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Opportunity costs of unpaid caregiving: Evidence from panel time diaries

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Abstract

We examine the association between unpaid caregiving by older Americans and time allocated to labor supply, home production, leisure, and personal care. After controlling for time-invariant heterogeneity using panel time diaries, we find that older caregivers reported reduced time allocated to each domain fairly evenly overall. However, women showed a stronger associated decline in personal care and labor supply while men showed stronger declines in time devoted to home production. Gendered differences are more pronounced with intensive and non-spousal care. Results highlight time-cost differentials that could be driving observed gender gaps in health and labor market outcomes among unpaid caregivers. The study also underscores the serious endogeneity concerns between caregiving and broader time allocation patterns and highlights the need for additional research.

Keywords: unpaid care, time-use, aging, gender inequality, home production, personal care

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1 Introduction

A majority of Americans will provide unpaid care during their lifetime. Between 2017 and 2018 alone, over 22% of women and 18% of men aged 55 or older provided unpaid eldercare to a relative, friend, or neighbor [Bureau of Labor Statistics, 2019]. With the continued aging of the U.S. population, demand for unpaid care services will likely continue to rise.[1] While caregivers provide a socially valuable service, caregiving is a time intensive task and must be met by other time allocation adjustments on the part of the care provider. These time trade-offs have significant implications for the health and well-being of caregivers. Understanding time allocation decisions is therefore critical for maintaining adequate supply of care services and promoting social welfare more broadly.

In this study, we use panel time-diaries to examine how older women and men reallocate their time in response to providing unpaid care. Until recently, research has focused on estimating cross-sectional correlations between unpaid care, labor supply, health, and time allocated to household chores and leisure [Henz, 2004, Trukeschitz et al., 2013, Bauer and Sousa-Poza, 2015, Kalenkoski, 2017, Moussa, 2019, Burch et al., 2019, Stanfors et al., 2019]. However, it is widely argued that cross-sectional estimates are strongly confounded by endogeneity [Heitmueller, 2007, Kalenkoski, 2017, Fischer and Müller, 2020]. For example, do individuals quit their job to provide care or do they provide care because they are unemployed? Importantly, use of panel data allows us to control for time-invariant unobserved heterogeneity across individuals and estimate a more robust association between unpaid care and broader time allocations.

Due to the lack of readily available panel time-diaries, studies that have used longitudinal data-sets to capture unobserved heterogeneity with caregiving have focused on labor market outcomes [Heitmueller, 2007, Van Houtven et al., 2013, Truskinovsky and Maestas, 2018, Fahle and McGarry, 2018].

[1] According to Folbre and Nelson [2000], the number of individuals 85 and older, who tend to require high levels of direct care, is projected to grow from about 1.6% of the population to about 4.6% between 2000 and 2050.

These studies have generally pointed to a negative relationship between caregiving and labor supply, with some evidence of stronger labor market trade-offs for women than men. However, to our knowledge, there are no longitudinal studies that estimate the association of caregiving with time use outside of labor market activity or in terms of the trade-offs between caregiving, leisure, and home production. Moreover, little is understood of how the reallocation of time differs between men and women who take up care responsibilities. Therefore, a comprehensive understanding of opportunity costs of caregiving and gender differences has been missing.

Our time-diary data come from the Disability and Use of Time Survey (DUST) collected in 2009 and 2013. Controlling for permanent unobserved heterogeneity, we estimate the association between caregiving and work, home production, personal care, and leisure activities overall and by gender. We first analyze the time trade-offs in daily activities with a continuous measure of caregiving collected over two 24-hour periods. We then classify high and low care intensities to assess non-linear associations and examine care for a spouse separately from other forms of care. Our research makes two primary contributions to the existing literature: (i) we use longitudinal data to estimate the association between care provision and the allocation of time between work, home production, leisure, and personal care, thus presenting a comprehensive picture of the opportunity costs of caregiving, (ii) we present results by gender to illuminate the mechanisms driving gender gaps in health and employment outcomes among unpaid carers.

While DUST data provide a unique chance to analyze these important trade-offs, it warrants mentioning at the outset that there are important limitations to our study. First, the sample size is small—946 total observations. With this in mind, we attempt to provide statistical test results where appropriate, and are transparent on what general conclusions can (and cannot) be drawn from our analyses. Second, we do not control for time-varying selection into caregiving. This could result in bias in interpretation of our estimates as causal effects. As this is a particular concern for work hours given the timing of retirement in the DUST sample, we also conduct analyses conditioning on

labor supply. This serves to minimize any residual bias due to retirement for time allocated to home production, leisure, and personal care. However, we cannot fully control for unobserved time-varying characteristics.

1.1 Related literature

Most of the research on caregiving by older adults has focused on labor market and/or health outcomes. Pinquart and Sörensen [2003, 2007] conducted a meta-analysis of existing literature and argue that intensive caregiving (i.e. a high amount of time spent providing care) increases stress and likelihood of depression, and lowers the subjective well-being, physical health, and self-efficacy of caregivers. Based on a wide review of the interdisciplinary literature, Bauer and Sousa-Poza [2015] also conclude that informal care is associated with poorer mental and physical health as well as lower levels of employment. A systematic review covering literature from 2008-2018 by Spann et al. [2020] found that time-intensive caregiving increases stress, limits mobility, and can make caregivers feel that they are never "off-duty." The study also concludes there are high opportunity costs to caregiving, including forgoing networking events or promotions at work due to high demands on caregiver time.

Only a few studies have explicitly examined the differential impact of caregiving on men and women. The evidence on gendered labor market effects are mixed. For the U.S., Van Houtven et al. [2013] estimate wage penalties, early retirement, and reduced hours only for women, but significant participation effects only for men providing personal care. In Britain, Carmichael and Charles [2003] found larger participation effects on females among those caring at least 10 hours a week. Other studies have generally found labor market effects to be similar across genders [Lilly et al., 2010, Nguyen and Connelly, 2014, Stanfors et al., 2019]. In contrast to the mixed evidence on labor market outcomes, most studies identify stronger negative effects on women's mental health, including stress, depression, anxiety, and life satisfaction [Yee and Schulz, 2000, Raschick and Ingersoll-Dayton, 2004, Bookwala, 2009]. Pinquart and Sörensen [2006] find that these gender differences can be partly explained

by women providing longer and more intense care.

Women are far more likely overall to provide care and to spend time in home production than men [Ferrant and Thim, 2019]. At the same time, evidence on the effect of caregiving on home production is sparse. Stanfors et al. [2019] find a positive correlation between time spent in caregiving and home production in Canada, Sweden, and the UK, with no significant gender differences. However, the study is based on cross-sectional observation which raises endogeneity concerns. By exploiting longitudinal data, we provide a more robust estimate of the effect of caregiving on time devoted to home production.

In an attempt to better understand the effect of caregiving on caregiver's health and productivity, we also differentiate personal care (e.g. sleep) from all other forms of leisure in all our analyses. In addition to health effects, chronic exhaustion and lack of sleep could lead to decreased productivity at work, implying lower wages [Bonke et al., 2004], and increase the risk of accidents or mistakes [Spann et al., 2020]. It could also result in caregivers having to take sick leave [Nilsen et al., 2017, Spann et al., 2020]. We anticipate personal care could have strong 'respite' effects, thus improving the quality of care along with the well-being and health of the caregiver.

Finally, there is some evidence that the effects of caregiving differ by type of care recipient. In particular, health burdens appear to be higher when providing care to a spouse than to a parent [Pinquart and Sörensen, 2003, Raschick and Ingersoll-Dayton, 2004]. Hypothesized explanations include spousal caregivers being older themselves and facing more intensive responsibilities than parental caregivers. We complement these proposed mechanisms by examining the differential effect of spousal and non-spousal caregiving on overall time allocation for the full sample and by gender.

1.2 Conceptual framework

The basic trade-offs we consider are highlighted in the standard economic theory of time allocation [Becker, 1965]. These models predict that utility

maximizing individuals allocate time across work, leisure, and home production (e.g. cooking, cleaning, etc.) based on relative opportunity costs and marginal utility gains. An individual chooses allocations such that a marginal increase in time spent on any activity yields the same increase in utility. The provision of unpaid care can also be rationalized in this framework. For example, if a son is altruistic towards his mother, an increase in her care needs effectively raises his marginal benefit of providing care. All else equal, this implies a shift towards more care provision and away from other activities.

The relative change amongst other activities depends on the relative opportunity costs of forgoing each activity. For example, higher wages increase the cost of reducing labor supply. Therefore, all else equal, a caregiver with high earnings may be less likely to reduce time spent at work than one with comparatively low earnings. This point also highlights the potential endogeneity problem in estimating effects of caregiving on time allocation. If the opportunity costs of caregiving are high enough, the son may choose not to provide care to his mother at all. Instead, he may substitute paid care from the market or bargain with a retired sibling to provide care. As opportunity costs are often unobserved in the data (e.g. retirees potential wages) this could lead to biased estimates of the effect of caregiving on work or other time allocations.

While relative opportunity costs are crucial in determining time reallocation in response to care provision, preference relations could also play an important role. In particular, a "respite" effect has been hypothesized in which carers prefer additional leisure (or even paid work) to get away from their caregiving responsibilities [Twigg and Atkin, 1994, Carmichael and Charles, 1998, Heitmueller, 2007]. If unpaid care and leisure are complements, care may increase the value of leisure. In this case, the effect of caregiving on leisure (or work) could be small or even positive. This highlights that the predictions of the simple model are theoretically ambiguous and depend on preferences and relative opportunity costs of forgone activities.

Heterogeneous response to caregiving is also inherent in this class of models due to differences in opportunity costs and/or preferences. As mentioned above, higher wages suggest a higher opportunity cost of lost labor and, all

else equal, a smaller labor supply response to care provision. Extending the basic framework to include intra-household bargaining further motivates expected heterogeneous response [Miller and Bairoliya, 2020]. For example, if a comparatively low earner holds less bargaining power in the household, they may adjust time less along dimensions that most directly impact welfare of their partner (e.g. home production).

Individual time allocation trade-offs are also determined by segregation and discrimination in home production and labor markets. For example, using the American Time Use Survey (ATUS), Hersch [2009] found that the average time spent by women on home production activities is larger than men, with a larger share of women's total home production time devoted to routine housework such as cleaning and cooking. Bonke et al. [2004] argue that the timing and inflexibility of these particular types of tasks interfere with paid work. The authors posit that individuals who bear comparatively rigid housework burden may seek jobs that offer convenient hours and/or flexible working schedules. Hence, in accordance with the theory of compensating wage differentials, they might have to accept lower pay to compensate employers for accommodating their preferences. Moreover, various forms of correlated discrimination in the labor market may serve to increase wage gaps even further.

All of these preexisting forces—low bargaining power, flexible employment, low wages, and rigid home production—may serve to increase participation in care provision and/or alter the time trade-offs of caregivers. For example, women may face different trade-offs if they hold more flexible paid jobs while preforming less flexible home production on average. Drawing on the available theories, we hypothesize that men, on average, will be more likely to decrease home production than paid labor supply in response to caregiving. On the other hand, we expect women to be comparatively more likely to reduce paid work over home production. We also expect that, on average, lower female bargaining power will lead to larger leisure and/or personal care declines for women than men. Caregiving would thereby exacerbate gender market segregation and inequality more broadly among older adults.

2 Data and empirical methods

2.1 Data

We use data from the 2009 and 2013 DUST supplements to the Panel Study of Income Dynamics (PSID). The 2009 DUST sampled 543 married couples in the PSID with both spouses at least age 50 and one at least age 60. Effectively the sample was constructed to be representative of married people ages 60 and older and their spouses. The 2013 DUST attempted to re-interview the 2009 respondents following a similar survey structure.[2] The major benefit of DUST is the availability of panel time-dairies. The main limitation is small sample size and collection of only two waves. Of the 755 individuals in the 2009 DUST with a completed time diary, we dropped 270 due to missing follow-up data from 2013.[3] Another 12 were dropped due to missing explanatory variables. This left a balanced analytic sample of 946 observations from 473 individuals.

The framework of the DUST supplements entailed asking each spouse in each wave to complete a survey and two time diaries, one for a weekday and one for a weekend day. Each diary includes the 24 hour period starting at 4AM on the designated day and running until 4AM the next day.[4] Similar to the ATUS, DUST respondents report each of their activities in order, providing either the duration or the start and finish time for each activity. If multiple activities were reported, respondents were asked to identify the "main" activity, which we use to construct our time use variables. We combined the two diaries for each respondent providing us with 48 hours of time data from each individual in each survey wave.

Our primary outcome variables are reported minutes spent in work, home production, leisure, and personal care. We constructed each measure based on nine "supercategories" developed by the DUST survey team to consistently

[2]The 2013 DUST included additional respondents not included in the 2009 wave. As we have only one wave of data for these individuals, we exclude them from all analyses.

[3]We kept all respondents with at least one completed time diary in each wave to preserve sample size.

[4]Activities that ran past 4AM were also recorded in the diary. We cut-off all activities at 4AM in our analyses to ensure each diary was exactly 24 hours.

code time diary data. Working time predominately consists of paid employment, but also includes any volunteer work or schooling. Home production includes primarily routine daily tasks such as shopping, cooking, cleaning, laundry, pet care, appliance/vehicle maintenance, and financial management and household planning. Leisure includes activities such as socializing, watching TV, reading, relaxing, exercise, sports, arts, entertainment and travel, and religious and spiritual practice. Lastly, personal care is dominated by sleep followed by grooming and eating.

The key explanatory variable in our analysis is reported time spent in unpaid caregiving. Caregiving activities include all unpaid physical, medical, and school related assistance to others.[5] In our benchmark model we treat caregiving as a continuous variable to analyze the effects on time allocation. In examination of non-linear effects, we also divide caregiving into three categories: (i) no caregiving, (ii) low intensity caregiving (<1.5 hours), and (iii) high intensity caregiving (>1.5 hours). We chose the cut-point of 1.5 hours (out of 48 hours) largely to maintain a large enough sample of high intensity caregivers for analysis given our relatively small sample size. Given the evidence of heterogeneous health impacts by type of care recipient, we also analyze the effect of spousal versus non-spousal caregiving. This level of analysis is possible given the relatively large share of spousal care among the examined age group. However, missing information and small sample size prevents any further breakdown of care recipients (e.g. parent, grandchild, etc.).

Given the evolving health of the surveyed population, we use a number of available health measures as additional controls in our estimations. First, we include a self-reported health satisfaction index that scales from 1 (not satisfied at all) to 7 (very satisfied). Second, we include six indicators for reported difficulty with hearing, vision, mobility, memory/mental functioning, personal care, and household activities. The limitation indicators are modeled after those in the American Community Survey and are designed to identify the population with disabilities.

[5]School related assistance makes up a very small share of care and results are insensitive to their exclusion.

As a final set of controls, we include the full time allocation reported by the spouse of each respondent. Specifically, we include reported minutes the spouse spent in work, home production, leisure, personal care, and unpaid caregiving.[6] We chose to include these allocations to control for spousal spillover effects. For example, a husband that falls ill may choose to reduce his time in home production. This may lead to an increase in both caregiving and home production of his wife. Thus, not controlling for the reduction in the husband's home production could upwardly bias estimates of the effect of caregiving on the wife's home production. This ability to explicitly control for spousal time patterns is another unique benefit of the DUST survey.

2.2 Empirical specifications

In our benchmark empirical specification, we exploit the panel structure of DUST by estimating the following model:

$$Y_{it} = \beta Care_{it} + X_{it}^{'}\delta + \theta_i + \pi_t + \epsilon_{it} \tag{1}$$

where Y_{it} is an outcome of interest for individual i in time t (minutes of work, home production, leisure, or personal care); $Care_{it}$ is hours of unpaid care; X_{it} is a vector of control variables; θ_i is an unobserved individual-level effect; π_t is a survey wave intercept; and ϵ_{it} is a random error term. The unobserved θ_i is modeled as a fixed effect with no restriction on the correlation with other model regressors. Included in the control vector X_{it} are dummies for gender, age[7], marital status, and health variables along with measures of spousal time allocations. Due to missing time-diary entries or data error, some time diaries did not sum to 48 hours. We also control for this with a measure of missing time (in minutes). We allow for covariance in errors across outcomes by estimating the system of four equations jointly (i.e. seemingly unrelated regressions).[8]

[6]Respondents without a spouse in 2013 (e.g. death or divorce) were given zero minutes in all categories.

[7]Grouped into 2-year age intervals.

[8]Given that our independent variables are the same across equations, estimating as a system does not improve efficiency over equation-by-equation estimation. However, system

We also impose the restriction that the β coefficients across outcomes sum to sixty to capture the full reallocation of time in response to providing an additional hour of care.

In subsequent analyses on non-linear associations we use the following modified empirical specification:

$$Y_{it} = \beta_L Low_{it} + \beta_H High_{it} + X_{it}^{'}\delta + \theta_i + \pi_t + \epsilon_{it} \tag{2}$$

where Low_{it} is an indicator for low intensity caregivers; $High_{it}$ is an indicator for high intensity caregivers; and other independent variables and error structures are as previously defined. Note that the reference caregiving group are those that provided no unpaid care. Here we do not impose any restrictions on the β coefficients.

When turning to spousal/non-spousal care we again use an only slightly modified specification:

$$Y_{it} = \beta_S Spousal_{it} + \beta_N NonSpousal_{it} + X_{it}^{'}\delta + \theta_i + \pi_t + \epsilon_{it} \tag{3}$$

where $Spousal_{it}$ is hours of unpaid care to a spouse; $NonSpousal_{it}$ is hours of unpaid care to anyone else; and other independent variables and error structures are as previously defined. Here we impose that both β_S and β_N sum to sixty across outcome equations.

The coefficient(s) of interest across all models is β, which captures the association between caregiving and outcomes. Estimated coefficients can only be interpreted as causal effects if caregiving is uncorrelated with any unobserved determinants of examined outcomes. It is clear that respondent health and age are likely to correlate with both caregiving and other time allocations. However, we control for this with the inclusion of age dummies and a variety of health measures. The individual fixed effect ensures that the error term is not correlated with any time-invariant unobservable characteristics. However, with this framework, it is important to note that we cannot rule out bias due

estimation allows us to impose coefficient restrictions and conduct cross-equation hypothesis testing. We estimate the system via maximum likelihood using Stata's *gsem* command.

to possible correlation between time-varying unobservable heterogeneity and caregiving [Semykina and Wooldridge, 2010].

In our analysis on the full sample, we test the null hypothesis that caregiving associations are equal across the four time-use outcomes. This gives a sense of whether caregiving crowds out time differently across the outcomes. In our gender stratified analyses, we test the null hypothesis that caregiving associations are the same across genders for each outcome (e.g. is the association with leisure the same for women and men). We conduct similar tests across low/high intensity and spousal/non-spousal care. Given our small sample and exploratory nature of our study, we do not correct for multiple hypothesis testing to minimize type II error. However, we present all Wald statistics and associated p values in results tables for examination.

3 Results

3.1 Descriptive statistics

Table 1 shows the descriptive statistics for the panel differentiated by gender. The time allocation variables sum to 48 hours for each observation (2-days, a weekday and a weekend). Men were more likely to report time spent working than women (38% vs 29%) and worked an hour more on average. Women spent an average of just over 15 hours on leisure and 22 hours on personal care compared to over 16 and 21 hours for men. Women also averaged almost 7 hours on home production activities while men averaged about an hour less.[9]

Insert Table 1 here

In their 48-hour time diaries, 34% of women and 25% of men reported providing any unpaid care. Fourteen percent of women and 10% of men reported high intensity care (>1.5 hours). On average, female caregivers provided 116 minutes of care while male caregivers provided about 18 minutes less. For

[9]These results are largely consistent with time-diary data from the ATUS [Aguiar and Hurst, 2007, Hersch, 2009].

women, average time spent in spousal care was less than 20% of total caregiving time. In contrast, average spousal care for men made up more than a third of their total average caregiving time.

Overall, health differences across genders were not large. Women reported somewhat more difficulty walking/climbing and conducting errands alone. Men reported more difficulty with hearing. Women were also about three years younger on average.

3.2 Caregiving and time-use

Table 2 presents the estimated association between an additional hour of caregiving and minutes devoted to work, home production, leisure, and personal care for the entire sample. The first column provides results without including individual fixed effects. In this case, an additional hour of caregiving is associated with a decrease in time spent on work by 34 minutes, leisure by 27 minutes, and personal care by 15 minutes. In contrast, an hour of caregiving is associated with a 15 minute *increase* in home production. We can formally reject the null hypothesis that reported coefficients on *Care* are equal across the four equations ($\chi^2 = 30.60$). If interpreted as the causal effect of caregiving, this implies individuals do not evenly reallocate their time in response to caregiving, most notably increasing home production while reducing primarily leisure and labor supply.

Insert Table 2 here

The second column in Table 2 takes time-invariant unobserved heterogeneity into account by including individual fixed effects. An additional hour of caregiving is associated with a decrease in work of approximately 17 minutes. While still statistically significant, this point estimate is considerably lower than without the individual fixed effects, highlighting the overestimation bias in pooled cross-sectional estimates. Point estimates on leisure and to a lesser extent personal care are also attenuated. However, the most drastic change occurs for home production. Specifically, an additional hour of caregiving is now

associated with a 15 minute *decrease* in home production, a statistically significant decline. Overall, this suggests that individuals spending comparatively more time in home production and less time in work, leisure, and personal care may have been more likely to select into caregiving.

The estimated coefficients add up to an hour indicating that the total association of caregiving with time re-distribution have been captured. Moreover, we can no longer reject the null that coefficients on *Care* are equal across the four equations ($\chi^2 = 0.26$). This combined with examining the point estimates suggests a fairly even reallocation of time away from all four time-use categories for the full sample after controlling for time-invariant unobserved heterogeneity.

Table 3 shows the coefficients on caregiving differentiated by gender. All specifications include individual fixed effects. For women in the sample, caregiving is significantly related to reduced labor supply (20 minutes) and personal care (18 minutes). Moreover, while not statistically significant due to small sample size, the negative point estimates for home production (10 minutes) and leisure (12 minutes) are similar in magnitude.

Insert Table 3 here

In contrast to women, caregiving does not have a statistically significant correlation with the labor supply or personal care of men, with point estimates under six minutes. Instead, an hour of caregiving by men is associated with a significant 28 minute reduction in home production and 24 minute reduction in leisure.

Overall, gender stratified results suggest that caregiving men concentrate time adjustments on the home production and leisure margins. In contrast, women also reduce labor supply and personal care. However, given the small sample, we cannot formally reject the hypotheses that reported coefficients on *Care* are equal between men and woman in this model specification.

3.3 Non-linear patterns

Table 4 presents full sample results when caregivers are classified by intensity to examine non-linear associations. For low intensity care, point estimates suggest time reductions may be strongest for labor supply (30 minutes) and leisure (54 minutes), although both coefficients were noisy and statistically insignificant. In fact, low intensity care had a marginally significant *positive* association with home production (46 minutes). This is tentatively consistent with some complementarity between home production and low intensity caregiving.

Insert Table 4 here

High intensity caregivers had significantly reduced work activity (73 minutes), home production (63 minutes), and personal care (49 minutes) in the full sample. They also had reduced leisure (15 minutes), but this decline was statistically insignificant. Overall, point estimates suggest that high intensity caregivers may have adjusted labor supply and home production more than leisure and to some extent personal care. Moreover, we can statistically reject that low and high intensity carers had equal reductions on the home production ($\chi^2 = 12.27$) and personal care ($\chi^2 = 4.28$) margins. Specifically, high intensity caregivers had significantly larger associated declines in home production and personal care than low intensity carers.

Table 5 presents non-linear results stratified by gender. Panel (a) provides results for low intensity care and panel (b) for high intensity care. For the sub-sample of women, low intensity care was associated with reduced labor supply (27 minutes) and leisure (78 minutes), though results were only significant for leisure. However, there was a significant associated *increase* in home production of 72 minutes. In contrast, there was no significant relationship with home production for high intensity female carers (with a *negative* point estimate of 10 minutes). Women providing high intensity care also had significantly reduced labor supply (82 minutes) and personal care (101 minutes).

Insert Table 5 here

Table 5 also presents analogous results for men. There were no significant associations for low intensity male caregivers. High intensity care was associated with reduced male labor supply (42 minutes) and leisure (18 minutes), both insignificant results. The major takeaway is the significant 148 minute reduction in male home production. This reduction in home production for high intensity male carers was significantly stronger than for high intensity female carers ($\chi^2 = 4.38$). Also note the *positive* but insignificant association with personal care for men. This lies in sharp contrast to the large decline in personal care among high intensity female carers. Formally, we can reject the null that coefficients on personal care are equal for men and women providing high intensity care ($\chi^2 = 5.91$).

3.4 Spousal and non-spousal care

Table 6 presents results broken down by spousal and non-spousal care. Providing an additional hour of care to a spouse was associated with a significant reduction in leisure of 41 minutes. While point estimates on work and personal care were negative for spousal care, they were statistically insignificant. In contrast, care provided to anyone other than a spouse was significantly related to reduced labor supply (20 minutes), household production (21 minutes), and personal care (12 minutes). Comparing coefficients across types of care, we can only statistically reject that the reduced leisure for spousal caregivers was the same amount as non-spousal caregivers ($\chi^2 = 4.19$).

Insert Table 6 here

Table 7 presents results for spousal and non-spousal care stratified by gender. Panel (a) provides results for spousal care and panel (b) for non-spousal care. Overall, stratified results are noisy but a few gendered patterns emerge. Point estimates suggest time adjustments for spousal caregiving were concentrated along the leisure margin for both women (59 minutes) and men (38 minutes). Men also had reduced personal care (23 minutes) while women had (insignificantly) reduced labor supply (30 minutes). However, we cannot for-

mally reject that the associations with spousal caregiving are the same across genders for any outcome.

Insert Table 7 here

In terms of non-spousal caregiving, women had significantly reduced labor supply (19 minutes) and personal care (24 minutes). In sharp contrast, men only had significantly reduced home production (52 minutes). Formally, we can reject that the coefficients for female and male non-spousal carers are equal on the home production ($\chi^2 = 4.17$) and personal care ($\chi^2 = 6.65$) margins.

3.5 Labor supply margins

As an additional analysis, we examined the association of caregiving with labor supply separately for the extensive and intensive margins (i.e. employment versus hours of work). This serves as a sensitivity test for our main conclusions and also helps facilitate a more direct comparison of our results with the existing literature. For the extensive margin, we simply estimated our benchmark model (1) with a binary indicator of any minutes of work reported in the 48-hour time diary. However, given our small and relatively older sample population, we were unable to exclude those with zero reported work minutes to examine the intensive margin with much statistical precision. Instead, we simply re-estimated the benchmark model for work minutes but also included the binary indicator for positive work minutes (i.e. we controlled for the extensive margin). This helps us get a sense of how our main results disaggregate into the extensive/intensive labor supply margins. Results are presented in Table 8 for the entire sample and stratified by gender.

Insert Table 8 here

The first column shows that caregiving was associated with a significant 2.8 percentage point decline in the probability of reporting any time working for the overall sample. The second row shows that after conditioning on the extensive margin, caregiving was insignificantly related with a reduction of

labor supply of just under 8 minutes. This is just under half the benchmark point estimate for work reported in Table 2, suggesting roughly half of the total association can be explained by the extensive margin. While the existing literature is somewhat mixed, these results are consistent with the general findings of small negative effects of caregiving on both margins of labor supply [Bauer and Sousa-Poza, 2015].

The last columns in Table 8 present results by gender. Point estimates for the extensive margin were similar to the overall sample for men and women but were insignificant given the reduced sample size. In contrast, there was a significant reduction in minutes worked for women even after controlling for the extensive margin, but not for men. Van Houtven et al. [2013] find similar patterns using longitudinal data from the Health and Retirement Study (HRS) to examine caregiving effects on the older US population. While the authors find declined employment probabilities only for a subset of male caregivers, they find a significant fall in work hours only for women.

3.6 Conditioning on labor supply

While panel data allows us to control for permanent unobserved heterogeneity across individuals, it does not allow us to correct estimates for unobserved time-varying confounders. In particular, retirement is potentially of first-order importance among the age group sampled for the DUST survey. For example, a son may choose to retire between survey waves for reasons independent of caregiving, then subsequently choose to provide care due to their retirement. This implies that at least some of the correlation between caregiving and work in our results is likely driven by reverse causation or omitted variable bias. Ideally we would have some instrumental variable to more precisely tease out the causal effect of caregiving on work and other time allocations. Unfortunately, we have not found a suitable instrument for this purpose, particularly given the small sample size. However, here we try to minimize the bias for non-labor market outcomes arising from the retirement decision by conditioning on labor supply.

We take two alternate approaches to this analysis. First, we use our benchmark model but we include reported minutes worked as a control instead of an outcome in the system. We also include an indicator for any minutes of work reported. This allows us to observe the time allocations of caregivers controlling for any associated differences in labor supply. Second, we conduct our benchmark analysis for the sub-sample of respondents that did not report any minutes worked in either survey wave. This can roughly be considered the time allocation patterns for post-retirement caregivers (sample size precludes us from examining the pre-retirement sub-sample). This analysis helps us get a sense of the bias on non-labor outcomes that may be arising through retirement. There could, of course, be other time-varying omitted variables correlated with both caregiving and time allocated to home production, leisure, and personal care. However, these biases are less clear and likely to be smaller than those that could arise due to the timing of retirement. Nonetheless, it is important to recognize this possibility and encourage additional research in the future using alternate data sources.

Table 9 provides results conditioning on labor supply. Panel (a) provides results when including work variables as controls and panel (b) when limiting the sample to those who did not report working in either survey wave. The first column in panel (a) shows that after controlling for work, an hour of caregiving is associated with a decrease in time allocated to home production (19 minutes), leisure (25 minutes), and personal care (15 minutes) in the full sample. Similar to our benchmark results, these are fairly similar declines across the three categories, though a somewhat stronger concentration in leisure. The first column in panel (b) shows a similar overall pattern when conditioning on not working at all, with a further shift towards leisure (32 minutes) and away from home production (11 minutes).

Insert Table 9 here

The second column in Table 9 provides results for women. In panel (a) there are now marginally significant negative associations with home production (16 minutes) and leisure (20 minutes) but the strongest declines remain in

personal care (23 minutes) as in the benchmark model. When conditioning on non-workers only, a similar pattern exists, though associations are only significant for personal care given the small sample. The final column shows results for men and are very similar to the benchmark model—time reductions concentrated in home production and leisure with little association with personal care.

4 Discussion

Our analyses examined the time-allocation adjustments associated with caregiving by older adults in the DUST supplement of PSID. We analysed associations with work, leisure, home production, and personal care. After controlling for time-invariant heterogeneity using panel time diaries, we found that older caregivers had reduced time allocated to each domain fairly evenly overall. Moreover, ignoring unobserved heterogeneity resulted in significant bias, most notably on the home production margin, where the estimated association switched sign. This underscores the serious endogeneity concerns between caregiving and broader time allocation patterns.

Gendered analyses revealed that caregiving men had a stronger tendency than women to have reduced home production. Women showed stronger declines in labor supply. This could be driven by the well-known and persistent gender wage gap. Bonke et al. [2004] argue that the timing and inflexibility of housework completed by women also has negative effects on their earnings and careers through demands for more flexible work arrangements. It may similarly be that women are unable to substitute caregiving for rigid home production, instead adjusting their comparatively less costly labor supply. In contrast, men may substitute time spent on caregiving with foregone home production, which does not impede their labor market activity. Our findings corroborate these arguments and provide an explanation of gender inequality in wages and work with a care shock, which has been documented in developed economies [Carmichael and Charles, 2003, Van Houtven et al., 2013, Bauer and Sousa-Poza, 2015, Kalenkoski, 2017].

Overall, low intensity care was associated with increased home production and high intensity care with decreased home production. It could be that low intensity care may not warrant quitting or adjusting a job, rather, it may require cutting back on some leisure activities and staying home more. This may push up home production because the carer may need to be around the house more anyway. High intensity care is a significantly higher burden and may strain the carer's capacity to engage in productive activities. The relative association of both low and high intensity care with home production burden was significantly higher for women compared to men. This signifies the double burden of work and home production for women which appears more binding under any amount of care provided.

We also observed that caregiving was associated with a larger reduction in personal care for women compared to men. However, we did not find notable differences in leisure adjustments across genders. If spousal leisure is a complement to one's own leisure, low bargaining power may explain the reduction in personal care as opposed to additional leisure for women. The reduction in personal care by female caregivers may also help explain the larger negative health effects for women found in previous studies [Yee and Schulz, 2000, Raschick and Ingersoll-Dayton, 2004, Bookwala, 2009].

Finally, when care was provided to a spouse, both women and men reduced leisure time more than other margins. This could be due to spousal care occurring at older ages when caregivers are more likely to already be out of the labor market. It could also be that ill health of a spouse substantially reduces the value of leisure, leading to concentrated time adjustments along this margin. In contrast, non-spousal care seemed to have stronger associations on the "productive" margins of labor supply and home production. If leisure serves to promote well-being, these results are largely consistent with evidence that health effects are worse for spousal compared to non-spousal care [Pinquart and Sörensen, 2003, Raschick and Ingersoll-Dayton, 2004].

4.1 Study limitations

There are several important limitations to our study that warrant reiteration. First, given the small sample size and large standard errors, some of our estimates are not precise. Further, sub-grouping the sample by gender restricts conclusive evidence of gender differences in some of our specifications. However, we try to address the small sample issue by estimating the system of equations jointly and testing the null hypothesis across genders for each outcome.

Second, as previously detailed, the use of individual fixed effects would not be sufficient in adjusting for any time-varying residual confounding that is associated with unpaid care decisions across individuals (e.g., retirement or family wealth shocks). We conducted analyses conditional on labor supply to try to address the most likely source of bias (retirement) but other time-varying confounders may remain.

Third, we have limited our analyses to time spent on self-identified "main" activities while ignoring secondary activities. For example, a caregiver may need to passively keep watch of a care recipient even when conducting other chores around the house. This could increase stress or lower productivity during home production implying an additional cost of caregiving that we are not capturing in our analyses. Thus, we could be underestimating the full time-cost and gender differentials of caregiving. However, despite these caveats, our findings provide novel evidence on the relative opportunity costs between unpaid care, work, home production, leisure, and personal care.

5 Conclusions

Our approach of panel analysis of time diaries highlights three important features that should be considered in future research on unpaid care. First, we move beyond the formal labor market by looking at leisure, personal care, and home production trade-offs for a more comprehensive picture of the opportunity costs of caregiving. Recognizing the full range of opportunity costs is

critical to simultaneously incentivize adequate supply of care services and promote the health and well-being of unpaid care providers. Second, our gender disaggregated lens highlights the differential time trade-offs with caregiving between men and women. In particular, we argue that the incentives to reduce labor supply and personal care could be a reason for the disproportionate work and health penalty on female caregivers. Third, we underscore the issue of endogeneity in caregiving and correct for selection bias by capturing unobserved heterogeneity with fixed effects. Future studies should aim to further investigate the role of time-varying heterogeneity as data allows.

Results from this study should also be considered in the context of current and proposed national policy changes.[10] Recently, the US government's approach to tackling the issue of caregiving and labor force participation is at odds: policymakers are encouraging labor force participation of older adults, especially women, while demographic changes, rising healthcare costs, and proposed benefit cuts in Medicare and Medicaid programs could lead to an increase in the demand for family provision of informal care. In this context, given our findings on the relationship between caregiving and time allocation patterns, current leave policies are likely not generous enough to meet these competing goals. Moreover, state and federal leave policies could be gender sensitive given the evidence of a disproportionate double burden of work for women at home and in the labor market. More broadly, there is a strong need for continued integrated analyses of the qualitative and quantitative aspects of the social organization of care, especially in regard to gender equality.

[10]Our study also underscores the importance of the Affordable Care Act (2010). By providing access to affordable health insurance outside the formal labor market, the ACA allows individuals to escape "job-lock" [Kofoed and Frasier, 2019] after experiencing a caregiving shock, thus providing more flexible and efficient labor market conditions for informal care providers.

Table 1: Descriptive statistics

	Women				Men			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Worked (indicator)	0.29	-	0.00	1.00	0.38	-	0.00	1.00
Time allocation (mins)								
Work	127.96	260.36	0.00	1465.00	187.59	313.44	0.00	1475.00
Leisure	917.59	321.91	0.00	1886.00	987.44	371.56	0.00	2040.00
Personal care	1354.58	238.49	340.50	2400.00	1283.31	238.12	483.75	2450.00
Home production	407.80	248.99	0.00	1742.00	347.07	267.03	0.00	1557.00
Caregiving	39.62	91.67	0.00	685.00	24.82	66.57	0.00	550.00
Missing time	32.58	131.91	0.00	1485.00	48.04	182.82	0.00	2224.00
Caregiver (indicator)								
Any care	0.34	-	0.00	1.00	0.25	-	0.00	1.00
Low intensity care	0.20	-	0.00	1.00	0.15	-	0.00	1.00
High intensity care	0.14	-	0.00	1.00	0.10	-	0.00	1.00
Care if provided (mins)								
Total	116.06	125.66	1.00	685.00	97.53	101.87	2.00	550.00
Spousal	20.41	45.35	0.00	360.00	36.18	77.04	0.00	550.00
Non-spousal	95.65	120.35	0.00	600.00	61.34	80.96	0.00	471.00
Health measures								
Health satisfaction (1-7)	5.33	1.33	1.00	7.00	5.37	1.27	1.00	7.00
Difficulty (indicators)								
Hearing	0.14	-	0.00	1.00	0.27	-	0.00	1.00
Seeing	0.13	-	0.00	1.00	0.15	-	0.00	1.00
Concentrating	0.13	-	0.00	1.00	0.10	-	0.00	1.00
Walking/Climbing	0.35	-	0.00	1.00	0.27	-	0.00	1.00
Dressing/Bathing	0.06	-	0.00	1.00	0.05	-	0.00	1.00
Errands alone	0.13	-	0.00	1.00	0.05	-	0.00	1.00
Age (years)	67.60	7.87	50.00	92.00	70.55	7.85	52.00	90.00
Observations	498				448			
Individuals	249				224			

Source: Disability and Time Use Survey, 2009 and 2013, combined two 24 hour time diaries.

Table 2: Care provision and time allocation

	No fixed effects		Fixed effects	
Outcome	β	N	β	N
Work	-33.796***	946	-17.131***	946
	(5.975)		(6.554)	
Home Production	15.335***	946	-15.398**	946
	(5.853)		(7.239)	
Leisure	-26.792***	946	-15.377*	946
	(7.569)		(8.674)	
Personal Care	-14.747***	946	-12.094**	946
	(5.403)		(6.093)	
Wald Statistic: $\chi^2(3)$	30.60		0.26	
p	0.00		0.967	

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of an additional hour of unpaid care on outcomes (in minutes). Additional independent variables in all regressions: gender, age, marital status, health, missing time, and spousal time allocations. Wald statistic on the null hypothesis that β is equal across the four outcomes.

Table 3: Care provision and time allocation by gender

	Women		Men		Wald statistic	
Outcome	β	N	β	N	$\chi^2(1)$	p
Work	-20.488**	498	-5.074	448	1.31	0.252
	(9.346)		(9.697)			
Home Production	-9.606	498	-28.306**	448	1.37	0.242
	(8.864)		(13.321)			
Leisure	-11.553	498	-24.280*	448	0.49	0.485
	(11.670)		(14.000)			
Personal Care	-18.353**	498	-2.340	448	1.65	0.199
	(8.397)		(9.233)			

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of an additional hour of unpaid care on outcomes (in minutes). Additional independent variables in all regressions: age, marital status, health, missing time, and spousal time allocations. Wald statistic on the null hypothesis that β is equal for women and men.

Table 4: Non-linear care provision and time allocation

	Low intensity care		High intensity care		Wald statistic	
Outcome	β_L	N	β_H	N	$\chi^2(1)$	p
Work	-30.330	946	-72.504***	946	1.83	0.176
	(24.452)		(27.191)			
Home Production	46.134*	946	-62.928**	946	12.27	0.001
	(24.578)		(30.715)			
Leisure	-54.316	946	-15.347	946	1.12	0.290
	(31.653)		(34.069)			
Personal Care	3.241	946	-48.542**	946	4.28	0.039
	(21.390)		(24.739)			

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of high/low intensity unpaid care (indicator) on outcomes (in minutes). Additional independent variables in all regressions: gender, age, marital status, health, missing time, and spousal time allocations. Wald statistic on the null hypothesis that β is equal for high and low intensity care.

Table 5: Non-linear care provision and time allocation by gender

Panel (a) Low intensity care						
	Women		Men		Wald statistic	
Outcome	β_L	N	β_L	N	$\chi^2(1)$	p
Work	-26.566	498	-15.996	448	0.04	0.850
	(29.049)		(47.943)			
Home Production	72.417**	498	-20.612	448	2.88	0.090
	(32.711)		(44.047)			
Leisure	-77.667*	498	-30.414	448	0.45	0.501
	(40.198)		(57.573)			
Personal Care	-3.492	498	33.735	448	0.76	0.382
	(31.709)		(28.511)			
Panel (b) High intensity care						
	Women		Men		Wald statistic	
Outcome	β_H	N	β_H	N	$\chi^2(1)$	p
Work	-82.378**	498	-41.764	448	0.47	0.492
	(40.549)		(43.030)			
Home Production	-10.449	498	-148.405***	448	4.38	0.036
	(38.210)		(53.825)			
Leisure	-14.547	498	-18.261	448	0.00	0.960
	(45.783)		(57.212)			
Personal Care	-100.580***	498	19.623	448	5.91	0.015
	(35.382)		(34.608)			

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of high/low intensity unpaid care (indicator) on outcomes (in minutes). Additional independent variables in all regressions: age, marital status, health, missing time, and spousal time allocations. Wald statistic on the null hypothesis that β is equal for women and men.

Table 6: Spousal and non-spousal care provision and time allocation

	Spousal care		Non-spousal care		Wald statistic	
Outcome	β_S	N	β_N	N	$\chi^2(1)$	p
Work	-8.848	946	-19.961***	946	0.72	0.395
	(10.959)		(7.720)			
Home Production	1.520	946	-21.061***	946	2.18	0.140
	(13.201)		(8.070)			
Leisure	-41.256***	946	-6.705	946	4.19	0.041
	(11.109)		(11.218)			
Personal Care	-11.417	946	-12.273*	946	0.00	0.954
	(12.372)		(7.312)			

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of an additional hour of unpaid spousal/non-spousal care on outcomes (in minutes). Additional independent variables in all regressions: gender, age, marital status, health, missing time, and spousal time allocations. Wald statistic on the null hypothesis that β is equal for spousal and non-spousal care.

Table 7: Spousal and non-spousal care provision and time allocation by gender

Panel (a) Spousal Care						
	Women		Men		Wald statistic	
Outcome	β_L	N	β_L	N	$\chi^2(1)$	p
Work	-29.565	498	-0.931	448	0.96	0.327
	(27.870)		(11.742)			
Home Production	10.383	498	2.166	448	0.06	0.8032
	(29.882)		(13.450)			
Leisure	-58.604**	498	-38.361**	448	0.40	0.527
	(28.244)		(15.485)			
Personal Care	17.785	498	-22.874**	448	2.32	0.127
	(28.854)		(9.662)			
Panel (b) Non-spousal Care						
	Women		Men		Wald statistic	
Outcome	β_L	N	β_L	N	$\chi^2(1)$	p
Work	-19.090**	498	-8.360	448	0.38	0.539
	(9.378)		(14.312)			
Home Production	-12.686	498	-52.447***	448	4.17	0.041
	(9.591)		(17.127)			
Leisure	-4.303	498	-13.111	448	0.12	0.731
	(13.340)		(23.224)			
Personal Care	-23.921***	498	13.947	448	6.65	0.009
	(8.913)		(11.569)			

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of an additional hour of unpaid spousal/non-spousal care on outcomes (in minutes). Additional independent variables in all regressions: age, marital status, health, missing time, and spousal time allocations. Wald statistic on the null hypothesis that β is equal for women and men.

Table 8: Care provision and alternate labor margins

	Full sample		Women		Men	
Outcome	β	N	β	N	β	N
Worked (0/1)	-0.028**	946	-0.023	498	-0.024	448
	(0.012)		(0.018)		(0.019)	
Minutes worked	-7.714	946	-13.093*	498	3.909	448
	(4.877)		(7.112)		(7.302)	

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of an additional hour of unpaid care on outcomes. Additional independent variables in all regressions: gender, age, marital status, health, missing time, and spousal time allocations.

Table 9: Care provision and time allocation conditional on labor supply

Panel (a) Work as control variable						
	Full sample		Women		Men	
Outcome	β	N	β	N	β	N
Home Production	-19.305***	946	-16.192*	498	-27.898**	448
	(7.116)		(8.495)		(13.056)	
Leisure	-25.562***	946	-20.750*	498	-28.365**	448
	(8.242)		(11.483)		(12.956)	
Personal Care	-15.133***	946	-23.059***	498	-3.737	448
	(5.836)		(8.016)		(8.890)	
Panel (b) Conditional on no work either wave						
	Full sample		Women		Men	
Outcome	β	N	β	N	β	N
Home Production	-11.644	520	-17.845	296	-29.397*	224
	(9.590)		(12.367)		(15.143)	
Leisure	-32.852***	520	-15.961	296	-28.047**	224
	(9.344)		(14.836)		(13.882)	
Personal Care	-15.504**	520	-26.194**	296	-2.556	224
	(7.888)		(12.245)		(13.564)	

Robust standard errors (clustered at the individual level) in parentheses, p-values—***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. β reports effect of an additional hour of unpaid care on outcomes (in minutes). Additional independent variables in all regressions: gender, age, marital status, health, missing time, and spousal time allocations.

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