AN INTERVIEW-BASED COMPARISON OF THE TTO AND VAS VALUES GIVEN TO EQ-5D STATES OF HEALTH BY THE GENERAL GERMAN POPULATION

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ABSTRACT

The aim of this survey study was to derive the relative values which are attached to different states of health by the general public in Germany. These states were composed using the five dimensions of the EuroQol (EQ 5-D) questionnaire, and the values were derived using the time trade-off (TTO) and the visual analogue scale (VAS) method. Between October 1997 and March 1998, face-to-face interviews were conducted with 339 individuals in north Germany. The interviewers were asked to value up to 15 different states of health from a sample of 43 states representing the full range of different severe states of health. The results show a low concurrence with the results of the British general population study published in 1996.

The second objective of the study was to compare different possibilities for modelling the data in order to derive values for all possible 243 states of health listed by the EQ-5D. The calculations of the British additive model and the German multiplicative model are based on the TTO values using a linear regression. Multiplicative modelling showed inconsistent results due to negative TTO values. The model parameters in both the British and the German sample revealed major differences in valuation by the general population.

Keywords:
EQ-5D valuation modelling population-study Germany

1 INTRODUCTION

Quality of life research has gained much importance in the recent years. In the health-economic literature the interest in using methods to quantify intangible effects of health services in cost effectiveness analyses and cost utility analyses has grown. Therefore, welfare-theoretical concepts such as the standard gamble method and psychometric concepts (e.g. questionnaires for the measurement of the quality of life) are used today.

One of the major objectives of the EuroQol (EQ-5D) questionnaire as a single index instrument is the aggregation of a health state valuation (expressed in five items) in only one value. 14 health states are currently validated on the original questionnaire form using a rating scale

(here in form of a vertical analogue scale - VAS -). In different model calculations the attempt has already been undertaken to use these values also for the estimation of the over 200 re maining EQ-5D states with the help of a linear regression.[1] However, at least two problems were linked with these modelling attempts: the number of health states which could be valued in postal surveys was small and a welfare-theoretical base of the rating scale was missing.

In the following interview-based study the EQ-5D health states are not only valued by means of visual analogue scale, but also according to the time trade off method. The primary research question was whether the results of the two evaluations differ and, if so, whether a systematic connection between the EQ-5D VAS values and TTO values exists. The second research question was whether the TTO values, which were collected with an almost identical study design in Great Britain[2], match with the German results. For this purpose, the British and the German models were finally applied to derive a EQ-5D index value from the German TTO survey data.

2 DATA

Between October 1997 and March 1998 a total of 339 persons in Northern Germany (county of Lower Saxony and Bremen) were questioned at home by 18 trained student interviewers.

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1 Badia, X., Roset, M., Monserrat, S., Herdman, M.: The Spanish VAS tariff based on valuations of EQ-5D health states from the general population, Paper presented at the 10th EuroQol conference, October 1997, Rotterdam. and Claes, C., Greiner, W., Uber, A. Schulenburg, J.-M. Graf v.d.: The new German version of the EuroQol quality of life questionnaire, Paper presented at the 10th EuroQol conference, October 1997, Rotterdam.

2 Dolan, P./Gudex, C./Kind, P./Williams, A. (1996)
The time Trade-Off Method: Results from a general population study, in: Health Economics, Vol. 5, S. 141 - 154

First a sample was randomly selected out of the telephone directory of the German telephone company TELEKOM. In order to represent urban and rural regions equally, the selection was based on postal zip code areas. Due to the fact that the male name of a mixed household is preferred in the telephone register, half of the persons selected were female in order to avoid a selection bias. These persons were informed in writing about the study and requested to confirm for their willingness to participate using a reply card. A small reward (20 DM) was offered to honour the participation in the study. 380 addresses were distributed to the interviewers who agreed upon interview dates with the study participants by telephone. If it was not possible to find a mutual date for a meeting or after three failed attempts to contact the person, the interview was cancelled. Thus the sample size finally dropped to 339 evaluative interviews. Moreover, 5 interviews had to be aborted prematurely because the participants could not master the task.

Various influences distorted the structure of the original sample which had been randomly selected. The return of the reply cards showed addresses of women to be underrepresented (see table 1). This can be explained from the fact that the interviews should have been conducted at the home of the participants, and women were obviously opposed to this procedure. Alternatively neutral interview places (such as university offices) were also offered, but this opportunity was not used at all. In addition, the age groups of employed persons were underrepresented. Due to their job these people were quite restricted in finding time to conduct the interview, although the student interviewers did offer dates at the weekend if necessary.

Table 1: Sociodemographic basis variables

Criterion		n	Proportion in %	Proportion in Germany in %
				(Year: 1997)**)
Gender	male	187	55.3	48.74
	female	152	44.7	51.13
(Chi-Square-Test)				$\alpha < 0.05$
				(Year: 1996)**)
Age groups	15 - 25	26	7.7	13.1
(without 0 - 15 years)	25 - 45	105	31.1	38.1
	45 - 65	136	40.2	30.1
	>= 65	71	21.0	18.7
(Chi-Square-Test)				$\alpha < 0.01$
Experience with disease	own	136	40.0	
	family	232	68.2	
	care giving	117	34.4	
Occupation in health or social sector	yes	85	25.0	
Smoking	yes	76	22.8	26.7#)
	former smoker	109	32.7	
	non-smoker	148	44.4	73.3
Apprenticeship	yes	314	92.4	
Academic education	yes	112	32.9	
				(Year: 1997)
Occupation	employed	175	51.5	43.63**)
	in education	31	9.1	
	retired	105	30.9	
	other (unemployed, housewife etc.)	29	8.5	
Problems in health dimension	Mobility	58	17.1	
	Self-Care	6	1.8	
	Usual activities	30	8.8	
	Pain / Discomfort	125	36.9	
	Anxiety/Depression	42	12.4	

**) See StBA http://www.statistik-bund.de/basis/d/...

#) See StBA (1997), p. 434

3 METHODS

3.1 INTERVIEW STRUCTURE

The interview can be separated into several sections. After the interviewer had introduced himself and briefly described the background of the study, the study participants were first asked to give some information about their socio-demographic background (age etc.) and to answer the questions of the EQ-5D. Afterwards the interviewer transferred selected cards (see appendix) to the study participant. The health states which should be valued were selected from the full set of 243 possible health states in order to cover clinically relevant states and a broad range of rather mild to severe health states. The selection was optimized using the experiences with the British sample analysis.

On the cards health states are described according to the EQ-5D health status system. The participant had to read these cards very carefully and rank them from good to worst health states. It should be assumed that in each case the respective health state finishes after ten years, and subsequently the life is terminated. The next task of the participant was to value the health states on the cards on a visual analogue scale, whereby modifications of the card ranking order were permitted at any time. The location of the cards on the visual analogue scale was noted by the interviewer with the help of short-names, which were only visible for the interviewer (i.e. VA for a very mild status). At the end of this interview section a self-assessment of the participant's current own health state was requested on the visual analogue scale.

In the last part of the interview the selected cards were evaluated successively according to the time trade off method. For this purpose a double-sided time board was used. On the front and back side of the time board two time axes, marked as life A and life B, are visible. On the front of the time board the time axis of life A is the reference health state 11111 (health state without restrictions). Life B is represented by those cards which should be evaluated. While the time of life B is ten years in any case, the time of life A can be varied between zero and ten years.

Following this, the participant had to imagine that he was currently in the health state described on the card. It is assumed that this health state stops exactly after ten years and afterwards life is terminated. A control question demands the verification that the participant prefers the alternative to live ten years in the health state without restrictions (life A) than in the health state with restrictions (life B). If the participant decided for the life B instead, the pro

cedure was described once more by the interviewer and the control question was asked again. If the participant could still not master the task, the interview was terminated.

Afterwards the interviewer asked whether the participant would prefer to die immediately than to survive in life B. The interviewer visualized this question by shifting the time board needle of life A to zero years.

If the participant preferred life B, in the next step the lifetime in life A was set to five years with the question whether the participant would prefer five years in the health state without restrictions (life A) instead of living in the health state assigned in the life B. If the participant decided for life A, the time interval was subsequently shortened in yearly steps (successively four, three... years), until the person decided for life B. In the reverse case the time interval under life A was extended so long in yearly steps (six, seven ... years) until the participant preferred life A instead of B. As soon as this change took place (or the participant claimed to be indifferent about the value of both health states) the result was noted and it was proceeded by the next card.

A special situation occurred whenever at the value nine years no change has been achieved. In this case the interviewer asked the participant, whether he or she was willing at all to sacrifice a certain period (weeks or months) in order to avoid life B. This situation is plausible, as on some cards only relatively small restrictions to health were presented, e.g. some problems with mobility.

If the participant decided on preferring a sudden death, the interviewer proceeded with the back side of the time board. On this side the lives A and life B are shown as well. Sudden death is assigned to life B. Life A means that the participant should imagine living "t" years in the health state as described on the card, followed by "10 - t" years in the disease-free health state 11111. This situation is comparable with the position of patients who are on a waiting list for a certain therapy, and are going to regain complete health after this therapy. The starting point for this part of the interview was a situation with a five year waiting period in the health state with restrictions and five years lifetime without restrictions. If the participant decided for life B (sudden death), the waiting period was reduced up to the point where the participant decided for life A. In the reverse case the waiting period was extended. As a result, the interviewer noted the number of years with a negative sign.

Each participant valued between 13 and 15 health states per interview on the visual analogue scale and according to the time-trade-off method. Up to 14 states were included for the regression, as the health state 11111 (reference state for the TTO method) is missing; this state was evaluated only on the visual analogue scale. The interview duration amounted to 43 minutes on average. Older study participants needed somewhat more interview time than younger on

average (Mann-Whitney U - test: $\alpha = 0.01$). The interview duration was also dependent on individual interviewer (Kruskal-Wallis H-test: $\alpha = 0.01$).

3.2 CALCULATION OF TTO-VALUE

To calculate the TTO values, the following procedure was used: t indicates the number of years, which are spent with full health. Valuations of health states between full health and death are standardized to a value scale between 0 and 1. Valuations of health states worse than sudden death are standardized according to the formulas mentioned in table 5 between 0 and -1. The TTO value t was corrected on further analysis by the value 0.5. The 0,5-correction with t is ap

propriate, since in the interview in each case only whole years were considered for the remaining lifetime. Extension (reduction) of the remaining lifetime in the survey causes, thereby, a correction of the value t by -0,5 (+ 0.5). For example, if a change from life B to life A happened at 7 years, it was assumed that the participant would already have decided for a change with a remaining lifetime of 6.5 years for life A. If the participant was indifferent between lives A and B, the 0.5 correction of t was omitted. It was also omitted for the values t = 0, 5 or 10 or if t was specified in weeks.

Table 2: Conversion of the base TTO values

With 0.5 correction	**Values t > 5:**
	TTO value = (t – 0.5) / 10
	Values t < 5:
	TTO value = (t + 0.5) / 10
	Worse than sudden death: Values 0 < t < 5: TTO value = [(t + 0.5)/10] – 1
	Worse than sudden death: Values 5 < t < 10: TTO value = [(t – 0.5)/10] – 1
Without 0.5 correction	**t = 0, 5 or 10 or participant was indifferent between life A and life B:**
	TTO value = t / 10
	Worse than sudden death: TTO value = [t / 10] – 1
If t was indicated n weeks:	(9 + t/52)/10

3.3 EXTREME VALUES

Subjective evaluations of the quality of life have a high variability. Nevertheless, it is helpful to exclude extreme values, which are clearly and remarkably over or under most other values from the analysis. The method of the selection is boxplot. A boxplot is a comprehensive plot with the outputs median, quartile values and extreme values. A boxplot consists of boxes, which contain 50 % of the values between the 25 th and 75 th percentile, and lines, which extend to the highest and to the lowest value. Extreme values are characterized in a boxplot by the distance (more than 1.5 drawer) between the scope of the 50 % of the middle values.

The extreme values of the available VAS- and TTO-data were determined and excluded from further analysis. Table 3 shows the number of extreme values for each evaluated health state. The extreme value ratio amounts to about 1 % of VAS values with a bandwidth from 0 to 6 %. The TTO values show more extreme values: 1.5 % with a bandwidth from 0 to 10.4 %.

Table 3: Extreme values

health state		n	extreme values			
			VAS	%	TTO	%
BE	11111	339			--	
LA	11122	94	3	3,2	10	
LB	11113	145			14	
LC	21133	81				
LD	21222	101	1	1,0	3	3,0
LE	11133	92				
LF	12211	96	3	3,1	6	6,3
LG	12121	97	2	2,1	4	4,1
LH	22112	93			4	4,3
LI	11312	160			3	1,9
MA	32331	94	5	5,3	1	1,1
MB	22122	91			4	4,4
MC	12222	83			2	2,4
MD	21323	89	3	3,4		
ME	32211	138	2	1,4		
MF	12223	98			4	4,1
MG	22331	86				
MH	21232	88				
MI	22222	149			8	5,4
MX	13212	103			3	2,9
SA	33232	96	5	5,2		
SB	23232	142	2	1,4		
SC	23321	89				
SD	22323	99	1	1,0		
SE	32223	149	3	2,0		
SF	32232	97	5	5,2		
SG	33321	102	2	2,0		
SH	33323	84	5	6,0		
SI	33212	96	5	5,2		
VA	11112	150	5	3,3	12	8,0
VB	11121	172	5	2,9	18	10,4
VC	11211	163	4	2,5	14	8,6
VD	12111	158	6	3,8	12	7,6
VE	21111	151	4	2,6	12	7,9
VX	11131	111				
WO	33333	339				
Total		4515	45	1,0	68	1,5

3.4 DISTRIBUTION

Most of the statistical analyses are based on the acceptance of normal distribution. The analysis of the normal distribution was made separately for VAS and TTO data with the Kolmogrov-Smirnov tests (Lilliefors). In 9 cases of 36 health states (VAS data) the normal distribution is statistically plausible (see table 4). Normal distribution of the TTO data is only statistically plausible in 6 of 35 health states. Less severe health states are rather negatively-skewed (median is higher than mean) and on the other hand, health states with serious problems are rather positively-skewed.

Table 4: Test on normal distribution (VAS- and TTO-Data)

health state		VAS	normal distribution is plausibly	TTO	normal distribution is plausibly
BE	11111	$\alpha < 0,01$		--	
LA	11122	$\alpha > 0,20$	yes	$\alpha < 0,01$	
LB	11113	$\alpha < 0,01$		$\alpha < 0,01$	
LC	21133	$\alpha < 0,01$		$\alpha > 0,20$	yes
LD	21222	$\alpha < 0,10$	yes	$\alpha < 0,01$	
LE	11133	$\alpha < 0,05$		$\alpha > 0,20$	yes
LF	12211	$\alpha < 0,05$		$\alpha < 0,01$	
LG	12121	$\alpha < 0,05$		$\alpha < 0,01$	
LH	22112	$\alpha > 0,20$	yes	$\alpha < 0,01$	
LI	11312	$\alpha < 0,05$		$\alpha < 0,01$	
MA	32331	$\alpha < 0,01$		$\alpha < 0,01$	
MB	22122	$\alpha > 0,20$	yes	$\alpha < 0,01$	
MC	12222	$\alpha > 0,20$	yes	$\alpha < 0,01$	
MD	21323	$\alpha < 0,10$		$\alpha > 0,10$	yes
ME	32211	$\alpha < 0,05$		$\alpha < 0,01$	
MF	12223	$\alpha > 0,20$	yes	$\alpha < 0,01$	
MG	22331	$\alpha < 0,05$		$\alpha > 0,20$	yes
MH	21232	$\alpha < 0,05$		$\alpha < 0,01$	
MI	22222	$\alpha > 0,20$	yes	$\alpha < 0,01$	
MX	13212	$\alpha < 0,10$	yes	$\alpha < 0,01$	
SA	33232	$\alpha < 0,01$		$\alpha < 0,01$	
SB	23232	$\alpha < 0,01$		$\alpha < 0,01$	
SC	23321	$\alpha < 0,05$		$\alpha < 0,01$	
SD	22323	$\alpha < 0,01$		$\alpha < 0,01$	
SE	32223	$\alpha < 0,01$		$\alpha < 0,01$	
SF	32232	$\alpha < 0,01$		$\alpha < 0,01$	
SG	33321	$\alpha < 0,01$		$\alpha > 0,10$	yes
SH	33323	$\alpha < 0,01$		$\alpha < 0,01$	
SI	33212	$\alpha < 0,01$		$\alpha > 0,10$	yes
VA	11112	$\alpha < 0,01$		$\alpha < 0,01$	
VB	11121	$\alpha < 0,01$		$\alpha < 0,01$	
VC	11211	$\alpha < 0,01$		$\alpha < 0,01$	
VD	12111	$\alpha < 0,01$		$\alpha < 0,01$	
VE	21111	$\alpha < 0,01$		$\alpha < 0,01$	
VX	11131	$\alpha < 0,10$	yes	$\alpha < 0,01$	
WO	33333	$\alpha < 0,01$		$\alpha < 0,01$	

In Table 5 the evaluations of the health states are presented according to the VAS (column 2) and to the TTO method (column 6). The average values of the VAS are obviously rather evenly distributed on the scale from 0 to 100. The apparent uniform distribution could be jus-

tified in the study design. At the beginning of the evaluation the study participants were requested to arrange the cards with the health states from good to bad. Afterwards, the cards should be set on the thermometer. For further illustration the average values of the postal survey from the German population samples of the years 1994 and 1997 are presented in columns 4 and 5. In the postal survey such a systematic procedure during the evaluation did not belong to the task. Even if far fewer health states in the written survey were evaluated, a similar distribution structure is obvious.

3.5 RESULTS OF EVALUATION

The TTO values for health states with only small restrictions show clearly higher values than the corresponding VAS values. To avoid smaller impairments of their health the study participants were obviously not willing to sacrifice a relevant proportion of lifetime. While the scale of the VAS is almost unitless (although the comparison with a thermometer is often mentioned), the TTO method connects the health-related quality of life with the temporal dimension by the question, how much lifetime the study participants are prepared to give up. The negative scale [0; -1] is filled by the TTO values only partially.

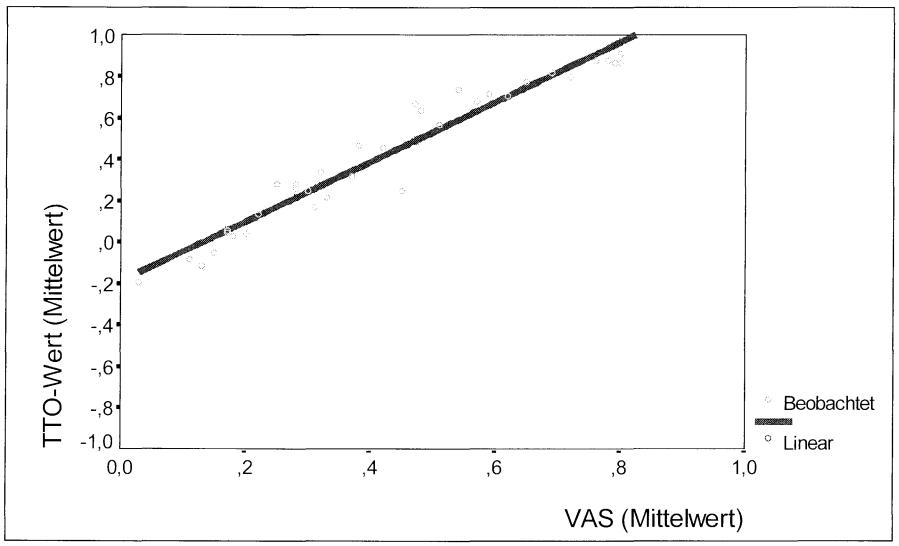
Table 5: TTO- and VAS valuations of selected health states

Health state		n	mean VAS	SD	Mean VAS (1994)	mean VAS (1997)	mean TTO	SD	Δ
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(2) - (6)
BE	11111	339	0.99	0.05	0.96	0.95	-	-	
VE	21111	151	0.80	0.15		0.77	0.91	0.21	-0.11
VD	12111	158	0.76	0.18	0.71	0.60	0.88	0.23	-0.12
VA	11112	150	0.78	0.18	0.82	0.76	0.88	0.25	-0.10
VB	11121	172	0.80	0.15	0.78	0.75	0.87	0.25	-0.07
VC	11211	163	0.79	0.14	0.81	0.79	0.87	0.28	-0.08
LF	12211	96	0.69	0.17			0.82	0.31	-0.13
LA	11122	94	0.72	0.16	0.66	0.62	0.80	0.36	-0.08
LG	12121	97	0.65	0.19	0.56		0.78	0.28	-0.13
MC	12222	83	0.54	0.18			0.74	0.34	-0.20
LD	21222	101	0.59	0.16			0.72	0.31	-0.13
LH	22112	93	0.62	0.17			0.71	0.37	-0.09
MB	22122	91	0.57	0.18			0.68	0.38	-0.11
LI	11312	160	0.47	0.20			0.67	0.34	-0.20
MI	22222	149	0.48	0.20			0.64	0.42	-0.16
LB	11113	145	0.51	0.25			0.57	0.50	-0.06
MX	13212	103	0.38	0.22			0.47	0.47	-0.09
MF	12223	98	0.42	0.18			0.46	0.49	-0.04
MD	21323	89	0.32	0.18			0.34	0.47	-0.02
MH	21232	88	0.37	0.20	0.37	0.42	0.32	0.52	0.05
SC	23321	89	0.28	0.18			0.28	0.54	0.00
SD	22323	99	0.25	0.17	0.19	0.24	0.28	0.54	-0.03
MG	22331	86	0.28	0.18			0.26	0.49	0.02
ME	32211	138	0.30	0.18	0.30	0.36	0.25	0.52	0.05
VX	11131	111	0.45	0.23			0.25	0.55	0.20
LE	11133	92	0.33	0.21			0.22	0.52	0.11
LC	21133	81	0.31	0.19			0.17	0.52	0.14
SI	33212	96	0.22	0.16			0.14	0.51	0.08
SG	33321	102	0.17	0.14	0.17	0.21	0.06	0.49	0.11
SE	32223	149	0.17	0.13			0.05	0.50	0.12
SB	23232	142	0.20	0.14			0.04	0.52	0.16
MA	32331	94	0.18	0.15			0.03	0.42	0.15
SF	32232	97	0.15	0.13			-0.05	0.43	0.20
SH	33323	84	0.11	0.11			-0.08	0.45	0.19
SA	33232	96	0.13	0.13			-0.11	0.44	0.24
WO	33333	339	0.03	0.07	0.04	0.09	-0.19	0.39	0.22

One of the research questions of this study was whether a systematic connection exist between the EQ-5D -VAS and EQ-5D -TTO values. Using a linear regression we found a strong relation between EQ-5D -VAS values and EQ-5D TTO values. The following regression equation shows how a VAS value can be transformed into a TTO value (see also chart 1):

TTO = -0.191356 + 1.445847 VAS (R square = 0,94).

Chart 1: Linear transformation of VAS- in TTO-values



As presented in table 6 the negative part of the scale is used substantially more in the British study. The TTO values of the German study are higher for all health states in comparison to the British study, the TTO values of 30 health states being statistically significantly higher ($\alpha < 0,05$; one sample t-test).

Table 6: TTO values in Northern Germany and UK

healthstate		Germany mean TTO	SD	UK[3] mean TTO	SD	Δ
		(1)	(2)	(3)	(4)	(1) - (3)
VE	21111	0.91	0.21	0.87	0.24	0.04*
VD	12111	0.88	0.23	0.83	0.30	0.05*
VA	11112	0.88	0.25	0.82	0.29	0.06*
VB	11121	0.87	0.25	0.85	0.25	0.02
VC	11211	0.87	0.28	0.87	0.23	0.00
LF	12211	0.82	0.31	0.76	0.33	0.06*
LA	11122	0.80	0.36	0.72	0.37	0.08*
LG	12121	0.78	0.28	0.74	0.32	0.04
MC	12222	0.74	0.34	0.54	0.47	0.20*
LD	21222	0.72	0.31	0.55	0.46	0.17*
LH	22112	0.71	0.37	0.66	0.38	0.05
MB	22122	0.68	0.38	0.53	0.47	0.15*
LI	11312	0.67	0.34	0.55	0.47	0.12*
MI	22222	0.64	0.42	0.50	0.47	0.14*
LB	11113	0.57	0.50	0.39	0.56	0.18*
MX	13212	0.47	0.47	0.38	0.54	0.09
MF	12223	0.46	0.49	0.21	0.56	0.25*
MD	21323	0.34	0.47	0.15	0.59	0.19*
MH	21232	0.32	0.52	0.06	0.61	0.26*
SC	23321	0.28	0.54	0.14	0.61	0.14*
SD	22323	0.28	0.54	0.04	0.59	0.24*
MG	22331	0.26	0.49	-0.01	0.60	0.27*
ME	32211	0.25	0.52	0.14	0.60	0.11*
VX	11131	0.25	0.55	0.20	0.60	0.05
LE	11133	0.22	0.52	-0.05	0.61	0.27*
LC	21133	0.17	0.52	-0.07	0.59	0.24*
SI	33212	0.14	0.51	-0.02	0.60	0.16*
SG	33321	0.06	0.49	-0.14	0.57	0.20*
SE	32223	0.05	0.50	-0.19	0.56	0.24*
SB	23232	0.04	0.52	-0.10	0.59	0.14*
MA	32331	0.03	0.42	-0.27	0.55	0.30*
SF	32232	-0.05	0.43	-0.23	0.57	0.18*

[3] See Dolan, P. (1996), S. 145

SH	33323	-0.08	0.45	-0.39	0.49	0.31*
SA	33232	-0.11	0.44	-0.33	0.51	0.22*
WO	33333	-0.19	0.39	-0.54	0.41	0.35*

*) Difference from zero is statistically significant (one sample t-test).

4 MODELLING

4.1 TARIFF I

To calculate an index value for each possible EQ-5D health state an OLS regression with linear, additive combinations according to the British study design was initially selected.

The arguments were coded as follows:

1. A variable for each EQ-5D dimension, which illustrates the modification of response level 1 (no problems) to response level 2 (some problems) or the modification of response level 2 (some problems) to response level 3 (extreme problems).
2. A dummy variable for each EQ-5D dimension, which represents the modification of response level 1 or 2 to response level 3.
3. A dummy variable which has the value 1 for health states with at least one dimension with level 3 (extreme problems), e.g. 13111 or 13333.

Table 7: Definition of the independent arguments

Variable	Definition
a	Constant factor
MO	1, if mobility is on level 2 (some problems), 2, if mobility is on level 3 (extreme problems), other: 0
SC	1, if self care is on level 2 (some problems), 2, if self care is on level 3 (extreme problems), other: 0
UA	1, if usual activities is on level 2 (some problems), 2, if usual activities is on level 3 (extreme problems), other: 0
PD	1, if pain / discomfort is on level 2 (some problems), 2, if pain / discomfort is on level 3 (extreme problems), other: 0
AD	1, if anxiety / depression is on level 2 (some problems), 2, if anxiety / depression is on level 3 (extreme problems), other: 0
M2	1, if mobility is on level 3 (extreme problems), other: 0
S2	1, if self care is on level 3 (extreme problems), other: 0
U2	1, if usual activities is on level 3 (extreme problems), other: 0
P2	1, if pain / discomfort is on level 3 (extreme problems), other: 0
A2	1, if anxiety / depression is on level 3 (extreme problems), other: 0
N3	1, if any level is on 3 (extreme problems), other: 0

4.2 TARIFF II

To compare different model constructions, a model with a multiplicative combination of the parameters was calculated according to the following formula: OLS-regression (ordinary-least-square regression) equation connected the instalment for the second and third answering level ("some problems" and "severe problems"). The independent variable appears as an exponent dummy variable. The dependent variable is defined as QoL given to a particular health state. We can not use adjusted health state data, because the logarithm of negative values is not defined. The mathematical model is shown below. The instalment parameters of the tariff (a retransformation of the lg-equation results) are presented in Table 9.

$$QoL = ß_0 * ß_{12}^{b12} * ß_{13}^{b13} * ß_{22}^{b22} * ß_{23}^{b23} * ß_{32}^{b32} * ß_{42}^{b42} * ß_{43}^{b43} * ß_{52}^{b52} * ß_{53}^{b53} * e_i \quad /\ln$$

$$\ln QoL = \ln ß_0 + b12 \ln ß_{12} + b13 \ln ß_{13} + b22 \ln ß_{22} + b32 \ln ß_{32} + b33 \ln ß_{33} + b42 \ln ß_{42} + b43 \ln ß_{43} + b52 \ln ß_{52} + b53 \ln ß_{53} + \ln e_i$$

Variable	Definition
Qol =	Index-Value of health status
$ß_0$ =	Constant factor = 100 (see definition), associated with any move away from full health
$ß_{xy}$ =	Instalment (x = EQ-5D dimension; y = answering level)
bxy =	Dummy variable
b.2 =	1 if answering level is 2 or 3
b.3 =	1 if answering level is 3
e_i =	Residual

4.3 RESULTS

The regression according to the additive, linear model resulted in instalments for impairments indicated in each dimension as presented in Table 7. The parameter estimations for the variables UA, AD, S2 and U2 (using the TTO values) are not significantly different from zero. Moreover, the parameter estimations for the variable U2 are positive, which contradicts the formulation of the model. With the VAS values similar significance problems occur. The certainty measure (R square) for the regression with the TTO values was $R^2 = 0.43$, which was not satisfying (like the R^2 in the British study). The regression with VAS values resulted clearly in a better value ($R^2 = 0.73$). With the help of these parameter estimations index values can be calculated. In column 2

of Table 8 the index values with the parameter estimations of the VAS values using the additive tariff were calculated; column 4 in Table 8 was accordingly calculated with the TTO values. The means of the VAS and TTO values are quite similar to the values calculated using the parameter estimations (mean difference -0.0045 or -0.0060). The index values based on TTO are higher than the index values based on VAS in the upper area of the scale.

Table 8: Parameter estimations

Variable	VAS	TTO	UK
a	0.885 *)	0.929 *)	0.918
MO	-0.061 *)	-0.082 *)	-0.069
SC	-0.108 *)	-0.063 *)	-0.104
UA	-0.045 *)	-0.010	-0.036
PD	-0.078 *)	-0.104 *)	-0.123
AD	-0.084 *)	-0.017	-0.071
M2	-0.034 *)	-0.139 *)	-0.176
S2	0.083 *)	-0.050	-0.006
U2	0.089	0.038	-0.022
P2	0.017	-0.081 *)	-0.140
A2	0.064 *)	-0.061 *)	-0.094
N3	-0.248 *)	0.285 *)	-0.269
R square	0.73	0.43	0.46
Signif F	0.00	0.00	

*) statistically significant ($\alpha < 0.05$)

The N3 variable did not improve the quality of the model (measured by R square). It seems that this variable, which was introduced in the analysis of the British sample, is not suitable for the German data. That means that there is still no standard model for international comparisons of the EQ-5D index value.

Table 9: Index values calculated with tariff I

		Mean actual VAS	**Esti-mated index**	Δ	Mean actual TTO	**Esti-mated index**	Δ
		(1)	**(2)**	(1) - (2)	(3)	**(4)**	(3) - (4)
be	11111	,9870	**1,0000**	-,0130	-	**-**	-
ve	21111	,8169	**,8310**	-,0141	,9614	**,8981**	,0633
vb	11121	,8171	**,8172**	-,0001	,9417	**,8834**	,0583
vc	11211	,8053	**,8518**	-,0465	,9383	**,9825**	-,0442
vd	12111	,7814	**,7913**	-,0099	,9341	**,9315**	,0026
va	11112	,7999	**,8109**	-,0110	,9340	**,9916**	-,0576
la	11122	,7347	**,7303**	,0044	,9029	**,8773**	,0256
lf	12211	,7087	**,7453**	-,0366	,8872	**,9164**	-,0292
lg	12121	,6655	**,7107**	-,0452	,8220	**,8173**	,0047
mc	12222	,5375	**,5777**	-,0402	,7769	**,7960**	-,0191
lh	22112	,6212	**,6376**	-,0164	,7698	**,8259**	-,0561
ld	21222	,6002	**,6174**	-,0172	,7602	**,7626**	-,0024
mb	22122	,5715	**,5570**	,0145	,7314	**,7116**	,0198
mi	22222	,4774	**,5109**	-,0335	,7067	**,6965**	,0102
lb	11113	,5107	**,5446**	-,0339	,7045	**,6073**	,0972
li	11312	,4723	**,4770**	-,0047	,6967	**,6806**	,0161
mf	12223	,4195	**,3114**	,1081	,5128	**,4117**	,1011
mx	13212	,3766	**,3842**	-,0076	,5051	**,4825**	,0226
md	21323	,2990	**,3160**	-,0170	,3440	**,3990**	-,0550
mh	21232	,3684	**,3079**	,0605	,3233	**,2474**	,0759
sc	23321	,2772	**,2886**	-,0114	,2800	**,2955**	-,0155
sd	22323	,2482	**,2095**	,0387	,2788	**,3329**	-,0541
mg	22331	,2808	**,2533**	,0275	,2640	**,2081**	,0559
me	32211	,2890	**,3213**	-,0323	,2529	**,2714**	-,0185
vx	11131	,4545	**,5077**	-,0532	,2491	**,3682**	-,1191
le	11133	,3296	**,4073**	-,0777	,2190	**,2943**	-,0753
lc	21133	,3065	**,3404**	-,0339	,1713	**,1948**	-,0235
si	33212	,1943	**,2130**	-,0187	,1355	**,1541**	-,0186
sh	33323	,0872	**,0838**	,0034	,0750	**-,0073**	,0823
sg	33321	,1631	**,1843**	-,0212	,0588	**,0666**	-,0078
se	32223	,1570	**,1402**	,0168	,0542	**,0833**	-,0291
sb	23232	,1986	**,1801**	,0185	,0368	**,0700**	-,0332
ma	32331	,1460	**,1489**	-,0029	,0188	**-,0208**	,0396
sf	32232	,1299	**,0970**	,0329	-,0541	**-,0476**	-,0065
sa	33232	,1149	**,0757**	,0392	-,1068	**-,1589**	,0521
wo	33333	,0247	**,0272**	-,0025	-,1849	**-,2059**	,0210
mean difference				-0,2362			0,0839

In order to conduct a regression according to the multiplicative model I with TTO values, it was at first necessary to change the scale of the TTO values [- 1; 1] by adding 1 [0; 2]. The parameter estimations for VAS and TTO values are presented in Tables 9 and 10. Significant problems result with both the parameter estimations for VAS and TTO. On the one hand this result could be explained by the fact that some problems with mobility or some pain does not considerably impair the quality of life. On the other hand, it is possible that there are dependencies between the five dimensions. If a person indicates, for example, that he or she has extreme problems with mobility, it is likely that general activities are also reduced. Thus, prerequisites of the OLS regression are hurt and the parameter estimation distorted. The quality measure of R Square proves substantially better with the OLS regression of the VAS data than with the TTO data.

Table 10: Estimation of the EQ-5D index value (VAS data)

Answering level	Value by response category		
Dimension (parameter)	**no problems (1)**	**Some problems (2)**	**severe problems (3)**
Constant factor (full health) = 0.9256**)			
1. Mobility	1.00	0.9447	0.4157**)
2. Self-Care	1.00	0.8080**)	0.5819**)
3. Usual Activity	1.00	0.8803**)	0.6291**)
4. Pain / Discomfort	1.00	0.9745	0.4793**)
5. Anxiety / Depression	1.00	0.8174**)	0.5728**)
R Square			0.72

**) statistically significant ($\alpha < 0.01$)

If, for example, a participant indicated severe problems in items 4 and 5 (health state 11133), the QoL value would be:

QoL 11133 = 0,9256 * 1,00 * 1,00 * 1,00 * ß42 * ß43 * ß52 * ß53
= 0,9256 * 1,00 * 1,00 * 1,00 * 0,9745 * 0,4793 * 0,8194 * 0,5728 = 0,2024

Table 11: Estimation of the EQ-5D index value (TTO-data)

Answering level / Dimension (parameter)	Value by response category: no problems (1)	some problems (2)	severe problems (3)
Constant factor (full health) = 0,9268**)			
1. Mobility	1.00	0.9184**)	0.7793*
2. Self-Care	1.00	0.9742	0.8388**)
3. Usual Activity	1.00	0.9213**)	0.9929
4. Pain / Discomfort	1.00	0.9403**)	0.7461**)
5. Anxiety / Depression	1.00	1.0172	0.8373**)
R Square			0.36

**) statistically significant ($\alpha < 0,01$)

In columns 2 (4) of Table 12 index values with the parameter estimations of the VAS values (TTO values) and the multiplicative tariff II are determined. The modelled values are not satisfyingly similar to the average VAS values and in particular to the TTO values (mean differences: 1.44 and 3.35). Even after correction of the index based on TTO values for the average difference of 3.35 the deviations of the average value TTO compared to the index TTO are still high. By the transformation of the scale [- 1; 1] to [0; 2] for the regression the dependent variables are strongly distorted. It can be concluded that this step is obviously inadequate.

Table 12: Index values from the multiplicative tariff II

		Mean actual VAS	**Esti-mated index VAS**	Δ	Mean actual TTO	Estimated index TTO	Δ
		(1)	**(2)**	(1) - (2)	(3)	(4)	(3) - (4)
be	11111	.9870	.9256	.06	-	-	-
va	11112	.7999	.7566	.04	.9340	.9599	-.0259
lb	11113	.5107	.4334	.08	.7045	.6411	.0634
vb	11121	.8171	.9020	-.08	.9417	.8118	.1299
la	11122	.7347	.7373	.00	.9029	.8429	.0600
vx	11131	.4545	.4323	.02	.2491	.3518	-.1027
le	11133	.3296	.2024	.13	.2190	.1513	.0677
vc	11211	.8053	.8148	-.01	.9383	.7752	.1631
li	11312	.4723	.4190	.05	.6967	.7929	-.0962
vd	12111	.7814	.7479	.03	.9341	.8771	.0570
lg	12121	.6655	.7288	-.06	.8220	.7650	.0570
lf	12211	.7087	.6584	.05	.8872	.7294	.1578
mc	12222	.5375	.5244	.01	.7769	.6541	.1228
mf	12223	.4195	.3004	.12	.5128	.3850	.1278
mx	13212	.3766	.3132	.06	.5051	.4755	.0296
ve	21111	.8169	.8744	-.06	.9614	.7696	.1918
lc	21133	.3065	.1912	.12	.1713	.0574	.1139
ld	21222	.6002	.6132	-.01	.7602	.5593	.2009
mh	21232	.3684	.2939	.07	.3233	.1634	.1599
md	21323	.2990	.2209	.08	.3440	.2964	.0476
lh	22112	.6212	.5775	.04	.7698	.7536	.0162
mb	22122	.5715	.5628	.01	.7314	.6489	.0825
mi	22222	.4774	.4954	-.02	.7067	.5191	.1876
sd	22323	.2482	.1785	.07	.2788	.2629	.0159
mg	22331	.2808	.1828	.10	.2640	.1063	.1577
sb	23232	.1986	.1382	.06	.0368	-.0493	.0861
sc	23321	.2772	.2219	.06	.2800	.2438	.0362
me	32211	.2890	.2585	.03	.2529	.2377	.0152
se	32223	.1570	.1180	.04	.0542	-.0088	.0630
sf	32232	.1299	.0987	.03	-.0541	-.1167	.0626
ma	32331	.1460	.0760	.07	.0188	-.1378	.1566
si	33212	.1943	.1230	.07	.1355	.0561	.0794
sa	33232	.1149	.0574	.06	-.1068	-.2591	.1523
sg	33321	.1631	.0922	.07	.0588	-.0307	.0895
sh	33323	.0872	.0432	.04	.0872	-.1745	.2617
wo	33333	.0247	.0207	.00	-.0247	-.3841	.3594
mean difference				1.44			3.35

5 CONCLUSION

The comparison of the results between the German and the English studies showed clear differences in the evaluation of the health states and thus also with the parameter values of the different index models. Since the study designs were quite similar, this result is surprising. The differences for VAS evaluations are much smaller. Obviously the intercultural differences are far more important for TTO evaluations than so far assumed.

Furthermore, the study showed that even with adjustments of the scale TTO surveys are not suitable for multiplicative index models as the distortion effect due to negative values is too great. Therefore, the application of TTO data to calculate index values is only possible with additive models.

This study is considered a contribution to the study question as to which influences national peculiarities have on the evaluation of health states. Further TTO surveys according to the EQ-5D system in other countries will show whether similar values to Germany, the UK or elsewhere can be determined or whether even on an aggregated national level quite individual evaluation patterns have to be considered.

6 REFERENCES

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7 APPENDIX

Selection of the cards by the interviewers

Always to be evaluated:

11111		33333
BE	(just with thermometer)	WO

3 from 6 " very mildly " impaired health states

11112	11121	11211	12111	21111	11131
VA	VB	VC	VD	VE	VX

3 from 9 easily impaired health states

11122	11113	21133	21222	11133
LA	LB	LC	LD	LE

12211	12121	22112	11312
LF	LG	LH	LI

4 from 10 means impaired health states

32331	22122	12222	21323	32211
MA	MB	MC	MD	ME

12223	22331	21232	22222	13212
MF	MG	MH	MI	MX

3 from 9 heavily impaired health states tariff

33232	23232	23321	22323	32223
7.1.1.1.1 A	SB	SC	SD	SE

32232	33321	33323	33212
SF	SG	SH	SI