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

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

Summary

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 €7.7-9.6 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 resources management

JEL Classification: Q26, Q28

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I. 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 Venice¹, 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 effective in the navigable waters within the jurisdiction of the City of Venice, including to shallow water areas (e.g., Burano, Cavallino Treporti, Valli di Chioggia, Sant'Erasmus), 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.

¹ 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.

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. Salomon 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.² 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 mooring spaces, 40% of which are on water. On average, each mooring space generates revenue for about €200 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 on 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,³ implying that boat owners who keep their vessels there are likely to bear the full brunt of the speed limits.

² 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.

³ 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.

Third, the speed limit regulations may have a large impact on the future development of private marinas. Many observers believe that the demand for mooring spaces 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 mooring spaces 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 €7.7-9.6 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.

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.

II. 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 representative of the universe of facilities and launching points on the Lagoon.

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.

Variable	Observations	Mean	Standard deviation
Male (dummy)	263	0.7186	0.4497
Age (years)	263	45.58	10.55
Full-time employed (dummy)	263	0.7947	0.4039
Retired (dummy)	263	0.1027	0.3040
High-school diploma (dummy)	263	0.4880	0.4998
College degree (dummy)	263	0.1103	0.0980
Household size	263	3.09	0.93
Household income (euro per year)	263	33,654	18,036
<i>Environmental organization/volunteer</i>	263	0.076	0.01

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,⁴ 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

⁴ We calculate this average after excluding one obvious outlier from the subsample of wood boats. Had this outlier of 440 HP been included, the average engine power would have been about 104 HP.

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.

C. Boating Trips

The number of annual Lagoon trips ranges from 1 to 70, the average is 9.6, and the standard deviation is 10.00. About three-quarters of the sample report taking ten or less trips per year, and 55% report taking 6 or less, 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. The second and 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 table 2, 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 €60. The speed limits raise fuel costs, since these boats are extremely fuel-inefficient at low speeds, as well as travel time.⁵ It is not, therefore, surprising that the average cost per trip increases significantly with the imposition of the new speed limits.

Table 2 – Average costs per trip in €(standard deviation in parentheses).

	Out-of-pocket cost per trip	Full cost per trip I (wage rate)	Full cost per trip II (1/3 of the wage rate)
In the absence of speed limits	43.32 (33.52)	58.35 (38.89)	48.45 (35.08)
In the presence of speed limits	125.45 (127.70)	160.14 (143.89)	137.74 (132.88)

III. 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:

$$(1) \quad U = U(X, L, r(q)).$$

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

⁵ 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 Km.

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:

$$(2) \quad y + w \cdot [\bar{T} - L - r(t_1 + t_2)] = X + (f + P_d \cdot d) \cdot r$$

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 1.⁶

This yields the demand function for trips:

$$(3) \quad r^* = r^*(y, w, p_r, q)$$

where $p_r = w(t_1 + t_2) + f + p_d \cdot d$ 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,

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

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

⁶ 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.

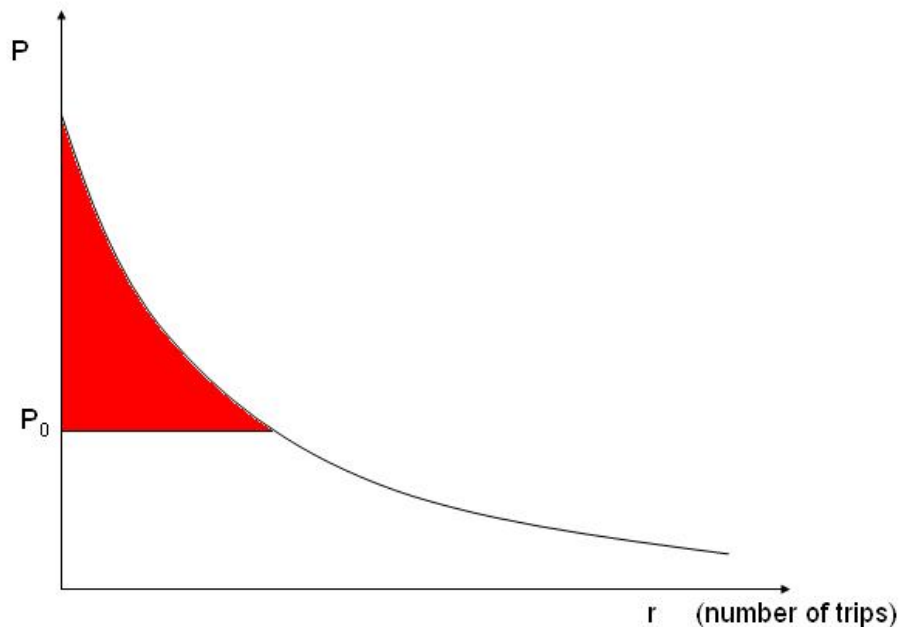
price per trip be biased, the severity of the bias depending on the correlation between the two price variables.

Once the demand function has been estimated, the consumer surplus provides an approximation of the welfare associated with visiting the site.⁷ Formally, based on equation (4), the consumer surplus is equal to:

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

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 shaded area in Figure 1.

Figure 1: Inverse demand function for trips and surplus (area in red).



⁷ 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.

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.⁸

B. 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:

$$(6) \quad \Pr(Y = y) = \frac{e^{-\lambda} \lambda^y}{y!},$$

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:

$$(7) \quad \Pr(Y_i = y_i) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y_i!},$$

and

$$(8) \quad \lambda_i = \exp(\mathbf{x}_i \boldsymbol{\beta}_1 + p_i \beta_2).$$

⁸ 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.

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 (8) 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_i s. Accordingly, if we wish to estimate the parameters in (8) using the method of maximum likelihood, the correct probability function is:

$$(9) \quad h(y) = \frac{y \cdot \Pr(y)}{\sum_{w=1}^{\infty} w \cdot \Pr(w)} = \frac{y \cdot \Pr(y)}{\lambda},$$

where $\Pr(\cdot)$ is the Poisson distribution function (equation (7)), and the subscript i has been omitted to avoid notational clutter (Shaw, 1988).⁹

The likelihood function of the sample is thus $\prod_i h(y_i)$, and the log likelihood function is

$$(10) \quad \sum_i \log h(y_i).$$

It is easily shown (see Shaw, 1988) that (9) is simplified to the probability function of a Poisson variate defined as $y' = y - 1$. This approach produces population estimates of the coefficients, although one only has the sample that was intercepted on-site (Englin and Shonkwiler, 1995).

⁹ A similar type of adjustment can be implemented with negative binomial trips. We experimented with estimating negative binomial models corrected for on-site sampling, but these models failed to converge. We therefore restrict attention to the Poisson model corrected for on-site sampling.

C. 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. Following common practice, we compute the opportunity cost of time in two ways, using the wage rate and one-third of the wage rate (Cesario, 1976), respectively.¹⁰ 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, p. 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., 2005, 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.

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), 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.

¹⁰ McConnell and Strand (1981) have suggested an approach for estimating this fraction directly from the data reported by the respondent in a TCM survey, and, more recently, Shaw and Feather (1999) develop the correct imputation of the opportunity cost of time for those persons who work more hours than they wish, fewer hours than they would prefer, or are not gainfully employed. Hynes et al. (2005) use data from a general household survey to estimate a hedonic wage model in order to predict the market wage rate of students and persons who do not report their income in a travel cost survey.

IV. Results

In what follows, we report results based on the Poisson model with the correction for on-site sampling [equation (9), likelihood function (10), and λ specified as an exponential function of the regressors, as in equation (8)].

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.

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 €147, €140, and €293, based on the results of specification (I), (II) and (III), respectively.¹¹ Each of the model specifications implies that imposing the speed limits would reduce the expected number of trips by about two trips,¹² for welfare changes of €05, €135, and €1040 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 €7.692 to €9.647 million a year.

V. 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.

Most travel cost method specialists recommend using the full price of a trip, which is inclusive of the opportunity cost of time, when fitting such trip demand functions. However Azevedo et al. (2003) point out that, due to the difficulty of knowing exactly what the value of

¹¹ 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 $(€1200 \times 0.70) = €840$. We add about €400 a year for maintenance and insure to obtain €1240.

¹² The exact change in the average predicted number of trips is 2.02 in specification (I), 1.71 in specification (II) and 2.03 in specification (III).

time is, doing so is likely to introduce measurement errors, which may invalidate the estimate of the coefficient on price, and hence the welfare statistics.

Accordingly, we experimented with three alternative measures of the price per trip—out-of-pocket costs plus two alternative measures of the full cost—but our 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 annual trips by two. The corresponding change in surplus is €05-1135 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 €7.692 to 9.647 million per year. These losses must be added with losses experienced by other categories (e.g., the marina industry; water taxi 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 €2 to €16, depending on the severity of the violation and on 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.

In the absence of the speed limit, the surplus per trip is €15-314, depending on the choice of the price per trip variable. The surplus per trip is €155-236 with the speed limits. The loss of welfare on a per trip basis is thus €9-78. 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 0.6-0.8—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 (0.4 to 0.5) 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, the fines are inadequate to ensure that boaters will obey the speed limits and limit the damages to environmentally sensitive areas. These considerations should play a role in the benefit-cost calculus, and in the design of an effective speed limit policy.

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- (lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003
- (lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL), Venice, August 28-29, 2003
- (lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003
- (lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003
- (lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003
- (lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004
- (lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004
- (lxxii) This paper was presented at the 10th Coalition Theory Network Workshop held in Paris, France on 28-29 January 2005 and organised by EUREQua.
- (lxxiii) This paper was presented at the 2nd Workshop on "Inclusive Wealth and Accounting Prices" held in Trieste, Italy on 13-15 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics
- (lxxiv) This paper was presented at the ENGIME Workshop on “Trust and social capital in multicultural cities” Athens, January 19-20, 2004
- (lxxv) This paper was presented at the ENGIME Workshop on “Diversity as a source of growth” Rome November 18-19, 2004
- (lxxvi) This paper was presented at the 3rd Workshop on Spatial-Dynamic Models of Economics and Ecosystems held in Trieste on 11-13 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics
- (lxxvii) This paper was presented at the Workshop on Infectious Diseases: Ecological and Economic Approaches held in Trieste on 13-15 April 2005 and organised by the Ecological and Environmental Economics - EEE Programme, a joint three-year programme of ICTP - The Abdus Salam International Centre for Theoretical Physics, FEEM - Fondazione Eni Enrico Mattei, and The Beijer International Institute of Ecological Economics.

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