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Benefit Transfer: A Comparison of WTP for Air Quality between France and Germany

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Abstract. A contingent valuation study was carried out under similar conditions on two sites simultaneously: Strasbourg (France) and Kehl (Germany) in order to test the reliability of the benefit transfer method. On average, the air quality is approximately the same in the two cities. Using a transfer of the benefit function, we compared the direct estimated benefits from improved air quality with the transferred benefits in the same city. The originality of this test is that the valued good is the same in both cities, which means that the transfer is an "intra-site" transfer. However our findings show that the method of benefit transfer was not generally valid. Indeed inhabitants of Kehl declared a higher price for their state of health and air quality than inhabitants in Strasbourg. This result could be explained by a stronger sensitivity to environmental problems in Germany.

Key words: air pollution, benefits transfer, contingent valuation

JEL classification: C12, C42, Q25

1. Introduction

The benefit transfer method uses the estimated benefit at one site in order to calculate the benefit of another site. The reliability and accuracy of this method remains questionable for economic valuations of non-market goods. However the benefit transfer method has some important advantages for the policy maker. Indeed, valuing the benefits induced by an environmental quality improvement program (i.e. air quality or water quality improvements) takes time and money. Moreover some constraints (such as the precautionary principle) could lead the policy maker to make decisions without waiting for the results of a cost-benefit analysis. In such a case, it might be helpful to rely on valuations obtained through the benefit transfer method.

As, in general, benefit transfers are made across sites as well as over time, the temporal dimension must be taken into account to test the validity of the benefit transfer method.

Before using the benefit transfer method for policy purposes, the accuracy and the reliability of the method have to be established. In the last decade, several studies have been performed to test the reliability of this method (e.g.

Bergland et al. 1995). The findings of these studies raised the issue of the validity of the benefit transfer method. In this paper, we provide an empirical test of the validity of environmental benefit transfer based on CV studies. As the site characteristics are identical, the conditions are theoretically ideal. However, even though the air quality is the same, the two populations are different, in terms of nationality, culture and sensitivity to the environment.

In the next section, a brief review of the literature is given followed by a short description of our approach to test the benefit transfer between Strasbourg (France) and Kehl (Germany). The third section describes the questionnaire's design. Section 4 presents the main results of the surveys and the test of benefit transfer. Section 5 concludes with a discussion of the results and questions the validity of the benefit transfer method.

2. Methodology

The benefit transfer method consists of transferring the estimated value from one site, called the ''study site'' to another, called the ''policy site''. In other words, a study already performed in one site is used for policy decisions in another site. This method is based on a very strong hypothesis: the study site and the policy site are perfect substitutes. Of course, in reality perfect substitutes do not exist even if two sites are very similar. They only exist when the policy site in period $t + n$ corresponds exactly to the study site that was used in period t. Even in this case, which we shall call ''intrasite and intertemporal transfer'', one may encounter serious difficulties. Of course, in the usual case of ''intersite and intertemporal transfer'', benefit transfer is subject to even greater error.

Two broad approaches may be distinguished for benefit transfer: transferring mean unit value and transferring benefit functions.

2.1. TRANSFERRING MEAN UNIT VALUE

Transferring mean unit value consists of calculating the benefits for the policy site based on the mean of the willingness to pay (WTP) from the study site. In this case, one assumes that the study site is ''sufficiently similar'' to the policy site in regard to the mean WTP, which could be viewed as a good approximation. The advantage of this approach lies in its simplicity. The only difficulty is to define the population affected by the policy, but obviously this problem exists with the other approach as well.

If the transfer is conducted between two sites in the same country, the monetary unit is the same and the transfer consists only in a multiplication of the mean WTP from the study site by the size of the population from the policy site. The question is more difficult when estimates of WTP computed in one country (generally the United States) are transferred to other countries. The "mean unit value" approach corrects only for income differentials between countries.[1] Navrud (1998) raised the question of transferability of American data to European countries, as there were no data available for these countries. But such a transfer from the United States to Europe is subject to two major sources of uncertainty. The first is due to geographical differences. The second is a temporal uncertainty due to the fact that American studies were carried out in the 1980s. When Navrud compared his data (a Norwegian study) with that obtained by Tolley et al. (1994), the transferred measures tended to overestimate by 30% the direct benefit obtained by the earlier CV studies.

Alberini et al. (1997) also used two American studies, Tolley et al. (1986) and Loehman et al. (1979), for benefit transfer from the United States to Taiwan. With both studies, the transferred measures were enclosed into the Confidence Interval of the value estimated by the CV conducted in Taiwan. The authors concluded that the transfer between US and Taiwan is valid, but remained cautious about a generalization of their results.

More sophisticated benefit transfer techniques consist of adjusting mean values before the transfer. This particular approach is essentially used when conducting meta analysis (e.g. Smith and Huang 1993). Indeed, the adjustment is necessary when the study site value is old or when the quality of the environmental goods is not the same.

2.2. TRANSFERRING THE BENEFIT FUNCTION

While the transfer of mean unit value is easy to apply it is not very accurate. The approach of transferring the estimated benefit function for the study site will potentially produce more accurate results. It involves calculating the benefit for the policy site using the benefit function generated at the study site. Of course, the practitioner needs data on the policy site population like age, sex, income, etc. Nevertheless this type of data are usually easier to gather than data on individual valuations which usually do not exist. The background hypothesis is that the different explanatory variables of WTP are the same in the two sites.

Most of the previous tests on the validity of the benefit transfer method used this approach. Bergland et al. (1995) conducted two similar CV studies of water quality improvements in two different Norwegian water courses whose characteristics were similar. Based on these two separate valuations for sites A and B, they transfer the valuations from site A to site B, and vice versa. Both hypotheses of each transfer were rejected even though the conditions of this test were optimal (identical site characteristics and the two studies were conducted at the same time). Despite these disappointing results, we decided to retain the benefit transfer function approach for our test.

3. The Surveys

A brief description of the CV studies used in the two municipalities, Strasbourg (France) and Kehl (Germany) is given.[2] First of all, it should be noted that these towns are neighboring, meaning that they have the same levels of air quality.[3] Thus the transfer is both intratemporal and intrasite.

The two surveys were carried out between the 12 and 23 January 1998. The sample size was 1000 people in Strasbourg and 454 people in Kehl.[4] The interviews were conducted face to face in the street by interviewers from an opinion poll institute.

Many verbal protocols (cf. Schkade and Payne 1993) were used in order to build the contingent questionnaire. In the first stage of the questionnaire the respondents had to describe their health state for the two months preceding the survey.[5] During this stage, the respondents had to describe the pain induced by the symptoms and whether or not these symptoms led to a restriction of their activities. Furthermore, they also had to describe the health status of the different members of their family. At the end of this part of the questionnaire the respondent gave their own evaluation of the air quality in their town.

The second stage proposed a hypothetical scenario consisting of an improvement in air quality which would induce a decrease in the occurrence of light symptoms. The respondents were given a description of the program that introduced reduced car traffic in the center of the city, a change of domestic heating systems, reduction of industrial wastes … The description of this program was of course very simple. For example a 50% reduction in air quality would induce a 50% reduction of light symptoms produced by air pollution. The program would last five years. The payment vehicle was a contribution to a public agency which measures air quality.

Before the elicitation question, the respondents had to choose between two situations. The first proposed to keep the present air quality ("no change"), while the second proposed a situation that would induce a better air quality but at some cost ("improved air quality"). Respondents who chose the "second situation" were asked a sequence of questions in order to elicit their WTP. The elicitation format used is a new one, based on close-ended questions. The idea is to bracket the respondents' WTP, i.e. the first bid is very low (resp. very high), the second very high (resp. very low) and so on. Since the first bid is either very low or very high, we expected that the anchoring effect would be reduced compared to the standard referendum question or the double or triple bounded format. The amounts of the different bids were based on the results from a pilot group, where the elicitation question was an open-ended question. The bracketing technique consists of asking about five close-ended questions (the number of questions changed according to the responses of the individual) and ends with an open-ended question.[6] The analyses presented in this paper are based on the answer to this open-ended question. After the elicitation question, the respondents were invited to give the reasons why they were willing to pay for this program. Those who chose the "first situation" only had to explain their choice and the interviewer proceeded directly to the first question of the third stage.

In the third stage, we questioned the respondents about their attitudes toward air quality. This stage ended with several questions about the respondents' individual characteristics: age, sex, education level, job, household size, household income, etc.

4. Valuation Results and Test of Benefit Transfer

As said earlier, our test of the transferability hypothesis was interesting because the valuated environmental good was exactly the same in the two sites (intrasite transfer). On the other hand, the two populations are different in terms of nationality, habits, customs and education. Even so, one can imagine that the possibility of transfer is increased in this case. Indeed in such a case, if the representative sample of the population A is representative for the population B as well, the transfer is warranted. In addition this type of transfer has some interest for economic valuation. Indeed, many environmental goods are shared by different populations. If it can be shown that the transfer method is accurate, then only one study is necessary to obtain the entire benefit from an improvement or a preservation of the quality of the good. For example, groundwater could be a transfrontier good. Rozan et al. (1999) carried out a CV study in order to value the benefits of the preservation of the water quality of the Alsatian Aquifer. They tested the possibility of transfer between Alsatian users, as their sample included several cities. Again, the transfer was not valid, even if the cities which had experienced pollution are not taken into account. Indeed, the hypothesis of transferability was rejected in 75% of the cases, although the error rates were relatively low. When transferability was tested with the polluted cities, the hypothesis was always rejected and the error rates were very high (between 30% and 50%). In this case, using benefit transfer should be done with care and caution. Nevertheless, the transfer could be helpful in order to assess total economic value, as this aquifer is the biggest one in Europe and part of it is in Germany.

In this study the transfer was tested in two directions, i.e. both sites were used as policy and study sites. The benefit function was obtained by a weighted least-square regression (in order to correct heteroscedasticity) on the whole sample, meaning that the respondents who had chosen the "no-change situation" were considered as having zero WTP.[7] This benefit function assumes that the WTP is explained by the fact of having experienced the different light symptoms and by dummies representing different levels of income. Moreover, econometric treatments have shown that smoking habits could be a confounding factor.[8] Therefore we worked with two different subsamples (smokers and non smokers). As some WTP estimates are obtained in Deutsch Mark, they have been converted in order to express all mean WTP in Francs.[9] Tables I and II present the regression results obtained for Strasbourg and for Kehl in the case of non smokers.

All explanatory variables are dummies. Concerning the light symptoms, each takes 1 if the respondent had experienced the symptom during the two last months. Concerning income, it takes on a value of 1 if the total monthly income of the household is in this bracket. The bracket [5000; 7500] is the reference one. Most of the dummies are significant at the 1% level. Concerning income, respondents with higher income expressed higher WTP. Concerning light symptoms, such as runny nose or sore throat, most of them are significant and this is an important point. Indeed the hypothetical scenario proposed improving air quality in order to reduce light symptoms among the population. The fact that light symptoms are mostly significant shows that respondents are willing to pay for an improvement of their health.

Table I. The benefit function for Strasbourg – non-smokers

WTPnorm	Coef.	Std. err.	t	$P > \|t\|$
Itchy eyes	0.643	0.21	3.049	0.002
Runny nose	0.403	0.18	2.204	0.028
Sore throat	0.675	0.19	3.439	0.001
Earache	1.165	0.34	3.443	0.001
Cough	−0.464	0.19	−2.357	0.018
Hoarseness	0.987	0.21	4.596	0.000
Breath. diff.	−0.615	0.18	−3.426	0.001
Sinusitis	−0.0317	0.23	−0.135	0.892
Bronchitis	0.749	0.31	2.384	0.017
Headache	0.171	0.18	0.943	0.345
<5000 F	0.654	0.22	2.948	0.003
[7500–12,500]	1.552	0.22	7.044	0.000
[12,500–15,000]	2.773	0.36	7.632	0.000
>15,000	2.806	0.27	10.031	0.000
Intercept	0.765	0.16	4.620	0.000

Variance-weighted least-squares regression; Number of obs = 554; Goodness-of-fit χ^2 (539) = 3203.95; Model χ^2 (14) = 311.23; Prob > χ^2 = 0.00.

Table II. The benefit function for Kehl – non-smokers

WTPnorm	Coef.	Std. err.	t	$P>\|t\|$
Itchy eyes	−1.419	1.07	−1.323	0.186
Runny nose	−4.814	0.77	−6.252	0.000
Sore throat	7.484	1.09	6.825	0.000
Earache	0.979	2.13	0.459	0.647
Cough	−0.133	0.79	−0.168	0.866
Hoarseness	6.405	1.00	6.385	0.000
Breath. diff.	1.995	0.86	2.327	0.020
Sinusitis	−3.654	1.67	−2.188	0.029
Bronchitis	2.738	1.31	2.083	0.037
Headache	0.276	0.84	0.328	0.743
<5000 *F*	−2.760	0.90	−3.076	0.002
[7500, 12,500]	8.163	1.71	4.785	0.000
[12,500, 15,000]	5.249	1.64	3.195	0.001
>15,000	12.367	2.08	5.932	0.000
Intercept	6.296	0.95	6.614	0.000

Variance-weighted least-squares regression; Number of obs = 306; Goodness-of-fit χ^2 (291) = 1686.71; Model χ^2 (14) = 310.54; Prob > χ^2 = 0.00.

However their effects on WTP are different between the samples. For example, "runny nose" has a positive impact in the sample of Strasbourg but a negative one in the sample of Kehl. It is not easy to explain these results but they could depend on the perceptions of the respondents. Some of them may attribute some symptoms to other cause (for example: passive smoking, allergies and so on…).

First of all, we tested for model equality, by doing an *F*-test, which is often called a "Chow" test (Chow 1960). For this test we ran three regressions (Strasbourg sample, Kehl sample and the pooled model) for smokers and for non smokers. The *F* statistic (see Greene 1997) for testing the restriction that the coefficients in the two equations are the same is

$$F[J, n_1 + n_2 - 2J] = \frac{(e'^{*}e^{*} - e'e)/J}{e'e/(n_1 + n_2 - 2J)}$$

where $e'^{*}e^{*}$ is the residual sum of squares from the restricted regression and J is the number of restrictions. The hypothesis that the parameters for the two regression equations are identical cannot be rejected. Details about the *F*-test are presented in Table III. However, as Downing and Ozuna (1996) have shown, the equality between the coefficients from the benefit function is not sufficient to warrant the validity of the transfer.

Table III. Results of the *F*-test

	Pooled model	Strasbourg sample	Kehl sample
Non-smokers			
Number of observations	860	554	306
Sum of squares	38175.35	20157.42	17099.49
The *F*-statistic	1.36		
The tabled critical value (5%)	1.67		
Smokers			
Number of observations	594	446	148
Sum of squares	29131.96	20519.01	8127.89
The *F*-statistic	0.64		
The tabled critical value (5%)	1.67		

Next, we conducted a test of the validity of the benefit transfer: a mean comparison between the mean transferred WTP and the mean WTP obtained directly by the CV study (a *t*-test). This test was conducted using the methods of convolutions. Indeed, Poe et al. (1994) argued that this method is appropriate for assessing the statistical difference between empirical distributions. Results based on the method of convolution are presented in Table IV. The 95% confidence intervals of the convolution never included zero. Thus, the null hypothesis of equality between the transferred and the

Table IV. Approximate significance levels for convolutions of difference ($WTP_{Transferred} - WTP_{Predicted}$) of distributions

	Confidence interval bounds for the convolution					
	Lower bound [range]		Upper bound [range]		*P*-value	
	2.5%	5%	5%	2.5%	95%	90%
Strasbourg Non-smokers	252.15 [176; 405]	504.78 [358;699]	9562.22 [8637;10,630]	9817.01 [8888;10,915]	0.8	0.82
Strasbourg Smokers	164.25 [111;236]	327.41 [238;427]	6154.74 [5544;6695]	6315.69 [5751; 6861]	0.72	0.73
Kehl Non-smokers	94.83 [34; 181]	194.22 [124; 344]	3755.71 [3221; 4662]	3860.55 [3299; 4822]	0.8	0.75
Kehl Smokers	58.00 [27; 94]	116.05 [73; 166]	2175.07 [1861; 2667]	2234.22 [1918; 2713]	0.84	0.76

Note: Range based on 100 replications.

Table V. Results of the transfer between Strasbourg and Kehl

Study sites		Policy sites			
		Strasbourg		Kehl	
		Non-smokers	Smokers	Non-smokers	Smokers
Strasbourg	Mean WTP	356 *F*	349 *F*	306 *F*	335 *F*
	95% Conf. interval	[343–370]	[338–359]	[288–325]	[315–355]
Kehl	Mean WTP	512 *F*	416 *F*	427 *F*	460 *F*
	95% Conf. interval	[490–535]	[392–439]	[397–456]	[422–498]
Error rates		+ 30%	+ 16%	–28%	–27%

In the CV study the sample in Strasbourg was 1000 (554 non-smokers and 446 smokers) and in Kehl, the sample was 454 (306 non-smokers and 148 smokers).

predicted WTP (H_0: $WTP_{transferred} = WTP_{predicted}$) was rejected in both tests. As both sites were used as policy and study sites Table V provides the different results. Direct mean WTP, based on the CV studies are written in italics. This value is compared to the transferred mean WTP which is presented in the same column just above or below the direct mean WTP. The last line provides the error rate, based on the formula of Kirchhoff et al. (1997): $([WTP_{transferred} - WTP_{predicted}] * 100)/WTP_{predicted}$.

This case is a priori ideal (intratemporal and intrasite transfer) and even so the error rate is around 30%. Therefore, unfortunatly we can assume that the error rate will be much higher in the general case (intertemporal and intersite transfer).

The question of the validity of the transfer as well as the level of error rate must be viewed according to the use of the transfer results. Indeed, if the transfer was used to estimate the benefits in order to conduct a cost-benefit analysis and then to make policy decisions, this error of magnitude could be acceptable. But if the transfer was conducted in order to establish the amount for estimating compensation, this error could be too large.

5. Discussion

This paper has tested the benefit transfer method using two original studies done simultaneously. The originality of this test is that the two sites face the same air quality but differ in terms of their population. While the income distribution, as well as the structure of the samples, were the same (in terms of age, sex, number of children, etc.), the mean WTP in Strasbourg was lower

(282FF) than the mean WTP in Kehl (466FF). Inhabitants of Kehl declared a higher price for their state of health and air quality than inhabitants in Strasbourg. This result could be explained by a stronger sensitivity to environmental problems in Germany.[10] Indeed, Brouwer and Spaninks (1999) showed that including some factors which show the different attitudes of respondents could improve the quality of the transfer.

Our results suggest that one should be cautious about the use of the benefit transfer method. However, in some cases, transfers may be appropriate for some policy analyses where errors of 30% or more are acceptable. Indeed, transferability must be evaluated with respect to the purpose: the cost-benefit analysis or the design of compensation schemes. While compensation schemes require more accurate measures, from a CBA point of view, the policy maker can rely on approximate values in order to reach an acceptable decision. Knowing that the WTP obtained by CV studies only provides an order of magnitude of the benefit, an error of 15% could be acceptable for a cost-benefit analysis. Our results are limited support in some circumstances but give some elements to encourage other tests of transferability.

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Notes

1. Different hypothesis can be assumed. The simplest hypothesis assumes that the elasticity of WTP with respect to income is 1.0. A more sophisticated hypothesis is to use an estimated income elasticity from the valuation literature. See Alberini et al. (1997) for a discussion and an illustration of these approaches.
2. A complete description of these studies can be found in Rozan (1999).
3. The air pollution problems originate from both traffic and industrial activities.
4. There are 171.436 households in Strasbourg and 12.770 households in Kehl.
5. Health state in the survey is only related to light symptoms, like headache, eye irritation, cough, etc.
6. This method of "bracketing" was originally used in experimental economics (Delquié 1993). The aim of his study is to observe the subjects indifference value of a lottery. "To avoid directional biases, bounds are tightened on both sides. Once the algorithm has converged to a sufficiently narrow range, subjects are finally invited to entered their

numerical matching response" (p. 1385). We have adapted this technique, which was originally run on a computer, to CV studies in order to avoid anchoring effect. We tested two different versions.

7. In Rozan (2000a), we first analysed the data based on the fact that the respondent agreed or didn't agree to participate financially to the program. Thus, based only on respondents who agreed to participate, we regressed the WTP amount (WLS regression). This regression was based on a sub-sample (respondents whom their WTP is >0). Therefore, we introduced as an explanatory variable, the inverse Mills ratio, in order to take into account this truncated distribution. After that, the mean WTP is then,

$$E[\text{WTP}/x] = E[\text{WTP}/\text{yes}, x] \cdot \text{Probability}(\text{yes}/x) + E[\text{WTP}/\text{no}, x] \cdot \text{Probability}(\text{no}/x)$$

Or

$$E[\text{WTP}/\text{no}, x] = 0; \text{thus } E[\text{WTP}/x] = E[\text{WTP}/\text{yes}, x] \cdot \text{Probability}(\text{yes}/x)$$

The inverse Mills ratio is never significant. Thus for the transfer, we directly apply the WLS regression on the whole sample, respondents who refused to participate and respondents who agreed to participate. This model gives an estimation of the mean WTP equal to the two-step estimation describes above.

8. An ex ante hypothesis was that smokers could have different behaviour toward air pollution than non smokers. In order to test this hypothesis we worked with two sub-samples and we found that the two models are significantly different. Therefore we always separated smokers and non smokers. A second hypothesis was that the smoke habit could be endogenous to the decision to participate or not to the program (Rozan 2000a). In order to test this hypothesis, we saw out a simultaneous probit model (Grenier and Jacobzone 1996), but we found no significant correlation between the two variables.
9. The conversion is only based on the change rate (1DM = 3.35FF), as the income distribution is approximately the same between the two towns. Also in the two samples, the income distributions are approximately the same. We only based on the change rate because the power parity is approximately the same in this transfrontalier region.
10. In Rozan (2000b), we have pooled the data of the two samples. We created a variable which indicates the nationality of the respondent. This variable was highly significant with a positive coefficient (to be German induced a higher WTP) in the linear regression.

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