Environment and Development Economics 8: 351–371 © 2003 Cambridge University Press
DOI:10.1017/S1355770X03000184 Printed in the United Kingdom

Transferring the benefits of avoided health effects from water pollution between Portugal and Costa Rica

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ABSTRACT. Two very similar contingent valuation surveys eliciting willingness-to-pay (WTP) to avoid eye irritation, gastroenteritis, and coughing episodes due to seawater pollution were conducted on visitors to beaches in Portugal and Costa Rica. Various forms of the hypothesis regarding the transfer of mean WTP between the two countries were rejected, as was the hypothesis that model parameters were drawn from the same pooled sample across countries for three different illness episodes. When compared to on-site studies in Costa Rica, benefit transfer from Portugal leads to errors typically of the order of 100 per cent. Adjusting WTP for declared income or other easily accessible socio-demographic variables does not reduce transfer error. This study shows that transfer of health benefit estimates can be potentially quite unhealthy for policy analysis, questioning whether the time and resource savings are justified in this particular transfer context.

1. Introduction

Given the considerable time and expense involved in conducting non-market valuation surveys, it is not always feasible to undertake an original study. If a similar project has previously been undertaken elsewhere, estimates of its economic consequences might be useable as an indicator of the impacts of the new project. Such an approach has become known as 'benefit transfer' because the estimates of economic benefits are 'transferred' from a site where a study has already been completed ('study site') to another site of interest ('policy site') (Brookshire, 1992; Brookshire and Neill, 1992).

The review of benefit transfer in a 1992 issue of Water Resources Research led to an increasing number of published studies that try to assess the validity of transferring contingent valuation estimates of willingness-to-pay

We are grateful to Richard Ready, University of Pennsylvania, Ståle Navrud, Agricultural University of Norway, and to two anonymous reviewers for comments and suggestions. Any mistakes or omissions are our own.
Research conducted while at the Institute of Economics and Social Science, Agricultural University of Norway, with support from the Centre for Studies of the Environment and Resources (SMR), University of Bergen, and Norwegian Research Council.

(WTP) between study and policy sites (Bergland, Magnussen, and Navrud, 1999; Brookshire and Neill, 1992; Brouwer and Spaninks, 1997; Desvousges, Naughton, and Parsons, 1992; Downing and Ozuna, 1996; EC, 1999; Kirchhoff, Colby, and LaFrance, 1997; Loomis, 1992).

Most benefit transfer studies reported in the literature are within-country transfers, and only a couple concern the transfer of WTP to avoid health effects of environmental quality (Desvousges, Johnson, and Banzal, 1998; EC, 1999). To our knowledge, only one cross-country study has been attempted, testing the transfer of WTP to avoid illness episodes between five European countries (EC, 1999). Average absolute transfer error from a pooled four-country model to a fifth country was 36.2 per cent for unadjusted mean WTP, 43.6 per cent for simple income-adjusted WTP, and 45.4 per cent for WTP conditional on a function of socio-demographic explanatory variables. Of note was the fact that increasing site-specific information did not reduce transfer errors.

Few studies have shown WTP estimates and valuation functions to be transferable by commonly accepted statistical criteria (Desvousges, Naughton, and Parsons, 1992; León et al., 1997; Smith, 1992). Desvousges, Johnson, and Banzaf (1998) and EC (1999) suggest that, while benefit transfer might be accurate enough to be used in certain decision contexts within the same country and for the same good, there is reason to expect that benefit transfer may lead to greater errors across national, institutional, and cultural contexts. In particular, there is very little empirical research to document the validity and reliability[1] of economic valuation transfers from developed to developing countries, despite the fact that these types of transfers are commonly practiced in benefit–cost analysis by development organizations (World Bank, 1998; ADB, 1996).

The present study evaluates the validity of transferring estimates of WTP to avoid an episode day of eye irritation, stomach upset (gastroenteritis), and coughing between populations of seaside beach visitors in Portugal and Costa Rica. Our survey and estimation methodology follow EC (1999) of which the Portuguese study was a part, and additionally we conduct tests of common benefit transfer hypotheses (Brookshire, 1992; Bergland, Magnussen, and Navrud, 1999). To our knowledge this is the first study looking at transfer of WTP estimates between so-called developed and developing countries.

The following section briefly reviews a number of common hypotheses regarding the validity of the benefit transfer and the methodology for eliciting and estimating WTP for the three illness symptoms. The subsequent section presents the statistical results of WTP estimation in Portugal and Costa Rica. The benefit transfer between the two countries and respective hypothesis tests are examined in turn. Finally, we make several recommendations regarding transfers of health benefit estimates between countries as distinct as Costa Rica and Portugal.

[1] By convergent validity in a primary study we refer to the finding of significant variables of the same sign and magnitude as appear in potential sources of benefit transfer estimates in the published literature; by reliability of the benefit transfer we mean the size of transfer error between study and policy sites.

Table 1. *Validity hypotheses for benefit transfer*

Transfers of simple mean WTP	
$H_{1.1}$ Benefits transfers are robust to differences in site characteristics X.	$w^{s\|s} = a_i{*}w^{p\|p}$, $a_1 = 1$,
$H_{1.2}$ The values generated by adjusting simple mean WTP for PPP-adjusted GNP (a_2) and household income (a_3) ratios between primary study and policy sites, are identical.	$w^{s\|s} = a_i{*}w^{p\|p}$, $a_i = a_2$, $a_i = a_3$
Benefit function transfer	
H_2. The values generated with the coefficients from the study site applied to the policy site characteristics are identical to the values that would be obtained with a primary study at the policy site.	$w^{s\|s} = w^{p\|s} = f(\hat{\beta}^p, X^s)$
Parameter tests of function transfer	
$H_{3.1}$ Estimated benefit functions at the policy site and study site are drawn from the same population.	$\beta = \hat{\beta}^p = \hat{\beta}^s$
$H_{3.2}$ Estimated benefit functions at the policy site and study site are equal.	$\hat{\beta}^p = \hat{\beta}^s$

Note: The first superscript indicates the origin of the estimated coefficients β, while the second indicates the origin of the site or population characteristics contained in the data matrix *X*. Study site (superscript s) is the source of the secondary estimate to be transferred, while the policy site (superscript p) is the 'target' to which the transfer is applied.

2. Hypotheses

In evaluating the validity of benefit transfers between Portugal and Costa Rica, we test three frequently employed hypotheses proposed by Brookshire (1992). Table 1 presents a summary of tests for simple transfers of unconditional mean WTP, benefit function transfer of the conditional mean, and the similarity of value function parameters between sites.

If $a_i = a_i = 1$, hypothesis $H_{1.1}$ refers to the equality between unconditional mean WTP at both sites. This is only likely to happen if the elasticities of site coefficients are low, effects linear, or variables not significant. Transferring unadjusted WTP is an unsophisticated procedure, but may be justified when no site-specific variables are available for the study site.

Two alternative assumptions commonly made in 'desk-top' applications of the benefit transfer approach are that WTP for public goods increases with PPP-adjusted GNP/capita ($a_i = a_2$) or, similarly, with average household income ($a_i = a_3$) (table 2). We also compare transfer errors of these two approaches to those of the unadjusted mean, testing hypothesis $H_{1.2}$.

In hypothesis H_2 the predictive power of the transferred benefit function is tested against the primary estimate of WTP at the policy site. This test only examines the convergent validity of transferring the benefit function itself.

Table 2. *Comparison of reported income levels and GNP/capita*

	PPP-adj. GNP/capita (1996)	*Adjustment factor (a_2)*	*PPP-adj. average reported income*	*Adjustment factor (a_3)*
Costa Rica	6.470	0.481	16.65	1.101
Portugal	13.450	2.079	15.13	0.909

Note: Figures in 1,000 US$ (1997) unless otherwise stated.
Source: World Development Indicators 1998, World Bank.

Bergland, Magnussen, and Navrud (1999) propose two specific tests of the validity of using parameters of the benefit transfer function to predict WTP at new sites. Hypothesis $H_{3.1}$ examines whether parameters at the study (*s*) and policy sites (*p*) are drawn from the same population. To test it, we use a likelihood ratio test, treating each site as a nested model of the pooled sample (Greene, 1993). In doing so we make no assumption as to which particular study represents the 'true' parameters.[2]

3. Survey methodology

The contingent valuation is a survey-based method which has been used extensively to determine household and resource user stated WTP for public and quasi-public goods (Mitchell and Carson, 1989; Hanemann and Kanninen, 1996). In this study WTP to avoid three different illness episodes was obtained through a contingent valuation survey of visitors to beaches near Lisbon, Portugal, in May 1998 (Machado and Mourato, 1999). In January 1999 the same survey was administered at three beaches on the Pacific coast of Costa Rica.[3]

In the survey, respondents were presented with general information about illnesses that can result from bathing in sea water polluted by sewage and were told that, on average, five out of every 100 bathers get ill at the beaches involved in the study. Each respondent was then asked to imagine three situations: waking up one morning suffering from eye irritation, stomach upset, or coughing. Each episode would last one day and each respondent was asked about all three episodes sequentially. Table 3 presents detailed episode descriptions. Respondents were then asked to imagine that they could pay an amount of money to avoid experiencing each episode.

[2] A fourth hypothesis evaluates whether estimated parameters at the study site are *equal* to estimated parameters at the policy site ($H_{3.2}$ in table 1). Chow-tests (Loomis, 1992) and Score tests have been applied for this purpose (Bergland, Magnussen, and Navrud, 1999). Testing such a hypothesis assumes that the parameters at the policy site are 'true' and checks whether the parameters at the study site are significantly different. This test can be reversed by assuming that the study site parameters are 'true'. If $H_{3.1}$ is rejected we would expect $H_{3.2}$ to be rejected as well, as it imposes an additional restriction regarding the choice of the 'true' parameters. Only if $H_{3.1}$ is not rejected is there a rationale to conduct a test of the stricter $H_{3.2}$.

[3] Manuel Antonio, Jaco, and Puntarenas beaches.

Table 3. *Description of episodes as read to respondents*

	Episodes		
	One day of eye irritation	*One day of stomach upset (gastroenteritis)*	*One day of coughing*
Symptoms	• Mildly red, watering, itchy eyes which you will want to rub; • Runny nose with sneezing spells.	• Persistent nausea and headache; • Occasional vomiting • Some stomach pain/cramps; • Diarrhoea at least twice during the day.	• Persistent, phlegmy cough about every half an hour during the day; • Some chest tightness and light breathing difficulty, but no pain.
Restrictions	• No restrictions on normal activities	• Some restrictions on normal activities	• No restrictions on normal activities
Duration	• One day, followed by return to normal health	• One day, followed by return to normal health	• One day, followed by return to normal health

Pains were taken to simplify the scenario to make conditions as favourable as possible for benefit transfer. Harrington and Portney (1987), and later Desvousges, Johnson, and Banzaf (1998), developed a theoretical model which explains how household's WTP for avoiding an episode of pollution-related sickness depends on effects of income, pain and suffering, leisure and avertive and mitigative expenditures. We used this model as a guide in designing the contingent valuation scenario. By asking respondents to react to a marginal change (an episode day) *after* having contracted the symptom (i.e. *ex post* WTP), we could ignore information about the pollution levels, its effect on avertive expenditure, and on WTP responses. Furthermore, valuing *ex post* rather than *ex ante* WTP should remove uncertainty about the health effect actually occurring, thereby avoiding personal risk evaluations of the dose-response function (Desvousges, Johnson, and Banzaf, 1998). Although *ex ante* WTP is more realistic in a world of uncertainty, existing evidence suggests that the upward bias incurred is probably small for minor illnesses (less than 1 per cent in Freeman, 1989). In addition, by asking respondents to ignore their expenditures on medicine and doctors' visits the effect of mitigating expenditures could also be controlled for.

To further reduce the influence of context on the WTP results no particular payment vehicle was specified. As the efficiency of institutions providing water quality and health care vary from country to country, we avoided introducing probability of provision or transaction cost considerations that was outside the scope of this research. We could have tried to further isolate our WTP estimates to include only effects on pain and suffering and increased leisure by asking respondents to ignore potential income losses from a day of illness. However, in our particular cases, both Portugal and Costa Rica have a national health service funded by general taxation with service free at the point of delivery, which should reduce the effect of sickness-related income loss on WTP. However, institutional differences may be relevant where large differences in social welfare systems lead to very different levels of worker sickness compensation. This combined effort to reduce scenario context and improve transfer conditions comes at the cost of increasing the hypothetical nature of the scenario, and possibly causing respondents to give unconsidered or economically 'inconsequential' answers (Carson, Groves, and Machina, 1999). This dilemma is discussed in conclusion.

Table 4. *Example of a top-down payment card*

Esc	*✓ if prepared to pay*	*Examples of what could be bought with similar amounts of money*
0		Phone call . . . Box of Matches . . . Loaf of Bread . . .
25		Local Bus Ride . . . Cup of Coffee . . . Lottery Ticket . . .
50		Newspaper . . . Everyday Groceries (e.g. Loaf of
230		Bread; Packet of Sugar; Pint of Milk)
460		
700		Glossy Magazine . . . Everyday Toiletries (e.g. Soap,
1,150		Shampoo, Razors, Moisturiser Cream) . . . Pint of
1,800		Beer . . . Cinema Ticket . . . Average Hourly Wage . . .
2,500		Paperback Book . . . Compact Disc
3,200		
4,100		Item of Clothing (e.g. shirt; blouse; tie; jeans) . . .
5,300		Ladies Haircut and Style . . . Meal in a Restaurant . . .
6,700		Ticket for a Trip Out (e.g. Theatre; Football Match;
8,500		Amusement Park)
10,800		
13,800		Household Appliance (e.g. Hoover) . . . Small
17,500		Electrical Good (e.g. Telephone-Answering Machine;
22,000		Mobile Phone; Portable CD Player) . . . Item of
27,500		Clothing (e.g. Dress; Jacket; Pullover)
33,500		
41,500		Annual Household Electricity Bill . . . Expensive
52,000		Item of Clothing (e.g. Suit; Designer Dress) . . .
64,500		Weekend Break
80,500		
98,000		Colour TV . . . Camcorder . . . Two Week Holiday
120,000		Abroad . . . Fridge-Freezer . . . Washing Machine
147,000		
180,000		
218,000		
270,000		
328,000		
403,000		
495,000		
610,000		
750,000		

WTP was elicited using a 'top–down payment card' (EC, 1999) with 32 amounts denominated in Escudos (Portugal) and Colones (Costa Rica). The Costa Rican payment card was obtained by converting Escudos amounts using a purchasing power parity (PPP) adjusted exchange rate via US$.[4] Table 4 provides an example. Amounts in the card increase more or less geometrically ranging from approximately US$0.20 to US$6,100, with figures rounded to the nearest decimal, 10, 100, or 1,000 colones (Costa Rica). On the payment card, amounts could be compared to different common household consumer items of the same value.

Respondents were asked to place a tick next to every amount they were almost certain they would pay, place a cross next to every amount they were almost certain they would not pay, and leave blank spaces next to amounts they were unsure about being prepared to pay or not. Using this approach the last ticked amount provides a lower bound on maximum WTP; while the first amount marked with a cross is the upper bound on maximum WTP, with 'almost certainty'. Since true WTP lies somewhere in between the last tick and the first cross in the card, the data can be treated as interval data.

4. Estimation procedure

Both non-parametric and parametric models were used to analyse the data. Following the method of Kristrom (1990), non-parametric mean WTP values were calculated by linear extrapolation, taking the midpoints in each censored interval, multiplying by the percentage of responses in that interval and summing (integrating) over all intervals. The upper interval was censored at the maximum bid on the payment card.

Cameron (1988) first showed that responses to dichotomous choice WTP questions could be treated similarly to survival data. In the payment card used in this study the respondent ticks successively higher amounts until reaching a 'threshold' interval which contains their maximum WTP. This is analogous to the bio-essay literature modelling of survival time responses (Greene, 1993). We used the SAS Lifereg Procedure® to model censored interval responses directly as the dependent variable. In this approach parameters on independent variables have the convenient interpretation as marginal effects on expected WTP for each respondent.

For the payment card approach used here responses to successively higher 'threshold' bids are interpreted as censored intervals. Maximum WTP falls either below the lowest amount (A_{min}), between the ticked amount (A_{tick}) and the next amount (A_{tick+1}), or above the highest amount on the payment card (A_{max}). This lets us define an indicator, I_i, for the censored intervals

$$
\begin{array}{lll}
I_{\text{no tick}} = 1 \text{ for } y_i < A_{\min}, & & 0 \text{ otherwise} \\
I_{\text{tick}} = 1 \text{ for } A_{\text{tick}} \le y_i < A_{\text{tick}} + 1, & & 0 \text{ otherwise} \\
I_{\text{max tick}} = 1 \text{ for } A_{\max} \le y_i, & & 0 \text{ otherwise}
\end{array}
$$

[4] Financial exchange rates used: 233.4 (Colones/$ for Costa Rica) and 175.3 (Escudos/$ for Portugal); PPP-adjusted exchange rate: 96.1 (Colones/$ for Costa Rica) and 123 (Escudos/$ for Portugal). Sources were OECD, World Bank, and Central Bank of Costa Rica, 1997 data.

True WTP y_i is unobserved for respondent i, but manifested through the definition of the indicator variable, I_i

$$y_i = \mathbf{x}'\beta + \varepsilon_i \tag{1}$$

where $\mathbf{x}$ is a vector of covariate values, β = parameter vector, and ε_i is an error term. WTP to avoid an episode day is a compensating variation measure of change in welfare (C), where the respondent compares expenditure functions with and without the illness symptom to the bid offered. The probability of placing a tick at any given bid amount, A_j, is given by

$$\begin{aligned} &\Pr\{\text{response}_j = \text{'✓' at } A_j\} = \Pr\{y_i > A_j\} \\ &= \Pr\{\mathbf{x}_i'\beta + \varepsilon_i > A_j\} = \Pr\{w_i > (A_j - \mathbf{x}_i'\beta/\sigma\}\ (9) \end{aligned} \tag{2}$$

where σ is an unknown scale parameter and w_i is the chosen distribution of WTP operationalizing the model, with probability density function f and cumulative distribution function $F(A_j) = 1 - \Pr\{.\}$. The log-likelihood can then be written as

$$\begin{aligned} \ln L = \sum\Big(I_{\text{no tick}} \ln\big[F(A_{\min})\big] + I_{\text{tick}} \ln\big[F(A_{\text{tick}+1}) - F(A_{\text{tick}})\big] + I_{\text{max tick}} \\ \ln\big[1 - F(A_{\max})\big]\Big) \end{aligned} \tag{3}$$

A comparison was made of the three illness episodes in both countries using different assumptions about the error term ϵ: normal, log-normal, logistic, log-logistic, and Weibull distributions. As explained under estimation issues, below, all parametric analyses were conducted using the Weibull distribution defined as (SAS Procedures Manual)

$$F(w) = \exp\left[-w^{1/\sigma} \cdot \exp\left(-\frac{\mu}{\sigma}\right)\right] \tag{4}$$

where μ and σ are location and scale parameters respectively recovered from the likelihood function. In testing the transfer of different mean WTP estimates outlined in H_1–H_2, non-linearity of this model require the use of a simulation technique. A numerical approximation of the Weibull survival function was therefore used to calculate conditional mean expected WTP for the population (EC, 1999)

$$E(WTP \mid X) = \sum_i \exp\left[-(i - 0.5)^{\frac{1}{\sigma}} \cdot \exp\left(-\frac{\mu + X'\beta}{\sigma}\right)\right] \tag{5}$$

where i = 1 to maximum bid on payment card. The Krinsky and Robb (1986) simulation procedure was run to obtain an estimate of the variation of WTP. Model parameters (μ, σ, β) were drawn 1,000 times at random from the variance-covariance matrix, calculating WTP at each draw using equation (5).

5. Results

Sample characteristics

Interviewers in both countries selected only beach visitors who lived in the metropolitan areas of Lisbon and San Jose, respectively, in order to make

Table 5. *Descriptive statistics*

Variable	*Costa Rica* *Mean*	*Costa Rica* *St.error*	*Portugal* *Mean*	*Portugal* *St.error*
Socio-demographics				
Sex (% male)	0.51	(0.02)	0.44	(0.02)
Couple (% cohabitation/married)	0.53	(0.02)	0.50	(0.02)
Age (years)	31.92	(0.50)	36.36	(0.70)
Household size (members)	4.32	(0.08)	3.25	(0.14)
Children < 15 yrs. old in household	1.20	(0.06)	0.51	(0.05)
University degree (% yes)	0.51	(0.02)	0.27	(0.02)
Primary school only (% yes)	0.07	(0.01)	0.19	(0.02)
Employed (% yes)	0.78	(0.02)	0.81	(0.02)
Annual personal income (PPP-adj. 1,000 US$ '97)	16.65	(0.58)	15.13	(0.45)
Resource use				
Beach use in past year (no. visits)	7.37	(0.75)	27.7	(1.54)
Health				
Alergy diagnosis (% yes)	0.19	(0.02)	0.27	(0.02)
Irritable bowel diagnosis (% yes)	0.05	(0.01)	0.04	(0.01)
Bronchitis diagnosis (% yes)	0.03	(0.01)	0.06	(0.01)
Asthma diagnosis (% yes)	0.12	(0.02)	0.08	(0.01)
Duration of last diarrhoea episode (days)	0.75	(0.08)	0.29	(0.11)
Duration of last eye irritation episode (days)	1.28	(0.15)	0.62	(0.14)
Duration of last cough episode (days)	1.33	(0.16)	0.41	(0.14)
Overall sample size	411		401	

samples as comparable as possible. This sample selection strategy is justified by the aim of the study being to test the reliability of transferring marginal values of health effects under as favourable cross-country conditions as possible, rather than estimating total welfare effects of a particular policy at either site. Table 5 summarizes sample characteristics.

The Costa Rican sample was found to be younger, more educated, and had higher PPP-adjusted income than the Portuguese sample. Inspection of the data shows that mean driving time from San Jose to the beaches is over three hours by car, while respondents from Lisbon live within some 20 km from the nearest beaches, which are accessible by city public transport. While travel costs are not expected to influence WTP for avoiding illness episodes, it probably selects for the more affluent visitors in Costa Rica who can afford a private vehicle. Thus, WTP in Costa Rica would probably be lower if the survey had been conducted in the capital itself. Another difference of note is the fact that Costa Ricans reported experiencing longer illness episodes than in Portugal. This could correlate positively with WTP.

Table 6 shows response rates in the two samples. Only half of the Costa Rica sample received the payment card treatment described above (while the other half answered a slightly modified version). Hence, comparable

Table 6. *Sampling and data treatment*

	Costa Rica			*Portugal*		
Population of visitors	unknown			unknown		
Total sample †	436 (100%)			n.a.		
– overall survey non-response	25 (6%)			n.a.		
= overall survey response	411 (94%)			401 (%n.a.)		
– payment card experiment	201			–		
= comparable payment cards ‡	210 (100%)			401 (100%)		
	Eye	*Gastro*	*Cough*	*Eye*	*Gastro*	*Cough*
– WTP protests	4 (2%)	3 (1.5%)	5 (2.3%)	58 (14%)	60 (15%)	63 (16%)
– WTP consistent outliers	5 (2.3%)	5 (2.3%)	5 (2.3%)	1 (0.2%)	1 (0.2%)	1 (0.2%)
– WTP consistent zeros	1 (0.5%)	1 (0.5%)	1 (0.5%)	50 (12%)	50 (12%)	50 (12%)
– WTP coding error/missing	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (0.7%)	3 (0.7%)
= Valid WTP responses	200	201	199	292	287	284
WTP < lowest bid (left tail)	11 (6%)	2 (1%)	22 (11%)	6 (2%)	10 (4%)	27 (10%)
WTP > lowest bid	189 (94%)	199 (99%)	177 (89%)	286 (98%)	277 (96%)	257 (90%)

Notes: n.a. = total sample size and sample response rates were not recorded in the Portuguese survey.
† Total sample and non-response rates in the Portuguese sample were not recorded.
‡ A payment card experiment was conducted in Costa Rica using split samples. Here we include only respondents with comparable payment cards.

responses number 210 and 401 for the Costa Rican and Portuguese samples, respectively.

A notable difference between the two samples is the larger percentage of protests and 'consistent zeros' to the WTP question in Portugal. Consistent zeros answered zero WTP on all three episodes but did not state protest reasons for their unwillingness to participate in the survey. Correlations with differences in population characteristics were performed to gain insight into the large difference in consistent zeros across studies.

In Portugal, older respondents answered more often with zero values on all three symptoms or answered with protests (gastroenteritis); male respondents protested more often than female respondents for two of three episodes; respondents living as couples were more likely to protest for all three episodes; also, extreme values or protests were not correlated with income. This pattern repeated itself for the Costa Rican sample with one exception: while in Costa Rica university education significantly increased protest rates, in Portugal no such effect could be detected. Table 5 shows that Portuguese respondents were somewhat older than Costa

Ricans; the male/female ratio was lower in Portugal; and the percentage of respondents living as couples was about the same. There is therefore no clear indication that differences in population characteristics could have caused the reported difference in 'consistent zero' responses. There were also small differences in survey protocol between the two countries: while in Portugal, many respondents filled out the payment cards themselves; in Costa Rica the interviewers recorded the verbal responses. Smaller incentives for yeah-saying among the Portuguese respondents who filled out payment cards themselves may explain some of this difference in protest and true zero response rates between the two samples. Remaining explanations of the difference in protest rates include cultural differences in the willingness to complete surveys related to WTP and health issues. Neither of these aspects could be controlled for with our data.

Estimation issues

The treatment of consistent zeros is problematic. On the one hand, excluding consistent zeros from the sample biases Portuguese WTP upward relative to the Costa Rican sample. On the other hand, if these responses are treated as valid zeros the probability mass in the left tail of the WTP distribution grows to between 16 per cent and 25 per cent of the valid WTP responses in the Portuguese sample. Large differences in probability mass at zero ideally require different statistical specifications of WTP for the Costa Rican and Portuguese models. However, testing benefit function transfer hypotheses required the use of the same distributional specification across sites. We therefore chose to treat consistent zeros in the same way as protests by excluding them from the estimation of WTP. Comparing likelihood values under this assumption, the Weibull distribution outperformed the log-logistic and other distributions in four out of six country-symptom cases. Visual inspection of the empirical and parametric survival curves indicated that the Weibull adjusted better at very high WTP amounts in all cases. This distribution is also consistent with the reasonable assumption that WTP is necessarily positive for avoiding illness. Excluding consistent zeros was also the strategy adopted in the European health benefit transfer study between five European countries (EC, 1999) making comparisons with our results on transfer reliability more valid. The consequences for valuation validity and transfer reliability of excluding consistent zero responses from the sample are explored in the next section.

WTP results

Table 7 shows the non-parametric and parametric mean WTP for the three episodes, compared across countries and treatments of 'consistent zeros'.

Costa Ricans ranked the ill-health episodes in the same way as the Portuguese; WTP(gastroenteritis) > WTP(eye irritation) > WTP(coughing). This ranking was as expected from the description of episode duration where gastroenteritis involved restrictions to normal activity, while the other two episodes did not. In all cases Portuguese unconditional WTP was higher than that of Costa Ricans by 81–113 per cent. There is therefore some consistency in responses, although little convergence.

Table 7. *Unconditional mean WTP*

Episode	*Model*	*Costa Rica*	*Portugal*
Eye irritation			
	Non-parametric	57.50	104.25
	(ex. zeros)	(15.43)	(23.01)
	Non-parametric	57.21	89.03
	(inc. zeros)	(15.36)	(19.75)
	Parametric	50.67*	91.62*
	(Weibull, ex. zeros)	(5.84)	(8.94)
Stomach upset			
	Non-parametric	65.75	162.60
	(ex. zeros)	(5.75)	(31.69)
	Non-parametric	65.43	137.27
	(inc. zeros)	(5.73)	(26.93)
	Parametric	65.3*	138.90*
	(Weibull, ex. zeros)	(4.56)	(15.33)
Coughing			
	Non-parametric	37.05	85.80
	(ex. zeros)	(6.60)	(23.15)
	Non-parametric	36.86	72.3
	(inc. zeros)	(6.57)	(19.58)
	Parametric	36.54*	75.15*
	(Weibull, ex. zeros)	(4.67)	(9.62)

Notes: All values in USD. Standard error of mean in parentheses. *On-site estimate used as basis for comparison in calculating transfer errors (table 12).

Inspection of table 7 also shows that non-parametric mean WTP values are consistently higher than the parametric means for each episode considered separately, but not significantly different. Using the Weibull distribution gives conservative estimates of WTP. By excluding 'consistent zero' responses in the Portuguese sample the non-parametric estimates are biased upwards by about 10–15 per cent.

Tables 8–10 report the results of modelling the probability of accepting to pay a particular amount in the payment card (table 4) as a function of explanatory covariates. The chosen covariates are a set of socio-demographic variables that were considered easily accessible in census data (sex, age, education, marital situation, number of children, income). They are typical candidates in transfers of benefit functions. These variables were kept in all models, whether they were revealed to be significant or not.

Although sex, age, education, and income do, to varying degrees, explain WTP for each episode, generally, the explanatory power of these variables is low. Significant explanatory variables are not the same across episodes in each country. One explanation is that avoiding each episode is regarded as conveying distinct benefits which were not captured by the simple episode descriptions given in the survey. Sex is the only significant variable across samples for the same episode (coughing), but the signs are opposite: Costa Rican males seem to be less concerned by the illness episode than females, while the opposite is true in Portugal.

Table 8. *Eye irritation*

Sample:	*Costa Rica*		*Portugal*		*Pooled*	
Variables:	*Est.*	*st.error*	*Est.*	*st.error*	*Est.*	*st.error*
Intercept	3.749	0.405***	3.374	0.325***	3.558	0.259***
Costa Rican					−0.521	0.163***
Sex[d] (1=male)	−0.544	0.200***	0.248	0.195	−0.098	0.145
Couple[d]	0.080	0.233	−0.083	0.222	0.079	0.160
Age	−0.008	0.014	0.012	0.008	0.009	0.007
Children < 15	0.029	0.085	0.082	0.110	0.048	0.071
University[d]	0.256	0.220	0.162	0.234	0.240	0.161
Income missing[d]	2.413	0.735***	0.484	0.298	0.732	0.256***
Personal income	0.006	0.010	0.004	0.010	0.004	0.007
Scale	1.354	0.075	1.583	0.069	1.541	0.052
Log-likelihood	−581.63		−906.65		−1499.10	
Sample size	200		292		492	
$H_{3.1}$: Likelihood ratio test statistic:	q = 21.62		$Pr(\chi^2 > 15.51) = 0.05$		d.f. = 8	

Notes: [d] dummy variable. *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

Table 9. *Gastroenteritis*

Sample:	*Costa Rica*		*Portugal*		*Pooled*	
Variables:	*Est.*	*st.error*	*Est.*	*st.error*	*Est.*	*st.error*
Intercept	4.555	0.286***	4.259	0.366***	4.388	0.261***
Costa Rican					−0.666	0.162***
Sex[d] (1=male)	−0.217	0.149	0.750	0.209***	0.418	0.138***
Couple[d]	0.069	0.165	0.249	0.247	0.159	0.160
Age	−0.023	0.009**	−0.007	0.009	−0.008	0.007
Children < 15	0.017	0.063	−0.001	0.112	0.027	0.066
University[d]	−0.048	0.161	0.537	0.260**	0.366	0.159**
Income missing[d]	0.623	0.523	−0.110	0.335	0.111	0.253
Personal income	0.023	0.007***	−0.016	0.012	0.001	0.008
Scale	0.981	0.051	1.717	0.075	1.490	0.049
Log-likelihood	−918.37		−563.53		−1521.86	
Sample size	201		287		488	
$H_{3.1}$: Likelihood ratio test statistic:	q = 79.92		$Pr(\chi^2 > 15.51) = 0.05$		d.f. = 8	

Notes: [d] dummy variable. *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

It was also of interest to compare whether subjective health characteristics, environmental and health attitudes were influencing WTP in the same way in both countries. This type of information is usually not readily available at most policy sites (e.g. through a census), and unlikely to be included in non-experimental benefit transfer situations, but is included here for discussion purposes. Groups of these variables were tested,

Table 10. *Coughing*

Sample:	*Costa Rica*		*Portugal*		*Pooled*	
Variables:	*Est.*	*st.error*	*Est.*	*st.error*	*Est.*	*st.error*
Intercept	2.171	0.465***	2.943	0.372***	2.951	0.300***
Costa Rican					−0.767	0.190***
Sex[d] (1=male)	−0.496	0.235**	0.708	0.227***	0.202	0.167
Couple[d]	−0.103	0.257	0.198	0.259	0.065	0.186
Age	0.030	0.017*	0.012	0.010	0.016	0.008*
Children < 15	0.104	0.096	−0.037	0.126	0.055	0.081
University[d]	0.365	0.263	0.746	0.277***	0.630	0.188***
Income missing[d]	−0.146	0.856	−0.358	0.358	−0.270	0.300
Personal income	0.003	0.013	−0.015	0.013	−0.005	0.009
Scale	1.616	0.093	1.810	0.086	1.775	0.065
Log-likelihood	−575.00		−862.66		−1447.37	
Sample size	199		284		483	
$H_{3.1}$: Likelihood ratio test statistic:	$q = 19.42$		$\Pr(\chi^2 > 15.51) = 0.05$		d.f. = 8	

Notes: [d] dummy variable. *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

adding them to the basic socio-demographic model in turn. Any significant variables were included in both country models of the same episode and the models were re-estimated. Variables which were not significant at a 10 per cent level were dropped before adding the next group. At each step we checked to see whether remaining variables were highly correlated (Pearson's correlation coefficient $r > 0{,}3$ at 10 per cent level). If so we excluded the variable of least theoretical or practical interest. This specification procedure is admittedly subjective and illustrates the problems that multiple collinearity poses for benefit transfer studies. We then compare the coefficients' sign and significance in the resulting model specifications across symptoms and countries holding specification constant across models.

Table 11 contains the comparison of the signs and significance of these extended models.[5] It provides a quick visual check on model similarities across a number of explanatory variables often included in CV studies of health effects.

As before we see very few significant coefficients with the same sign: WTP for health improvements does not seem to be related to country-specific attitudes in any obvious manner. Moreover, in the majority of cases variables are significant in one country, but not in the other, for the same episode. We do not know whether these differences are due to differences in sample size, measurement error, or to true differences, but WTP to avoid one illness does not seem to consistently depend on the same characteristics between countries. Finally, in only one case do signs

[5] Full model results are available from the authors upon request.

Table 11. *Sign-and-significance table for 'full' model parameters across symptoms*

	Sample					
	Eye		*Gastro*		*Cough*	
Variables	*C.R.*	*P.*	*C.R.*	*P.*	*C.R.*	*P.*
Intercept	+++	+++	+++	+++	+++	+++
Socio-demographics						
Sex[d] (1 = male)	−	0	−−−	+++	0	+++
Couple[d]	0	0	0	0	0	+
Age	0	0	0	−−	++	0
Children < 15 yrs.	0	0	0	0	0	0
University[d]	0	0	0	0	++	+
Income missing[d]	+	0	0	0	0	0
Personal income	0	0	+++	0	0	0
Recreation/Environment Attitudes						
Swimming *main* reason for beach visit[d]			+	−−−	0	−−
Swimming one reason for beach visit[d]	−−−	0			−−−	0
Water sports one reason for beach visit			−−	0		
Medical reason for visiting beach[4]			++	0		
Water pollution reason for avoiding beach[4]	+	−−−	0	−−−		
Beach water pollution a general problem					−−	0
Symptoms						
Alergy diagnosis[d]			0	−−		
Ranking eye symptom (1 = most, 3 = least important)	−−−	−−				
Duration of last cough episode					++	0
General Health Attitudes						
Subjective health (5 = above,1 = below average)			+++	0	0	−
Health most important thing in my life[d]	0	++	0	+++	+++	−
Difficult to change my bad health habits[d]	0	−−				
Careful with my health[d]	0	−−				
Preventive measures won't avoid sickness[d]	−−	−−			−	−
Other things than health are more important[d]	−	0				
Better healthy and poor than rich and ill[d]	−−	0	−−−	0		
Only concerned about serious illness[d]					0	−

Notes: +++, ++, +: parameter positive and significant at 1%, 5% and 10% respectively.
−−−, −−, − : parameter negative and significant at 1%, 5% and 10% respectively. 0: parameter not significantly different from 0 at 10% level. [d] dummy variable.

reverse across episodes in the same country,[6] meaning that we have little evidence that respondents were answering health episode questions inconsistently.

The changing significance levels of the socio-demographic coefficients from tables 8–10 to table 11 shows that there is some multiple collinearity with the attitude variables. These models therefore run some risk of excluded variable bias when only socio-demographic coefficients are used to condition transfers.

Tables 8–11 show that, although we tried to reduce context as much as possible in the survey hoping to reduce the influence of site-specific recreation and environmental attitudes on WTP, respondents are 'saturated in context', with several explanatory variables having a significant influence on WTP at the 1 per cent level. On the other hand, variables describing respondents risk aversion, and whether respondents contemplated mitigation costs in their WTP responses, were not significant in any of the models, indicating that these aspects of context did not come into play. Health attitude variables were expected to influence WTP. Ranking of eye irritation had the expected sign, but otherwise there was little evidence of previous illness experience affecting WTP responses.

Finally, table 11 provides an intuitive understanding of why conditioning on covariates can lead to worse transfers. As the model specification becomes more complex through largely *ad hoc*[7] additions of significant variables, the chances of effects cancelling one another out increases (Parsons and Kealy, 1994). This suggests that there may be little empirical and even less practical justification for including otherwise unobservable attitude variables in a benefit transfer model.

6. Benefit transfer and hypothesis testing

This section analyses the validity and reliability of the benefit transfer between the two countries. Table 12 summarizes transfer errors for non-parametric and Monte Carlo simulations of parametric mean WTP.[8] Below each transfer error estimate we report whether the hypothesis of convergent validity was rejected or not. As we move down the table we see the transfer errors resulting from making the WTP estimate conditional on increasing information in the form of model assumptions and specific characteristics of the study site.

The non-parametric models show that excluding 'consistent zeros' increases transfer errors, but not by enough to change the overall conclusion (rows 1 and 2 in table 12). The simple mean WTP transfer hypothesis is rejected at the 95 per cent level for all episodes ($H_{1.1}$). The parametric models show that equality of the unconditional mean WTP in Portugal and Costa Rica ($H_{1.1}$) is also rejected for all episodes. Such a transfer would

[6] The 'health most important' dummy variable reverses sign across episodes in the Portuguese sample.

[7] '*Ad hoc*' in the sense of situation-specific, rather than grounded in economic theory.

[8] Transfer error proportion = (transferred WTP—policy site WTP)/policy site WTP.

Table 12. *Results from benefit transfer tests and transfer errors*

Model of mean WTP (data treatment)	*Policy site*	*Transfer error proportions*			*Average absolute error (%)*
		Eye irritation	*Stomach upset*	*Coughing*	
Non-parametric (inc. consistent zeros)	**Costa Rica**	0.556 *$H_{1.1}$ rejected*	1.080 *$H_{1.1}$ rejected*	0.961 *$H_{1.1}$ rejected*	**86.6%**
	Portugal	−0.357 *$H_{1.1}$ rejected*	−0.523 *$H_{1.1}$ rejected*	−0.490 *$H_{1.1}$ rejected*	**45.7%**
Non-parametric (excl. consistent zeros)	**Costa Rica**	0.813 *$H_{1.1}$ rejected*	1.473 *$H_{1.1}$ rejected*	1.316 *$H_{1.1}$ rejected*	**120.0%**
	Portugal	−0.448 *$H_{1.1}$ rejected*	−0.596 *$H_{1.1}$ rejected*	−0.568 *$H_{1.1}$ rejected*	**53.7%**
Parametric models:					
No covariates	**Costa Rica**	0.808 *$H_{1.1}$ rejected*	1.127 *$H_{1.1}$ rejected*	1.057 *$H_{1.1}$ rejected*	**99.7%**
	Portugal	−0.447 *$H_{1.1}$ rejected*	−0.530 *$H_{1.1}$ rejected*	−0.514 *$H_{1.1}$ rejected*	**49.7%**
No covariates GNP/capita-adjusted	**Costa Rica**	−0.130 *$H_{1.2}$ rejected*	0.023 *$H_{1.2}$ rejected*	−0.011 *$H_{1.2}$ not rejected*	**5.5%**
	Portugal	0.150 *$H_{1.2}$ rejected*	−0.098 *$H_{1.2}$ rejected*	0.011 *$H_{1.2}$ not rejected*	**8.6%**
No covariates income-adjusted	**Costa Rica**	0.989 *$H_{1.2}$ rejected*	1.342 *$H_{1.2}$ rejected*	1.265 *$H_{1.2}$ rejected*	**119.9%**
	Portugal	−0.497 *$H_{1.2}$ rejected*	−0.573 *$H_{1.2}$ rejected*	−0.558 *$H_{1.2}$ rejected*	**54.3%**
Conditional on socio-demographic covariates	**Costa Rica**	0.700 *H_2 rejected* *$H_{3.1}$ rejected*	1.651 *H_2 rejected* *$H_{3.1}$ rejected*	1.530 *H_2 rejected* *$H_{3.1}$ rejected*	**129.4%**
	Portugal	−0.578 *H_2 rejected* *$H_{3.1}$ rejected*	−0.597 *H_2 rejected* *$H_{3.1}$ rejected*	−0.485 *H_2 rejected* *$H_{3.1}$ rejected*	**55.3%**

Note: 95% confidence level. Monte Carlo simulation of covariates in models using mean values for independent variables.

result in an average absolute error across symptoms of 99.7 per cent. Conversely, the transfer error from Costa Rica to Portugal is about 50 per cent (row 3). However, if we adjust the same figures by the PPP-adjusted personal income ratio, transfer error actually increases to 119.9 per cent and $H_{1.2}$ is rejected (row 5). Using the simplest of adjustment methods leads to an improved transfer, while using the information contained in site-specific income increases errors. If we adjust the unconditional mean WTP by the PPP-adjusted GNP/capita ratio we see that transfer error to Costa Rica falls to 5.5 per cent (row 4). However, there is no reason to adjust responses from non-average samples of the population using average national income and these results should be considered coincidental (i.e. samples of local beach users are usually not representative of the country population).

https://doi.org/10.1017/S1355770X0300184 Published online by Cambridge University Press

The equality of mean WTP conditional on readily available socio-demographic characteristics is also rejected (row 6 in table 12), i.e. H_2 is rejected. The transfer error from Portugal to Costa Rica increases to 129.4 per cent. In tables 8–11 we reported the regression results for each episode. We also conducted a likelihood ratio test of whether the parameters of the socio-demographic model at the two sites are drawn from the same population ($H_{3.1}$). This was rejected with 95 per cent confidence for all episodes. Hence, as mentioned above, there seem to be no statistical grounds for conducting a transfer conditioned on available census-type information. Ultimately, whether the transfer errors reported in table 12 are 'too large' to be used in policy applications will depend on the decision-maker and the particular application context.

Why does adjusting for site-specific income and socio-demographic variables counter-intuitively increase transfer errors? In our samples, Costa Rican beach users had higher mean income than the Portuguese beach users, while Portuguese mean income was higher than for Costa Ricans. Adjusting WTP with differences in mean income between sites increases transfer error because the positive correlation between WTP and income expected within each sample does not hold across the country samples. The same reasoning may be applied to the other socio-demographic coefficients, although economic theory does not provide us with any predictions of their sign. A plausible explanation for diverging rather than converging transfer errors is that preferences as expressed by WTP actually are different between beach users in the two countries, with otherwise identical socio-demographic characteristics and income. These cross-country preference shifts cannot necessarily be predicted by data from within-country variations in WTP. This offers a caution to benefit transfer practitioners adjusting WTP across countries with benefit functions estimated at a single site.

7. Conclusions

The objective of the study was to value ill health episodes caused by swimming in polluted water in Costa Rica, and evaluate the transfer of WTP estimates between this and a nearly identical study conducted previously in Portugal. To our knowledge this is the only contingent valuation study where the same survey instrument was used in so-called developed and lesser developed countries, allowing tests for differences in preferences, while holding survey design constant.

Validity tests of transferring mean willingness-to-pay between Portugal and Costa Rica were rejected while a test of model parameters rejected that the WTP-models at each site were drawn from the same pooled sample for all three illness episodes. When compared to on-site studies in Costa Rica, different benefit transfer approaches from Portugal lead to absolute average errors in the order of 87–130 per cent. Adjusting WTP for declared income or other easily accessible socio-demographic variables increased, rather than reduced, transfer error. This is partly due to a self-selection in the Costa Rican sample where respondents had higher than normal income. However, the counterintuitive result that the more information that is used, the worse the result, calls for added caution in conducting benefit transfers over such different contexts. We observed a large unexplained difference in protest rates between the two countries. More conservative treatment of protest responses would have reduced transfer errors by between one-fifth and one-third depending on the direction of the transfer, as indicated by differences in non-parametric expected WTP. However, this would not change the overall conclusion that benefit transfers are largely rejected using commonly applied statistical transfer hypothesis.

Our efforts to provide as favourable transfer conditions as possible lead to compromises and dilemmas; not specifying a payment vehicle reduced the effect of possible institutional differences between the two countries on WTP, but probably at the cost of less-significant benefit functions; comparable statistical treatment of consistent zero and protest responses allowed us to test benefit function transfer hypotheses, but at the cost of biasing transfer errors somewhat. Still, we feel that the trade-offs between good experimental and policy-applied study designs, between study validity and transfer reliability, is a common dilemma in the benefit transfer literature, and one well illustrated by our results.

To offer some encouragement, transfer errors are comparable to uncertainty in other sources of information that would be required in a modelling a damage function of beach water pollution. A recent review of epidemiological studies has shown that overall relative risk for swimming in relatively polluted water, versus swimming in clean water, range between 0.4 and 3.0 for studies of respiratory and gastroenteritic symptoms (WHO, 1998).[9] While this may initially be comforting to CV practitioners, it means that aggregated uncertainty of damage functions will probably be larger than acceptable for most policy makers. However, survey-based valuation studies in developing countries are relatively cheap,[10] while valuation of health end-points in developed countries are scarce and have yet to identify systematic factors of cross-country variation. In light of the large transfer errors found in this study, we therefore think efforts to obtain primary valuation estimates at the policy site in the developing country would be well spent, provided contingent valuation of the environmental good in question can meet basic validity requirements, somewhat compromised here by our benefit transfer experiment.

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[9] Relative risk of swimming in clean water, versus not swimming at all, ranged between 1.0 and 2.5 for gastroenteric symptoms alone (WHO, 1998), i.e. from having no additional risk to being 2.5 times more likely to contract gastroenteritis under similar water pollution conditions.

[10] For example, a household survey in Costa of WTP to avoid water pollution, cost about US$23 per valid response, including flights, focus group, pilot and main surveys with a total 691 valid responses (74 per cent response rate) (Barton, 1999). Although we have no detailed cost estimates for this particular beach visitor survey, unit costs were lower due to less time required to intercept each respondent than in the household survey.

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