MODELLING HETEROGENEITY AND UNCERTAINTY IN CONTINGENT VALUATION: AN APPLICATION TO THE VALUATION OF INFORMAL CARE

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ABSTRACT

Both the lack of market data and the need to adopt a more holistic approach in the valuation of non-market activities within health care has pointed towards the use of contingent valuation (CV) methods. However, to date, few studies have employed such techniques to value informal care, despite its provision being an important public policy question. We propose an analytical framework that through the use of random parameters models and respondents' certainty scales can incorporate both unobserved and observed heterogeneity in the CV modelling. This is the first CV study of informal care for Scotland (UK) and a £7.68 per hour value is estimated.

Keywords: contingent valuation; uncertainty; heterogeneity; informal care

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I INTRODUCTION

When a market does not exist for the good or service being valued, valuation is often elicited through contingent valuation (CV) surveys. CV has been extensively used in agricultural (Martín-López et al., 2007), environmental (Bateman, 1996; Buckley et al., 2009; Dupont, 2004), transport (Andersson, 2008) and health economics (Bayoumi, 2004; Hanley et al., 2003; Jan and Smith, 2001; Smith and Sach, 2010; van der Star and van den Berg, 2011) to value policy interventions and is recommended by the Treasury for the valuation of quality in the provision of public services (http://www.hm-treasury.gov.uk/).

However, most CV studies ignore the importance of unobserved preference heterogeneity in their modelling, often assuming a common vector of parameters across individuals for the estimation of their WTP function. At the same time, respondents' certainty has started to play a big role in CV, with studies verifying its importance in mitigating problems of hypothetical bias (Blumenschein et al., 2001) or anomalous response patterns (Watson and Ryan, 2007).

In this paper we incorporate individual unobserved and observed heterogeneity and respondent uncertainty into the modelling of an open-ended CV question using a random parameter linear model. The model is utilised to estimate an average monetary value and its determinants for informal care in the UK. A WTA question is applied and modelled where individual heterogeneity and respondent uncertainty enter the WTA function directly. Their effects on the monetary valuations are considered. The results indicate that both have a significant role in modelling informal care values. Furthermore, at the applied level, this is the first CV study

valuing informal care in the UK. This is clearly a crucial policy question with an ever increasing older population.

This paper is organised as follows. Related background literature is presented in the next section, focusing on what informal care is and its impact, valuation of informal care, and modelling unobserved preference heterogeneity and uncertainty, Section III provides information on the methods, outlining the survey development and econometric analysis. The estimation results are presented in Section IV. Section V discusses the results and section VI provides a short conclusion.

II RELATED LITERATURE

II.1 Informal care and its impact

Informal care, or unpaid care as it might be otherwise called, involves the provision of care to ill, disabled, or frail individuals, by non-professionals, free of charge or payment. The relationship between carers and care recipients can range from close relatives to friends and neighbours (Smith and Wright, 1994). Informal care is an economic transfer (Pezzin and Schone, 1999), and constitutes a significant part of non-market economic activity. Early estimates of the total value of informal care in the UK (Laing, 1993; Nuttall et al., 1993) ranged from £34 billion to £39 billion per year, while recent estimates report higher values of £57.4 to £87 billion per year (Buckner and Yeandle, 2007; Carers UK, 2002), figures higher than the annual cost of all aspects of the NHS. [1] Specifically for Scotland, a recent study for the

[1] Audited in 2006/7 as £81.678billion (Department of Health: Departmental Report 2007, The Stationary Office, May 2007).

Scottish Government (APS Group Scotland, 2010) reports that one in eight people are involved in the provision of some form of informal care, with total savings to health and social carer services of about £7.68 billion per year.

Informal care can have heterogeneous health effects on the carers. On the one hand, it is a stressful and burdensome activity, resulting in various serious physical and mental health problems, and associated with lower productivity (Bédard et al., 2004; Buck et al., 1997; Cameron et al., 2006). Studies have reported significant associations between depression, social isolation, loss of privacy, no time for self-care, health and financial problems and care giving (Sawatzky and Fowler-Kerry, 2003; Schulz and Williamson, 1991), while others have found a negative link with subjective well-being (Mentzakis et al., 2011a). However, on the other hand, a clear connection between caregiving and positive health effects has also been established (McMunn et al., 2009), while a number of studies have reported a positive effect of activities like informal care-giving (such as volunteering) on health and non-health utility/happiness (Borgonovi, 2008; Brouwer et al., 2005; Mendes et al., 2003). [2]

II.2 Valuing informal care

Methods proposed to value informal care include opportunity cost (OC), market replacement cost (MRC), contingent valuation (CV) and conjoint analysis (CA) (Liljas, 1998; McDaid, 2001; Mentzakis et al., 2011b; van den Berg et al., 2004), with

[2] Note that if informal care (IC) poses a net cost on carers we would not expect them to provide such care. However, most often IC is provided because of a lack of alternatives to provide such care, and therefore a lack of choice over such provision (i.e. a forced choice) (Cormac and Tihanyi, 2006). Feelings of duty, inevitability, and loyalty have also been found to be important in the provision of IC (Boeije et al., 2003; Simoni and Trifiletti, 2004), as well as family structure and siblings availability (Bolin et al., 2007; Checkovich and Stern, 2002; Heitmueller, 2007). Thus, depending on the level of inclusiveness of outcomes, we could observe individuals providing IC despite potential net costs from such provision.

the most common techniques applied being opportunity cost (OC) and market replacement costs (MRC). Under the former, the value of informal care time is the forgone benefits by the caregiver that arise due to time spent caring. Ideally this implies valuing the carer's time according to the next best activity that the caregiver would take up were they not providing care. Under the MRC method, the value is determined by the wage of a professional caregiver that could be hired to replace the informal caregiver. Typically the MRC is applied using the cost of local authority (public) home care, encompassing a fixed rate that includes salary, on-costs and any elements for travel and overheads (McDaid, 2001).

Table 1 presents a selection of studies utilising either or both of these methods. Over a variety of contexts and countries, studies generated values in the range of £2.22 per hour to £14.47 per hour using the OC method, and £3.65 to £14.50 using the MRC method. Heterogeneity in values is a result of the various components (see Table 1 for details). Given that these approaches are not valuing identical services (the activity valued using MRC is not a perfect substitute for the informal care service that a professional provides), values generated may not be the same. Studies employing both methods have found MRC to result in higher values than the OC method (Dewey et al., 2002; van den Berg et al., 2006).

Shortcomings are associated with both the OC and MRC methods. Regarding OC, identification of leisure and housework as next best activities (Liljas, 1998; McDaid, 2001; Netten, 1993) brings problems, as these activities suffer from similar valuation problems, since they are also activities outside the labour market. This leads to the use of employment as an assumed next best activity, although even here it is still difficult to obtain wage rates for people who are unemployed, retired, disabled and others who do not participate in the labour force (van den Berg et al., 2004). On

the other hand, MRC is based on the assumption of exact substitution between informal caregivers and professional carers, both in terms of quality and efficiency (McDaid, 2001). Further, both methods fail to recognise the interdependent utilities structure between carers and care recipients (van den Berg et al., 2005) and the 'double nature' of informal care provision, entailing both utility and disutility to the caregiver. Thus, both methods fail to capture important components of the valuation.[3]

Another way to value informal care, using market data, would be to model data on actual out-of-pocket individual expenses for services that substitute or complement informal care. However, limited data is available at a household level with nationally representative UK datasets. Given this, the possibility of using market data as a means of valuation through the revealed preferences of households is very limited. [4]

An alternative method to estimate monetary values, in the absence of market data, is contingent valuation (CV). This technique is based on the premise that the maximum amount of money (or minimum compensation) an individual is willing to pay (willing to accept) for a service is an indicator of the utility of that service (Dupuit, 1844). Further, it is argued that, assuming the hypothetical market is well explained to respondents, they will consider all aspects of the good or service when providing a monetary value. The method was introduced into health economics to allow for more holistic approaches to valuation, going beyond health outcomes and

[3] Given the background of each method, the relation between OC and MRC depends on the value chosen for the MRC and the actual wage rate of the carer. From an economic perspective, one could argue that the OC should be higher than MRC, as the informal caregiver would otherwise hire a professional in their place. However, this is not always the case as non-monetary aspects (i.e. health burden of the carer, availability of carers, feelings of duty etc.) enter the informal care decision process.

[4] Exceptions might be the use of subjective well-being functions (Mentzakis et al., 2011a).

therefore valuing attributes that conventional methods omitted (Donaldson et al., 2006). Thus, within the context of informal care, respondents could consider the 'double-nature' of informal care, jointly valuing the positive and negative aspects.

Using CV, monetary values are generated from responses to hypothetical questions where individuals are asked to state the amount of money they are willing-to-pay or willing-to-accept to avoid or accept an event happening to them (for more on CV see (Haab and McConnell, 2002)). Whilst CV has been widely applied in health economics in a wide variety of contexts (for reviews see, (Diener et al., 1998; Klose, 1999; Olsen and Smith, 2001; Ryan et al., 2003)), only three studies (de Meijer et al., 2010; van den Berg et al., 2005; van den Berg et al., 2005) have elicited per hour informal care valuations, all of which are based in The Netherlands. The first two are based on the same data, with the results and the methodology of the first embedded in the second, while the third paper augments the dataset with some previously collected data and performs similar willingness to pay (WTP) analysis. Using dichotomous choice questions with open-ended follow-up, WTP and willingness to accept (WTA) were derived with corresponding values of £5.30 per hour and £6.47 per hour in a sample of 120 carers of rheumatoid arthritis patients (May 2005 rate 1€=£0.683) and £5.85 per hour and £7.15 per hour in a more heterogeneous sample of 450 carers (van den Berg et al., 2005; van den Berg et al., 2005), with close figures also obtained by de Meijer et al. (de Meijer et al., 2010).

II.3 Modelling unobserved preference heterogeneity and uncertainty

Whilst the general literature in marketing (Smith, 1956) and economics (Andersen et al., 2010; Barsky et al., 1997) has advocated the importance of unobserved preference

heterogeneity, most CV applications fail to allow for such heterogeneity (including the three informal care CV studies). In contrast, unobserved preference heterogeneity has featured prominently in the applications of discrete choice experiments (DCEs) to generate monetary values, with latent class and random parameters models often utilized (Greene and Hensher, 2003; Hole, 2008; McFadden and Train, 2000; Mentzakis et al., 2011b). For example, a recent DCE study on informal care valuation that used a latent class model found significantly different behavioral and valuation patterns among the sampled respondents (Mentzakis et al., 2011b). Such flexible models allow for the identification of distinct preferences patterns in the study sample and are more able to accurately represent the variety of opinions or potential valuation within society.

Another important issue that has received attention in stated preferences studies is respondents' (un)certainty. Early critiques of the CV methods (Diamond and Hausman, 1994) discussed the importance of certainty and stability of individual preferences in relation to the reliability and validity of such techniques. As such, uncertainty has been examined in the environmental economics literature (Hanley et al., 2009; Ready et al., 2001) and specifically in relation to elicitation formats, such as the multiple bounded dichotomous choice (Evans et al., 2003; Welsh and Poe, 1998) where it was found that lack of certainty tended to overestimate values. Work incorporating similar information on dichotomous choice formats has also verified the significance of uncertainty and the positive effects of its calibration (Blumenschein et al., 2008; Blumenschein et al., 1998; Johannesson, 1999). Within the health economics literature efforts have mostly been focused on dichotomous choice questions, where accounting for uncertainty was found to mitigate the potential problems arising from the hypothetical nature of the questions (Blumenschein et al.,

2001), while others further reported that more certain individuals were less anomalous in their response patterns (Watson and Ryan, 2007). However, in most cases uncertainty is not modeled as part of the WTP function but rather as an exogenous factor that helps researchers classify the sampled individuals. Thus, one cannot specifically comment on the effects in terms of both magnitude and sign of (un)certainty.

III METHODS

III.1 Survey development and elicitation format

To develop the survey instrument two focus group meetings were initially held with staff from a UK Carers Centre, followed by two pilot surveys directed at small sub-samples of carers. This feasibility work indicated that a WTP question was problematic. Specifically, participants in the focus groups felt asking individuals to pay to avoid providing care was insensitive, potentially resulting in a very low response rates, and/or a high number of protest answers. Similar concerns have been expressed elsewhere (van den Berg et al., 2005). It was thus decided to use the willingness to accept (WTA) approach. For the particular context of informal care, the use of WTA was further justified by a recent study (van den Berg et al., 2005) which had confirmed that WTA and WTP produced similar results. [5] This is not surprising given that IC is provided within a market with particular characteristics (unlike many others often used in experiments). Carers are very familiar with the good valued, they

[5] Significant differences between WTA and WTP valuation have been, however, noted for other valuation contexts (Horowitz and McConnell, 2002).

have a large vested interest in it, they have to make decisions related to IC issues daily (both economic and task related), while at the same time the presence of the professional care market provides enough anchoring for their stated values (Akter et al., 2008).

The open-ended WTA format was used. In general, the OE format avoids common biases present in other formats (i.e. starting point bias, anchoring bias, range bias etc.), while it is very informative and statistically efficient. However, its use in the CV literature is limited as it is believed to be cognitively demanding, potentially leading to protest and zero answers (Bateman et al., 2002). However, with respect to its external validity properties, a recent study (Christie, 2007) found that for those who had actually stated a value there was no difference between hypothetical and actual valuations. A previous study looking at OE WTA questions found that hypothetical open-ended and random n^{th}-price auction resulted in insignificant differences, whereas controlling for individual characteristics hypothetical and actual value were statistically the same (List and Shogren, 2002). A similar study (Nape et al., 2003) looking at the hypothetical bias of WTA questions also found that, controlling for individual characteristics, hypothetical and actual WTA values were not different. Our piloting of the WTA OE questions resulted in very few zero and protest answers further supporting the use of this approach.

Following the OE WTA elicitation question, individuals indicated the certainty with which they stated their WTA. In the psychological literature, numerical scales have been shown to be superior to verbal scales, resulting in less variability within and between subjects (Budescu et al., 1988), thereby enhancing their accuracy(Rapoport et al., 1990). It has also been argued that numerical scales suffer less from problems of subjective interpretation (Weber and Hilton, 1990).

Nevertheless, a recent study showed that both numeric and verbal scales were equally successful in alleviating hypothetical bias problems, while values near 10 appeared to be equivalent to Absolutely Yes (Blomquist et al., 2009).[6] This study used a quantitative 0-10 certainty scale. During the pilot stage no problems with this format were observed, with no participants indicating difficulties in responding. The presentation of the OE WTA question and the certainty response scale are shown in the Appendix.

III.2 Independent variables

In addition to the WTA related questions, respondents provided additional information on a number of factors that informed the regression modelling looking at factors determining WTA values. Investigating such relationships, as well as useful from a policy perspective, allows investigation of the internal validity of responses i.e. whether results move in line with a priori expectations. Table 2 shows the information collected, and the a priori hypotheses. Information was collected on: individual characteristics (age; gender; employment status; marital status; household income); duration of care provision (in years); number of hours per week providing personal and supervisory care; whether in receipt of carer's allowance; impact on health status of providing care (Burden) and relationship with care recipient (caring for partner/spouse or child). Household income was asked per year, before tax and

[6] It should be noted however that both types of certainty scales assume that all respondents interpret such scales in a similar way (i.e. no heterogeneity). Failure of this assumption would require designs which avoid such problems (Hanley et al., 2009) or, at least, some modelling of the potential heterogeneity of uncertainty (as also discussed in the analysis section).

including any benefits or pensions measure. Carer's Allowance is a taxable means tested benefit (about £50.55 per week at the time of the study) paid to those who look after (spending 35+ hours a week) a disabled person. The impact on health status of providing care was estimated as the difference between two health status questions. The first asked respondents: 'Please think back over the last 12 months about how your health has been. Compared to people of your own age, how would you rate your health status on the scale below?' The scale was from 0–10, with 0 representing 'worst possible health status' and 10 'best possible health status'. The second question asked respondent again to think back about their health over the last 12 months, using the same scale, and to state what they believed their health status would have been if they had not been providing care. A 'Burden' variable was constructed from these questions (taking the value of 1 when the difference between the two health status questions, i.e. without informal care minus with informal care, was larger than 3) to capture the perceived burden of providing informal care. Duration was also included as a squared term to allow for non-linear effects. In an effort to mitigate measurement error problems on questions regarding income and number of hours per week providing personal and/or supervisory care (despite attempts to make people aware of such potential overstating in the wording of the question) all three variables were included as dummies. Income took the value of one if stated income was above £10,000 (the cut-off point for the first quartile), whereas for personal care and supervisory care, a value of one was assigned if the individual provided more than 35 hours per week of care (35 hours is the carer's allowance cut-off).

III.3 Survey administration

A total of 1331 carers, residing in Scotland were sent the main questionnaire.[7] Subjects were identified from a central database of carers held by Carers Scotland[8] or from affiliated local organisations. The study protocol, describing data collection methods, study sample and timetable, was reviewed and approved by Carers Scotland prior to data collection.

III.4 Econometric analysis

For the analysis we use a random parameters linear (RPL) regression model which allows for individual heterogeneity (observed and unobserved) (Greene, 2003). The estimated parameters for the covariates are introduced as normally distributed random parameters [9] whose mean is allowed to be a function of respondents' certainty (i.e. heterogeneity based on observables).

$$WTA_i = \exp(\beta'_{k,i} x_{k,i} + \varepsilon_i) \qquad (1)$$

[7] Despite this survey targeting current caregivers, using the Carers Scotland database meant that not all ex-carers contact details had been removed. All in all, 11 ex-carers returned the questionnaire, with 10 almost empty and only 1 providing usable information. Hence, ex-carer cannot be used as control in the estimated equation.

[8] Carers Scotland is an organisation mainly involved with the representation of the carers' community and the protection of their rights, as well as the provision of direct support, help and information (www.carerscotland.org).

[9] Normally distributed random parameters are preferred as they provide support for both sides of the distribution (i.e. positive and negative), which is preferable given that the effects of the covariates vary at the individual level, and a priori expectations for their signs relate to the overall effect and are to be tested.

where $\beta_{k,i} = \beta_k{}^0 + \delta_k z_i + v_{k,i}$ (2)

x_k are the covariates entering the model [10] and i are the individuals. $\beta_k{}^0$ is the effect of the mean of the distribution of the random parameter, δ_k is the estimated effect of heterogeneity affecting the mean of the distribution and z_i is the heterogeneity introduced in the mean, in our case the respondents' certainty. In this way certainty directly influences the effects of the covariates on WTA. $v_{k,i}$ is a normally distributed random term (i.e. all of our random parameters enter the model as normally distributed), while ε_i, is a log-normally distributed error term. Estimation is performed through maximum simulated likelihood with 1000 Halton draws for the simulation. [11] Halton draws have been shown to be more efficient that random draws reducing significantly the total number of draws required (Bhat, 2001). [12]

Having obtained a mean and a standard deviation (σ_k) for each of the random parameters total effects ($\beta_k{}^0 + \delta_k \cdot Z + \sigma_{k,i} \cdot N$) are calculated for a simulated sample of 10,000 individuals where *Z* is simulated from the empirical distribution of certainty (Martinez and Martinez, 2008) and *N* is normally distributed with a mean of zero and a standard deviation of one (Hensher et al., 2005). Such total effects (TE) have the advantage that they allow for out of sample inference and they show the total effect a

[10] The constant is entered as a random parameter (i.e. a random intercept model).

[11] While random effects linear model (i.e. random intercept) are commonly fit by GLS, the integral of a random parameters model is unlikely to have a closed form and hence simulation methods are required (Greene, 2007).

[12] All estimations are performed in LIMDEP v9.0, Econometric Software, Inc.

covariate has on the WTA. Note that the sign and size of TEs can be different from the estimated mean effect, β_k^0, as the influence of observed (i.e. certainty) and unobserved heterogeneity (as captured by the S.D.s) is incorporated in the calculations. Furthermore, following the model estimation a mean WTA value is predicted and a standard error is obtained by bootstrapping (250 replications), while corrections for non-normality when transforming log(WTA) to natural units, £, are also taken into account (Duan, 1983).

IV RESULTS

IV.1 Sample characteristics

270 questionnaires were returned, resulting in a response rate of 20%. However, 24 were not completed as individuals were no longer carers and a further 32 contained missing items. Thus, 214 respondents provided data for analysis and descriptive statistics for the estimation sample are presented in Table 3. The mean age of carers was 57 years, with more than 71% being 50+. Carers had been providing care for an average period of 14 years, with variation between a few months to a few decades. Almost half the sample provided more than 35 hours per week of personal care, while around 65% gave the same number of hours supervising. 78% of respondents care for a partner/spouse or child, 42% stated receipt of carer's allowance and more than half reported major health deterioration due to caring (i.e. burden). Despite our low response rate, on some characteristics our sample population is comparable to those from the nationally (Scotland) representative sample of carers from the BHPS (a commonly used micro-panel dataset, representative of the UK).

With respect to certainty, the distribution is skewed slightly to the right with increased frequencies for levels 5, 8 and 10 and an average respondents' certainty of 6.5 (Table 4). Looking at the raw WTA values, the mean is about £8.5 with the maximum stated value being £30, while mean WTA values are comparable across most certainty levels.[13]

IV.2 Regression results

Table 5 presents the regression results. Similar to standard log-linear regression, coefficients are interpreted as percentage changes in WTA following a unitary change in the continuous covariates or a discrete change in binary covariates. [14] In general, we find the flexibility of the model and its allowance for individual heterogeneity to be of importance with both the estimated standard deviations (unobservable heterogeneity) and the heterogeneity estimated parameters (heterogeneity based on certainty) being highly statistically significant. For instance, looking at the estimated coefficients related to age (Table 3), the mean effect of age [15] is a 0.97% increase in WTA which, however, has a large (almost two thirds of the effect, σ_{Age} = 0.62%) and significant variability across individuals, while the average effect of certainty is a decrease in WTA of about 1.6% [16] implying that increasing certainty for a given age

[13] Running a regression of the WTA against the certainty levels and a constant reveals that only certainty level 2, 4, 6 and 8 are significantly different from the base (i.e. level 0).

[14] Rather than the coefficient, it is the coefficient times 100 that is to be interpreted.

[15] The fixed mean effect is comparable to the standard linear regression coefficients.

[16] For exposition, the effect of certainty is taken as $\delta_k \bar{z}_i$ (see eq. 2), where $\bar{z}_i$ is the sample average certainty at 6.49.

reduces the compensation required. Similar patterns are observed for all covariates, with the resulting TE often being of opposite sign to the initial mean effect.

Looking at heterogeneity based on certainty, all demographic characteristics (with the exception of gender) reduce the requested WTA, while the opposite is observed for the caregiving relating covariates (with the exception of carer's allowance receipt). In terms of magnitude, taken at the sample average certainty, the effects of age, gender, employed, married, burden and relation seem to exceed the mean effect of the corresponding covariate, while in absolute values carer's allowance, income, relation and burden display the largest influences.

Similarly, the model detects highly significant unobserved heterogeneity (based on the S.D. of random parameters), implying large variability in the mean effect that each covariate places on the WTA. As discussed previously, SD for age is about two thirds of its mean, while that of income is about one half (0.15 vs. 0.34). Such significant spread of the distributions is a clear indication of the distinct individual preferences within the sample and a caution against depicting such preferences by simple mean effects.

Turning to TE, WTA decreased by about 1% for every extra year of age, while females require 2% higher compensation relative to males. Being employed or married decreases WTA by 11%, 5% and 1%, respectively. On the other hand, having household income of more than £10,000 decreases WTA by 3.7%. Turning to the characteristics related to caregiving, an increase of about 2% is reported for every extra year of duration although the effect changes sign as the years increase. Provision of more than 35 hours per week of personal care increases WTA by 23%, while a 9.4% reduction is observed for the same amount of supervision. Finally, those who already receive Carer's allowance, report a health burden from caregiving, or those

who care for a partner or child, require an increase in the required compensation of 6.6%, 4.8% and 6.8%, respectively. Finally, the predicted mean hourly figure from the estimation, shown in Table 3, is around £7.68 with a 95% confidence interval between £7.19 and £8.17.

V DISCUSSION

Both the lack of market data and the need to adopt a more holistic approach in the valuation of non-market activities within health care has pointed towards the use of CV methods. However, to date, few studies have employed such techniques to value informal care, despite its provision being an important public policy question. To our knowledge this is the first CV study valuing informal care in Scotland. At the same time, little attention has been paid in the CV literature to issues of unobserved preference heterogeneity. Here we propose an analytical framework that through the use of random parameters models and certainty scales can incorporate both unobserved and observed heterogeneity in the CV modelling.

Our results indicate that ignoring heterogeneity and assuming that preferences and valuations can be accurately depicted only by the mean effect of the covariates may be misleading. [17] All random parameters had highly significant SD estimated parameters, revealing an important dispersion around the means of the random parameters. Similar findings were obtained by Mentzakis et al. (Mentzakis et al.,

[17] It should, however, be noted that for this particular application the estimated IC values obtained from a simple OLS model are largely comparable (i.e. £8.36) with the RPL results. Nevertheless, this is likely an artefact of our dataset (i.e. similar stated WTAs across the certainty distribution) and not a result of the proposed methodology.

2011b) when examining preference and value heterogeneity in informal care using a discrete choice experiment. Translating such findings into policy implications is challenging since value discrimination and segmentation of the markets would be required. What can, however, be taken from the consistency with which such results appear is the need to incorporate values that are more closely related to individual based preferences in the economic evaluations of health care interventions.

Of similar importance are the findings regarding the effects of certainty (such effects could also be termed as heterogeneity based on observables). It is apparent from the estimated coefficients that certainty can explain a significant portion of the heterogeneity observed around the mean of the parameters and can exert sizeable influence that can potentially change the sign of the covariate. Interestingly, we find that higher certainty associated with the demographic characteristics decreases WTA, something that was also observed in past studies where it was found that lack of certainty resulted in overestimations (Blumenschein et al., 2001; Evans et al., 2003; Welsh and Poe, 1998). On the contrary, certainty in relation to the characteristics of the informal care situation (e.g. providing more than 35 hours per week, higher burden, close relation to the recipient) tends to increase the requested compensation. This suggests that informal care is something burdensome, and individuals should be compensated for providing it. The fact that certainty in relation to receipt of carer's allowance reduces such WTA requests could potentially be further evidence for this.

What is important to note is the synergetic effects that both types of heterogeneity (unobserved and observed) estimations reveal. For the total effects, about half the signs are opposite to the mean effect, while significant differences are further observed in the sizes. This suggests a misreporting of both direction and magnitude of traditional estimation methods.

Despite potential concerns in using WTA (i.e. respondents do not face an income constraint, unlike WTP where the respondent has to consider ability to pay); the approach seemed to work well in the current study, with minimal extreme WTA values both in the pilot and the main survey. Nevertheless, for applications where use of WTP questions is not contextually problematic and where pilot work cannot verify the validity of WTA and OE formats, the use of a binary response formats and WTP questions are recommended to ensure incentive compatibility (Carson and Groves, 2007). Further confirmation on the validity of both the OE and WTA formats for our study comes from the theoretical validity of the obtained effects, as well as, from the relative proximity of the monetary values to the past CV studies (convergent validity).

In particular, we find that increasing age reduces required compensation which is in line with our a priori hypothesis. This could be a result of lower opportunity cost amongst older people (bearing in mind that our mean sample age is 57 years old). We also find an increased opportunity cost for the employed (Carmichael and Charles, 2003), as indicated by the employed mean effect coefficient. However, the latter effect is mitigated by the large effect of respondents' uncertainty and variability in responses, leading to negative total effects. The positive effects of income (also confirming our hypothesis) may be a result of the higher opportunity cost that the carers on higher incomes are faced with. That is, the opportunity cost of time is expected to increase with income (White-Means, 1992). A similar finding was reported by Mentzakis et al. (Mentzakis et al., 2009). Those with higher incomes are more likely to be involved in higher paying activities and therefore require higher compensations to provide an hour of care. Furthermore, in common with other studies (de Meijer et al., 2010), we find that females tend to state higher WTA values than men. This could potentially reflect an attempt of older females (76% females in the

sample) to compensate for the reduced earnings as a results of caregiving (Carmichael and Charles, 2003).

Our results have also shown that a prolonged period of provision and increased hours of personal care leads to higher valuation, while the opposite holds for supervising partially confirming our initial hypotheses. Whilst the explanation for duration is straight forward and similar to past studies (de Meijer et al., 2010), we also observe an adaptation effect (Groot, 2000) where 'chronic' caregivers tend to reduce the needed compensation. On the other hand, the difficulty in performing each task is a plausible explanation for the difference between care tasks. Personal care requires constant physical contact and direct interaction, with higher chances to cause strain and health problems for the carer. On the other hand, supervising is notably less demanding, and mostly requires social interaction with the care recipient, allowing for participation in parallel tasks and activities. A complementary explanation would be related to the process utility that has been reported in past studies (Brouwer et al., 2005). That is, carers derive utility from their caring role. It is more likely that this utility is present during the easier tasks, through ability to engage in other activities whilst supervising.

Finally, individuals reporting a higher burden from caring request higher compensations, something that was also observed elsewhere (van den Berg et al., 2005). Despite its intuitive explanation, what is more interesting is the behaviour of those receiving the carer's allowance, who also request higher compensations. Since carer's allowance is dependent on the financial status of the carer as well as on the number of hours they provide, as we had hypothesised earlier, it is possible that carer's allowance serves as a proxy for poverty (low income) or heavy commitment and burden. On the other hand, sample statistics show that only 42% of the carers

actually receive the allowance, while the percentages of those who report providing large number of hours and suffering heavily from the provision are much higher. This could imply the possibility of either a significant barrier in access to allowance, or carers tend to overstate their contributions. Further research would be valuable to investigate these hypotheses.

Turning our attention to the mean WTA values, hourly compensation required is estimated as £7.68. Previous informal care valuations studies in the Netherlands have reported similar albeit slightly lower mean sample values ranging from about £6 to £7 per hour (de Meijer et al., 2010; van den Berg et al., 2005). The closeness of the values is perhaps surprising given the use of different elicitation formats (open-ended versus dichotomous choice questions with an open-ended follow-up) and the use of different estimation methods. On the other hand, our WTA values seem to be lower than opportunity cost and market replacement cost studies for the UK (Buckner and Yeandle, 2007; Carers UK, 2002; McCrone et al., 2003) (with the exception of (Nuttall et al., 1993)).

The estimation and convergent validity of such values are indeed an important first step for their incorporation in economic evaluations. However, following Kaldor Hicks, actual provision of such compensations is not necessary. Nevertheless, there is evidence that individuals would value financial compensation as it would make them feel appreciated (Ellins et al., 2012; Fry et al., 2011). The importance of carer recognition has also been recognised from a theoretical perspective, with the importance of "doulia rights", where carers have the right not to be impoverished from the provision of care and should therefore be compensated financially for the care provided (Arksey and Moree, 2008). From an economic perspective the question then arises of if we provided payments to informal carers, would the act of paying

crowd out the caring motivation? [18] A number of points are worth noting here. Firstly, IC is not a purely voluntary activity (as noted above) (Cormac and Tihanyi, 2006) and hence the potential crowding out effect may be largely mitigated. Secondly, at the more general level, the literature suggests that the crowding-out effect is not always present. Mellstrom and Johannesson (Mellstrom and Johannesson, 2008) testing for crowding-out in blood donations, failed to find a statistically significant effect (although there was a gender effect). Further, reviewing the crowding out literature, Gneezy et al (Gneezy et al., 2011) stylise their argument as "Pay enough or don't pay at all" (also the title of a paper by Gneeze and Rustichini QJE, 2000), arguing that "for most tasks, if incentives are large enough, their direct price effect will be larger than the crowding out effect in the short run" (i.e. while the incentive is in place).

VI CONCLUSION

This study shows the potential of contingent valuation methods in valuing informal care and the advantages of flexible estimation models that capture individual heterogeneity (both unobserved and observed). Ignoring variability of preferences and respondent's certainty can lead to misreporting of effects not only in terms of over/under-estimation but even in terms of direction. Although the predicted WTA values are relatively close to those reported in similar CV studies, less proximity is observed with more traditional methods, such as opportunity and replacement costs, providing further evidence for a more holistic treatment of informal care valuation. However, our small sample, together with the low response rate (although not uncommon for general population mail surveys) limit generalisablility and therefore

[18] We thank a reviewer for raising this point.

caution is required in drawing inferences from our results, suggesting the need for further confirmatory research.

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REFERENCES

Akter, S., Bennett, J., and Akhter, S. (2008). Preference uncertainty in contingent valuation. *Ecological Economics*, 67, **3,** pp. 345-351.

Andersen, S., Harrison, G. W., Lau, M. I., and Rutström, E. E. (2010). Preference heterogeneity in experiments: Comparing the field and laboratory. *Journal of Economic Behavior & Organization*, 73, **2,** pp. 209-224.

Andersson, H. (2008). Willingness to pay for car safety: Evidence from sweden. *Environmental & Resource Economics*, 41, **4,** pp. 579-594.

APS Group Scotland. (2010). Caring together: The carers strategy for scotland 2010 - 2015. DPPAS 10110.

Arksey, H. and Moree, M. (2008). Supporting working carers: Do policies in england and the netherlands reflect "doulia rights"? *Health & Social Care in the Community*, 16, **6,** pp. 649-657.

Barsky, R. B., Kimball, M. S., Thomas Juster, F., and Shapiro, M. D. (1997). Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement survey. NBER Working Papers 5213.

Bateman, I., Carson, R. T., Day, B., et al. (2002). Economic valuation with stated preferences techniques: A manual. Cheltenham, UK: Edward Elgar.

Bateman, I. J. (1996). Household willingness to pay and farmers' willingness to accept compensation for establishing a recreational woodland. *Journal of Environmental Planning and Management*, 39, **1,** pp. 21-44.

Bayoumi, A. M. (2004). The measurement of contingent valuation for health economics. *PharmacoEconomics*, 22, **11,** pp. 691-700.

Bédard, M., Koivuranta, A., and Stuckey, A. (2004). Health impact on caregivers of providing informal care to a cognitively impaired older adult: Rural versus urban settings. *Canadian journal of rural medicine : the official journal of the Society of Rural Physicians of Canada*, 9, **1,** pp. 15-23.

Bhat, C. R. (2001). Quasi-random maximum simulated likelihood estimation of the mixed multinomial logit model. *Transportation Research Part B: Methodological*, 35, **7,** pp. 677-693.

Blomquist, G., Blumenschein, K., and Johannesson, M. (2009). Eliciting willingness to pay without bias using follow-up certainty statements: Comparisons between Probably/Definitely and a 10-point certainty scale. *Environmental & Resource Economics*, 43, **4,** pp. 473-502.

Blumenschein, K., Blomquist, G. C., Johannesson, M., Horn, N., and Freeman, P. (2008). Eliciting willingness to pay without bias: Evidence from a field experiment. *Economic Journal*, 118, **525,** pp. 114-137.

Blumenschein, K., Johannesson, M., Blomquist, G. C., Liljas, B., and Richard M. O'Conor. (1998). Experimental results on expressed certainty and hypothetical bias in contingent valuation. *Southern Economic Journal*, 65, **1,** pp. 169-177.

Blumenschein, K., Johannesson, M., Yokoyama, K. K., and Freeman, P. R. (2001). Hypothetical versus real willingness to pay in the health care sector: Results from a field experiment. *Journal of Health Economics*, 20, **3,** pp. 441-457.

Boeije, H. R., Duijnstee, M. S. H., and Grypdonck, M. H. F. (2003). Continuation of caregiving among partners who give total care to spouses with multiple sclerosis. *Health and Social Care in the Community*, 11, **3,** pp. 242-252.

Bolin, K., Lindgren, B., and Lundborg, P. (2007). Informal and formal care among single-living elderly in europe. *Health Economics*, 17, **3,** pp. 393-409.

Borgonovi, F. (2008). Doing well by doing good. the relationship between formal volunteering and self-reported health and happiness. *Social science & medicine*, 66, **11,** pp. 2321-2334.

Brouwer, W. B. F., VanExel, N. J. A., VanDenBerg, B., VanDenBos, G. A. M., and Koopmanschap, M. A. (2005). Process utility from providing informal care: The benefit of caring. *Health Policy*, 74, **1,** pp. 85-99.

Buck, D., Gregson, B. A., Bamford, C. H., Mcnamee, P., Farrow, G. N., Bond, J., et al. (1997). Psychological distress among informal supporters of frail older people at home and in institutions. *International Journal of Geriatric Psychiatry*, 12, **7,** pp. 737-744.

Buckley, C., van Rensburg, T. M., and Hynes, S. (2009). Recreational demand for farm commonage in ireland: A contingent valuation assessment. *Land Use Policy*, 26, **3,** pp. 846-854.

Buckner, L. and Yeandle, S. (2007). Valuing carers – calculating the value of unpaid care.

Budescu, D. V., Weinberg, S., and Wallsten, T. S. (1988). Decisions based on numerically and verbally expressed uncertainties. *Journal of Experimental Psychology: Human Perception and Performance*, 14, **2,** pp. 281-294.

Cameron, J. I., Cheung, A. M., Streiner, D. L., Coyte, P. C., and Stewart, D. E. (2006). Stroke survivors' behavioral and psychologic symptoms are associated with informal caregivers' experiences of depression. *Archives of Physical Medicine and Rehabilitation*, 87, **2,** pp. 177-183.

Carers UK. (2002). Without us...? calculating the value of carers' support.

Carmichael, F. and Charles, S. (2003). The opportunity costs of informal care: Does gender matter? *Journal of Health Economics*, 22, **5,** pp. 781-803.

Carson, R. and Groves, T. (2007). Incentive and informational properties of preference questions. *Environmental and Resource Economics.* 37(1), 181-210.

Checkovich, T. J. and Stern, S. (2002). Shared caregiving responsibilities of adult siblings with elderly parents. *Journal of Human Resources*, 37, **3,** pp. 441-478.

Christie, M. (2007). An examination of the disparity between hypothetical and actual willingness to pay using the contingent valuation method: The case of red kite conservation in the united kingdom. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 55, **2,** pp. 159-169.

Cormac, I. and Tihanyi, P. (2006). Meeting the mental and physical healthcare needs of carers. *Advances in Psychiatric Treatment*, 12, **3,** pp. 162-172.

de Meijer, C., Brouwer, W., Koopmanschap, M., van, d. B., and van Exel, J. (2010). The value of informal care - a further investigation of the feasibility of contingent valuation in informal caregivers. *Health economics*, 19, **7,** pp. 755-771.

Dewey, H. M., Thrift, A. G., Mihalopoulos, C., Carter, R., Macdonell, R. A. L., McNeil, J. J., et al. (2002). Informal care for stroke survivors: Results from the north east melbourne stroke incidence study (NEMESIS). *Stroke*, 33, **4,** pp. 1028-1033.

Diamond, P. A. and Hausman, J. A. (1994). Contingent valuation: Is some number better than no number? *Journal of Economic Perspectives*, 8, **4,** pp. 45-64.

Diener, A., O'Brien, B., and Gafni, A. (1998). Health care contingent valuation studies: A review and classification of the literature. *Health Economics*, 7, **4,** pp. 313-326.

Donaldson C, Mason H, Shackley P. Contingent valuation in health care. In: Jones AM, ed. *The Elgar Companion to Health Economics.* Cheltenham, UK, Edward Elgar; 2006:392-404.

Duan, N. (1983). Smearing estimate: A nonparametric retransformation method. *Journal of the American Statistical Association*, 78, **383,** pp. 605-610.

Dupont, D. P. (2004). Do children matter? an examination of gender differences in environmental valuation. *Ecological Economics*, 49, **3,** pp. 273-286.

Dupuit, J. (1844). On the measurement of the utility of public works. *Annales des ponts et chaussées*, .

Ellins, J., Glasby, J., Tanner, D., McIver, S., Davidson, D., Littlechild, R., et al. (2012). Understanding and improving transitions of older people: A user and carer centred approach. Final report.

Ettner, S. L. (1996). The opportunity costs of elder care. *Journal of Human Resources*, 31, **1,** pp. 189-205.

Evans, M. F., Flores, N. E., and Boyle, K. J. (2003). Multiple-bounded uncertainty choice data as probabilistic intentions. *Land Economics*, 79, **4,** pp. 549-560.

Fry, G., Singleton, B., Yeandle, S., and Buckner, L. (2011). Developing a clearer understanding of the Carer's allowance claimant group. Department for Work and Pensions - Research Report No 739.

Gneezy, U., Meier, S., and Pedro Rey-Biel. (2011). When and why incentives (don't) work to modify behavior. *Journal of Economic Perspectives*, 25, **4,** pp. 191-210.

Greene, W. H. (2003). Econometric analysis. Upper Saddle River, NJ: Prentice Hall.

Greene, W. H. (2007). Limdep v9.0 - econometric modeling guide, vol 1. New York: Econometric Software, Inc.

Greene, W. H. and Hensher, D. A. (2003). A latent class model for discrete choice analysis: Contrasts with mixed logit. *Transportation Research Part B: Methodological*, 37, **8,** pp. 681-698.

Groot, W. (2000). Adaptation and scale of reference bias in self-assessments of quality of life. *Journal of Health Economics*, 19, **3,** pp. 403-420.

Haab, T. C. and McConnell, K. E. (2002). Valuing environmental and natural resources: The econometrics of non-market valuation. Cheltenham, UK: Edward Elgar.

Hanley, N., Ryan, M., and Wright, R. (2003). Estimating the monetary value of health care: Lessons from environmental economics. *Health Economics*, 12, **1,** pp. 3-16.

Hanley, N., Bengt Kriström, and Shogren, J. F. (2009). Coherent arbitrariness: On value uncertainty for environmental goods. *Land Economics*, 85, **1,** pp. 41-50.

Heitmueller, A. (2007). The chicken or the egg? endogeneity in labor market participation of informal carers in england. *Journal of health economics*, 26, **3,** pp. 536-559.

Hensher, D. A., Rose, J. M., Greene, W. H. (2005). Applied choice analysis: A primer. Cambridge, UK: Cambridge University Press.

Hole, A. R. (2008). Modelling heterogeneity in patients' preferences for the attributes of a general practitioner appointment. *Journal of Health Economics*, 27, **4,** pp. 1078-1094.
Horowitz, J. K. and McConnell, K. E. (2002). A review of WTA/WTP studies. *Journal of Environmental Economics and Management*, 44, **3,** pp. 426-447.
Jan, A. O. and Smith, R. D. (2001). Theory versus practice: A review of 'willingness-to-pay' in health and health care. *Health economics*, 10, **1,** pp. 39-52.
Johannesson, M. (1999). Calibrating hypothetical willingness to pay responses. *Journal of Risk and Uncertainty*, 18, **1,** pp. 21-32.
Klose, T. (1999). The contingent valuation method in health care. *Health Policy*, 47, **2,** pp. 97-123.
Laing W. Who pays for long-term care in the UK? In: Anonymous *Financing Long-Term Care*, Age Concern England; 1993:.
Liljas, B. (1998). How to calculate indirect costs in economic evaluations. *PharmacoEconomics*, 13, **1 PART I,** pp. 1-7.
List, J. and Shogren, J. (2002). Calibration of willingness-to-accept. (0054).
Martinez, W. L. and Martinez, A. R. (2008). Computational statistics handbook with MATLAB. Boca Raton, FL: Chapman & Hall/CRC.
Martín-López, B., Montes, C., and Benayas, J. (2007). The non-economic motives behind the willingness to pay for biodiversity conservation. *Biological Conservation*, 139, **1-2,** pp. 67-82.
McCrone, P., Darbishire, L., Ridsdale, L., and Seed, P. (2003). The economic cost of chronic fatigue and chronic syndrome in UK primary care. *Psychological Medicine*, 33, **2,** pp. 253-261.
McDaid, D. (2001). Estimating the costs of informal care for people with alzheimer's disease: Methodological and practical challenges. *International Journal of Geriatric Psychiatry*, 16, **4,** pp. 400-405.
McFadden, D. and Train, K. (2000). Mixed MNL models for discrete response. *Journal of Applied Econometrics*, 15, **5,** pp. 447-470.
McMunn, A., Nazroo, J., Wahrendorf, M., Breeze, E., and Zaninotto, P. (2009). Participation in socially-productive activities, reciprocity and wellbeing in later life: Baseline results in england. *Ageing & Society*, 29, **05,** pp. 765-782.
Mellstrom, C. and Johannesson, M. (2008). Crowding out in blood donation: Was titmuss right? *Journal of the European Economic Association*, 6, **4,** pp. 845-863.
Mendes, d. L., Glass, T. A., and Berkman, L. F. (2003). Social engagement and disability in a community population of older adults. *American Journal of Epidemiology*, 157, **7,** pp. 633-642.
Mentzakis, E., McNamee, P., and Ryan, M. (2009). Who cares and how much: Exploring the determinants of co-residential informal care. *Review of Economics of the Household*, 7, **3,** pp. 283-303.
Mentzakis, E., McNamee, P., Ryan, M., and Sutton, M. (2011a). Valuing informal care experience: Does choice of measure matter? *Social Indicators Research*, pp. 1-16; 16.
Mentzakis, E., Ryan, M., and McNamee, P. (2011b). Using discrete choice experiments to value informal care tasks: Exploring preference heterogeneity. *Health economics*, 20, **8,** pp. 930-944.
Nape, S., Frykblom, P., Harrison, G. W., and Lesley, J. C. (2003). Hypothetical bias and willingness to accept. *Economics Letters*, 78, **3,** pp. 423-430.
Netten A. Costing informal care. In: Netten A and Beecham J, eds. *Costing Community Care: Theory & Practice*. Hants, England, Ashgate Publishing Ltd; 1993:43-12.
Nuttall, S., Blackwood, l., Bussell, B., Cliff, J., Cornall, J., Cowley, A., et al. (1993). Financing long-term care in britain. *Journal of the Institute of Actuaries*, 121, **1,** pp. 1-68.
Olsen, J. A. and Smith, R. D. (2001). Theory versus practice: A review of 'willingness-to-pay' in health and health care. *Health Economics*, 10, **1,** pp. 39-52.
Pezzin, L. E. and Schone, B. S. (1999). Intergenerational household formation, female labor supply and informal caregiving: A bargaining approach. *Journal of Human Resources*, 34, **3,** pp. 475-503.
Rapoport, A., Wallsten, T. S., Erev, I., and Cohen, B. L. (1990). Revision of opinion with verbally and numerically expressed uncertainties. *Acta Psychologica*, 74, **1,** pp. 61-79.
Ready, R. C., Navrud, S., and Dubourg, R. R. (2001). How do respondents with uncertain willingness to pay answer contingent valuation questions? *Land Economics*, 77, **3,** pp. 315-326.
Ryan, M., Watson, V., and Amaya-Amaya, M. (2003). Methodological issues in the monetary valuation of benefits in healthcare. *Expert Review of Pharmacoeconomics and Outcomes Research*, 3, **6,** pp. 717-727.
Sawatzky, J. E. and Fowler-Kerry, S. (2003). Impact of caregiving: Listening to the voice of informal caregivers. *Journal of Psychiatric and Mental Health Nursing*, 10, **3,** pp. 277-286.
Schulz, R. and Williamson, G. M. (1991). A 2-year longitudinal study of depression among alzheimer's caregivers. *Psychology and aging*, 6, **4,** pp. 569-578.

Simoni, S. and Trifiletti, R. (2004). Caregiving in transition in southern europe: Neither complete altruists nor free-riders. *Social Policy and Administration*, 38, **6,** pp. 678-705.

Smith, K. and Wright, K. (1994). Informal care and economic appraisal: A discussion of possible methodological approaches. *Health economics*, 3, **3,** pp. 137-148.

Smith, R. D. and Sach, T. H. (2010). Contingent valuation: What needs to be done? *Health Economics, Policy and Law*, 5, **01,** pp. 91-111.

Smith, W. R. (1956). Product differentiation and market segmentation as alternative marketing strategies. *The Journal of Marketing*, 21, **1,** pp. 3-8.

van den Berg, B., Brouwer, W., VanExel, J., Koopmanschap, M., VanDenBos, G. A. M., and Rutten, F. (2006). Economic valuation of informal care: Lessons from the application of the opportunity costs and proxy good methods. *Social Science and Medicine*, 62, **4,** pp. 835-845.

van den Berg, B., Bleichrodt, H., and Eeckhoudt, L. (2005). The economic value of informal care: A study of informal caregivers' and patients' willingness to pay and willingness to accept for informal care. *Health economics*, 14, **4,** pp. 363-376.

van den Berg, B., Brouwer, W. B. F., and Koopmanschap, M. A. (2004). Economic valuation of informal care: An overview of methods and applications. *European Journal of Health Economics*, 5, **1,** pp. 36-45.

van den Berg, B., Brouwer, W., van Exel, J., and Koopmanschap, M. (2005). Economic valuation of informal care: The contingent valuation method applied to informal caregiving. *Health economics*, 14, **2,** pp. 169-183.

van der Star, S. M. and van den Berg, B. (2011). Individual responsibility and health-risk behaviour: A contingent valuation study from the ex ante societal perspective. *Health Policy*, 101, **3,** pp. 300-311.

Watson, V. and Ryan, M. (2007). Exploring preference anomalies in double bounded contingent valuation. *Journal of Health Economics*, 26, **3,** pp. 463-482.

Weber, E. U. and Hilton, D. J. (1990). Contextual effects in the interpretations of probability words: Perceived base rate and severity of events. *Journal of Experimental Psychology: Human Perception and Performance*, 16, **4,** pp. 781-789.

Welsh, M. P. and Poe, G. L. (1998). Elicitation effects in contingent valuation: Comparisons to a multiple bounded discrete choice approach. *Journal of Environmental Economics and Management*, 36, **2,** pp. 170-185.

White-Means, S. I. (1992). Allocation of labor to informal home health production: Health care for frail elderly, if time permits. *Journal of Consumer Affairs*, 26, **1,** pp. 69-89.

Table 1. Opportunity cost and market replacement cost empirical results (figures are given in £ per hour)

	Country	Opportunity cost (£) (OC)	Context	OC by	Market replacement cost (£) (MRC)	MRC by
Andersson et al., 2003	Sweden	12.46 and 6.00	Advanced home care	Hourly gross salary and leisure (i.e. hourly net salary)		
Bachynsky et al., 2000	Canada		Alzheimer's		7.90	Wage rate of home care
Buckner and Yeandle, 2007	UK		Generic		14.50	Cost per hour of providing home care to an adult
Carers UK, 2002	UK		Generic		9.95	Average between homecare in independent sector and median cost of local authority homecare
Dewey et al., 2002	Australia	2.22	Stroke survivors	Leisure (i.e. 1/3 of wage rate)	4.24 and 5.1	Wage rate of unqualified healthcare workers; wage rate of nursing employees at level 2.
Gitlin et al., 2010	USA		Dementia		6.63	Wage rate of home health aid
Iskedjian et al., 2003	Canada	5.58 and 6.62	Parkinson's	Mean of 3 wage rates (i.e. minimum wage; average Canadian industrial wage; average hourly nursing wage) and average industrial wage		
Jonsson et al., 2006	Sweden	14.57 and 2.08	Alzheimer's	Average hourly salary and leisure		
Laing, 1993			Generic		7.00	Wage rate for home helps/home care workers
Langa et al., 2001	USA		Dementia		4.48	Wage rate for home health aide
Leon et al., 1998	USA		Alzheimer's		3.65 and 4.17	Wage rate for home health aide and personal care attendant; Wage rate for homemaker
Liu et al., 2002	UK	8.32 and 5.73	Coronary heart disease	Economically active (i.e. average net wage rate) and inactive (i.e. average net wage rate for caring services) carers		
Marin et al., 2003	USA		Alzheimer's		10.04	Wage rate for nurse's aide
Maud et al. 2008	Netherlands		Alzheimer's		6.26	Wage rate of middle aged cleaning person
McCrone et al., 2003	UK		Chronic fatigue		11.00	Wage rate of home care worker
Nuttall et al., 1993	UK		Generic		7.00	Wage rate of basic formal care
Schneider et al., 2003	UK		Dementia		3.60 and 10.30	Unskilled (i.e. national minimum wage) and skilled (i.e. wage rate for home care) tasks
van den Berg et al., 2006	Netherlands	7.2 and 11.80	Rheumatoid arthritis		9.19 and 13.8	Mixture of tasks (ADL = 5.80 and IADL= 22.22)

Wilson et al., 2005	USA		HIV and other chronic illnesses		12.39, 7.97, 5.10, 5.91, 4.38, 4.45, 4.87	By type of care: registered nurse, licensed prof. nurse, nurse's aide, non-nursing health aide, maid, welfare service aide, child-care worker
Wilson et al., 2009	UK	13.11	Dementia	Gross average wage rate		

Table 2. Variable definitions and a priori hypotheses

		A priori hypotheses
Age	Age of respondent	Elder carers are expected to have lower opportunity cost hence lower WTA (Ettner, 1996)
Gender	Dummy variable indicating if individual is female	Females are expected to have lower opportunity cost hence lower WTA (Carmichael and Charles, 2003)
Employed	Dummy variable indicating if individual is full-time employed	Employed have higher opportunity cost hence higher WTA (Carmichael and Charles, 2003),
Married	Dummy variable indicating if individual is married	No a priori expectation
Household Income	Dummy variable indicating if individual's annual household income is greater than £10000	Higher income likely indicates higher opportunity cost hence higher WTA (Mentzakis et al., 2009).
Duration	Number of years providing informal care	Longer duration could imply higher WTA. However, if adaptation sets in lower WTA is possible (de Meijer et al., 2010)
Personal	Dummy variable indicating if individual provides more than 35 hours of personal care per week	More hours have higher opportunity cost hence higher WTA (van den Berg et al., 2005)
Supervise	Dummy variable indicating if individual provides more than 35 hours of supervising per week	More hours have higher opportunity cost hence higher WTA (van den Berg et al., 2005)
Carer's Allowance	Dummy variable indicating if individual receives carer's allowance (carer's allowance is a means tested benefit for those who look after someone)	No a priori expectation. However, if CA is a proxy for carers that are already burdened and provide a lot of IC then higher WTA
Burden	Dummy variable indicating if individual states health status is heavily burdened by provision of care	Heavier burden implied higher WTA (van den Berg et al., 2005).
Relation	Dummy variable indicating if individual provides care to partner/spouse or son/daughter	No a priori expectation. However, it is possible that the closer the carer is to the patient the lower the WTA

Table 3. Descriptive statistics for continuous and discrete variables

	Survey Sample				BHPS sample	
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.
Age	57.4	12.1	27	86	50.1	15.25
Duration	14.5	10.3	>year	54	---	---
WTA	8.52	4.12	0	30	---	---
WTA certainty	6.49	3.02	0	10	---	---

	Percentage of the sample (%)	
	Survey Sample	BHPS sample
Gender (females)	76	62
Employed	13	12
Married	75	65
Income	76	82
Personal	45	57.84[a], 9.2[b]
Supervise	64	
Carer's allowance	42	---
Burden	56	---
Relation	78	---

[a] Individuals providing care within their household, no disaggregation by task in the BHPS.

[b] Individuals providing care outside their household, no disaggregation by task in the BHPS.

Table 4. Certainty distribution and average WTA by certainty level

	Percentage	.	Mean WTA
0	4.21		6.28
1	5.14		8.77
2	3.74		9.75
3	4.21		6.39
4	5.61		10.92
5	15.42		7.90
6	7.48		9.63
7	8.41		8.25
8	15.89		8.99
9	5.14		9.05
10	24.77		8.23

Table 5. Regression and valuation results from the random parameter linear regression specification

	Coef.	z-statistic	Total effect (TE)	TE S.D.
Means of random parameters (β_k^0)				
Age	0.0097	737.6	-0.0070	0.0092
Gender (females)	-0.1195	-393.0	0.0665	0.2124
Employed	0.0032	6.9	-0.1071	0.0943
Married	0.0704	188.6	-0.0094	0.0552
Income	0.3419	925.2	0.0373	0.1973
Duration	0.0366	789.1	0.0199	0.0068
Duration_squared	-0.0005	-487.9	-0.0002	0.0001
Personal	0.2101	679.4	0.2310	0.0343
Supervise	-0.2133	-743.0	-0.0944	0.0639
Carer's allowance	0.4889	1492.8	0.0659	0.1794
Burden	-0.1762	-616.6	0.0476	0.1027
Relation	-0.2376	-598.3	0.0676	0.1579
Constant	1.0139	932.9	2.0188	0.4284
Heterogeneity in the means of random parameters (δ_k)				
Age	-0.0024	-1343.6		
Gender (females)	0.0267	655.1		
Employed	-0.0159	-245.5		
Married	-0.0115	-226.3		
Income	-0.0439	-904.0		
Duration	-0.0024	-388.2		
Duration_squared	0.0000	297.5		
Personal	0.0030	72.5		
Supervise	0.0171	418.2		
Carer's allowance	-0.0609	-1347.2		
Burden	0.0322	851.5		
Relation	0.0439	828.9		
Constant	0.1446	971.6		
Standard deviation of random parameters (σ_k)				
Age	0.0062	8680.6		
Gender (females)	0.1958	3261.0		
Employed	0.0819	525.9		
Married	0.0441	844.8		
Income	0.1516	2887.3		
Duration	0.0008	293.9		
Duration_squared	0.0000	61.3		
Personal	0.0328	416.5		
Supervise	0.0413	715.2		
Carer's allowance	0.0513	574.6		
Burden	0.0472	685.6		
Relation	0.0965	1860.6		
Constant	0.1290	2983.5		
Observations	214			
WTA (£)	7.68			
WTA s.e.	0.25			

Appendix

Presentation of the open-ended question

In this question we are interested in the value you place on each hour of care you might provide.

Imagine that a new government scheme was to be put in place and you were to be compensated for the care you might provide; How much do you think you should be paid for each hour of care? Please remember that receiving direct compensation could enable you to manage your budget more effectively and allocate sums of money towards needs you consider important and necessary.

In thinking about a value, you might want to consider the total amount of time you spent caring in the last month, and what other activities you could enjoy if you had the chance to provide less care. You might, also, want to consider any effects that the caring role has on your own health and life.

I think I should be paid at least £_____.____per hour

How sure are you of the amount you stated in the previous question? (Please circle a number)