Modeling health state preference data using fixed and random effects models

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1. Introduction

The use of preference-based measures of health in the measurement of Health-Related Quality of Life (HRQOL) has been increasing throughout the world. The SF-6D is a new preference-based measure of health derived from the SF-36 that has become widely used in economic evaluation, though it still has several limitations (Brazier et al, 2002). The SF-6D is a six-dimensional health state classification system (physical function, role limitations, social functioning, pain, mental health and vitality), with four to six levels, allowing for a total of 18,000 distinct health states (Brazier et al, 2002; Ferreira and Ferreira, 2006). The instrument generates a preference-based index allowing the computation of health state values that can be regarded as a continuous outcome.

This study aims to model health state preference data using the SF-6D and to suggest alternative models for predicting health state utilities using panel data models. This work also seeks to investigate the problems found in the SF-6D and to suggest possible changes to it.

2. Methods

A sample of 249 health states defined by the SF-6D has been valued by a representative random sample of the general population, stratified by gender and age, using the Standard Gamble (SG). The SG is one of the main techniques for valuing health states. It gives the respondent a choice between a certain intermediate outcome and the uncertainty of a gamble with two possible outcomes, one of which is better than the certain intermediate outcome and one of which is worst (Brazier et al, 2007). The SG method enabled the elicitation of the values (utilities) of the health states.

Additional 50 health states including extra levels on two dimensions (Physical Functioning and Role Limitations) of the SF-6D were valued, aiming to solve one of the most important limitations assigned to the SF-6D, the floor effect (large number of individuals reporting a lot of problems in the SF-6D) (Brazier et al, 2004; Stavem et al, 2005).

Econometric models were estimated on the relationship between the SF-6D and the SG values, aiming to analyze the models underlying the SF-6D and to estimate new models for predicting health state valuations for all the 18,000 states defined by the SF-6D and for all the 26,250 states defined by the revised SF-6D. The models were estimated at both the individual and aggregate levels, since there may be a respondent effect due to variations between respondents and within respondents (Brazier et al, 2002; McCabe et al, 2005). Firstly, an ordinary least squares estimation was used, assuming that each individual health state value was an independent observation. Models with main effects, with interaction effects and with the constant forced to unity are presented. Breush-Pagan tests revealed heteroscedasticity problems in all models. In order to deal with this, all models were estimated using White's heteroscedasticity consistent standard errors. Secondly, random effects (RE) models were estimated using generalized least squares (GLS) regressions, allowing for more complex modeling of the variance components observed at both levels of the hierarchy (Greene, 2003; Jones, 2001; Rabe-Hesketh and Everitt, 2007). The choice between fixed and RE was done by running a Hausman test, which pointed to the use of RE. The RE model can be defined by:

(1) $$y_{ij} = \alpha + \mathbf{x}'_{ij}\boldsymbol{\beta} + \mathbf{r}'_{ij}\boldsymbol{\theta} + u_j + e_{ij},$$

where $i = 1,2,\ldots, n$ represents the health states, $j = 1,2,\ldots, m$ represents the respondents, y_{ij} is the adjusted values of the health state i valued by respondent j, $\mathbf{x}'_{ij} = (x_{1ij}, x_{2ij},\ldots, x_{vij})$ is a vector of v dummies explanatory variables referenced to the same unity, in which $x_{vij} = x_{\delta\lambda ij}$ for each level λ of dimension δ of the SF-6D. The $\mathbf{r}'_{ij} = (r_{1ij}, r_{2ij},\ldots, r_{uij})$ term is a vector of u interactionated variables between the different levels of the attributes, also referenced to the same unity. Further, $\boldsymbol{\beta}' = (\beta_1, \beta_2, \ldots, \beta_v)$ and $\boldsymbol{\theta}' = (\theta_1, \theta_2, \ldots, \theta_u)$ are vectors of parameters. The u_j term is the respondent specific variation that is assumed to be random across individual respondents and e_{ij} is an error term for the ith health state valuation of the jth individual, assuming that it varies randomly across observations, with $e_{ij} \sim [0, \sigma_e^2]$. Additionally, $Cov(u_j, e_{ij}) = 0$, which means that the health states are randomly allocated to the respondents. Thirdly, generalized estimation equations (GEE) were used to estimate the RE models with the constant forced to unity, allowing for the accommodation of the correlated data (Hardin and Hilbe, 2003; Vittinghoff et al, 2005). Finally, alternative functional forms were considered to account for the skewed distribution of health state valuations. A logit and two log-log transformations, as well as a Tobit transformation, were applied. All the alternative functional forms were modelled with RE.

3. Results

All models were analyzed in terms of their coefficients, overall fit and the ability for predicting the SG values for all health states. The RE models estimated through GLS and the models estimated through GEE produced significant coefficients for the levels of both the standard SF-6D and the revised SF-6D, which were found to be robust across model specification. Table 1 shows the best models estimated for the standard SF-6D. The coefficients are expected to be negative and increasing in absolute size, because the dummies represent progressively worse problems on each dimension, when compared to the baseline for that dimension (Brazier et al, 2002). When a coefficient decreases in absolute size, an inconsistency occurs.

Since there were thousands of possible interaction effects that could be introduced in the model, within the limitations of this study, we reduced the interactions entered in the model by considering a dummy (WORSE), which accounted for all situations where any dimension was in the worse level.

The RE model with interaction effects presents 23 coefficients with the expected negative sign and 20 significant estimates. The few coefficients that don't have a negative sign were the second and third level of pain, even though they aren't significant. This model has only 5 inconsistencies (from PF2 to PF3, from RL2 to RL3, from SF2 to SF3, from MH2 to MH3 and from VIT2 to VIT3).

Regarding the RE model with main effects and with the intercept restricted to unity, the estimated coefficients are negative for all dimension levels, as expected, with the exception of the second level of pain, although this isn't significant. It has 17 significant estimates and concerning the number of inconsistencies, it also has five (from PF2 to PF3, from SF2 to SF3, from PAIN4 to PAIN5, from MH2 to MH3 and from VIT2 to VIT3). However, these inconsistencies don't constitute a serious problem, since they will only reduce the sensitivity at the upper end of physical function, social functioning, mental health and vitality and in the intermediate levels of pain.

The examination of their root mean square absolute error, explanatory power and mean absolute error (MAE) leads to the conclusion that both models have a good performance, especially when compared with the performance of other instruments of HRQOL measurement (Dolan, 1997; McCabe et al, 2005).

Table 1 – RE Models (individual level: n=630)

	Models	
	with interaction effects	with main effects and constant forced to unity
c	0.817***	1.000***
PF2	**-0.040***	**-0.050****
PF3	**-0.024**	**-0.032**
PF4	**-0.036***	**-0.049***
PF5	**-0.042***	**-0.055***
PF6	**-0.179*****	**-0.214*****
RL2	**-0.028***	**-0.031**
RL3	**-0.003**	**-0.003**
RL4	**-0.056****	**-0.054***
SF2	**-0.033***	**-0.038***
SF3	**-0.015**	**-0.014**
SF4	**-0.052***	**-0.039**
SF5	**-0.066****	**-0.069****
PAIN2	0.007	0.006
PAIN3	0.007	**-0.001**
PAIN4	**-0.047***	**-0.061***
PAIN5	**-0.050***	**-0.054***
PAIN6	**-0.073*****	**-0.090*****
MH2	**-0.054****	**-0.059****
MH3	**-0.025**	**-0.009**
MH4	**-0.059****	**-0.070****
MH5	**-0.092*****	**-0.103*****
VIT2	**-0.040***	**-0.051****
VIT3	**-0.026**	**-0.036**
VIT4	**-0.039****	**-0.046****
VIT5	**-0.082*****	**-0.097*****
WORSE	0.033*	-
Adjusted R^2	0.588	-
Inconsistencies	5	5
MAE	0.061	0.059

* $p<0.10$. ** $p<0.01$. *** $p<0.001$. Estimates shown in bold are negative values.

PF-Physical functioning; RL-Role limitations; SF-Social functioning; P–Pain; MH-Mental health; V–Vitality.

4. Conclusion

This research demonstrates that it is possible to estimate preference weights for HRQOL measurement. The best models estimated for the preference-based utility measure used seem to adequately predict the health states values of the general population. Actually, the performance of the RE models with the constant restricted to unity performed better than the fixed effects models. The restriction of the intercept to unity is sustained by the need of generating models for use in Cost-Utility Analyses (it is necessary to assume that the best health state defined by the SF-6D has a value of 1 and the best way to do this is to restrict the intercept to unity). There are concerns regarding some inconsistent estimates for two levels of one of the dimensions (pain) in both the standard and the revised SF-6D. It is also worth further research on the over prediction of the value of the poorest health states observed in some cases.

The models estimated provide preference based quality of life weights, when health status data has been collected using the SF-6D or the SF-36 questionnaire. Nevertheless, there is a need for revising the SF-6D descriptive system. In fact, the results confirm the usefulness of additional levels on the SF-6D, improving its efficiency in measuring the health states utilities and in diminishing the floor effect.

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SUMMARY

The use of preference-based measures of health in the measurement of Health Related Quality of Life has become widely used in health economics. Hence, the development of preference-based measures of health has been a major concern for researchers throughout the world.

This study aims to model health state preference data using a new preference-based measure of health (the SF-6D) and to suggest alternative models for predicting health state utilities using fixed and random effects models. It also seeks to investigate the problems found in the SF-6D and to suggest eventual changes to it.

RÉSUMÉ

L'utilisation du concevoir-basé comme système de mesure en santé est devenu de plus en plus utilisé dans le mesure de la qualité de vie liée à la santé, domaine de l'économie de la santé. Ainsi, le développement de ces mesures est devenu un souci majeur pour les chercheurs du monde entier.

Cette étude vise à modeler des données de préférence d'état de santé en utilisant une nouvelle mesure préférence-basée de santé (le SF-6D) et à suggérer des modèles alternatifs pour des utilités de prévision d'état de santé en utilisant les modèles fixés et aléatoires d'effets. Elle cherche également à étudier les problèmes trouvés dans le SF-6D et à suggérer d'éventuels changements.