CONTINGENT VALUATION

The economic value of informal care: a study of informal caregivers' and patients' willingness to pay and willingness to accept for informal care

Bernard van den Berg[a],*, Han Bleichrodt[b] and Louis Eeckhoudt[c]

[a] *CHERE, University of Technology, Sydney, Australia*
[b] *iBMG/iMTA, Erasmus Medical Centre, Rotterdam, The Netherlands*
[c] *Catholic Faculties Mons, Belgium and Lille, France*

Summary

We provide a new test of the feasibility of using contingent valuation to value informal care. We start with a theoretical model of informal caregiving and derive that willingness to pay depends positively on wealth and negatively on own health, whereas the effect of other's health is sign-ambiguous. These predictions are tested in two new data sets on patients' and caregivers' willingness to pay (WTP) and willingness to accept (WTA) for informal care. The data are generally consistent with the theoretical predictions: wealth generally has a positive impact and own health a negative impact. Other's health has a mixed effect. We find only small differences between WTP and WTA. Our findings suggest that contingent valuation may be a useful technique to value informal care in economic evaluations of health care. Copyright © 2005 John Wiley & Sons, Ltd.

Introduction

It has been argued that economic evaluations should adopt the societal perspective [1,2]. This means that everyone affected by the intervention should be considered and that all significant outcomes and costs that flow from the intervention should be counted [1]. Informal care is a significant part of the total care provided to care recipients with chronic or terminal diseases [3]. In spite of this, the costs and effects of informal care, both for the informal caregiver and for the patient they care for, are often ignored in economic evaluations [4]. This might be due to a lack of valuation methods that are both theoretically valid and empirically feasible.

The existing literature on the valuation of informal care focuses on the informal caregivers, in particular on the valuation of the time spent on providing informal care. The two methods that have been proposed to value the time spent on providing informal care are the opportunity cost method and the replacement cost method. Neither

*Correspondence to: Centre for Health Economics Research and Evaluation, University of Technology, Sydney PO Box 123, Broadway, NSW 2000, Sydney, Australia. E-mail: Bernard.Vandenberg@chere.uts.edu.au

of these methods accurately reflects the preferences of the informal caregiver and of the patient. The opportunity cost method values informal care by foregone wages and, therefore, ignores the (dis)-utility that informal caregivers derive from providing informal care. For a cost analysis this is appropriate, for a full cost–benefit analysis the opportunity cost method is too narrow. The replacement cost method (also called proxy good method) values informal care at the price of the market substitute, professional care, and, therefore, assumes that informal care and professional care are perfect substitutes. This assumption is not realistic, however. The informal caregiver decided to provide informal care because he or the patient considered professional care, too expensive or of too low quality [5], or because professional care is not available, e.g. when the patient is on a waiting list for professional care, or out of a feeling of obligation. Valuing informal care at the price of professional care, in consequence, does not reflect the preferences of the informal caregiver and the patient.

The valuation of the effects of informal care for the patient are rarely addressed, probably because it is believed that these will be picked up by quality of life estimates. This belief may not be justified, however, because the common methods for valuing health-related quality of life are unable to detect the interdependency between the preferences of patients and informal caregivers. For instance, the EQ-5D asks respondents to focus solely on their own health status. Such interdependencies can, however, be important in the provision of informal care.

The aforementioned problems can in theory be avoided by using the concept of willingness to pay (WTP) or willingness to accept (WTA). The contingent valuation method (CV) is one way to measure WTP or WTA. CV is rooted in applied welfare economics and directly elicits informal caregivers' and patients' preferences. The feasibility of applying CV to value informal care has been shown by Van den Berg *et al.* [6]. That paper, however, was somewhat *ad hoc* in that it lacked a formal theoretical model of the valuation of informal care. Hypotheses were merely formulated on the basis of a graphical model and on intuitive grounds. van den Berg *et al.* moreover, focused mainly on the preferences of the informal caregivers.

The aim of the present paper is to extend the research initiated by van den Berg *et al.* [6] into the

feasibility of using CV to value informal care. We present an economic model of informal care that takes into account the perspectives of both the informal caregiver and the patient and that models the interdependencies in their preferences. We use this model to derive hypotheses about the willingness to pay and the willingness to accept for informal care of the caregiver and the patient and about the effect of changes in certain key variables on the valuation of informal care. We then test these hypotheses in two new data sets.

In what follows, the next section describes our theoretical model of informal caregiving and derives the hypotheses to be tested. The section following this describes the two data sets, while the succeeding section presents the results. Finally, the last section concludes the paper.

Theory

The informal caregiver

Consider first the informal caregiver. We assume that the informal caregiver derives utility from consumption (c_{ic}), his own health (h_{ic}), and the health of the patient (h_p). The patient receives both formal care (FC) and informal care (IC). We assume that informal care has a positive effect on the patient's health, $\partial h_p/\partial \text{IC} > 0$. To justify this assumption suppose that a patient has problems with mobility. Providing informal care for this patient may mean helping him with moving around and, consequently, the mobility of the patient improves. Obviously, the more care is provided, the more opportunities the patient has to move around and the more his mobility improves. Our conclusions are, however, not affected in case informal care does not improve the health of the patient, $\partial h_p/\partial \text{IC} = 0$. No assumptions are imposed about the effect of formal care on the patient's health. The informal caregiver's utility becomes

$$U^{ic} = U^{ic}(c_{ic}, h_{ic}(\text{IC}), h_p(\text{IC}, \text{FC})) \qquad (1)$$

where U^{ic} is the caregiver's utility function. Whether this is a von Neumann–Morgenstern utility function or any other type of multi-attribute utility function is immaterial for our analysis. The only restriction we impose on U^{ic} is that it is

increasing and concave in consumption, the caregiver's health, and the patient's health.

As seems plausible, caregiving is more urgent the worse is the patient's health and we, therefore, assume that the effect of informal care on the patient's health is larger the worse is the health of the patient: $\partial^2 h_{ic}/\partial h_p \partial IC < 0$. This latter assumption is not necessary; all conclusions derived below remain valid when $\partial^2 h_{ic}/\partial h_p \partial IC = 0$.

Several studies suggest that providing informal care may have a negative effect on the informal caregiver's health [7,8] and we, therefore, let $\partial h_{ic}/\partial IC \leq 0$. Because caregiving is more burdensome the worse is the health of the patient, we assume that the negative effect on the caregiver's health is larger the worse is the health of the patient: $\partial^2 h_{ic}/\partial h_p \partial IC < 0$. Again, this latter assumption is not necessary; all conclusions derived below remain valid when $\partial^2 h_{ic}/\partial h_p \partial IC = 0$.

Reflecting the institutional setting in the Netherlands (we will use the data from two Dutch samples to test some predictions of the model), we take formal care as exogenously given. We also assume that the amount of informal care is exogenously given. We believe that this assumption most closely mirrors the practice of informal caregiving. Alternatively, we could take the amount of informal care as endogenous, i.e. as determined by the optimizing behaviour of the caregiver. Modifying the analysis in this way does not change the predictions of the model as we show in Appendix A.

The informal caregiver has initial wealth W_{ic} and can earn labor income at wage rate r. The amount of time the informal caregiver can work depends on the amount of informal care he provides, assuming that there is no joint production between paid work and providing informal care. The informal caregiver's budget constraint then becomes

$$W_{ic} + r(1 - IC) = c_{ic} \qquad (2)$$

Substitution of (2) into (1) gives

$$U^{ic} = U^{ic}(W_{ic} + r(1 - IC), h_{ic}(IC), h_p(IC, FC)) \quad (3)$$

We can now determine the informal caregiver's willingness to pay for a decrease in the amount of informal care, defined as the maximum amount of wealth he is willing to give up for a decrease in the amount of informal care that he provides. That is,

we seek to determine the amount Δ that solves

$$U^{ic}(W_{ic} - \Delta + r(1 - IC - \delta), h_{ic}(IC - \delta),$$
$$h_p(IC - \delta, FC)) = U^{ic}(W_{ic} + r(1 - IC), h_{ic}(IC),$$
$$h_p(IC, FC)) \qquad (4)$$

Totally differentiating (3) gives

$$V^{ic} = \frac{dW_{ic}}{dIC}$$

$$= r - \frac{(\partial h_p/\partial IC)(\partial U^{ic}/\partial h_p) + (\partial h_{ic}/\partial IC)(\partial U^{ic}/\partial h_{ic})}{\partial U^{ic}/\partial W_{ic}} \qquad (5)$$

The first term in (5) represents the monetary gain from reducing the amount of informal care, additional labor income. The second term denotes the monetary value of the change in utility that follows from a decrease in informal care. The sign of the second term is ambiguous, because $\partial h_p/\partial IC > 0$ and $\partial h_{ic}/\partial IC \leq 0$. However, we found that informal caregivers generally want to pay for a reduction in the amount of informal care they provide, even when they have no paid job. This implies that $(\partial h_p/\partial IC)(\partial U^{ic}/\partial h_p) + (\partial h_{ic}/\partial IC)(\partial U^{ic}/\partial h_{ic})$ is negative. The intuition behind this negative sign is that the informal caregiver provides more informal care than he considers optimal (recall that the amount of informal care is exogenously determined). That is, in the case of no wage income, the benefits of giving informal care are less than the costs, or $(\partial h_p/\partial IC)(\partial U^{ic}/\partial h_p) + (\partial h_{ic}/\partial IC)(\partial U^{ic}/\partial h_{ic})$ is negative. To also take into account the possibility of zero willingness to pay, we assume that $(\partial h_p/\partial IC)(\partial U^{ic}/\partial h_p) + (\partial h_{ic}/\partial IC)(\partial U^{ic}/\partial h_{ic}) \leq 0$.

Let us examine what happens if some key variables change. First we consider the effect of a change in the patient's health. From (5) we obtain

$$\frac{\partial V^{ic}}{\partial h_p}$$

$$= - \frac{\frac{\partial U^{ic}}{\partial W_{ic}}\left(\frac{\partial h_p}{\partial IC}\frac{\partial^2 U^{ic}}{\partial h_p^2} + \frac{\partial^2 h_p}{\partial h_p \partial IC}\frac{\partial U^{ic}}{\partial h_p} + \frac{\partial h_{ic}}{\partial IC}\frac{\partial^2 U^{ic}}{\partial h_p \partial h_{ic}} + \frac{\partial^2 h_{ic}}{\partial h_p \partial IC}\frac{\partial U^{ic}}{\partial h_{ic}}\right)}{\left(\frac{\partial U^{ic}}{\partial W_{ic}}\right)^2}$$
$$- \frac{\frac{\partial^2 U^{ic}}{\partial h_p \partial W_{ic}}\left(\frac{\partial h_p}{\partial IC}\frac{\partial U^{ic}}{\partial h_p} + \frac{\partial h_{ic}}{\partial IC}\frac{\partial U^{ic}}{\partial h_{ic}}\right)}{\left(\frac{\partial U^{ic}}{\partial W_{ic}}\right)^2} \qquad (6)$$

The term $\partial^2 U^{ic}/\partial h_p \partial h_{ic}$ indicates how the informal caregiver's marginal utility of health changes with the patient's health, and the term $\partial^2 U^{ic}/\partial h_p \partial W_{ic}$ indicates how the informal caregiver's marginal utility of wealth depends on the health of the patient. It might be reasonable to assume that both terms are non-negative. We can see no plausible

reason why the caregiver would value additional health or wealth less when the patient is in better health. On the other hand, it is conceivable that he values extra health or wealth less if the patient is in worse health. In that case, the terms $\partial^2 U^{ic}/\partial h_p \partial h_{ic}$ and $\partial^2 U^{ic}/\partial h_p \partial W_{ic}$ are positive. If we assume that $\partial^2 U^{ic}/\partial h_p \partial h_{ic}$ and $\partial^2 U^{ic}/\partial h_p \partial W_{ic}$ are both positive, then the first term in the numerator of (5) is negative. If $(\partial h_p/\partial IC)(\partial U^{ic}/\partial h_p) + (\partial h_{ic}/\partial IC)(\partial U^{ic}/\partial h_{ic})$ is zero then an increase in the patient's health increases the caregiver's willingness to pay. If $(\partial h_p/\partial IC)(\partial U^{ic}/\partial h_p) + (\partial h_{ic}/\partial IC)(\partial U^{ic}/\partial h_{ic})$ is negative, the effect of a change in the patient's health on the informal caregiver's willingness to pay is sign-ambiguous.

The effect of the informal caregiver's health on his willingness to pay is equal to

$$
\begin{aligned}
&\frac{\partial V^{ic}}{\partial h_{ic}} \\
&= -\frac{\begin{array}{l}\dfrac{\partial U^{ic}}{\partial W_{ic}}\left(\dfrac{\partial h_p}{\partial IC}\dfrac{\partial^2 U^{ic}}{\partial h_p \partial h_{ic}} + \dfrac{\partial h_{ic}}{\partial IC}\dfrac{\partial^2 U^{ic}}{\partial h_{ic}^2}\right) \\ -\dfrac{\partial^2 U^{ic}}{\partial h_{ic} \partial W_{ic}}\left(\dfrac{\partial h_p}{\partial IC}\dfrac{\partial U^{ic}}{\partial h_{ic}} + \dfrac{\partial h_{ic}}{\partial IC}\dfrac{\partial U^{ic}}{\partial h_{ic}}\right)\end{array}}{\left(\dfrac{\partial U^{ic}}{\partial W_{ic}}\right)^2}
\end{aligned} \quad (7)
$$

We assume that $\partial^2 U^{ic}/\partial h_{ic} \partial W_{ic}$, which indicates how the marginal utility of wealth depends on health, is non-negative. This assumptions is common in the literature on willingness to pay [9,10] and there exists some empirical evidence to support it [11,12]. Hammerschmidt *et al.* [13] found, however, that $\partial^2 U^{ic}/\partial h_{ic} \partial W_{ic}$ is negative. If $\partial^2 U^{ic}/\partial h_{ic} \partial W_{ic}$ is non-negative then $\partial V^{ic}/\partial h_{ic}$ is negative. Hence, the better the caregiver's health status, the less he is willing to pay to reduce the amount of informal care that he provides. In the derivation of (7) we assumed that the effects of informal care on the patient's health and on the informal caregiver's health do not depend on the health of the informal caregiver. It seems conceivable that the positive effect of informal care on the patient's health increases with the caregiver's health and that the negative effect of informal care on the caregiver's health is less the better is the caregiver's health. The conclusions are not affected if we make these assumptions.

The effect of the informal caregiver's wealth on his willingness to pay is equal to

$$
\begin{aligned}
&\frac{\partial V^{ic}}{\partial W_{ic}} \\
&= -\frac{\begin{array}{l}\dfrac{\partial U^{ic}}{\partial W_{ic}}\left(\dfrac{\partial h_p}{\partial IC}\dfrac{\partial^2 U^{ic}}{\partial h_p \partial W_{ic}} + \dfrac{\partial h_{ic}}{\partial IC}\dfrac{\partial^2 U^{ic}}{\partial h_{ic} \partial W_{ic}}\right) \\ -\dfrac{\partial^2 U^{ic}}{\partial W_{ic}^2}\left(\dfrac{\partial h_p}{\partial IC}\dfrac{\partial U^{ic}}{\partial h_{ic}} + \dfrac{\partial h_{ic}}{\partial IC}\dfrac{\partial U^{ic}}{\partial h_{ic}}\right)\end{array}}{\left(\dfrac{\partial U^{ic}}{\partial W_{ic}}\right)^2}
\end{aligned} \quad (8)
$$

Under the assumptions made above, the first term in the numerator of (8) is sign-ambiguous, the second term is positive. It seems reasonable, however, that *ceteris paribus* the effect of the patient's health on the caregiver's marginal utility of wealth is small compared to the other terms in (8). If so, the effect of wealth on willingness to pay for a reduction in informal care is positive, i.e., the higher the caregiver's wealth, the more he is willing to pay for a reduction in the amount of informal care.

The patient

Let us next consider the patient. We assume that the patient derives utility from his consumption (c_p), the informal caregiver's health, and his own health. The patient's utility is increasing and concave in all its arguments. Due to his illness, the patient does not engage in labor market activities. Besides informal care, the patient may also receive formal care. The price of formal care is set, without loss of generality, equal to 1 per unit of formal care. As before, the amount of formal care and the amount of informal care are exogenously given. The patient's utility is equal to

$$U^p = U^p(c_p, h_{ic}(IC), h_p(IC, FC)) \quad (9)$$

The patient's budget constraint is

$$W_p = c_p + FC \quad (10)$$

and thus

$$U^p = U^p(W_p + FC, h_{ic}(IC), h_p(IC, FC)) \quad (11)$$

The patient's willingness to pay for increases in informal care is defined as the amount Δ

that solves

$$U^{\mathrm{p}}(W_{\mathrm{p}} - \Delta - \mathrm{FC}, h_{\mathrm{ic}}(\mathrm{IC} + \delta), h_{\mathrm{p}}(\mathrm{IC} + \delta, \mathrm{FC}))$$
$$= U^{\mathrm{p}}(W_{\mathrm{p}} - \mathrm{FC}, h_{\mathrm{ic}}(\mathrm{IC}), h_{\mathrm{p}}(\mathrm{IC}, \mathrm{FC})) \quad (12)$$

and is equal to

$$V^{\mathrm{p}} = -\frac{\mathrm{d}W_{\mathrm{p}}}{\mathrm{d}\mathrm{IC}}$$
$$= \frac{(\partial h_{\mathrm{p}}/\partial \mathrm{IC})(\partial U^{\mathrm{p}}/\partial h_{\mathrm{p}}) + (\partial h_{\mathrm{ic}}/\partial \mathrm{IC})(\partial U^{\mathrm{p}}/\partial h_{\mathrm{ic}})}{\partial U^{\mathrm{p}}/\partial W_{\mathrm{p}}} \quad (13)$$

Because $\partial h_{\mathrm{p}}/\partial \mathrm{IC} > 0$ and $\partial h_{\mathrm{ic}}/\partial \mathrm{IC} \leq 0$, (13) is sign-ambiguous. We found, however, that patients are willing to pay for increases in the amount of informal care, and hence, it seems plausible to assume that $(\partial h_{\mathrm{p}}/\partial \mathrm{IC})(\partial U^{\mathrm{p}}/\partial h_{\mathrm{p}}) + (\partial h_{\mathrm{ic}}/\partial \mathrm{IC})(\partial U^{\mathrm{p}}/\partial h_{\mathrm{ic}})$ is positive. Given that the amount of informal care is exogenously given, this positive sign suggests that the amount of informal care the patient receives is less than he considers optimal.

We next consider the effect of changes in the key variables, starting with the effect of a change in the patient's health.

$$\frac{\partial V^{\mathrm{p}}}{\partial h_{\mathrm{p}}}$$

$$= \frac{\begin{gathered}\frac{\partial U^{\mathrm{p}}}{\partial W_{\mathrm{p}}}\left(\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}}\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{p}}^2} + \frac{\partial^2 h_{\mathrm{p}}}{\partial h_{\mathrm{p}}\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{p}}} + \frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}}\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{p}}\partial h_{\mathrm{ic}}} + \frac{\partial^2 h_{\mathrm{ic}}}{\partial h_{\mathrm{p}}\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}}\right)\\ -\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{p}}\partial W_{\mathrm{p}}}\left(\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{p}}} + \frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}}\right)\end{gathered}}{\left(\frac{\partial U^{\mathrm{p}}}{\partial W_{\mathrm{p}}}\right)^2}$$
$$(14)$$

As noted, empirical evidence suggests that the marginal utility of wealth increases with own health and, therefore, $\partial^2 U^{\mathrm{p}}/\partial h_{\mathrm{p}}\partial W_{\mathrm{p}} \geq 0$. It is further conceivable that the patient enjoys increases in his own health at least as much when the informal caregiver is in good health than when he is in bad health. This implies that $\partial^2 U^{\mathrm{p}}/\partial h_{\mathrm{p}}\partial h_{\mathrm{ic}} \geq 0$. Under these assumptions, $\partial V^{\mathrm{p}}/\partial h_{\mathrm{p}}$ is negative and willingness to pay for increases in informal care decreases with the patient's health. This seems plausible: the better the patient's health the less he needs additional informal care and the less he will, in consequence, be willing to pay for additional informal care.

Equation (15) shows the effect of the informal caregiver's health on the patient's willingness to pay.

$$\frac{\partial V^{\mathrm{p}}}{\partial h_{\mathrm{ic}}}$$

$$= \frac{\begin{gathered}\frac{\partial U^{\mathrm{p}}}{\partial W_{\mathrm{p}}}\left(\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}}\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{p}}\partial h_{\mathrm{ic}}} + \frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}}\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}^2}\right)\\ -\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}\partial W_{\mathrm{p}}}\left(\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{p}}} + \frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}}\right)\end{gathered}}{\left(\frac{\partial U^{\mathrm{p}}}{\partial W_{\mathrm{p}}}\right)^2} \quad (15)$$

It seems reasonable to assume that $\partial^2 U^{\mathrm{p}}/\partial h_{\mathrm{ic}}\partial W_{\mathrm{p}}$ is non-negative. That is, the patient enjoys extra wealth at least as much when the caregiver is in good health than when he is in bad health. If so, under the assumptions already made, (15) is sign-ambiguous. Adding assumptions about how the effect of informal care on the patient's health and on the informal caregiver's health depends on the health of the caregiver does not change this conclusion.

Finally, consider the effect of changes in wealth on the patient's willingness to pay for an increase in informal care:

$$\frac{\partial V^{\mathrm{p}}}{\partial W_{\mathrm{p}}}$$

$$= \frac{\begin{gathered}\frac{\partial U^{\mathrm{p}}}{\partial W_{\mathrm{p}}}\left(\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}}\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{p}}\partial W_{\mathrm{p}}} + \frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}}\frac{\partial^2 U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}\partial W_{\mathrm{p}}}\right)\\ -\frac{\partial^2 U^{\mathrm{p}}}{\partial W_{\mathrm{p}}^2}\left(\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{p}}} + \frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}}\frac{\partial U^{\mathrm{p}}}{\partial h_{\mathrm{ic}}}\right)\end{gathered}}{\left(\frac{\partial U^{\mathrm{p}}}{\partial W_{\mathrm{p}}}\right)^2} \quad (16)$$

The first term of (16) is sign-ambiguous, the second negative. It might be expected, however, that *ceteris paribus* the effect of the informal caregiver's health on the patient's marginal utility of wealth, $\partial^2 U^{\mathrm{p}}/\partial h_{\mathrm{ic}}\partial W_{\mathrm{p}}$, is small compared to the other terms in (16). If so, (16) is positive and the patient's willingness to pay for an increase in informal care will increase with income.

The theoretical predictions derived in this section are summarised in Table 1. The table shows the effect on the informal caregiver's and the patient's willingness to pay of the three key variables: wealth, patient's health, and informal caregiver's health. A plus-sign indicates a positive relationship, a minus-sign indicates a negative

Table 1. Theoretical predictions

	V^{ic}	V^{p}
h_{p}	?	–
h_{ic}	–	?
W	+	+

relationship, and a question mark means sign-ambiguous.

Methods

We collected two sets of data to test the predictions of our theoretical model, summarised in Table 1. The first data set consisted of patients with rheumatoid arthritis (RA) and their informal caregivers. These data were collected as a supplement of the RA+ study, a panel study of health care utilisation among people with RA [14,15]. In the 2001 wave of this panel, 365 out of 683 care recipients indicated to receive informal care. We mailed them a postal survey. Moreover, we asked them to hand over an enclosed survey to their primary informal caregiver. Because we collected the data as a supplement to the RA+ study, patients were encouraged by their physicians to participate.

The second data set was collected 6 months after the RA sample with the aid of Dutch regional support centres for informal caregivers. We approached 59 regional centres, 40 of which were willing to participate in the research. Through these centres, we sent 3258 postal surveys to informal caregivers and asked them to hand over an enclosed survey to the patient they cared for. We refer to this data set as the heterogeneous (HET) sample.

In both samples we determined patients' willingness to pay (WTP) for an additional hour of informal care per week and their willingness to accept (WTA) for a reduction by 1 h in the amount of informal care they currently received. For the informal caregivers we determined their WTA to provide an additional hour of informal care per week and their WTP to reduce the amount of informal care they provided by 1 h per week. In the latter case we told them that another caregiver would provide that hour of care instead. We feared that if we did not tell the caregivers that their care would be replaced, some of them would be

unwilling to answer because the care recipient needed the care. Note that the replacement of care does not affect our theoretical predictions. Assuming that the difference in quality of the care is negligible, it follows that $\partial h_{p}/\partial IC > 0$. It is easily verified that setting $\partial h_{p}/\partial IC = 0$ in Equations (6) – (8) does not affect the entries of Table 1.

The full wording of the questions is given in Appendix B. In case the patient was a child or the patient was not able to fill in the survey due to his health problems, the parents or the informal caregiver were asked to complete the 'objective' part of the survey, questions like gender and age. They were instructed not to fill in the 'subjective' questions like WTP or WTA.

There is a continuous debate about payment formats in CV studies. Open-ended questions might be the best way to elicit respondents' maximum or minimum prices because this question format does not involve any of the biases that have been identified in the literature. Mitchell and Carson [16] showed that open-ended questions work smoothly when respondents are familiar with the concept under valuation. We felt that this condition is fulfilled for the valuation of informal care. In the pilot study for RA we found, however, that respondents had difficulties with the open-ended question format. We therefore opted for dichotomous questions with open-ended follow-up. The respondents could either accept or reject a bid of x Dutch guilders, where x was one of {10, 15, 20, 25, 30}. This corresponds to the following amounts in Euros: {4.54, 6.81, 9.08, 11.34, 13.61}. The bids were randomly allocated to the respondents. If a respondent rejected the bid, he was asked to state the bid that he would accept. This kind of approach has been successfully applied before [17]. In the HET sample we used open-ended questions, because these questions worked well in the pilot tests of this study.

In both samples, we measured health-related quality of life of the informal caregivers and the patients through the EQ-5D algorithm [18]. In the RA-population, we also measured the impact of providing informal care on the informal caregiver through the caregiver reaction assessment (CRA) [15,19]. In the RA sample, we used postal codes as a proxy for household wealth. It has been shown that this proxy method is reliable [20]. In the HET sample, the patient and the caregiver were asked to state their net monthly family income. The time spent on providing informal care was measured by presenting a list of 16 care tasks. Informal

caregivers were asked to report the time they spent on these tasks during the week preceding the interview.

Patients were asked whether they received any other informal care and professional home care and whether they were on a waiting list for professional care. Informal caregivers were asked whether they had paid work, about their social relationship with the patient, whether they lived together with the patient, and how many years they already provided informal care. Finally, patients and informal caregivers were asked some socio-demographic questions.

Results

One hundred forty-nine pairs of patients and their informal caregivers completed the RA survey, a response rate of 40.8%. Four hundred forty-four pairs of patients and their informal caregivers completed the HET survey. There were also 65 patients in the HET survey who completed a survey without their informal caregiver returning the questionnaire and 421 informal caregivers who completed the questionnaire without their patient returning the questionnaire. Hence, the final HET sample consisted of 509 patients and 865 informal caregivers, which amounts to a response rate of 21.1%. An explanation for the difference in response rate between the RA and the HET sample may be that in the RA sample, physicians supported the research and stimulated participation, while in the HET sample there were no such incentives to participate.

Sample characteristics

Table 2 gives background information about the patients and their informal caregivers. The table shows that there are some differences between the two samples. In the case of RA, almost 90% of the caregivers live together with their patient, in the HET sample this is true in approximately 60% of the cases. Other differences are that the proportion of male patients is higher in the HET sample, that quality of life, both of the patient and of the caregiver, is lower in the HET sample, and that the amount of informal care provided (in mean hours per week) is substantially higher in the HET sample.

Table 3 gives the diseases of the patients and the informal caregivers in the HET sample.

WTP and WTA

The response rate for the WTP/WTA questions ranges from 75.2 to 82.6% in the RA sample and from 51.2 to 63.9% in the HET sample. Within samples, there is not much difference in response rates between the WTP and the WTA questions.

Table 4 shows the mean and median results of the WTP and WTA questions. In both samples, WTA is higher than WTP. In all but one case the difference is significant. The difference between WTA and WTP is relatively small compared to CV studies that valued other types of 'goods'. These studies typically found that WTA was at least two times larger than WTP [21]. Despite the different payment formats in the two populations, both mean and median WTP and WTA are quite similar. It is worth nothing, however, that WTP for the informal caregiver is slightly overestimated because we told subjects that the hour of care they would provide less would be replaced. This means that $\partial h_p / \partial IC$ will be approximately zero, instead of positive when there is no compensation, and (4) shows that WTP is higher than when there is no compensation.

WTP and WTA are lower than the formal market tariffs for professional home care in the Netherlands. In 2002, the maximum price for professional housework was 26.70 Euro and the maximum price for professional personal care was 34.10 Euro. This maximum price was set by an agency responsible for setting the maximum prices for health care services.

Estimations

We next present empirical results on the relation between WTP and WTA and income and both the patient's and the informal caregiver's health-related quality of life. We tried several functional forms for the relation, including logarithmic and quadratic specifications. The models that we present are those that fitted the data best. Conclusions are not affected by only presenting the models that best fitted the data: it was never true that a variable that was statistically insignificant in the models presented was statistically significant in any of the other models. We

Table 2. Characteristics care recipients and informal caregivers

Characteristic	Mean RA sample	Mean HET sample
Care recipients		
Age[a]	62.1	66.6
Sex[b]	16.1	48.8
Education		
Low	43.9	52.1
Middle	38.5	31.0
High	9.5	12.1
EQ-5D	0.48	0.30
Waiting list[c]	5.9	11.5
Professional care[c]	26.1	58.3
Other informal care[c]	68.0	41.6
Income[c]		
Income Low	22.8	N/A
Income Middle	41.6	N/A
Income High	24.2	N/A
Income Unknown	9.4	N/A
Net monthly income[d]	N/A	1371.3
Informal caregivers		
Age[a]	62.1	60.2
Sex[b]	75.3	23.3
Partner[c]	91.5	48.9
Live together	87.6	58.2
Paid job	36.9	23.4
Education		
Low	34.9	37.9
Middle	46.3	44.7
High	13.4	16.0
Income[c]		
Income Low	22.8	N/A
Income Middle	41.6	N/A
Income High	24.2	N/A
Income Unknown	9.4	N/A
Net monthly income[d]	N/A	1627.28
Care duration[a]	11.4	8.7
Total informal care time[e]	26.4	49.0
EQ-5D	0.82	0.75
CRA loss of physical strength	2.26	N/A
N	149	509 patients and 865 informal caregivers

[a] In years.
[b] Percentage males.
[c] Percentages.
[d] Family income in Euro.
[e] Mean hours a week.

estimated all models by ordinary least squares with robust standard errors.

As discussed before, in case of RA there may be a starting-point bias and we, therefore, corrected for the provided start bids by means of an independent variable. We did not have income information for a substantial part of the RA sample. We, therefore, used dummy variables, including a dummy 'income unknown', to test for the effect of income.

Table 5 summarizes the data for the RA sample. The start bid has a higher coefficient in the regression for WTA than in the regression for WTP both for informal caregivers and for patients. Moreover, the start bid is only statistically significant in the regression for WTA. This

Table 3. Percentage patients and informal caregivers with certain disease in HET

Diseases	Patient[a]	Informal caregiver
Respiratory diseases	0.07	0.29
Circulatory diseases	0.19	0.45
Digestive diseases	0.07	0.09
Endocrine, metabolic and nutritional diseases	0.08	0.13
Musculoskeletal diseases	0.27	0.67
Neurological diseases	0.28	0.56
Skin diseases	0.05	0.06
Psychological diseases	0.20	0.16
N	865	865

[a] Reported by the informal caregiver.

Table 4. Results CV questions in Euro

	Mean WTP (n)	SD	Mean WTA (n)	SD	Difference WTP–WTA	Median WTP	Median WTA
RA							
Care recipients	7.84 (120)	4.43	8.22 (112)	4.13	$P = 0.1789$	6.81	6.81
Informal caregivers	7.80 (114)	4.58	9.52 (123)	6.61	$P = 0.0077$	9.08	9.08
HET							
Care recipients	6.72 (325)	5.30	8.62 (308)	6.41	$P < 0.0001$	6.81	6.81
Informal caregivers	8.61 (443)	5.73	10.52 (503)	6.80	$P < 0.0001$	6.81	9.08

Table 5. Informal caregiver's and patient's log WTP and log WTA in the RA sample (P values in parentheses)

Independent variables	Dependent variable: informal caregivers' log WTA	Dependent variable: informal caregivers' log WTP	Dependent variable: patients' log WTA	Dependent variable: patients' log WTP
Start bid	0.10 (0.000)	0.04 (0.135)	0.06 (0.000)	0.03 (0.146)
Dummy income low (income middle = ref.)	−0.36 (0.070)	−0.48 (0.033)	0.23 (0.100)	0.11 (0.544)
Dummy income high (income middle = ref.)	−0.05 (0.810)	−0.22 (0.229)	0.28 (0.019)	0.29 (0.015)
Dummy income unknown (income middle = ref.)	0.13 (0.317)	−0.47 (0.020)	0.02 (0.905)	−0.08 (0.616)
Informal caregiver's health		−1.64 (0.118)	0.70 (0.342)	
Informal caregiver's health^2		1.29 (0.138)	−0.74 (0.190)	
Patient's health	0.49 (0.241)		−0.64 (0.001)	
Patient's health^2	−1.17 (0.118)		0.50 (0.129)	
Intercept	1.43 (0.000)	2.28 (0.000)	1.59 (0.000)	1.73 (0.000)
R^2	0.19	0.11	0.26	0.08
F-test for income dummies	3.36 (0.038)	0.65 (0.525)	2.37 (0.098)	3.18 (0.045)
N	121	113	109	120

suggests that the start bid has led to an upward bias in WTA, but not in WTP.

The influence of income on WTP and WTA is largely in line with our theoretical predictions. If statistically significant, the dummy for low income is negative and the dummy for high income is positive. Income has no significant impact on informal caregivers' WTP: the F-test for the joint influence of the income dummies is insignificant.

Own health has the predicted negative effect on the patient's WTA; in all other regressions the impact of own health (i.e. the impact of the caregiver's health on the caregiver's WTA and WTP and of the patient's health on the patient's WTP) is not statistically significant. No statistically significant evidence of other's health (i.e. the patient's health on the caregiver's WTA and WTP and the caregiver's health on the patient's WTA and WTP) is observed. Measuring informal caregiver's health with the CRA subscale 'loss of physical strength' instead of the EQ-5D did not affect the above conclusions.

Tables 6–9 report the results for the HET sample. Because the HET sample consisted of patients and informal caregivers with various diseases there is a danger of heteroskedasticity. We, therefore, divided the HET sample into different subgroups. The stratification was based on the informal caregivers' and the patient's illnesses. When there were not enough respondents per illness, we clustered them. The criterion was that there should be at least 50 respondents per subgroup and that there should be no evidence of heteroskedasticity in the resulting subgroups. As the tables show, the goodness of fit of the various models, as measured by the adjusted R^2, is low in some subgroups, which means that we should interpret the results with caution.

The effect of income on WTP and WTA is mixed. Income has the predicted positive effect on the informal caregiver's WTP and, in two out of four subgroups, on the patient's WTP. In all other cases, the effect of income is not statistically significant.

Own health generally has the predicted negative effect: in general the informal caregiver's WTA and WTP decrease with the caregiver's health and the patients' WTA and WTP decrease with the patient's health. In some cases the effect of the patient's health is inverse U-shaped; WTP and WTA rise first as own health improves, then they fall.

The impact of other's health is mixed. Patient's health has generally a negative impact on the informal caregiver's WTA, but a positive impact on the caregiver's WTP; there is no statistically significant effect of the caregiver's health on the patient's WTA and the effect on the patient's WTP is inverse U-shaped.

Discussion

The aim of this paper was to test in further detail whether CV can be used to value informal care. To that end, we specified a theoretical model of informal caregiving and tested whether WTP and WTA satisfied the predictions that we derived from that model. Of course, one could object that a violation of these hypotheses might indicate a misspecification of the model. The model was rather general, however, and based on findings from the empirical literature. We, therefore, expect that most caregivers and patients behave approximately in the way specified by the model. Hence, if

Table 6. Informal caregiver's log WTA in the HET sample (P values in parentheses)

Independent variables	A	B	C	D	E
Log monthly income	−0.10 (0.422)	0.04 (0.763)	−0.01 (0.897)	−0.08 (0.325)	0.01 (0.960)
Informal caregiver's health	1.51 (0.086)	−0.45 (0.008)	−0.53 (0.005)	−0.27 (0.059)	
Informal caregiver's health^2	−1.64 (0.032)				−0.41 (0.010)
Patient's health	0.08 (0.615)	0.18 (0.214)	0.22 (0.054)	0.10 (0.381)	0.11 (0.358)
Patient's health^2	−0.68 (0.041)	−0.56 (0.069)	−0.44 (0.086)	−0.27 (0.141)	−0.43 (0.123)
Constant	3.03 (0.001)	2.40 (0.010)	2.82 (0.001)	3.07 (0.000)	2.51 (0.004)
R^2	0.16	0.06	0.08	0.03	0.05
N	94	166	94	172	182

Note: subgroup A = respiratory diseases, subgroup B = circulatory diseases, subgroup C = digestive diseases; endocrine, metabolic and nutritional diseases; skin diseases; psychological diseases, subgroup D = musculoskeletal diseases, subgroup E = neurological diseases.

Table 7. Informal caregiver's log WTP in the HET sample (*P* values in parentheses)

Variable	A	B	C	D	E
Log monthly income	0.12 (0.261)	0.21 (0.014)	0.21 (0.038)	0.22 (0.015)	0.31 (0.006)
Informal caregiver's health	−0.64 (0.026)	1.82 (0.077)	1.74 (0.129)	1.87 (0.055)	1.42 (0.173)
Informal caregiver's health^2		−1.58 (0.046)	−1.42 (0.127)	−1.73 (0.028)	−1.30 (0.109)
Patient's health	0.30 (0.018)	0.28 (0.033)	0.38 (0.040)	0.27 (0.042)	0.25 (0.057)
Patient's health^2					
Constant	1.67 (0.046)	0.06 (0.936)	0.01 (0.994)	0.03 (0.971)	−0.63 (0.480)
R^2	0.08	0.11	0.15	0.11	0.10
N	88	148	86	153	164

Note: subgroup A = respiratory diseases, subgroup B = circulatory diseases, subgroup C = digestive diseases; endocrine, metabolic and nutritional diseases; skin diseases; psychological diseases, subgroup D = musculoskeletal diseases, subgroup E = neurological diseases.

Table 8. Patient's log WTA in the HET sample (*P* values in parentheses)

Variable	A	B	C	D
Log monthly income		0.03 (0.805)		−0.02 (0.896)
Informal caregiver's health	1.00 (0.324)	−0.81 (0.358)		−0.09 (0.906)
Informal caregiver's health^2	−1.14 (0.261)	0.57 (0.440)		−0.02 (0.973)
Patient's health	0.93 (0.126)	0.38 (0.218)	0.54 (0.101)	0.11 (0.712)
Patient's health^2	−1.82 (0.052)	−0.90 (0.086)	−0.85 (0.061)	−0.41 (0.306)
Constant	1.95 (0.000)	2.20 (0.009)	2.10 (0.000)	2.31 (0.010)
R^2	0.08	0.03	0.02	0.01
N	74	124	165	133

Note: subgroup A = respiratory diseases; digestive diseases; endocrine, metabolic and nutritional diseases; skin diseases; psychological diseases, subgroup B = circulatory diseases, subgroup C = musculoskeletal diseases, subgroup D = neurological diseases.

Table 9. Patient's log WTP in the HET sample (*P* values in parentheses)

Variable	A	B	C	D
Log monthly income			0.24 (0.071)	0.21 (0.071)
Informal caregiver's health		1.39 (0.199)	0.06 (0.839)	
Informal caregiver's health^2		−1.25 (0.158)		
Patient's health		0.60 (0.100)	1.03 (0.033)	
Patient's health^2	−0.66 (0.038)	−0.87 (0.133)	−1.38 (0.048)	
Constant	1.91 (0.000)	1.57 (0.000)	−0.01 (0.995)	0.29 (0.721)
R^2	0.05	0.05	0.08	0.02
N	105	126	128	183

Note: subgroup A = respiratory diseases; digestive diseases; endocrine, metabolic and nutritional diseases; skin diseases; psychological diseases, subgroup B = circulatory diseases, subgroup C = musculoskeletal diseases, subgroup D = neurological diseases.

people are able to come up with meaningful answers to CV questions, then we would expect that their responses are to a large extent in line with the specified model.

With respect to the impact of income, we generally find the predicted positive effect in the RA sample and, to a lesser extent, in the HET sample. Own health generally has the predicted negative effect in the HET sample, but in the RA sample we only observe it for the patient's WTA. The effect of other's health (for instance patient's health on caregiver's WTP and WTA and *vice*

versa) varies. Recall that our model made no predictions regarding this effect. We tentatively conclude that our findings are generally in the direction predicted by the theoretical model, even though the effects are not always statistically significant and some deviations exist.

An encouraging finding for the use of CV to value informal care is that we find only small differences between WTP and WTA. The mean WTP is in all cases lower than the mean WTA and the ratio of mean WTA over mean WTP ranges from 1.0 for the RA patients to 1.3 for the HET patients. These ratios are small compared to other studies that report WTA/WTP ratios ranging from 1.4 [22] to 61.0 [23,24]. For the medians the ratios are even closer to 1, only for informal caregivers in the HET sample is the ratio different from 1 (1.3). The reason why we find small disparities between WTA and WTP might be that our subjects have relatively well-defined preferences for informal care. Most likely they have thought about how much they would be willing to spend on additional care. In the other studies that have been reported in the literature, people are often asked for their valuation of goods on which they have spent little thought. In such cases, people's preferences are likely to be more affected by biases [25]. These biases can explain the often huge differences between WTP and WTA that have been observed.

In most applications of CV to health only WTP was asked [26,27]. An exception is a study of Borisova and Goodman [28], whose findings about the disparity between WTP and WTA are in line with ours. They applied CV to value travel time and found a ratio between WTA and WTP of 1.3.

Let us finally discuss two limitations of our study that may be addressed in future research. A first problem may be that the observed explanatory power of our models, in particular in the HET sample, was rather low. It should be kept in mind though that low R^2 values are not uncommon in explaining individuals' subjective valuations. Objective variables do not fully explain individual choices since the importance of personality on determining individual well-being cannot be ignored. A recent review suggests that objective socio-economic and demographic variables can explain up to 20% of individual well-being [29]. Explanatory values that are comparably low as ours have been observed in other CV studies in health [30]. A second limitation is that we did not test for scope effects: the finding that valuations are insensitive to the size of the effect. In our study

this might have meant that respondents had the same WTP for, say, a 2 h increase in informal care as for a 1 h increase in informal care. It is well known from previous studies that scope effects can be important [31]. Whether they also affect the valuation of informal care remains to be tested.

Acknowledgements

Appendix A

We show that taking informal care endogenous does not change our conclusions. We determine the optimal amount of informal care that the informal caregiver will supply. His optimisation problem is

$$\max_{c_{ic}, IC, \lambda} L = U^{ic}(c_{ic}, h_{ic}(IC), h_p(IC, FC)) + \lambda(c_{ic} - W_{ic} - r(1 - IC)) \qquad (A1)$$

The first-order conditions are

$$\frac{\partial L}{\partial c_{ic}} = \frac{\partial U^{ic}}{\partial c_{ic}} + \lambda = 0 \qquad (A2)$$

$$\frac{\partial L}{\partial IC} = \frac{\partial U^{ic}}{\partial h_{ic}} \frac{\partial h_{ic}}{\partial IC} + \frac{\partial U^{ic}}{\partial h_p} \frac{\partial h_p}{\partial IC} + \lambda r = 0 \qquad (A3)$$

$$\frac{\partial L}{\partial \lambda} = c_{ic} - W_{ic} - r(1 - IC) = 0 \qquad (A4)$$

Totally differentiating (A1) gives

$$dL = \frac{\partial U^{ic}}{\partial c_{ic}} dc_{ic} + \left(\frac{\partial U^{ic}}{\partial h_{ic}} \frac{\partial h_{ic}}{\partial IC} + \frac{\partial U^{ic}}{\partial h_p} \frac{\partial h_p}{\partial IC} \right) dIC + d\lambda(c_{ic} - W_{ic} - r(1 - IC)) + \lambda(dc_{ic} - dW_{ic} + r \, dIC) = 0 \qquad (A5)$$

By (A2), $(\partial U^{ic}/\partial c_{ic} + \lambda) \, dc_{ic} = 0$ and by (A4) $c_{ic} - W_{ic} - r(1 - IC) = 0$. Hence, we are left with

$$\left(\frac{\partial U^{\mathrm{ic}}}{\partial h_{\mathrm{ic}}}\frac{\partial h_{\mathrm{ic}}}{\partial \mathrm{IC}} + \frac{\partial U^{\mathrm{ic}}}{\partial h_{\mathrm{p}}}\frac{\partial h_{\mathrm{p}}}{\partial \mathrm{IC}} + \lambda r\right) \mathrm{dIC} - \lambda\, \mathrm{d}W_{\mathrm{ic}} = 0$$

(A6)

or

$$\frac{\mathrm{d}W}{\mathrm{dIC}} =$$

$$\frac{\lambda r + (\partial U^{\mathrm{ic}}/\partial h_{\mathrm{ic}})\,(\partial h_{\mathrm{ic}}/\partial \mathrm{IC}) + (\partial U^{\mathrm{ic}}/\partial h_{\mathrm{p}})\,(\partial h_{\mathrm{p}}/\partial \mathrm{IC})}{\lambda}$$

(A7)

By (A2), $\lambda = -\partial U^{\mathrm{ic}}/\partial c_{\mathrm{ic}} = -\partial U^{\mathrm{ic}}/\partial W_{\mathrm{ic}}$, and hence we arrive back at (5). Note that this does not mean that willingness to pay will be the same. In fact, from (A3) we know that willingness to pay at the optimum amount of informal care is zero, whereas in (5) it may well be different from zero (when informal care is not at its optimal level). The predictions of the effects of changes in wealth, the patient's health and the informal caregiver's health on willingness to pay are, however, same and this is what we intended to show.

Appendix B

Informal caregiver WTA

Suppose your patient needs per week 1 h extra care and the government compensates you for this. What is the minimum amount of money you would want to receive from the government net of taxes to provide this additional hour of care? (1) fx Euro, (2) less than fx Euro, that is…., (3) more than fx Euro, that is….

Informal caregiver WTP

Suppose there is a possibility for you to provide per week 1 h less informal care. Someone else will replace you, so the total amount of care for the patient remains the same. What is the maximum amount of money you would want to pay in order that someone else takes over this hour of care? (1) fx Euro, (2) less than fx Euro, that is…., (3) more than fx Euro, that is….

Patient WTA

Suppose you receive per week 1 h less informal care and the government compensates you for this. What is the minimum amount of money you would want to receive from the government net of taxes for this hour less informal care? (1) fx Euro, (2) less than fx Euro, that is….., (3) more than fx Euro, that is….

Patient WTP

Suppose you need an additional hour of informal care per week and you have to pay for this hour yourself. What is the maximum amount of money you would want to pay for this extra hour of informal care? (1) fx Euro, (2) less than fx Euro, that is….., (3) more than fx Euro, that is….

References

1. Russell LB, Siegel JE, Daniels N et al. Cost–effectiveness analysis as a guide to resource allocation in health: roles and limitations. In *Cost–Effectiveness in Health and Medicine*, Gold MR, Siegel JE, Russell LB et al. (eds). Oxford University Press: New York, 1996.
2. Drummond MF, O'Brien BJ, Stoddart GL et al. *Methods for the Economic Evaluation of Health Care Programmes*. Oxford, 1997.
3. Norton EC. Long-term care. In *Handbook of Health Economics*, Culyer AJ, Newhouse JP (eds). Elsevier: Amsterdam, 2000.
4. Stone PW, Chapman RH, Sandberg EA et al. Measuring costs in cost–utility analyses. Variations in the literature. *Int J Technol Assess Health Care* 2000; **16**(1): 111–124.
5. Gronau R. Home production – a survey. In *Handbook of Labor Economics,* Ashenfelter O, Layard R (eds). Elsevier Science Publishers: Amsterdam, 1986.
6. Van den Berg B, Brouwer WBF, Van Exel JAJ et al. Economic valuation of informal care: the contingent valuation method applied to informal caregiving. *Health Econ* 2005; **14**(2): 169–183.
7. Hughes SL, Giobbie-Hurder A, Weaver FM et al. Relationship between caregiver burden and health-related quality of life. *Gerontologist* 1999; **39**(5): 534–545.
8. Schulz R, Beach SR. Caregiving as a risk factor for mortality: the caregiver health effects study. *J Am Med Assoc* 1999; **282**(23): 2215–2219.

9. Jones-Lee MW. The value of changes in the probability of death or injury. *J Polit Econ* 1974; **82**: 835–849.

10. Weinstein MC, Shepard DS, Pliskin JS. The economic value of changing mortality probabilities. *Q J Econ* 1980; **94**: 373–396.

11. Viscusi WK, Evans W. Utility functions that depend on health status: estimates and economic implications. *Am Econ Rev* 1990; **80**: 353–374.

12. Sloan FA, Viscusi WK, Chesson HW *et al*. Alternative approaches to valuing intangible health losses: the evidence of multiple sclerosis. *J Health Econ* 1998; **17**: 475–482.

13. Hammerschmidt T, Zeitler HP, Leidl R. A utility-theoretic approach to the aggregation of willingness to pay measured in decomposed scenarios: development and empirical test. *Health Econ* 2004; **13**(4): 345–361.

14. Jacobi CE, Triemstra M, Rupp I *et al*. Health care utilization among rheumatoid arthritis patients referred to a rheumatology center: unequal needs, unequal care? *Arthritis Rheum* 2001; **45**: 324–330.

15. Jacobi CE, van den Berg B, Boshuizen HC *et al*. Dimension-specific burden of caregiving among partners of rheumatoid arthritis patients. *Rheumatology* 2003; **42**: 1–8.

16. Mitchell RC, Carson RT. *Valuing drinking water risk reductions using the contingent valuation method: a methodological study of risks from THM and Giardia*. Draft Report to the US Environmental Protection Agency, Washington, DC, 1986.

17. Baarsma B. *Monetary Valuation of Environmental Goods: Alternatives to Contingent Valuation*, vol. 302. University of Amsterdam: Amsterdam, 2000.

18. Dolan P. Modelling valuations for EuroQol health states. *Med Care* 1997; **35**(11): 1095–1108.

19. Given CW, Given B, Stommel M *et al*. The caregiver reaction assessment (CRA) for caregivers to persons with chronic physical and mental impairments. *Res Nurs Health* 1992; **15**(4): 271–283.

20. Smits J, Westert GP, Van den Bos GAM. Socio-economic status of very small areas and stroke incidence in the Netherlands. *J Epidemiol Community Health* 2002; **56**: 637–640.

21. Horowitz JK, McConnell KE. A review of WTA/WTP studies. *J Environ Econ Manage* 2002; **44**: 426–447.

22. Eisenberger R, Weber M. Willingness-to-pay and willingness-to-accept for risky and ambiguous lotteries. *J Risk Uncertainty* 1995; **10**: 223–233.

23. Brookshire DS, Coursey DL. Measuring the value of a public good: an empirical comparison of elicitation procedures. *Am Econ Rev* 1987; **77**: 554–566.

24. Brown TC, Gregory R. Why the WTA–WTP disparity matters. *Ecol Econ* 1999; **28**: 323–335.

25. Fischhoff B. Value elicitation: is there anything in there? *Am Psychol* 1991; **46**(8): 835–847.

26. Diener A, O'Brien B, Gafni A. Health care contingent valuation studies: a review and classification of the literature. *Health Econ* 1998; **7**(4): 313–326.

27. Olsen JA, Smith RD. Theory versus practice: a review of 'willingness-to-pay' in health and health care. *Health Econ* 2001; **10**(1): 39–52.

28. Borisova NN, Goodman AC. Measuring the value of time for methadone maintenance clients: willingness to pay, willingness to accept, and the wage rate. *Health Econ* 2003; **12**: 323–334.

29. Kahneman D, Diener E, Schwarz N. *Foundations of Hedonic Psychology: Scientific Perspectives on Enjoyment and Suffering*. Russell Sage Foundation: New York, 1999.

30. Johannesson M, Johansson PO, Kriström B *et al*. Willingness to pay for lipid lowering: a health production function approach. *Appl Econ* 1993; **25**.

31. Yeung RYT, Smith RD, McGhee SM. Willingness to pay and size of health benefit: an integrated model to test for 'sensitivity to scale'. *Health Econ* 2003; **12**: 791–796.