The impact of informal care provision on loneliness & social isolation

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Abstract

While informal care is regarded as an appealing alternative to formal care, it often comes at the expense of the caregiver. Existing studies have primarily focused on the financial implications of informal caregiving with limited attention to its hidden costs, including social aspects. This study contributes to the literature by examining the effects of informal caregiving on loneliness and social isolation using longitudinal data from a large nationally representative household survey in Australia. To study the relationship, we first employ a dynamic difference-in-differences (DID) method, exploiting the variation in the timing of caring across informal caregivers. Second, we complement our analysis with an instrumental variables (IV) method, using eligibility to government-funded *Carer Payment* as IV. Both strategies show that informal caregiving increases the probability of experiencing loneliness, particularly among female and spousal caregivers. Our DID results do not show an effect on social isolation, whereas IV estimates suggest that informal caregiving increases social isolation among male compliers, but not females. Some of the effect of informal care on social health seems to be driven by changes to the relationship satisfaction between spouses when taking on a carer role.

Keywords: informal care, loneliness, social isolation, mechanism, relationship
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1 Introduction

With an ageing population, the global burden of disease is growing and care demands are rising, placing pressure on already stretched long-term care (LTC) systems (Barczyk and Kredler, 2019; Feigin et al., 2016). LTC is a labour-intensive sector, which has experienced substantial problems in recruiting and training of new staff, as well as retaining its existing workforce (OECD, 2020). Governments around the world are therefore incentivising the supply of care within the community, away from institutions, forgoing the high direct costs of formal care alternatives. Also among households, informal care is regarded as an appealing alternative to formal care, due to low out-of-pocket costs and the ability to accommodate care recipients' preferences of ageing in place (Bonsang, 2009; Bakx et al., 2015; Guerrero et al., 2020; Hollingsworth et al., 2022; Lee and Kim, 2012; Urwin et al., 2019). But despite this seemingly low-cost alternative to formal care, providing informal care can create large opportunity costs, that are potentially less tangible and hidden from decision makers (Cecchini, 2018).

Externalities of informal caregiving remain understudied, primarily, because people who select into caregiving differ in many ways from those that do not, often based on characteristics that also impact outcome measures, making it hard to establish causal estimates. To date, few studies have accounted for this selection issue, linking informal caregiving to reduced income, wages, and employment of the caregiver (Leigh, 2010; Heger and Korfhage, 2020; Schmitz and Westphal, 2017; Schmitz and Stroka, 2013; Simard-Duplain, 2022; Van Houtven et al., 2013). Other studies have shown that providing informal care can negatively affect the caregiver's health and well-being (Bom et al., 2019; Bom and Stöckel, 2020; De Zwart et al., 2017; Heger, 2017; Schmitz and Westphal, 2015; Van den Berg et al., 2014). In the latter, well-being has been measured using a general life satisfaction rating, without a clear understanding of the specific aspects of well-being, that are being impacted. In this paper, we investigate two dimensions of well-being as underexplored externalities of caregiving. More specifically, we study the impact of informal care provision on loneliness and social isolation, contributing to the evolving literature on the costs of informal caregiving.

Loneliness and social isolation are of particular interest in the context of well-being among caregivers for several reasons. First, in a report commissioned by *Carers UK*, a membership charity for carers in the United Kingdom, over half of carers responded they had lost touch with friends and family because of their caring responsibilities, which negatively impacted their social connectedness (CarersUK.org, 2015). Second, the prevalence of both loneliness and social isolation is rising, not only among the older population who traditionally were known to be at higher risk, but primarily among young people, with some experts calling it a new epidemic and the World Health Organization declaring it a global public health concern (General, 2023; WHO, 2024). Prevalence estimates suggest that women are more often impacted by loneliness whereas males more often suffer from social isolation. Lastly, new evidence and awareness of the health and economic consequences of social health have emerged over the last decade (Kung et al., 2021). Studies have found that loneliness and social isolation are not only related to mental health and quality-of-life, but also to physical health, reduced productivity and higher staff turnover rates (Holt-Lunstad et al., 2015; Jeffrey et al., 2017; Manera et al., 2022).

To study the relationship between informal caregiving, loneliness and social isolation, we use a large longitu-

dinal dataset from a representative sample of Australian households over an 18-year period (2005-2022). The Household Income and Labour Dynamics Survey in Australia (HILDA) includes rich information on respondent's time spent caring for family members or relatives and their social health since 2005. To overcome the problem that selection into caregiving is non-random, we use two complementary identification strategies. First, we restrict our sample to only include respondents who provide informal care at some point during our 18-year study period and exploit the timing of the 'onset' of caregiving using a dynamic difference-in-differences (DID) method. Our identification assumption is that this homogenous group of respondents only differ in the timing of when they start providing informal care. Second, we complement this analysis employing an instrumental variables (IV) method, using exogenously annually determined eligibility criteria for informal carers to receive income support payment, known as the *Carer Payment*, as IV.[1]

Several features of our IV ensure that it fulfills the exclusion restriction. First, the *Carer Payment* eligibility rules are determined by the Australian Government every six months, where income and asset thresholds are indexed based on consumer price indices and average earnings. In addition, the *Carer Payment* underwent a program reform in 2009 that imposed more substantial changes to the income cut-off threshold to access the income support payment, creating an unanticipated change in eligibility criteria. Second, we determine respondent's eligibility based on their income and assets in the survey interview prior to a serious health shock to a family member or relative.[2] We expect such a life event to create an exogenous demand shock for respondents to provide informal care (Hollingsworth et al., 2022). Measuring eligibility prior to such an event will eliminate a scenario where people change their labour market behaviour to become eligible for the *Carer Payment* when care demand arises, which could be a threat to our identification strategy. To provide evidence that respondents do not manipulate their eligibility when starting to provide informal care, we show that the distribution of when carers become eligible relative to when they start caring is approximately uniformly distributed.

Our DID results show that taking on caring responsibilities significantly increases the chance of feeling lonely, with an average effect size of around 3.5 percentage points. The event study estimates show that on average two years after starting to provide informal care, there is a statistically significant increase of around 2.5 percentage points in the probability of feeling lonely, which increases to 2.9 percentage points in year three and four, with recovery thereafter. Separating our sample by gender, results reveal that the effect is only statistically significant for our female sample, with slightly higher effect sizes. For females we find an average increase of 4.8 percentage points. In contrast, we do not find an effect of informal care on social isolation.

Also our IV estimates show a positive effect of informal caregiving on loneliness. This is true even when

[1]Next to altruistic motives, respondent's decision to provide informal care (or not) is usually influenced to some extent by their opportunity costs and/or financial incentives (Løken et al., 2017). To compensate caregivers for their time, Australians may be eligible to receive means-tested income support. Being able to receive support payments when caregiving will presumably impact the decision of whether to take on caring duties or not.

[2]Respondents in HILDA are asked whether a close relative or family member experienced a serious personal injury or illness in the past year. Such a serious health shock or injury is usually sudden and unanticipated and can cause long-term disability and illness (Fadlon and Nielsen, 2021). Chronic disease and disability are the main reasons why individuals require LTC, often increasing care dependency abruptly.

focusing on respondents who do not reduce their employment by more than 8 hours per week, providing reassurance that the effect is not only due to people dropping out of the labour force. Average effect sizes for the whole sample vary between 10 to 18 percentage points, depending on the specification, i.e., whether we only use the income or consider also the assets when determining *Carer Payment* eligibility of respondents. Again, we find that caregiving increases the probability of feeling lonely only for females with no effect on male caregivers. The IV results for social isolation indicate that informal care increases the likelihood of being socially isolated at the 10% significance level by 8 to 15 percentage points. Separating the analyses by gender, we find that the effect is only statistically significant for the male sample, whereas we don't find any effect for females. These findings are in line with the psychological literature on the topic (Li et al., 2021).

Next, we analyse the responses to caregiving across different caregiver - care recipient relationships and study changes in the relationship satisfaction as potential pathway. Results suggest that it is primarily informal caregivers who care for a spouse who are more likely to experience loneliness or social isolation. The effect for female spousal caregivers seems to be on loneliness and for male spousal caregivers on social isolation. This is consistent across our DID and IV results. We do not find an effect among informal caregivers who provide care to a child or parent, also due to small F-statistics and inconsistent results in the first stage IV estimation.

Probing further into the relevant mechanism behind the effect of caregiving on loneliness and social isolation, we study satisfaction with the relationship to the care recipient as potential explanatory pathways.[3] Applying a two-step strategy, we first show that becoming an informal caregiver for a spouse negatively impacts the respective relationship. Including the relationship satisfaction measure in our main specification as control variable, we find that the informal caregiving coefficients slightly diminish, indicating that the caregiver-care recipient relationship satisfaction may play a role in the informal care and social health relationship (Skaff and Pearlin, 1992).

Our study makes several important contributions to the literature. First, we provide robust estimates of the effect of informal caregiving on loneliness and social isolation that address issues of self-selection. Studies investigating this relationship so far have mainly used cross-sectional data (Hajek and König, 2019; Beach et al., 2021).[4] Having information on informal care and loneliness at only one point in time does not allow researchers to make firm conclusions about the direction of causation, if any. In addition, people who select into caregiving most likely differ from those who do not. This self-selection issue implies that some confounding factors are inherently unobservable and cross-sectional data won't be sufficient to tackle the endogeneity problem.

[3] In addition to primary stressors that are related to the disability and needs of the care recipient, Pearlin et al. (1990) classify secondary stressors as role strains, including job and family conflicts, which are often related to the quality of the caregiver - care recipient relationship. HILDA collects information on the type of relationship between caregiver and care recipient (e.g. spouse, child, parent) as well as changes to the relationship satisfaction. This information allows us to study how changes to the level of satisfaction with the relationship may mediate the impact of providing informal care on social health.

[4] To the best of our knowledge, only two studies have used longitudinal data to study the relationship between informal caregiving and loneliness (Hajek and König, 2019; Zwar et al., 2020). Zwar et al. (2020) used two waves from the German Ageing Survey and employ a fixed-effects regression, showing that caregiving is significantly associated with higher levels of loneliness among males. Hajek and König (2019) used two earlier waves of the same survey and found no difference in loneliness between caregivers and non-caregivers. The models employed can address time-invariant omitted variable bias, but issues of self-selection may persist.

Second, our paper adds to the existing literature investigating the effects of informal caregiving on mental health and well-being, with loneliness and social isolation being important determinants of these health dimensions. Several studies have examined the effect of informal care on mental health [5], depression and/or anxiety[6], life-satisfaction[7], and well-being [8], but the potential explanatory pathways in the relationship are not well understood. A number of pathways are discussed qualitatively (Hajek et al., 2023), and Le and Ibuka (2023) provide some early evidence that the loss of social networks may play a role but acknowledge that causal evidence is missing. The importance of social connections in a person's overall well-being has recently received much attention with the World Health Organization establishing a Commission on Social Connection (WHO, 2024). Understanding the exact pathways of how caregiving impacts well-being and mental health will help policy makers to design interventions that can help reduce these kind of opportunity costs.

Third, we add to the literature by identifying potential mediators in the relationship between informal care, loneliness and social isolation. The decision to become a caregiver for a family member or relative is usually a complex decision, partially driven by a sense of family responsibility. One reason why some caregivers may end up feeling lonely or socially isolated can depend on several moderating factors. A key determinant may be changes in the caregiver-care recipient relationship when transitioning into a caregiver role. Literature has shown that prolonged periods of caregiving for a spouse can culminate in psychological distress which can interfere with the quality of the relationship (Schmitz and Westphal, 2015). Especially loneliness, which is defined as a subjective feeling of good quality and satisfying social relationships may be impacted by a change in satisfaction with the relationship (Badcock et al., 2022). In contrast, social isolation is defined as 'objectively' having few social relationships or infrequent social contact, which may be driven by time constraints due to caring responsibilities (Badcock et al., 2022). In line with our theory (Pearlin et al., 1990) and previous qualitative literature (Skaff and Pearlin, 1992), we provide evidence that caring for a spouse leads to a deterioration in the satisfaction with their relationship, which seems to explain at least to some extend the effect on social health.

The rest of the paper proceeds as follows. In Section 2 we provide an overview of the institutional background for carers and the *Carer Payment* in Australia. Section 3 presents the data and variables. Section 4 outlines the research design and empirical strategies. In Section 5, we present results for our main specifications, as well as heterogeneous results by caregiver - care recipient relationship, robustness checks and potential mechanisms. Section 6 discusses and concludes.

2 Background

Informal carers are defined as people who provide care to someone in need within the context of an existing relationship, such as a family member, relative or a friend. In 2018, 10% of the Australian population (2.65 million people) provided some form of informal care (AIHW, 2021). Informal carers thus play a crucial role in

[5] See Bom et al., 2019; Bom and Stöckel, 2020; Coe and Van Houtven, 2009; Le and Ibuka, 2023; Schmitz and Westphal, 2015.
[6] see Coe and Van Houtven, 2009; De Zwart et al., 2017; Heger, 2017; Kolodziej et al., 2022.
[7] see Le and Ibuka, 2023.
[8] see Chen et al., 2019; Van den Berg et al., 2014.

sustaining the viability of the LTC system in Australia and hence the government provides a range of support services for carers, including financial assistance and income support. The *Carer Payment* is the most meaningful financial support for caregivers. If caring duties are significant enough "to limit their ability to engage in paid work", carers can receive this means-tested income support payment (AIHW, 2021). To access the payment the caregiver must meet eligibility rules. Despite being an Australian resident and providing constant and substantial care, the caregiver has to pass an income and asset test. In 2022, the maximum income threshold (i.e. before becoming ineligible for the payment) was with about 82,500 Australian dollar ($) slightly below the annual median Australian household income and more than 75% of the Australian population owned less than the maximum asset threshold of $1,127,700 in assets. The monthly maximum payment in the same year was close to the minimum wage with $3,932 for a single and $5,928 for a couple. In total, around 10% of all informal carers received the *Carer Payment*.

Carers may also receive the *Carer Allowance*, which is a much smaller payment and can be paid in addition to the income support payment. The *Carer Allowance* eligibility rules are less stringent and available to more informal carers, than the *Carer Payment*. Other support services include short-term care such as *Respite Care*, which may involve someone else providing care for a few hours a week to support the primary carer, and the *Carer Supplement*, a once-per-year payment to cover costs e.g. for aids. Besides the support for caregivers, people aged 65 and above with disease, disability or frailty are also entitled themselves to government-funded aged care services.[9] While this funding can be used to pay for formal caregivers, it is not possible to use the money to compensate informal caregivers. Similarly, people with disability may be able to receive financial support through the *National Disability Insurance Scheme (NDIS)*, but this funding does not allow to pay a family member or friend to be a support worker. This means the *Carer Payment* is the most important financial support service for informal caregivers, making it particularly relevant for our study. Discussed further below, we use the eligibility criteria for the *Carer Payment* as IV to identify the causal effect of informal caregiving on loneliness and social isolation.

3 Data and variables

3.1 Data source

For our empirical approach, we use longitudinal data from the HILDA survey, which collects yearly information of about 17,000 individuals living in private households using face-to-face interviews and self-completion questionnaires. Data includes demographic characteristics, respondent's health status, information on informal caregiving, social capital, social support, employment and time use; among many others (Watson and Wooden, 2012). While HILDA started in 2001, we focus on survey waves 2005 and onwards, because the informal care module was not introduced until then. Our sample includes respondents between the ages 15 and 80. Descriptive

[9]The Commonwealth Home Support Programme is one of such services and was introduced to keep old people with disability at home when care needs are not too severe (Australian Government, 2022). The Home Care Packages were introduced in 2013 to support people with more complex needs. When entering into aged care approval from the Aged Care Assessment Team (ACAT) is required. An assessment is carried out under the Federal Government's Aged Care Assessment program (ACAP) to determine an individual's care needs, their eligibility and the corresponding financial care package (Australian Government, 2022).

statistics are summarised in Table 1 and variable definitions are presented in Table A1 in the Appendix.

3.2 Variables

Informal care

We identify respondents as informal caregivers if they answered to be 'actively caring for a household member or for non-residents due to a long-term health condition, elderly, disability' (Zhu and Onur, 2023; Van den Berg et al., 2014). In robustness checks, we focus on (i) respondents who provide care to a household member only, and (ii) study the logarithm of the average number of hours in a typical week respondents report spending time 'caring for a disabled spouse or disabled adult relative or caring for elderly parents or parents-in-law'. Our heterogeneity analysis further distinguishes caregiving for (i) a spouse, (ii) a child, or (3) a parent.

Loneliness

Consistent with previous studies (Flood and Flood, 2005; Kung et al., 2021), we measure loneliness using the HILDA question asking whether respondents agree with the following statement: "I often feel very lonely." Responses to this question are arranged on a seven-point scale (from 1 "strongly disagree" to 7 "strongly agree"). To obtain a binary measure, responses from (5) somewhat agree to (7) strongly agree, were coded as 1 (Yes) to denote loneliness while (1) to (4) were coded as 0 (No), to indicate otherwise.

Social Isolation

While loneliness is a subjective feeling and is measured directly in HILDA, social isolation is an objective state, where respondents have only few social relationships or infrequent social contact with others. While living alone is often an important risk factor for social isolation, the majority of informal caregivers live with the person they care for but can still be socially isolated if other social connections are lacking. Hence, we classify a respondent as being socially isolated if they report to only 'get together socially with friends or relatives not living with them' less than once per week and they strongly agree, agree or somewhat agree with the following statement 'people don't come to visit me as often as I would like'.

Control variables

The decision to provide informal care to a family member or relative in need depends to a large extent on a person's preferences, time constraints and related opportunity costs. These vary substantially by socio-demographic background. To account for this, we control for age, household income and educational attainment (whether they received a Bachelor's degree or higher). To account for time constraints, we control for the number of hours a respondent works in a regular week, their marital status and the number of children. The household size is an important predictor for caregiving, and physical health problems may impede with the ability to provide care, which we wish to control for by including a binary variable on whether a respondent has restrictions with activities of daily living (such as dressing or bathing themselves, lifting or carrying groceries, climbing several flights of stairs etc.). Exact variable definitions are provided in A1.

Mechanisms

In our mechanism analysis, we are interested in whether changes to a carer's relationship satisfaction with the care recipient may be one explanatory pathway influencing how informal caregiving may lead to loneliness or social isolation. Respondents in HILDA are ask how satisfied or dissatisfied they currently are with the relationship with their (i) partner, (ii) child, and (iii) parent. Knowing who the respondents care for, we study how informal caregiving may increase the chance of answering *completely dissatisfied* on a scale of 0 = completely dissatisfied to 10 = completely satisfied.

Table 1: Summary Statistics

	Informal caregiving (Yes/No)		All respondents
	No (N = 264,334)	Yes (N = 20,769)	
Informal care			
Informal caregiving (Yes/No)			0.073 (0.260)
Informal caregiving within the household (Yes/No)			0.044 (0.205)
Informal caregiving for a spouse (Yes/No)			0.022 (0.145)
Informal caregiving for a child (Yes/No)			0.018 (0.133)
Informal caregiving for a parent (Yes/No)			0.025 (0.157)
Weekly hours of informal care	0.442 (3.999)	14.726 (26.886)	1.509 (9.104)
Social Health			
Loneliness (Yes/No)	0.174 (0.379)	0.220 (0.414)	0.177 (0.382)
Social Isolation (Yes/No)	0.167 (0.373)	0.208 (0.406)	0.170 (0.376)
Individual Level Controls			
Age	44.339 (19.084)	51.889 (16.608)	44.889 (19.016)
Female (Yes/No)	0.518 (0.500)	0.643 (0.479)	0.527 (0.499)
Whether has children (Yes/No)	0.638 (0.481)	0.792 (0.406)	0.649 (0.477)
Bachelor's degree or higher (Yes/No)	0.250 (0.433)	0.209 (0.407)	0.247 (0.431)
Household income	93,778 (76,657)	82,739 (74,466)	92,974 (76,553)
Married (Yes/No)	0.457 (0.498)	0.578 (0.494)	0.466 (0.499)
Number of working hours	23.589 (21.105)	15.556 (19.669)	23.004 (21.107)
Restrictions with ADL (Yes/No)	0.442 (0.497)	0.623 (0.485)	0.456 (0.498)
Household size	2.859 (1.477)	2.963 (1.428)	2.867 (1.474)
Instrumental variables			
Family health shock × eligibility for CP based on income test only (Yes/No)	0.372 (0.483)	0.465 (0.499)	0.380 (0.485)
Family health shock × eligibility for CP based on income & asset test (Yes/No)	0.345 (0.475)	0.448 (0.497)	0.354 (0.478)
Mechanism: Relationship satisfaction			
Dissatisfied with relationship to spouse (Yes/No)	0.009 (0.094)	0.012 (0.108)	0.009 (0.095)
Dissatisfied with relationship to parent (Yes/No)	0.015 (0.121)	0.021 (0.143)	0.015 (0.123)
Dissatisfied with relationship to child (Yes/No)	0.010 (0.101)	0.009 (0.097)	0.010 (0.100)

Note: Standard deviation appear in parentheses. CP = *Carer Payment*.

4 Empirical and identification strategy

Difference-in-differences method

The goal of our study is to understand the causal effect of caregiving on feeling lonely or being socially isolated. Identification of a causal effect of caregiving on social health is challenging, because caregiving is usually a choice and people who select into caregiving systematically differ from those who don't. Therefore, simple ordinary least square (OLS) results may be biased. To tackle the endogeneity issue due to this selection bias, in our first empirical strategy we focus on a homogenous group of people who all decide to take on informal care at some point during the study period, but at different points in time. In other words, they only differ in the timing

of when they start to provide informal care. We then implement an event study design in which we compare changes in loneliness in the years after people take on informal caring responsibilities. Individuals who have not yet provided informal care to a family member or relative act as a control group.

Our analysis relies on the assumption that loneliness and social isolation would have developed similarly among the control group in the counterfactual event that they had not taken on caring responsibilities. To support this identification assumption, we present our estimates in the form of event study graphs to establish that trends in the treatment and control group behaved similarly in the years preceding informal care. In addition, we control for a respondent's average weekly hours of work and their income prior to providing informal care as well as their age. In other words, conditional on working the same hours, having the same income and being around the same age, we would expect the treatment and control group to experience the same loneliness and social isolation trajectory prior to informal caregiving.

The corresponding empirical model reads as follows:

$$Y_{it} = \alpha_i + \eta_t + \sum_{\tau=-7, \tau \neq -1}^{7} \beta_\tau \times \mathbb{1}(InformalCare_{i,t} = \tau) + X'_{it}\Gamma + \epsilon_{it} \quad (1)$$

where *i* denotes individuals and *t* denotes the survey waves. $\mathbb{1}(InformalCare_{i,t} = \tau)$ are binary variables indicating the informal caregiving status of individual *i* at time *t*, with τ the number of years relative to the year the respondent indicated for the first time to be providing informal care to a relative or friend. τ = 0 denotes the year the respondent first provided informal care and the year prior to caring (τ = -1) is the omitted category. Y_{it} indicates whether respondent *i* experiences (1) loneliness or (2) social isolation at time *t*. X' is a vector of our pre-treatment control variables. α_i are individual fixed effects, η_t are time effects and υ_{it} is the idiosyncratic error term.

Difference-in-differences approaches with staggered timing of treatments, as is the case in our study, might lead to biases if newly treated observations, so called 'switchers', are compared with already treated observations. This is because traditional Two-Way Fixed Effects (TWFE) frameworks estimate a variance-weighted average of treatment effects, which may include 'negative weights' in a scenario where treatment effects change over time. This problem can be prevented by comparing newly treated observations only with not yet treated observations, implemented in contemporary DID estimators that account for the negative weighting problem (Callaway and Sant'Anna, 2021; De Chaisemartin and d'Haultfoeuille, 2024; Sun and Abraham, 2021). We use the dynamic event study estimator by De Chaisemartin and d'Haultfoeuille (2024), which allows for heterogeneity in the level of treatment. The estimator also permits time-varying co-variates and the outcome being affected by current and lagged treatments.

Instrumental variables (IV) method

In the second empirical strategy, we employ an instrumental variables approach. Here, we begin with the naive specification, regressing loneliness and social isolation on a binary informal caregiving variable, given by the

following equation:

$$Y_{it} = \beta_0 + \beta_1 InformalCare_{it} + \mathbf{X}_{it}\beta_2 + \eta_t + \upsilon_{it} \tag{2}$$

where $InformalCare_{it}$ indicates the informal caregiving status of individual *i* at year *t*. Y_{it} is a binary variable indicating whether respondent *i* experiences (1) loneliness or (2) social isolation at time *t*. ***X*** is a vector of control variables discussed in Section 3. η_t are time effects and υ_{it} is the idiosyncratic error term.

Results from an OLS model are unlikely to be consistent due to endogeneity issues discussed in Section 1. As a next step, we therefore employ a Fixed Effects (FE) model, taking advantage of the panel data nature of HILDA:

$$Y_{it} = \theta_0 + \theta_1 InformalCare_{it} + \mathbf{X}_{it}\theta_2 + \eta_{1t} + \alpha_{1i} + \epsilon_{1it} \tag{3}$$

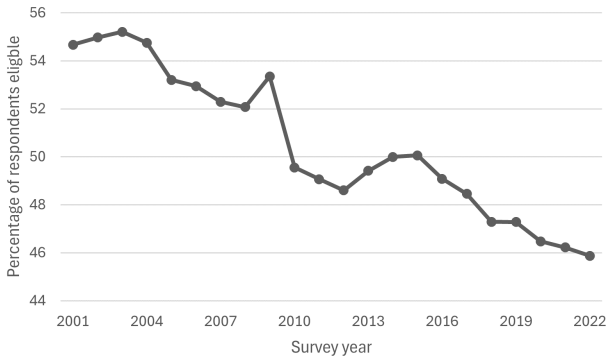
where α_{1i} are individual fixed effects, which resolve any problems resulting from a correlation between informal care and unobserved individual heterogeneity. The identification in this model comes from the within-individual variation in providing informal care and their loneliness/social isolation status during the sampling periods.

While the FE model will eliminate all time-invariant characteristics that are associated with both the decision to provide informal care as well as loneliness/social isolation, self-selection issues may persist. We address this issue using an IV approach.

We use exogenously determined eligibility criteria for the *Carer Payment* as an IV. The intuition is that being eligible to receive financial compensation for caring will most likely be a strong incentive to take on a caring role, everything else equal. To be eligible for the *Carer Payment*, Australians need to fulfill several criteria. First, they need to provide constant care to someone with a disability, a medical condition, or an adult who is frail aged for at least six months. Second, their income and assets must be below yearly exogenously determined thresholds (see historical income and asset thresholds in Tables A4 - A5). Having information on respondents' income and assets, we are able to determine a respondent's eligibility status. The income and asset thresholds are determined by the Australian Government on a annual basis, following a mixture of inflation, consumer price index measures, cost of living indices and average weekly earnings. In addition, during our study period, in 2009, the *Carer Payment* income test underwent a reform, whereby eligibility rules became more stringent. Prior to the reform, for every 1,000 dollars owned in assets above a yearly determined minimum asset threshold, the *Carer Payment* was reduced by $6 per month; and for every dollar earned above a income threshold, the payment was reduced by 80 cents per month, the so called *taper rates* (Australian Government, 2023b). Once a maximum income or asset threshold were reached, the *Carer Payment* reduced to zero (Australian Government, 2023a), i.e., carers became ineligible.[10] In 2009, the income taper rate was increased from 80 cents for every dollar earned above the minimum income threshold, to 1 dollar. This resulted in the maximum income threshold decreasing by more than 12 percentage points. In HILDA the number of respondents being eligible for the *Carer Payment* reduced subsequently by eight percentage points (53.5/49.5) and has been on a decline overall (see Figure 1).

[10]The asset threshold varies depending on whether the caregiver owns a home or not and whether they have a spouse or not. Asset thresholds do not include the value of the family home, but the threshold is lower if one does own a house.

Figure 1: Percentage of HILDA respondents eligible for the *Carer Payment* over time



Note: Eligibility is determined based on the income test and respondent's self-reported income in the HILDA survey.

To be able to interpret IV estimation, it must satisfy several key assumptions. First, the instrument has to be independent of the error term and only affect loneliness through informal caregiving. A threat to identification for this IV would be if respondents are able to manipulate their eligibility when taking on caring responsibilities. We do not find any evidence of this. Looking at the distribution of when carers become eligible to the *Carer Payment* during the study period relative to when they first start caring, we observed an approximately uniform distribution with only a small increase around zero (see Figure 2). As a precaution, we determine a respondent's eligibility status in the survey year prior to an exogenous demand shock, namely a serious personal injury or illness to a close relative / family member. First of all, we expect such a life event to increase care dependency of the family member/relative and subsequently increase the probability of respondents to become informal carers. Second, measuring eligibility prior to such a health shock means that any doubt around manipulation of *Carer Payment* eligibility are minimised.

Figure 2: Distribution of when carers became eligible relative to when they started caring

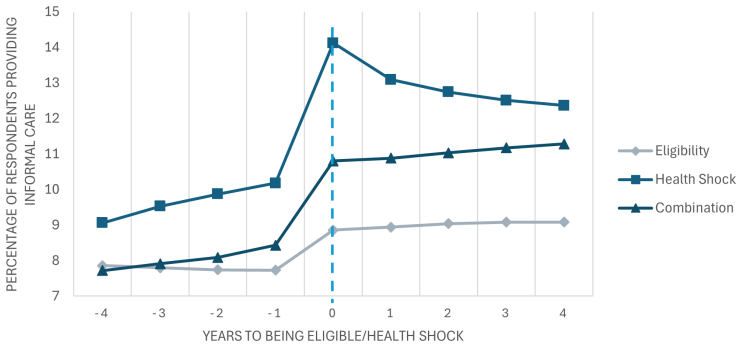


Note: For all HILDA respondents we calculated the difference of when carers became eligible relative to when they started caring (i.e. date started caring minus date became eligible), excluding those who are eligible or are caring from the first wave onwards as well as those that are eligible over the entire study period.

A second assumption is that the instrument must be strongly correlated with the likelihood of providing informal care. This is to be expected in our case, considering that both the health shock and availability to income support payments will make caregiving more probable and attractive/affordable. Indeed, we find that the prevalence of informal caregiving increases after (i) a close relative or family member experiences a serious

injury or illness, (ii) respondents become eligible for the *Carer Payment*, and (iii) the combination of the two (see Figure 3). We confirm this assumption also in our first-stage regressions.

Figure 3: Prevalence of informal caregiving four years before and after (i) becoming eligible for the *Carer Payment*, (ii) a family member/relative experiences a health shock and (iii) the combinatino of both.



Note: Author's calculation based on responses to the HILDA questionnaire

A third assumption is the monotonicity condition, which requires that satisfying the eligibility condition will not reduce the likelihood of providing informal care. This is unlikely to be the case where being eligibility for a subsidy when caregiving would discourage someone from deciding to take on caring responsibilities.

While information about respondent's income is collected in every survey wave, wealth data is only included every four years in the HILDA questionnaire. For years where both income and asset information are available, we find that for more than 90% of our respondents, the *Carer Payment* eligibility is based on the income test rather than the asset test. This is because the income threshold is the more stringent one of the two. Considering this small percentage of respondents who rely on the asset threshold and to be able to use information from all 18 survey waves, we present results for both situations where only the income test is used as eligibility criteria and where the income and asset test are applied as eligibility criteria (see summary statistics in Table 1).

We thus use the following instrumental variables model:

$$InformalCare_{it} = \lambda_0 + \lambda_1(HealthShock_{it} \times Eligibility_{i\delta-1}) + \mathbf{X}_{it}\lambda_2 + \eta_{2t} + \alpha_{2i} + \epsilon_{2it} \tag{4}$$

$$Y_{it} = \gamma_0 + \gamma_1 InformalCare_{it} + \mathbf{X}_{it}\gamma_2 + \eta_{3t} + \alpha_{3i} + \epsilon_{3it} \tag{5}$$

In the first-stage (equation 4), $HealthShock_{it}$ is a dummy that takes the value one if the respondent in year t itself or any prior year has reported that a family member or relative has experienced a serious injury or illness. We denote the year in which the respondent for the first time reported that a household member experienced a health shock as δ. $Eligibility_{i\delta-1}$ denotes the second treatment indicator: $Eligibility_{i\delta-1} = I(Income_{i\delta-1}/Asset_{i\delta-1} < Threshold_{\delta-1} = 1)$ with $Income_{i\delta-1}/Asset_{i\delta-1}$ being the household income/asset in the year prior to the first time the respondent reported that a household member experienced a health shock and $Threshold_{\delta-1}$ denotes the yearly income/asset threshold (for singles or couples,

respectively) in the year prior to the initial health shock of a family member. The interaction of the treatment indicators is the instrument for informal caregiving. λ_1 thus measures the intent-to-treat effect of being eligible for the *Carer Payment* prior to a close relative or family member experiencing a serious personal injury or disease. In the second stage (equation 5), $InformalCare_{it}$ is the predicted informal care status from the first-stage.

To estimate our IV, we employ a bivariate probit IV estimator, which is more robust when outcome and treatment variables are binary (Semykina and Wooldridge, 2018). Most importantly, the binary IV estimator permits consistent estimation in the presence of non-random self-selection into treatment. To facilitate our time invariant IV and avoid the incidental parameter problem, which may occur using fixed effects with binary outcome measure, we follow Mundlak (1978) and Semykina and Wooldridge (2018) and add time means of explanatory variables, in binary models often referred to as correlated random effects. Estimated coefficients are thus based on the deviations of the variables from its individual time means and are thus comparable to FE estimates. In order to separate the effect of caregiving from that of a potential corresponding reduction in working hours, which may lead to loneliness and social isolation by itself, we also present results for a sample of respondents who do not reduce their working hours by more than eight hours per week over the study period, i.e. less than a day per week.

5 Results

5.1 Main Results

We start by examining the impact of informal caregiving on loneliness and social isolation using our DID specification. Table 2 provides estimates for samples that include (i) all caregivers (Panel A), (ii) female caregivers only (Panel B), and (iii) male caregivers only (Panel C). In columns (1) and (2), the average treatment effects with and without controls are provided for loneliness as dependent variable, whereas columns (3) and (4) show the average treatment effects for social isolation as dependent variable. In our interpretations that follow, we focus on the models with controls.

The average effect of informal care on loneliness for Panel A is estimated to be around 3.5 percentage points, whereas the coefficients on social isolation are positive but not statistically significant. Figure 4 depicts corresponding event study estimates, where graph *a)* shows the effects on loneliness for all respondents together up to 7 years before and after taking on caring responsibilities. The figure includes 95% confidence bands around the event coefficients. Estimates suggest that the effect occurs two to four years after starting to provide informal care and recovers thereafter. The event study coefficients in graph *b)* do not show an increase in social isolation for Panel A (see Table A2 for precise event study estimates).

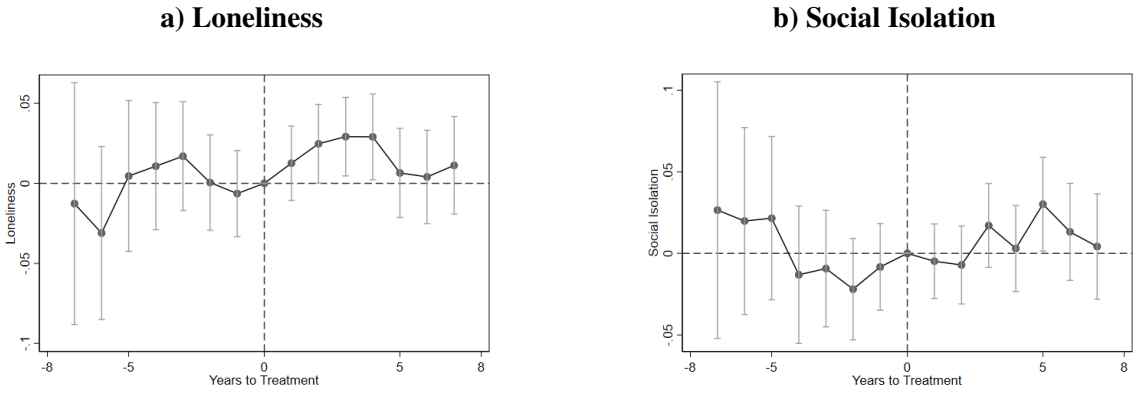
The average treatment effects in Table 2 and the event study coefficients depicted in Figure A1 provide evidence that the effect on loneliness is more pronounced among female caregivers. The estimates suggest that informal caregiving increases loneliness among female caregivers by 3.8 percentage points. Our DID estimates do not provide evidence of an effect of informal caregiving on social isolation.

Table 2: DID Results: The impact of informal care on loneliness and social isolation

	Y = Loneliness		Y = Social Isolation	
	(1) No control	(2) Controls	(3) No controls	(4) Controls
Panel A: All				
Informal cargiving	0.036**	0.035*	0.009	0.016
	(0.018)	(0.022)	(0.019)	(0.022)
Observations	39,356	29,028	37,635	27,895
Switchers	16,984	11,578	15,626	10,710
Panel : Female				
Informal caregiving	0.048**	0.038*	0.024	0.037
	(0.023)	(0.026)	(0.020)	(0.023)
Observations	24,511	18,332	23,169	17,432
Switchers	10,676	7,483	9,450	6,902
Panel C: Male				
Informal caregiving	0.014	0.025	0.000	-0.008
	(0.032)	(0.038)	(0.031)	(0.038)
Observations	14,845	10,696	14,002	10,170
Switchers	6,308	4,095	5,531	3,654

Note: This table presents average treatment effects for the effect of informal caregiving on loneliness and social isolation and is based on equation (1) using the DID estimator proposed by De Chaisemartin and d'Haultfoeuille, 2024. Event-study coefficients estimated from equation (1) are provided in Table A2 and are displayed in Figures 4 and A1. The dependent variable in columns (1) and (2) is the binary loneliness measure and in columns (3) and (4) it is the binary social isolation measure. Control variables in columns (2) and (4) include the pre-treatment number of weekly hours of work, household income and age. All Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 4: Event-study: Informal caregiving and loneliness and social isolation



Notes: The figure plots the post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, as well as 95% confidence intervals for loneliness and social isolation. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects.

OLS and FE results are presented in the Appendix Table A3. All estimates show a positive and statistically significant association between informal care, loneliness and social isolation. The only exception is the effect of informal care on social isolation when focusing on a sample that does not reduce their working hours by more than 8 hours per week. This is rather intuitive given that social isolation is an objective measure, indicating infrequent social contacts rather than a subjective feeling of insufficient good quality social contacts like loneliness. In a scenario where respondents do not reduce their working hours much, an objective loss of social contacts, i.e. social isolation seems very unlikely to occur.[11]

[11]These results and further IV estimates with the same sample and social isolation as outcome will therefore act as a 'sense check'.

Next we present our IV results. Using eligibility rules as instrument in our IV approach means we identify the Local Average Treatment Effect (LATE) for those people whose decision to provide care is driven by being eligible for the *Carer Payment* when a family member or relative experiences a serious illness or disability. This is an important consideration when interpreting results.

Tables 3 and 4 present results from our IV specifications for loneliness and social isolation as outcome measures, respectively. Column (1) presents results using only the income test as eligibility criteria for the *Carer Payment*, thus providing the largest sample sizes. Column (2) presents estimates when using both income and asset tests to identify eligible respondents. Finally, in column (3), we present results for the sample of respondents who do not reduce their working hours by more than eight hours per week. For all IV models, the first-stage results and F-statistics are presented underneath the main results.

Studying loneliness in Table 3, we find that all our coefficients in Panel A are positive and statistically significant, indicating that also our IV estimates provide evidence that informal caregiving increases the chance of experiencing loneliness. All F-statistics exceed the rule of thumb of around 10 and the coefficients of the IV in the first stages are positive and statistically significant. Effect sizes vary between specifications from around 10 percentage points to about 18 percentage points. Results for our female sample in Panel B of Table 3 are very similar to the results for the full sample. The coefficients of informal care on loneliness among the male sample in Panel C are not statistically significant and close to zero, indicating that informal caregiving does not increase loneliness among male caregivers who take on caring duties due to being eligible for the *Carer Payment* when a relative or family member experiences a health shock.

Focusing on social isolation as a dependent variable in Table 4, estimates are less consistent. While the F-statistics exceed the rule of thumb of 10 in Panel A and B, F-statistics in Panel C and those using income and assets to determine eligibility become smaller, most likely due to small sample sizes. Estimates in Panel A are positive and statistically significant at the 10% significance level, except for our sample that does not reduce their working hours by more than one day per week, which again, is what one would expect for such a sample in the social isolation model. All the estimates for our female sample in Panel B are statistically insignificant, leading us to conclude that informal caregiving does not influence social isolation among female caregivers. Panel C estimates are all positive and statistically significant, despite becoming less precise due to small samples in some specifications and subsequent implausible large point estimates. E.g. in column (3), focusing on a sample of respondents who don't reduce their working hours by more than eight hours per week, the coefficient increases to 23 percentage points.

Overall, our IV estimates suggest that informal care has a positive and relatively large impact on loneliness, especially among females, while it appears to contribute to social isolation among some male caregivers, but these effects are only statistically significant at the 10% significance level.

Table 3: Instrumental variables results for loneliness

	Instrumental variables correlated random effects		
	All respondents		$\leq$ 8h work reduction
	Income test only	Income and Asset test	Income test only
	(1)	(2)	(3)
Panel A: All			
Informal care (Yes/No)	0.099**	0.183***	0.135**
	(0.046)	(0.064)	(0.057)
First stage			
IV coefficient	0.018***	0.020***	0.032***
	(0.003)	(0.007)	(0.007)
Kleibergen-Paap Chi2 (p-value)	35.311	10.537	30.590
	(0.000)	(0.002)	(0.000)
Cragg-Donald Wald F statistic	169.030	47.176	121.268
Number of observations	145,971	35,733	37,719
Number of individuals	12,522	2,986	4,217
Panel B: Female			
Informal care (Yes/No)	0.106**	0.167*	0.181***
Marginal effects	(0.005)	(0.109)	(0.062)
First stage			
IV coefficient	0.023***	0.023**	0.038***
	(0.005)	(0.011)	(0.009)
Kleibergen-Paap Chi2 (p-value)	25.994	4.746	21.475
	(0.000)	(0.028)	(0.000)
Cragg-Donald Wald F statistic	125.906	24.422	80.346
Number of observations	82,325	19,551	22,733
Number of individuals	6,972	1,619	2,469
Panel C: Male			
Informal care (Yes/No)	0.003	0.079	-0.011
	(0.116)	(0.104)	(0.129)
First stage			
IV Coefficient	0.012**	0.015*	0.021**
	(0.005)	(0.008)	(0.009)
Kleibergen-Paap Chi2 (p-value)	11.344	6.142	8.786
	(0.000)	(0.013)	(0.003)
Cragg-Donald Wald F statistic	52.763	28.428	35.699
Number of observations	63,646	16,182	14,986
Number of individuals	5,550	1,367	1,748

Note: All regressions include individual level controls (age, the number of children, income, education, marital status, the number of working hours, whether the respondent has any limitations with ADL and their household size), as well as their time averages and year fixed effects. Column (1) presents results for the model where only the income threshold is used to determine *Carer Payment* eligibility as IV, whereas column (2) uses both income and asset thresholds. Column (3) focuses on a sample of respondents who do not reduce their working hours by more than eight hours per week over the sample period. All Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Instrumental variables results for social isolation

	Instrumental variables correlated random effects		
	All respondents		$\leq$ 8h work reduction
	Income test only	Income and Asset test	Income test only
	(1)	(2)	(3)
Panel A: All			
Informal care (Yes/No)	0.079*	0.151*	0.035
	(0.051)	(0.088)	(0.087)
First stage			
IV coefficient	0.017***	0.019***	0.030***
	(0.004)	(0.007)	(0.007)
Kleibergen-Paap Chi2 (p-value)	34.516	9.068	29.319
	(0.000)	(0.002)	(0.000)
Cragg-Donald Wald F statistic	163.484	43.933	114.926
Number of observations	144,290	35,323	7,078
Number of individuals	12,512	2,985	4,208
Panel B: Female			
Informal care (Yes/No) Marginal	0.001	0.013	-0.010
effects	(0.066)	(0.197)	(0.101)
First stage			
IV coefficient	0.022***	0.021*	0.036***
	(0.005)	(0.012)	(0.010)
Kleibergen-Paap Chi2 (p-value)	25.532	4.531	20.824
	(0.000)	(0.033)	(0.000)
Cragg-Donald Wald F statistic	122.758	22.996	77.333
Number of observations	81,385	19,327	22,313
Number of individuals	6,964	1,618	2,462
Panel C: Male			
Informal care (Yes/No) Marginal	0.128*	0.166*	0.232**
effects	(0.092)	(0.105)	(0.120)
First stage			
IV Coefficient	0.012***	0.016*	0.022***
	(0.005)	(0.009)	(0.008)
Kleibergen-Paap Chi2 (p-value)	10.950	5.825	8.083
	(0.000)	(0.014)	(0.004)
Cragg-Donald Wald F statistic	50.018	25.958	31.804
Number of observations	62,905	15,996	14,765
Number of individuals	5,548	1,367	1,746

Note: Note: All regressions include individual level controls (age, the number of children, income, education, marital status, the number of working hours, whether the respondent has any limitations with ADL and their household size), as well as their time averages and year fixed effects. Column (1) presents results for the model where only the income threshold is used to determine *Carer Payment* eligibility as IV, whereas column (2) uses both income and asset thresholds. Column (3) focuses on a sample of respondents who do not reduce their working hours by more than eight hours per week over the sample period. All Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.2 Heterogeneity based on caregiver - care recipient relationship

In our heterogeneity analysis, we aim to disentangle which caregivers are more or less likely to be affected by providing informal care and hence split caregivers into those caring for (1) a spouse, (2) a parent, or (3) a child. Intuitively one would expect these different 'kinds' of caregiving to also impact social health differently, particularly because the care recipients might have varying needs while the care provision may occur at different points in the caregivers life.

Again, we begin with our DID estimates in Table 5, providing estimates for all caregivers (Panel A),

(ii) female caregivers only (Panel B), and (iii) male caregivers only (Panel C). Results suggest that informal caregiving has the largest impact on spousal caregivers. Studying loneliness, it is the female sample that shows a statistically significant effect of providing informal care on loneliness among spousal caregivers, whereas for male spousal caregivers we find an effect on social isolation. On average, being a female caregiver for a spouse increases the chance of experiencing loneliness by 10.5 percentage points, with the largest effects occurring three to four years after taking on a carer role (see Figure 5 for event study estimates). Being a male caregiver for a spouse increases the chance of experiencing social isolation by on average 11.7 percentage points, with the largest effect occurring immediately after taking on a caring role (see Figure 6 for event study estimates). While we don't find any effect on loneliness or social isolation when caring for a child, estimates suggest male caregivers might experience a higher likelihood of feeling lonely when caring for a parent, but this effect is only statistically significant at the 10% significance level (see event study estimates in Figures A2 - A3).

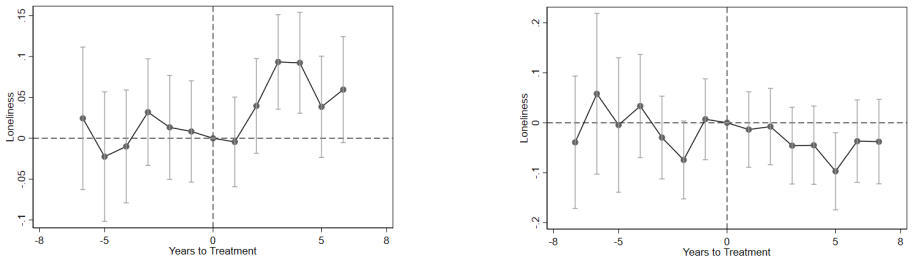
Table 5: Heterogeneity: DID Results for the impact of informal care on loneliness and social isolation by different caregiver - care recipients relationship

	Y = Loneliness			Y = Social Isolation		
	(1) Spouse	(2) Parent	(3) Child	(4) Spouse	(5) Parent	(6) Child
Panel A: All						
Informal caregiving	0.025	0.027	0.040	0.074*	0.000	0.038
	(0.041)	(0.035)	(0.048)	(0.042)	(0.032)	(0.048)
Observations	44,646	40,317	45,079	43,781	39,415	44,289
Switchers	2,870	5,621	2,275	2,555	5,271	2,121
Panel : Female						
Informal caregiving	0.105***	0.004	0.022	0.049	0.043	0.047
	(0.045)	(0.041)	(0.060)	(0.056)	(0.033)	(0.057)
Observations	28,574	25,585	28,518	28,025	24,973	27,989
Switchers	1,820	3,759	1,561	1,610	3,366	1,435
Panel C: Male						
Informal caregiving	-0.082	0.099*	0.094	0.117**	-0.023	0.017
	(0.063)	(0.062)	(0.081)	(0.054)	(0.062)	(0.082)
Observations	16,059	14,721	16,559	15,831	14,390	16,292
Switchers	1,050	1,862	714	948	1,743	686

Note: This table presents average treatment effects for the effect of informal caregiving on loneliness and social isolation and is based on equation (1) using the DID estimator proposed by De Chaisemartin and d'Haultfoeuille, 2024. Corresponding event-study coefficients are displayed in Figures 5 - 6 and A2 - A3. The dependent variable in columns (1) to (3) is a binary loneliness measure and in columns (4) and (6) it is a binary social isolation measure. Columns (1) and (4) provide estimates for spousal caregivers, columns (2) and (5) for parental caregivers, and columns (3) and (6) for respondents who care for a child. Control variables include the pre-treatment number of weekly hours of work, household income and age. All Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure 5: Event-study: The effects of informal caregiving on loneliness for spousal caregivers

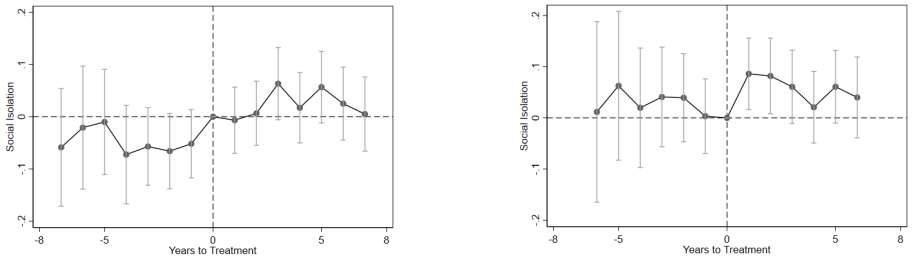
a) Female **b) Male**



Notes: The figure plots the post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, as well as 95% confidence intervals for loneliness. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects.

Figure 6: Event-study: The effects of informal caregiving on social isolation for spousal caregivers

a) Female **b) Male**



Notes: The figure plots the post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, as well as 95% confidence intervals for loneliness and social isolation. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects.

The IV results focusing on heterogeneous effects among caregivers are displayed in Table 6 and show a similar pattern. Being a female caregiver, caring for a spouse, increases the likelihood of experiencing loneliness, and being a male caregivers, caring for a spouse, increases the likelihood of experiencing social isolation. First stage estimates for the parental and children caregivers are inconsistent with what we expected, showing a negative sign of our IV on parental caregiving (columns (3) and (4) in Table 6) and F statistics below one for the specification studying caregiving for a child (columns (5) and (6) in Table 6). We conclude that being eligible for the *Carer Payment* may be more of an incentive to providing informal care among spousal caregivers rather than people caring for a child or a parent, which may explain the inconsistent results in these specifications.

Table 6: IV Results: The impact of informal caregiving on loneliness and social isolation by different caregiver - care recipients relationships

	Spouse/partner		Parent		Child	
	(1) Female	(2) Male	(3) Female	(4) Male	(5) Female	(6) Male
Panel A: Loneliness						
Informal caregiving (Yes/No)						
Informal caregiving to	0.195***	0.066	-0.135	-0.343***	0.207***	0.290***
spouse/parent/child	(0.046)	(0.073)	(0.092)	(0.054)	(0.049)	(0.080)
First stage						
IV coefficient	0.017***	0.013***	-0.007**	-0.004*	0.009***	0.005**
	(0.004)	(0.004)	(0.003)	(0.002)	(0.003)	(0.002)
Kleibergen-Paap Chi2 (p-value)	24.245	13.567	37.127	10.295	0.233	0.591
	(0.000)	(0.000)	(0.000)	(0.001)	(0.629)	(0.442)
Number of observations	59,893	46,800	82,325	63,646	82,325	63,646
Number of individuals	5,472	4,338	6,972	5,550	6,972	5,550
Panel B: Social Isolation						
Informal caregiving (Yes/No)						
Informal caregiving to	0.040	0.193**	-0.342***	-0.494***	0.086	0.318***
spouse/parent/child	(0.053)	(0.090)	(0.075)	(0.067)	(0.062)	(0.108)
First stage						
IV coefficient	0.017***	0.013***	-0.007**	-0.003	0.009***	0.005**
	(0.004)	(0.004)	(0.003)	(0.002)	(0.003)	(0.005)
Kleibergen-Paap Chi2 (p-value)	24,020	13,368	35.898	10.462	0.209	0.550
	(0.000)	(0.000)	(0.000)	(0.001)	(0.648)	(0.459)
Number of observations	59,062	41,179	81,385	62,905	81,385	62,905
Number of individuals	5,463	4,333	6,964	5,548	6,964	5,548

Note: All regressions include individual level controls (age, the number of children, income, education, marital status, the number of working hours, whether the respondent has any limitations with ADL and their household size), as well as their time averages and year fixed effects. Columns (1) and (2) focus on spousal caregivers for females and males, respectively, whereas columns (3) and (4) focus on parental caregivers and columns (5) and (6) on informal caregivers caring for a child. All Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.3 Robustness checks

We further present results showing the robustness of our IV results across a couple of alternative definitions of our informal care measure in Table 7. First, we show in Panel A that the results are robust to using the (log) number of caring hours as the independent variable, rather than a binary variable. Second, in Panel B, we use an informal care measure that only classifies respondents as caregivers if they provide care to a household member (i.e. within the household). Columns (1) and (2) present results for loneliness and columns (3) and (4) present results for social isolation. The results presented are from the specification using all survey years and thus the income test only to determine eligibility status of respondents. Results in Panel A show that every additional hour of providing informal care increases the probability of feeling lonely or experiencing social isolation. Results in Panel B show that providing informal care for someone inside the household increases the chance of feeling lonely, but we do not find any statistically significant effect on social isolation. Considering that respondents who provide informal care to someone from within the household do not live alone, this result is not surprising.

Table 7: Robustness checks: Using the logarithm of caring hours and only caregivers for household members as explanatory variable

	Loneliness		Social Isolation	
	(1)	(2)	(3)	(4)
	Female	Male	Female	Male
Panel A: Log of caring hours				
Log of hours caring	0.027***	0.018***	0.030***	0.028***
	(0.005)	(0.007)	(0.005)	(0.007)
First stage				
IV coefficient	0.016*	0.007	0.017*	0.007
	(0.009)	(0.014)	(0.009)	(0.015)
Kleibergen-Paap Chi2 (p-value)	32.391	6.949	31.749	6.586
	(0.000)	(0.008)	(0.000)	(0.010)
Number of observations	9,995	5,420	9,878	5,349
Number of individuals	2,666	1,708	2,686	1,699
Panel B: Caring giving for household member only				
Informal caregiving within the	0.165***	0.138**	-0.024	0.099
household (Yes/No)	(0.044)	(0.059)	(0.049)	(0.080)
First stage				
IV coefficient	0.025***	0.015***	0.024***	0.014***
	(0.004)	(0.004)	(0.004)	(0.004)
Kleibergen-Paap Chi2 (p-value)	55.829	23.076	54.520	22.582
	(0.000)	(0.008)	(0.000)	(0.000)
Number of observations	82,314	63,637	81,374	62,896
Number of individuals	6,972	5,549	6,964	5,547

Note: All regressions include individual level controls (age, the number of children, income, education, marital status, the number of working hours, whether the respondent has any limitations with ADL and their household size), as well as their time averages and year fixed effects. Panel A shows results for a specification where the logarithm of caring hours is used as independent variable and Panel B focuses on informal caregivers who provide care to someone within the household. Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4 Potential mechanisms

Based on Pearlin et al. (1990)'s caregiver stress model and previous literature (Badcock et al., 2022; Skaff and Pearlin, 1992), we investigate a particular channel via which informal caregiving may translate to loneliness and social isolation: changes to the relationship satisfaction between caregiver and care recipient. Empirically, we apply a two-step sequential strategy which has been widely used in the literature (Churchill et al., 2020; Koomson et al., 2022). Based on findings from our heterogeneity analysis, we focus in this section on spousal caregivers only. In a first step, we test whether informal caregiving increases caregiver's likelihood of being dissatisfied with the relationship with their spouse. Results are presented in columns (1) and (2) of Table 8, showing that indeed providing informal care to a spouse increases the probability of being dissatisfied with the relationship to their spouse. In the second step, we include the relationship dissatisfaction measure as control variable in our main specification. We expect the inclusion of these variables of interest to diminish the coefficient on informal caregiving or render its significance levels if the variables are potential mediators. For a fair comparison, we re-run the original model with the same sample sizes and present those results in Panel B, columns (3) - (6) of Table 8. In line with previous IV results, Panel B shows that providing informal care to spouse increases the probability of feeling lonely among females and the probability of experiencing social isolation among males.

Including the relationship satisfaction measure in this regression, decreases the coefficients on informal caregiving, by around 6 to 7 percentage points. This indicates that the effect of providing informal care on loneliness and social isolation may to some extend be explained by a deterioration in the relationship quality

between caregivers and their spouses, but in the absence of causal mediation analyses, this conclusion remains tentative.

Table 8: The effect of informal care on caregiver–care recipient relationship and caregiver's social health

	Dissatisfaction with relationship		**Loneliness**		**Social Isolation**	
	(1) **Female**	(2) **Male**	(3) **Female**	(4) **Male**	(5) **Female**	(6) **Male**
Panel A						
Informal Care (Yes/No)						
Informal caregiving to spouse	0.035**	0.045**	0.122**	0.026	0.040	0.219**
	(0.015)	(0.020)	(0.049)	(0.063)	(0.065)	(0.092)
Relationship dissatisfaction						
Relationship to spouse			0.078***	0.098***	0.035*	0.091***
			(0.018)	(0.017)	(0.019)	(0.026)
First stage						
IV Coefficient	0.022***	0.016***	0.022***	0.016***	0.022***	0.016***
	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)
Kleibergen-Paap Chi2 (p-value)	33.731	19.326	33.878	19.400	33.742	19.086
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of observations	44,812	39,302	44,812	39,302	44,253	38,787
Number of individuals	4,606	3,950	4,606	3,950	4,600	3,943
Panel B						
Informal Care (Yes/No)						
Informal caregiving to spouse			0.131***	0.054	0.042	0.233**
			(0.050)	(0.064)	(0.064)	(0.091)
First stage						
IV Coefficient			0.022***	0.016***	0.022***	0.016***
			(0.005)	(0.004)	(0.005)	(0.004)
Kleibergen-Paap Chi2 (p-value)			33.731	19.326	33.583	19.013
			(0.000)	(0.000)	(0.000)	(0.000)
Number of observations			44,812	39,302	44,253	38,787
Number of individuals			4,606	3,950	4,600	3,943

Note: All regressions include individual level controls (age, the number of children, income, education, marital status, the number of working hours, whether the respondent has any limitations with ADL and their household size), as well as their time averages and year fixed effects. Columns (1) and (2) show estimates for the effect of spousal informal caregiving on being dissatisfied with the relationship to the spouse for females and males respectively. Columns (3) and (4) show results for loneliness as outcome measure and columns (5) and (6) for social isolation, for females and males, respectively. Panel A includes the relationship dissatisfaction measure, whereas Panel B does not, but uses the same sample as Panel A. Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6 Discussion and Conclusion

One out of every ten people in Australia and most advanced economies provide informal care to a family member or relative, making it the most common form of long-term care across the globe. Providing informal care has important benefits for the person being cared for as well as caregivers themselves. It usually allows the care recipient to remain in their home, reduces out-of-pocket costs and can be rewarding for caregivers. However, there is an increasing number of studies outlining the indirect costs associated with caregiving. Several studies have examined the effect of informal care on financial outcomes, including, income, wages, and employment among caregivers (Schmitz and Westphal, 2017; Schmitz and Stroka, 2013; Van Houtven et al., 2013), with some studies showing a negative impact on caregivers' health, including mental health, well-being and depression (Bom et al., 2019; De Zwart et al., 2017; Schmitz and Westphal, 2015; Van den Berg et al., 2014). Literature studying other hidden costs of informal care provision, including determinants of well-being such as inadequate social interactions, is currently lacking.

Against this background, our study contributes to the literature by providing the first robust evidence of the effect of informal caregiving on loneliness and social isolation. Leveraging a nationally representative panel survey containing information on informal care, loneliness and social isolation dating back to 2005, we employ two complementary identification strategies. First, we exploit the time variation in the onset of caregiving in a dynamic DID setting to study the effect of caregiving on social health. Second, in an IV specification, we use eligibility thresholds for the *Carer Payment* as an IV to evaluate the impact of informal caregiving on loneliness and social isolation. In this IV specification, we make also use of information on major life events provided by respondents in HILDA, namely a serious personal injury or illness to a close relative / family member and combine this with eligibility criteria. Both, the DID and IV specifications provide consistent and robust evidence of the effect of providing informal care on loneliness among female caregivers and on social isolation among male caregivers. Distinguishing between different caregiver - care recipient relationships, our results show that the effect between informal caregiving and social health is primarily driven by spousal caregivers, whereas we don't find any effect among caregivers caring for a child and only some indication of a potential effect among male caregivers caring for a parent.

Finally, we examine whether changes to the relationship satisfaction between caregivers and their spousal care recipient may partly explain its observed effect on social health, that we observed. Our results suggest that caring for a spouse increases the likelihood of being dissatisfied with the relationship and once including the dissatisfaction measure in the main specification, we observe a slight reduction in our main estimates. This suggests that at least some of the effects of caregiving on loneliness and social isolation seems to be driven by changes to the relationship quality between spouses. These results are in line with the psychological literature on identify loss among informal caregivers who care for a spouse, where this loss of identify is a result of engulfment in the caregiver role and loss of a 'partnership' (Skaff and Pearlin, 1992).

Not only since the beginning of the COVID-19 pandemic when many people were forced to socially isolate, but already prior to that, loneliness had become a global problem, driven by the fact that especially people in Western countries live more often alone. While it has been widely acknowledged that loneliness is a public health issue, it is now commonly argued that loneliness and social isolation are also economic problems (Kung et al., 2021; Murthy, 2020). Research provides evidence of the strong link between loneliness and mental health and increased use of health care services (Kung et al., 2021). In addition, the mortality impact of loneliness has been estimated to be as large as smoking 15 cigarettes a day (Murthy, 2020). Loneliness has also been linked to reduced productivity and job satisfaction at work (De Neve et al., 2018). Kung et al. (2021) show that it is primarily young females who are at risk of becoming lonely and socially isolated in Australia. Females represent the majority of informal caregivers and therefore present a real risk of experiencing loneliness due to caregiving.

Understanding the impact of providing care to a family member or relative is crucial when designing long-term care and carer support policies. While the *Carer Payment* is able to provide financial support, social support may be particularly helpful among spousal caregivers, considering that these represent around one third of all caregivers. In developed countries, including the United States, Canada, Europe, Australia, and New Zealand

some support services exist, but these primarily focus on financial compensation, rather than on the health and well-being of caregivers. Considering the costs associated with loneliness and social isolation, governments around the world ought to consider alternative support options for informal caregivers, with particular focus on those who are at high risk of poor social health.

Our study has several strengths and limitations. The HILDA dataset provides rich and high-quality information on respondent's informal care responsibilities as well as their social health over a long study period and among many respondents of all ages. Australia provides an ideal setting with their government-funded *'Carer Payment'* and eligibility changes during the study period that can be exploited to provide robust evidence of the effect of informal caregiving on loneliness and social isolation. Although the IV interpretation of estimates is limited to those people responding to eligibility, understanding the impact of such a payment is an important contribution in itself. In addition, we provide a second empirical strategy applying to a broader population, showing similar results, providing confidence in our study conclusions. Nevertheless, we would like to acknowledge that the HILDA data is based on self-responses and we have observed some inconsistencies in our data, where respondents reported caring hours in the time survey, but did not classify as informal caregiver. While our empirical strategies should overcome such data challenges, further analysis using administrative data could enhance confidence in the study's conclusions.

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Appendices

A Variable definitions

Table A1: Variable definitions

Variables	Description
Informal Caregiving	
Informal caregiving	= 1 if the respondent actively cares for a household member or non-resident due to long-term health condition, disability or elderly; = 0 otherwise.
Informal caregiving within the household	= 1 if the respondent actively cares for a household member due to long-term health condition, disability or elderly; = 0 otherwise.
Informal caregiving for a spouse	= 1 if the respondent actively cares for a spouse due to long-term health condition, disability or elderly; = 0 if not providing informal care.
Informal caregiving for a child	= 1 if the respondent actively cares for a child due to long-term health condition or disability; = 0 if not providing informal care.
Informal caregiving for a parent	= 1 if the respondent actively cares for a parent due to long-term health condition, disability or elderly; = 0 if not providing informal care.
Weekly hours of informal care	= combined hours and minutes the respondent cares for disabled/elderly relative in a regular week.
Social Health	
Loneliness	= 1 if the respondent feels often very lonely; = 0 otherwise.
Social isolation	= 1 if the respondent gets together socially with friends or relatives less than once per week and feels like people don't come to visit them as often as they would like to; = 0 otherwise.
Individual Level Control variables	
Female	= 1 if the respondent is female; = 0 otherwise.
Age	Age of respondent in number of years
Whether has children	= 1 if the respondent has children; = 0 otherwise.
Bachelor's degree or higher	= 1 if the respondent has a Bachelor's degree or a higher academic degree; = 0 otherwise.
Household income	Disposable household income.
Married	= 1 if respondent is married; = 0 otherwise.
Number of working hours	Number of hours the respondent works in paid employment in a regular week.
Restrictions with ADL	=1 if respondent has limitations with any activities of daily living, including dressing or bathing themselves, lifting of carrying groceries, climbing several flights of stairs; = 0 otherwise.
Household size	The number of people residing in the respondent's household.
Instrumental Variables	
Health shock	= 1 if a respondent's close relative or family member experienced a serious personal injury or illness in the past year; = 0 otherwise.
Eligibility	= 1 if respondent's household income and/or asset are below the *Carer Payment* income and asset threshold; = 0 otherwise.
Mechanisms: Relationship satisfaction	
Dissatisfied with relationship to spouse	= 1 if respondent is dissatisfied with their relationship to their spouse; = 0 otherwise.
Dissatisfied with relationship to child	= 1 if respondent is dissatisfied with their relationship to their child; = 0 otherwise.
Dissatisfied with relationship to parent	= 1 if respondent is dissatisfied with their relationship to their parent; = 0 otherwise.

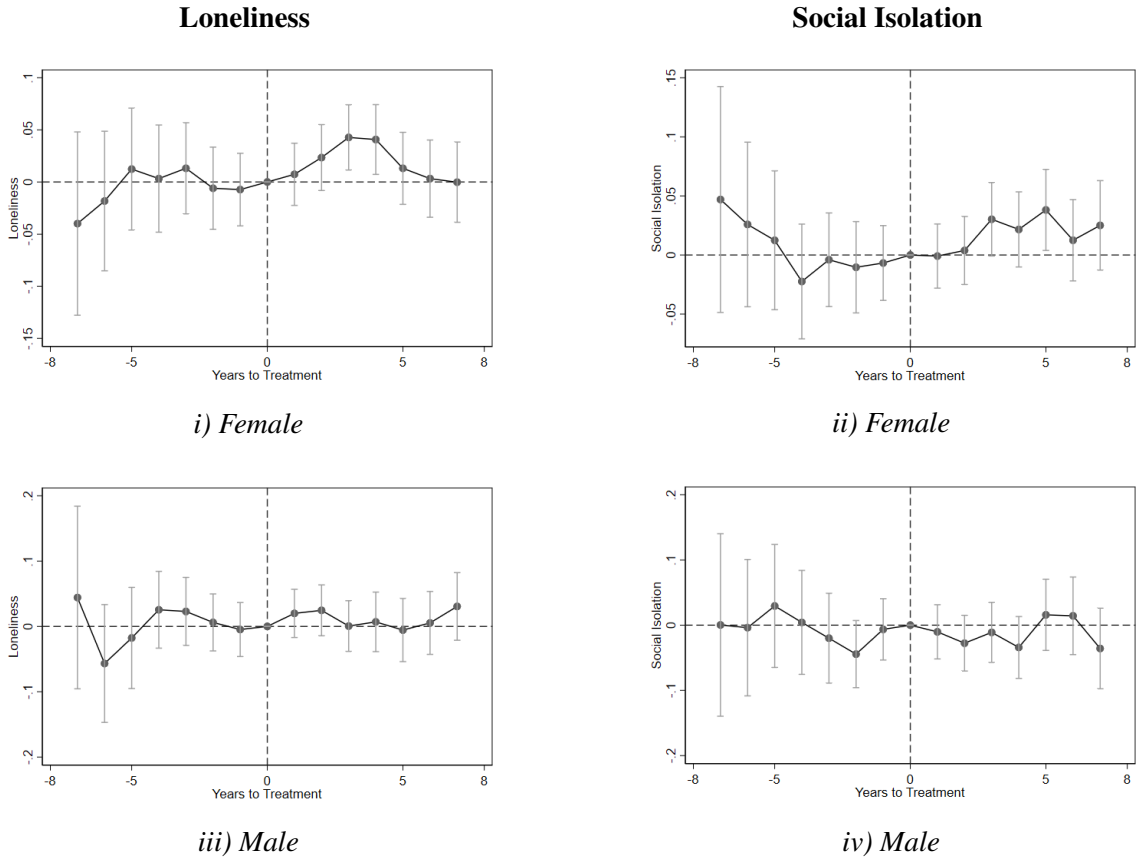
B Event-study estimates

Table A2: DID Event Study results: The impact of informal care on loneliness and social isolation

	Y = Loneliness			Y = Social Isolation		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Female	Male	All	Female	Male
Period -7	-0.013	-0.040	0.044	0.027	0.047	0.000
	(0.039)	(0.045)	(0.071)	(0.040)	(0.049)	(0.071)
Period -6	-0.031	-0.018	-0.057	0.020	0.026	-0.004
	(0.028)	(0.034)	(0.046)	(0.029)	(0.036)	(0.053)
Period -5	0.005	0.012	-0.018	0.022	0.012	0.029
	(0.024)	(0.030)	(0.040)	(0.026)	(0.030)	(0.048)
Period -4	0.011	0.003	0.026	-0.013	-0.022	0.004
	(0.020)	(0.026)	(0.030)	(0.021)	(0.025)	(0.041)
Period -3	0.017	0.013	0.023	-0.009	-0.004	-0.020
	(0.017)	(0.022)	(0.027)	(0.018)	(0.020)	(0.035)
Period -2	0.001	-0.006	0.006	-0.022	-0.010	-0.044*
	(0.015)	(0.020)	(0.022)	(0.016)	(0.020)	(0.026)
Period -1	-0.006	-0.007	-0.005	-0.008	-0.007	-0.006
	(0.014)	(0.018)	(0.021)	(0.014)	(0.016)	(0.024)
Period 0						
Period 1	0.013	0.007	0.020	-0.005	-0.001	-0.010
	(0.012)	(0.015)	(0.019)	(0.012)	(0.014)	(0.021)
Period 2	0.025**	0.023	0.025	-0.007	0.004	-0.028
	(0.013)	(0.016)	(0.020)	(0.012)	(0.015)	(0.022)
Period 3	0.029***	0.043***	0.001	0.017	0.030*	-0.011
	(0.012)	(0.016)	(0.020)	(0.013)	(0.016)	(0.023)
Period 4	0.029***	0.041***	0.007	0.003	0.022	-0.034
	(0.013)	(0.016)	(0.023)	(0.013)	(0.016)	(0.024)
Period 5	0.007	0.013	-0.006	0.030**	0.038**	0.016
	(0.014)	(0.018)	(0.025)	(0.015)	(0.018)	(0.028)
Period 6	0.004	0.003	0.005	0.013	0.012	0.014
	(0.015)	(0.019)	(0.025)	(0.015)	(0.018)	(0.030)
Period 7	0.011	-0.000	0.030	0.004	0.025	-0.036
	(0.016)	(0.020)	(0.026)	(0.016)	(0.019)	(0.031)
Observations	29,028	18,332	10,696	27,895	17,432	10,170
Switchers	11,578	7,483	4,095	10,710	6,902	3,654

Note: This table presents post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, depicted in Figure 4. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects. Standard errors in parentheses are clustered on individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A1: Event-study: Informal caregiving and loneliness and social isolation

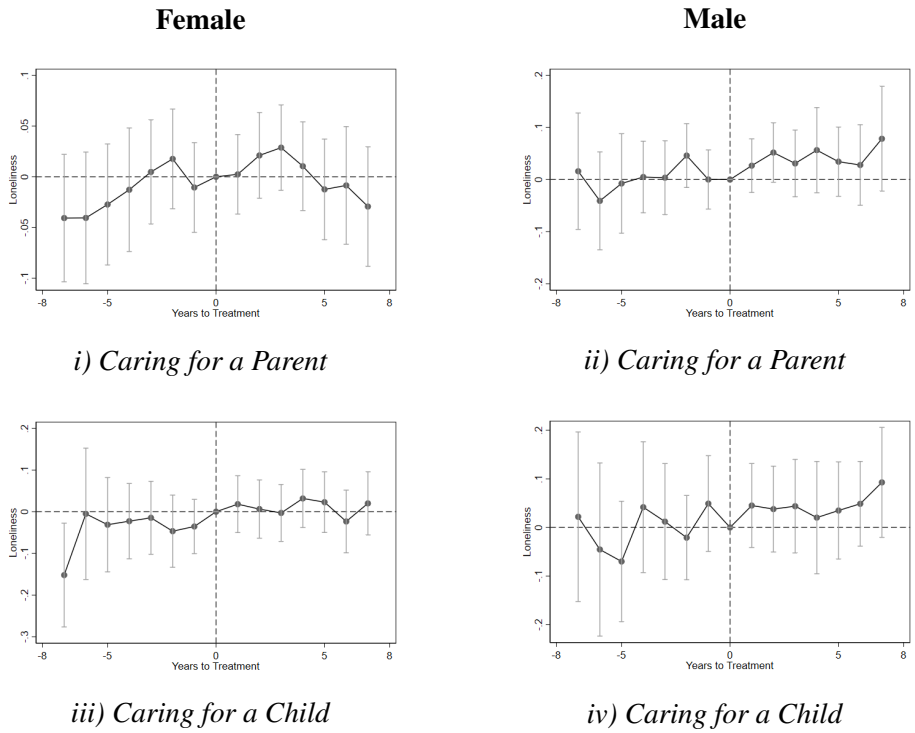


i) Female *ii) Female*

iii) Male *iv) Male*

Notes: The figure plots the post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, as well as 95% confidence intervals for loneliness and social isolation. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects.

Figure A2: Event-study: Heterogeneous effects of informal caregiving on loneliness by caregiver - care recipients relationship



i) Caring for a Parent

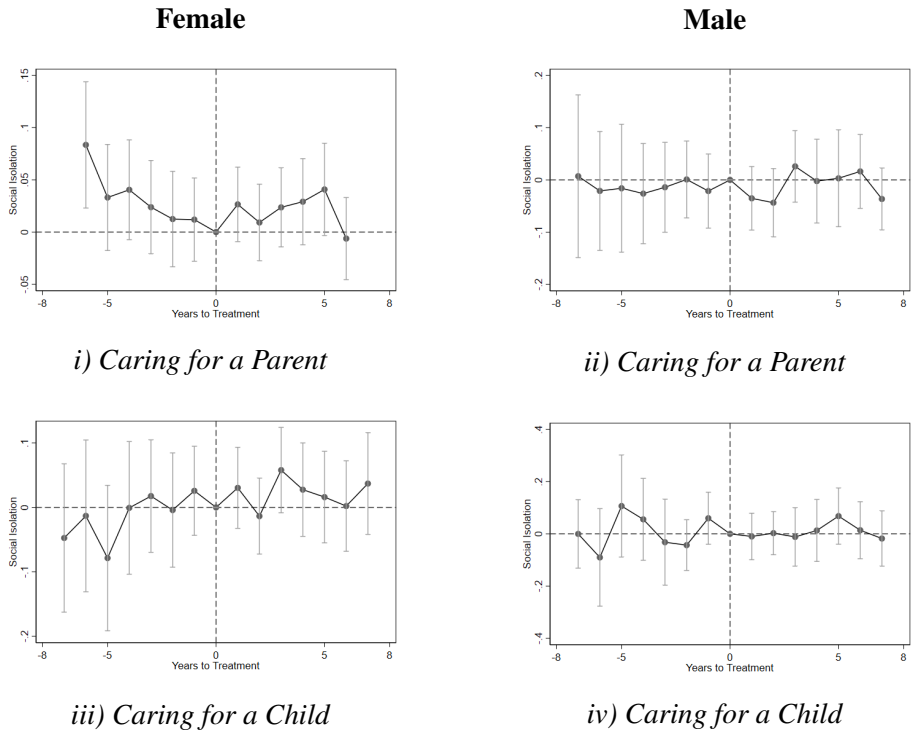
ii) Caring for a Parent

iii) Caring for a Child

iv) Caring for a Child

Notes: The figure plots the post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, as well as 95% confidence intervals for loneliness. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects.

Figure A3: Event-study: Heterogeneous effects of informal caregiving on social isolation by caregiver - care recipients relationship



i) Caring for a Parent

ii) Caring for a Parent

iii) Caring for a Child

iv) Caring for a Child

Notes: The figure plots the post-treatment and anticipatory effects from the event-study specification based on De Chaisemartin and d'Haultfoeuille (2024) approach, as well as 95% confidence intervals for social isolation. The set of control variables includes pre-treatment income, pre-treatment working hours and age, as well as individual and time fixed effects.

C OLS and FE Results

Table A3: OLS and Fixed-effects results: The relationship between informal care and loneliness and social isolation

	Loneliness			Social Isolation		
	All respondents		≤ 8h work reduction	All respondents		≤ 8h work reduction
	OLS	FE	FE	OLS	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All						
Informal care (Yes/No)	0.036***	0.007**	0.013**	0.026***	0.009***	0.005
	(0.005)	(0.003)	(0.007)	(0.005)	(0.034)	(0.007)
Number of observations	237,335	237,355	73,242	235,057	235,057	72,313
Number of individuals	28,205	28,205	13,691	28,154	28,154	13,644
Panel B: Female						
Informal care (Yes/No)	0.034***	0.008*	0.011*	0.028***	0.009**	0.004
	(0.006)	(0.005)	(0.006)	(0.006)	(0.004)	(0.008)
Number of observations	126,315	126,315	40,282	125,134	125,134	39,736
Number of individuals	14,646	14,646	7,279	14,620	14,620	7,256
Panel C: Male						
Informal care (Yes/No)	0.038***	0.006	0.019*	0.028***	0.010*	0.010
	(0.008)	(0.006)	(0.012)	(0.008)	(0.006)	(0.012)
Number of observations	111,040	111,040	32,960	109,923	109,923	32,577
Number of individuals	13,559	13,559	6,412	13,534	13,534	6,388

Note: All regressions include individual level controls (age, the number of children, income, education, marital status, the number of working hours, whether the respondent has any limitations with ADL and their household size) and year effects. Columns (2) - (3), (5) - (6) also control for individual FE. Columns (3) to (6) restrict the sample to those that do not reduce their working hours by more than 8 hours per week over the study period. All Standard errors in parentheses are clustered on the individual level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

D Historical *Carer Payment* income and asset thresholds

Table A4: Historical income thresholds for *Carer Payment*

	Income free limit		Maximum income threshold	
Year	Single	Couple	Single	Couple
2000	2,756	4,888	28,139	47,255
2001	2,912	5,200	29,318	49,277
2002	3,016	5,304	30,680	51,487
2003	3,120	5,512	32,146	53,970
2004	3,172	5,616	33,556	56,355
2005	3,224	5,720	34,593	58,104
2006	3,328	5,928	36,212	60,847
2007	3,432	6,032	37,973	63,726
2008	3,588	6,240	39,627	66,450
2009	3,692	6,448	44,047	70,304
2010	3,796	6,656	40,643	62,208
2011	3,900	6,864	42,331	64,802
2012	3,952	6,968	43,683	66,867
2013	4,056	7,176	45,872	70,216
2014	4,160	7,384	47,557	72,810
2015	4,212	7,488	48,386	74,084
2016	4,264	7,592	49,057	75,124
2017	4,368	7,800	49,985	76,575
2018	4,472	7,904	51,160	78,291
2019	4,524	8,008	52,140	79,789
2020	4,628	8,216	52,998	81,141
2021	4,680	8,320	53,487	81,900

Source: Department of Social Services, Australian Government, 2023a

Table A5: Historical asset thresholds for *Carer Payment*

	Asset free limit				Maximum asset threshold			
	Homeowners		Non-homeowners		Homeowner		Non homowner	
Year	Single	Partners	Single	Partner	Single	Patner	Single	Partner
2000	133,250	189,500	228,750	285,000	393,583	624,033	489,083	719,533
2001	141,000	200,500	242,000	301,500	411,833	658,567	512,833	753,567
2002	145,250	206,500	249,750	311,000	428,983	686,167	533,483	784,667
2003	149,500	212,500	257,500	320,500	447,200	714,500	555,200	817,500
2004	153,000	217,500	263,500	328,000	464,633	743,400	575,133	848,400
2005	157,000	223,000	270,500	336,500	478,733	766,267	592,233	873,767
2006	161,500	229,000	278,500	346,000	498,767	799,767	615,767	909,267
2007	166,750	236,500	287,750	357,500	521,017	835,233	642,017	949,233
2008	171,750	243,500	296,250	368,000	541,383	870,033	665,883	985,533
2009	178,000	252,500	307,000	381,500	591,900	912,933	720,900	1,036,433
2010	181,750	258,000	313,250	389,500	654,150	977,200	785,650	1,101,700
2011	186,750	265,000	321,750	400,000	679,450	1,015,800	814,450	1,142,800
2012	192,500	273,000	332,000	412,500	701,867	1,046,933	841,367	1,180,433
2013	196,750	279,000	339,250	421,500	732,850	1,094,700	875,350	1,229,700
2014	202,000	286,500	348,500	433,000	758,367	1,130,300	904,867	1,271,800
2015	205,500	291,500	354,500	440,500	771,833	1,150,300	920,833	1,294,300
2016	209,000	296,500	360,500	448,000	783,267	1,243,550	934,767	1,313,800
2017	251,875	377,750	453,375	579,250	544,292	818,617	745,792	1,020,117
2018	258,500	387,500	465,500	594,500	557,783	838,700	764,783	1,045,700
2019	263,250	394,500	473,750	605,000	568,483	854,633	778,983	1,065,133
2020	268,000	401,500	482,500	616,000	578,067	868,967	792,567	1,083,467
2021	270,500	405,000	487,000	621,500	583,367	876,667	799,867	1,093,167

Source: Department of Social Services, Australian Government, 2023a