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Should I Care or Should I Work? The Impact of Working in Older Age on Caregiving

Ludovico Carrino[a,b] Vahé Nafilyan[c], Mauricio Avendaño Pabon[b,d]
[a]Department of Global Health & Social Medicine, King's College London, London, UK
[b]Department of Economics, Ca' Foscari University Venezia, Italy
[c]King's Business School, King's College London, London, UK
[d]Department of Social and Behavioural Sciences, Harvard University, Boston, USA

Abstract
This paper examines the impact of an increase in labour supply on women's informal caregiving, due to changes in pension rules. We exploit a unique reform that increased the female State-Pension-Age (SPA) in the UK for up to 6 years. Using an instrumental variable approach to account for the endogeneity of labour supply, we show that an increase in employment substantially reduces the intensity of informal care: working for 30 hours/week reduces care-intensity by 6.6 hours/week, and reduces the probability of providing intensive care ($\geq$ 20 hours/week) by 4 percentage points. We show that these effects are concentrated among women working in physically and psychologically demanding jobs. Our results provide evidence that increasing women's labour supply in older age by raising the statutory age of retirement may decrease the intensity of informal care, which raises concerns about the availability of informal care in ageing populations.

Keywords: informal care, retirement, labour supply, pension reform
JEL: J14, J22, J26, H55

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Corresponding author: Ludovico Carrino, ludovico.carrino@kcl.ac.uk , Department of Global Health & Social Medicine, King's College London, London, UK

1. INTRODUCTION

Ageing societies face two competing challenges resulting in paradoxical policy responses: On the one hand, an increase in the proportion of older people with physical and cognitive limitations leads to an increase in the demand for long-term care (Kingston *et al.*, 2018). In England, from 2015 to 2035, the number of adults aged 85 and older with low dependency will increase by 148%, while the number of 85-year olds with high dependence will increase by 92% (Kingston *et al.*, 2018). Motivated by concerns about the impact of these trends on costs of long-term care in future decades, Governments have responded by increasing incentives for unpaid care provided by family and friends (Brugiavini *et al.*, 2017; Gori and Fernandez, 2015; Van Houtven *et al.*, 2013). This form of informal care represents the majority of care provided to older people in OECD countries (Verbeek - Oudijk *et al.*, 2014). Simultaneously, continuous increases in life expectancy at age 65 have led to concerns about the sustainability of pension systems. In response, Governments have introduced policy reforms to increase employment in older age by raising the statutory age of retirement by several years (Börsch-Supan, 2014). These policies have resulted in marked increases in employment rates in older age, particularly among women (OECD, 2017c).

An important, yet overlooked question is how an increase in women's labour supply affects the supply of informal care to dependent family members and friends. While unpaid, informal care has substantial economic value (Colombo *et al.*, 2011): A recent report estimates that the economic value of carers in the UK in 2015 was £132 billion a year, which is close to the total costs of health spending in the UK (Buckner and Yeandle, 2015). The impact of increased labour supply on informal care supply is ambiguous: on the one hand, informal care supply would decline in response to increased employment at ages 55 to 65, due to reduced time allocation decisions imposed by a demanding job (Burr and Colley, 2017). On the other hand, if caregiving is inflexible to employment (e.g., due to moral obligations), time allocation for leisure time will decline, keeping informal care provision constant (He and McHenry, 2016). Given recent forecasts that predict a substantial increase in care-demand and costs (de la Maisonneuve and Martins, 2013; EUROSTAT, 2015), understanding how caregiving adapts to higher employment participation is crucial, particularly in the context of changing family patterns which have reduced the supply of informal care (e.g., lower number of children, greater geographic mobility) (Geerts *et al.*, 2012; Heitmueller, 2007; WHO, 2015). Likewise, recent policies that incentivise informal care at home (Courtin *et al.*, 2014; Riedel and Kraus, 2011; WHO, 2015) and tighten eligibility rules for formal care (Brugiavini *et al.*, 2017; Gori and Fernandez, 2015; Van Houtven *et al.*, 2013) highlight the need to understand the broader impact of recent pension reforms on informal care supply.

In this paper, we exploit a recent reform in the UK that substantially increased the State Pension Age (SPA) by as much as 6 years beyond age 60 for women born after March 1950. Economic theory predicts that caregivers' optimal care provision equals the marginal utility of care-time, work-time and leisure-time, under a time and budget constraint (Pezzin *et al.*, 1996). Thus, receiving a pension (non-labour income) is expected to reduce working hours and increases both care- and leisure-time (Johnson and

Sasso, 2000). In addition, the willingness to supply care decreases with the opportunity costs of caring, which are lower for retired women and higher for workers with higher earnings who can purchase care on the market (Van Houtven *et al.*, 2013). An altruistic caregiver embeds the health status of the care-recipient into her own utility function (Stabile *et al.*, 2006; Van Houtven and Norton, 2004). A reduction in the supply of care may thus decrease the caregiver's utility if the negative effect on the health of the care recipient is larger than the increase in utility derived from additional leisure or consumption. The nature and strength of the social mores operating on the caregiver may imply that a significant reduction in care would reduce her utility (e.g., by triggering feelings of "guilt") which might offset the benefits from working longer (Al-Janabi *et al.*, 2018; Carmichael and Charles, 2003). Finally, the opportunity costs of caring may also depend on the type of care given –whether inside or outside the household- as well as the intensity of care provided and the closeness of the kinship bond between carer and care recipient (Broese van Groenou and De Boer, 2016; Carmichael *et al.*, 2010; Michaud *et al.*, 2010; Van Houtven *et al.*, 2013).

Establishing whether employment has a causal effect on the incidence and intensity of informal care provision is difficult because employment is potentially endogenous: the amount of informal care provided influences employment decisions, and both informal care and employment decisions are endogenous to unobservable individual and family characteristics. Prior literature has examined the impact of caregiving on labour market participation and wages (see, e.g., Schmitz and Westphal (2017), Van Houtven et al. (2013), Crespo and Mira (2014), Bolin et al. (2008b), Mentzakis et al. (2009), Michaud et al. (2010), Jacobs et al. (2014)), but few studies have examined the impact of employment on the supply of informal care. Using dynamic analysis in the British Household Panel Study (BHPS), Michaud et al. (2010) find a negative effect of employment on future informal care both within and outside the household. Carmichael et al. (2010) apply discrete-time models using the BHPS, and find that employment has a negative impact on willingness to supply informal care. Both of these papers rely on the assumption that employment prior to caring is exogenous. He and McHenry (2016) overcome this assumption by using state-level unemployment rates as instrumental variable for employment status and find that an increase in working hours reduces informal care provision. Their identification strategy assumes that local unemployment rates are exogenous and do not have a direct effect on the supply of informal care.

The studies above require strong assumptions about the exogeneity of employment decisions, and they focus primarily on young and middle-age workers. To our knowledge, there is little evidence on the impact of increased employment around the age of retirement on the supply of informal care. This is important because older adults aged 55 to 65 represent about 30% of the total caregiving population, 60% of which are women (OECD, 2017a; Rodrigues *et al.*, 2012). In this paper, we use State Pension eligibility age as an instrumental variable to capture an exogenous incentive to stay longer in the labour market. The State pension age increase in the UK significantly raised older female employment rates (Cribb *et al.*, 2016), but it is unlikely to have affected informal care supply other than by raising

employment. Moreover, the reform generated variation in SPA for women of the same age, allowing us to flexibly control for age effects.

Using data from the *Understanding Society survey* collected between 2009 and 2017, we estimate the impact of employment on both the incidence and intensity of caregiving for women aged 55-65 in a two-part model (Carrino et al., 2018c). Our results demonstrate a trade-off between employment and informal care provided outside the household: Relative to non-employment, working 30 hours per week leads to a reduction in the provision of informal care of 6.6 hours a week, with an elasticity of 0.37%. We find a reduction of 4 percentage points in the supply of intensive care (20+ hours per week), and a reduction of 11.6 percentage points in the supply of meaningful care (5+ hours per week). Our results indicate that the effect of employment on informal care supply is significantly stronger for women in physically and mentally demanding jobs.

Our study makes several important contributions to the literature. First, we are the first to show the impact of increasing the statutory retirement age on the supply of informal care among older women, who make up a large share of the population providing care. Second, our findings highlight the need to address potential reductions in the supply of informal care as a result of increasing incentives to work. Combined with reductions in public-care coverage and tightened public spending on social care (AgeUK, 2017), this reduction is likely to lead to an increase in unmet need for social care in older age in future decades (Pickard, 2015). SPA is predicted to rise by one and a half years in the next decade across OECD countries (OECD, 2017b). Our findings suggest that the traditional source of informal care will decline, and highlight the conflict between policies aimed at increasing employment and those aimed at increasing the supply of informal care. While a reduction in informal caregiving may be compensated by an increase in the use of more expensive formal care, existing evidence suggests that formal and informal care are not perfect substitutes (Balia and Brau, 2013; Bonsang, 2009; Carrino et al., 2018c). Therefore, reduced informal care supply may not only increase formal care costs but it may also result in rising unmet needs among older dependents (AgeUK, 2017; Carrino *et al.*, 2018c; European Commission, 2014; Iparraguirre, 2017; Muir, 2017; OECD, 2017d).

The remaining of this paper is organised as follows: Section 2 describes the data, empirical model and instrumental variable approach; section 3 discusses our main results and robustness checks; and section 4 concludes and discusses policy implications of our findings.

2. METHODS

2.1 DATA, SAMPLE SELECTION AND DESCRIPTIVE EVIDENCE

We use data from 2009 to 2017 (eight waves) from *Understanding Society,* an annual survey on a sample of household members aged 16+ in the UK comprising detailed information on health, work, education, income, family and social life. Full details of the survey are available at Lynn (2009) and Knies (2016).

We focus on women aged between 55 and 65, as women of these ages provide a large share of all informal care and they are the target of the State pension age eligibility reform (Section 2.2). We exclude women who never worked as they are not eligible to the state pension (1,174 women); women who were interviewed via a proxy (391); and women with missing values for our variables of interest (304). Our final sample consists of 7,102 women and 27,044 observations.

Informal caregivers are defined as those reporting to "look-after or give special help" to someone who is "sick, disabled or elderly" (Carmichael and Ercolani, 2016). Informal carers may co-reside with the recipient (in-household) or elsewhere (extra-household care setting) and report the weekly number of care-hours provided (Figure 1) .[1] In section 3.1.1 we follow Michaud *et al.* (2010) and Carmichael *et al.* (2010) and define two dichotomous indicators for the provision of, respectively, meaningful care (at least 5 hours per week) and intensive care (at least 20 hours per week).

The survey includes information on hours usually worked per week, for main and second occupation. As the working hours sometimes exceed plausible values, we trim this variable at the 99th percentile. We also employ a binary indicator for working zero vs one or more hours per week. Moreover, we transform both working and care hours using an inverse hyperbolic sine function, which is equivalent to the logarithmic transformation, while being able to deal with zero values (Burbidge et al., 1988).
We exploit information on respondents' socioeconomic status, derived from the hierarchical National Statistics Socio-economic Classification (NS-SEC), which distinguishes between managerial / professional, intermediate (including small employers and own-account workers), and routine/manual-workers.[2] We include as control variables several additional respondents' characteristics such as living arrangements ("single/never married", "living in couple", "widowed/divorced/separated"), the year at which respondents left their last job, number of children, educational attainment (categorised as A-level or higher, GCSE level, no education), and a binary indicator on whether the respondent owns her home. We also exploit information on respondents' year-and-month of birth, as well as interview date, to build a binary indicator for whether a respondent is above or below her State Pension age at the time of interview.

[1] Care hours are reported in brackets. Two brackets, namely, "care under 20 hours" and "care 20 hours or more" (6% of caregivers) are purposely less precise than other categories. When dropping these respondents, results are confirmed (upon request). Due to data limitation, it is not possible to disaggregate care-hours for the 1% of the respondents who provide both in- and extra-household care. Since care intensity is significantly higher for in-household settings (compared to extra-household care), we classify such respondents as in-household caregivers (as suggested by Michaud et al. (2010)).
[2] The NS-SEC coding is based on a cross-reference between individuals' current or last occupational category (based on the Standard Occupational Classification, SOC2000), firm size, and employment status (employer, self-employed or employee).

Descriptive evidence

Table 1 provides descriptive statistics for the total sample. The average age is 60, and the majority of respondents is working, living in couple, below the SPA, and home-owner.[3] Nearly half of women has one child, about half has an A-level education certificate, and around one-third is in the lowest SES. Compared to women who report that they do not work, those in paid-work are younger, have a higher SES, have higher education and are more likely to report having no children (columns b, c).

Table 1, Descriptive statistics for the total sample and by employment status

	(a)		*(b)*		*(c)*	
	Whole population		*Not in paid work*		*In paid work*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Age	59.84	3.164	61.15	3.004	58.77	2.873
working	0.547	0.498	0	0	1	0
Hours worked	15.63	16.74	0	0	28.05	12.59
retired	0.322	0.467	0.712	0.453	0	0
Below State Pension Age	0.614	0.487	0.422	0.494	0.772	0.420
Living with a partner	0.703	0.457	0.688	0.463	0.716	0.451
Widowed	0.240	0.427	0.253	0.435	0.229	0.420
Single	0.057	0.232	0.059	0.237	0.054	0.228
No children	0.256	0.437	0.210	0.408	0.294	0.456
One child	0.475	0.499	0.495	0.500	0.459	0.498
Two children or more	0.268	0.443	0.294	0.456	0.247	0.431
No education	0.168	0.374	0.248	0.432	0.102	0.303
Education at GCSE level	0.339	0.473	0.343	0.475	0.335	0.472
Education at A-level or higher	0.493	0.500	0.409	0.492	0.563	0.496
SES routine	0.379	0.485	0.425	0.494	0.342	0.474
SES intermediate	0.269	0.444	0.253	0.435	0.282	0.450
SES managerial	0.351	0.477	0.322	0.467	0.376	0.484
house owned	0.808	0.394	0.763	0.425	0.845	0.362
Provides informal care	0.286	0.452	0.288	0.453	0.284	0.451
- inside household	0.080	0.272	0.103	0.304	0.061	0.241
- outside household	0.206	0.404	0.185	0.389	0.223	0.416
Provides 5+ hours informal care	0.186	0.389	0.204	0.403	0.172	0.377
- in household	0.068	0.252	0.0908	0.287	0.049	0.217
- outside household	0.118	0.323	0.114	0.317	0.122	0.327
N	27045		12238		14807	

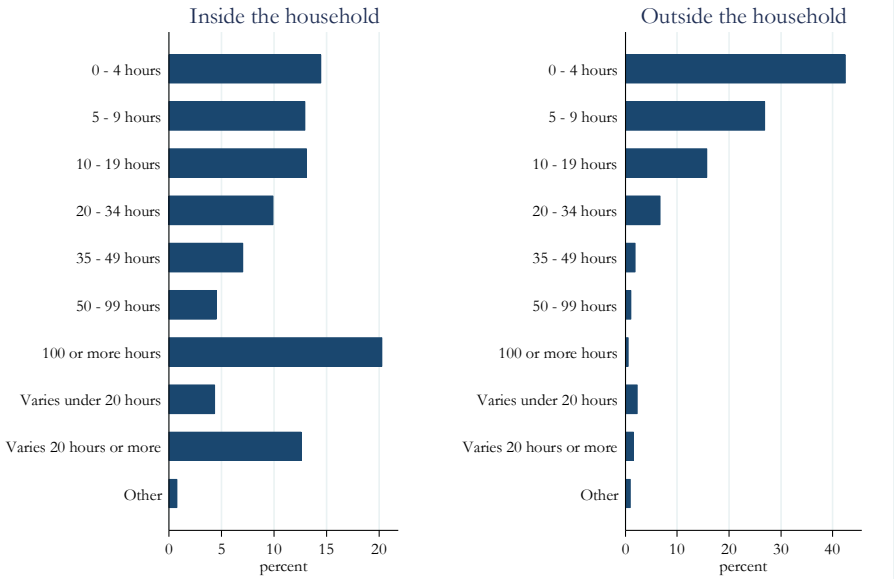
Note: The sample includes women aged 55-65 between 2009 and 2017, who have been engaged in paid work. It excludes women who never worked and those whose interview was carried out via a proxy interview. The SES classification follows the National Statistics SEC-3 taxonomy.

Descriptive statistics confirm several stylised facts (Carmichael and Ercolani, 2016; Michaud *et al.*, 2010): First, around 28% of respondents provide informal care. Second, extra-household caregiving is more common but less intensive than in-household care (Figure 1). Third, employed women are more

[3] Respondents who report that they are not working report that they are either retired (30.9%) undemployed, (2.5%) r sick/ homecarer (9.60%) or other (0.3%).

likely to provide extra-household care and less likely to provide in-household care than non-working women. Fourth, women at work provide less intensive care than women out of work. Fifth, care outside the household is primarily provided to parents (68.8%), followed by friends/neighbours (17.3%) and other relatives (16.5%). By contrast, care inside the household is primarily provided to a spouse (65.4%), followed by parents (17.1%) and children (13.5%).

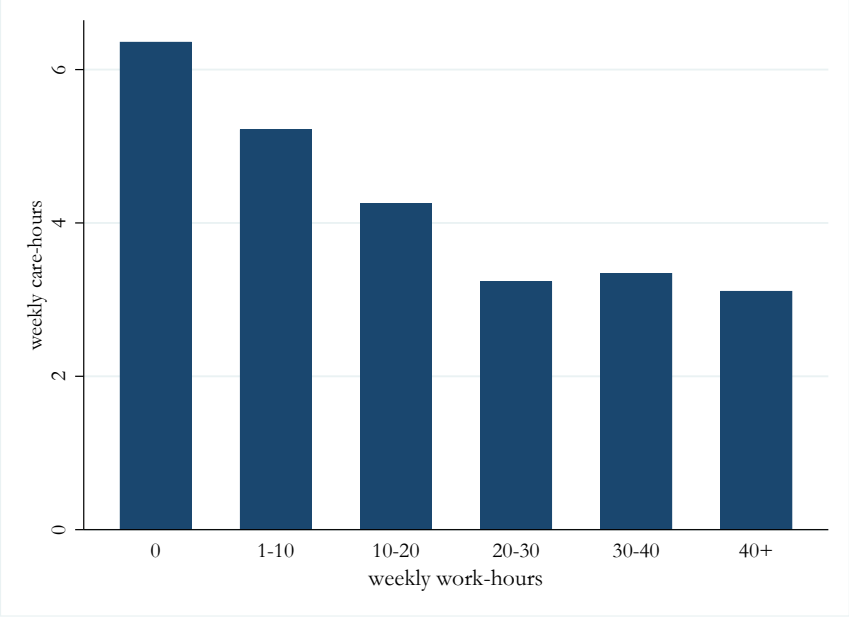
Figure 1 Hours spent providing care, inside and outside the household



Note: the sample includes women aged 55-65 between 2009 and 2017 who have ever been engaged in paid work and currently provide informal care

Figure 2 shows that there is a negative and graded relationship between the intensity of work (as measured by weekly working hours) and the intensity of informal care provided (as measured by weekly hours of care per week). For example, women who report zero working hours provide on average 6.4 hours of care per week; women who work 10-19 hours provide an average of 4.3 hours of care per week; while women who work for 40 hours or more provide only 3 hours of care per week. This association is likely to reflect both the impact of informal care on work, as well as the impact of work on care. Therefore, in the next section, we discuss our econometric specification approach to estimate the causal impact of work on informal caregiving exploiting the UK pension reform.

Figure 2, working-hours and care-hours



Note: the sample includes women aged 55-65 between 2009 and 2017 who have ever been engaged in paid work and currently provide informal care

2.2 ECONOMETRIC SPECIFICATION

We investigate the causal effect of working on the supply of informal care in older age. We adopt a two-part model (2PM), which separately models informal care provision at the extensive and the intensive margin: first, the individual decides whether to provide care; second, conditional upon caregiving, she determines the amount of care provided. This is the standard model in the health economics literature to model strictly positive variables with a large number of zero values. . Following prior literature, "zero" caregiving hours indicate that no care was provided (see, e.g., Duan et al. (1983), Van Houtven and Norton (2004) and Carrino et al. (2018c)).

The first part of the model is estimated through a probit regression for individual *i* at time *t*:

$$(1) \qquad Pr(ICH_{it} > 0) = \gamma_0 + \gamma_1 WH_{it} + \sum_a \delta_a 1(A_i = a) + \sum_y \vartheta_y 1(Y_t = y) + X_{it}\beta + \varepsilon_{it}$$

where *ICH* represents the number of informal care hours provided per week. The type of care provided, its intensity, and the identity of the care-recipient are likely to differ depending on care-setting i.e., extra- vs in-household, and this may affect the relationship between care and employment, e.g., in-household caregiving has been shown to have a stronger negative effect on employment than extra-household care (Carmichael et al., 2010; Heitmueller, 2007; Mentzakis et al., 2009; Michaud et al., 2010). Thus, we implement separate models by care-setting. *WH (working hours)* is a continuous variable for working hours, transformed using the inverse hyperbolic sine. This transformation provides a coefficient interpretation equivalent to the logarithmic transformation, while being able to deal with zero values

(Burbidge et al., 1988). In an alternative specification, we employ a dichotomous variable for being in paid work. We flexibly control for age, as it is likely to be an important determinant of both employment and caregiving supply, by adding fixed effects for age in years (A). We also control for common trend shocks in caregiving outcomes as well as in employment, with a set of dummies for interview year (Y).[4]

Whilst we control flexibly for age and interview year, the treatment and control groups may still differ on several sociodemographic characteristics because of cohort effects. To mitigate this potential issue, we include in the vector X a range of socio-demographic characteristics that are likely to have changed across cohorts. As younger cohorts in the UK have lower fertility (Kneale and Joshi, 2008), and having children could affect both women's employment/retirement decision and the supply of care, we include a categorical variable for having zero, one/two, or at least three children. Younger cohorts are also much more likely to attain secondary education and be employed in intermediate/managerial occupations than older cohorts (OECD, 2015), which could potentially affect both employment and caregiving decision. We thus control for highest educational attainment (A-level or higher, GCSE level or less than GCSE/no education), and having (or having had) a routine, intermediate or managerial level job (NS-SEC classification). Similarly, we account for individuals' marital status (dummies for being single, widowed/separated, living with someone) to account for cohort differences in family forms and living arrangements (Sobotka and Toulemon, 2008). Furthermore, we control for country dummies (England, Wales, Scotland and Northern Ireland) to account for geographical factors that might have a direct effect on health. Finally, we add a binary variable for home-ownership to control for a measure of financial resources that is unlikely to be affected by our instrument (eligibility to the State pension, see the next section). Although such controls should enhance the precision of our estimates, and improve the credibility of our identification strategy, we show that our results are robust to excluding these controls from the model. We do not control for health measures in our main specification, as health may be endogenous to informal care: First, unobservable variables like personality may affect both respondents' health and informal care decisions (Bom et al., 2018); second, caregiving may impact the provider's physical and mental health, both in the short and in the long-run (see Bom et al. (2018), Zwart et al. (2017) and Carrino et al. (2018b) for a review). However, in the robustness checks section, we show that our results are robust to extensive controls for the health of the caregiver.

In the second part of the model, estimate on the conditional sample of caregivers, the dependent variable is interval informal care transformed using the inverse hyperbolic sine, with same regressors as in (1), estimated through an interval regression model (Bettin and Lucchetti, 2012; Stewart, 1983).

$$\log(ICH_{it}^{*}) = \gamma_0 + \gamma_1 WH_{it} + \sum_a \delta_a 1(A_i = a) + \sum_y \vartheta_y 1(Y_t = y) + X_{it}\beta + \upsilon_{it} \quad (2)$$

with $ICH_{it} = j$ if $\xi_{j-1} < ICH_{it}^{*} \leq \xi_j, j=1,\ldots,m$ where we account for m cut-off points .

[4] We test for alternative specifications in the robustness section.

2.2.1 Instrumental variable approach

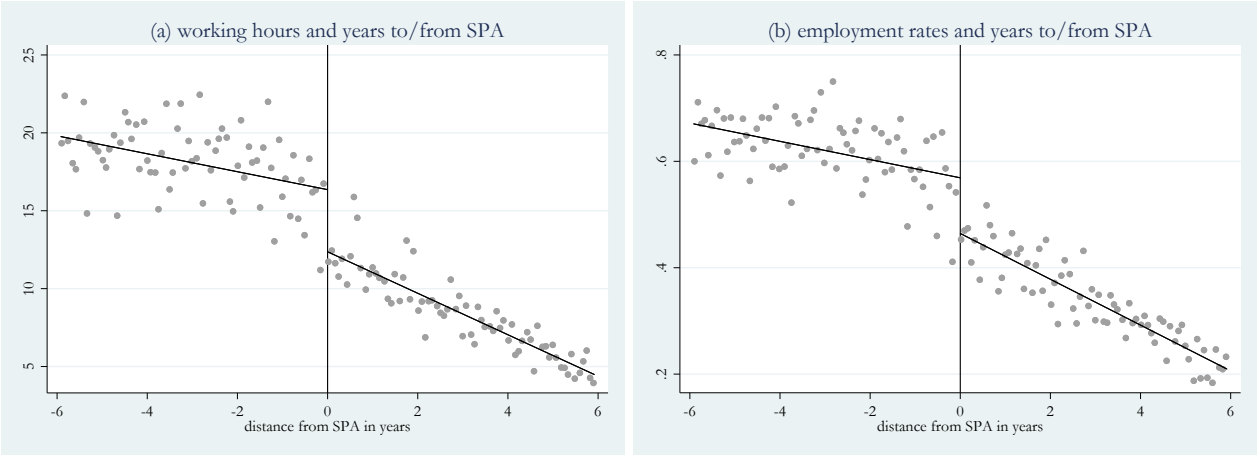
The causal effect of work on caregiving can be consistently identified at both margins only if the error terms ε_{it} and υ_{it} are uncorrelated with employment status. This assumption is unlikely to hold for several reasons (Carmichael et al., 2010; Crespo and Mira, 2014; He and McHenry, 2016). First, as individuals make caregiving and employment decisions jointly, reverse causality is likely to exist. Second, observable and unobservable individual and family characteristics influence both decisions, e.g., the degree of dependency of the care recipient, the caregiver's preferences between caregiving and leisure. Thus, to identify the causal effect, we use eligibility to the State Pension to instrument employment status. More formally, we model working hours as a function of being under the State Pension Age (SPA) and the same covariates as in equations (1) and (2):

$$WH_{it} = \alpha_0 + \alpha_1 underSPA_{it} + \sum_a \delta_a 1(A_i = a) + \sum_y \vartheta_y 1(Y_t = y) + X_{it}\beta + \varepsilon_{it}$$

Where $underSPA_{it}$ is a binary variable indicating whether the individual i observed at time t is under the SPA. In the UK the SPA is the minimum age at which people can claim the Basic State Pension, which provides an almost-flat minimum level of retirement income (the specific amount depends National Insurance contribution-years, see OECD (2013), PPI (2015) for further details). Since 2010, the female SPA has been raised gradually (from the baseline age of 60) for women born after March 1950. The increase, based on year-and-month of birth, will increase SPA to 66 by 2020 (see Thurley and Keen (2017) and Figure 4 in the Appendix). To determine pension eligibility, we combine information on year-and-month of birth with date-of-interview (which are also included as separate controls as explained above).

To be valid, our instrumental variable should satisfy four conditions. First, it must be strongly correlated with employment, our endogenous variable. Recent estimates show that eligibility to the State pension provide a strong retirement incentive (Belloni et al., 2016; Bonsang et al., 2012; Cribb et al., 2016; Staubli and Zweimüller, 2013). Second, whilst the instrument may have no effect on some individuals, it must affect everybody who is affected in the same way (monotonicity). The eligibility to the State Pension may not affect the employment decision of some groups, e.g., those who would have continued working past their SPA, but it is unlikely that people would decide to start working as a result of becoming eligible to the State Pension. Figure 3 plots the employment rates and average working-hours by distance to/from SPA (in years), highlighting a large discontinuity at SPA.

Figure 3, weekly working hours (a) and employment rates (b) by distance to/from SPA



Notes: panel (a) shows the average weekly hours worked (non-working women are assigned zero hours); panel (b) shows the percentage of women reporting to be working for pay.

Third, the instrument must be uncorrelated with error terms ε_{it} and υ_{it}, that is, as-good-as randomly assigned (Angrist and Pischke (2009). Our instrument satisfies this requirement, as the State Pension Age is regulated by law based on birth-date, a variable on which respondents have no control. Fourth, the instrument must satisfy the exclusion restriction, which, in our context, implies that being above/below SPA affects care giving only thought an effect on employment. Individuals who are above the SPA are older than those below SPA, which could influence the propensity to provide care directly. To prevent this, we account for age and year effects by adding fixed effects for both age and year. This is only possible because, due to the reform, pension eligibility does not depend only on age, but also on birthdate. Conditioning on age, being above the SPA is unlikely to directly affect care giving through other channels than employment and retirement. Nevertheless, the impact of working longer on caregiving could be mediated through health or income, which could change at retirement, and we test for such mechanisms in Section 3.2.1.

A potential concern with our identification strategy is that reaching the SPA may not affect the working hours of women who have long been disengaged from the labour market, but it would increase their income as they would be able to claim a State Pension.[5] A higher income without a reduction in working hours may reduce the amount of informal care if it increases the purchase of formal care, as formal care is a partly a substitute for informal care (Bonsang, 2009; Carmichael *et al.*, 2010; Carrino *et al.*, 2018c; He and McHenry, 2016; Stabile *et al.*, 2006). For long-term inactive women, reaching the SPA may thus result in higher income and lower caregiving provision. By contrast, for working women, we expect that reaching the SPA would reduce working hours and increase caregiving. Thus, including long-term inactive women may bias upward the estimate of the (instrumented) γ_1 coefficient in (1) and (2), i.e.,

[5] For women born after (before) April 1950, the full pension amount (£126/week) requires 30 (39) years of National Insurance contribution. It is reduced pro rata based on contribution years. No pension is earned below 1 (10) years of contribution.

understate the effect of working on caregiving, which we would expect to be negative. Therefore, as a robustness check (Section 3.2.2), we estimate models that exclude women who permanently left the labour force before their SPA (one year before in one model, five year before SPA in another).

Following recent literature (Deb et al., 2017; Terza et al., 2008), we estimate model (1) as an IV-probit, through a 2 stage residual inclusion (2SRI), where the instrumented variable is the continuous amount of log working hours. As per the instrumented interval regression model (2), we employ the eintreg command in Stata15. In all analyses, standard errors are clustered at the month-of-birth level (224 clusters) to account for the fact that treatment assignment varies by month of birth, but findings are robust to standard errors being clustered at the individual level (Section 3.2). Our estimates should be interpreted as a Local Average Treatment Effect (LATE), that is, the effect of being in paid employment as a result of being below the SPA on caregiving.

3. RESULTS

Table 2 reports the results of equation (1). Columns 1-2 summarises estimates on the impact of employment on the probability of work (the extensive margin), separately for care inside (Panel A) and outside the household (Panel B). In a regular probit model (column 1), higher working hours is associated with higher probability of in-household care, but not with the probability of extra-household care. Column 2 summarises the results of our IV model using State Pension eligibility as an instrumental variable. The F-test of the excluded instrument (being below SPA) is large and highly significant (first-stage results are available in the Appendix 6.2). Results from the second stage provide no evidence that working hours has a causal effect on the probability of caregiving (column 2).

Columns 3-4 summarise results for the intensive margin based on model (2). The reported coefficient is an elasticity, i.e. the percentage change in caregiving hours resulting from a 1% change in working hours, computed at averages (roughly 15 working hours a week, 9 hours of non-residential care per week). A negative and relatively small statistical association is found in the OLS model, for both care settings. IV estimates, by contrast, suggest a significant impact of working on non-residential care: a 1% increase in work-hours reduces care-hours by 0.37%. This implies that an increase by 30 hours leads to a decrease in extra-household caregiving by 6.6 hours a week, corresponding to almost 1 hour per day. We find no statistically significant effect for in-household care. However, because of the small number of observations, our instrument becomes weak and we may lack power to detect the causal effect of working

hours on care intensity. Findings for models that use a binary indicator for being in paid work offer a similar picture (Appendix Table 7).[6]

Table 2 Effect of working hours on informal care provision

	Any amount of care		log weekly hours among carers	
	(1) probit	(2) Probit IV	(3) Interval reg.	(4) Interval reg. IV
A – extra-household caregiving				
Log working-hours	0.002	-0.029	-0.059***	-0.367***
	(0.002)	(0.033)	(0.010)	(0.120)
N	27,045	27,045	5,566	5,566
F-test excl. instr.		47.070		28.676
Mean outcome		0.206		9.077
B – in-household caregiving				
Log working-hours	-0.009***	-0.019	-0.128***	-0.336
	(0.001)	(0.021)	(0.019)	(0.349)
N	27,045	27,045	2,173	2,173
F-test excl. instr.		47.070		4.344
Mean outcome		0.080		31.300

Note: In columns 1 and 2 the dependent variable is a binary indicator for any care provided outside (Panel A) or inside the household (Panel B). In columns 3 and 4 the dependent variable is the log of weekly hours spent providing care coded as intervals. In columns 2 and 4, log of working hours is instrumented by the status of being above/below State Pension Age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report marginal coefficients computed at means for a probit (column 1), iv-probit (column 2), interval regression (3), and instrumented interval regression (4) models. Standard errors are clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017, having been engaged in paid work in their life.

3.1.1 Heterogeneity by caregiving intensity

As the results above are based on the entire distribution of self-reported care hours, we now assess heterogeneity by care intensity. Higher intensity may reflect higher care commitment/responsibility, potentially implying lower substitutability between care and work. Conversely, high intensity caregiving may be harder to combine with work (He and McHenry, 2016). Based on prior literature (see Carmichael

[6] We estimate the model through the biprobit command in Stata, due to the presence of a dichotomous dependent and independent (endogenous) variables. The instrument is still informative and valid.

et al. (2010)), we define high intensity caregiving with a threshold of 20+ hours a week. Furthermore, the distribution of care-hours is highly skewed in non-residential settings: as almost 50% provide fewer than 5 hours a week (Figure 1), we also use 5 hours as cutoff for meaningful extra-household caregiving (Michaud et al. (2010)). We run a series of IV-probit models as in (1), for the aforementioned dichotomous dependent variables.

Focusing on non-residential care, results in Table 3 highlight that working leads to a substantial decrease in both meaningful extra-household caregiving (above 5 hours) and intensive caregiving (above 20 hours).[7] The coefficients indicate that, for a 10% increase in working hours (equal to 1.5 hours per week, computed at the average of 15 hours), the prevalence of 5+ hours caregiving drops by 0.63 percentage points (average prevalence 11.6%) while intensive care drops by 0.2% (average 2.5%). We find no evidence of an impact on intensive in-household care.

Table 3. Heterogeneous effects of working hours by level of caregiving intensity

	In household intensive care (20+ hrs week)		Extra-household intensive care (20+ hrs week)		Extra-household care 5+ hrs week	
	(1) probit	(2) iv-probit	(3) Probit	(4) iv-probit	(5) probit	(6) iv-probit
Log working hrs	-0.009***	-0.010	-0.003***	-0.020**	-0.003	-0.063***
	(0.001)	(0.015)	(0.001)	(0.009)	(0.002)	(0.021)
N	27,045	27,045	27,045	27,045	26,812	26,812
F-test excl. instr.	46.41		46.41		46.41	
Mean outcome	0.044		0.024		0.117	

Note: In columns 1 to 4 the dependent variable is a binary indicator for providing 20+ weekly hours of care inside/outside the household. In columns 5 and 6 the dependent variable is a binary for 5+ hours care provision outside the household. In columns 2, 4 and 6, log-working hours are instrumented by the status of being above/below State Pension Age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report marginal coefficients computed at means. Standard errors are clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017 who were engaged in paid work at some point in their life.

3.1.2 Heterogeneity by job-demand

We now investigate whether the previous findings are heterogeneous across job types, as women in more demanding occupations may find it harder to balance care duties while working in older age (Broese van Groenou and De Boer, 2016; Burr and Colley, 2017). We exploit two external indices built by Kroll and

[7] When focusing on the 5+ hours cutoff, we drop respondents who reported care hours as "20 hours or less" instead of using more detailed bands.

Lampert (2011), on physical and psycho-social burden (further details in the Appendix 6.3). These indices have been externally validated (Santi et al. (2013)) and adopted in economics research, as they are more informative on job-demand than the coarse distinctions (e.g., white vs blue collar) based on the first digit of the ISCO-code (Mazzonna and Peracchi, 2017). We retrieve the indices for 99% of our sample using the 4-digit International Classification of Occupation (ISCO-88) for linkage. Following Santi et al. (2013) and Mazzonna and Peracchi (2017), we split the sample between those working in high- and low-demand occupations for each index, using a cutoff score of 6 (out of 10), and estimate our models for each sub-group.[8]

We find no statistically significant effect at the extensive margin, and no effect for in-household care overall. At the intensive margin for extra-household care, Table 4 highlights that the trade-off between employment and care-intensity is large and significant for caregivers from demanding jobs (elasticity coefficient around 0.6). For women with a psychosocially or physically strenuous job, an increase of 30 working hours reduces caregiving by 10.8 hours. By contrast, we found no evidence of an effect of working hours on caregiving intensity for women in occupations classified as low demand. Similar findings emerge when looking at the probability to provide 5+ or 20+ hours of care (Appendix Table 8).

Table 4, Effect of working hours on extra-household care hours, by job exposure (physical or psycho-social)

	log weekly hours among extra-hh carers (Instrumented interval-regression)			
Exposure	Psycho-social strenuous job		Physical strenuous job	
	No	Yes	No	yes
Log working hours	-0.129	-0.639***	-0.253	-0.602**
	(0.142)	(0.236)	(0.137)	(0.267)
N	2,497	3,012	3,103	2,406
F-test excl. instr.	15.548	11.560	18.851	8.463

Note: the dependent variable is the log of weekly hours spent providing care outside the household among caregivers, coded as intervals. Log-working hours are instrumented by the status of being above/below State Pension Age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report coefficients from an instrumented interval regression, with standard errors clustered at the month-year of birth level. See Appendix 6.3 for details on the job-demand indices.

[8] One concern is that women may self-select themselves into less straining jobs as a result of being below SPA. We find no evidence that being below SPA is associated with job demand (Appendix 6.2).

3.2 ROBUSTNESS CHECKS

3.2.1 The role of health and income

The observed relationship between employment and caregiving could be mediated by the respondent's health status. For example, if health improves after retirement, this might allow for higher care-provision. The existing theoretical frameworks on the positive or negative health consequences of work disengagement lead to mixed predictions (see, e.g., the discussion in (Hessel, 2016; Mazzonna and Peracchi, 2017; Rohwedder and Willis, 2010)). Empirical evidence reports either positive (Belloni et al., 2016; Bertoni et al., 2017; Bloemen et al., 2017; De Grip et al., 2012), negative (Behncke, 2012; Bonsang et al., 2012; Mazzonna and Peracchi, 2017), or no effect of retirement on physical or mental health(Bloemen *et al.*, 2017; Coe and Zamarro, 2011). Some recent studies suggested that a rise in employment as a result of a change in statutory retirement ages leads to a positive effect on health behaviour (Bertoni *et al.*, 2018), but a negative effect on mental or physical health (Carrino *et al.*, 2018a; De Grip *et al.*, 2012; Shai, 2018).

Although we did not include health in our main model due to potential endogeneity with care provision, we report robustness analyses that include caregiver's health as regressor. We employ several combinations of measures for caregivers' health, described in Appendix 6.4 (full results in Table 13). In Table 5 we show results for models which include the SF-12 Mental Composite Score, MCS, and Physical Composite Score, PCS (column 1), and the General Health Questionnaire score, GHQ (column 2). Overall, estimates for the coefficient of interest (working-hours) are consistent and stable across all specifications. Results for the 5+ or 20+ care-hours cutoffs, as-well-as for job-demand heterogeneity, are available upon request.

A second potential mechanism involves the impact of employment on earnings. While retirement increases the endowment of leisure time, it negatively affects individual and household income (Banks et al., 1998), which could lead to increased informal caregiving, e.g., because of reduced resources to pay for formal care (He and McHenry, 2016; Stabile et al., 2006). We thus test the robustness of our results by adding controls for household income in the log (excluding individual's income from the amount). Results are summarised in Table 5 (column 3) and Table 9 in log or quintiles. Results from these models are very close to those from our original specification.

Table 5, sensitivity analysis controlling for income and health

	(1)	(2)	(3)
	A - Caring outside the household (among caregivers)		
Log working hours	-0.395**	-0.375**	-0.343**
	(0.154)	0.151)	(0.134)
N	5,566	5,566	5,566
F test excluded instrument	18.611	18.957	24.389
	B - Caring inside the household (among caregivers)		
Log working hours	-0.453	-0.479	-0.375
	(0.648)	(0.514)	(0.461)
N	2,173	2,173	2,173
F test excluded instrument	1.070	1.796	2.618
Income measures	-		Log HH income
Caregiver's health	MCS, PCS scores	GHQ	-

Note: The dependent variable is the log of weekly hours spent providing care, among caregivers, coded as intervals. Log-working hours are instrumented by the status of being above/below State Pension Age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. Standard errors are clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017, who were engaged in paid work at some point in their life. See Appendix 6.4 for details on health measures. Household income is the sum of labour-, miscellaneous-, private benefit-, investment-, pension- and social benefit income, net of taxes on earnings, national insurance contributions and council tax. Figures are adjusted in real terms (July 2015) with the Consumer Prices Index including owner occupiers' housing costs.

3.2.2 Different specifications

We perform several additional sensitivity analyses and summarise them in Table 6, focusing on effects on the intensive margin. Results are comparable to columns 3 and 4 of Table 2 (our preferred specification). First, results are robust to excluding covariates other than age and year dummies (necessary for the exclusion restriction to hold), in column 1. Second, we include dummies for age-quarter and interview year-quarter (column 2). While our results are less precisely estimated, the overall pattern is very similar to that observed in our preferred specification. In addition, our findings are robust to parametric specifications for age and year as 2nd or 3rd order polynomials (results available upon request).

Third, we exclude individuals who permanently left the labour force at least 5 (column 3) or one year (column 4) before their SPA.[9] This is done to address potential concerns with the exclusion restriction, as pension eligibility status is unlikely to affect working hours for women who have already stopped working, while it would affect their pension income and, through income, it could affect care-provision (section 2.2.1). The results from these models are very close to those in our original specification. Results are also robust to clustering standard errors at the individual level (column 5); and using a dichotomous independent (working yes/no), or dependent variable (providing 5+ or 20+ care-hours, results available upon request). Finally, we re-estimate models for in-household care restricting the sample to women with a partner, and/or including partner's health as additional covariate. These models yielded very similar results to those in our original specification (results available upon request).

[9] We remove 1659 (2100) women who continuously classified themselves as working zero hours and non-unemployed in the 5 (1) years preceding their SPA, and onward. Around 56% of them classified as retired, 20% sick/disabled, 24% home-carers.

Table 6, Effect of working on care hours: sensitivity analysis

	(1) IV Interval reg	(2) IV Interval reg	(3) IV Interval reg	(4) IV Interval reg	(5) IV Interval reg
	A - Caring outside the household				
Log working hours	-0.360***	-0.278*	-0.311***	-0.254***	-0.367**
	(0.137)	(0.143)	(0.117)	(0.085)	(0.146)
N	5,566	5,566	4,395	3,923	5,566
F test excluded instrument	22.186	18.548	30.836	57.896	16.485
	B - Caring inside the household				
Log working hours	-0.408	-0.351	-0.040	-0.028	-0.336
	(0.507)	(0.404)	(0.212)	(0.137)	(0.407)
N	2,173	2,173	1,459	1,238	2,173
F test excluded instrument	1.725	2.744	8.845	22.260	2.541
Covariates	No	Yes	Yes	Yes	Yes
Age	Year FE.	Quarter FE.	Year FE.	Year FE.	Year FE.
Year	Year FE.	Quarter FE.	Year FE.	Year FE.	Year FE.
Sample	All	All	Excl. resp. left work 5+ yrs before SPA	Excl. resp. left work 1+ yrs before SPA	All
Clustered SE	MoB	MoB	MoB	MoB	Individual

Note: "FE."= fixed effects; "MoB" = month of birth. "All sample" includes women aged 55-65 between 2009 and 2017, having been engaged in paid work in their life. Model in column 1 only includes age and year additional controls. Model 2 controls for age-quarters fixed effects; model 3 controls for age-quarters and year-quarters fixed effects; models 4 (5) exclude from the sample those who left their last job at least 5 (1) years before their State pension age. Model 5 clusters standard errors at the individual level. The dependent variable is always the log of weekly hours spent providing care, among caregivers, coded as intervals. Log-working hours is instrumented by the status of being above/below State pension age (SPA). Models 2-5 additionally control for Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report coefficients from an instrumented interval regression. Standard errors are clustered at the month-year of birth level apart from column 5 (individual level).

4. CONCLUSION

In this paper, we estimate the causal effect of labour supply on informal care provision in older age. Using an instrumental variable approach to account for the endogeneity of labour supply, our results show that working more hours as a result of being ineligible for State pension reduces the intensity of informal care provided by older women outside the household. For an average woman working 30 hours per week, the effect amounts to a reduction in extra-household caregiving by 6.6 hours per week, i.e., almost 1 hour per day. Similarly, work reduces the probability of providing both meaningful (5+ hours per week) and intensive care (20+ hours per week). The impact of work on caregiving intensity is stronger for women in physically and psychologically demanding jobs. Conversely, work has no impact on the probability of providing no informal care at all (0 hours per week).

Our results can be interpreted based on theoretical models on the relationships between labour supply and caregiving. These models assume that the marginal utility of caregiving is positive because of altruistic preferences (Stabile *et al.*, 2006; Van Houtven and Norton, 2004). Individuals choose the optimal hours of caregiving so that that the marginal utility of caregiving is equal to the marginal utility of working and of leisure (Johnson and Sasso, 2000). It may seem surprising that an increase in employment reduces the intensity of caregiving but it does not affect the probability of caregiving. However, this may indicate that the marginal utility of caregiving for a few hours is larger than that of lesure and work due to the moral obligation attached to caring for close kinship, and conversely, the utility loss associated with not fulfilling the moral obligation to provide care (Al‐Janabi *et al.*, 2018; Burr and Colley, 2017). In addition, although the reduction in informal care could be compensated by purchasing formal care on the market, recent evidence suggests that, especially for higher skilled tasks, formal and formal care provision are not perfect substitutes but complements (Bonsang, 2009; Carrino *et al.*, 2018c). Furthermore, the marginal contribution of informal care to the well-being of the dependent recipient may be larger than that of formal care. Finally, the substitution of informal with formal care is limited by the higher relative price of the latter.[10]

Our study contributes to the public economics literature by showing that policies that increase retirement age may have unintended consequences on the provision of informal care, which may reduce the welfare gains arising from raising the labour supply of older women. While the reduction in informal caregiving may be compensated by an increase in the use of formal care, it would involve significant public and private costs. Numerous studies have investigated the relationship between informal and formal care use, with most evidence showing complementarity for high-skills care (Balia and Brau, 2013; Bonsang, 2009;

[10] We do not examine the net change in the overall care received by the dependent person, as we lack data on the help provided by other relatives, children and friends of the care-recipient (Kalwij *et al.*, 2014). It is nevertheless possible that the observed reduction in intensity is at least partially compensated by an increase in care by other formal or informal providers.

Carrino et al., 2018c), and substitution for low-skill care (Bolin et al., 2008a; Bonsang, 2009; Stabile et al., 2006; Van Houtven and Norton, 2004). However, if reduced informal care supply is not compensated by formal care, it would increase unmet needs and negatively affect the health and well-being of older adults in need of care, which could in turn increase healthcare costs in older age (AgeUK, 2017; Iparraguirre, 2017; Pickard, 2015).

Our findings provide useful inputs for the optimal design of policies that aim to increase the supply of informal care (Courtin *et al.*, 2014). For example, eligibility to the UK's Carer's Allowance includes providing at least 35 hours of care per week, and having a net weekly income below £123. This may be suboptimal if women may wish to provide some hours of informal care while at the same time continuing to work, suggesting that more flexible eligibility criteria might improve the take up and efficiency of the programme. Optimal welfare may also require alternative policies such as work flexibility laws that enable women to combine demanding jobs with caring responsibilities (OECD, 2017d).

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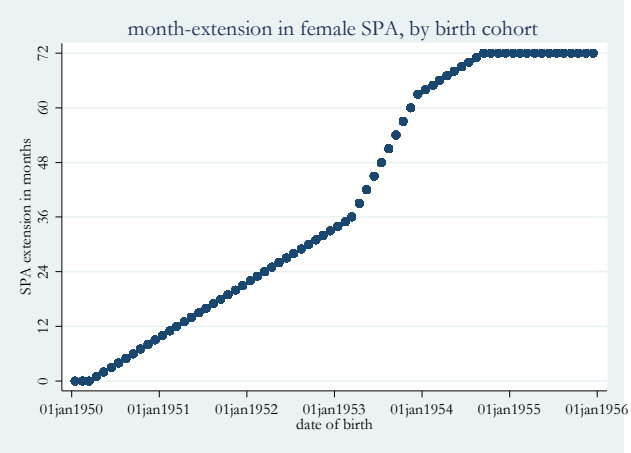
6. APPENDIX

6.1 ADDITIONAL FIGURES AND TABLES

6.1.1 Diagram: the legislated female SPA increase

Figure 4, postponement in the State Pension Age for women, as per Pension Acts 1995, 2011 and 2014



Note: authors' calculations based on Pension Acts 1995, 2011 and 2014

6.1.2 Results using a dummy for working status (yes/no)

At the intensive margin, results from the instrumented model suggest that working leads to a substantial reduction (75%) in weekly care-hours among non-residential caregivers (column 4).[11] Given an average amount of 9 care-hours per week, the reduction due to working amounts to 6.5 hours per week.

Table 7, Effect of working (yes/no) on care provision, extensive and intensive margin

	Any amount of care		log weekly hours among carers	
	(1) probit	(2) IV-probit	(3) Interval reg	(4) Int reg IV
A – extra-household caregiving				
working	0.012	-0.041	-0.248***	-1.392***
	(0.009)	(0.101)	(0.038)	(0.447)
N	27,045	27,045	5,566	5,566
F-test excl. instr.		43.344		31.211
Mean outcome		0.206		9.077
B – in-household caregiving				
working	-0.035***	-0.009	-0.491***	-1.196
	(0.006)	(0.021)	(0.075)	(1.226)
N	27,045	27,045	2,173	2,173
F-test excl. instr.		40.381		5.337
Mean outcome		0.080		31.300

Note: In columns 1 and 2 the dependent variable is a binary indicator for any care provided outside (Panel A) or inside the household (Panel B). In columns 3 and 4 the dependent variable is the log of weekly hours spent providing care coded as intervals. In columns 2 and 4, working is instrumented by the status of being above/below State pension age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report marginal coefficients computed at means for probit (column 1), iv-probit (column 2), interval regression (3), and instrumented interval regression (4) models. Standard errors are clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017, having been engaged in paid work in their life.

[11] To get the percentage change, we compute: $(e^{-1.392} - 1) \cdot 100$

6.1.3 Effect of working on high/low caregiving intensity, by job-exposure

Table 8, Effect of working hours on low/high caregiving intensity, by job exposure (physical or psycho-social)

	(A)				(B)			
	Extra-hh care for 5+ hours a week (IV-probit)				Extra-hh for 20+ hours a week (IV-probit)			
Exposure	No psycho-social	Yes Psycho-social	No physical	Yes Physical	No psycho-social	Yes Psycho-social	No physical	Yes Physical
Log working hours	-0.0328	-0.0723***	-0.0567	-0.0612***	-0.0414	-0.0224*	-0.0205	-0.030**
	(0.043)	(0.0232)	(0.0421)	(0.0217)	(0.052)	(0.0133)	(0.0430)	(0.0150)
N	10,732	15,789	13,549	12,972	10,732	15,789	13,549	12,972
F-test excl. instr.	13.47	30.80	12.90	34.53	13.47	30.80	12.90	34.53

Note: the dependent variables are binary indicators for providing 5+ (panel A) or 20+ weekly hours of care (panel B) outside the household. Log-working hours are instrumented by the status of being above/below State pension age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report marginal probit coefficients computed at means. Standard errors are clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017, having been engaged in paid work in their life.

6.1.4 Further measures of income and health

Table 9, sensitivity analysis with alternative measures of income

	(1)	(2)	(3)
	A - Caring outside the household		
Log working hours	-0.343**	-0.335**	-0.358***
	(0.134)	(0.130)	(0.137)
N	5,566	5,566	5,566
F test excluded instrument	24.389	25.956	22.962
	B - Caring inside the household		
Log working hours	-0.375	-0.374	-0.373
	(0.461)	(0.477)	(0.429)
N	2,173	2,173	2,173
F test excluded instrument	2.280	2.160	2.503
Income measures	Log HH income	HH inc. quintile	Log (HH – indiv) inc.

Note: the dependent variable is the log of weekly hours spent providing care outside the household among caregivers, coded as intervals. Log-working hours are instrumented by the status of being above/below State Pension Age (SPA). All models control for fixed effects for age (in years), interview year, Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. We report coefficients from an instrumented interval regression, with standard errors clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017, having been engaged in paid work in their life. Household income is the sum of labour-, miscellaneous-, private benefit-, investment-, pension- and social benefit income, net of taxes on earnings, national insurance contributions and council tax. Figures are adjusted in real terms (July 2015) with the Consumer Prices Index including owner occupiers' housing costs.

6.2 FIRST-STAGE RESULTS

Table 10, first-stage results: the effect of pension eligibility on labour supply

	Log working hours		Working	
	(1)	(2)	(3)	(4)
Under SPA	0.493***	0.461***	0.096***	0.090***
	(0.068)	(0.067)	(0.015)	(0.015)
F-test excl. instr.	52.093	47.070	37.637	34.476
N	27,045	27,045	27,045	27,045
Additional covariates	No	Yes	No	Yes

Note: In columns 1 and 2 the dependent variable is the log of working hours. In columns 3 and 4 it is a binary variable indicating whether the respondent is working. All models control for fixed effects for age (in years) and interview year. Additional covariates include Socio-economic Status (NS-SEC), home-ownership, marital status (dummies for being single or widowed), number of children (dummies for one child, two or more), highest educational attainment and country dummies. Standard errors are clustered at the month-year of birth level. The sample includes women aged 55-65 between 2009 and 2017, having been engaged in paid work in their life.

6.3 JOB-DEMAND INDICES

We exploit an index of job-exposure stemming from the Job Exposure Matrices (JEM) built by Kroll and Lampert (2011). The JEM is based on data from a large-scale representative survey on working conditions for 20.000 employees in Germany, and matched to the 4-digit International Classification of Occupation (ISCO-88) codes. The JEMs were constructed using hierarchical linear regression models using summary scores for job exposures in three domains based on 39 individual job characteristics. The overall index of job-demand ranges from 1 (low exposure) to 10 (high exposure) and summarises 5 dimensions of occupational burden: Ergonomic Stress, Environmental Pollution, Mental Stress, Social Stress and Temporal Loads. Two sub-indices are available, capturing Physical demand (based on Ergonomic Stress and Environmental Pollution) and Psycho-social demand (based on Mental Stress, Social Stress and Temporal Loads). The indices are controlled for respondent characteristics such as age, gender, working hours and experience on the job. They were validated externally using data of the German Health Update 2009 [19] and the German Socio-Economic Panel Study.
High-demand jobs are e.g., craft, agricultural, transport/travel and sales occupations, plant operators, social workers, general managers, health professionals; low-demand jobs are, e.g., government, legal, social science and engineering professionals, secretaries and office clerks.
The index can be matched to 99% of our sample through the 4-digit ISCO codes. Following Santi et al. (2013) and Mazzonna and Peracchi (2017), we identify as high-demanding those occupations with a score of 6 or higher.
The classification by low/high job-demand does not correspond to the classification by SES: for example, among women in high physical-demanding jobs (12,972), 65% have routine SES; among low physical-demanding jobs (13,549) 15% have routine SES. Conversely, 77% of routine women have a high-demanding job, compared to 24% of non-routine women.

Self-selection into job-demand type

We checked whether people select into less straining jobs as a result of being below SPA, running a probit model for the probability of having a high-physical or a high-psychosocially straining job, and SPA eligibility as independent variable, plus all the socio-demographic controls in (1). No significant result emerged (available from the authors).

6.4 HEALTH MEASURES

In this paper we use three widely validated measures of mental and physical health available in Understanding Society: the General Health Questionnaire, the Mental Component Score, and the Physical Component Score. Such measures are widely used in the economics literature as measures of health (Bünnings, Kleibrink, & Weßling, 2017; Clark, 2003; Dustmann & Fasani, 2016; Marcus, 2013; Mitra & Jones, 2017; Schmitz, 2011).

General Health Questionnaire (GHQ-12)

The General Health Questionnaire index (GHQ-12) measures psychological distress, by collecting information on loss-of-concentration, loss-of-sleep, feeling of playing useful roles, incapability of making decisions, feeling of being under strain, ability to overcome difficulties, enjoyment for day-to-day activities, inability to face-up problems, feeling of unhappiness/depression, loss of confidence, feeling of worthlessness, general happiness. It consists of 12 items, each evaluating how often respondents experienced a given positive or negative condition, on a zero-to-three Likert scale. The items are listed in the following Table. The index ranges between 0 and 36, with higher values signalling worse health.

The dataset also provides an alternative compact version of the GHQ index where each item is first dichotomised (assigning value 1 if the original score is two or three) and then summed so that the index ranges from 0 to 12. On this reduced scale, a cutoff score of 3+ signals the presence of depressive disorders (Goldberg et al., 1997; Goldberg & Williams, 1988).

Table 11, Items in the General Health Questionnaire, Understanding Society Survey

	Components and Questions	answer
	Anxiety and depression	
	"Have you recently…"	
2	lost much sleep over worry?	
5	felt constantly under strain?	0 Not at all; 1 No more than usual; 2 Rather more than
6	felt you couldn't overcome your difficulties?	usual; 3 Much more than usual
9	been feeling unhappy or depressed?	
	Social Dysnfunction	
1	been able to concentrate on whatever you're doing?	
3	felt that you were playing a useful part in things?	
4	felt capable of making decisions about things?	0 Better than usual; 1 Same as usual; 2 Less than usual;
7	been able to enjoy your normal day-to-day activities?	3 Much less than usual
8	been able to face up to problems?	
12	been feeling reasonably happy, all things considered?	
	Loss of confidence	
10	been losing confidence in yourself?	0 Not at all; 1 No more than usual; 2 Rather more than
11	been thinking of yourself as a worthless person?	usual; 3 Much more than usual

Note: adapted from Dustmann and Fasani (2016)

Mental Component Score and Physical Component Score (SF-12)

The Short Form-12 (SF-12, version 2) is a generic health-related quality of life instrument based on a score for 12 items. Each item is evaluated with either 1-3 or 1-5 Likert scales, and then aggregated (with equal weights) in one of eight factors: physical functioning, role limitations due to physical health issues, role limitations due to emotional problems, mental health, bodily pain, general health, vitality/energy/fatigue and social functioning. Factors are aggregated into a physical health (PCS) and a mental health (MCS) component score, each ranging from 0 to 100 (with a mean of 50), with higher values signalling better health. Full details on the scoring methodology are available in Ware (2002).

Table 12, items in the SF-12 questionnaire, Understanding Society Survey

	Question	answer
	Physical Functioning	
2	Does your health now limit you in moderate activities (moving a table/a vacuum cleaner,..)	Yes, limited a lot; Yes, limited a little; No, not limited at all
3	Does your health now limit you in climbing several flights of stairs	
	Role Physical	
4	During the past 4 weeks, how much of the time have you accomplished less than you would like due to your physical health	All/Most/Some/A little/None of the time
5	During the past 4 weeks, how much of the time were you limited in the kind of work/ activities you do due to your physical health?	
	Bodily Pain	
8	During the past 4 weeks, how much did pain interfere with your normal work, including both work outside the home and housework?	Not at all; A little bit; Moderately; Quite a bit; Extremely
	General Health	
1	In general, would you say your health is...	Excellent; Very good; Good; Fair; Poor
	Vitality	
10	How much of the time during the past 4 weeks did you have a lot of energy?	All/Most/Some/A little/None of the time
	Social functioning	
12	During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities like visiting friends or relatives?	All/Most/Some/A little/None of the time
	Role emotional	
6	During the past 4 weeks, how much of the time have you accomplished less than you would like as a result of any emotional problems, such as feeling depressed or anxious?	All/Most/Some/A little/None of the time
7	During the past 4 weeks, how much of the time did you do work/activities less carefully than usual as a result of any emotional problems?	
	Mental health	
9	How much of the time during the past 4 weeks have you felt calm and peaceful?	All/Most/Some/A little/None of the time
11	How much of the time during the past 4 weeks have you felt downhearted/depressed?	

Note: adapted from Ware (2002).

The following table complements Table 5 in the main text, by adding alternative controls for health.

Table 13, sensitivity analysis with different specifications for caregiver's health

	(1)	(2)	(3)	(4)	(5)	(6)
	A - Caring outside the household					
Log working hours	-0.387***	-0.389**	-0.388***	-0.375**	-0.374**	-0.395**
	(0.148)	(0.153)	(0.148)	(0.151)	(0.152)	(0.154)
N	5,566	5,566	5,566	5,566	5,566	5,566
F test excluded instrument	20.030	18.480	19.940	18.957	18.879	18.611
	B - Caring inside the household					
Log working hours	-0.377	-0.441	-0.392	-0.479	-0.478	-0.453
	(0.383)	(0.502)	(0.370)	(0.514)	(0.517)	(0.648)
N	2,173	2,173	2,173	2,173	2,173	2,173
F test excluded instrument	3.117	1.831	3.343	1.796	1.760	1.070
Health measures	SF12 MCS	SF12 PCS	MCS <= 45	GHQ	GHQ cutoff	MCS, PCS, GHQ

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