Labour supply and informal care supply: The impacts of financial support for long-term elderly care*

Bruce Hollingsworth[a], Asako Ohinata[b†], Matteo Picchio[c,d,f], and Ian Walker[f,g]

[a] *Health Economics at Lancaster, Division of Health Research, Lancaster University, United Kingdom*

[b] *Department of Economics, University of Leicester, United Kingdom*

[c] *Department of Economics and Social Sciences, Marche Polytechnic University, Italy*

[d] *Department of Economics, Ghent University, Belgium*

[f] *IZA, Germany*

[g] *Management School, Lancaster University, United Kingdom*

June 7, 2019

Abstract

We investigate the impact of a policy reform, which introduced free formal personal care for those aged 65 and above, on caregiving behaviour. We show that free formal personal 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.

Keywords: Long-term elderly care; ageing; financial support; informal caregiving; difference-in-differences.
JEL classification codes: C21, D14, I18, J14

---

*Asako Ohinata, Bruce Hollingsworth and Ian Walker gratefully acknowledge financial support from the UK Medical Research Council (MR/K022083/1). We wish to thank Vittorio Bassi, Anthony Harris, Annika Herr, Shiko Maruyama, Tom Buchmueller, Ron Harstad and the seminar and conference participants of the 2017 8th Australasian Health Econometrics Workshop (Airlie Beach), the 2017 Essen Health Conference (Essen), the 2017 Joint Research Centre (European Commission, Ispra), the 2017 Royal Economic Society Conference (Bristol), the 2017 Seventh Workshop of the fRDB Fellows and Affiliates (Ancona), the 2016 COMPIE meeting (Milan), and the 2016 57th SIE Annual meeting (Milan) for their comments and suggestions.

†Corresponding author: Department of Economics, University of Leicester, Leicester, LE1 7RH, The United Kingdom. Tel.: +44 116 252 2894. *E-mail address:* ao160@le.ac.uk

1 Introduction

The majority of frail older individuals in OECD countries receive care at home. Families often provide informal personal care, which is non-medical care providing support for daily activities (see Appendix Afor the type of care activities). Some frail individuals also rely on formal care workers for personal care provision. The latter involves payment, which quickly accumulate and pose a significant financial risk. Policy makers have been implementing various measures to provide financial and/or in-kind support to individuals receiving care at home. Building sustainable schemes requires understanding how families respond to such governmental support by substituting informal care with formal care. However, the existing literature has mainly focused on the substitutability between informal home care and institutionalisation whereas evidence on the substitutability between the two types of home care is relatively scarce.

In this paper, we study the effects of the 2002 Scottish Community Care and Health Act (CCHA), which offers in-kind formal personal care support to individuals in need without any means-testing. Using the 1998–2007 UK Family Resources Survey (FRS) 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). 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. In addition, we also study how the policy affected the caregivers' labour supply at the extensive and intensive margins.

Only a handful of studies investigate the effect of governmental support on the informal caregiving behaviour at home. Costa-Font et al. (2018) studies the effect of cash subsidies on informal caregiving and find that the frail individuals increased intergenerational transfers to their family members, who in turn increased their informal caregiving. Arntz and Thomsen (2011) conduct an experiment that offer either in-kind or cash benefits to individuals in six German counties. They find that compared to cash benefits, in-kind benefits induce substitution between informal and formal care although the sample size was limited to 160. Here we build on complementary evidence to these papers by studying the effects of in-kind benefits.

There are two papers that investigate the effect of the 2002 Scottish policy on informal caregiving by using the British Household Panel Survey (BHPS), but they have not reached a consensus on the direction of the policy impact. Bell et al. (2007) look at the immediate effect of the policy, i.e. one-year after the policy implementation, and find no effect. Karlsberg Schaffer (2015) covers a longer time horizon (between 1998 and 2008) and finds a positive impact of the policy on informal caregiving.

This study has several advantages over these two papers. Firstly, our study employs a much larger dataset that includes approximately seven times more caregiver observations. Using the larger sample size and the information included in FRS on the relationships between the care givers and the recipients, we study in detail how the policy impact differs across different groups of families. Secondly, having a large sample allows us to separately study the policy effects among those who provide care to a family member in the same house (i.e. co-residential care) as well as in the different household (i.e. extra-residential care). Since the intensity and the types of care are likely to differ between the two care settings, the response to the governmental support may be different. Lastly, we also study the policy effect on the caregivers' labour supply.

2 Context

Formal personal care costs in the UK prior to 2002 exposed individuals to significant uncertainties. As an example, an individual receiving formal personal care in England in 2001 on average paid £4,742.40 per year, which is more than the annual amount of basic state pension (£3,770) in the same year.

In order to address the financial uncertainty, the Royal Commission on Long-Term Care for the Elderly was set up by the Labour government in December 1997. The resulting 1999 Sutherland Report recommended that formal personal care for those aged 65+ should be provided free of charge after a rigorous need-based assessment is conducted by local authorities.

This recommendation was taken up only by Scotland, who acquired the power to set its own social care policies as the result of the 1999 devolution that transferred part of the policy setting power from Westminster in London to Scotland. However, the rest of UK decided not to adopt the recommendations made by the Sutherland report and continued to charge for formal personal care. The Scottish Executive set up the Care Development Group in January 2001 to investigate on the estimated cost of introducing such a policy. The Bill passed and received Royal Assent on 12 March 2002 to become the 2002 Community Care and Health Act.

CCHA offers in-kind personal care worth up to £145 per week to those receiving care in their own homes. The average weekly amount paid to those at home in 2003 was £80 (National Statistics, 2012). This implies that those living in Scotland on average received £4160 worth of formal personal care in a year.

For those receiving care in nursing homes, the uniform amount of £145 are paid once they qualify for CCHA. Aside from the introduction of CCHA, nursing care home res-

idents were also affected by two additional policies. First, Scottish individuals in care homes were no longer entitled to the Attendance Allowance (AA), which is a non-means-tested weekly benefit for severely disabled people aged 65. AA had been paid out to all UK individuals regardless of the location of residence as long as the local authority assesses as being in need. Secondly, nursing care (NC) allowances were introduced throughout the UK between October 2001 and October 2002. NC is medical care offered by registered nurses. Individuals that receive care in their own homes have always received this care for free at the point of delivery. In contrast, those in residential care homes needed to cover the cost. The NC allowance was introduced in order to eliminate the disparity in the amount of nursing care cost across the choice of residence (see Ohinata and Picchio (2019) for more information). These additional changes may have encouraged the elderly to move into nursing homes. Figure 1 presents the trends in the number of care home residents between 2000 and 2007 in England and Scotland. The number of residents both in England and Scotland had been relatively stable. Therefore, this suggests that the additional financial support for care home residents did not induce individuals to enter nursing homes.

2.1 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.

We have several outcomes of interest.

- An indicator variable that equals 1 if the individual looked after an adult (family members or friends/neighbours)
- An interval-coded variable measuring the number of hours per week of informal care given to an adult
- An indicator variable that equals 1 if the individual is employed
- The number of weekly working hours

The first and the third outcomes study the effect of the policy on the extensive margin whereas the second and the fourth outcomes investigate the impact on the intensive margin. In addition, the first two outcomes are further divided into co-residential and extra-residential caregiving (see Appendix B for more information).

Our analysis spans from 1998 since all the relevant dependent and independent variables are available only from this year. We employ data until 2007, since the 2008 financial crisis may have led to asymmetric impacts across regions on individual time endowments and their labour supply. We exclude Northern Ireland from our analysis because FRS does not collect data from the area before the 2002/2003 survey. We further restrict the sample to exclude those younger than 25 to reduce the chance of including those who are still in education. After eliminating these observations as well as individuals with missing observations, the final sample size is 399,098. 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 1 presents descriptive statistics of the outcome variables 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 2, because of its interval-coded nature.

2.2 The econometric model

We employ a difference-in-differences (DD) estimator to identify the policy effects in Scotland (treatment group) in comparison to the rest of the UK (control group). Using the month and year of interview information available in our data, we define the after policy introduction period to be March 2002, which is the month that the bill passed.

Our empirical evaluation is in a repeated cross sections framework. We specify the following model for a generic outcome variable y for the ith 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), household composition and a set of time-varying regional-level variables.
- $\boldsymbol{\gamma}_r$ is a set of regional fixed effects (regional dummies).
- $\boldsymbol{\phi}_t$ is a set of time fixed effects. The unit of time is the tax year, i.e. from the 6th April until the next year 5th April, since the post-introduction period more closely

corresponds to the beginning of the 2002 tax year.

- 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 δ_{DD} is the effect of the introduction of free personal care in Scotland on caregiving.
- ε_{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 σ^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 σ) 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.

2.3 Identification assumptions

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

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 if the the 2002 reform was not implemented.

We check the validity of Assumption 1 by comparing the trends in care supply of England-Wales versus Scotland. We estimate Eq. 3, which regresses each outcome variable against all the covariates discussed earlier together with a set of time dummies whose coefficients are allowed to be different between Scotland and England-Wales.

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

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.

The estimated coefficients on these dummy variables are plotted in Figure 3. In Panels (a), (d) and (g) of Table 2, we present results from tests to verify whether these sets of trends are statistically parallel to each other. To do this, 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.

Panels (b), (e), and (h) in Table 2 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. By doing so, it is as if we are pretending that the 2002 Scottish policy was implemented prior to 2002. The insignificant test results confirms the parallel trends assumption.

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 which each the North (North-West, North-East, and Yorkshire and the Humber), the Centre (Wales, West Midlands, and East Midlands), and the South (South-West, South-East, Eastern, and London) are considered as a treated region, respectively. Since regions outside of Scotland did not implement the policy, the estimated 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.

Since the progression of the bill was closely followed by the UK media and received wide coverage (e.g. BBC, 2001; Inman, 2002), it is likely that households in Scotland were aware of the policy even prior to its implementation in July 2002. 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 Appendix E.

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.

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 (2019), 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.

3 Estimation results

3.1 The impact of the reform on caregiving behaviour

Panel (a) of Table 3 reports the estimated baseline policy effect for the probability and the weekly hours of co-residential caregiving.[1][2] 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.

[1] Table F.3 in Appendix F reports descriptive statistics of all the covariates used in the econometric analysis

[2] Table F.4 in Appendix F present the coefficient estimates of all the covariate included in these regressions.

The impact of the 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 3. 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 from the estimated coefficients. Therefore, we report at the bottom of row (a) the marginal effects of the policy conditional and unconditional on the number of hours 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. Conditional on giving care, 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 larger than zero is in line with the one from the linear probability model and it is equal to -0.4 percentage points.[3]

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. 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 3, 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 3). 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.[4] This is due to the fact that informal carers may have

[3]The increase in the demand for formal care after 2002 may have increased the average price of care in Scotland. If this were the case, our estimates would present the lower bound (i.e. closer to zero than would have been in the absence of the policy). See Appendix C for more discussions.

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

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. In panel (d) of Table 3 , we restrict the dependent variable to equal to one only when co-residential care is given to individuals aged 65 or older. The estimate indicates that the policy reduced the probability of caregiving by 0.2 percentage points and the hours of care by approximately 0.18 hours.

To further investigate how co-residential caregiving behaviour changed close to the age 65 cut off point, we also present additional results for those providing care to individuals aged 60 and above. From panel (e) of Table 3, 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 the reform, in relative terms the reduction amounts to 17.8%, larger than the one from the baseline model. These results suggest that caregivers changed the caregiving patterns even before the frail individuals became eligible to benefit from the policy. One potential explanation for this finding is that caregivers may have decided to rely on formal care as the lifetime cost of formal care decreased after 2002.

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.[5] Our data suggests that the overwhelming majority of extra-residential caregiver is looking after their parents living in different households. Table 4 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.

One possible explanation for the finding 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.

3.2 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

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

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 5 displays the estimation results of the equations for the employment status and the number of weekly working hours.[6] We 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.

3.3 Heterogeneity of the reform effects across caregivers

Table 6 reports summary statistics of the outcome variables for co-residential caregiving and labour force participation by gender, age, and education. These statistics reveal that men and women are equally likely to give co-residential informal care and be in employment, but men are more likely to work longer hours. In addition, individuals who left education before age 16 as well as those aged 55 and above are more likely to give co-residential informal care. These individuals are also slightly less attached to the labour market.[7]

Table 7 reports the heterogeneous effects on co-residential caregiving behaviour and labour supply. 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 suggest that the policy effects are similar in magnitude across gender. This result is perhaps a little surprising, because we often have the impression that women are more likely to provide informal care compared to men. However, as shown earlier in Table 6, equal proportions of men and women in our sample provide co-residential care. Approximately 81% of this is given to spouses. Since 87% of spousal co-residential care is offered by a single informal caregiver, the policy could have provided a major relief for these informal caregivers from the care responsibilities. Turning to the heterogeneous policy effect on working behaviour, we find

[6] All the coefficient estimates can be found in Table F.5 in Appendix F.

[7] We did not find any significant heterogeneous effects on extra-residential caregiving. Therefore, we focus exclusively on the effects on the co-residential care in the proceeding analysis.

some evidence of differences in the effects of the policy across gender. More specifically, men were more likely to increase labour force participation as well as working hours.

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 the less educated. 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,[8] 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. [9]

4 Conclusions

This paper studies the impact of the Scottish Care and Health Act 2002, which introduced in-kind subsidies for 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 co-residential informal caregiving by 0.4 percentage points, which amounts to a decrease of about 12.9% relative 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 among individuals older than 55: 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. We find that those receiving extra-residential care were more reliant on formal care than co-residential care recipients. Therefore, the policy may have simply subsidised the cost of formal care without changing the composition of informal and formal care.

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

[9] We further conduct various sensitivity analysis. The results are included in Appendix E.

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.

References

Arntz, M. and S. L. Thomsen (2011). Crowding out informal care? evidence from a field experiment in germany. *Oxford Bulletin of Economics and Statistics 73*(3), 398–427.

BBC (2001, 24 September). *Free care deal for elderly people*. BBC. Retrieved from http://news.bbc.co.uk/1/hi/scotland/1559427.stm.

Bell, D. N., A. Bowes, and A. Heitmueller (2007). Did the introduction of free personal care in Scotland result in a reduction of informal care? WDA-HSG Discussion Paper No. 2007-3.

Cameron, A. C., J. B. Gelbach, and D. L. Miller (2008). Bootstrap-based improvements for inference with clustered errors. *Review of Economics and Statistics 90*(3), 414–427.

Cameron, A. C. and D. L. Miller (2015). A practitioner's guide to cluster-robust inference. *Journal of Human Resources 50*(2), 371–372.

Costa-Font, J., S. Jiménez-Martín, and C. Vilaplana (2018). Thinking of incentivizing care? The effect of demand subsidies on informal caregiving and intergenerational transfers. IZA DP No. 11774.

Department of Health (2003). *Personal Social Services expenditure and unit costs: England: 2003-2004*. United Kingdom, Government.

Department of Health (2004). *Personal Social Services expenditure and unit costs: England: 2004-2005*. United Kingdom, Government.

Department of Health (2005). *Personal Social Services expenditure and unit costs: England: 2005-2006*. United Kingdom, Government.

Department of Health (2006). *Personal Social Services expenditure and unit costs: England: 2006–2007*. United Kingdom, Government.

Department of Health (2007). *Personal Social Services expenditure and unit costs: England: 2007-2008*. United Kingdom, Government.

Duranton, G. and V. Monastiriotis (2002). Mind the gaps: The evolution of regional earnings inequalities in the U.K., 1982–1997. *Journal of Regional Sciences 42*(2), 219 – 256.

Hatton, T. and M. Tani (2005). Immigration and inter-regional mobility in the UK, 1982–2000. *Economic Journal 115*(507), F342–F358.

Inman, P. (2002, 23 March). *Free and easy for the Scots*. The Guardian. Retrieved from http://www.theguardian.com/society/2002/mar/23/longtermcare.housinginretirement3.

Karlsberg Schaffer, S. (2015). The effect of free personal care for the elderly on informal caregiving. *Health Economics 24*(S1), 104–117.

Liang, K.-Y. and S. L. Zeger (1986). Longitudinal data analysis using generalized linear models. *Biometrika 73*(1), 13–22.

MacKinnon, J. and M. Webb (2017). Wild bootstrap inference for wildly different cluster sizes. *Journal of Applied Econometrics 32*(2), 233–254.

National Statistics (2002). *Community Care Statistics 2001: Home care services for adults, England*. National Statistics, Department of Health, London.

National Statistics (2013). *Care home census 2013: Statistics on adult residents in care homes in Scotland*. Information Services Division Scotland, Edinburgh.

National Statistics, Scotland (2018). *Free personal and nursing care, Scotland, 2006–2007*. The Scottish Government.

NHS (2006). *Community care statistics 2006:Supported residents (Adults), England*. The NHS information centre for health and social care.

NHS (2008). *Community care statistics 2008:Supported residents (Adults), England*. The NHS information centre for health and social care.

Ohinata, A. and M. Picchio (2019). Financial support for long-term elderly care and household saving behaviour. *Oxford Economic Papers*, retrieved from https://academic.oup.com/oep/advance–article/doi/10.1093/oep/gpy073/5308378?guestAccessKey=cd89a270–35ac–4cfa–bab9–67901a486f2d.

Webb, M. D. (2014). Reworking wild bootstrap based inference for clustered errors. Queen's Economics Department Working Paper No. 1315.

Tables and Figures

Table 1: 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.

Table 2: 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[ℌ]	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[ℌ]	-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[ℌ]	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 (more discussions on the statistical inferences can be found in Appendix D).

[ℌ] 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.

Table 3: 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	
σ			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	
σ	–		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	
σ	–		122.671	
Log-likelihood	–		-14,892.106	
R^2	0.033		–	
(d) Relation with the care recipient: 65 or older				
After*Scotland (I_{rt})§	-0.002	0.055*	-11.434	0.045*
Average partial effect of the policy				
$\Delta\mathrm{P}\,(y=1\|z)$	–		-0.002	
$\Delta\mathrm{E}\,(y\|z, y>0)$	–		-1.000	
$\Delta\mathrm{E}\,(y\|z)$	–		-0.185	
σ	–		138.862	
Log-likelihood	–		-37,840.127	
R^2	0.067		–	
(e) 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	
σ	–		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 (more discussions on the statistical inferences can be found in Appendix D).

Table 4: 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	
σ	–		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 (more discussions on the statistical inferences can be found in Appendix D).

Table 5: 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 (more discussions on the statistical inferences can be found in Appendix D).

Table 6: 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

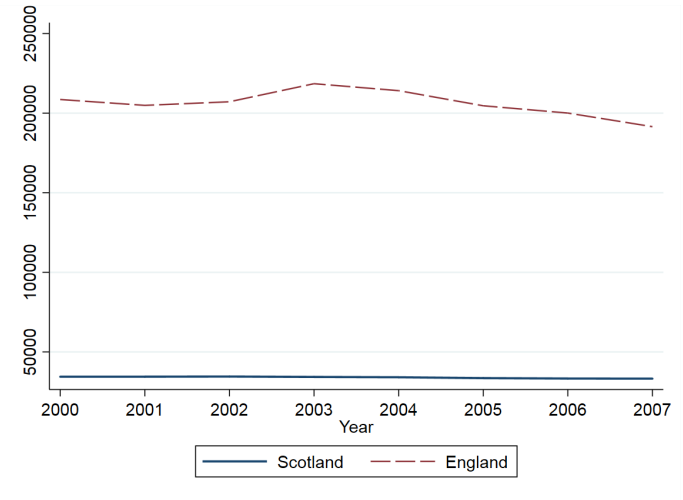
Table 7: Heterogeneity of the reform effect on co-residential caregiving and labour supply

	Linear probability model for co-residential informal caregiving		Interval regression for hours of co-residential caregiving		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

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.

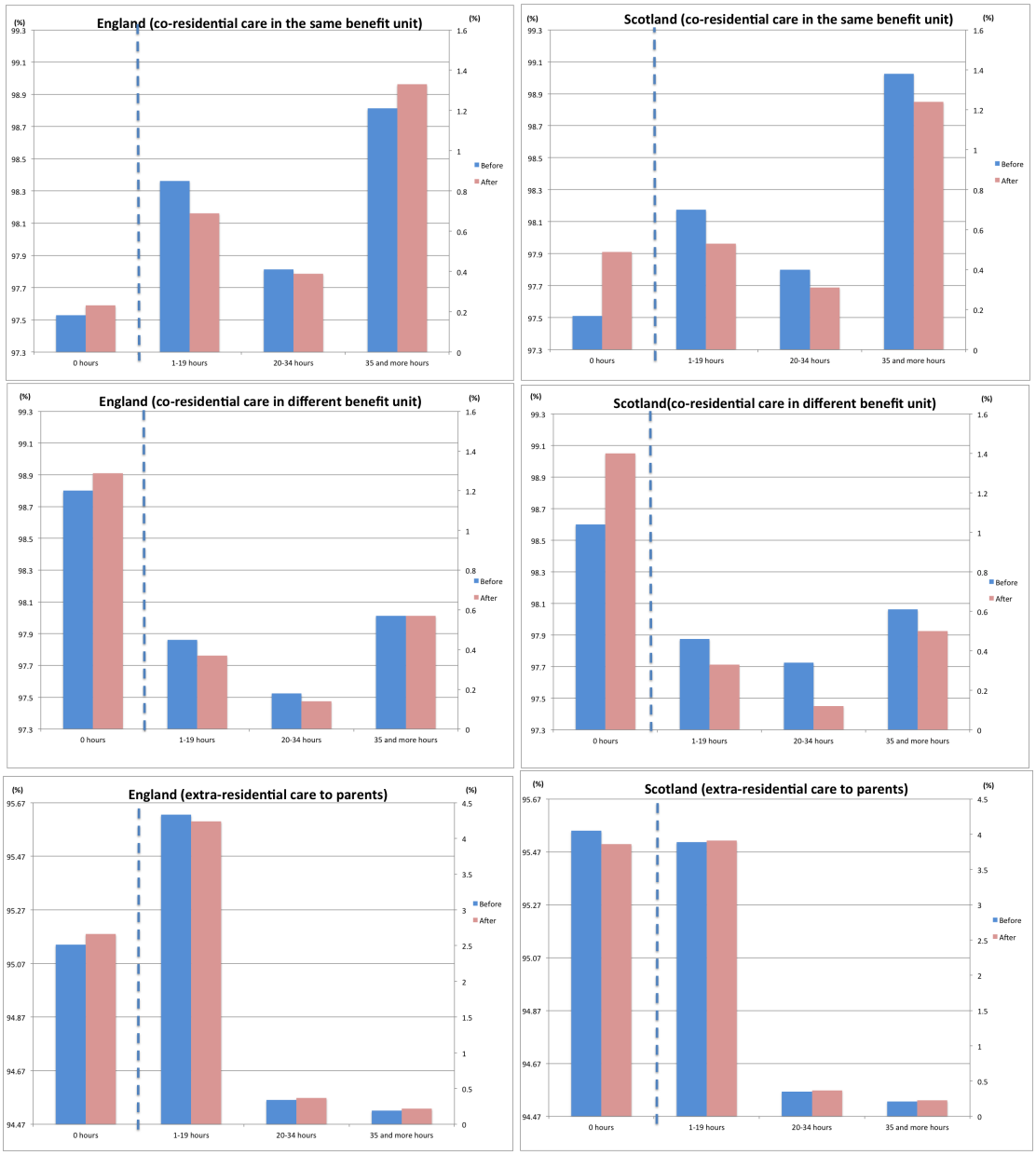
† We report p-values robust to heteroskedasticity (more discussions on the statistical inferences can be found in Appendix D).

Figure 1: Number of nursing home residents in England and Scotland



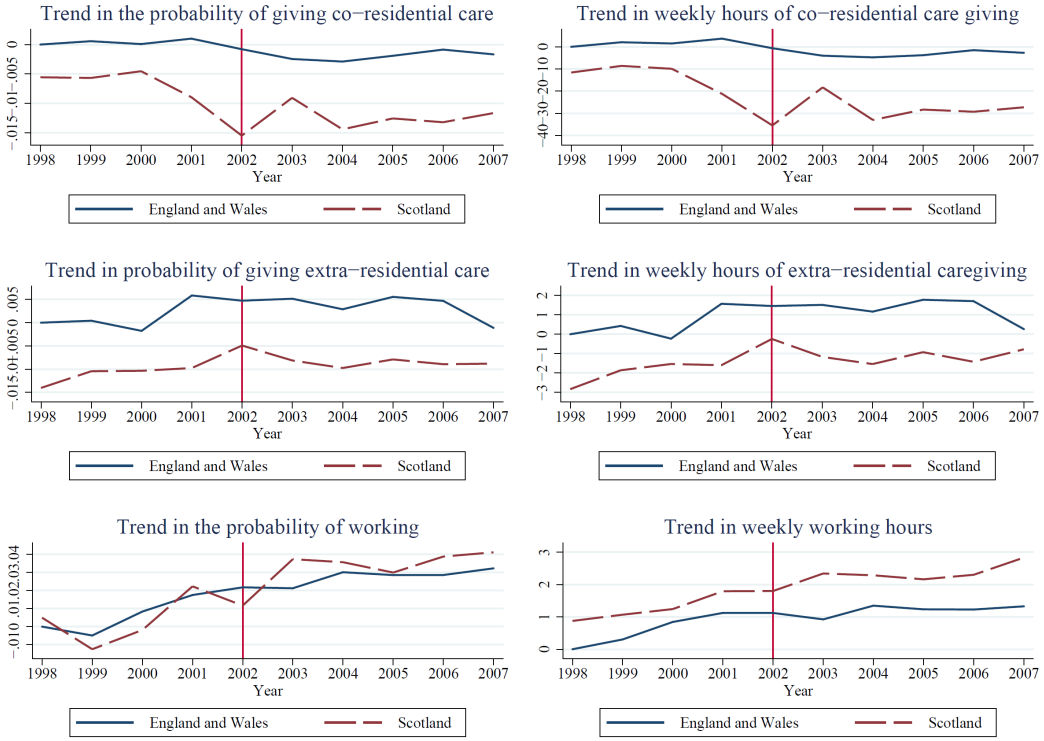
Sources: National Statistics (2002), NHS (2006), NHS (2008) for England. National Statistics (2013) for Scotland.
Notes: In this figure, we report the trends in the number of nursing home residents in England and Scotland between 2000 and 2007. Due to the data limitations, trends for the other regions are not included in the figure.

Figure 2: Histograms of hours of care



The above figures show the distributions of co-residential and extra-residential 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.

Figure 3: 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 F.3. The reference time dummy is 1998 for England-Wales.

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 Information on the dependent variables

In Section 2.1, we discussed that we employ several dependent variables.

- An indicator variable that equals 1 if the individual looked after an adult (family members or friends/neighbours)
- An interval-coded variable measuring the number of hours per week of informal care given to an adult
- An indicator variable that equals 1 if the individual is employed
- The number of weekly working hours

The first and the third variables are both dummy variables whereas the number of hours per week of informal caregiving is an interval-coded variable. When we study the impacts on the hours of informal caregiving 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 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.

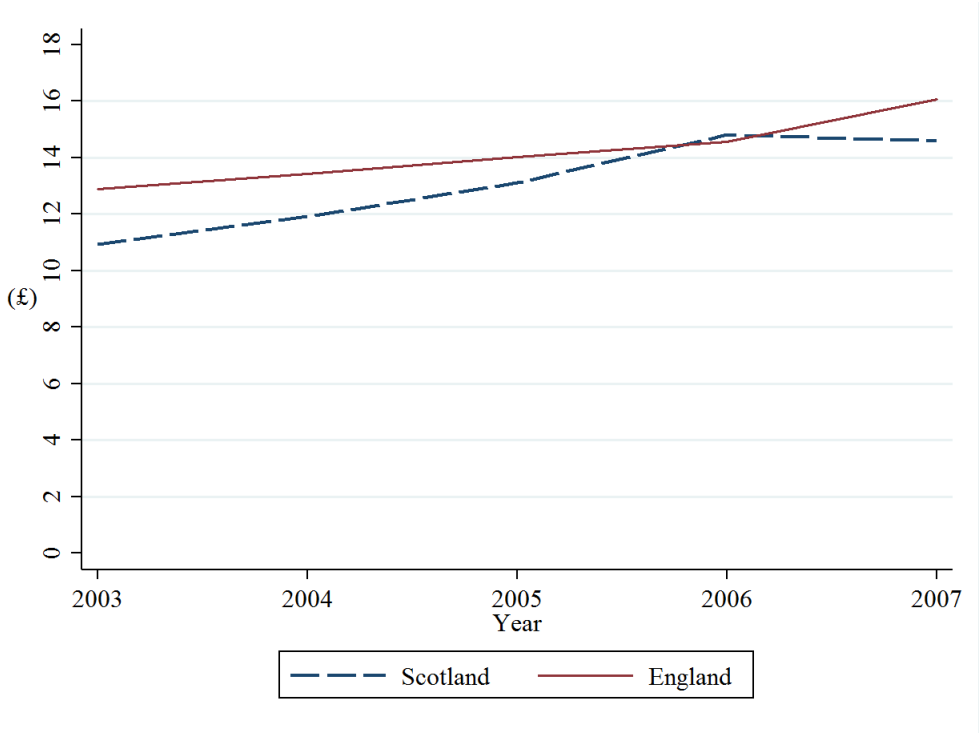
The number of weekly working hours is a continuous variable. Since there is a mass of individuals (16.1%) with zero weekly working hours, we estimate the equation for the weekly working hours with a Tobit model. The linear model and the Tobit version deliver very similar estimation results and marginal effects.

C Price of care

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. 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 different methods of calculation adopted 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.

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 Information on the statistical inferences

In our DD application, the identification of the policy effect is based on the 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).[10]

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 tend 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

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

type II errors.[11] 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 standard errors obtained without controlling for clusters almost always returned values that are in between the two wild cluster standard errors. Two other p values, i.e., the wild cluster bootstrap procedure by Cameron et al. (2008) with unrestricted and restricted residuals are available from the corresponding author on request.[12]

E 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 E.2). As discussed in Section 2.3, 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.

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). From panel (b) of Table E.2, we observe that the policy effects are only marginally different from those of the benchmark estimates in Tables 3 and 5.

Finally, 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 E.2 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.

[11] 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.

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

Table E.2: Robustness checks of the reform effect on caregiving and labour force participation

	Linear probability model for co-residential caregiving		Interval regression for hours of co-residential caregiving		Linear probability model for extra-residential caregiving		Interval regression for hours of extra-residential caregiving		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

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 (more discussions on the statistical inferences can be found in Appendix D).

F Other tables

Table F.3: 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 F.4: The impact of the reform on co-residential informal caregiving

	Linear probability model for informal caregiving		Interval regression for hours of informal caregiving	
	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	
σ	–		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 (more discussions on the statistical inferences can be found in Appendix D).

Table F.5: 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 children	-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 (more discussions on the statistical inferences can be found in Appendix D).