trip used. Specification (I) enters the out-of-pocket cost of a trip, specification (II) the full cost per trip at the full wage rate, and specification (III) the full cost per trip at one-third of the wage rate. Income is entered separately in all three specifications.

The coefficient on price per trip is negative and significant, as expected, in all specifications, regardless of the measure of price used. The three coefficients on price are reasonable, and imply price elasticities of trips of -0.04, -0.03, and -0.04, respectively. In turn, these mean that for the average boater in our sample it takes a price increase of about 60% for expected trips to decline by one. This effect is consistent across the three specifications of the model.

In all three specifications, household income enters in the regression with a negative sign, and the coefficient is significant, even in specifications (II) and (III), where income is already factored into the price per trip. Males take about 25-26% more trips than female respondents, all else the same. By contrast, despite their free time, retired persons take 36-41% fewer trips than all others, a result that perhaps is due to the fact that they limit boating to a shorter period in the summer. In spite of this, age is positively and significantly related to the number of trips. We find that the type of boat owned and its engine power-to-length characteristics do significantly influence the number of trips, but the fact that one keeps his or her boat at a privately owned marina does not. We also do not find any statistically discernible differences in the number of trips between people that do and do not have a college degree.

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are not substitutes for the Venice Lagoon for "pure" boating. Although Marano and the surrounding beach resorts boast about 5000 berths, the usual destination of the boating trips originating from these marinas is usually the Adriatic Sea, not the Lagoon of Marano.

[17] Since we do not have information about our respondents' discretionary time, in practice this dummy captures the full time term employed in Bockstael et al. (1987). Larson and Shaikh (2001) note that to be consistent with two budget-models, recreational demand models should include the time budget, in addition to the price per trip and money income.

Table 3 – Poisson regressions with truncation and endogenous stratification
(t-statistics in parentheses)

	Model I	Model II	Model III
Intercept	2.013 (13.17)	1.9943 (13.43)	2.0081 (13.29)
Out-of-pocket price per trip (price)	-0.0043 (-3.93)		
Full price per trip at wage rate (Prezzosenzarec)		-0.0027 (-3.17)	
Full price per trip at 1/3 od wage rate (Prezzosenza13)			-0.0037 (-3.61)
Household income (Newincome)	-5.62E-06 (-3.57)	-4.65E-06 (-2.91)	-5.02E-06 (-3.18)
MALE	0.2299 (3.72)	0.2281 (3.71)	0.2317 (3.76)
RETIRED	-0.5268 (-4.94)	-0.4326 (-3.97)	-0.4337 (-3.98)
Age	0.0063 (2.05)	0.0067 (2.18)	0.0063 (2.03)
COLLEGE dummy	-0.1367 (-1.48)	-0.1356 (-1.46)	-0.1376 (-1.49)
MARINA dummy	-0.0426 (-0.60)	-0.0443 (-0.62)	-0.0442 (-0.62)
Dinghy dummy (Gommone)	-0.4649 (4.65)	-0.4833 (-4.81)	-0.4812 (-4.80)
Boat is a sailboat or a row boat (Velaremi)	0.2893 (2.37)	0.3669 (3.01)	0.3611 (2.96)
Length/horse power (Powerratio)	1.4346 (3.82)	1.0247 (3.06)	1.2638 3.51
Log-likelihood	-1069.15	-1060.04	-1058.46
Obs.	188	185	185

Since our likelihood function adjusts for the nature of the sample, the estimated coefficients refer to the *population* of boaters, and can therefore be used to compute welfare statistics for the population. Unfortunately, at this time we do not have information about the average income, age, employment status, etc. for the population of Lagoon of Venice boaters. We therefore compute the welfare measures for each person in our sample using the population coefficients, assuming that the individual characteristics (income, age, etc.) of the persons in the sample are similar to those of the population of Lagoon boaters.

At the current prices (in the absence of limits), the average consumer surplus in the sample is €2045, €3290, and €2442, based on the results of specification (I), (II) and (III), respectively[18]. Each of the model specifications implies that imposing the speed limits would reduce the expected number of trips by about two trips[19], for welfare changes of €608 (standard error around this estimate €82), €790 (s.e. €110), and €677 (s.e. €94) in specifications (I), (II), and (III), respectively. Assuming conservatively that the number of Lagoon boaters using private marinas on the mainland side of the Lagoon is about 8500, the welfare losses due the imposition of the speed limits range from €5.165 to €6.718 million a year[20].

5. Discussion and Conclusions

We have estimated single-site travel cost models of boating trips into the Lagoon of Venice to study the possible welfare losses due to the imposition of speed limit, one of the policies currently in place to reduce wave motion in the Lagoon. The latter is responsible for damages to environmentally sensitive areas and to buildings.

Data limitations prevent us from using econometric equations deriving from two-constraint theoretical model, so we estimated conventional models with the full price of a trip (out-of-pocket costs plus the value of time) and, for good measure, a model where out-of-pocket costs and income are entered separately. Estimation results, predicted welfare change and predicted number of trips with and without speed limits are remarkably similar across these alternative approaches. Our calculations indicate that establishing the speed limits almost triples the cost of a boating trip, and our models in turn indicate that such increase reduces annul trips by two. The corresponding change in surplus is €608-790 a year, so even conservative estimates of the number of boaters using private marinas on the mainland side of the Lagoon (about 8500) result in relatively large losses of welfare on the order of €5.165 to 6.718 million per year. These losses must be added with losses experienced by other categories (e.g., the marina industry; water taxi

[18] A more refined measure of the consumer surplus per year can be calculated by subtracting the fixed costs. We estimate the fixed costs to be about €1240 a year. This figure is calculated as follows. Boat owners who keep their boats at private marinas pay on average €1200 a year for their berth. Since 70% of our sample keep their boats at private marinas, the average over the entire sample is €(1200×0.70)=€840. We add about €400 a year for maintenance and insure to obtain €1240.

[19] The exact change in the average predicted number of trips is 2.02 in specification (I), 1.83 in specification (II) and 2.05 in specification (III).

[20] The 95% confidence interval around these figures are €3.792-6.537 million, and €4.883-8.553 million, respectively.

and commercial boat operators within the city of Venice, etc.), and then compared with the monetized benefits of imposing speed limits to conduct a complete cost-benefit analysis of this policy.

Our welfare loss calculations assume, of course, full compliance to the speed limits on the part of the recreational boaters. Facing these welfare losses, and given the current penalty structure for violations, should we expect boaters to actually obey these speed limits? We reason that a boater will ignore the speed limits on a given trip if the welfare loss due to the limits is greater than the expected penalty, which is the product of the fine times the probability of being caught and fined.

The fines for breaking the limits range from €52 to €516, depending on the severity of the violation and on the whether the violation occurred in the open Lagoon or near urban centers. The prescribed penalty is usually reduced for boaters caught speeding but willing to pay the penalty on the spot. We estimate that the average fine is €100 for violations occurring in the open Lagoon, and €155 for violations taking place in inner canals, in the city of Venice proper, and near urban centers.

Since the surplus per trip is €230-367 (based on model specifications I and II, respectively), and the surplus *loss* per trip (after adjusting to the speed limits) is about €76-99, for violations occurring in the open Lagoon, where the average fine is about €100, the likelihood of being caught must be extremely high – greater than 0.76 – for the boater to choose to comply with the speed limits. For violations occurring in inner canals and near urban areas, where the penalty is higher (€155), a lower likelihood of being caught (0.49 to 0.64) is sufficient to create the incentive to comply with the limits.

In practice, we believe that the actual likelihood of being caught is much lower than these break-even thresholds, especially in the open Lagoon. Given the large welfare loss incurred by boaters and the current monitoring levels, it would appear that the current fines and enforcement level are inadequate to ensure that boaters will obey the speed limits and limit the damages to environmentally sensitive areas. Stepped-up enforcement – which raise the cost of the policy –and increased fines may be necessary to realize reductions in wave motion. Indeed, at least in theory, the ordinances allow the authorities to impound the boat and initiate penal proceedings for "environmental damage" against boat owners responsible for severe violations of the speed limits. These considerations should play a role in the benefit-cost calculus, and in the design of an effective speed limit policy.

References

Alberini A. and Reppas D. (2005). Model Misspecification and Endogenous On-site Sampling in the Travel Cost Method. Presented at the 2005 EAERE annual meeting, Bremen, June.

Alberini A., Zanatta V. and Rosato P. (2007). Combining Actual and Contingent Behavior to Estimate the Value of Sports Fishing in the Lagoon of Venice. *Ecological Economics* 61(2-3): 530-541.

Azevedo C.D., Herriges J.A. and Kling C.L. (2003). Combining Revealed and Stated Preferences: Consistency Tests and Their Interpretations. *American Journal of Agricultural Economics* 85(3): 525-37.

Bockstael N., Strand E., Ivar E., and Hannemann, W.M. (1987). Time and Recreation Demand Model. *American Journal of Agricultural Economics* 69(2): 293-302.

Bound J. and Krueger A.B. (1991). The Extent of Measurement Error in Longitudinal Earnings Data: Do Two Wrongs Make a Right?. *Journal of Labor Economics* 9(1): 1-24.

Cesario F.J. (1976), Value of Time in Recreation Benefit Studies. *Land Economics* 52(1): 32-41.

Englin J. and Shonkwiler J.S. (1995). Estimating Social Welfare using Count data models: An Application to Long-run Recreation Demand under Conditions of Endogenous Stratification and Truncation. *The Review of Economics and Statistics* 77(1): 104-112.

Feather P. and Shaw W.D. (1999). Estimating the cost of Leisure time for recreation demand models. *Journal of Environmental Economics and Management* 38(1): 49-65.

Freeman M.A. (2003). *The Measurement of Environmental and Resource Values*. 2nd edition, Washington, DC: Resources for the Future.

Greene W. (2007), *Econometric Analysis*, 6th Edition, Upper Saddle River: Prentice Hall.

Haab T.C. and McConnell K.E. (2003). *Valuing Environmental and Natural Resources. The Econometrics of Non-market Valuation*. Cheltenham, UK: Edward Elgar.

Hynes S., Hanley N., and O'Donoghue C. (2005). Measuring the Opportunity Cost of Time in Recreation Demand Modeling: An Application to a Random Utility Model of Whitewater Kayaking in Ireland. Paper presented at the 14th Annual EAERE Meeting, Bremen, June.

Larson D.M. and Shaikh S.L. (2001). Empirical specification requirements for two constraint models of recreation choice. *American Journal of Agricultural Economics* 83(2): 428-440.

McConnell K.E. and Strand I.E. (1981). Measuring the Cost of Time in Recreation Demand Analysis: An Application to Sport Fishing. *American Journal of Agricultural Economics* 63 (1): 153-156.

Parnell K.E. and Hansen H.K. (2001), Wakes from Large High-Speed Ferries in Confined Coastal Waters: Management Approaches with Examples from New Zealand and Denmark. *Coastal Management* 29(3): 217-237.

Shaw D. (1988). On-site Samples' Regression. Problems of Non-negative Integers, Truncation and Endogenous Stratification. *Journal of Econometrics* 37: 211-223.

Shaw, W.D. and Feather P. (1999). Possibilities for including the opportunity cost of time in recreation demand analysis. *Land Economics* 75(4): 592-602.

Smith V.K., Desvousges W.H. and McGivney M.P. (1983). The opportunity cost of travel time in recreation demand models. *Land Economics* 59(3): 259-78.

Solomon B.D., Corey-Luse C.M. and Halvorsen K.E. (2004). The Florida Manatee and Eco-Tourism: Towards a Safe Minimum Standard. *Ecological Economics* 50(1-2): 101-115.

Thomas, J. and Stratis N. (2002). Compensating variation for recreational policy: A random utility approach to boating in Florida. *Marine Resource Economics* 17(1): 23-35.

U. S. Department of Transportation (1997). *Departmental Guidance for the Valuation of Travel Time in Economic Analysis*, Washington, DC: April.

U. S. Department of Transportation (2003). *Revised Departmental Guidance for the Valuation of Travel Time in Economic Analysis*, Washington, DC: February.

Appendix

Figure A.1 – The Lagoon of Venice and the Adriatic Sea coastline near Venice.