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# LABOUR SUPPLY AND INFORMAL CARE SUPPLY: THE IMPACTS OF FINANCIAL SUPPORT FOR LONG-TERM ELDERLY CARE

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**Abstract**

We investigate the impact of a policy reform, which introduced free formal personal care for all those aged 65 and above, on caregiving behaviour. Using a difference-in-differences estimator, we estimate that the free formal care reduced the probability of co-residential informal caregiving by 12.9%. Conditional on giving co-residential care, the mean reduction in the number of informal care hours is estimated to be 1.2 hours per week. The effect is particularly strong among older and less educated caregivers. In contrast to co-residential informal care, we find no change in extra-residential caregiving behaviour. We also observe that the average labour market participation and the number of hours worked increased in response to the policy introduction.

**JEL Class.:** C21, D14, I18, J14

**Keywords:** Long-term elderly care; ageing; financial support; informal caregiving; difference-in-differences

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# Labour Supply and Informal Care Supply: The Impacts of Financial Support for Long-Term Elderly Care*

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## 1 Introduction

Individuals increasingly face the need for long-term elderly care towards the end of their lives. In most developed countries, financial support schemes exist to pay for care provided by professional nurses. However, the elderly and their families usually contribute towards the cost of personal care, which is defined here as the assistance with daily activities such as bathing, eating, or dressing (detailed examples of personal care are included in Appendix A).

Governments in many developed countries are seeking to develop schemes to provide financial support for care costs to the elderly. When designing such a system, policy makers must consider the potential behavioural changes in people's care usage. For example, generous financial support to pay for formal personal care may induce the elderly to substitute formal paid care for informal care, provided by family members. Such substitution is likely to be strong in the case of personal care as this is unskilled relative to nursing care. It is also possible that financial support induces moral hazard and the elderly may demand formal care beyond the total amount of care that they used to consume before any

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policy introduction. Both responses would increase the cost of offering financial support to the elderly. Understanding the magnitude of such changes in the demand for formal care is important for evaluating reforms.

Existing literature on the impact of financial support on elderly care, mostly from the USA, does not distinguish between nursing care and personal care, although the different degrees of substitutability between formal and informal care for these two types of care are likely to imply different responses to financial support (e.g., Ettner, 1994; Pezzin et al., 1996; McKnight, 2006; Orsini, 2010). Moreover, these studies typically focus only on those with a low income or the very frail.

In this paper, we present evidence of the responsiveness of informal personal caregiving to changes in governmental financial support schemes from one of the largest natural experiments ever conducted. This occurred in the UK as a result of the greater powers devolved to Scotland that led to the 2002 Community Care and Health (Scotland) Act (CCHA), which offered free formal personal care in the form of lump-sum care allowances to those residing in Scotland. Because the policy only applied to those in Scotland, observations in England and Wales can be used as a control group in order to identify the policy effect. Using the 1998–2007 UK Family Resources Survey and employing a difference-in-differences estimator, we investigate how the CCHA changed informal personal caregiving behaviour both at the intensive margin (i.e., number of hours of care) and at the extensive margin (i.e., whether to use informal care or not).

There are three papers that investigate the 2002 Scottish policy but they have not reached a consensus even as to the direction of the policy impact (McNamee, 2006; Bell et al., 2006; Karlsberg Schaffer, 2015). McNamee (2006) presents descriptive evidence of an increased demand for formal personal care in Scotland. Bell et al. (2007) and Karlsberg Schaffer (2015) use the British Household Panel Survey (BHPS) and employ a difference-in-differences estimator to investigate how caregiving behaviour changed after the 2002 policy. Bell et al. (2007) employ the data between 1999 and 2003 and find no effect. Karlsberg Schaffer (2015) extends the study of Bell et al. (2007), using the same BHPS data, but covers a longer time horizon (between 1998 and 2008) and finds a positive impact of the policy on informal caregiving.

Although Bell et al. (2007) and Karlsberg Schaffer (2015) extend the study by McNamee (2006) by adopting difference-in-differences estimators to investigate a causal impact, they both suffer from several limitations. For example, Bell et al. (2007) only investigate a short-term impact by using data just one year after the introduction of the policy, so it is not surprising that they find no significant impact. In addition, BHPS does

not report the relationship between caregivers and care-recipients when care is given to those living outside of the household (i.e. extra-residential care). The question on extra-residential caregiving includes care given to children and family and non-family members who suffer from sickness or physical disabilities. In order to increase the chance of analysing care activities fir older individuals, Bell et al. (2007) limits the age of their extra-residential caregivers sample to those aged 50 and above. On the other hand, Karlsberg Schaffer (2015) analyses both the co-residential and extra-residential care activities by pooling all the observations and limits her total sample to those who are aged 45 years or older. These sample restrictions reduce the overall sample sizes of Bell et al. (2007) and Karlsberg Schaffer (2015) to approximately 30,000 over the period of four years and 70,000 over the ten-year period, respectively. This implies that both of their estimates rely on the annual Scottish sample of approximately 70 caregivers' observations. These small sample sizes compromise the precision of their estimates and are the likely explanation for the lack of common trends in the outcome variables suggested in the graphical analysis included in Karlsberg Schaffer (2015).

Our paper contributes to the existing literature by exploiting the 2002 Scottish policy and by presenting complementary evidence using a much larger dataset, the Family Resources Survey (FRS), which provides more precise estimates. First, the dataset provides rich information for those offering co-residential as well as extra-residential care. Second, we investigate an evaluation of the impact of the 2002 Scottish policy on caregiving behaviour both at the extensive (i.e. probability of caregiving separately by living arrangement) and the intensive margins (i.e. hours of care by living arrangement). A further, and important, contribution of our study is that it allows analyses of labour market responses to policy. That is, we can see whether changes in caregiving behaviour caused by an exogenous policy change translate to changes in labour supply, at the intensive and extensive margins.

We estimate that the Scottish policy reduced the probability that an individual informally takes care of another adult living in the same household by 0.4 percentage points, which is a reduction of approximately 12%. Conditional on giving co-residential care, the reduction in the number of hours of informal care amounts to 1.2 hours per week. The observed effect is particularly strong among older and less educated caregivers.[1] In con-

[1]The price of formal personal care in Scotland may also have changed in response to the introduction of the 2002 policy and its subsequent change in the demand for informal care. In Appendix C, we present a graph of the average prices of formal care in Scotland and England between 2003-2007. The graph indicates that the price of formal care went up in both regions during the period, but the increase in Scotland was marginally steeper than that in England. Although this figure needs to be interpreted with caution due to the

trast, caregiving to those living in separate households (i.e. extra-residential caregiving) did not change in response to the policy introduction.

There are two suggestive pieces of evidence explaining the lack of effects on extra-residential care. The first possibility is that the living arrangement may have changed as a result of the policy. On the one hand, just as in the case of co-residential care, the policy may have reduced extra-residential caregiving due to the availability of cheaper formal care. On the other hand, however, the availability of a more affordable formal personal care option may have led frail individuals to live independently for a longer period. If formal and informal care are complements in the latter channel (i.e., family members supplementing the formal care with their informal care provision), then the latter channel would lead to an increase in the probability of informal caregiving (Pezzin et al., 1996; Pezzin and Schone, 1999; Karlsberg Schaffer, 2015). We indeed find that the probability of co-residence with the elderly dropped after the policy introduction. The second explanation is that those who were receiving extra-residential care were already dependent on formal care even prior to the introduction of the policy. As a result, the policy introduction may have merely allowed the recipients to pay the care cost using the allowances instead. We indeed find that approximately 40% of extra-residential care recipients depend on formal care compared to approximately 12% of extra-residential care recipients.

In addition, we find positive effects on labour force participation and hours of work. The observed increase in the probability of employment was $0.7$ percentage points and an additional 0.4 hours of work. Most notably, the largest increase in the labour force participation and the hours of work were found for those aged 55 and above.

# 2 Context

Prior to 2002, formal personal care costs in the UK were paid almost entirely by care recipients and their families. These costs of elderly care exposed all individuals to significant uncertainties because those who developed a need for extensive long-term care would face a significant financial burden. As an example to illustrate the extent of their financial burden, an individual receiving personal care in England in 2001 on average received 7.6 hours of personal care per week at the cost of £12 per hour (National Statistics, 2002;

differential methods employed in the estimation of these prices across the two regions, it suggests that our estimated policy impacts may reflect this increase in the price of formal care. If this is true, our estimates present a lower bound in the absolute value, i.e. the negatively (positively) estimated effect is closer to zero than would otherwise have been in the absence of the change in price. For more discussions on how these prices were obtained, please see Appendix C.

Department of Health, 2001). Moreover, out of 400,000 formal care recipients, around 39 percent requested 6 or more visits and more than 5 hours of care per week. Half of these clients required more than 10 contact hours and 6 or more visits during the week. These numbers imply that formal personal care recipients on average paid £4,742.40 per year in 2001, which is more than the annual amount of basic state pension (£3,770) in the same year. Even when we calculate a conservative estimate, a median care-receiving household that used formal care for 3.5 hours a week would needed to have paid £2,184 per year. This implies that the majority of care-recipients' basic pension would be needed to finance their care. In addition, one should not forget that these are not the only expenses incurred by the elderly in need of formal care. Local government often charge for meals delivered to home, or for participating in day care sessions.

In order to address the financial concerns among the elderly, the Royal Commission on Long-Term Care for the Elderly was set up by the Labour government in December 1997 under the chairmanship of Sir Stewart Sutherland. The Commission reported back to the UK Parliament in March 1999 (Sutherland Report), recommending that for those aged 65 and above, formal personal care should be provided free of charge after a rigorous need-based assessment is conducted by local authorities.[2]

At the same time as the publication of the Sutherland report, the UK political system went through significant changes as powers were transferred from Westminster to devolved governments in Scotland, Wales and the Northern Ireland. The devolved governments were introduced on 1st July 1999 in Scotland and Wales and on 2nd December 1999 in the Northern Ireland. England remained under the direct control of Westminster.

As a result of devolution, each government acquired the power to form its own health care policies and this led regions in the UK to adopt different long-term care policies.[3] Although the rest of UK decided not to adopt the recommendations made by the Sutherland report and continues to charge for formal personal care, Scotland adopted the idea of state-funded personal care. The Scottish Executive set up the Care Development Group in January 2001, which was aimed at pursuing options on how to implement state-funded personal care and to evaluate the estimated cost of introducing such a policy. After several revisions, the Bill passed and received Royal Assent on 12 March 2002 to become

[2]The Commission, however, argued that the hotel costs and costs of meals on wheels or providing personal assistance with shopping should still be paid by individuals.

[3]Devolution provided Scotland with the power to set policies on health, education and local authority administrations. Flagship policies aside from the policy studied in this paper include the abolition of University tuition fees and policies to reduce homelessness in Scotland. Although employment or retirement policies may bias our results, these policies are universally applied to all of UK by Westminster. See Keating et al. (2003) for the summary of policies separately introduced in Scotland and the rest of the UK.

the CCHA, which in turn was implemented on 1st July 2002.

The amount of allowance depends on the amount of care needed but also on where the elderly individual received care. Table 1 summarises individuals' financial gains due to the reform by care setting (i.e. in a care home, or at home in the community) and the region of residence. For each group, the maximum possible amount of weekly allowances given to individuals is shown. The calculated amounts reflect other policy reforms that were implemented at the same time (see Appendix B for more information on these reforms).

**Table 1:** Examples of weekly allowance calculations (£ per week)

| Care received in care homes | Before the reforms £ per week | After the reforms £ per week |
|---|---|---|
| England | 53.55 | 200.00 |
| Wales | 53.55 | 176.86 |
| Northern Ireland | 53.55 | 157.20 |
| Scotland | 53.55 | 210.00 |
| Care received at home | | |
| England | 53.55 | 57.20 |
| Wales | 53.55 | 57.20 |
| Northern Ireland | 53.55 | 57.20 |
| Scotland | 53.55 | 202.20 |

*Notes:* This table illustrates how the maximum amounts of weekly allowances changed before and after the reforms depending on where the elderly reside and where they receive care. The pre-reform amounts are calculated using the 2000 rates whereas the 2003 rates are employed for the calculations of the post-reform amounts. Since the formal personal care allowance in Scotland for those receiving care at home is not fixed, we use the average amount provided to the elderly, i.e. £80 (National Statistics, 2012). These calculations also incorporated the other allowances such as the Attendance Allowances and the nursing care allowances to illustrate the overall changes that individuals experienced over time. Details on these allowances are included in the Appendix B.

As Table 1 indicates, when the elderly receive care in residential care homes, they experienced an increase in the allowances of similar magnitude regardless of the region of residence. These increases are due to other policies that were introduced at around the same time as the policy that we are studying (see Appendix B for more details). However, it is only those who received care at home in Scotland that benefited from the introduction of CCHA.[4] Therefore, our results in this paper reflect the isolated impact of the free personal care policy affecting those who were receiving care at home. Given that approximately 70% of individuals are reported to receive care at home in 2004–2005 (AgeUK, 2014), the Scottish policy changes are likely to affect a large proportion of the

[4]Even after the reform, individuals are still asked to pay other costs such as costs of cleaning, day care, laundry or meals on wheels.

population. Based on the amount reported in Table 1, computing the difference between the variation in the allowances of care received at home in Scotland and the one in the rest of the UK yields £145 per week,[5] which amounts to £7,540 per year.

Care allowances can be given to families as direct payments, in which case the care recipients receive the allocated care allowances, and the money can be used to set up the care arrangements that suit their needs. Alternatively, these families can request that the local authority arranges for community care services.

In theory, the availability of the direct payments option may lead each family to use the allowance as a cash transfer within the family, and the informal caregiver may continue to give care (Costa-Font et al., 2016). However, in most cases, direct payments option can only be used to buy community care services, and it cannot be used to employ relatives (National Health Service, 2015) and how the money is used is monitored by each local authority by checking receipts. On some occasions, the local authority may agree that the money is used to hire family members. However, this case is limited to those who require this arrangement for cultural or religious reasons. In addition, out of 60,000 formal care recipients in Scotland, less than 200 individuals used the option between 2002-2004. Although the number of individuals requesting this option increased over time, only approximately 2,000 out of 70,000 clients used it in 2007 (Gillespie, 2017). The system design, as well as these numbers reported in Gillespie (2017), suggest that the use of allowances to pay the informal carers is an unlikely or a secondary outcome at least during the period of our analysis.

# 3 Data, estimation strategy, and identification

## 3.1 Data, sample, and variable definition

This study employs the repeated cross section of the UK Family Resources Survey (FRS). FRS has been collected by the Department for Work and Pension on an annual basis since 1992. Every year approximately 24,000 private households and 45,000 individuals are interviewed, and the information is collected at the household, benefit unit (defined as an individual, or a couple with or without dependent children), and individual levels. Our analysis spans from 1998 since all the relevant dependent and independent variables are available only from this year. We exclude the waves after 2007 because of the financial crisis, which may have led to asymmetric impacts across regions on individual time en-

[5] (£202.20 – £53.55) – (£57.20 – £53.55) = £145.

dowments and their labour supply. We exclude Northern Ireland from our analysis, since FRS does not collect data from the area before the 2002/2003 survey. After keeping the 1998-2007 waves and removing individuals in Northern Ireland, the sample size becomes 439,410. Removing those younger than 25 reduces the sample to 399,124 units. Finally, we drop observations if they did not report the number of hours of caregiving and this results in the final sample size of 399,098.

We have several outcomes of interest.

- An indicator variable that equals 1 if the individual looked after an adult (family members or friends/neighbours), to evaluate the impact of the reform on the informal caregiving at the extensive margin.
- The number of hours per week of informal care given to an adult (family members or friends/neighbours), to assess the effects of the policy on caregiving at the intensive margin.
- An indicator variable that equals 1 if the individual is employed, to understand if there is an indirect effect on labour supply at the extensive margin;
- The number of weekly working hours, to see if the policy generated an indirect impact on labour supply at the intensive margin.

The first two outcomes are further divided into co-residential and extra-residential caregiving. We observe co-residential caregiving to all family members. Although we also observe extra-residential caregiving to relatives as well as friends, the overwhelming majority of extra-residential care is given to parents. We, therefore, focus our extra-residential care analysis exclusively on care given to parents.

The number of hours per week of informal caregiving is an interval-coded variable. When we study the impacts on caregiving behaviour within the same household, the relevant dependent variable is the sum of two underlying interval-coded variables. One variable reports the number of hours of informal care given to adults in the household within the same benefit unit (i.e. to a partner/spouse). The other variable reports the number of hours of informal care given to adults in the household in different benefit units (e.g. by an adult in the household to an elderly parent. For both of these variables, the information on the number of weekly hours of informal caregiving is reported with the interval structure. We build the number of hours per week of informal caregiving to adults by assigning to each individual an interval whose lower bound is given by the sum of the lower bounds of the two underlying variables and whose upper bound is the sum of the two upper bounds.

In contrast, for the analysis of the hours of extra-residential caregiving, we use a single interval-coded variable.

When the outcome variable is labour force participation, we further restrict the sample to those aged between 25 and 74 years of age, who report less than 60 weekly working hours, who are not retired, not students, not permanently or temporarily sick/disabled. In this case, the resulting sample size is 254,402.

Table 2 presents descriptive statistics of all the outcome variables, except for the number of hours of co-residential or extra-residential informal caregiving, before and after March 2002 for Scotland and the rest of Britain. Figures of the number of weekly hours of co-residential and extra-residential informal caregiving are instead reported separately in Figure 1, because of its interval-coded nature. Table 2 shows that the fraction of people providing co-residential informal care to other adults slightly decreased from the before- to the after-period both in Scotland and in the rest of Britain. However, the reduction is larger in Scotland: -0.6 percentage points in Scotland compared to -0.1 percentage points in England and Wales. The difference-in-differences amounts to -0.4 percentage points and it is significantly different from zero. When we look at the statistics for extra-residential care given to parents, the changes in the fractions are smaller and insignificant. Comparing the employment status and working hours before and after 2002, Scottish individuals increased their labour market participation both at the intensive and extensive margins compared to those in England and Wales. While the participation rate and the average weekly working hours rose by 4.3 percentage points and 1.4 hours per week in Scotland, the counterparts in England and Wales amount to 2.5 percentage points and 0.7 hours. In the raw data, therefore, we find some evidence suggesting that the co-residential informal caregiving and labour force participation behaviour changed in Scotland relative to England and Wales after 2002. In the multivariate analysis that follows we check whether this evidence from the raw data remains after controlling for a rich set of time-varying and time-constant determinants of the outcome variables and possible heterogeneity across different regions caused by a changing economic and social environment.

Figure 1 shows the distributions of co-residential and extra-residential informal care hours before and after March 2002 separately for England and Scotland: the top two graphs show the hours of co-residential care given to someone in the same benefit unit, the middle two graphs present the hours of co-residential care given to those in a different benefit unit, and the bottom two graphs show the hours of extra-residential care given to parents. The left-hand side axis in each figure shows the percentage of individuals in England and Scotland who provided zero hours of informal care. On the other hand, the

**Table 2:** Summary statistics of the outcome variables before and after the reform of the treatment and control groups

| | Scotland | | | England & Wales | | |
|---|---|---|---|---|---|---|
| | Mean | SD (SE) | Observations | Mean | SD (SE) | Observations |
| *Informal care giver (co-residential)* | | | | | | |
| Before: 1998-2001 | 0.031 | 0.174 | 13,626 | 0.031 | 0.173 | 141,261 |
| After: 2002-2007 | 0.025 | 0.157 | 41,687 | 0.029 | 0.169 | 202,524 |
| Mean difference after-before | -0.006*** | (0.002) | 55,313 | -0.001*** | (0.001) | 343,785 |
| Difference-in-differences | -0.004*** | (0.001) | 399,098 | | | |
| *Informal care giver (extra-residential)* | | | | | | |
| Before: 1998-2001 | 0.046 | 0.210 | 13,626 | 0.050 | 0.218 | 141,261 |
| After: 2002-2007 | 0.047 | 0.212 | 41,687 | 0.050 | 0.219 | 202,524 |
| Mean difference after-before | 0.001 | (0.002) | 55,313 | 0.0003 | (0.001) | 343,785 |
| Difference-in-differences | 0.001 | -0.001 | 399,098 | | | |
| *Employment indicator* | | | | | | |
| Before: 1998-2001 | 0.825 | 0.380 | 8,370 | 0.822 | 0.387 | 91,122 |
| After: 2002-2007 | 0.868 | 0.339 | 25,111 | 0.847 | 0.360 | 129,799 |
| Mean difference after-before | 0.043*** | (0.005) | 33,481 | 0.025*** | (0.002) | 220,921 |
| Difference-in-differences | 0.017*** | (0.003) | 254,402 | | | |
| *Weekly working hours* | | | | | | |
| Before: 1998-2001 | 30.950 | 18.033 | 8,370 | 30.879 | 18.494 | 91,122 |
| After: 2002-2007 | 32.350 | 16.632 | 25,111 | 31.567 | 17.633 | 129,799 |
| Mean difference after-before | 1.401*** | 0.223 | 33,481 | 0.688*** | 0.078 | 220,921 |
| Difference-in-differences | 0.713*** | 0.138 | 254,402 | | | |

*Notes:* *** Significant at 1%. SD and SE stand for standard deviation and standard error, respectively.

right-hand side axis in every figure presents the percentage of individuals who offered positive hours of informal care. These graphs indicate that individuals in Scotland were less likely to provide co-residential care after the policy introduction and the percentage of individuals offering no informal care increased compared to those in England. This is true regardless of whether we look at care hours given to those in or out of the caretaker's benefit unit. The bottom two graphs show that changes in the hours of extra-residential care are small for all categories and both regions.[6]

## 3.2 The econometric model

Identification of the policy effect relies on the fact that the free personal care was introduced only for a particular group of individuals in Britain and that both the treated population (those in Scotland) and the untreated population (those in the rest of Britain) are observed before and after the reform. More specifically, we employ a difference-in-differences (DD) estimator to estimate changes in the differences in various outcomes between Scotland and the rest of the UK before and after the reform. Using the month and year of interview information available in our data, we define the after policy introduction period to be March 2002. March is chosen as the cut-off month since the Scottish bill introducing free personal care for the elderly passed on 12 March 2002.

Our empirical evaluation is in a repeated cross sections framework. We specify the following model for a generic outcome variable $y$ for the $i$th individual in region $r$ and in tax year $t$

$$y_{irt} = \mathbf{x}'_{irt}\boldsymbol{\beta} + \boldsymbol{\gamma}_r + \boldsymbol{\phi}_t + \delta_{DD} I_{rt} + \varepsilon_{irt}, \tag{1}$$

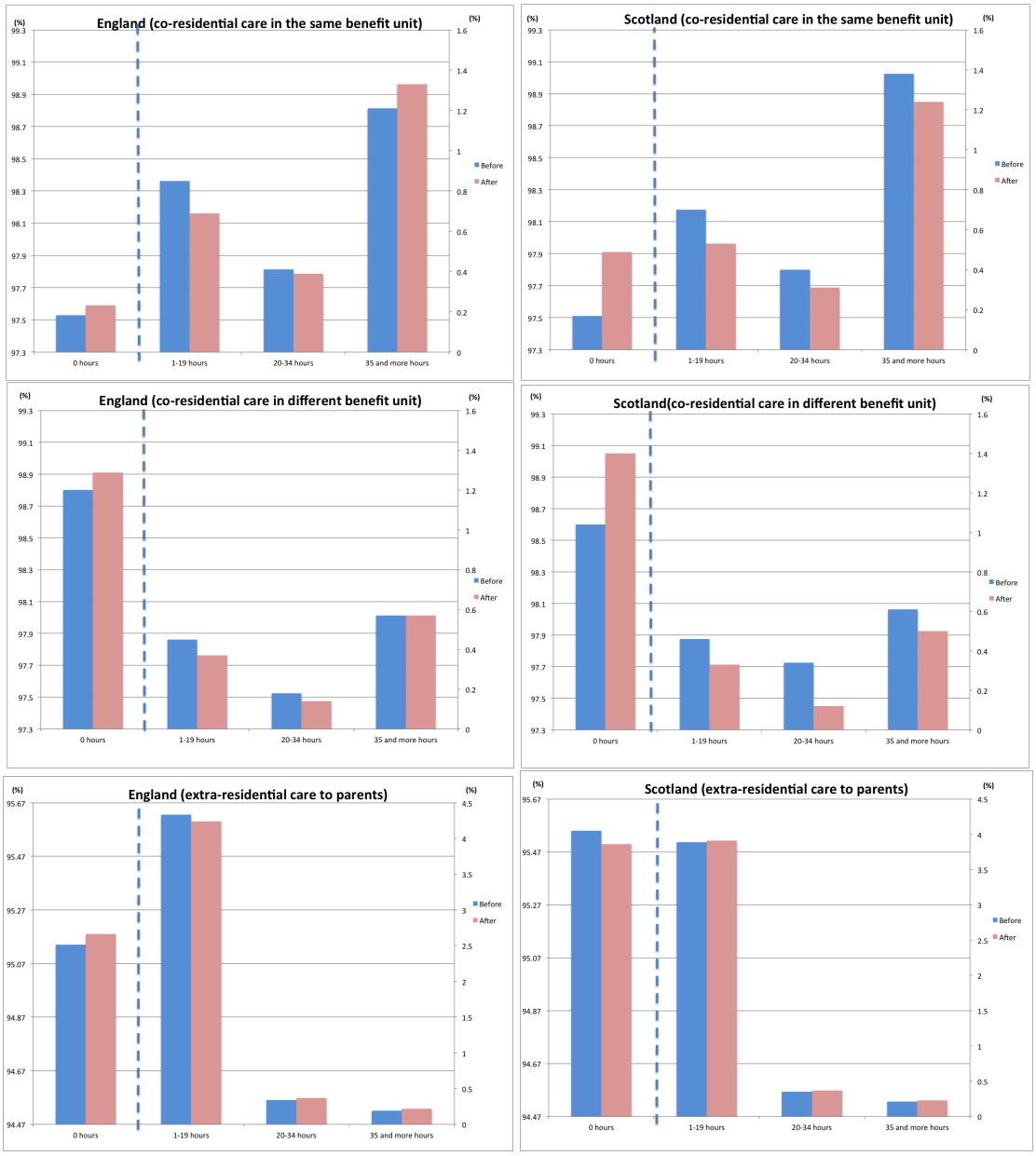
where:

- $\mathbf{x}_{irt}$ is the $K \times 1$ vector of relevant individual characteristics and $\boldsymbol{\beta}$ is the conformable vector of coefficients. The regressors in $\mathbf{x}_{irt}$ are gender, marital status, age of individual $i$ and of the spouse (if present), race, education of individual $i$ and of the spouse (if present), number of dependent children, number of household members, number of household members older than 64, and a set of controls for time-varying regional heterogeneity and regional specific trends, like the regional activity rate by gender, per capita gross value added, and its variation.

- $\boldsymbol{\gamma}_r$ is a set of regional fixed effects (regional dummies).

[6]Table D.4 in Appendix D reports descriptive statistics of all the covariates used in the econometric analysis, computed both on the larger sample that is used to model caregiving and on the subsample for modelling labour force participation.

**Figure 1:** Histograms of hours of care




The above figures show the distributions of co-residential and extra-resdential care hours in England and Scotland before and after March 2002. In each figure, the left-hand side axis is applicable only for the bar showing "0 hours of care", whereas the right-hand side axis should be used for the bars for other hour categories.

- $\boldsymbol{\phi}_t$ is a set of time fixed effects (tax year dummies).
- $I_{rt}$ is the regressor of interest. It is an indicator variable equal to 1 if individual $i$ resides in Scotland after the reform, i.e. after March 2002. The corresponding parameter $\delta_{DD}$ is the effect of the introduction of free personal care in Scotland on caregiving.
- $\varepsilon_{irt}$ is the error term at individual level.

The parameters of Equation (1) are estimated either by using Ordinary Least Squares (OLS) or interval regressions depending on the outcome variables. Specifying the informal caregiving indicator and the labour force participation indicator using the linear model in Equation (1) implies that we are estimating linear probability models for the probability of giving informal care and of being employed. On the other hand, the variable for the number of hours of informal care given to adults has a limited support since it is interval-coded, suffers from the right or left censoring for some observations, and presents a sizeable mass of observations at zero. We model this interval-coded variable using a generalisation of the type-I Tobit model.

In the case of estimating interval regressions, we assume that Equation (1) represents the latent variable model for the number of hours of caregiving, if it were observed without the interval-coding problem, and that the error term, conditional on all the control variables, has a zero-mean normal distribution with variance equal to $\sigma^2$. This is sufficient to derive the probabilities of observing the realization of the latent variable being equal to zero (corner solution), larger or smaller than an observed cut points (right or left censoring), and between two observed cut points (interval censored). The sample density is fully determined by these response probabilities up to a finite number of parameters (the parameters in Equation (1) and $\sigma$) and, therefore, the model can be estimated by maximum likelihood. Let us define $w_{irt} \equiv \mathbf{x}'_{irt}\boldsymbol{\beta} + \boldsymbol{\gamma}_r + \boldsymbol{\phi}_t + \delta_{DD} I_{rt}$. The contribution to the sample log-likelihood of individual $i$ living in region $r$ and in tax year $t$, with an observed number of hours of caregiving in $(c_i^{j-1}, c_i^j]$, is:

$$\ell_{irt} = \begin{cases} \log\left\{\Phi[(c_i^j - w_{irt})/\sigma]\right\}, & \text{if } c_i^{j-1} = 0 \text{ and } y_{irt} \leq c_i^j; \\ \log\left\{\Phi[(c_i^j - w_{irt})/\sigma] - \Phi[(c_i^{j-1} - w_{irt})/\sigma]\right\}, & \text{if } c_i^{j-1} < y_{irt} \leq c_i^j; \\ \log\left\{1 - \Phi[(c_i^{j-1} - w_{irt})/\sigma]\right\}, & \text{if } y_{irt} > c_i^{j-1} \text{ and } c_i^j = +\infty; \end{cases} \tag{2}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function.

In our DD application, the identification of the policy effect is based on variation across regions and years. Therefore, the regressor of principal interest is correlated within the cluster (i.e. region), and inference should take this into account. Although the cluster-robust variance estimator (CRVE) is an easy way to deal with correlation within-groups (Liang and Zeger, 1986), this approach is unbiased only when the number of clusters is large enough, and the asymptotic results can be safely invoked. In our application, the number of clusters (i.e., regions) is 11 and cluster-robust errors may suffer from a type I error (i.e. over-rejection of true null).[7]

Cameron et al. (2008) propose a wild cluster bootstrap-$t$ procedure to get critical values when the number of clusters is small. However, MacKinnon and Webb (2017) show that with unbalanced clusters and a small number of treated clusters (only one in our case), the wild cluster bootstrap based on unrestricted residuals as well as the CRVE $t$ statistics tends to over-reject, also resulting in type I errors; the wild cluster bootstrap based on restricted residuals tends instead to under-reject just as severely, resulting in type II errors.[8] To the best of our knowledge, there is currently no method to safely obtain critical values in a DD model with a small number of untreated clusters and one treated cluster. Due to this problem, we report $p$-values without controlling for clusters. This is because the inferences obtained without controlling for clusters almost always returned results that are in the middle of all the inferences. Three other $p$ values, i.e., those based on the CRVE $t$ statistics[9] and the wild cluster bootstrap procedure by Cameron et al. (2008) with both unrestricted and restricted residuals are available from the corresponding author on request.[10]

## 3.3 Identification assumptions

The identification of the policy effects through a DD approach is based on some underlying assumptions.

[7] See Cameron and Miller (2015) for an overview of the problems in doing inference when the number of clusters is small.

[8] In MacKinnon and Webb (2017), the wild cluster bootstrap based on restricted residuals is the procedure in which the model is re-estimated under the null hypothesis of no treatment effect in the bootstrap algorithm. When the procedure is based on the unrestricted residuals, the null hypothesis is instead not imposed.

[9] More specifically, given $R$ the number of regions, we will compute $\sqrt{R/(R-1)}$-clustered robust standard errors and $t_{R-1}$ critical values as suggested in Brewer et al. (2013).

[10] We bootstrapped the residuals 2,500 times using the Webb six-point distribution as weights (Webb, 2014).

*Assumption 1 (Parallel trend assumption):* Conditional on $(\mathbf{x}_{irt}, \boldsymbol{\gamma}_r, \boldsymbol{\phi}_t)$, individuals residing in Scotland experience similar trends in the outcome variables as those in the rest of the UK in the absence of the 2002 reform.

We check the validity of Assumption 1 by comparing the trends in care supply of England-Wales versus Scotland. Figure 2 reports the least squares estimates, or interval regression estimates if the dependent variable is the weekly hours of caregiving, of the coefficients of the tax year dummies for Scotland and of the tax year dummies for England-Wales (the tax year dummy for England-Wales in 1998 is the reference). We obtained them by regressing each outcome variable on a set of time dummies whose coefficients are allowed to be different between Scotland and England-Wales and all the other regressors in the baseline equation. In other words, we estimated the following equation

$$y_{irt} = \mathbf{x}'_{irt}\boldsymbol{\omega} + \boldsymbol{\gamma}_r + \boldsymbol{\phi}_t^{EW} + \boldsymbol{\phi}_t^{Sc} + u_{irt}, \tag{3}$$

where $\boldsymbol{\phi}_t^{EW}$ are tax year dummies if individual $i$ lives in England-Wales and $\boldsymbol{\phi}_t^{Sc}$ are tax year dummies if individual $i$ lives in Scotland.[11]

The estimated coefficients on these dummy variables are plotted in Figure 2. The trends in Scotland and the rest of the UK of almost all the outcome variables look parallel before the reform. In Panels (a), (d) and (g) of Table 3, we present results from statistical tests to verify whether these sets of trends are indeed parallel. To do this, for each outcome, we jointly test if, $\forall t = 1998, \ldots, 2001$, $\boldsymbol{\phi}_t^{Sc} - \boldsymbol{\phi}_t^{UK} = k$, where $k \in \Re$ is some constant. If the null hypothesis cannot be rejected, then the distance between the Scottish trend and the British trend is constant, i.e. the trends are parallel before the reform. The $p$-values shown in these panels confirm that the trends are parallel before the reform.[12] [13][14]

[11] $\boldsymbol{\phi}_{1998}^{UK}$ is normalized to zero.

[12] This is true even when we look at various inferences that take account of clustering. All the other inferences are available upon request.

[13] As discussed under Assumption 2, the wide media coverage as early as 2001 may have contributed to the drop in the probability and hours of informal caregiving shown in Figure 2. However, our parallel trend test indicates that this observed drop in 2001 are statistically insignificant.

[14] Another interesting feature of Figure 2 is that both the probability and hours of co-residential informal caregiving increased in 2003. This is perhaps because the Scottish public misunderstood the generosity of this policy. Bell et al. (2006) conducted interviews to care workers and discovered that care recipients had thought that the policy automatically entitles them to full formal personal care coverage and had not understood that they had to go through the need-based assessments. The observed decline in 2002 and the subsequent increase in 2003 may reflect the fact that informal caregivers adjusted their amount of caregiving upon finding out the actual amount of allowances that their frail family members received.

## **Table 3:** Identification assumption tests

| | Linear probability model for co-residential care giving | | Interval regression for hours of co-residential care giving | |
|---|---|---|---|---|
| | Coeff. | $p$-value[§] | Coeff. | $p$-value |
| *(a) Test of parallel trend* | | 0.593 | | 0.418 |
| *(b)Placebo test: the 2002 policy reform in previous years* | | | | |
| After$_{t-1}$*Scotland | -0.005 | 0.223 | -13.077 | 0.176 |
| After$_{t-2}$*Scotland | 0.002 | 0.694 | -0.519 | 0.957 |
| After$_{t-3}$*Scotland | 0.001 | 0.850 | 0.556 | 0.955 |
| Test of joint significance | | 0.620 | | 0.447 |
| *(c)Placebo test: the 2002 policy reform in other regions* | | | | |
| After*North[♋] | 0.001 | 0.472 | 2.039 | 0.470 |
| After*Center[♌] | -0.002 | 0.036** | -4.248 | 0.184 |
| After*South[¬] | 0.002 | 0.205 | 1.563 | 0.619 |
| Test of joint significance | | 0.195 | | 0.617 |
| Observations | 399,098 | | 399,098 | |

| | Linear probability model for extra-residential care giving | | Interval regression for hours of extra-residential care giving | |
|---|---|---|---|---|
| | Coeff. | $p$-value | Coeff. | $p$-value |
| *(d) Test of parallel trend* | | 0.551 | | 0.550 |
| *(e) Placebo test: the 2002 policy reform in previous years* | | | | |
| After$_{t-1}$*Scotland | -0.007 | 0.191 | -1.826 | 0.175 |
| After$_{t-2}$*Scotland | 0.003 | 0.605 | 1.157 | 0.403 |
| After$_{t-3}$*Scotland | 0.003 | 0.594 | 0.462 | 0.746 |
| Test of joint significance | | 0.568 | | 0.548 |
| *(f) Placebo test: the 2002 policy reform in other regions* | | | | |
| After*North[♋] | -0.002 | 0.388 | -0.186 | 0.637 |
| After*Center[♌] | 0.003 | 0.187 | 0.495 | 0.454 |
| After*South[¬] | -0.001 | 0.762 | -0.223 | 0.599 |
| Test of joint significance | | 0.619 | | 0.743 |
| Observations | 399,098 | | 399,098 | |

| | Linear probability model for employment | | Hours of work | |
|---|---|---|---|---|
| | Coeff. | $p$-value | Coeff. | $p$-value |
| *(g) Test of parallel trend* | | 0.433 | | 0.831 |
| *(h) Placebo test: the 2002 policy reform in previous years* | | | | |
| After$_{t-1}$*Scotland | 0.015 | 0.175 | 0.293 | 0.556 |
| After$_{t-1}$*Scotland | -0.003 | 0.835 | -0.326 | 0.545 |
| After$_{t-1}$*Scotland | -0.013 | 0.300 | -0.139 | 0.796 |
| Test of joint significance | | 0.413 | | 0.847 |
| *(i) Placebo test: the 2002 policy reform in other regions* | | | | |
| After*North[♋] | 0.002 | 0.619 | 0.133 | 0.387 |
| After*Center[♌] | 0.005 | 0.213 | 0.072 | 0.675 |
| After*South[¬] | -0.006 | 0.097* | -0.196 | 0.207 |
| Test of joint significance | | 0.374 | | 0.655 |
| Observations | 254,402 | | 254,402 | |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. All the regressors included in the baseline models are also included in these models. The corresponding estimated coefficients are not reported for the sake of brevity and are available from the authors upon request.

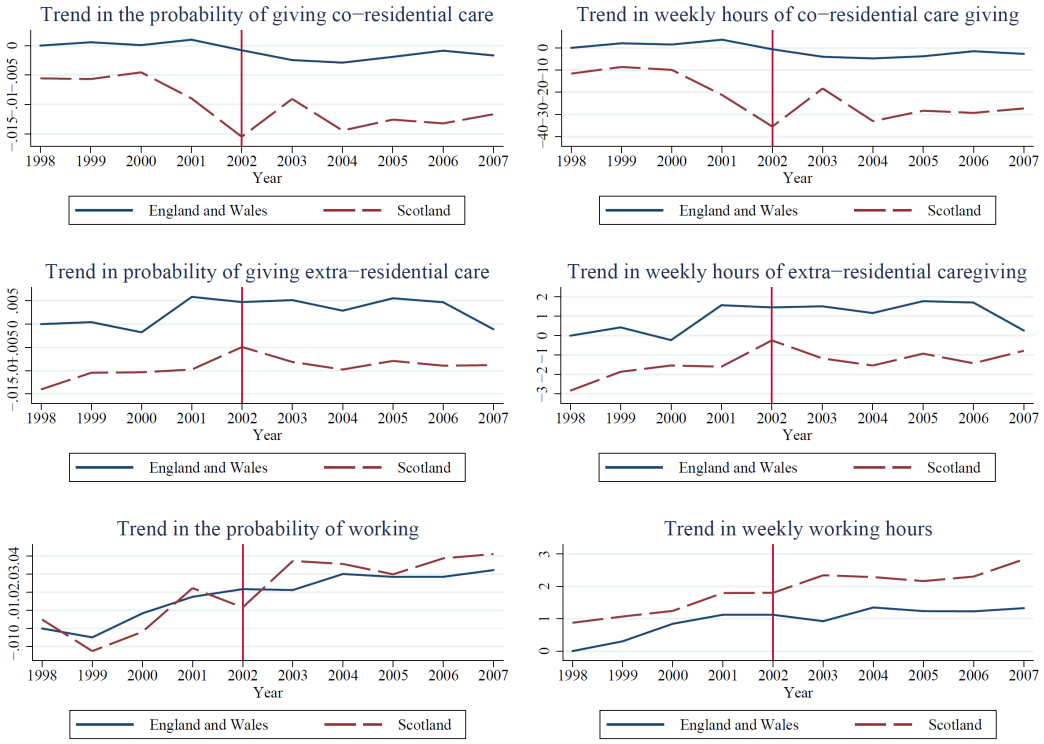
[§] We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are available upon request.

[♋] In the North, we include North-West, North-East, and Yorkshire and the Humber.

[♌] In the Centre, we include Wales, West Midlands, and East Midlands.

[¬] In the South, we include South-West, South-East, Eastern, and London.

**Figure 2:** Testing the parallel trend assumption of the outcome variables




*Notes*: In this figure, we report the least squares estimates (or interval regression estimates if the dependent variable is the number of hours of caregiving) of the coefficients of the year dummies for Scotland and England-Wales. We obtained them by regressing each outcome variable on a set of time dummies whose coefficients are allowed to be different between Scotland and England-Wales and, as further control variables, all the other regressors reported in Table D.4. The reference time dummy is 1998 for England-Wales.

Panels (b), (e), and (h) in Table 3 report another parallel trend test, which is performed by including among the regressors the lag of order one, two, and three of the policy indicator $I_{rt}$ and by testing the significance of the associated coefficients.[15]. By doing so, it is as if we are pretending that the 2002 Scottish policy was implemented one, two, or three years in advance. The test of significance of the coefficients of these lags should not therefore reject the null hypothesis. This is indeed what we find.

Finally, panels (c), (f) and (i) show results from our last placebo test, pretending that the policy was introduced also in other regions of the UK. To do this, Scottish individuals are removed from the sample. We then estimate 3 models, in each of which we pretended that the policy took place respectively in the North (North-West, North-East, and Yorkshire and the Humber), in the Centre (Wales, West Midlands, and East Midlands), and in the South (South-West, South-East, Eastern, and London). The underlying idea of this test is to treat other regions as if they also experienced the introduction of the policy in 2002. Since regions outside of Scotland did not implement personal care policies, the policy effects are expected to be jointly insignificant. This is what we find in almost all cases.

*Assumption 2 (No anticipation):* The Scottish individuals were not able to anticipate the introduction of the personal care reform.

The Sutherland Report in 1999 and the subsequent establishment of the 2001 Care Development Group in Scotland to consider the recommendations of the Report was widely covered by the mainstream media (e.g. BBC, 2001). In addition, the decision of the Scottish government to take up the recommendation was publicised by the media as early as January 2002 (e.g. Inman, 2002). As a result of this wide media coverage, households could have anticipated the introduction of the policy. The Scottish individuals might then have faced the incentives to alter their caregiving behaviour and labour force participation decisions before April 2002. In order to test this assumption, we include a robustness check by eliminating all the observations collected in the 12 months preceding the after policy period, i.e. from March 2001 until February 2002. The results are reported in Section 5.

*Assumption 3 (Stable sample composition):* Conditional on $(\mathbf{x}_{irt}, \boldsymbol{\gamma}_r, \boldsymbol{\phi}_t)$, the composition of the treated and control groups is assumed to be stable before and after the policy.

[15] Since we have four periods before the reform, we cannot include further lags.

According to Assumption 3, the sample compositions of those in Scotland, England, and Wales need to be stable over the years, conditional on observed covariates. This assumption eliminates the possibility that individuals' moves from England and Wales to Scotland in response to the policy introduction were motivated by greater needs for formal personal care. The analysis in Ohinata and Picchio (2017), which was conducted by using the 1999–2007 British Household Panel Survey, indicates that the policy introduction did not modify the probability of the British and the Welsh of moving to Scotland.[16]

# 4 Estimation results

## 4.1 The impact of the reform on caregiving behaviour

Panel (a) of Table 4 reports the estimated baseline policy effect for the probability and the weekly hours of co-residential caregiving.[17] The 2002 Scottish reform significantly reduced the probability of giving co-residential care to other adults by $0.4$ percentage points. Given that the fraction of individuals giving care in Scotland before the policy was $3.1\%$, the estimated effect implies a reduction in the probability of giving care by approximately $12.9\%$ with respect to the pre-treatment Scottish average.

The impact of the personal care reform on the number of weekly hours of co-residential caregiving is also negative and significant, as it is shown in the right columns of panel (a) in Table 4. Because of the interval-coded nature of the outcome variable and the resulting non-linearity of its model, we cannot quantify the impact of the policy on hours of caregiving just by looking at the estimated coefficient of the policy variable. Therefore, we report the estimation of marginal effects of the policy conditional and unconditional on the number of hours being larger than zero at the bottom of row (a). We also compute the marginal effect on the probability of caregiving hours of being larger than zero. The 2002 Scottish reform of the personal care for the elderly reduced the average number of weekly caregiving hours by approximately $0.29$ hours per week. If we condition on the number of hours being strictly larger than zero, the estimated reduction increases to $1.17$ hours. Since approximately one third of the caregivers in our sample give care for $19$ hours a week or less, reduction in the magnitude of $1.17$ hours per week in relative term is non-negligible. The impact of the reform on the probability of caregiving hours of being

[16] See Table 4 in Ohinata and Picchio (2017).

[17] Table D.5 in Appendix D present the coefficient estimates of all the covariate included in these regressions.

larger than zero is in line with the one from the linear probability model and it is equal to $-0.4$ percentage points.

The behavioural change in terms of informal co-residential caregiving induced by the policy introduction might differ depending on the relationship between the caregiving individual and the care-receiving adult. For example, individuals who have been taking care of their spouse may continue to give care regardless of the availability of free personal care because of their closer relationships to each other. On the other hand, individuals taking care of other relatives within the same household may more strongly respond to the policy introduction by reducing their informal caregiving. Using the household relationship information available in our dataset, we estimate the baseline equations 1 and 2 but by redefining the dependent variables on the basis of whether the care is given to the spouse or to a parent in the same household. The fraction of individuals in our sample who take care of the spouse is $2.4\%$. The fraction of those taking care of parents (living in the household) is $0.57\%$.

In panel (b) of Table 4, we see that the effect of policy on the probability of giving informal care to the spouse is negative and significant ($-0.3$ percentage points). When we look at the impact on the probability of giving co-residential care to at least one parent, the size of the reduction is smaller and insignificant ($-0.1$ percentage points as shown in panel (c) of Table 4). A similar conclusion can be drawn when we look at the changes in co-residential caregiving at the intensive margin. Just as before, the reduction in the hours of co-residential care is significant when we look at those who were giving care to their spouses. On the other hand, the coefficient for the hours of caregiving to parents is insignificant and smaller in magnitude.

So far, we have not restricted the age of care recipients when defining the outcome variables for caregiving behaviour. This is because, although the policy applied only to those aged 65 and above, informal carers may have changed their behaviour in anticipation of their care recipients becoming eligible in the near future or, with the policy change, they might shift the caregiving from a household member older than 64 to a younger member. To study how those who were actually affected by the Scottish policy adjusted their caregiving behaviour, we restrict the dependent variable only to take account of care given to individuals aged 60 or older.[18] From panel (d) of Table 4, we observe that the effect of the policy was to reduce the probability of informal co-residential caregiving by $0.4$ percentage points and the hours of care by approximately $0.27$ hours. Given that the fraction of people giving care to a household member older than 59 was 2.22% in Scotland before

[18] Around 71% of the informal caregivers were taking care of a household member older than 59.

**Table 4:** The policy impact on informal caregiving within the household

| | Linear probability model for informal caregiving | | Interval regression for hours of informal caregiving | |
|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† |
| *(a) Policy impact: Baseline* | | | | |
| **After*Scotland ($I_{rt}$)**§ | -0.004 | 0.018** | -10.469 | 0.010** |
| *Average partial effect of the policy* | | | | |
| $\Delta \mathrm{P}\,(y=1\|z)$ | | | -0.004 | |
| $\Delta \mathrm{E}\,(y\|z, y>0)$ | | | -1.169 | |
| $\Delta \mathrm{E}\,(y\|z)$ | | | -0.291 | |
| $\sigma$ | | | 143.921 | |
| Log-likelihood | | | -68,873.510 | |
| $R^2$ | 0.037 | | | |
| *(b) Relation with the care recipient: Spouse* | | | | |
| **After*Scotland ($I_{rt}$)**§ | -0.003 | 0.032** | -10.620 | 0.028** |
| *Average partial effect of the policy* | | | | |
| $\Delta \mathrm{P}\,(y=1\|z)$ | – | | -0.003 | |
| $\Delta \mathrm{E}\,(y\|z, y>0)$ | – | | -1.024 | |
| $\Delta \mathrm{E}\,(y\|z)$ | – | | -0.240 | |
| $\sigma$ | – | | 150.834 | |
| Log-likelihood | – | | -55,183.120 | |
| $R^2$ | 0.040 | | – | |
| *(c) Relation with the care recipient: Parent* | | | | |
| **After*Scotland ($I_{rt}$)**§ | -0.001 | 0.375 | -6.501 | 0.363 |
| *Average partial effect of the policy* | | | | |
| $\Delta \mathrm{P}\,(y=1\|z)$ | – | | -0.001 | |
| $\Delta \mathrm{E}\,(y\|z, y>0)$ | – | | -0.487 | |
| $\Delta \mathrm{E}\,(y\|z)$ | – | | -0.035 | |
| $\sigma$ | – | | 122.671 | |
| Log-likelihood | – | | -14,892.106 | |
| $R^2$ | 0.033 | | – | |
| *(d) Relation with the care recipient: 60 or older* | | | | |
| **After*Scotland ($I_{rt}$)**§ | -0.004 | 0.007*** | -13.833 | 0.005*** |
| *Average partial effect of the policy* | | | | |
| $\Delta \mathrm{P}\,(y=1\|z)$ | – | | -0.004 | |
| $\Delta \mathrm{E}\,(y\|z, y>0)$ | – | | -1.334 | |
| $\Delta \mathrm{E}\,(y\|z)$ | – | | -0.268 | |
| $\sigma$ | – | | 142.643 | |
| Log-likelihood | – | | -37,840.127 | |
| $R^2$ | 0.067 | | – | |
| Observations | 399,098 | | 399,098 | |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. All the regressors included in the baseline models are also included in these models. The corresponding estimated coefficients are not reported for the sake of brevity and are available from the authors upon request.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are also available upon request.

the reform, in relative terms the reduction amounts to 17.8%, larger than the one from the baseline model.

In addition to the effects on co-residential care, the policy may have also affected the amount of care given to those living in different households.[19] Our data suggests that the largest group of extra-residential caregiver is looking after their parents living in different households. Table 5 displays the estimated policy impact on care given to parents outside the household. We find that the policy had a negligible consequence and the coefficient is not significantly different from zero.

**Table 5:** The policy impact on informal caregiving to parents living outside the household

| | Linear probability model for informal caregiving to parents living outside the household | | Interval regression for hours of informal caregiving to parents living outside the household | |
|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† |
| **After*Scotland ($I_{rt}$)** | 0.001 | 0.786 | 0.098 | 0.862 |
| *Average partial effect of the policy* | | | | |
| $\Delta \mathrm{P}\,(y=1\|z)$ | – | | 0.0004 | |
| $\Delta \mathrm{E}\,(y\|z, y>0)$ | – | | 0.013 | |
| $\Delta \mathrm{E}\,(y\|z)$ | – | | 0.005 | |
| $\sigma$ | – | | 24.2460 | |
| Log-likelihood | – | | -108,060.84 | |
| $R^2$ | 0.026 | | – | |
| Observations | 399,098 | | 399,098 | |

*Notes:* All the regressors included in the baseline models are also included in these models. The corresponding estimated coefficients are not reported for the sake of brevity and are available from the authors upon request.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are also available upon request.

There are several potential explanations for the lack of an effect on extraresidential caregiving behaviour. The first possibility is that the policy may have affected families' cohabitational decisions. On the one hand, just as in the case of co-residential care, the policy may have reduced extra-residential caregiving due to the availability of cheaper formal care. At the same time, however, availability of affordable formal care may have encouraged the elderly to live independently for a longer period. If formal and informal care are complements in the latter channel (i.e., offspring supplementing the formal care with their informal care provision), then this would lead to an increase in the probability of informal caregiving. (Pezzin et al., 1996; Pezzin and Schone, 1999; Karlsberg Schaffer,

[19] Approximately 2.95% and 4.94% of our total sample report providing co-residential and extra-residential care, respectively.

2015). To test whether cohabitation behaviour changed as a result of the policy introduction, we run a further DD analysis. We restrict the sample to individuals younger than 65 (resulting in 272,047 observations) and include a dummy indicator equal to 1 if the individual shares the household with at least one member who is older than 64 as the dependent variable. By estimating a linear probability model, we find that the likelihood of living with at least another adult older than 64 decreased in Scotland by approximately 0.55 percentage points. Since the Scottish pre-treatment fraction of people living with older family members was $5.7\%$, the estimated reduction is approximately $10\%$. These estimates provide suggestive evidence explaining the lack of policy effects for care given to parents living outside of the household.

The second possibility is that those receiving extra-residential care are already more reliant on formal care than co-residential care recipients in order to live independently. If this is the case, the introduction of the policy may have merely subsidised the cost that recipients were already paying by themselves. Information in FRS reveals that approximately 40% of extra-residential care recipients received formal care during the observation period as opposed to 12.7% of co-residential care recipients.[20]

## 4.2 The impact of the reform on working behaviour

If the policy had the effect of reducing the time people spend informally taking care of other adults in the same household, one might wonder how these individuals decided to use the additional available hours. They might use them for leisure, or they might increase their labour supply. The personal care reform reduced the actual and expected household expenditures for the personal care needed for older household members, generating an income effect in the optimal choice between working hours and net available income for consumption of other goods. The income effect would negatively affect the labour force participation provided that leisure time is not an inferior good. However, the policy also reduced caregivers' opportunity cost of work. This may have led caregivers to increase their labour supply after the policy introduction. We now try to understand whether the 2002 Scottish reform had an indirect effect on the labour supply among caregivers both at the extensive and intensive margins. Table 6 displays the estimation results of the equations for the employment status and the number of weekly working hours.[21] We

[20] However, it is worth pointing out that the number of care recipient observations in FRS is limited and these numbers need to be interpreted with caution (e.g. approximately 2700 co-residential and extra-residential care recipients observations per year in total).

[21] All the coefficient estimates can be found in Table D.6 in Appendix D.

find that the free personal care reform increased the probability of employment by $0.7$ percentage points although the result is statistically insignificant. On the other hand, the number of working hours significantly increased by $0.41$ hours.[22]

**Table 6:** The policy impact on the employment and weekly working hours

| | Linear probability model for being employed | | Linear model for weekly working hours | |
|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† |
| After*Scotland ($I_{rt}$)§ | 0.007 | 0.140 | 0.410 | 0.050** |
| Observations | 254,402 | | 254,402 | |
| $R^2$ | 0.109 | | 0.261 | |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. The estimated coefficients of the full set of yearly dummies are not reported for the sake of brevity and are available from the authors upon request.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are also available upon request.

## 4.3 Heterogeneity of the reform effect

In this subsection, we try to understand whether the estimated effects are heterogeneous across some individual characteristics. There are at least two good reasons to study the heterogeneity of the policy effect. First, there might be some individuals who react more because recouping the time used for informal caregiving might be more profitable for them. For example, the opportunity cost of informal caregiving might be higher among the more educated individuals than that of less educated individuals. Second, some categories of individuals may have no involvement in informal caregiving activities both with and without the policy. If so, the policy effect for these individuals would be zero, and they would attenuate the overall average effect.

We study the heterogeneity of the policy effects across the following individual dimensions: gender, education, and age. Furthermore, we studied the policy effects by the

[22] Since there is a mass of individuals (16.1%) with zero weekly working hours, we estimated the equation for the weekly working hours with a Tobit model, so as to take into account the corner solution at zero hours. The linear model and the Tobit version deliver very similar estimation results and marginal effects. The estimated policy effect on the probability of employment from the Tobit model is $0.005$, with resulting marginal effects of the policy on weekly hours of co-residential caregiving equal to $0.40$. These figures are very close to the marginal policy effect of $0.007$ and $0.410$ coming from the linear model reported in Table 6.

presence within the household of at least one person aged 60 or older. We choose this cut-off age, since individuals caring for those who are close to the eligible age may also respond by altering their caregiving and subsequently their labour supply behaviour in the anticipation that formal personal care would become significantly cheaper in the near future. On the contrary, we expect that individuals without old household members would not change their behaviour.[23] We implement the heterogeneity analysis by interacting the policy dummy ($I_{rt}$), the indicator for the period after the reform, and the indicator for living in Scotland with the variables for the chosen dimensions over which we investigate the potential heterogeneous responses. Then we replicate the DD analysis.[24]

Table 7 reports the heterogeneous effects on co-residential caregiving behaviour and labour supply.[25] We did not find any significant policy effects on extra-residential caregiving by gender, age groups, education, and presence of persons older than 59. Hence, we do not show here the estimation results of the heterogeneous policy effects on extra-residential caregiving. Panel (a) shows that men and women have reduced their involvement in co-residential caregiving by the same order of magnitude, both at the intensive and extensive margins. The tests of equality of these coefficients cannot reject the null hypothesis of the homogeneous effect of the personal care reform. This result is perhaps a little surprising, because we often are given the impression that women are more likely to provide informal care compared to men. However, equal proportions of men and women in our sample provide co-residential care (see Table D.7 in Appendix D for the summary statistics). Approximately 81% of this is given to spouses. Given that 87% of co-residential care recipients in our data receive care from a single informal caregiver, the policy most likely provided opportunities for these informal caregivers to seek external formal support. This option to seek external help seems to have been taken up regardless of the gender of the caregiver.[26]

Turning to the heterogeneous policy effect on working behaviour, we find some evidence of differences in the effects of the policy across gender. More specifically, men

[23] Table D.7 in Appendix D reports summary statistics of the outcome variables for co-residential caregiving and labour force participation by gender, age, education, and the presence of household members older than 59.

[24] We also studied the heterogeneity of the policy effect by the presence of kids in the household. We found that none of the estimated policy depend on the presence of kids.

[25] We tested the parallel trend assumption in each subsample as we did in Subsection 3.3. We fail to reject the null hypothesis of parallel trend in caregiving behaviour and labour market participation outcome variables in each of the subsample identified by the dimensions across which we study the heterogeneity of the effect.

[26] Our data reveals that women are twice more likely to provide extra-residential care (typically to parents living outside of their households).

**Table 7:** Heterogeneity of the reform effect on co-residential caregiving and labour supply

| | Linear probability model for co-residential informal care giving | | Interval regression for hours of extra-residential care giving | | Linear probability model for being employed | | Linear model for weekly working hours | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† | Coeff. | $p$-value† | Coeff. | $p$-value† |
| *(a) By gender* | | | | | | | | |
| Men | -0.004 | 0.113 | -9.882 | 0.093* | 0.011 | 0.057* | 0.714 | 0.020** |
| Women | -0.004 | 0.069* | -11.664 | 0.037** | 0.006 | 0.369 | 0.378 | 0.183 |
| Equality test ($p$-value) | | 0.982 | | 0.825 | | 0.587 | | 0.419 |
| *(b) By education* | | | | | | | | |
| Left education before age 16 | -0.010 | 0.004*** | -15.668 | 0.004*** | 0.011 | 0.291 | 0.873 | 0.048** |
| Left education at or later than age 16 | -0.001 | 0.497 | -6.613 | 0.280 | 0.004 | 0.394 | 0.195 | 0.409 |
| Equality test ($p$-value) | | 0.026** | | 0.265 | | 0.570 | | 0.175 |
| *(c) By age* | | | | | | | | |
| $[25, 55)$ | -0.001 | 0.571 | -4.369 | 0.473 | 0.002 | 0.732 | 0.204 | 0.367 |
| 55 or older | -0.009 | 0.010** | -16.042 | 0.003*** | 0.028 | 0.033** | 1.177 | 0.031** |
| Equality test ($p$-value) | | 0.045** | | 0.150 | | 0.060* | | 0.098* |
| *(d) By education and age* | | | | | | | | |
| Age $[25, 55)$ and left education before 16 | -0.006 | 0.318 | -9.483 | 0.393 | -0.004 | 0.754 | 0.424 | 0.467 |
| Age $[25, 55)$ and left education at or after 16 | -0.001 | 0.803 | -3.559 | 0.627 | 0.002 | 0.694 | 0.097 | 0.691 |
| Age 55 or older and left education before 16 | -0.011 | 0.008*** | -17.666 | 0.005*** | 0.026 | 0.129 | 1.156 | 0.091* |
| Age 55 or older and left education at or after 16 | -0.004 | 0.449 | -13.518 | 0.225 | 0.034 | 0.108 | 1.529 | 0.089* |
| Equality test ($p$-value) | | 0.112 | | 0.524 | | 0.246 | | 0.243 |
| *(e) By presence of other household members older than 59* | | | | | | | | |
| Yes | -0.020 | 0.002*** | -17.216 | 0.002*** | 0.024 | 0.192 | 1.517 | 0.041** |
| No | 0.0003 | 0.816 | -1.743 | 0.770 | 0.006 | 0.255 | 0.287 | 0.186 |
| Equality test ($p$-value) | | 0.002*** | | 0.057* | | 0.331 | | 0.111 |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. All the regressors included in the baseline models are also included in these models. The corresponding estimated coefficients are not reported for the sake of brevity and are available from the authors upon request.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are also available upon request.

were more likely to increase labour force participation as well as working hours.

On the other hand, panel (b) presents estimates that indicate that the policy effects have varied with education. While the estimates on almost all outcomes are close to zero for those who left school when they were 16 or older, they are much larger in absolute values for those who left before turning 16. In addition, distinguishing between people strictly younger than 55 and those older than 55 reveals that the reform effects in the benchmark models are mainly driven by older people (panel (c)).

Since most of the people who left education before turning 15 are older than 55,[27] it is not clear whether the detected heterogeneity is related to low education or to the older age. Henceforth, we interact the policy dummy with each of the dummies on age and on the level of education (panel (d)). We find that the policy affected the caregiving behaviour of those who are older than 55 and low educated.

Finally, when the effect is allowed to depend on the presence of household members aged 60 or older, we find suggestive evidence that the effects found in the baseline model both in terms of co-residential caregiving and labour force participation are fully driven by individuals in households with other members older than 59 (panel (e)). Among this subsample, the reduction in the probability of giving informal care to a household member decreases by 2 percentage points. Given that before the reform in Scotland, the fraction of individuals living with at least one household member older than 59 and providing co-residential informal care was 9.9%, the relative decrease amounts to 20%.

# 5 Sensitivity analysis

We conduct various sensitivity analyses in order to test the robustness of our baseline findings. In the first sensitivity analysis, we exclude year 2001 from our sample in order to test the possible anticipation effect (panel (a) of Table 8). As discussed in Section 3.3, from the time the Sutherland Commission was set up, the entire process until the enactment of the Scottish CCHA was highly publicized by the media. As a result of this wide media coverage, individuals may have anticipated the introduction of the policy. The estimates indicate that excluding 2001 in our sample raises, in absolute value, the estimated policy caregiving and work related effects. This is a potential piece of evidence of anticipation, since our robustness check suggests that individuals may have already reduced (increased) their caregiving (work probability or hours) from 2001.

[27] In our sample, 74.9% of those who left education before turning 16 are older than 55.

**Table 8:** Robustness checks of the reform effect on caregiving and labour force participation

| | Linear probability model for co-residential care giving | | Interval regression for hours of co-residential care giving | | Linear probability model for extra-residential care giving | | Interval regression for hours of extra-residential care giving | | Linear probability model for being employed | | Linear model for weekly working hours | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† | Coeff. | $p$-value† | Coeff. | $p$-value† | Coeff. | $p$-value† | Coeff. | $p$-value† |
| **(a) Removing 2001** | | | | | | | | | | | | |
| (i) Homogeneous policy effect: | -0.006 | 0.008*** | -14.122 | 0.002*** | -0.000 | 0.874 | -0.123 | 0.852 | 0.010 | 0.087* | 0.402 | 0.102 |
| (ii) Heterogeneous policy effects by age: | | | | | | | | | | | | |
| $[25, 55)$ | -0.003 | 0.238 | -9.492 | 0.155 | 0.004 | 0.222 | 0.646 | 0.407 | 0.002 | 0.755 | 0.125 | 0.635 |
| 55 and older | -0.010 | 0.015** | -17.666 | 0.004*** | -0.006 | 0.108 | -1.662 | 0.162 | 0.045 | 0.004*** | 1.626 | 0.011** |
| Observations | | 358,545 | | 358,545 | | 358,545 | | 358,545 | | 228,257 | | 228,257 |
| **(b) Removing London** | | | | | | | | | | | | |
| (i) Homogeneous policy effect: | -0.004 | 0.018** | -10.794 | 0.015** | 0.002 | 0.372 | 0.399 | 0.503 | 0.009 | 0.066* | 0.364 | 0.101 |
| (ii) Heterogeneous policy effects by age: | | | | | | | | | | | | |
| $[25, 55)$ | -0.001 | 0.490 | -4.805 | 0.449 | 0.005 | 0.134 | 0.803 | 0.250 | 0.004 | 0.422 | 0.166 | 0.486 |
| 55 and older | -0.009 | 0.011** | -15.661 | 0.007*** | -0.001 | 0.655 | -0.199 | 0.851 | 0.031 | 0.020** | 1.160 | 0.035** |
| Observations | | 359,271 | | 359,271 | | 359,271 | | 359,271 | | 226,843 | | 226,843 |
| **(c) Removing London and the South regions** | | | | | | | | | | | | |
| (i) Homogeneous policy effect: | -0.003 | 0.148 | -7.794 | 0.109 | 0.004 | 0.204 | 0.781 | 0.752 | 0.003 | 0.592 | 0.238 | 0.376 |
| (ii) Heterogeneous policy effects by age: | | | | | | | | | | | | |
| $[25, 55)$ | -0.001 | 0.721 | -3.963 | 0.570 | 0.006 | 0.128 | 1.045 | 0.218 | -0.002 | 0.784 | 0.014 | 0.959 |
| 55 and older | -0.007 | 0.076* | -14.255 | 0.027** | 0.001 | 0.842 | 0.188 | 0.877 | 0.021 | 0.146 | 0.993 | 0.095* |
| Observations | | 235,636 | | 235,636 | | 235,636 | | 235,636 | | 145,429 | | 145,429 |
| **(d) Removing individuals older than 64** | | | | | | | | | | | | |
| (i) Homogeneous policy effect: | | | | | | | | | 0.007 | 0.141 | 0.401 | 0.058* |
| (ii) Heterogeneous policy effects by age: | | | | | | | | | | | | |
| $[25, 55)$ | | | | | | | | | 0.002 | 0.673 | 0.205 | 0.364 |
| $[55, 64]$ | | | | | | | | | 0.030 | 0.030** | 1.230 | 0.035** |
| Observations | | | | | | | | | | 247,992 | | 247,992 |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. All the regressors included in the baseline models are also included in these models. The corresponding estimated coefficients are not reported for the sake of brevity and are available from the authors upon request.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are also available upon request.

Second, we remove households living in London from our sample. We do this because London is likely to differ substantially from the rest of UK in terms of its economic activities and demographic characteristics such as migration movements (Duranton and Monastiriotis, 2002; Hatton and Tani, 2005). This suggests that people residing in London might not be a valid control for those in Scotland. From panel (b) of Table 8, we observe that the policy effects are only marginally different from those of the benchmark estimates in Tables 4 and 6.

Third, we further eliminate the Southern regions to see whether our results are robust. The underlying idea behind this sensitivity analysis is to compare regions that are likely to be closer to Scotland in terms of social organization and cultural background because of their geographic proximity. Panels (c) of Table 8 suggest although both the caregiving or the work related outcomes are less significant compared to the baseline estimates, the magnitude of the estimates are similar. In addition, just as we saw in Table 7, the estimated effects are stronger among the older individuals.

Fourth, in panel (d), we replicated the analysis for the labour force participation by limiting the sample to the 25-64 age range. In the baseline model, we kept those between 65 and 74 years of age still active in the labour market and who had not retired by the interview date. This additional group was kept in the sample as their labour market status may lead them to respond to the policy change, for example, by further postponing their retirement. When we remove them from the sample, the sample size shrinks by 6,410 observations. The estimation results are very much in line with those reported in Table 6: the fraction of people at work increased by 0.7 percentage points ($p$-value equal to 0.141) and the number of weekly working hours increased by 0.4 ($p$-value is 0.058).

# 6 Conclusions

This paper studies the impact of the Scottish Care and Health Act 2002, which introduced subsidies for the elderly residing in Scotland to pay for their formal personal care costs, on the informal caregiving behaviour and working behaviour of Scottish people. We used difference-in-differences estimators since this reform was implemented only in Scotland, while the rest of the UK kept the old system. We find that the Scottish policy reduced the probability of an individual of taking care of another adult by $0.4$ percentage points, which amounts to a decrease of about $12.9\%$ relatively to the pre-treatment Scottish fraction of caregivers. Regarding the number of hours per week of co-residential informal caregiving, the reduction is about $0.29$ hours per week. Conditional on giving co-residential care,

the estimated effect suggests a reduction of about $1.17$ hours per week. The effect is particularly strong among older caregivers. On the other hand, we observe that the sample of individuals increased their employment probability or working hours. This effect is particularly strong and significant when we allow the effect to be heterogeneous across age. We find that individuals older than 55 substantially increased their labour supply both at the extensive margin ($+2.8$ percentage points) and at the intensive margin ($+1.18$ hours per week). In contrast to the findings for co-residential care, we found no effect for extra-residential care. This suggests that a reduced probability of living with one's frail elderly relatives may be a potential explanation for this finding.

These estimated effects may seem small as they refer to impacts at the individual level. However, scaling up these estimates reveals that the macro consequences of the policy are substantial. For example, the estimates suggest that the policy reduced hours of informal co-residential care by a little more than one million hours, the observed increase in hours of work would also be a little more than one million hours, overall. Together with the estimated reduction in informal co-residential caregiving, these numbers indicate that households substituted one hour of informal care for one hour of work. Therefore, while the introduction of the 2002 policy may have been costly, the policy at the same time promoted Scottish individuals to participate more in the labour market. A more substantial general equilibrium analysis is needed to make a clearer judgement on the overall impact of the policy. This is left for future research.

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# Appendix

## A Types of formal personal care

**Table A.1:** Types of formal personal care

| | |
|---|---|
| Personal Hygiene | Bathing, showering, hair washing, shaving, oral hygiene, nail care |
| Continence Management | Toileting, catheter/stoma care, skin care, incontinence laundry, bed changing |
| Food and Diet | Assistance with the preparation of food and the fulfilment of special dietary needs |
| Problems with Immobility | Dealing with the consequences of being immobile or substantially immobile |
| Counselling and Support | Behaviour management, psychological support, reminding devices |
| Simple Treatments | Assistance with medication (e.g. eye drops, application of lotions), oxygen therapy |
| Personal Assistance | Assistance with dressing, surgical appliances, prostheses, mechanical and manual aids. Assistance to get up and go to bed. |

*Notes:* "Free Personal and Nursing Care" (2017, May 03) retrieved from http://www.gov.scot/Topics/Health/Support-Social-Care/Support/Older-People/Free-Personal-Nursing-Care.

## B Other formal care related policy reforms

In addition to the 2002 Scottish CCHA, other reforms influenced the elderly care cost, which contributed to the changes in the amounts of allowances individuals received. As stated below, however, these policies were implemented throughout the UK, and it is the free personal care element of the 2002 CCHA reform that contributed to the substantially larger increase of allowances Scottish individuals received compared to those living elsewhere in the UK.

### B.1 Nursing care cost

Nursing care is the type of care that involves medical care provided by registered nurses. Prior to 2001, nursing care provided in UK residential care homes was maintained by social services administered by each local authority. Financial support for nursing care was only offered on a stringent means-tested basis. In contrast, nursing care offered at home or in hospitals was organised by the National Health Service (NHS) and, therefore, was free of charge at the point of delivery.

In response to the 1999 Sutherland report, which recommended that both personal and nursing care be offered free of charge regardless of care settings, England and Wales each implemented their free nursing care policy in October and December 2001. Scotland and Northern Ireland introduced their policy in June and October 2002, respectively. They paid allowances directly to care homes where the individual is receiving nursing care. The policy change, therefore, was

aimed at correcting the unequal cost treatment for patients receiving nursing care in care homes compared to those receiving free nursing care either at home or in hospitals.

## B.2 Attendance Allowances

The Attendance Allowance (AA) is a non-means tested weekly benefit for severely disabled people aged 65 or over who need help with personal care. It is paid out to all UK individuals in need. The amount of AA depends on the severity of the elderly's disability. After local authorities assess the elderly's condition, allowances are paid out in two levels depending on the elderly's condition.

After the 2002 CCHA reform, Scottish individuals receiving free personal care in care homes no longer qualified to receive AA. In contrast, Scottish individuals receiving care in their homes continued to receive AA, which implies Scottish individuals in care homes would receive approximately 50 pounds per week less allowances compared to care home residents in other UK regions. However, this is compensated by the generous allowances of the free personal care as shown in Table B.3 below, leaving the total amounts of allowances received by those in care homes to be similar across the UK regions.

## B.3 Summary of formal care related policies

Table B.2 summarises which allowances were given out to the elderly before and after the policy changes in 2001 and 2002. Since the amounts of allowances differed depending on the care settings, the table separately list the available allowances by where the elderly received care. There are two groups who benefited from the reforms: i) those receiving nursing care in care homes in all the regions of the UK; ii) the Scottish individuals receiving formal personal care.

In Table B.3, we illustrate how the maximum amounts of weekly allowances changed before and after the reforms depending on where the elderly reside and where they receive care. The pre-reform amounts are calculated using the 2000 rates whereas the 2003 rates are employed for the calculations of the post-reform amounts. The table highlights that the changes in the nursing care allowances only applied to those who receive care in residential care homes and the increase experienced by these individuals are comparable across regions. Scottish individuals receiving care at home, however, saw a sharp increase in their care allowances due to the 2002 policy reform. This implies two things. Firstly, it is the 2002 Scottish policy to offer free personal care that induced the significant care price variation. Secondly, since the majority of individuals receive care in their homes, the price variation is likely to induce behavioural responses among all Scottish individuals.

**Table B.2:** Availability of allowances before and after the 2001–2002 reforms

| | Scotland | | England, Wales, and Northern Ireland | |
|---|---|---|---|---|
| | At home | Care home | At home | Care home |
| | Before the 2001–2002 reforms | | | |
| Nursing care cost covered | Yes | No | Yes | No |
| Personal care allowance | No | No | No | No |
| Attendance allowance | Yes | Yes | Yes | Yes |
| | After the 2001–2002 reforms | | | |
| Nursing care allowance | Yes | Yes | Yes | Yes |
| Personal care allowance | Yes | Yes | No | No |
| Attendance allowance | Yes | No | Yes | Yes |

*Notes:* This table summarises the availability of various allowances in Scotland, England, Wales, and Northern Ireland before and after the 2001-2002 reforms. Regardless of the regions, the amount of nursing care allowance is fixed only for those receiving nursing care in care homes. In contrast, those receiving nursing care at home or in NHS hospitals receive the care free of charge.

**Table B.3:** Maximum weekly allowance calculations (£ per week)

| | Before the reforms (2000 rate) | After the reforms (2003 rate) |
|---|---|---|
| Care received in care homes | £ per week | £ per week |
| England | 53.55 (AA) | 57.20 (AA) + 142.80 (NC) = 200.00 |
| Wales | 53.55 (AA) | 57.20 (AA) + 119.66 (NC) = 176.86 |
| Northern Ireland | 53.55 (AA) | 57.20 (AA) + 100.00 (NC) = 157.20 |
| Scotland | 53.55 (AA) | 145.00 (FPC) + 65.00 (NC) = 210.00 |
| | Before the reforms (2000 rate) | After the reforms (2003 rate) |
| Care received at home | £ per week | £ per week |
| England | 53.55 (AA) | 57.20 (AA) |
| Wales | 53.55 (AA) | 57.20 (AA) |
| Northern Ireland | 53.55 (AA) | 57.20 (AA) |
| Scotland | 53.55 (AA) | 57.20 (AA) + 145 (FPC) =202.20 |

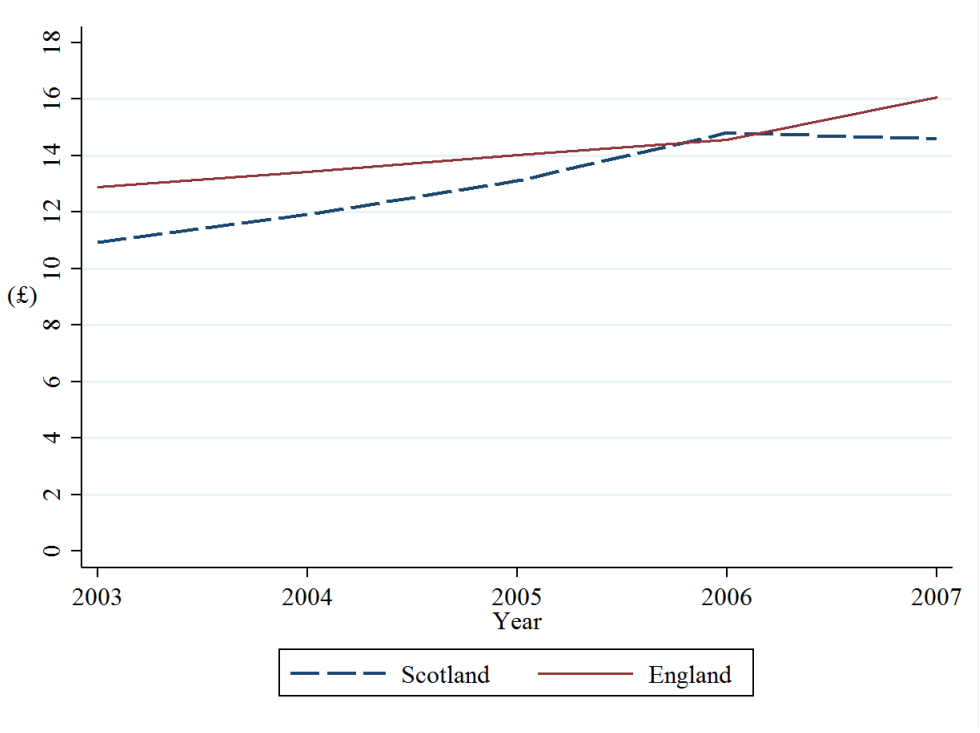
*Notes:* This table illustrates how the maximum amounts of weekly allowances changed before and after the reforms depending on where the elderly reside and where they receive care. The pre-reform amounts are calculated using the 2000 rates whereas the 2003 rates are employed for the calculations of the post-reform amounts. AA stands for Attendance Allowance; FPC means Formal Personal Care allowance; NC is the Nursing Care allowance. Since in Scotland the formal personal care allowance for those receiving care at home is not fixed, we use the maximum amount provided to the elderly in residential care homes, i.e. £145. Note that the nursing care provided in the elderly's home is offered for free at the point of delivery. As a result, nursing care allowance is only given to the elderly receiving care in care homes. In addition, it is worth noting that the attendance allowance is not provided to the Scottish elderly receiving care in care homes after the 2002 reform.

# C Price of care

The figure below shows the trends of the price of formal elderly care in Scotland and England. Interpreting this figure requires caution as the average prices for Scotland and England are calculated using different methods. For Scottish prices, we took the total expenditure spent on personal care in Scotland and divided the figure with the total number of hours of personal care (National Statistics, Scotland, 2018). For English prices, the hourly home care prices are taken directly from (Department of Health, 2003, 2004, 2005, 2006, 2007).

Since the definitions of statistics used to calculate these prices changed over time, the figure only presents the prices of the restricted period of 2002–2007 to ensure that the measurement of corresponding prices are consistent in each region.

**Figure C.1:** Average price of formal care in Scotland and England




Source: National Statistics, Scotland (2018); Department of Health (2003, 2004, 2005, 2006, 2007)

# D Other tables

**Table D.4:** Summary statistics

| | Caregiving sample | | Labour supply sample | |
|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| Co-residential care giver | 0.030 | 0.170 | – | – |
| Extra-residential care giver | 0.050 | 0.218 | – | – |
| Employment indicator | – | – | 0.839 | 0.367 |
| Average weekly working hours | – | – | 31.378 | 17.871 |
| Female | 0.532 | 0.499 | 0.527 | 0.499 |
| Age | 51.094 | 15.972 | 43.168 | 11.015 |
| Age of the spouse (if present) | 45.286 | 21.711 | 38.372 | 19.223 |
| Couple | 0.702 | 0.457 | 0.760 | 0.427 |
| # of people older than 64 in the household | 0.410 | 0.702 | 0.086 | 0.338 |
| # of household members | 0.969 | 0.724 | 1.064 | 0.724 |
| # of dependent children | 0.537 | 0.952 | 0.761 | 1.051 |
| White | 0.939 | 0.239 | 0.929 | 0.257 |
| *Region of residence* | | | | |
| North-East | 0.045 | 0.207 | 0.042 | 0.200 |
| North West and Merseyside | 0.114 | 0.318 | 0.112 | 0.315 |
| Yorkshire and the Humber | 0.083 | 0.277 | 0.082 | 0.275 |
| East Midlands | 0.073 | 0.260 | 0.074 | 0.261 |
| West Midlands | 0.086 | 0.280 | 0.085 | 0.279 |
| Eastern | 0.091 | 0.288 | 0.095 | 0.293 |
| London | 0.100 | 0.300 | 0.108 | 0.311 |
| South East | 0.136 | 0.342 | 0.144 | 0.351 |
| South West | 0.083 | 0.276 | 0.082 | 0.274 |
| Wales | .0504 | 0.051 | 0.046 | 0.209 |
| Scotland | .1438 | 0.139 | 0.132 | 0.338 |
| *Education (Age left)* | | | | |
| $0-12$ | 0.004 | 0.062 | .0021 | .0460 |
| $13-15$ | 0.344 | 0.475 | .2013 | .4009 |
| $16-18$ | 0.467 | 0.499 | .5622 | .4961 |
| $19-21$ | 0.092 | 0.289 | .1172 | .3217 |
| $22-23$ | 0.060 | 0.237 | .0788 | .2694 |
| $24-27$ | 0.025 | 0.157 | .0318 | .1754 |
| 28 or more | 0.008 | 0.088 | .0067 | .0814 |
| *Education (age left) of the spouse (if present)* | | | | |
| $0-12$ | 0.126 | 0.332 | 0.156 | 0.363 |
| $13-15$ | 0.301 | 0.459 | 0.194 | 0.396 |
| $16-18$ | 0.410 | 0.492 | 0.458 | 0.498 |
| $19-21$ | 0.083 | 0.275 | 0.096 | 0.295 |
| $22-23$ | 0.053 | 0.225 | 0.064 | 0.245 |
| $24-27$ | 0.022 | 0.147 | 0.026 | 0.159 |
| 28 or more | 0.005 | 0.072 | 0.005 | 0.071 |
| Regional activity rate by gender | 0.755 | 0.083 | 0.757 | 0.083 |
| Per capita regional gross value added (£) | 16335.970 | 4633.528 | 16,480.920 | 4,743.404 |
| Variation of per capita regional gross value added | 0.047 | 0.016 | 0.047 | 0.016 |
| *Wave* | | | | |
| 1998 | 0.092 | 0.289 | 0.092 | 0.289 |
| 1999 | 0.100 | 0.300 | 0.102 | 0.303 |
| 2000 | 0.095 | 0.294 | 0.096 | 0.294 |
| 2001 | 0.102 | 0.302 | 0.103 | 0.304 |
| 2002 | 0.108 | 0.310 | 0.109 | 0.311 |
| 2003 | 0.107 | 0.309 | 0.106 | 0.308 |
| 2004 | 0.104 | 0.305 | 0.103 | 0.304 |
| 2005 | 0.104 | 0.306 | 0.104 | 0.306 |
| 2006 | 0.096 | 0.294 | 0.095 | 0.293 |
| 2007 | 0.092 | 0.289 | 0.090 | 0.287 |
| Observations | 399,098 | | 254,402 | |

† Age and age of the spouse are right censored at 80 years.

**Table D.5:** The impact of the reform on co-residential informal caregiving

| | Linear probability model for informal care giving | | Interval regression for hours of informal care giving | |
|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† |
| **After*Scotland ($I_{rt}$)§** | **-0.004** | **0.018**** | **-10.469** | **0.010**** |
| Female | -0.009 | 0.003*** | -19.274 | 0.006*** |
| Age | -0.001 | 0.000*** | -1.330 | 0.000*** |
| Age of the spouse (if present) | 0.001 | 0.000*** | 1.151 | 0.000*** |
| Couple | -0.001 | 0.279 | 18.776 | 0.000*** |
| # of people older than 64 in the household | 0.028 | 0.000*** | 42.062 | 0.000*** |
| # of household members | 0.012 | 0.000*** | 29.430 | 0.000*** |
| # of dependent children | -0.002 | 0.000*** | -8.628 | 0.000*** |
| White | -0.003 | 0.020** | -6.119 | 0.040* |
| *Education (age left) - Reference* $0-15$ | | | | |
| $16-18$ | -0.010 | 0.000*** | -19.477 | 0.000*** |
| 19 or more | -0.015 | 0.000*** | -43.768 | 0.000*** |
| *Education (age left) of the spouse (if present) - Reference* $0-15$ | | | | |
| $16-18$ | -0.026 | 0.000*** | -34.265 | 0.000*** |
| 19 or more | -0.031 | 0.000*** | -56.017 | 0.000*** |
| Regional activity rate by gender | -0.001 | 0.002*** | -1.321 | 0.003*** |
| Per capita regional gross value added (£) | 0.000 | 0.138 | 0.002 | 0.082* |
| Variation of per capita regional gross value added | -0.052 | 0.006*** | -118.491 | 0.007*** |
| *Region of residence - Reference: North-East* | | | | |
| North West and Merseyside | 0.000 | 0.805 | -2.014 | 0.619 |
| Yorkshire and the Humber | 0.000 | 0.913 | -1.994 | 0.627 |
| East Midlands | -0.003 | 0.090* | -9.316 | 0.042** |
| West Midlands | -0.004 | 0.032** | -11.285 | 0.014 |
| Eastern | -0.009 | 0.001*** | -23.769 | 0.000*** |
| London | -0.018 | 0.009*** | -50.977 | 0.004*** |
| South East | -0.016 | 0.000*** | -44.648 | 0.000*** |
| South West | -0.004 | 0.097* | -10.163 | 0.067* |
| Wales | 0.006 | 0.001*** | 10.187 | 0.004*** |
| Scotland | -0.006 | 0.010** | -13.807 | 0.015** |
| *Wave -Reference: 1998* | | | | |
| 1999 | 0.000 | 0.744 | 1.857 | 0.524 |
| 2000 | 0.000 | 0.955 | 1.235 | 0.698 |
| 2001 | 0.001 | 0.658 | 2.602 | 0.434 |
| 2002 | -0.001 | 0.371 | -2.113 | 0.580 |
| 2003 | -0.002 | 0.373 | -2.040 | 0.651 |
| 2004 | -0.003 | 0.182 | -5.162 | 0.334 |
| 2005 | -0.002 | 0.472 | -3.670 | 0.551 |
| 2006 | -0.001 | 0.721 | -1.745 | 0.802 |
| 2007 | -0.001 | 0.657 | -2.544 | 0.748 |
| Constant | 0.056 | 0.000*** | -252.769 | 0.000*** |
| *Average partial effect of the policy* | | | | |
| $\Delta \mathrm{P}(y=1\|z)$ | – | | -0.004 | |
| $\Delta \mathrm{E}(y\|z, y>0)$ | – | | -1.169 | |
| $\Delta \mathrm{E}(y\|z)$ | – | | -0.291 | |
| Observations | 399,098 | | 399,098 | |
| Log-likelihood | – | | -68,873.51 | |
| $\sigma$ | – | | 143.9211 | |
| $R^2$ | 0.0373 | | – | |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. The estimated coefficients of the full set of yearly dummies are not reported for the sake of brevity and are available from the authors upon request.

§ After is equal to 1 if the observation is collected after 2002 and 0 otherwise.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are available upon request.

**Table D.6:** Estimation results of the employment and weekly working equations

| | Linear probability model for being employed | | Linear model for weekly working hours | |
|---|---|---|---|---|
| | Coeff. | $p$-value† | Coeff. | $p$-value† |
| **After*Scotland ($I_{rt}$)§** | 0.007 | 0.140 | 0.410 | 0.050** |
| Female | 0.005 | 0.528 | -10.091 | 0.000*** |
| Age | 0.026 | 0.000*** | 1.723 | 0.000*** |
| Age square | 0.000 | 0.000*** | -0.022 | 0.000*** |
| Couple | 0.075 | 0.000*** | 3.179 | 0.000*** |
| # of people older than 64 in the household | -0.046 | 0.000*** | -2.731 | 0.000*** |
| # of household members | 0.000 | 0.733 | -0.189 | 0.000*** |
| # of dependent kids | -0.075 | 0.000*** | -4.142 | 0.000*** |
| White | 0.113 | 0.000*** | 4.478 | 0.000*** |
| *Education (age left) - Reference* $0-15$ | | | | |
| $16-18$ | -0.010 | 0.000*** | 2.111 | 0.000*** |
| 19 or more | -0.015 | 0.000*** | 5.380 | 0.000*** |
| *Education (age left) of the spouse (if present) - Reference* $0-15$ | | | | |
| $16-18$ | -0.026 | 0.000*** | 0.544 | 0.000*** |
| 19 or more | -0.031 | 0.000*** | -0.835 | 0.000*** |
| Regional activity rate by gender | -0.001 | 0.000*** | 26.407 | 0.000*** |
| Per capita regional gross value added (£) | 0.000 | 0.759 | 0.000 | 0.354 |
| Variation of per capita regional gross value added | -0.052 | 0.143 | 4.877 | 0.026** |
| North West and Merseyside | 0.013 | 0.009*** | 1.009 | 0.000*** |
| Yorkshire and the Humber | -0.005 | 0.370 | 0.438 | 0.044** |
| East Midlands | -0.006 | 0.328 | 0.849 | 0.000*** |
| West Midlands | -0.002 | 0.733 | 0.883 | 0.000*** |
| Eastern | -0.034 | 0.000*** | 0.195 | 0.549 |
| London | -0.014 | 0.455 | 1.321 | 0.116 |
| South East | -0.036 | 0.000*** | 0.264 | 0.533 |
| South West | -0.021 | 0.002*** | -0.289 | 0.312 |
| Wales | 0.025 | 0.000*** | 1.217 | 0.000*** |
| Scotland | -0.002 | 0.729 | 0.657 | 0.028** |
| *Wave -Reference: 1998* | | | | |
| 1999 | -0.006 | 0.092* | 0.276 | 0.067* |
| 2000 | 0.007 | 0.057* | 0.779 | 0.000*** |
| 2001 | 0.017 | 0.000*** | 1.097 | 0.000*** |
| 2002 | 0.018 | 0.000*** | 1.027 | 0.000*** |
| 2003 | 0.022 | 0.000*** | 0.956 | 0.000*** |
| 2004 | 0.029 | 0.000*** | 1.294 | 0.000*** |
| 2005 | 0.027 | 0.000*** | 1.162 | 0.000*** |
| 2006 | 0.028 | 0.000*** | 1.187 | 0.001*** |
| 2007 | 0.032 | 0.000*** | 1.351 | 0.001*** |
| Constant | 0.674 | 0.000*** | 29.602 | 0.000*** |
| Observations | 254,402 | | 254,402 | |
| $R^2$ | 0.109 | | 0.261 | |

*Notes:* *** Significant at 1%; ** significant at 5%; * significant at 10%. The estimated coefficients of the full set of yearly dummies are not reported for the sake of brevity and are available from the authors upon request.

† We report $p$-values robust to heteroskedasticity. Cluster robust $p$-values, $p$-values obtained with and without unrestricted wild cluster bootstrap-$t$ with 2,500 replications and Webb weights are also available upon request.

**Table D.7:** Mean of the dependent variables by gender, education, and age

| | Co-residential informal care giver | | Employment indicator | | Weekly working hours | |
|---|---|---|---|---|---|---|
| | Scotland | England & Wales | Scotland | England & Wales | Scotland | England & Wales |
| *By gender* | | | | | | |
| Men | 0.028 | 0.030 | 0.907 | 0.914 | 38.585 | 39.110 |
| Women | 0.026 | 0.030 | 0.813 | 0.767 | 26.173 | 24.251 |
| *By education* | | | | | | |
| Left education before age 16 | 0.041 | 0.051 | 0.809 | 0.784 | 29.163 | 27.922 |
| Left education before at or later than age 16 | 0.018 | 0.019 | 0.871 | 0.850 | 32.832 | 32.133 |
| *By age* | | | | | | |
| Age is $[25, 55)$ | 0.017 | 0.018 | 0.864 | 0.846 | 32.802 | 32.273 |
| Age is 55 or older | 0.040 | 0.047 | 0.824 | 0.794 | 28.463 | 26.902 |
| *By presence of household members older than 59 (excluding individual $i$)* | | | | | | |
| No | 0.012 | 0.013 | 0.864 | 0.846 | 32.628 | 32.070 |
| Yes | 0.077 | 0.088 | 0.792 | 0.759 | 26.391 | 24.927 |