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ARTICLE

The Shadow Prices of Voluntary Caregiving: Using Well-Being Panel Data to Estimate the Cost of Informal Care

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Abstract

This article uses the well-being valuation (WV) approach to estimate and monetize the well-being impacts of informal care provision on caregivers. Using nationally representative longitudinal data from the UK, the British Household Panel Survey, we address two challenging methodological issues related to the economic valuation of informal care: (i) the anticipatory nature of informal care; and (ii) the sensitivity of income estimates used in valuation. We address the anticipatory issue by focusing on well-being impacts associated with caring for a relative who had recently suffered a serious accident. We use the fixed effects filtered (FEF) estimator to estimate a "time-invariant income" coefficient free from individual fixed effects bias, which helps to partially improve the quality of the income estimate as an alternative to using instrumental variables. This estimate is used in the calculation of shadow prices of informal care. Our estimates suggest that, focusing on the first year of unanticipated care provision, those experiencing the well-being losses from providing unanticipated informal care would be willing to pay approximately £13,167 on average to avoid it.

1. Introduction

Caring for a family member with a severe disability or long-term illness imposes substantial financial and emotional burdens on the voluntary caregiver. Yet, the non-pecuniary cost of caregiving has often been neglected in attempts to estimate the societal cost of informal care (e.g., Smith & Wright, 1994; Posnett & Jan, 1996; Arno *et al.,* 1999; Hayman *et al.,* 2001). In the past, researchers have estimated the market value of the care provided by unpaid family members and friends, for example using the average weekly number of caregiving hours and average hourly wages of professional caregivers to calculate the market value of the care. However, there is no compelling reason to suppose that the value derived from a professional caregiving market accurately reflects the experience of individuals providing voluntary care for members of their own household.

Recent studies have adopted a new approach – the well-being valuation (WV) method – in their estimation of the monetary value of informal caregiving (e.g., van den Berg & Ferrer-i-Carbonell, 2007; Koopmanschap *et al.,* 2008; Bobinac *et al.,* 2010). This approach involves taking a randomly selected representative sample of individuals, asking them to rate their life satisfaction or momentary happiness, and using regression techniques to work out the implied "shadow price" of informal caregiving. This shadow price represents the additional income required to just compensate – no more, no less – for the well-being losses experienced by voluntary caregivers.

However, while previous WV studies have provided important information about the magnitude of the experiential cost of caregiving to society, the existing approach suffers from at least two major limitations. First, no distinction has been made in the past between the well-being consequences of informal caregiving that is anticipated, for example caring for a family member whose health has declined over time, and unanticipated caregiving, for example caring for a family member who has experienced an unexpected accident. It is possible that anticipation effects in informal care provision lead to its undervaluation due to the difficulty in empirically identifying the beginning of the provision of care, as we explain in more detail below.

Second, no consensus has been reached over which measure of income should be used in the calculation of shadow prices. Most studies use the uninstrumented time-varying income coefficient obtained from an individual fixed effects (FE) regression model, which often produces shadow prices that are too large to be considered realistic. One exception using the British Household Panel Survey (BHPS) was Powdthavee (2010), where participants' willingness to show their payslips was used as a formal instrument for income in a first-stage income regression. Other exceptions include studies using parental education as an instrument (e.g. Luechinger, 2009) or using windfall gains (e.g. Ambrey & Fleming, 2014). However, it is well-accepted that finding a good income instrument is difficult if not impossible (as discussed in e.g. Howley, 2017).

The current study makes use of two innovations that address both the anticipation and the income estimation issues. The first innovation is to separate informal care provision into two categories: care provision where the care receiver has been involved in an accident; and care provision where there has been no accident. The second innovation is to apply the fixed effects filtered (FEF) estimator introduced by Pesaran and Zhou (2016), which allows both time-invariant and time-varying income coefficients to be estimated free from individual fixed effects – though not necessarily from unobserved time-varying bias. We believe ours is the first study to employ the FEF method to estimate income coefficients.

Based on our estimates, we find that, in the first year, the average person would be willing to pay around £13,167 of their (time-invariant) income to avoid a situation where they were providing care for a family member who had a serious accident in the previous 12 months. This estimated compensating surplus CS is significantly smaller than the £15,165 value obtained using the estimated time-varying income coefficient.

2. Background

2.1. Informal care in the UK

Informal care is defined as personal and practical care provided by a member of one's own or another household. The Office of National Statistics (ONS) further defines personal care as "help with activities such as dressing, bathing, washing and feeding" and defines practical care as "help with activities such as mobility (for example, getting out of bed) and paperwork or financial matters" (ONS, 2016). In 2014, just over 2 million people in the UK were in receipt of informal care, a figure that had been broadly stable since 2005. However, receipt of full-time informal care has risen and so the total number of hours of informal care provided has increased by 24.9% over that period. According to the 2011 census, the ONS (2013) estimated that 5.8 million people in England and Wales were providing some level of unpaid care, amounting to around 1 in 10 members of the population.

These figures highlight the importance of informal care as a complement to, and in some cases a substitute for, formal care provided by the National Health Service and private health care. In a report for the King's Fund, Malley *et al.* (2006) suggest that current reliance on informal care is unsustainable, since demand is predicted to rise by around 45 per cent between 2003 and 2026. Providing informal care comes at a high cost to the carer. Some of these costs are directly incurred, such as an additional expenditure on heating and medical supplies, loss of income (Ettner, 1996; Carmichael & Charles, 2003; Heitmueller & Inglis, 2007), and a detriment to pension holdings. However, the indirect and non-financial costs can also be significant. For example, voluntary caregivers have been found to experience deterioration in their personal relationships, as well adverse effects on their own physical and mental health (e.g., van den Berg *et al.,* 2004; Wolff & Agree, 2004; Schulz & Sherwood, 2008). Nonetheless, despite the significant burden on caregivers, there is also some evidence suggesting that caregivers may also gain from becoming closer to a significant other (e.g., Jacob *et al.,* 2003; Andrén & Elmståhl, 2005; Zapart *et al.,* 2007).

Given the significant personal indirect costs of caregiving, it is surprising that the majority of previous research has focused almost exclusively on the estimation of the market value of the time input of the carer (e.g., Smith & Wright, 1994; Posnett & Jan, 1996), and using a proxy good method by taking the market price of a close substitute such as the wage rate of a professional caregiver to generate a monetary estimate of the cost of time spent providing informal care (e.g., van den Berg *et al.,* 2006). Van den Berg *et al.* (2014) highlight the lack of studies aiming to place a value on the indirect costs, and address this gap using perhaps the most comprehensive subjective well-being estimation to date. We address this and other relevant literature in what follows.

2.2. *The well-being valuation method*

The WV method involves estimating a regression equation in which a measure of cognitive or evaluative well-being (e.g., life satisfaction or momentary happiness) is explained by the occurrence of life events and some measure of income, among other things (see, e.g., Clark & Oswald, 2002). The relative size of the coefficients on income and a life event of interest reveals an implicit rate of substitution between the two variables. The ratio of these coefficients represents how much additional income would be required to generate a well-being gain that "just" equals the well-being gain associated with the occurrence of the life event, or to just offset the well-being loss if the effect of the life event is negative.

The WV method is increasingly used by economists to monetize many different life events that have no obvious market values. These include the values of marriage (Blanchflower & Oswald, 2004), social relationships (Powdthavee, 2008), terrorism (Frey *et al.,* 2009), air quality (Luechinger, 2009, 2010), airport noise (van Praag & Baarsma, 2005), and crime (Powdthavee, 2005). The WV approach has also gained significant attention in health economics as an alternative to the more traditional Stated Preference (SP) approach for determining the monetary valuation of changes in health (e.g., Ferrer-i-Carbonell & Van Praag, 2002; Graham *et al.,* 2011; Powdthavee & van den Berg, 2011; Brown, 2015; Howley, 2017).

An early WV study that aimed to monetize the experience of providing informal care was by van den Berg and Ferrer-i-Carbonell (2007). Participants were recruited from support centres specifically for carers. They completed questionnaires about their caring responsibilities and reported their subjective well-being (SWB). They also reported their willingness to accept (WTA) for undertaking an additional hour of care. Using the log of net income per month as the income measure, the authors found that the compensation carers would require to offset the well-being losses from providing an extra hour of informal care was about 9 or 10 Euros. This was broadly aligned with the WTA figures of between 9 and 11 euros. Unfortunately, the cross-sectional design meant that the authors were unable to correct for unobserved omitted variables that simultaneously affect both informal care and income estimates, as well as WTA itself. There is also a potential selection effect, since people who participated were older, more likely to have an illness, and likely to provide more hours of care than the national average.

These concerns prompted van den Berg *et al.* (2014) to conduct a more sophisticated analysis using the Household Income and Labour Dynamics in Australia (HILDA) survey, which is a nationally representative longitudinal dataset for Australia. The panel estimation controls for underlying time-constant variables that could influence both caregiving and subjective well-being, such as home environment and personality traits. Conditioning for individual fixed effects, their panel estimates imply that the money equivalent of informal care per hour is 115.20 Australian dollars.

Mentzakis *et al.* (2012) considered the potential differences between different well-being measures for valuing the cost of informal care. They used the BHPS, and again exploited the longitudinal nature of the data to control for time-invariant confounding factors. Controlling for individual fixed effects, they found that a person providing up to 20 hours of care per week would require between £2,000 and £9,000 additional income per week to be just as happy as if they were not providing that care. The wide range of values reflects the differences between measures of well-being, with the values produced by life satisfaction being significantly smaller than those produced by the General Health Questionnaire (GHQ-12) scores.

Subsequently, Schneider and Kleindienst (2016) used the 2006–2007 Survey of Health Ageing and Retirement in Europe to provide a cross-country estimate of the effect of informal care provision for family members living in separate households. They reported a positive net effect of providing "moderate" informal care equivalent to receiving €93 per week. This positive association may appear surprising, but it could be explained by the fact that care is provided for someone outside the household. They find that providing informal care reduces caregivers' life satisfaction when care is provided for more than 30 hours per week, which is more consistent with previous findings in the literature.

Most of the SWB literature discussed so far has focused on estimating willingness to accept (WTA) for providing informal care. Another useful approach in the wider SWB literature is to calculate *compensating surplus* values. These essentially report the amount by which income would need to reduce to offset the utility gain from no longer suffering the negative circumstance being valued, and as such it is akin to willingness to pay (WTP). This approach is especially common in environmental economics, for example by Frey *et al.*

(2009), Luechinger (2009), and Luechinger and Raschky (2009). A clear benefit of this approach is that it is more naturally comparable with market estimates of the value of caregiving whereby people pay others to provide care in their stead. Another benefit of the approach is that it avoids a situation where WTP exceeds total income, avoiding excessively high monetary estimates sometimes implied in a WTA framework.

Altogether, the existing literature suggests that there is a negative and statistically robust association between informal care and measures of carers' subjective well-being, and that when aggregated across populations and monetized using the WV method, this burden on society is significant in economic terms. However, in order for the WV estimates of the cost of informal care to be taken seriously by economists and policy makers, the issues concerning the anticipatory nature of informal caregiving, and concerning income specification used in the calculation of shadow prices, must be addressed. We address both issues simultaneously.

2.3. Anticipated and unanticipated informal caregiving

There is little empirical evidence on the consequences for carers' subjective well-being of informal care when the provision of care was not expected. Many previous studies are cross-sectional in nature and did not distinguish between the two types of care (e.g., van den Berg & Ferrer-i-Carbonell, 2007; Schneider & Kleindienst, 2016). Even those that used longitudinal data to study the relationship did not take into account the anticipatory nature of some types of informal care provision. In many cases, the provision of informal care increases gradually over time, which complicates the interpretation of panel data analyses since future informal care provision may be anticipated by potential caregivers, and well-being might change to reflect this in the years leading to individuals becoming carers in the data. This leading effect, if not controlled for in the estimation, can result in an underestimation of the influence of informal care provision on carers' well-being. Another concern is whether the distribution of caring is randomly allocated across the population, since confounding factors such as the level of health or income could influence the probability of requiring and providing informal care.

We attempt to address both of these issues by exploiting the longitudinal nature of the data, and adding an additional identifying feature. This is the provision of informal care for someone in the household who has experienced a serious accident between the previous year's and the current year's surveys. The key assumption is that, conditioning on individual fixed effects that are likely to include personality traits, risk attitudes, and stable environmental features, there is no anticipation of providing this type of informal care. In addition, an accident that leads to the need for care is more likely to be randomly allocated across the sample, compared to deterioration in health that leads to the need for care. Of course, the decision to provide (as opposed to outsource) informal care once an accident has taken place may not be exogenous. Nonetheless, we consider this innovation to be a significant improvement over current methods.

2.4. Income estimation

Another concern with previous WV studies is that income is heavily influenced by both unobserved time-varying and time-invariant characteristics of the individual in well-being regressions (Powdthavee, 2010; Fujiwara, 2013). To partially correct for the endogeneity problem relating to unobserved time-invariant bias, FE models have been applied to well-being data to partial out the time-invariant effects that would otherwise confound the income estimate (Ferrer-i-Carbonell & Frijters, 2004). However, the FE model will likely yield a very small estimated income coefficient – due in part to the attenuation bias typically associated with the FE model – producing valuation estimates that are too large to be taken seriously in policymaking. Powdthavee (2010) details the nature of the underestimation of the income coefficient in FE models.

Another drawback of the FE model is that it only uses the within variance and disregards the between variance, so it does not allow the estimation of time-invariant variables (Baltagi, 2001; Hsiao, 2003). This implies that income estimates produced by FE models in previous studies are essentially estimates of how *time-varying* income affects individuals' well-being. Yet, according to a recent study by Cai and Park (2016), individuals' well-being is more likely to be influenced by *time-invariant* rather than transitory income shocks. Their findings are consistent with Friedman's permanent income hypothesis, which assumes that a person's consumption is determined not only by current income but also by the income they expect to enjoy in the future (Friedman, 1957). A more appropriate income measure in the calculation of compensating values may therefore be time-invariant income, but this causes problems with standard FE estimation since it does not vary over time in panel data.

We attempt to partly address this methodological issue in our article by applying Pesaran and Zhou's FEF estimator on our well-being data (Pesaran and Zhou, 2016), enabling us to decompose variations in income into an explained and unexplained part, and so providing measures of both time-invariant and time-varying income. However, we remain silent on the possible influences of the unobserved time-varying bias on both time-varying and time-invariant income estimates. To be able to correct for both types of biases, we need a good IV for income in our FEF estimator. Yet, given that a good IV for time-invariant income is hard to find in any data, whilst longitudinal data of income and SWB are relatively more plentiful, we hope that our results at least offer a partial solution to the existing methodological problem.

There is one further notable criticism of the WV approach – that the size of the estimated income coefficient varies significantly across different well-being measures (Powdthavee & van den Berg, 2011). Although this important issue requires further debate and discussion, recent studies have tended to recommend life satisfaction as the well-being measure of choice for policy makers to target when designing policies (Clark *et al.,* 2017). There are several reasons for this recommendation. First, it is comprehensive – it refers to the whole of a person's life. Second, it is clear to the reader – it requires no process of aggregation by researchers. Third, it is democratic – it allows individuals to assess their lives on the basis of whatever they consider important without imposing anybody else's views of what emotions or experiences are valuable. Lastly, it has been shown to demonstrate a robust statistical relationship with income.

3. Data

The dataset comes from the BHPS. This is a nationally representative sample of the UK population, containing over 25,000 unique individuals. The survey was conducted mainly between September and December each year between September 1991 and April 2009 (Taylor *et al.,* 2001).

Our main outcome variable is life satisfaction, recorded in the self-reported section of the survey from wave 6 to 18 (except wave 11). The exact wording is:

> "*All things considered, how satisfied or dissatisfied are you with your life overall using a 1-7 scale? 1 = very dissatisfied, …, 7 = very satisfied*".

The question about caregiving appeared in every wave of the BHPS. Respondents were asked, "*Is there anyone living with you who is sick, handicapped or elderly whom you look after or give special help to (for example, a sick or handicapped (or elderly) relative/husband/wife/friend, etc.)?*". If yes, they were asked who the cared-for person is; and how many hours per week are spent caring for them, recorded as the number of hours in ranges. In cases where duration of care varied from week to week, it recorded whether care was provided for more than or less than 20 hours per week.

In each wave, every respondent reported whether he or she had an accident in the last 12 months, "*Since [T-1], have you had any kind of accident as a result of which you saw a doctor or went to hospital?*", where T-1 is one year earlier. Where a respondent indicated that they provided care, we match them with other family members' accident variable(s) to generate the "*Caring for other household members who had an accident in the last 12 months*" variable.

To assess the severity of the accident, we use two variables that derived from the following questions: "*Does your health in any way limit your daily activities compared to most people of your age?*", and "*Does your health limit the type of work or the amount of work you can do?*". We classify a person as having had a severe accident if they stated that their health limits their work and their daily activities. We classify the accident as moderate if they self-reported having had an accident in the last 12 months, but their current health did not limit their daily activities or work. We use this distinction in robustness analyses (for example, see Table 4).

We use the log of real equivalised household income (otherwise known as the "OECD equivalence income scale"), which allows different weights to be assigned to each child (0.5) and each additional adult (0.7) in the household. The log of real equivalised household income variable is averaged within-person over time across all waves within which they appear to create a proxy of time-invariant (or expected long-term) income in the panel.

We use data from Waves 6–18 in the BHPS, leaving out Wave 11 in which the life satisfaction question was omitted from the questionnaire. We restrict the sample to respondents of working age (16–65) who provided information on life satisfaction and informal care. This yields an unbalanced sample of 129,524 observations (23,091 unique individuals). Approximately 5.5% (N = 7,176) of observations (or n = 2,478 individuals) in our sample provided informal care for at least one member of the household. More women (N = 4,130 observations; n = 1,400 individuals) provided informal care than men (N = 3,046 observations; n = 1,078 individuals).[1] Of those informal carers, 8.3% (N = 595) of observations (or n = 448 individuals) provided care following an accident in the last year befalling the person being cared for (for men, this is n = 270 observations; n = 203

[1] The proportion in our sample is lower than that reported by the ONS. This is for two reasons. First, we limit the unpaid care to family members living in the same household as the individual. Second, we limited our sample to people aged 16–65 in order to estimate meaningful income effects. The number of people providing unpaid care is likely to be higher for the over 65 (one can imagine one elderly spouse caring for the other elderly spouse).

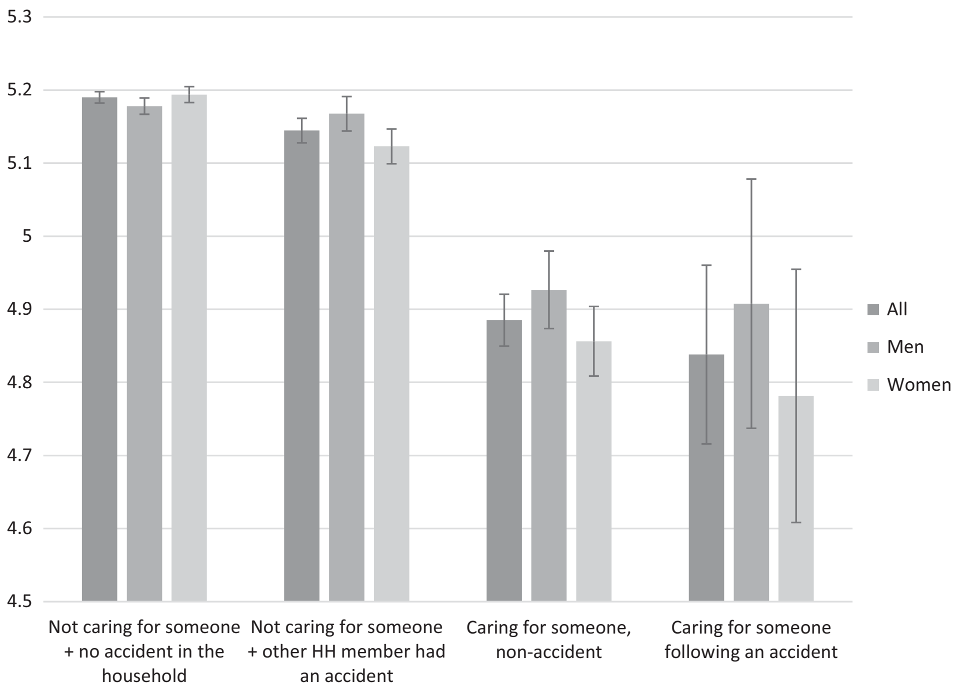

Figure 1. *Average life satisfaction by informal caring (*Note*: 4-standard-error bars (95% C.I.), 2 S.E. above, 2 S.E. below).*

individuals; and for women this is $n = 325$ observations; $n = 245$ individuals). The proportion of observations indicating the provision of 100 or more hours of informal care per week was 1.2% ($N = 1{,}590$ observations; $n = 691$ individuals) of the sample. See Appendix A for more descriptive statistics.

Figure 1 reports the average life satisfaction of non-carers, carers of a non-accident victim, and carers of an accident victim. The average life satisfaction scores of carers are noticeably lower than those of non-carers, on average. In addition, there appear to be some differences in average life satisfaction between carers of accident victims and carers of people who did not have an accident, though these differences are not statistically significantly different from zero, at least in the raw data. To assess the influence of the accident per se, we include the life satisfaction for those respondents for whom a household member experienced an accident in the last year but who did not provide care. These respondents reported lower SWB than those for whom no household members experienced an accident, but this effect is much smaller than the effect of the provision of care.

4. Empirical strategy

Consider the following life satisfaction regression equation:

$$LS_{it} = \alpha + \gamma C_{it} + \beta \ln y_{it} + \delta \ln Y_i + X'_{it}\theta + u_i + \varepsilon_{it}, \qquad (1)$$

where individuals are indicated by $i = 1, 2, \ldots, N$; time periods are indicated by $t = 1, 2, \ldots, T$; LS_{it} is the self-reported life satisfaction score for individual i in time t; α is the intercept; C_{it} is a dummy variable representing caring for other family members (defined differently depending on the specific model); $\ln y_{it}$ is a log of time-varying income that varies across i and t; $\ln Y_i$ is the log of expected long-term income, our proxy measure of permanent income which we will hereafter refer to as time-invariant income, and which by construction only varies across i; X'_{it} is a vector of individual characteristics; u_i captures unobserved individual-specific effects; and ε_{it} is the random error term. It is clear from Equation (1) that, without further restrictions on u_i, δ cannot be identified in a cross-sectional regression.

We use the term *time-invariant* for simplicity, although in reality this is a slow moving average concept. It can be interpreted as income that is representative across years.

To estimate δ, we exploit the longitudinal nature of the BHPS and apply the FEF estimator to equation (1), as follows:

Step 1: Using equation (1), we compute the individual fixed effects estimators of γ, β and θ, denoted by $\hat{\gamma}$, $\hat{\beta}$ and $\hat{\theta}$, and the associated residuals $\hat{\varepsilon}_{it}$, which are defined by

$$\hat{\varepsilon}_{it}, = LS_{it} - \hat{\gamma}C'_{it} - \hat{\beta}\ln y_{it} - \hat{\theta}X'_{it}. \tag{2}$$

The results of Step 1 generate the standard fixed effects estimates used in typical studies in this literature.

Step 2: Compute the within-person averages of these residuals, $\bar{\hat{\varepsilon}}_i = T^{-1}\sum_{t=1}^{T}\widehat{\varepsilon_{it}}$. Regress $\bar{\hat{\varepsilon}}_i$ on $\ln Y_i$ with an intercept to obtain $\hat{\delta}_{FEF}$, where

$$\hat{\delta}_{FEF} = \left[\sum_{i=1}^{N}\left(\ln Y_i - \overline{\ln Y}\right)\left(\ln Y_i - \overline{\ln Y}\right)'\right]^{-1}\sum_{i=1}^{N}\left(\ln Y_i - \overline{\ln Y}\right)\left(\bar{\hat{\varepsilon}}_i - \bar{\hat{\varepsilon}}\right)', \tag{3}$$

and

$$\hat{\alpha}_{FEF} = \bar{\hat{\varepsilon}} - \hat{\delta}'_{FEF}\overline{Y}, \tag{4}$$

where $\bar{\hat{\varepsilon}} = N^{-1}\sum_{i=1}^{N}\bar{\hat{\varepsilon}}_i$.

Hence, the FEF estimator produces the coefficients on informal caring, time-varying income, and time-invariant income that are orthogonal to individual fixed effects. Given that informal caregiving, C_{it}, can be further decomposed into caring for accident and non-accident victims, we can reasonably assume that caring for an accident victim is exogenously determined in a fixed effects regression (i.e., $COV\left(C_{it}^{accident}, \varepsilon_{it}\right) = 0$), whereas caring for a non-accident victim is relatively more likely to be confounded by unobserved time-varying factors that correlate with both informal caring and life satisfaction.

The specific model we run includes the different categories of caregiving. That is, we run the model in equation 1’. The variables *Care_Acc* and *Care_NoAcc* refer to giving care when the care receiver has and has not had an accident in the past 12 months, respectively. The variable *Widow* refers to losing a spouse that year. *ReceiveCare_Acc* is receiving care following an accident, and *ReceiveNoCare_Acc* is having had an accident in the past 12 months but not receiving care. *ReceiveCare_NoAcc* refers to being in receipt of care but not having had an accident in the last 12 months. One objection regarding Eq. (1) is that the life satisfaction of the carer is affected not only by providing informal care but also by the shock and/or empathy of having a family member going through a serious accident in the past year. We separate the two effects by including separate control variables for the number of "other" household members who had a serious accident in the last year, *OneOther_Acc* and *MoreOther_Acc* for (1 other, or 2–4 others, respectively). These controls are included in all of our regressions. In all cases, unless otherwise stated, we include accidents of all severity levels.

$$\begin{aligned} LS_{it} = {} & \alpha + \gamma_1 Care\_NoAcc_{it} + \gamma_2 Care\_Acc_{it} + \gamma_3 Widow_{it} \\ & + \gamma_4 ReceiveCare\_Acc_{it} + \gamma_5 ReceiveNoCare\_Acc_{it} \\ & + \gamma_6 ReceiveCare\_NoAcc_{it} + \gamma_7 OneOther\_Acc_{it} + \gamma_8 MoreOther\_Acc_{it} \\ & + \beta \ln y_{it} + \delta \ln Y_i + X'_{it}\theta + u_i + \varepsilon_{it}. \end{aligned} \tag{1'}$$

Unfortunately, without a valid instrumental variable for time-invariant income, $\hat{\delta}_{FEF}$ is still subject to omitted time-varying bias. Yet, given that we are able to correct for the unobserved heterogeneity bias in $\hat{\delta}_{FEF}$, and that life satisfaction and time-invariant income are both largely determined by factors that are fixed over time (e.g., ability, early life circumstances, personality traits), we believe that the true estimate of $\hat{\delta}$ is credibly similar to our estimated version of $\hat{\delta}_{FEF}$. Nevertheless, we would still urge readers to exercise caution when interpreting the time-invariant income coefficient.

With that in mind, in order to calculate (i) the time-varying income loss equivalent to providing care for an accident victim, and (ii) the time-invariant income loss equivalent to providing care for an accident victim, we simply compare the size of the coefficient on caring for an accident victim ($\hat{\gamma}$) with the size of the coefficients on time-varying income ($\hat{\beta}$) and time-invariant income ($\hat{\delta}_{FEF}$), respectively. Given that the income is in log form, we follow previous studies that use estimates in well-being regressions to calculate compensating surpluses of adverse life events (see, e.g., Frey *et al.*, 2009; Luechinger, 2009; Luechinger & Raschky, 2009) to work out the compensating surplus for providing care for an accident victim as follows:

$$CS^{Time-var\_inc}_{Care\_acc} = \bar{y} \times \left(1 - \exp\frac{\hat{\gamma}}{\hat{\beta}}\right), \tag{5}$$

and

$$CS^{Time-inv\_inc}_{Care\_acc} = \bar{y} \times \left(1 - \exp\frac{\hat{\gamma}}{\hat{\delta}_{FEF}}\right), \tag{6}$$

where $CS^{Time-var\_inc}_{Care\_acc}$ and $CS^{Time-inv\_inc}_{Care\_acc}$ are the estimated CS, which is the decrease in income necessary to hold life satisfaction constant in the counterfactual situation where the person was not providing informal caregiving; and $\bar{y}$ is the average equivalent household income across individuals in the sample. In other words, CS can be interpreted as the maximum WTP for an average individual to avoid the situation where they provide informal care following an accident. Provided that the estimated influence of caregiving on well-being is negative, the estimated CS will not be higher than the average household income, $\bar{y}$. This implies that, without borrowing, the person would not be willing to pay more for the avoidance of the caregiving situation than what she currently earns. Based on previous studies on the effect of time-varying and time-invariant income on life satisfaction (e.g., Powdthavee, 2010; Cai & Park, 2016), it is conjectured that $CS^{Time-var\_inc}_{Care\_acc} \geq CS^{Time-inv\_inc}_{Care\_acc}$.

Pooled OLS can be used to estimate $\hat{\delta}_{FEF}$. However, the current study uses the STATA code "*xtfef*," which was originally generated by Qiankun Zhou, to run the regression model. We include standard control variables in all of the FEF regressions reported in this study. These control variables include age and its square, dummies for different levels of education, marital status, employment status, self-assessed health, the number of days spent in hospital in the last 12 months, the number of children in the household, regional dummies to control for geographical variation, and survey wave identifiers. We also calculated the 95% confidence intervals of CS by substituting $\hat{\gamma}$with its lower and upper bound estimates in the Eqs. (5) and (6), whilst keeping everything else the same. Ideally, we would like to be able to use the non-linear combination command (*nlcom*) in STATA to automatically generate the confidence intervals for each CS. Nevertheless, the *xtfef* does not allow *nlcom* in the post-estimation calculation, which means that all CS and their confidence intervals had to be calculated by hand. Procedures, including for tests of significance, are presented in Appendix B.

It is worth noting here that alternative models to the FEF estimator include Fixed Effects Vector Decomposition (FEVD) (Plümper & Troeger, 2007) and, in the case where one or more of the time-invariant regressors are endogenous and there are valid instrumental variables (IVs), the Hausman–Taylor random coefficient panel data model (Hausman & Taylor, 1981). However, given that we do not have valid IVs for our time-invariant variables and that the variance estimator proposed for FEVD estimator is inconsistent (Breusch *et al.,* 2011; Greene, 2011), our preference is to use the FEF model, which has been shown to be consistent under fairly general conditions. In addition to this, the FEF model has been shown to produce estimates with extremely small bias even with N = 100.

5. Results

Table 1 reports a selected set of the first- and second-stage FEF life satisfaction estimates for the entire sample, and for men and women separately. Appendix C presents estimates of other control variables in the FEF regressions. The first-stage FEF estimates, which are fixed effects estimates on the time-varying variables, include estimates for providing and receiving informal care with and without a preceding accident, having an accident but not needing care, the number of "other" household members who had a serious accident within the last year, being a widow/widower, and log of real equivalent household income. This generates a time-varying income effect. For the second-stage, we only have a between-person estimate for the within-person average log of real equivalent household time-invariant income, generating a time-invariant income effect.

The full sample estimates show that six of the seven life events exhibit negative and statistically significant coefficients, whilst both time-varying and time-invariant income measures have positive and statistically well-determined coefficients. Unsurprisingly, bereavement reduces well-being most dramatically: becoming a widow or widower is associated with a statistically significant decline of around 0.22 points in life satisfaction, on average. Looking after a family member who had an accident within the last 12 months also significantly reduces well-being ($\beta = -0.192, \text{S.E.} = 0.050$); and this decline is statistically significantly worse than that associated with either caring for another household member who did not have an accident within the last 12 months ($\beta = -0.087, \text{S.E.} = 0.023$)

Table 1. *Fixed Effects Filtered Regressions of Life Satisfaction and Informal Caring, BHPS 1996–2008.*

Variables	All	Men	Women
Panel A: First-stage FE regression			
Informal caring			
Caring for other member who did not have an accident within last year	−0.087***	−0.009	−0.148***
	(0.023)	(0.034)	(0.031)
Caring for other member who had an accident within last year	−0.192***	−0.144**	−0.232***
	(0.050)	(0.071)	(0.072)
Widowhood and own experience of accident			
Widow/widower	−0.221***	−0.110	−0.267***
	(0.069)	(0.130)	(0.082)
Had accident within last year and being cared for	−0.202**	−0.194	−0.207**
	(0.073)	(0.118)	(0.092)
No accident within last year and being cared for by another member	−0.129***	−0.134**	−0.118**
	(0.038)	(0.061)	(0.047)
Number of other household members who had a serious accident within last year			
One other person	−0.046**	−0.043	−0.051
	(0.023)	(0.030)	(0.036)
From 2 up to 4 other people	−0.085	−0.023	−0.154
	(0.079)	(0.107)	(0.116)
Log of real equivalent household income	0.035***	0.042***	0.029***
	(0.006)	(0.009)	(0.009)
Panel B: Second-stage FEF regression			
Within-person average of log of real equivalent household income	0.096***	0.123***	0.099***
	(0.024)	(0.034)	(0.026)
Observations	129,524	59,551	69,960
Number of individuals	23,091	10,919	12,172

Note: *** < 1%; ** < 5%; * < 10%. Standard errors are in parentheses. Other control variables used in the first stage regression include age, age-squared, highest completed education, marital status, employment status, self-assessed health, the number of days spent in hospital in the last 12 months, the number of children in the household, regional dummies to control for geographical variation, and survey wave identifiers.

or having one household member (other than the respondent themselves) who had an accident within the last 12 months ($\beta = -0.046, \text{S.E.} = 0.023$). The coefficients on accident and non-accident caregiving are statistically significantly different (t = 5, p = 0.025). The same test between accident caregiving and having a household member who had an accident produces a t-statistic of 7.11, with a p-value = 0.007.

Having more than one household member who had an accident in the last 12 months is not significant in our sample. The estimates for being the person experiencing an accident and/or receiving care are included for comparison. Finally, we can see that the estimates for time-varying and time-invariant incomes are 0.035 (S.E. = 0.006) and 0.096 (S.E. = 0.024), respectively. Consistent with Cai and Park (2016), the estimated coefficient of time-invariant income is significantly larger than that of time-varying income in a life satisfaction regression.

Since a carer's own health status may be a mediator between caring and subjective well-being, we ran the regressions both including and not including the carer's own health as a control. The estimated coefficients on caring are −0.086 (S.E. 0.023) when health is controlled for, and − 0.092 (S.E. 0.024) when health is not controlled for.

Running a random-effects model – in other words, not filtering out the individual fixed effects from biasing the time-invariant income estimate – produces an estimated time-invariant income coefficient of 0.108 (S.E. = 0.013), which is approximately 12.5% larger than the FEF coefficient on time-invariant income (full results are available from the authors on request). Hence, the FEF model appears to be successful at filtering out any omitted time-invariant variables such as innate ability, early life family background, and personality traits that upwardly bias the time-invariant income coefficient.

There are some differences in the estimated coefficients across gender, with women reporting statistically significantly lower life satisfaction when they experience all the life events in Table 1, except for when they experience other members of the household having a serious accident during the year. In contrast, men report statistically significantly lower life satisfaction when caring for other household members who had an accident in the last year, and when they themselves receive care, but not for any other life event in our study.

How much would a person be willing to pay to avoid the negative well-being effect of anticipated *versus* unanticipated informal caregiving? To answer this question, Table 2 reports the CS, using either the time-varying or the time-invariant income coefficient, for all the life events listed in Table 1. The full sample estimates suggest that an average individual with a real equivalent income of £15,228 would be willing to pay $£15{,}288 \cdot \left(1 - e^{\frac{-0.192}{0.096}}\right) =$ £13,167 (approximately \$16,250 US dollars) in the first year of caring to compensate for having to care for a family member who recently had an accident, if the time-invariant income coefficient is used in the calculation of the CS. The same individual would be inferred to be willing to pay $£15{,}288 \cdot e^{\frac{0.192}{0.035}} =$ £15,165 (approximately £18,700 US dollars) if the time-varying income coefficient is used in the calculation of the CS. This difference is statistically significant based on a t-test calculated according to the procedures in Appendix B (t = 2.18). These estimated CS are significantly larger (t = 4.25) than the CS obtained for caring for family members who did not have an accident within the last 12 months.

It should be emphasized that the estimated CS of £13,167 is *independent* of the hedonic damage from having another household member experience a serious accident in the previous 12 months. The estimated CS for that case is approximately $£15{,}288 \cdot \left(1 - e^{\frac{-0.046}{0.096}}\right) =$ £5,797 in the first year following the accident. Hence, the total effect of informal caring and hedonic damage suffered by the carer from having a family member experience a serious accident is £13,167 + £5,797 = £18,964 in the first year. However, we will focus only on the caring effect when discussing the CS for informal caregiving.

Splitting the sample by gender, the estimated CS for informal caring for an accident victim range from £10,922 (time-invariant income) to £15,319 (time-varying income) for men, and £13,299 (time-invariant income) to £14,707 (time-varying income) for women.

Our results suggest that the implied monetary value of informal caregiving varies significantly between caring for accident and non-accident family members (t = 2.18), as well as across different income specifications (t = 4.25). This highlights the importance of distinguishing between informal caregiving provisions that are anticipated and unanticipated in nature. Assuming that time-invariant income, independent of individual fixed effects bias, is conceptually appropriate as a long-term predictor of life satisfaction, our

Table 2. *Compensating Surplus Using Estimates for Time-Invariant and Time-Varying Income.*

	All			Men			Women		
Compensating surplus (CS)	CS	% of income	95% C.I.	CS	% of income	95% C.I.	CS	% of income	95% C.I.
Average real equivalent household income per annum		£15,228			£15,833			£14,712	
(i) *CS calculated using time-invariant income*									
Caring for another member who did not have an accident within last year	£9,075	59.6%	[£5,293, £11,418]	£1,117	7.1%	[−£9,746, £7,367]	£11,412	77.6%	[£8,540, £12,948]
Caring for another member who had an accident within last year	£13,167	86.5%	[£9,388, £14,501]	£10,922	69.0%	[£255, £14,285]	£13,299	90.4%	[£8,663, £14,382]
Widow/widower	£13,704	90.0%	[£8,814, £14,866]	£9,359	59.1%	[−£37,769, £15,051]	£13,720	93.3%	[£9,514, £14,522]
Had serious accident within last year and being cared for	£13,371	87.8%	[£6,730, £14,822]	£12,562	79.3%	[−£6,444, £15,353]	£12,894	87.6%	[£3,050, £14,428]
No accident within last year but being cared for by another member	£11,256	73.9%	[£6,460, £13,428]	£10,506	66.4%	[£1,472, £13,857]	£10,245	69.6%	[£3,167, £12,983]
Number of "other" household members who had a serious accident within last year = 1	£5,797	38.1%	[£0, £9,388]	£4,671	29.5%	[−£2,347, £8,980]	£5,923	40.3%	[−£3,476, £10,465]
Number of "other" household members who had a serious accident within last year = 2–4	£8,946	58.7%	[−£17,347, £14,016]	£2,700	17.1%	[−£58,975, £13,527]	£11,606	78.9%	[−£17,635, £14,413]

Table 2. *Continued*

Compensating surplus (CS)	All CS	All % of income	All 95% C.I.	Men CS	Men % of income	Men 95% C.I.	Women CS	Women % of income	Women 95% C.I.
Average real equivalent household income per annum		£15,228			£15,833			£14,712	
(ii) *CS calculated using time-varying income*									
Caring for another member who did not have an accident within last year	£13,960	91.7%	[£10,508, £14,887]	£3,054	19.3%	[−£48,678, £13,301]	£14,622	99.4%	[£13,953, £14,701]
Caring for another member who had an accident within last year	£15,165	99.6%	[£14,129, £15,224]	£15,319	96.8%	[£736, £15,815]	£14,707	100.0%	[£14,004, £14,712]
Widow/widower	£15,200	99.8%	[£13,807, £15,227]	£14,679	92.7%	[−£547 k, £15,830]	£14,710	100.0%	[£14,290, £14,709]
Had serious accident within last year and being cared for	£15,181	99.7%	[£12,154, £15,227]	£15,676	99.0%	[−£27,205, £15,832]	£14,700	99.9%	[£8,055, £14,712]
No accident within last year but being cared for by another member	£14,846	97.5%	[£11,878, £15,184]	£15,181	95.9%	[£3,935, £15,797]	£14,460	98.3%	[£8,281, £14,702]
Number of "other" household members who had a serious accident within last year = 1	£11,137	73.1%	[£0, £14,129]	£10,145	64.1%	[−£7,900, £14,470]	£12,177	82.8%	[−£15,368, £14,500]
Number of "other" household members who had a serious accident within last year = 2–4	£13,885	91.2%	[−£107 k, £15,213]	£6,676	42.2%	[−£1,479 k, £15,777]	£14,639	99.5%	[−£202 k, £14,712]

Note: The estimated compensating surpluses (CS) are based on Table 1's estimates.

findings suggest that previous estimates of the social cost of informal care, and for many life events across a range of domains, may have been over-estimated when time-varying income has been used in the shadow price calculation.

As a robustness check, we interact the caring variable with dummy variables indicating medium- and long-hours caring. Specifically, we look at those providing care for between 20 and 99 hours per week, and those providing care for 100 hours per week or more. We report the implied CS estimates in Table 3. We find that the average CS for providing long-hours care are larger than the CS for providing shorter hours care; however, the differences between them are not statistically significant, with the hours of care variables reported in Table 3 not statistically significantly different than the baseline of up to 20 hours of care. Specifically, the CS were £14,730 in the first year if providing 100 or more hours per week, £14,121 in the first year if providing for between 20 and 99 hours of care per week, and £12,372 in the first year if providing up to 20 hours of care per week.

We next focus on whether the CS depends on the severity of the injury to the person being cared for. Specifically, we investigate whether the effects of caring on life satisfaction differ depending on whether the care recipient has a disability that prevents them from doing their daily activities. We decompose the "caring for an accident victim" into two categories: caring for those whose disability does not prevent them from doing their daily activities, and for those who cannot manage their daily activities. The implied CS are presented in Table 4.

We find that an average person would be willing to pay £13,872 in real equivalent time-invariant income to avoid a situation where they provide care for someone who has had an accident but can still do their daily activities. They would be willing to pay £13,982 to avoid a situation where they provide care for someone who has had an accident that results in him or her being incapacitated. These are neither statistically nor economically significantly different.

Having established that caregiving results in significant well-being losses in the year that the care provision begins, we next ask whether people adapt to different caregiving experiences. To test this, we expand Equation (1) to include leads and lags for each category of informal caring (accident and non-accident) – two-year leads and two-year lags. This allows us to compare the well-being dynamics around becoming an informal carer. We estimate this new equation using the FE estimator on a sample in which at least 5 years of life satisfaction and informal care status are consecutively observed (because of the need to go backward two periods and forward two periods). Data were drawn from waves 6–10 and 12–16.

Our empirical strategy is like that adopted by Clark *et al.* (2008) and Frijters *et al.* (2011). Since the table produces many coefficients, in Figure 2 we present only the graphical representations of the implied dynamics of life satisfaction before, during, and after the onset of each type of informal caregiving.

There is little evidence of a negative anticipation effect to becoming a carer for either accident or non-accident victims. This is the case even for women who go on to experience a significant drop in life satisfaction in the year of becoming a caregiver. For female carers, there is little adaptation to providing informal care for either an accident or a non-accident victim even 2 years afterward. Hence, our findings suggest that informal caregiving hurts if you are a woman, and it does not seem to hurt any less the longer you remain a caregiver.

Although there is no significant difference between the genders in terms of CS for providing care for someone who suffered an accident in the last 12 months (t = 1.49), the direct effect of care provision on life satisfaction is significant for women and not for men

Table 3. *Compensating Surpluses for Providing Different Hours of Care for Someone Who Had a Serious Accident Within Last Year.*

Variables	All	Men	Women
Panel A: First-stage FE regression			
Caring for other member who had an accident within last year	−0.159***	−0.123	−0.188***
	(0.059)	(0.083)	(0.086)
Caring for other member who had an accident within last year × 20–99 hours of caring per week	−0.090	−0.087	−0.097
	(0.133)	(0.163)	(0.199)
Caring for other member who had an accident within last year × 100+ hours of caring per week	−0.164	−0.171	−0.152
	(0.142)	(0.250)	(0.170)
Log of real equivalent household income	0.032***	0.040***	0.027***
	(0.006)	(0.009)	(0.009)
Panel B: Second-stage FEF regression			
Within-person average of log of real equivalent household income	0.095***	0.127***	0.097***
	(0.024)	(0.034)	(0.025)
Implied coefficients			
Caring for another member who had an accident +20–99 hours of care per week	−0.249***	−0.210	−0.285**
	(0.096)	(0.141)	(0.129)
Caring for another member who had an accident +100+ hours of care per week	−0.325***	−0.294*	−0.341***
	(0.103)	(0.177)	(0.127)
Average real equivalent household income per annum	£15,228	£15,833	£14,712
CS using time-invariant income:			
CS for caring for another member who had an accident + less than 20 hours of care per week	£12,372	£9,822	£12,594
(i) % of income	81%	62%	86%
(ii) 95% C.I.	[£5,338, £14,403]	[−£6,380, £14,206]	[£2,237, £14,352]
CS for caring for another member who had an accident +20–99 hours per week	£14,121	£12,803	£13,933
(i) % of income	93%	81%	95%
(ii) 95% C.I.	[£6,871, £15,081]	[−£12,078, £15,504]	[£3,575, £14,657]
CS for caring for another member who had an accident +100+ hours of care per week	£14,730	£14,269	£14,275
(i) % of income	97%	90%	97%
(ii) 95% C.I.	[£10,877, £15,171]	[−£9,562, £15,737]	[£8,712, £14,680]

Table 3. *Continued*

Variables	All	Men	Women
CS using time-varying income:			
CS for caring for another member who had an accident + less than 20 hours of care per week	£15,122	£15,102	£14,698
(i) % of income	99%	95%	100%
(ii) 95% C.I.	[£10,999, £15,225]	[−£30,558, £15,821]	[£6,578, £14,712]
CS for caring for another member who had an accident +20–99 hours per week	£15,222	£15,750	£14,712
(i) % of income	100%	99%	100%
(ii) 95% C.I.	[£12,663, £15,228]	[−£79,951, £15,833]	[£9,300, £14,712]
CS for caring for another member who had an accident +100+ hours of care per week	£15,227	£15,823	£14,712
(i) % of income	100%	100%	100%
(ii) 95% C.I.	[£14,859, £15,228]	[−£55,126, £15,833]	[£14,125, £14712]
Observations	129,524	59,551	69,960
Number of individuals	23,091	10,919	12,172

Note: All figures are in £1,000 and are calculated based on the same average real equivalent household income of £16,000 per annum. 95% confidence intervals are reported in brackets. ** <5%; *** <1%.

Table 4. *Compensating Surpluses: Focusing on the Severity of the Care Needed by Including the Effect of the Recipient's Disability on Their Daily Activities.*

Variables	All	Men	Women
Panel A: First-stage FE regression			
Caring for another member who had an accident within last year + cannot do daily activities	−0.191*** (0.059)	−0.148* (0.085)	−0.226*** (0.082)
Caring for another member who had an accident within last year + can still do daily activities	−0.196** (0.090)	−0.152 (0.129)	−0.227* (0.122)
Log of real equivalent household income	0.033*** (0.006)	0.042*** (0.009)	0.027*** (0.009)
Panel B: Second-stage FEF regression			
Within-person average of log of real equivalent household income	0.095*** (0.023)	0.119*** (0.033)	0.095*** (0.025)
Average real equivalent household income per annum	£16,017	£16,666	£15,461

Table 4. *Continued*

Variables	All	Men	Women
CS using time-invariant income:			
CS for caring for another member who had an accident within last year + cannot do daily activities	£13,872	£11,861	£14,029
(i) % of income	87%	71%	91%
(ii) 95% C.I.	[£8,589, £15,398]	[−£3,384, £15,514]	[£7,411, £15,206]
CS for caring for another member who had an accident within last year + can still do daily activities	£13,982	£12,020	£14,044
(i) % of income	87%	72%	91%
(ii) 95% C.I.	[£2,483, £15,711]	[−£23,949, £16,134]	[−£3,030, £15,352]
CS using time-varying income:			
Caring for another member who had an accident within last year + cannot do daily activities	£15,968	£16,175	£15,457
(i) % of income	100%	97%	100%
(ii) 95% C.I.	[£14,264, £16,016]	[−£11,474, £16,657]	[£13,905, £15,461]
Caring for another member who had an accident within last year + can still do daily activities	£15,975	£16,219	£15,458
(i) % of income	100%	97%	100%
(ii) 95% C.I.	[£6,154, £16,017]	[−£191 k, £16,665]	[−£13,558, £15,461]
Observations	125,500	57,875	67,625
Number of individuals	22,618	10,693	11,925

Note: All values are in £1,000 and are calculated based on the average real equivalent household income given in the table. 95% confidence intervals are reported in brackets. ** <5% and *** <1%.

(see Table 1). The lack of significant difference in CS is likely due to the imprecision of the CS estimate for men. We observe a strongly significant gender difference (t = 3.40) for caring for someone who did not suffer an accident, with women much more strongly negatively affected than men. To explain the underlying mechanisms behind the gender differences in life satisfaction between male and female caregivers, Table 5 estimates, separately for men and women, 9 panel regressions and 10 cross-section regressions on different self-reported outcomes. This includes 1 measure of mental strain in the General Health Questionnaire (GHQ-12) measured in all waves, 8 domain satisfactions measured in Waves 6–10 and 12–18, and 10 different measures of SF-36 mental health in Wave 9.

By focusing only on the estimated effect of informal caring following a family member's accident, Table 5 shows that self-reported mental strain levels are almost three times larger for female caregivers than for male caregivers. Women also report a significant drop in financial satisfaction in the year of becoming carers, whereas the equivalent coefficient is positive albeit marginally significant for men.

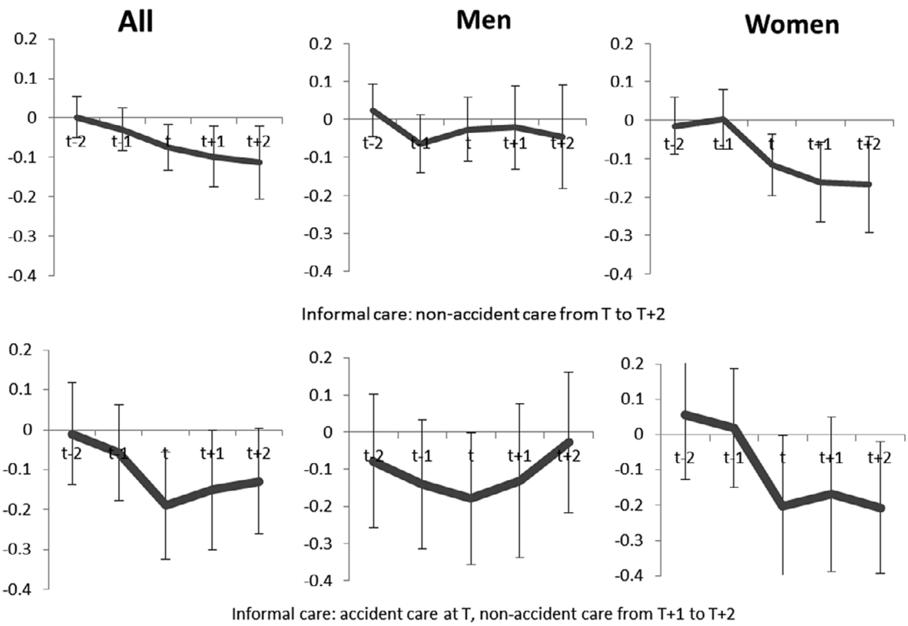

Figure 2. *Leads and lags in the provision of informal care to a person in the household. Panel (*a*) shows the effects where no accident occurs, and Panel (*b*) shows the effects where an accident occurs at time* t. Note*: 4-standard errors (two above, two below) or 95% confidence intervals are reported. Informal caring took place at time* t = *0. Each value represents the lead and lag coefficients of the relevant informal caring variable.*

Table 5. *Explaining Gender Differences in the Effect of Informal Caring Following an Accident.*

The estimated effect of caring for someone who had an accident in the last 12 months on different subjective outcomes	Men	Women
A) Fixed effects		
Mental strain		
GHQ-12 (Caseness)	0.277**	0.801***
Domain satisfaction		
Health satisfaction	0.017	0.018
Financial satisfaction	0.146*	–0.179**
Housing satisfaction	0.116	–0.088
Partner satisfaction	–0.122	0.085
Job satisfaction	0.110	0.123
Social life satisfaction	–0.018	–0.146
Amount of leisure satisfaction	–0.046	–0.188

Table 5. *Continued*

The estimated effect of caring for someone who had an accident in the last 12 months on different subjective outcomes	Men	Women
Use of leisure satisfaction	−0.053	−0.188
B) OLS – Wave 9 only		
SF36 – Mental health		
Past month: felt full of life	0.177	−0.138
Past month: been very nervy	0.317*	0.336**
Past month: felt down in the dump	0.035	0.190
Past month: felt calm and cheerful	−0.082	−0.110
Past month: had lots of energy	0.129	−0.199
Past month: felt downhearted and low	−0.133	0.311**
Past month: felt worn out	0.121	0.097
Past month: been a happy person	−0.096	−0.307**
Past month: felt tired	−0.110	0.350**
Past month: health limited social life	0.018	0.071

Note: *** < 1%; ** < 5%; * < 10%. Any figures that are without a star are statistically insignificantly different from zero at conventional confidence levels. See Table 1 for other control variables. GHQ-12 (Caseness) is a 13-point scale measure of psychological distress that ranges from 0 = best psychological well-being (low anxiety/stress) to 12 = worst psychological well-being (high anxiety/stress). Domain satisfaction is measured on a 7-point scale that ranges from 1 = completely dissatisfied to 7 = completely satisfied. SF-36 mental health, which was measured in Wave 9, elicits the respondent's mental health and is measured on a 6-point scale that ranges from 1 = none of the time to 6 = all the time.

Additionally, female caregivers are more likely to report feeling downhearted and low, feeling tired, or feeling nervy, and less likely to have been a happy person in the past month than female non-caregivers. By contrast, male caregivers only report feeling slightly more nervy in the past month compared to male non-caregivers. These findings are consistent with the hypothesis that female caregivers are more likely to be primary caregivers than male caregivers. Table 5's results also suggest that female caregivers are more likely than male caregivers to worry about their future incomes following an injury sustained by at least one of their family members from an accident.

Moreover, our regressions produce estimated income coefficients that are generally larger for men than for women, which is consistent with previous studies in the well-being literature that find the marginal effect of income on life satisfaction to be larger for men than women (e.g., Frijters et al., 2004).

5.1. Robustness checks

We also carried out the following robustness checks.

First, we examined how the income coefficients obtained from the FEF estimation differ from the more exogenously determined coefficients on lottery wins in the BHPS. We report the results from a significantly reduced sample size that contains only lottery winners in Appendix D. The estimated coefficient on lottery win is imprecisely estimated, which is consistent with previous studies that found a delayed lottery effect on subjective well-being (see, e.g., Gardner & Oswald, 2007). The coefficient on the within-person average of lottery win is positive and statistically significant, taking the value 0.05 (S.E. = 0.02), which is larger than the estimated time-varying income coefficient but still smaller than the estimated time-invariant income coefficient obtained in Table 1. However, the estimated coefficient on caring for someone who had a serious accident is statistically insignificantly different from zero among the sample of lottery winners. These results imply that even though the data on lottery winners are more appealing as their incomes are more exogenously determined than the rest of the population, the large drop in sample size means that there are too few observations of individuals who provide care for those who had experienced a serious accident in the previous year.

We also tested whether qualitatively similar results can be obtained if we were to limit our sample to those households with only two adults where there is less chance of the voluntary care being shared by someone else in the household. The results, reported in Appendix E, reveal that the estimated coefficient on voluntary caregiving is almost the same size ($\beta = -0.201$) as the equivalent coefficient obtained in Table 1. The same also applies to the size of both time-varying and time-invariant coefficients, thus suggesting that it makes virtually no difference to the CS estimates whether or not we limit the sample to consist of those households with only two adult members.

Finally, we checked whether the estimated CS vary significantly when a different time period was used to estimate the time-invariant income effects. To test this, we re-estimated the FEF regression equation on two balanced panels that have information on the person's household income for 7 and 13 consecutive years, respectively. The results, reported in Appendix F, show that the ratios of the parameters of interest, that is, $\frac{\hat{\gamma}}{\hat{\beta}}$, are similar across the unbalanced and the two balanced samples. These figures provide us with some confidence that qualitatively similar CS can be obtained even when different time periods are used to generate the time-invariant income variables.

6. Conclusion

This article provides empirical evidence on the amount that individuals experiencing the well-being losses of providing care might be willing to pay to avoid it. Using combined data on accidents and informal care, as well as the proxy time-invariant income coefficient that is free from unobserved time-invariant bias, we find that the average person providing informal care following an accident would be willing to pay £13,167 in the first year to avoid this situation, which is around £1,097 per month. This estimated CS is significantly larger than the one obtained for informal caregiving for someone who has not had an accident, which is £9,075 in the first year (or £756 per month). It is, however, smaller than the equivalent CS obtained using the time-varying income estimate, £15,165 in the first year. For context, paying for 20 hours of care per week for 52 weeks at an assumed cost of £9 per hour in the private care market would mean paying £9,360 per year for this care to be provided. It should come as no surprise that caring for a household member, with the associated emotional burdens, results in a larger implied cost.

Our results are also stronger for female than male caregivers, and we find little evidence of hedonic adaptation to providing care for either accident or non-accident victims in the household. Assuming that accidents that befell other family members are randomly distributed across carers in a fixed effects regression, the results provide some of the first large-scale evidence of the experienced utility effect of unanticipated informal caregiving, as well as their shadow prices.

In conclusion, it appears that an unexpected move into informal caregiving is a depressing life event, especially for women. This can be explained largely by the fact that, compared to male caregivers, female caregivers are significantly more likely to be primary caregivers; provide more intensive and complex care; have difficulty with care provision and balancing caregiving with other family and employment responsibilities; have relatively little formal caregiving support; and suffer from poorer emotional health secondary to caregiving. As such, it should probably come as no surprise that we find a stronger statistically significantly negative effect of informal caring for women than for men (e.g., Pinquart & Sorensen, 2003).

Aside from the policy-relevant estimates of the societal value of the SWB losses resulting from the provision of informal care, we hope to have presented a valuable new approach to estimating CS based on a time-invariant income coefficient that has been estimated free from individual fixed effects bias – though not necessarily from the unobserved time-varying bias. We believe that by adopting the FEF approach in the WV method, we can help improve the way cost–benefit analysis is typically carried out in decision-making for public policy even when there is no good IV for income available in the data.

Of course, our study is not without limitations. Both time-varying and time-invariant income measures are endogenously determined even when individual fixed effects are accounted for in the estimation. Short of having randomly assigned income that shifts people's average life-time earnings, such as lottery or inheritance windfalls of life-changing amounts, there is little that can be definitively done about the endogeneity of time-invariant income in standard data sets. This is an important point, and one that should stimulate future research in this area.

In addition to this, our article is silent on why some family members are willing to provide informal care but not others, and whether some accidents lead to informal caregiving by the household member in question but not others. These issues illustrate the difficulty inherent in identifying a clear counterfactual case for analysis. However, despite its limitations, our approach improves upon previous studies into the well-being effects of informal care provision by controlling for the usual endogeneity of the decline into the need for care for health reasons. Nonetheless, these questions illustrate that there is still considerable scope for omitted variable bias in the estimates of caregiving on the caregiver's subjective well-being, and that more research in this area is warranted.

Nevertheless, we believe that we have made a significant contribution to the WV literature by being among the first to attempt to estimate the effect of caregiving on the caregiver's life satisfaction conditional on a serious accident occurring in the household, and subsequently compare the implied CS across different income coefficients.

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Data availability statement. The British Household Panel Surveys (BHPS) is publicly available at https://beta.ukdataservice.ac.uk/datacatalogue/studies/study?id=5151. The code used to generate and analyse the data, as well as the Excel file used to generate the shadow prices, can be downloaded from https://github.com/npowdthavee/shadowprices.

Author contribution. Both R.M. and N.P. contributed equally to the conception, empirical analysis, and the writing of the manuscript.

Competing interest. The authors declare none.

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A. Appendix

Table 6. *Variable Summary.*

Variable	Mean	S.D.
Life satisfaction*	5.163	1.262
Within-person average of log of real equivalent household income*	9.439	0.536
Log of real equivalent household income*	9.468	0.703
Caring for other member who did not have an accident within last year	0.0508	0.220
Caring for other member who had an accident within last year	0.00460	0.0677
Providing medium-hours care (20–99 hours per week)	0.010	0.099
Providing long-hours care (100 or more hours per week)	0.012	0.110
Had accident within last year and being cared for	0.00310	0.0556
No accident within last year and being cared for by another member	0.0210	0.143
Proportion of "other" household members who had a serious accident within last year	0.0966	0.240
Age*	39.39	13.79
Age-squared*	1742.1	1113.3
Disabled	0.0497	0.217
Unemployed	0.0405	0.197
Self-employed	0.0781	0.268
Retired	0.0627	0.242
Not in the labour force	0.163	0.369
Married	0.531	0.499
Cohabiting	0.137	0.344
Divorced	0.0569	0.232
Separated	0.0191	0.137

Table 6. *Continued*

Variable	Mean	S.D.
Health: Poor	0.0811	0.273
Health: Fair	0.215	0.411
Health: Good	0.437	0.496
Health: Excellent	0.244	0.429
Highest qualification: Higher degree	0.0290	0.168
Highest qualification: 1st degree	0.115	0.319
Highest qualification: HND, HNC, teaching	0.0708	0.256
Highest qualification: A-level	0.214	0.410
Highest qualification: O-level	0.278	0.448
Highest qualification: CSE	0.0596	0.237
Homeowner	0.743	0.437
Number of days spent in the hospital in the last 12 months*	0.644	4.998
Number of children in the household	0.620	0.987

Note: $N = 129{,}524$. *denotes non-binary variables.

B. Appendix

B.1. Procedures for calculating 95% confidence intervals and *t*-tests for comparisons between CS estimates

We calculated the CS's 95% confidence intervals using the following formulas.

Upper 95% C.I.: $\bar{y} \times \left(1 - \exp\frac{\widehat{\gamma_U}}{\beta}\right)$, and.

Lower 95% C.I.: $\bar{y} \times \left(1 - \exp\frac{\widehat{\gamma_L}}{\beta}\right)$,

where $\widehat{\gamma_U}$ is $\hat{\gamma} + 1.96 \times S.E.(\gamma)$ and $\widehat{\gamma_L}$ is $\hat{\gamma} - 1.96 \times S.E.(\gamma)$ Given the exponential function in the CS formula, the estimated values of the upper and lower confidence intervals are naturally asymmetrical.

To conduct a *t*-test on the difference between two CS values, we applied the following formula

$$t = \frac{CS_a - CS_b}{\sqrt{\left(S.E._{CS_a}^2 + S.E._{CS_b}^2\right)}},$$

where CS_a and CS_b are the estimated CS for conditions a and b, respectively. Both $S.E._{CS_a}$ and $S.E._{CS_b}$ are standard errors of CS_a and CS_b, which can be calculated from each respective CS's 95% confidence interval using the following formula

$$S.E._{CS_a} = \frac{(95\%\ C.I. \text{ of } CS_a - CS_a)}{1.96}$$

However, since the absolute values of the upper and lower 95% C.I. are asymmetrical, we used the upper 95% C.I. value for CS_a and the lower 95% C.I. value for CS_b where $CS_a < CS_b$ in the t-test formula.

C. Appendix

Table 7. *Estimates of Other Control Variables.*

	(1)	(2)	(3)
Variables	All	Men	Women
Age	−0.037***	−0.075***	−0.021**
	(0.012)	(0.016)	(0.010)
Age-squared	0.000***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)
Disabled, long-term illness	−0.343***	−0.467***	−0.254***
	(0.031)	(0.048)	(0.041)
Unemployed	−0.301***	−0.358***	−0.247***
	(0.022)	(0.031)	(0.032)
Self-employed	0.008	0.003	0.017
	(0.018)	(0.022)	(0.030)
Retired	0.027	−0.003	0.052*
	(0.023)	(0.036)	(0.030)
Not in the labour force	−0.006	−0.015	0.006
	(0.014)	(0.029)	(0.016)
Married	0.173***	0.189***	0.168***
	(0.024)	(0.036)	(0.033)
Cohabiting	0.196***	0.213***	0.188***
	(0.021)	(0.031)	(0.028)
Divorced	−0.021	−0.061	−0.001
	(0.038)	(0.060)	(0.049)
Separated	−0.221***	−0.285***	−0.183***
	(0.041)	(0.062)	(0.053)
Health: poor	0.384***	0.429***	0.355***
	(0.033)	(0.047)	(0.044)
Health: fair	0.655***	0.676***	0.642***
	(0.033)	(0.049)	(0.045)
Health: good	0.863***	0.890***	0.846***
	(0.034)	(0.049)	(0.045)
Health: excellent	1.000***	1.019***	0.989***
	(0.034)	(0.050)	(0.047)
Higher degree	0.078	0.068	0.099
	(0.072)	(0.107)	(0.098)
First degree	0.020	−0.047	0.066
	(0.054)	(0.086)	(0.069)
HND, HNC, teaching	0.080	−0.026	0.179*
	(0.064)	(0.087)	(0.092)
A-level	0.059	0.029	0.086
	(0.047)	(0.075)	(0.060)

Table 7. *Continued*

	(1)	(2)	(3)
Variables	All	Men	Women
O-level	0.047	0.096	0.021
	(0.047)	(0.073)	(0.060)
CSE	−0.045	0.106	−0.196*
	(0.096)	(0.151)	(0.118)
Own home outright	0.004	−0.017	0.022
	(0.016)	(0.022)	(0.022)
Number of days spent in hospital last year	−0.002**	−0.003**	−0.002
	(0.001)	(0.001)	(0.001)
Number of children under 16	−0.001	0.008	−0.011
	(0.007)	(0.011)	(0.010)
Constant	4.520***	5.669***	4.252***
	(0.518)	(0.695)	(0.450)
Observations	129,520	59,517	69,994
R-squared	0.044	0.051	0.042
Number of individuals	23,088	10,917	12,171

Note: *** < 1%; ** < 5%; * < 10%. Standard errors are in parentheses.

D. Appendix

Table 8. *The Income Estimates of Lottery Winners.*

Variables	All
Panel A: First-stage FE regression	
Caring for other member who had an accident within last year	−0.133
	(0.211)
Log of lottery win	0.009
	(0.008)
Log of real equivalent household income	0.066***
	(0.027)
Panel B: Second-stage FEF regression	
Within-person average of log lottery win	0.052***
	(0.074)
Within-person average of log of real equivalent household income	0.198***
	(0.074)
Observations	12,545
Number of individuals	5,771

Note: *** < 1%. Standard errors are in parentheses.

E. Appendix

Table 9. *Limiting the Sample Size to Households with Only Two Adult Members.*

Variables	All
Panel A: First-stage FE regression	
Caring for other member who had an accident within last year	−0.201***
	(0.078)
Log of real equivalent household income	0.034***
	(0.009)
Panel B: Second-stage FEF regression	
Within-person average of log of real equivalent household income	0.115***
	(0.032)
Observations	68,525
Number of individuals	14,421

Note: *** < 1%. Standard errors are in parentheses.

F. Appendix

Table 10. *Balanced Panel Regressions.*

Variables	Estimates from Table 1	Within-person average income generated using 7 years of balanced panel (BHPS: Waves 6–12)	Within-person average income generated using 13 years of balanced panel (BHPS: Waves 6–18)
Panel A: First-stage FE regression			
Caring for other member who had an accident within last year	−0.192***	−0.286***	−0.244***
	(0.050)	(0.104)	(0.075)
Log of real equivalent household income	0.035***	0.036***	0.032***
	(0.006)	(0.012)	(0.009)
Panel B: Second-stage FEF regression			
Within-person average of log of real equivalent household income	0.096***	0.140***	0.136***
	(0.024)	(0.039)	(0.030)
Ratio of $\widehat{\frac{\gamma}{\beta}}$ *for time-invariant income*	−2.00	−2.04	−1.79
Exponential of $(\widehat{\frac{\gamma}{\beta}})$	0.14	0.13	0.16
Observations	129,524	38,979	67,527
Number of individuals	23,091	7,885	7,801

Note: *** < 1%. Standard errors are in parentheses.

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